AISAM

Associazione Italiana di Scienze dell'Atmosfera e Meteorologia

Conference Agenda and Abstracts

5° Congresso Nazionale AISAM

Lecce 5 – 8 febbraio 2024

UNIVERSITÀ DEL SALENTO

L'Università dei due mari

CNR ISAC

Sponsor:

VAISALA

Radarmeteo
Professional weather services

Hypermeteo
Climate & weather grids

EURELETTRONICA ICAS
soluzioni per la meteorologia

GILL LM
LOMBARD & MAROZZINI

Hortus
Monitoring Solutions & Software Applications

Trusted weather observations for a sustainable future

With 85 years of experience and customers in more than 170 countries, Vaisala is the gold standard in providing the most reliable and accurate weather information to enable weather resilient nations.

Learn more at
vaisala.com/capacitybuilding

VAISALA

Organizzazione:
Associazione Italiana di Scienze dell'Atmosfera e Meteorologia
Università del Salento
Istituto di Scienze dell'Atmosfera e del Clima, Consiglio Nazionale delle Ricerche

Chair:
Piero Lionello (Università del Salento)
Roberta D'Agostino (CNR-ISAC)

Comitato Scientifico:
Piero Lionello (Università del Salento)
Roberta D'Agostino (CNR-ISAC)
Alice Crespi (EURAC)
Angelo Finco (Università Cattolica)
Claudio Cassardo (Università di Torino)
Ferdinando De Tomasi (Università del Salento)
Ilaria Ferrando (Università di Genova)
Mario Marcello Miglietta (Università di Bari)
Micaela Menegotto (ARPA Puglia)
Paola Faggian (RSE)
Paola Mercogliano (CMCC)
Paolo Ruggieri (Università di Bologna)
Pierina Ielpo (CNR-ISWAC)
Riccardo Buccolieri (Università del Salento)
Valerio Capecchi (LaMMA)

Comitato Organizzatore:
Riccardo Buccolieri (Università del Salento)
Roberta D'Agostino (CNR-ISAC)
Ferdinando De Tomasi (Università del Salento)
Pierina Ielpo (CNR-ISAC)
Piero Lionello (Università del Salento)
Mario Marcello Miglietta (Università di Bari)

Martedì, 06/Feb/2024

8:30am - 9:30am

Registrazione
Location: **Poster area, Atrio, Edificio 5, Studium 2000, Università del Salento**

9:30am - 10:00am

Apertura ufficiale
Location: **Session room, Aula 7, Edificio 6, Studium 2000, Università del Salento**
Session Chair: **Piero Lionello**
Session Chair: **Roberta D'Agostino**
Benvenuto a nome dei Chairs Dott.ssa Roberta D'Agostino & Prof. Piero Lionello Intervento Prorettrice Università del Salento Prof.ssa Maria Antonietta Aiello Intervento responsabile di sede CNR ISAC Dott.ssa Piera Ielpo Saluto da parte delle istituzioni, Comune di Lecce Benvenuto da parte del comitato organizzatore, Prof. Marcello Miglietta Ringraziamento da parte del Comitato Scientifico Intervento Presidente AISAM Introduzione ai lavori Dott.ssa Roberta D'Agostino

10:00am - 11:00am

PROCESSI I
Location: **Session room, Aula 7, Edificio 6, Studium 2000, Università del Salento**
Session Chair: **Claudio Cassardo**.

10:00am - 10:15am

The relationships between environmental parameters and storm observations are not climate-change invariant. (INVITED) - WITHDRAWN

Agostino Manzato, Gabriele Fasano, Andrea Cicogna, Francesco Sioni, Arturo Pucillo
OSMER – ARPA FVG, Via Natisone 43, 33057 Palmanova (UD)

For climate models, forecasting environmental parameters is easier than explicitly predicting storm activity, including lightning flashes, hail, and accumulated convective rainfall. Often, a statistical relationship describing environmental parameters that favor storm occurrence or intensification is identified based on past data and then applied to future environmental scenarios.

In this study, numerous environmental parameters/instability indices are derived from radiosounding observations, sampling the atmosphere above Northeastern Italy during the convective seasons from 1992 to 2022. For instance, the temperature shows an increase of approximately 0.53°C every 10 years (as average across different mandatory levels), while the precipitable water exhibits a positive trend of about 13% per degree Celsius (with the saturation vapor pressure increasing by an average of 7.7% per degree Celsius). Most of the examined indices, particularly those linked to water content, wind shear and potential instability, demonstrate a noticeable upward trend that could potentially favor the formation and intensification of storms, hail, and rainfall. However, upon studying corresponding local storm-related observations, an equivalent trend is not clearly evident. Instead, mostly statistically non-significant trends are discovered.

In conclusion, the relationships between environmental parameters and observed convective events are not climate-change invariant. This discrepancy arises because the development of severe storms in NE Italy is a much more complex phenomenon, and simple statistical relationships with environmental parameters fail to describe it adequately. This sheds new light on the perspective of better understanding global warming concerning future storms and their effects.

10:15am - 10:30am

Characterisation of the flow dynamics in the Roughness Sublayer within and above a dense Amazonian Forest

Daniela Cava[1], Luca Mortarini[2], Daiane Brondani[2], Umberto Giostra[3]
[1]CNR-ISAC, Lecce (Italy); [2]CNR-ISAC, Turin (Italy); [3]Università degli Studi di Urbino 'Carlo Bo', Urbino (Italy)

The impact of atmospheric stability on the flow dynamics within the roughness sublayer (RSL) and the influence on it by the processes in the overlying atmosphere are investigated using measurements collected at the Atmospheric Tall Tower Observatory (ATTO) in the Amazon. Observations were taken at seven levels within and above the forest along an 81-meter and a 325-meter towers allowing a unique investigation of the vertical evolution of the turbulent field in the RSL and in the surface layer above it. The vertical structure of the turbulent flow and the evolution of the mixing-layer type coherent structures (CS) are investigated in five stability regimes defined according to the turbulent fluxes' behavior. CS are identified using an original method based on a non-linear fit of the 5-min autocorrelation function of the turbulent variables with a decaying, oscillating exponential function. The oscillating frequency of the fitting function is associated to the most energetic frequency in the spectrum and hence to the characteristic time scale of the coherent vortices. The shear length scale at the canopy top together with the CS time and separation length scales are evaluated to determine the influence of stability on the RSL and to verify the applicability of the mixing layer theory in stability conditions far from neutrality. Original parameterizations of these parameters are proposed.

The definition of an intense stable regime allows the identification of a peculiar condition characterized by low-wind and weak coherent structures confined close to the canopy top and producing negligible transport. Submeso motions dominate the flow dynamics in this regime both above and inside the RSL. Multiresolution analysis highlights the ability of submeso motions to propagate inside the canopy and to modulate the exchange, particularly of scalars, fully driving a large positive CO2 flux observed inside the forest in the intense stable regime.

10:30am - 10:45am

Misure dei flussi di O3, NOx e CO2 su suolo forestale: messa a punto di un sistema per la misura e primi risultati

Davide Plebani, Angelo Finco, Riccardo Marzuoli, Giacomo Gerosa
Università Cattolica del Sacro cuore, Italy

Grazie alla realizzazione e all'implementazione di un sistema di camere dinamiche per la misura degli scambi gassosi tra suolo e atmosfera è stato possibile misurare in maniera continuativa i flussi orari di O_3, NOx e CO_2 su suolo forestale. Le misure, effettuate tra il 14 maggio e il 19 luglio 2023, sono state condotte presso la Riserva Naturale di Bosco Fontana (Marmirolo, MN), un querco-carpineto dotato di un ricco sottobosco e abbondante lettiera.

La misura simultanea dei flussi di scambio ha evidenziato che le emissioni di ossido nitrico (NO) dal soprassuolo forestale di Bosco Fontana sono state mediamente molto più alte dei valori presenti in letteratura (con una emissione media pari a 3.1 ± 1.4 nmol NO m^{-2} s^{-1} per l'intero periodo di campionamento). Due possibili cause per queste alte emissioni di NO sono state identificate nell'apporto di azoto dai campi agricoli che circondano la Riserva Naturale e nella presenza di una abbondante lettiera in decomposizione; le emissioni di NO sono inoltre aumentate significativamente dopo abbondanti precipitazioni. Il flusso depositivo di O3 ha mostrato un valore medio di -1.5 ± 0.4 nmol O_3 m^{-2} s^{-1} con un massimo nelle ore centrali della giornata pari a -2.8 nmol O_3 m^{-2} s^{-1}. La resistenza alla deposizione di O_3 (Rb_{soil} + R_{soil}) è stata in media pari a 250 ± 80 s m^{-1}, valori di inferiori a quelli calcolati in altri studi su suoli forestali. Per quanto riguarda le deposizioni di NO_2 esse sono state mediamente pari a -0.5 ± 0.2 nmol NO_2 m^{-2} s^{-1}, con valori della resistenza alla deposizione compresi tra 400 e 600 m s^{-1} e con un massimo nella seconda parte del pomeriggio. Le emissioni di CO_2 sono state pari a 8.0 ± 2.2 mmol CO_2 m^{-2} s^{-1}, valore in linea con altri presenti in letteratura, mostrando una decrescita con il diminuire del contenuto idrico del suolo. Il sistema di misura sviluppato si è mostrato adeguato alla misura dei flussi di gas reattivi e non da un suolo forestale, questo sistema permetterà campagne di misura di lungo periodo per migliorare la comprensione degli scambi gassosi intra-canopy.

10:45am - 11:00am

Droplet fate in a cough puff

Paolo Martano
CNR ISAC, Italy

The dynamic and thermodynamic evolution of droplets of size range characterizing a cough is analysed using basic equations of motion, and coupled to the evolution of a spherical cloud puff in which they are supposed to be expired. It is found that the maximum contamination range of the emitted droplets is controlled by two different mechanisms: surface evaporation and inertia-gravitational settling, with a switching threshold around few tens of micron for the initial droplet radius. For the smallest droplets the environmental conditions (temperature and humidity) are found to be very effective in determining the contamination range even for weak entrainment in the cloud puff. This last fact could be of some relevance in the seasonal behaviour of air-borne epidemics.

11:00am - 11:30am

Coffee Break
Location: **Poster area, Atrio, Edificio 5, Studium 2000, Università del Salento**

11:30am - 12:45pm

PROCESSI II
Location: **Poster area, Atrio, Edificio 5, Studium 2000, Università del Salento**
Session Chair: **Mario Marcello Miglietta**
Session Chair: **Claudio Cassardo**

11:30am - 11:45am

Studio del flusso turbolento di particelle in ambiente suburbano polare (Fairbanks, Alaska)

Stefano Decesari[1], Antonio Donateo[1], Federico Scoto[1,3], Gianluca Pappaccogli[2], Francesca Lucia Lovisco[1,3], Maurizio Busetto[1]
[1]Institute of Atmospheric Sciences and Climate (ISAC), National Research Council of Italy (CNR), Italy; [2]Department of Biological Sciences and Technologies, University of Salento, Italy; [3]3Joint Research Center – ENI-CNR "Aldo Pontremoli", Italy

La qualità dell'aria in Artico costituisce un problema a lungo sottovalutato. Le condizioni di forte stabilità atmosferica associate ad elevate emissioni dovute al riscaldamento domestico e alla produzione di energia portano all'accumulo di inquinanti in atmosfera. In particolare, gli aerosol rappresentano inquinanti prioritari in tali ambienti e il loro comportamento nello strato limite invernale dell'Artico non influisce solo sulla qualità dell'aria, ma determina anche la deposizione sulle superfici nevose o di ghiaccio, portando a modifiche chimiche e fisiche nel manto nevoso. L'obiettivo del presente lavoro è analizzare lo scambio turbolento di particelle tra la superficie innevata e l'atmosfera in un sito urbano di background a Fairbanks (Alaska) nell'ambito dell'esperimento internazionale ALPACA (Alaskan Layered Pollution And Chemical Analysis). Le osservazioni sul campo sono state effettuate dal 26 gennaio al 17 febbraio 2022 presso il sito suburbano di UAF Farm situato alla periferia nord-ovest della città. Il raffreddamento superficiale ha comportato gradienti di temperatura superficiale fino a 10 °C in 10 m dal suolo. Il sistema di *eddy covariance* utilizzato per la misura dei flussi si basa su un contatore di particelle a condensazione (CPC) in grado di misurare le particelle ultrafini (UFP - 5 nm < dp < 1 µm) e un contatore ottico di particelle (OPC) per valutare i flussi di particelle nella moda di accumulo (ACC - 0,25 < dp < 0,7 µm) e quasi-coarse (Q-CRS - 0,8 < dp < 3 µm). Variazioni nelle condizioni di stabilità atmosferica sono risultati associati sia a fenomeni emissivi che deposizionali di aerosol. I valori mediani della velocità di deposizione sono 0.59, 0.35 e 2.67 mm s^{-1} per UFP, ACC e QCRS.

Sono stati determinati anche flussi di massa dipendenti dalle dimensioni delle particelle per questo set di dati ed è stata effettuata una comparazione con le deposizioni secche sul manto nevoso.

11:45am - 12:00pm

Can a Supercell Storm Generate a Meteotsunami? A Case Study from the Adriatic Sea in July 2023

Antonio Ricchi[1], Pierpaolo Falco[2], Francesco Memmola[2], Alessandro Coluccelli[2], Maurizio Brocchini[2], Sara Corvaro[2], Pierluigi Penna[3], Rossella Ferretti[1]

[1]University of L'Aquila/CETEMPS, Italy; [2]University of Marche; [3]IRBIM-CNR

In the afternoon of July 22, 2023, a very intense thunderstorm developed over the central Po Valley. It quickly cross the Adriatic sea traveling from the center of the Po Valley to the Croatian coast, moving in the direction northwest-southeast. The thunderstorm speed ranged between 50 and 80km/h, with a downdraft exceeding 100 km/h, wind gust up to 120 km/h, which led to the formation of intense hailstorms with hail larger than 8 cm. The pressure difference between the front and central regions of storm, reached 6 hPa, with peaks up to 10 hPa. As the supercell moved towards the coast, the combined effects of the downdraft and the pressure variation, along with the storm's speed, likely triggered a meteotsunami. Both amateur evidences and instrumental observations showed the propagation of a wave along the Adriatic coast, from North to South, with an amplitude of about 40 cm and a period of approximately 20 minutes. This phenomenon was observed from Ravenna (where the stormcell moves from land to sea) to Ancona, San Benedetto del Tronto, and Ortona with a propagation speed comparable with the storm speed thus, in good agreement with a possible Proudman resonance. Physical analysis and numerical simulations of the atmosphere and ocean were performed using numerical models: WRF (Weather Research and Forecasting System), ICON (Icosahedral Numerical Model), and ROMS (Regional Oceanographic Modeling System), coupled with SWAN (Simulating Waves in Nearshore) at 1 km horizontal resolution. The atmospheric results accurately reproduced the storm's structure and evolution. The coupled ROMS and SWAN model was performed to assess the individual impacts of the downdraft, the vertical component of the downdraft, the pressure surge, and the overall storm surge. This work presents the outcomes and key factors contributing to the generation and amplification of this phenomenon.

12:00pm - 12:15pm

Valutazione degli effetti diretti e indiretti dell'aerosol su eventi alluvionali in Liguria

Francesco Ferrari[1,4], Umberto Rizza[2], Mauro Morichetti[2], Federico Cassola[3], Mario Marcello Miglietta[2], Andrea Mazzino[1,4]

[1]Università di Genova, Italy; [2]CNR-ISAC, Italy; [3]ARPAL, Italy; [4]INFN sezione di Genova, Italy

La Liguria è spesso soggetta a precipitazioni particolarmente intense che frequentemente si traducono in eventi alluvionali. Qui, durante gli ultimi anni, sono stati registrati diversi record italiani in termini di intensità di precipitazione. Ne sono un esempio i 181 m/h durante l'alluvione del 4 Novembre a Genova o gli 884 mm/24h il 21 Ottobre 2021 a Rossiglione.

Quasi tutti gli eventi alluvionali che si registrano sulla regione originano da una configurazione sinottica comune, caratterizzata dalla presenza di un profondo minimo di pressione ad ovest della Liguria e una forte alta pressione di blocco sull'Est Europa. Tale configurazione è spesso responsabile per l'innesco di intensi sistemi convettivi autorigeneranti sul mar Ligure, che, nei casi in cui l'alta pressione di blocco sia sufficientemente forte da impedire la naturale evoluzione verso est del sistema di bassa pressione, possono diventare semi-stazionari e sfociare in eventi alluvionali. Questo tipo di configurazioni sinottiche sono inoltre responsabili per la formazione ed il trasporto verso il Nord Italia di significative quantità di aerosol, composto principalmente da polveri minerali sahariane e spray marino.

Lo scopo del presente lavoro è stato quindi valutare il ruolo che l'aerosol può avere nell'innesco e nell'evoluzione degli intensi sistemi convettivi che si sviluppano sulla Liguria in queste condizioni. A tal fine sono state eseguite simulazioni numeriche dei più recenti fenomeni alluvionali con il modello numerico Weather Research and Forecasting-Chem (WRF-Chem), versione 4.0, che oltre a simulare l'evoluzione meteorologica è in grado di simulare l'emissione, il trasporto, il mixing e le trasformazioni chimiche dell'aerosol. In particolare, il presente lavoro si è focalizzato sull'impatto che l'interazione nuvola-aerosol-radiazione può avere sulla fisica e sulla dinamica degli eventi studiati, cercando di disaccoppiare gli effetti diretti (aerosol-radiazione) e quelli indiretti (aerosol-nuvola) attraverso 3 diversi set di simulazioni. Un primo set di controllo in cui la parte chimica del modello non è stata attivata, non tenendo quindi conto né della produzione e trasporto dell'aerosol, né dei suoi effetti diretti o indiretti. Un secondo in cui solo gli effetti diretti dell'aerosol sono stati considerati, ed infine un terzo in cui sono stati attivati sia gli effetti diretti che indiretti.

12:15pm - 12:30pm

Anabatic-katabatic transition of a slope wind along a double finite slope.

Carlo Cintolesi, Clément Pelissier

University of Bologna, Italy

Slope flows are thermally driven winds triggered by the heating of the ground by solar radiation in the morning (upslope or anabatic flows), or by the cooling effects due to radiative transfer during the night (downslope or katabatic flows). Both play an important role in driving low atmosphere circulation in the presence of complex orography and in the proximity of valleys and mountains: they are effective in transporting pollutants and spices from urban to rural areas (or vice versa) and dominate the local circulation which in turns affects the local meteorology.

Despite the importance of such phenomena, a few studies investigate the characteristics and peculiarity of the anabatic winds and even less address the analyses on the transition between anabatic and katabatic flows, which mainly occur in the transition from day to night. In this contribution, we present the first Large-Eddy Simulation (to the best of the author's knowledge) of the transition from anabatic to katabatic wind along a double-finite slope, which is a geometrical simplification of a single mountain uniformly heated.

Simulations show, first, the main feature of an anabatic wind, which includes the characteristic thermal plumes and the extension of the thermal boundary layer, under the conditions of positive constant heat flux from the slope. Subsequently, the boundary conditions are modified to be time-varying and gradually shift to a negative heat flux. The transition is done in a supercritical regime; hence, the time variation allows the establishment of fully developed anabatic-katabatic flows. The analyses investigated the generation-destruction of turbulent structures, which play a crucial role in vertical transport and mixing, the evolution of the thermal boundary layer, and the turbulent kinetic energy budget.

12:30pm - 12:45pm

A multi hazard extreme weather event in the Mediterranean: verification and sensitivity tests

Elenio Avolio[1], Giuseppe Castorina[2], Agostino Semprebello[3], Rosa Claudia Torcasio[4], Stefano Federico[4]

[1]National Research Council of Italy, Institute of Atmospheric Sciences and Climate (CNR-ISAC), 88046 Lamezia Terme, Italy; [2]Italian Institute for Environmental Protection and Research (ISPRA) - Geological Survey of Italy Department, 00133 Roma, Italy; [3]Institute of Geophysics and Volcanology (INGV), 90146 Palermo, Italy; [4]National Research Council of Italy, Institute of Atmospheric Sciences and Climate (CNR-ISAC), 00140 Roma, Italy

The Mediterranean area is particularly prone to severe weather events. The warm sea, the complex orography and the synoptic-scale meteorology often trigger extreme weather phenomena of different nature, whose forecast is one of the major missions to cope for the forecaster community. A convective system affected three Italian regions (Sicily, Calabria, and Apulia) on 3-4 December 2022, producing heavy rains, wind gusts and a tornado. We studied the forecast sensitivity of this multi-hazard weather event to different physical parameterization and configuration settings of WRF (Weather Research and Forecasting) model. Sensitivity tests on the possible role of the SST and on the horizontal resolution of the model were performed. Moreover, an ensemble approach and a 6h rapid update data assimilation (3D-VAR)/forecast cycle were also investigated to further study the forecasting skill of the modeling system. Results show that most of the WRF configurations are able to well simulate most of the features of the weather system.

12:45pm - 1:00pm

INTERVENTO SPONSOR AISAM

Osservazione dei fenomeni severi: rianalisi vs pseudo rianalisi

Gianluca Ferrari[1], Federico Bottaro[1], Nicola Carlon[2]
1: Hypermeteo Srl, Roma (Italy); 2: Radarmeteo Srl, Due Carrare (Italy)

1:00pm - 2:00pm

LUNCH-BREAK

Location: **Poster area, Atrio, Edificio 5, Studium 2000, Università del Salento**

2:00pm - 3:00pm

Poster Session 01

Location: **Poster area, Atrio, Edificio 5, Studium 2000, Università del Salento**

[1] The interplay of mineral dust with radiation: analysis of the giant dust intrusion in the Atlantic Ocean on June 2020

Fabio Massimo Grasso[1], Umberto Rizza[1], Mauro Morichetti[1], Elenio Avolio[2], Ferdinando De Tomasi[3]

[1]CNR ISAC Lecce, Italy; [2]CNR ISAC Lamezia Terme, Italy; [3]Università del Salento, Dipartimento di Matematica e Fisica

Mineral dust is one of the most important atmospheric forcing agents and largely contribute to the uncertainties in estimating global climate radiative forcing. It directly modifies the radiation budget by absorbing and scattering short- and longwave radiation. It also affects the properties and lifetime of clouds and therefore indirectly change the Earth-system balance. Consequently, aerosols can influence land surface processes, the global surface temperature, the climate, the hydrological cycle, and terrestrial ecosystems. In this context, the quantification of dust aerosols in Earth System Models (ESMs) has important implications for water cycle and biogeochemistry studies.

In the last decade, the dust detection by remote sensing retrieval has registered an increase in spatial coverage, and satellite multiple detection channels have come to play important roles in dust source measurements. Dust scatters visible light and has a moderate absorption in the visible and near infrared region, it can also absorb longwave radiation from the ground and emit longwave radiation. Thus, these specific optical properties can be used in dust detection algorithms.

To complement measurements by remote sensing, numerical modeling may be considered an important approach to study the dust transport from the Saharan arid and semi-arid regions toward the Mediterranean and Atlantic area, allowing a comprehensive understanding of the dust intrusions and their effects on meteorology, air quality and human health.

---

[2] Contribution of ISAC (CNR) to Micrometeorology Scientific Research at the ATTO Project

Luca Mortarini[1], Daniela Cava[2], Daiane Brondani[1]
[1]CNR-ISAC, Turin (Italy); [2]CNR-ISAC, Lecce (Italy)

The Amazon Tall Tower Observatory (ATTO) is a research infrastructure realized in the Amazon pristine rain forest. The main goal of the project is to measure biological, chemical and meteorological data following a multi-disciplinary, multi-platform, multi-sensor and multi-frequency approach for understanding how the Amazon rainforest interacts with the soil beneath and the atmosphere above. ATTO represents a unique opportunity to learn more about the energy fluxes, the water and biogeochemical cycles above the Amazon Forest and their influence on the global climate.

Two towers (80 m and 325 m high) are instrumented with high-vertical resolution sensors for a continuous monitoring of different air layers inside and above the forest. The ATTO towers offer the rare possibility of a direct observation of turbulent quantities and of the atmosphere thermodynamics in the roughness sublayer (RSL) and in the surface layer above it. During night-time the whole boundary layer is lower than the tower.

The ISAC (CNR) contributes to the micrometeorology scientific research activity at the ATTO Project following different research topics, all aimed to a better understanding of the flow dynamics in different stability conditions and of the role of turbulent transport in the chemical components above the forest. We will give a brief overview of the main results and of the work in progress relative: to the estimation of the boundary layer height in stable stratification; to the numerical simulations LES (PALM-4U) of the microscale flow above the forest; to the developments of an original theoretical approach based on a cospectral-budget model for the RSL study; to the development of a Lagrangian model that recovers oscillatory correlations of wind components above tall canopies; to the validation of the Relaxed Eddy-Accumulation technique for estimating scalar fluxes for which fast-response gas analyzers are impractical or non-existent (such as methan, isoprene), crucial for understanding the biosphere-atmosphere interaction and its influence on the biodiversity.

---

[3] Presence of dry intrusions in the early stages of Mediterranean tropical-like cyclones

Daniele Nigro[1], Simona Bordoni[1], Lorenzo Giovannini[1], Marcello Miglietta[2]
[1]Università di Trento, Italy; [2]ISAC-CNR, Italy

Mediterranean Tropical Like Cyclones, also known as medicanes, are mesoscale cyclones that are observed in the Mediterranean region with a frequency of 1-2 per year, mainly in autumn and winter. The tropical-like phase of these cyclones is characterized by the presence of a symmetric thermal structure and a deep warm core, which are features typical of tropical cyclones. The mechanisms of formation and tropical transition have been investigated by many authors, but a definition of medicane has not been found yet due to the strong case-dependency.

In this work, 17 Mediterranean cyclones showing tropical features, including three potential medicanes in 2023, have been analyzed using ERA5 reanalysis dataset. Some general properties in the lower and upper troposphere have been investigated considering that winter cyclones present a lower dynamic tropopause than early autumn cyclones. Compared to the extra-tropical (initial) stage, during the deep warm core phase there is an overall negative correlation between the parameter -VTU, quantifying the thermal wind in the layer 700-400 hPa, and PV in the upper troposphere, while PV increases in the low troposphere due to latent heat release. Moreover, the environmental wind shear shows lower values, the jet stream is farther from the cyclone center, and the cyclone is vertically aligned.

Then, the presence of dry intrusions in the early stages has been investigated using back-trajectories, showing descending dry air associated with a PV streamer in all cases, meaning that the upper-level dynamics are fundamental in this phase. However, the threshold of 400 hPa of descent in 48 hours used in literature to define the dry intrusion appears too high in the Mediterranean, as in some cases a weaker PV streamer associated with a less pronounced descent is sufficient for the cyclogenesis. Lastly, Ianos, one of the strongest medicanes ever recorded, has been deeply investigated, showing some peculiarities compared to the other cyclones. In fact, it shows two weak descending flows associated with PV streamers, one in the early stage and one before the deep warm core phase, anticyclonic PV generation due to latent heat release as it occurs for tropical cyclones, and intense convection extending up to the tropopause in the mature stage. This cyclone has been analyzed through the pressure tendency equation (PTE) to quantify the role of the upper-level dynamics and of the diabatic heating. The same tool has been used to analyze the recent cyclone Daniel that affected Libya in September 2023.

---

[4] Tuning of WRF simulations with local climate zones over the urban area of Rome

Serena Falasca[1], Annachiara Bellini[1,2], Annalisa Di Bernardino[1], Anna Maria Iannarelli[3], Stefano Casadio[3]
[1]University of Rome La Sapienza, Italy; [2]ARPA Valle d'Aosta; [3]SERCO SpA

Cities are typically affected by the urban heat island effect, defined as the temperature rise of the city in comparison with the surrounding rural zones. In the context of the climate change, other issues such as the increase in heat waves in terms of frequency and intensity add up exacerbating the overheating to which city dwellers are subjected, with severe consequences on health and society.

The mitigation of such thermal stress represents a crucial challenge. To this end, several technical solutions have been developed and tested in recent decades, such as high albedo materials, waterbased blue technologies, and nature-based solutions.

Numerical models, such as Weather Research and Forecasting (WRF), play a crucial role in running the so-called "what-if" scenarios, where the application of one or more mitigation techniques is simulated and the

fields of weather variables are reproduced at high spatial-temporal resolution to explore the effectiveness and potential configurations of different mitigation solutions.

One of the main open challenges is the realistic reproduction of the urban texture. Recently, a WRF configuration based on the local climate zones has been implemented for the metropolitan area of Rome (Italy) thanks to the inclusion of the WUDAPT database (https://www.wudapt.org/). The aim of this work is performing sensitivity tests to the physics options offered by WRF, as the Planetary Boundary Layer schemes and the land use characteristics (materials and morphology). The numerical results are compared with each other, and with observations to evaluate the model performances in the different configurations.

---

[5] Machine learning-based sensitivity analysis of numerical simulations over complex terrain to surface parameters

Dario Di Santo[1], Andrea Zonato[2], Lorenzo Giovannini[1]

[1]Department of Civil Environmental and Mechanical Engineering, University of Trento, Trento, Italy;
[2]Koninklijk Nederlands Meteorologisch Instituut, De Bilt, Netherlands

Land surface models (LSMs) implemented in numerical weather predictions (NWP) models use several parameters to suitably describe the surface and its interaction with the atmosphere, whose determination is often affected by many uncertainties, strongly influencing simulation results. However, the sensitivity of meteorological model results to these parameters has not yet been studied systematically, especially in complex terrain, where uncertainty is expected to be even larger.

This study focuses on identifying critical LSM parameters influencing the development of thermally-driven circulations in mountain valleys, which are important for understanding local atmospheric processes. While previous sensitivity analyses employed offline LSM simulations, this study adopts an online coupled approach, utilizing the Noah-MP LSM within the Weather Research and Forecasting (WRF) model. Specifically, an idealized three-dimensional topography consisting of a valley-plain system is adopted.

To overcome computational limitations, an ensemble of machine learning algorithms, encoded in the novel tool ML-AMPSIT, is employed for the sensitivity analysis. By analyzing a complete diurnal cycle in the idealized valley setting, the study focuses on key vegetation parameters governing the interactions between Noah-MP and WRF, such as leaf dimension, leaf and stem area indices, reflectance/transmittance coefficients, height and roughness length of the canopy, canopy wind profile parameter and leaf/stem orientation parameters. The proposed approach, although novel in the context of LSM-NWP model coupling, draws from established applications of machine learning in various Earth science disciplines, underscoring its potential to improve the estimation of parameter sensitivities in NWP models.

---

[6] Numerical simulations of a supercell in northeastern Italy with WRF-HAILCAST

Andrea Perbellini[1], Francesco Sioni[2], Agostino Manzato[2], Lorenzo Giovannini[1]

[1]Department of Civil, Environmental and Mechanical Engineering, University of Trento, Trento, Italy;
[2]Agenzia Regionale Per l'Ambiente (ARPA) Friuli-Venezia Giulia – OSMER, Palmanova, Italy

In the early morning of 1 August 2021, a supercell developed over the Veneto plain and moved eastward towards Friuli-Venezia Giulia, locally producing hailstones with diameters up to 9 cm.

In the present work, this event is studied by means of simulations with the Weather Research and Forecasting (WRF) model at 1 km resolution, coupled with the HAILCAST hail growth parameterization, which provides estimates of the hail size at the ground. Several simulations are performed using different initial and boundary conditions (GFS and IFS forecasts) and different initialization times, to study the predictability of the event. The analysis of the model results highlights a significant sensitivity to the forcing meteorological model and to the initialization time. In particular, WRF is not able to properly simulate the development of strong convection over the Veneto and Friuli-Venezia Giulia plain in the early morning of 1 August using GFS forcing, while better results are obtained with IFS initial and boundary conditions, especially when simulations are initialized more than 24 hours before the event. However, the development of the supercell is properly simulated, with hailstone diameters comparable to observations, only when high vertical resolution data from the radiosounding of Udine Rivolto are nudged into the model, highlighting the importance, and at the same time the complexity, of correctly reproducing local thermodynamic conditions for the simulation of extreme convection events.

---

[7] Role of wind in the temporal and spatial distribution of strawberry powdery mildew in high-tunnel and soilless cultivation

Anna Aldrighetti[2,3], Sofia Farina[1,2], Ilaria Pertot[2,3], Dino Zardi[1,2]

[1]Atmospheric Physics Group, Department of Civil, Environmental and Mechanical Engineering, University of Trento, Italy; [2]C3A – Center Agriculture Food Environment, University of Trento, Italy; [3]Fondazione Edmund Mach - S. Michele all'Adige (Trento), Italy

The spreading of a plant disease, such as the strawberry powdery mildew (Podosphaera aphanis or Sphaerotheca macularis), in a field is mostly determined by the concurrence of two processes: the aerodynamic transport of the spores determined by the wind, and the biologic processes. Both of them can be reproduced by means of mathematical modell, combining schemes reproducing atmospheric flow with epidemiologic models. In this work, we focus on the role of wind transport in the temporal and spatial distribution of the strawberry powdery mildew in a greenhouse through the analysis of data collected during a field experiment performed in a high-tunnel and soilless cultivation, during which measured the wind inside and outside the tunnel was measured along with other meteorological variables, such as air temperature and humidity, during the spreading of the disease. The role of the wind transport in the final concentration

field of the infected plant is shown. The goal of the study is the identification of practical solutions that can be implemented during the cultivation process in order to reduce and stop the spreading of the disease in a fast and efficient way.

[8] Study of the structure of anabatic winds on a idealized slope studied using a K-ε model

Sara Careaga[1,4], Sofia Farina[1,2], Andrea Zonato[3], Vincenzo Carbone[4], Dino Zardi[1,2]

[1]Atmospheric Physics Group, Department of Civil, Environmental and Mechanical Engineering, University of Trento, Italy; [2]C3A – Center Agriculture Food Environment, University of Trento, Italy; [3]Koninklijk Nederlands Meteorologisch Instituut, Netherlands; [4]Department of Physics, University of Cosenza, Italy

The vertical structure of anabatic and katabatic winds developing over a simplified slope is studied using a one-dimensional numerical model. It is known from the literature thatf Monin Obukhov similarity theory (MOST), in the form which is usually adopted over flat uniform terrain, is not applicable to flows developing over nonhorizontal terrain (Sfyri et al, 2008), One of the reasons is that, unlike for horizontal terrain, turbulent fluxes are not invariant with distance from the surface in the slope wind layer (see other Farina et al. contribution to this conference). Based on the vertical structure of the kinetic energy dissipation rate ε emerging from the analysis of data from field measurements (see other Farina et al. contribution to this conference) , we use a k-ε closure to simulate the evolution of the flow and we seek for a scaling law. The main goal is to find appropriate t scaling laws for slope flows and to test similarity theories alternative to MOST.

[9] A study of the surface energy (SEB) and turbulent kinetic energy (TKE) balance for slope winds

Sofia Farina[1,2], Dino Zardi[1,2]

[1]Atmospheric Physics Group, Department of Civil, Environmental and Mechanical Engineering, University of Trento, Italy; [2]C3A – Center Agriculture Food Environment, University of Trento, Italy

Using the data collected during the MATERHORN experiment (Fernando et al, 2015) the diurnal and nocturnal budgetof the turbulent kinetic energy (TKE) on a gentle slope is computed and analyzed. Data from the turbulence towers located on the East-facing slope of Granite Mountain (Utah, USA) are used to compute the terms of the TKE and surface energy balance and their evolution in time and to identify the ones dominating it and the difference between daytime and nighttitme. Moreover, a comparison between the different approaches usable to compute TKE dissipation rate ε is provided, and profiles of it for anabatic winds is presented for the first time, as well as the other TKE balance terms. Turbulence production mainly by along slope momentum flux, and the normal heat flux is compensated by the dissipation one. Moreover, all the terms display the same vertical structure of higher values closer to ground and then strong decrease around 10.0 m AGL.

[10] Analysis of the vertical structure of first- and second-order turbulence moments in anabatic winds from field observations in three case studies

Sofia Farina[1,2], Dino Zardi[1,2]

[1]Atmospheric Physics Group, Department of Civil, Environmental and Mechanical Engineering, University of Trento, Italy; [2]C3A – Center Agriculture Food Environment, University of Trento, Italy

The turbulence structure of anabatic winds is investigated analysing data from various measurement campaigns, performed over different slope,s under the projects METCRAX (Whiteman et al, 2008), MATERHORN (Fernando et al, 2015) and MAP-RIVIERA (Rotach et al, 2004). The three field studies are representative of different topographical configurations and surface conditions and are used to identify the main characteristics and near-surface structure of the first and second-order moments of velocity and temperature associated with these circulations, as well as their relation with the environment in which they develop. Results show that both first and second order moments exhibit similar vertical structures even for anabatic flows developing in different environments. In particular, considering the first order moments, it is shown that: i) the height of maximum wind speed is very difficult to detect, due to lack of data in farther from the ground, ii) a steady steady is rarely met, both for anabatic an for katabatic winds, : they keep changing in time, and in particular wind intensity and jet height continuously grow, iii) they are characterized by negative slope-normal velocity components of the order of ~ 0.1 ms-1. Considering second order moments, the most striking feature is that the turbulentkinetic energy (TKE) does not reach a maximum and then decreases, far from the ground, but increases in the first meters above the ground (AGL) and then reaches an asymptotic value. Finally, the normalized standard deviations of temperature scale relatively well with the Obukhov length , although with a different structure than for flat terrain.

[11] On the scaling properties of three limitea-area numerical models

Valerio Capecchi[1], Alberto Ortolani[2], Bernardo Gozzini[1]

[1]Laboratorio LaMMA, Italy; [2]Istituto di BioEconomia, CNR, Italy

The ability to perform detailed weather simulations for real-time applications depends on the ability of the numerical model to effectively use large computational resources, which are becoming increasingly common even at relatively small supercomputing centres. However, to what extent the code of limited-area models scales as the computational power increases, results somehow vague, and, to our knowledge, no systematic

investigation exists in this regard. On the other hand, scalability performance plays a pivotal role in assessing the computational resources required to meet time-critical deadlines in operational weather agencies.

In the year 2022, the SPICAPE project was awarded computational resources by the ECMWF computing centre to address this knowledge gap. The project aimed to address and provide answers to the following issues and questions:

- establish a common framework, in terms of numerical workload, for three widely recognized and extensively utilized limited-area models: WRF, MOLOCH, and Meso-NH;

- study how the simulation speed (defined as the forecast length over the wall-clock elapsed time) scales as the computational power increases;

- determine, for each limited-area model, the tipping point from the strong to the weak scaling regime. This is achieved by determining the number (say N(x,y)) of grid points assigned to each computing core below which the time spent for inter-patch communication overwhelms the time spent for the model dynamics.

The results obtained indicate that, in line with previous investigations, the MOLOCH model is the fastest and scales efficiently up to an N(x, y) value of approximately 950. The Meso-NH model is the slowest but operates in a strong scaling regime up to an N(x, y) value of approximately 120. The WRF model falls in between, being, on average, 2.5 times slower than the MOLOCH model and twice as fast as the Meso-NH model. Its N(x, y) value is approximately 500.

---

[12] Previsione dei temporali in Italia con tecnica di regressione a quantili di tipo “forest"

Gianni Messeri[1,2], Riccardo Benedetti[2], Roberto Vallorani[1,2], Luca Fibbi[1,2]
[1]CNR IBE, Italy; [2]Consorzio Lamma, Italy

L’obbiettivo di questo lavoro è valutare l’applicabilità alla realtà italiana di un metodo probabilistico di previsione, anche operativa, delle fulminazioni e quindi dei temporali, prendendo spunto da quanto fatto presso il Reale Istituto Meteorologico Olandese e descritto in dettaglio nel Rapporto Interno IR-2019-03, a cura di E. Groot. Per tenere conto della maggior complessità del territorio italiano rispetto a quello olandese, la nostra penisola è stata suddivisa in aree morfologicamente omogenee, su ognuna delle quali è stato applicato un algoritmo per la previsione probabilistica delle fulminazioni, basato sulla tecnica di regressione a quantili di tipo “forest” (QRF), una delle più promettenti emerse negli ultimi anni. I predittori, rispetto ai quali la probabilità di fulminazione è condizionata, sono stati derivati dal modello non idrostatico ECMWF HRES, con orizzonte di previsione fino a 45 ore. Ognuno dei cluster del nostro dominio di studio è stato diviso in una serie di riquadri, ciascuno dei quali copre un'area dell’ordine di alcune migliaia di chilometri quadrati. In pratica la previsione è rappresentata dal verificarsi di almeno due fulmini all'interno di una delle suddette zone ed entro intervalli temporali di sei ore, fino a coprire l’intero orizzonte di previsione (3-9, 9-15, 15-21, 21-27, 27-33, 33-39, 39-45 UTC). Il database dei fulmini osservati è stato creato utilizzando il Lightning Network LAMPINET del Servizio Meteorologico dell'Aeronautica Militare Italiana. Per quanto riguarda le variabili indipendenti (predittori), queste sono costituite da una serie di variabili meteorologiche e indici di stabilità atmosferica provenienti, come detto, dal modello HRES ECMWF, dati, questi, ottenuti attraverso il Meteorological Archival and Retrieval System (MARS).

---

[13] Il sistema modellistico per la previsione della qualità dell'aria della Regione Puglia: stato dell'arte e prospettive future

Angela Morabito[1], Francesca Intini[1], Ilenia Schipa[1], Annalisa Tanzarella[1], Francesca Fedele[1], Andrea Tateo[1], Vincenzo Campanaro[1], Daniela Barbero[2], Umberto Giurato[2], Nicola Pepe[2], Nicolò Verardo[2], Giacinto Donvito[3], Gioacchino Vino[3]
[1]Arpa Puglia, Italy; [2]Arianet Srl; [3]INFN - Bari Italy

I servizi operativi che forniscono la previsione dello stato della qualità dell’aria a livello nazionale e regionale sono sempre più numerosi. Sulla regione Puglia la previsione della qualità dell’aria è stata resa operativa a partire dal 2016 con la pubblicazione giornaliera sul sito agenziale di diversi prodotti forniti ad una risoluzione di 4km sulla griglia regionale e ad 1km sull’area di Taranto. Il sistema modellistico è stato installato presso il cluster HPC della piattaforma computazionale ReCaS, un datacenter, gestito da INFN e UNIBA, con caratteristiche computazionali tali da garantire l’operatività dei codici e dei servizi previsionali. L’esecuzione in automatico delle catene previsionali, incentrate per la parte meteorologica sulle simulazioni ottenute mediante il modello numerico WRF e per la qualità dell’aria sul modello euleriano fotochimico FARM e sul modello lagrangiano a particelle SPRAY, è attualmente condotta dall’applicativo F-AIR 3.0. Nel corso del 2022 ReCaS, grazie al progetto IBISCO, finanziato sul bando "PON Ricerca e Innovazione 2014-2020", ha messo a disposizione aumentate risorse di calcolo ed un rinnovato ambiente informatico che prevede l’esecuzione delle applicazioni tramite docker container, una tecnologia che conferisce semplicità di configurazione ed esecuzione, affidabilità, flessibilità e sicurezza. Grazie ai fondi PNRR-PNC è stato quindi avviato l’aggiornamento ed il potenziamento dei servizi previsionali di qualità dell’aria sulla Puglia con l’obiettivo di migliorarne la risoluzione spaziale ed estenderne la durata temporale. In particolare sull’area di Taranto si potenzierà per il PM10 l’integrazione (già presente) tra le catene operative FARM e SPRAY al fine di rappresentare l’impronta delle emissioni industriali con il miglior dettaglio possibile (200m) considerando l'impatto del particolato secondario.

---

[14] Sistemi temporaleschi super-cellulari e impatto sull'aviazione: metodi previsionali attuali e futuri.

Francesco Sudati[1,2,3], Lucilla Milioni[3], Luca Brambilla[2]
[1]Università degli Studi di Milano, Italy; [2]Università degli Studi di Milano Bicocca; [3]Centro Nazionale di Meteorologia e Climatologia Aerospaziale

Il temporale è il fenomeno meteorologico più pericoloso per il volo, pertanto le previsioni meteo-aeronautiche sono fondamentali per un efficace ed efficiente gestione del traffico aereo. Nonostante che l'affidabilità delle previsioni meteorologiche di nowcasting e quelle a brevissima scadenza siano oggigiorno molto affidabili per un uso generale, per gli scopi aeronautici, ove è richiesta una elevata precisione nello spazio e nel tempo, non sempre è possibile prevedere con esattezza dove e quando una supercella temporalesca si manifesterà. Un recente lavoro di tesi ha indagato tra diversi prodotti modellistici cosiddetti di "post-elaborazione" in uso presso il Centro Nazionale di Meteorologia e Climatologia Aerospaziale, ente deputato dall'ICAO a svolgere il compito di "Italian Meteorological Watch Office" sullo spazio aereo nazionale. In particolare, l'analisi svolta ha riguardato 6 differenti prodotti di post-processing del modello ad alta risoluzione COSMO-IT, investigando su 28 eventi temporaleschi super-cellulari in Italia nel corso del periodo marzo 2021 – giugno 2022, con il fine di individuare il prodotto più idoneo per la previsione di supercelle temporalesche. Tutti i prodotti dedicati alla previsione dei temporali, di fronte al caso particolare di fenomeno super-cellulare, hanno mostrato chiari segni di scarsa predicibilità.

Per approfondire le ragioni di questa scarsa performance, si sono considerate le condizioni termodinamiche lungo il profilo verticale per mezzo dei radiosondaggi previsti dal modello climatologico ERA5. Dal confronto con i radiosondaggi osservati, si è riscontrato che in molti casi la simulazione può non essere totalmente rappresentativa dello stato termodinamico dell'atmosfera, specialmente per quanto riguarda gli strati più bassi. Per esempio, leggere discrepanze nella temperatura o nella quantità di umidità in prossimità del suolo in fase di previsione, possono sfociare in fenomeni temporaleschi notevolmente più intensi, oppure non manifestarsi affatto. La causa principale di tale errore risiede nell'errata simulazione dei valori di CAPE.

---

[15] Il contributo delle stazioni meteorologiche personali ed altri sistemi di misura nella verifica dei modelli numerici di simulazione dell'atmosfera.

Francesco Sudati[1,2,3]
[1]Università degli Studi di Milano, Italy; [2]Università degli Studi di Milano Bicocca, Italy; [3]Centro Nazionale di Meteorologia e Climatologia Aerospaziale, Italy

L'utilizzo di stazioni meteorologiche private o amatoriali è cresciuto enormemente negli ultimi anni e molti servizi meteorologici dei paesi più sviluppati si stanno organizzando per utilizzare questa grande quantità di informazione nei vari ambiti: assimilazione dati, post-processing, verifiche dei modelli. Il lavoro proposto si inserisce all'interno di un dottorato di ricerca, che ha l'obiettivo di esplorare le potenzialità che esistono in Italia in tale settore, con particolare riferimento al settore delle verifiche del modello ad alta risoluzione ICON in uso presso il Centro Nazionale di Meteorologia e Climatologia Aerospaziale. In modo particolare si sono considerate due grandi associazioni amatoriali nel settore: "Meteonetwork" e "Centro Meteorologico Lombardo", che dispongono di reti di misura a scale differenti, la prima a valenza nazionale, la seconda a scala regionale.

Le tappe del lavoro fin qui condotto hanno riguardato:

- Un controllo di qualità preventivo che ha consentito di stabilire su quali parametri vale la pena investire e su quali invece si ritiene che l'affidabilità non sia sufficiente.
- La costruzione dell'infrastruttura informatica e telematica necessaria al ricevimento in continuo dei dati.
- La creazione di programmi per la trasformazione del formato dei file proprietari in quello standard BUFR utilizzato dal sistema di assimilazione dati SAPP.
- La creazione dei "feedback file" per confrontare le osservazioni meteo personali con i dati GRIB del modello ICON nel punto di griglia più vicino.
- Analisi dei primi dati.

Infine verrà presentato anche il sistema di monitoraggio portatile "Meteotracker" come esempio di possibile sviluppo futuro di applicazione nel settore.

---

[16] MC-FORUM: il progetto ASI per la valutazione dell'impatto delle misure FORUM in ambito meteorologico e climatico

Alberto Ortolani[1,8], Alberto Carrassi[6], Federico Fabiano[2], Ugo Cortesi[3], Jost Von Hardenberg[5], Guido Masiello[7], Marco Ridolfi[4], Samantha Melani[1,8], Paolo Ruggieri[6], Stefano Della Fera[3], Tiziano Maestri[6], Luca Palchetti[4]
[1]Consiglio nazionale delle Ricerche - istituto per la BíoEconomia (CNR-IBE), Italy; [2]Consiglio Nazionale delle Ricerche - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy; [3]Consiglio Nazionale delle Ricerche - Istituto di Fisica Applicata "Nello Carrara" (CNR-IFAC), Italy; [4]Consiglio Nazionale delle Ricerche - Istituto Nazionale di Ottica (CNR-INO), Italy; [5]Politecnico di Torino - Dipartimento di Ingegneria dell'Ambiente, del Territorio e delle Infrastrutture (PoliTO-DIATI), Italy; [6]Università degli Studi di Bologna - Dipartimento di Fisica e Astronomia "Augusto Righi" dell'Alma Mater Studiorum (UniBO-DIFA), Italy; [7]Università degli Studi della Basilicata - Scuola di Ingegneria (UniBAS-SI), Italy; [8]Consorzio LaMMA, Italy

Le osservazioni satellitari svolgono un ruolo cruciale nella meteorologia operativa, fornendo dati omogenei e globali per l'atmosfera e la superficie terrestre, utilizzabili attraverso l'assimilazione dei dati (DA) per produrre stime dello stato del sistema Terra. La missione FORUM (Far-infrared-Outgoing-Radiation Understanding and Monitoring) è la nona missione Earth Explorer (EE9) dell'ESA, il cui lancio è previsto per il 2027. FORUM produrrà misure di radianza dell'emissione planetaria, risolte spettralmente dal medio al

lontano infrarosso (FIR) nella banda 100-1600 cm^{-1} con una risoluzione non apodizzata di 0,5 cm^{-1}. Le lunghezze d'onda FIR sono attualmente inesplorate dallo spazio nonostante costituiscano una grande frazione della radiazione a onde lunghe (OLR) emessa dal pianeta. Questo spettro incorpora le firme di diverse forzanti climatiche e dei relativi feedback, essendo anche altamente sensibile al vapore acqueo dell'alta troposfera e ai cirri, ed è cruciale per valutare il bilancio radiativo terrestre.

MC-FORUM (Meteo and Climate exploitation of FORUM), progetto biennale finanziato dall'Agenzia Spaziale Italiana (ASI), partirà alla fine del 2023, con l'obiettivo primario di sviluppare strumenti e competenze per sfruttare FORUM nei campi della meteorologia e del clima. Nel progetto si analizzerà l'impatto dei dati FORUM su diverse scale spazio-temporali e con diverse tecniche di DA (variazionali e basate su ensemble Kalman filter). Si svilupperanno inoltre strumenti per sfruttare le misurazioni FORUM all'interno di attività di diagnostica e di validazione di modelli climatici globali, per consentire lo studio di nuove parametrizzazioni e del potenziale di FORUM nella valutazione delle forzanti radiative e dei feedback climatici.

---

[17] Improving predictability of extreme precipitation by applying an ensemble-based approach

Matteo Siena[1], Paolo Ruggieri[1], Chiara Marsigli[2,3], Thomas Gastaldo[2], Silvana Di Sabatino[1]

[1]Università di Bologna, Italy; [2]ARPAE Emilia-Romagna; [3]DWD - Deutscher Wetterdienst

Extreme precipitation events are changing in frequency and intensity in Europe (see Papalexiou & Montanari, 2019, doi:10.1029/2018WR024067). Some of the main drivers of such events are the so-called Mesoscale Convective Systems (MCSs) that have typical dimensions of the order of ~100 km and are relatively large clusters of intense thunderstorms that produce rainfall, large hailstones and, occasionally, dangerous tornadoes. Italy is affected by these phenomena, with an apparently increasing frequency. On the 8th of September 2022, a very large MCS formed off the coast of Tuscany, supported by low level convergence of very warm and humid winds, that triggered deep convection over the Tyrrenian sea, despite the absence of cold air in the high levels. The main operational numerical models underestimated such event and did not reproduce well the spatial extent of the system. These errors are usually related to uncertainties in (i) estimation of moisture in the several layers of the atmosphere, (ii) parametrization schemes for cloud microphysics and (iii) orography representation. It follows that convection-permitting models are crucial to better solve these phenomena. Here, we focus on specific extreme precipitation case studies to carry out large ensembles with the ICON model at convection-permitting resolution in a limited area setup. Specifically, we analyse the highest percentiles of ensemble forecast distributions to carve out more reliable information on the actual extreme precipitation by exploiting resolved convection at resolutions < 2.2 km. Indeed, in case of an incoming perturbation characterized by synoptic setups with huge thermal gradients and water vapour transports, then, when selecting the extreme portions of the ensembles, we may be observing the most unusual weather patterns, thus the ones more likely to trigger extreme events. This approach could help improving the predictability of extreme precipitation drastically, allowing better understanding and time-space representation of such high-impact events.

---

[18] Analisi comparata di un modello di microscala per la deposizione secca di aerosol sugli isolatori di linee elettriche aeree

Nicola Luciano[1], Alessandra Balzarini[1], Anna Maria Toppetti[1], Paolo Omodeo[1], Guido Pirovano[1], Irene Gini[2], Luca Ferrero[2], Ezio Bolzacchini[2], Andrea Piccoli[1]

[1]Ricerca sul Sistema Energetico, Italy; [2]Dipartimento di Scienze Ambientali Università di Milano - Bicocca, Italy

La deposizione di particelle di aerosol sugli isolatori elettrici delle linee aree è un fenomeno che può porre gravi rischi all'affidabilità dei sistemi elettrici. Infatti, la contaminazione superficiale degli isolatori può alterare significativamente le proprietà dielettriche di queste componenti, soprattutto in specifiche condizioni ambientali, quali la presenza di nebbia o rugiada [1]. Dato il ruolo strategico dei sistemi elettrici di trasmissione e distribuzione, il fenomeno di deposizione di particelle di inquinanti di aerosol sugli isolatori è stato indagato sviluppando un modello fisico dedicato, che si affianca a modelli consolidati applicati nel contesto degli studi di qualità dell'aria. Questi ultimi non sono in grado di modellare accuratamente la deposizione sugli isolatori, essendo sviluppati per la simulazione della deposizione al suolo e trascurando effetti locali quali la geometria complessa degli isolatori e le caratteristiche locali del moto turbolento. Il modello di deposizione dedicato, avente risoluzione spaziale nell'ordine della dimensione dell'isolatore ($\approx 10^{-1}$ m), è stato sviluppato partendo da un set di dati proveniente da simulazioni fluidodinamiche e di modelli lagrangiani per la deposizione. Le prestazioni di questo modello di microscala sono state analizzate con un duplice approccio. È stata approfondita la formulazione del modello di deposizione secca per aerosol integrato in CAMx, derivato dagli studi di Zhang et al. [3], confrontandola con la formulazione del modello a scala dell'ostacolo. Inoltre, è stata condotta una campagna sperimentale che ha interessato 206 siti distribuiti nell'intero territorio italiano, articolata in cinque prelievi del deposito superficiale sugli isolatori condotti secondo la direttiva IEC60815, condotti tra il 2016 ed il 2018, che hanno permesso di calcolare l'*Equivalent Salt Deposit Density* (ESDD). I valori di ESDD misurati sono stati confrontati con le simulazioni derivanti dai due modelli citati. Il confronto, che rappresenta una sostanziale novità almeno per quanto riguarda il contesto italiano, mostra una sistematica sottostima operata dal modello di deposizione di Zhang integrato in CAMx e una sistematica sovrastima, con valori di *fractional bias* |FB|<2, operata dal modello di microscala.

---

[19] Previsione a brevissimo termine di fenomeni precipitativi in Regione Campania: un approccio probabilistico basato su misure radar in banda X

Clizia Annella[1,2], Vincenzo Capozzi[2], Mario Montopoli[3,2], Giovanni Zambardino[2], Giorgio Budillon[2]
[1]Center of Excellence Telesensing of Environment and Model Prediction of Severe events (CETEMPS), University of L'Aquila, L'Aquila, Italy; [2]Department of Science and Technology, University of Naples Parthenope, Napoli, Italy; [3]National Research Council of Italy, Institute of Atmospheric Sciences and Climate (CNR-ISAC), Rome, Italy

Il *nowcasting* rappresenta uno strumento essenziale per la previsione, su brevi scale spaziali e temporali, di eventi precipitativi intensi per l'emissione di allerte utili a mitigarne l'impatto sul territorio. Sebbene, oggigiorno, la modellistica numerica offra la possibilità di elaborare previsioni ad altissima risoluzione, la stessa risulta inefficace nelle previsioni a brevissimo termine a causa dei costi computazionali tipicamente proibitivi (Ayzel et al. 2029). Per tale ragione, negli ultimi anni la letteratura scientifica si è concentrata sullo sviluppo di metodologie di *nowcasting* basate sull'impiego dei radar meteorologici. In questo lavoro, è stata effettuata, in primis, un'analisi comparativa di alcuni algoritmi di *nowcasting* ben noti in letteratura. In particolare, mediante l'utilizzo del pacchetto *pysteps open souce* di *python* (Pulkkinen et al. 2029), sono state testate tre diverse tecniche per il calcolo del campo di moto delle precipitazione (Lucas-Kanade, Dynamic and Adaptive Radar Tracking of Storms e Variational-Echo-Tracking) adoperando sia le misure acquisite dal mosaico radar nazionale (da gennaio 2022 a maggio 2023) sia le misure acquisite da due radar in banda X operativi nella Regione Campania (da giugno 2020 a dicembre 2022). In seguito, con riferimento alla sola applicazione regionale, relativa al progetto "*Campania Region Meteorological Radar Network*" (Capozzi et al., 2022), tali campi sono stati impiegati come input dei seguenti metodi di *nowcasting*: estrapolazione lagrangiana, *Spectral Prognosis*, *Short-Term Ensemble Prediction System*, *Nowcasting Vertically Integrated Liquid* e *Lagrangian INtegro-Difference equation model with Autoregression*. I metodi sono stati confrontati tramite metriche continue, indici categorici e metriche spaziali. Come atteso, per ogni tecnica è evidente un peggioramento delle capacità previsionali al crescere del lead time. Dai risultati preliminari di questa analisi comparativa emergono differenze tra le performance dei diversi metodi legate sia alla stagionalità, sia all'intensità della precipitazione. Infine, tali metodi sono stati opportunamente combinati al fine di ottenere una previsione probabilistica dell'occorrenza dei fenomeni precipitativi, relativa ad una finestra temporale compresa fra 10 e 120 minuti, che consenta dunque di assegnare un grado di incertezza alla previsione da adoperare in un contesto operativo.

---

[20] Impatto di diverse condizioni iniziali e al contorno sulle catene operative di qualità dell'aria: un'applicazione sul dominio Italiano

Tony Christian Landi[1], Lidia Bressan[3], Massimo D'Isidoro[4], Mario Adani[4], Roberta Amorati[3], Elenio Avolio[2], Ilaria D'Elia[4], Mihaela Mircea[4], Felicita Russo[4], Michele Stortini[3]
[1]Consiglio Nazionale delle Ricerche - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC) Sede di Bologna, 40129 Italia; [2]Consiglio Nazionale delle Ricerche - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), sede di Lamezia Terme, 88046 Italia; [3]Agenzia Prevenzione Ambientale Energia Emilia-Romagna (ARPAE) Sede di Bologna, 40126 Italia; [4]ENEA - Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile, Laboratorio di Inquinamento Atmosferico, Bologna, Italia

In questo lavoro viene presentato un confronto tra tre catene modellistiche operative sul territorio nazionale per le previsioni della qualità dell'aria kAIROS, FORAIR-IT e CHIMBO, implementate rispettivamente da Arpae/SNPA, ENEA e CNR-ISAC. In particolare, l'esperimento riguarda i confronti quantitativi tra simulazioni numeriche ed osservazioni allo scopo di valutare le differenze attribuibili all'utilizzo di diverse condizioni iniziali ed al contorno (CIC) per le previsioni di qualità dell'aria sull'Italia.

Allo stato attuale, le previsioni di concentrazione degli inquinanti in atmosfera su scala nazionale vengono generate utilizzando un nesting a due domini (europeo ed italiano) ed usando come condizioni iniziali ed al contorno il modello di qualità dell'aria, implementato da ECMWF (European Centre of Medium-Range Weather Forecast) su scala globale (i.e. CAMS global), che ha una risoluzione spaziale di circa 40 km. Un valido miglioramento potrebbe derivare dalla sostituzione delle CIC, passando del modello globale a quello regionale (i.e. CAMS regional), il quale ha una risoluzione spaziale di circa 10 km. Questa nuova configurazione offrirebbe vantaggi di diversa natura: Da un punto di vista puramente computazionale (i) si eviterebbe di usare la configurazione nesting non dovendo più generare la simulazione sul domino europeo; (ii) essendo i prodotti regionali il risultato di un ensemble di modelli europei allo stato dell'arte ci si aspetta di avere una performance migliore rispetto a quella ottenuta dalle catene attuali.

Questo studio è realizzato nell'ambito del National Collaboration Programme (NCP) – Italy, sottoscritto tra ECMWF e ISPRA per rafforzare la conoscenza dei prodotti e servizi operativi CAMS e ottenerne il massimo beneficio attraverso attività di informazione, formazione, e supporto operativo allo sviluppo di prodotti a scala nazionale e locale. A tale programma partecipano ARPAE, ARPA Lombardia, ARPAV, ARPAC, ENEA, CNR-ISAC, UNITOV-DICII.

Links:

FORAIR-IT http://airqualitymodels.enea.it

kAIROS https://www.snpambiente.it/prodotti/previsioni-qualita-dellaria-in-italia/

CHIMBO https://www.isac.cnr.it/dinamica/projects/forecasts/chimbo/index.html

---

[21] Can a city intensify a local severe storm?

Francesco De Martin[1], Andrea Zonato[2], Silvana Di Sabatino[1]

[1]University of Bologna, Department of Physics and Astronomy, Bologna, Italy; [2]Koninklijk Nederlands Meteorologisch Instituut, De Bilt, Netherlands

It is well known that urban areas influence the atmospheric boundary layer, e.g., increasing the temperature with respect to the surrounding rural areas (the “urban heat island”, UHI), and perturbing the wind field. Some studies pointed out that cities can also modify the rainfall patterns, in particular deep moist convection is more frequently triggered over and downwind urban areas. While these topics are well addressed in the literature, the effect of cities on the most extreme convective events, such as hailstorms, downbursts or tornadoes, is poorly studied. Can a city intensify a local severe storm? This is a relevant question, since the exposure and vulnerability to the severe storm risk is higher in cities than in the surrounding rural areas.

Our analysis started with a case study, that occurred on 24-25 July 2023, when multiple severe storms caused extreme hailstorms and downbursts over Northern Italy. The most affected areas were the plain of the Friuli Venezia Giulia region and the urban area of Milan. For this latter area we tried to investigate if the urban land use may had intensified the severe storm. The analysis of surface weather stations showed that during the night between 24 and 25 July 2023, when the most severe storm occurred, the UHI was not present over Milan. On the other hand, analysing radar images, severe storms seemed to intensify crossing the urban area. A hypothesis is that the change of roughness due to the presence of the city, intensified the vertical motions. To address this hypothesis, numerical simulations with the Weather Research and Forecasting (WRF) model were performed. Those were carried out using the BEP-BEM parametrization scheme for urban areas (WRF-URBAN), and they were compared to observations to validate the model. First results from a real case study suggest that the city of Milan may had an effect on the severe storm development: we plan to perform some idealized simulations to consolidate our findings.

---

[22] On atmospheric pressure and temperature correlations

Francesco Sioni[1], Agostino Manzato[1], Gabriele Fasano[1], Cristian Lussana[2], Arturo Pucillo[1]

[1]Osservatorio Meteorologico Regionale OSMER-ARPA FVG, Palmanova, Italy; [2]Norwegian Meteorological Institute, Oslo, Norway

Temperature (T), pressure (p), and density (ρ) are fundamental variables describing the atmospheric behavior. This study investigates the interdependence of these variables near Earth's surface in real-world conditions and focus on the research questions: do pressure and temperature correlate positively or negatively? Are these results consistent for all stations in the extratropics? Do correlations change with altitude? Are these correlations independent on the time scale considered?

Initial analysis of hourly data demonstrates a weak correlation between temperature and pressure compared to the near-perfect inverse correlation between density and temperature. In fact, temperature and density depend only on local thermodynamic conditions, while pressure is representative of the properties of the entire vertical column of air. Further, 2D density plots representing hourly pressure against temperature exhibit a triangular shape for various extratropical stations in different countries. Regardless of the location, the upper boundary of this triangle consistently fits a linear equation with a constant slope and an intercept that scales with the average pressure of the station. This suggests a physical boundary beyond which specific combinations of pressure and temperature are not observed. This result can positively impact quality data check of pressure and temperature, identifying implausible data using a single equation valid for all locations that have a well developed PBL above. Exceptions are the high mountain stations, for which the 2D density plots show a strong linear correlation, very similar to what is found in the free atmosphere, when analysing radiosounding data.

Lastly, correlations between the temporal variations of temperature (δT) and pressure (δp) are calculated for different time windows (TWs). For surface stations under a well developed PBL, the variables correlate negatively for TWs less than 1 day, but the correlation is almost null for longer TWs. Conversely, for stations near the top of mountains or for soundings data , R(δT,δp) is always positive and reaches very high values (>0.7) at TWs longer than 5 days. These results reinforce the difference between the behavior and the timescales in a deep PBL, which is characterized by turbulence and friction, and the "free" or "near-free" atmosphere, which is governed by advection of air masses and is weakly subject to surface and strong turbulent processes.

---

[23] Un algoritmo di machine learning per la conversione della temperatura superficiale in temperatura dell’aria: test nella determinazione dell’isola di calore urbana di calore sulla città di Roma

Andrea Cecilia[1,2], Giampietro Casasanta[2], Igor Petenko[2], Alessandro Conidi[2], Stefania Argentini[2]

[1]Università di Roma Tor Vergata, dipartimento di Fisica; [2]CNR-ISAC Roma

La temperatura dell’aria (Ta) ha un ruolo cruciale in numerose applicazioni, tra le tante lo studio delle condizioni di stress fisico e la comprensione di fenomeni quali l’isola di calore urbana (UHI).

Le misurazioni di Ta acquisite da sensori in situ, spesso distribuiti in modo non uniforme, risultano limitate nel descrivere il pattern del campo spaziale di temperatura. D'altro canto, le misure di temperatura superficiale LST (Land Surface Temperature) ottenute tramite i satelliti geostazionari forniscono una panoramica spaziale più dettagliata, ma rappresentano una variabile diversa dalla temperatura dell’ aria.

In questo lavoro viene presentato un metodo, basato su algoritmi di machine learning, per stimare la LST rilevata dai satelliti geostazionari, in Ta.

Per effettuare la conversione, è stato implementato un algoritmo di gradient boosting, appartenente alla famiglia degli algoritmi di machine learning a struttura ad albero. Il metodo è applicato ai dati di LST e di Ta disponibili sulla città di Roma per le estati 2019 e 2020.

Utilizzando come variabili predittive la LST istantanea ed i valori aventi un ritardo variabile da 1 a 4 ore, insieme ad altri parametri come altitudine, imperviousness, uso suolo, copertura di alberi, copertura erbosa, indice di vegetazione NDVI e parametri temporali come l'ora del giorno, si è stimata la Ta, nei punti in cui non sono disponibili sensori di misura in situ.

I risultati indicano un errore medio di circa 1.2°C durante le ore diurne e di 0.8°C durante le ore notturne. Questo approccio costituisce un passo importante nella comprensione e la previsione delle temperature dell'aria in aree prive di dati di rilevamento in situ.

---

[24] Validation of aerosol chemical composition and optical properties provided by Copernicus Atmosphere Monitoring Service using ground-based global data.

Ana Carolina Amarillo[1,2], Gabriele Curci[1,2], Davide De Santis[3], Francesca Barnaba[4], Cristiana Bassani[5], Christopher Oxford[6], Eli Windwer[7], Fabio Del Frate[3]

[1]Dipartimento di Scienze fisiche e chimiche Universita' degli Studi dell'Aquila, Italy; [2]Centro di Eccellenza CETEMPS Universita' degli Studi dell'Aquila, Italy; [3]Tor Vergata University of Rome, Earth Observation Laboratory Civil Engineering and Computer Science Engineering Dept. - Rome, Italy; [4]Istituto di Scienze dell'Atmosfera e del Clima - ISAC Consiglio Nazionale delle Ricerche - CNR - Rome, Italy; [5]IIA - Institute of Atmospheric Pollution Research CNR - Italian National Research Council - Rome, Italy; [6]Washington University in St. Louis - USA; [7]Weizmann Institute of Science - Department of Earth and Planetary Sciences - Israel

Monitoring air pollution by particulate matter, both its concentration and composition, is very important due to its effects on human health and climate. In the PRIMARY project we aim at retrieving the aerosol composition from space using the hyperspectral observations from the Italian Space Agency's PRISMA mission. To this end, we are developing a machine learning algorithm trained with synthetic top-of-atmosphere reflectances and underlying aerosol fields. As part of this process, we plan to use the global forecasts from the Copernicus Atmosphere Monitoring Service (CAMS) as the core of this synthetic dataset. Here we assess the representation of the aerosol chemical composition and the related optical properties in CAMS, comparing the simulations with near-surface aerosol chemical analyses from the SPARTAN network and sun-photometer observations from the AERONET network. We found that CAMS forecasts change skill over time due to updates in the modelling system, with the latter two version cycles (46 and 47) being similar. Generally, they reproduce the aerosol composition with a normalized mean bias between -50 and 200%, but we found a substantial overestimation of organic matter (OM) by up to a factor of 10. Applying a single global average correcting factor to OM warrants a much more realistic representation of $PM_{2.5}$ total mass and relative fraction of single species in CAMS. We calculate aerosol optical properties, needed for subsequent use in a radiative transfer model, from the aerosol composition fields. Comparison against AERONET show that OM bias correction resulted in improvements in Extinction Ångstrom Exponent (), Single Scattering Albedo (SSA) and Asymmetry Parameter (g) estimations, confirming the possibility of using CAMS as the base for a synthetic retrieval training dataset.

---

[25] Implementation and testing of a WRF/WRFDA-based operational regional NWP routine for Italy: preliminary results.

Giorgio Doglioni[1,2], Nicola Carlon[3], Tullio Degiacomi[4], Lucia Cisco[4], Gianluca Ferrari[4], Dino Zardi[1,2]

[1]Center Agriculture Food Environment (C3A), University of Trento; [2]Department of Civil, Environmental and Mechanical Engineering (DICAM), University of Trento; [3]Radarmeteo s.r.l.; [4]Hypermeteo s.r.l.

To obtain optimal initial conditions for initializing regional-scale, high resolution NWPs (Numerical Weather Predictions), it is necessary to derive a realistic estimate of the state of the atmosphere at the initial time. This is operationally done via the technique known as Data Assimilation (DA).

We present a novel initialization routine, incorporating iterative calls to the 3DVAR algorithm within the WRF Data Assimilation (WRFDA) package (Barker et al., 2012), complemented by short integrations of the Weather Research and Forecasting (WRF) model. Focused on Italy at a resolution of 3.5 km, our approach has been operationalized since August 2023, initializing forecasts four times daily (00, 06, 12, 18 z) with a 72-hour forecast span. Initial and boundary conditions are sourced from the ICON-EU model, providing Europe-wide forecasts at 6 km resolution.

A comprehensive suite of near-real-time surface station measurements, alongside upper-air data from the NOAA Operational Model Archive and Distribution System (NOMADS), are assimilated during a 4-hour assimilation window, totaling over 7000 measurements. Assimilated variables consist of horizontal wind speeds, temperature, pressure, and specific humidity.

To assess the impact of the DA suite, parallel control forecasts without DA are conducted. Verification against observations for the initial 24 forecast hours is then carried out to investigate the improvement in the forecast skill resulting from the DA suite.

In this presentation we will first focus on the description of the development and testing of this initialization suite. Secondly, we will present the preliminary results of the verification of the forecasts, highlighting the improvement in forecast skill from the operational implementation of the developed DA system. For instance, we will show that the inclusion of DA in the modeling chain results in reduced biases in temperature and humidity at 2 meters with respect to the forecasts without DA. Moreover, we will discuss the issues that arose during the implementation and testing of the DA routine. In particular, several aspects concerning the assimilation of surface stations (Demortier et al., 2023) and of the assimilation of measurements in complex

terrain (Hacker et al., 2018) will be pointed out. Also, the programmed evolution of this initialization suite is discussed along with the expected improvements resulting from these modifications.

---

[26] Unraveling the Three-dimensional Dynamics of Urban Heat Islands under Heat Wave Conditions Through Numerical Simulations: A Case Study for Bologna

Marco Possega, Erika Brattich, Carlo Cintolesi, Paolo Ruggieri, Silvana Di Sabatino
University of Bologna, Italy

Urban Heat Islands (UHIs) are receiving increasing scientific and societal attention in the framework of urban planning and climate change mitigation, especially within the context of a changing climate marked by the heightened frequency and intensity of extreme heat events, notably heat waves (HWs). Despite the plethora of studies dealing with the interaction between the UHI and HW phenomena, its complex interaction has not been completely understood yet. In particular, the comprehension of the influence of diverse urban morphologies and terrain characteristics on the amplification of UHIs during HWs, as well as the temporal evolution of the UHI's vertical structure during the onset of a HW, is still incomplete. Indeed, few studies consider the disparities in thermal conditions between urban and rural areas across the entire urban boundary layer, usually addressing only the surface and the canopy.

This study represents a comprehensive investigation into the complex 3-dimensional dynamics of UHI effects during a recent HW event in the city of Bologna, Italy. The WRF (Weather Research and Forecasting) model is employed to simulate the thermal-fluid dynamics of Bologna's urban environment, providing a detailed assessment of temperature distributions and heat island characteristics in the entire Planetary Boundary Layer (PBL). The UHI is evaluated adopting two different approaches, namely the standard “rural-ring” method and the “urban-increment” technique, the latter of which better captures the effects of urbanization on the local climate. The analysis starts examining how the spatial distribution of factors like near-surface wind and relative humidity correlates with changes in the UHI effect. Since distinct Local Climate Zones (LCZs) may affect the interactions between UHI and HW due to potential variations in convective flux and wind flow patterns, the behaviors of some key factors such as advective flux, latent, and sensible heat flux are investigated in the different LCZs of Bologna. Subsequently, the focus shifts to the evolution of UHI structure over time from the surface to the top of the PBL, and its temporal correlation with the vertical attributes of the HW.

This work is situated within the broader context of studies exploring the influence of large-scale atmospheric features on local complex terrains, particularly urban areas. By exploiting the horizontal and especially vertical resolution of WRF model outputs, the drivers behind the complex interaction between UHI and HW are explored, with the objective of providing a representation of the temporal development of the 3-dimensional UHI structure during the notable HW event of August 2023. This approach may enhance our comprehension of heat transfer within the atmospheric boundary layer and facilitate the development of more effective mitigation strategies.

Acknowledgment: This research has been carried out in the framework of the project SoluTions foR mItiGatinG climate-induced hEalth thReats (TRIGGER) funded by the European Union under grant agreement nº 101057739.

3:00pm - 4:00pm

PREVISIONI I

Location: **Session room, Aula 7, Edificio 6, Studium 2000, Università del Salento**
Session Chair: **Angelo Finco**
Session Chair: **Valerio Capecchi**

3:00pm - 3:15pm

Forecasting severe weather convective events in the Mediterranean area. (INVITED)

Rossella Ferretti[1,2], Antonio Ricchi[1]
[1]Department of Physics and Chemistry, University of L'Aquila; [2]Center of Excellence CETEMPS

Forecasting severe weather is still challenging, especially if associated to very localized convective cells. A few recent floods occurring in Italy were characterized by poor forecast as for examples the ones in Senigallia (2022), Emilia-Romagna (2023), Tuscany (2023) and TLC-Daniel (2023). These events were characterized by different large scale forcing but all of them had a very strong impact at the ground producing severe damages and casualties, and a few of them lasted for several hours because of the large-scale systems persistency.

In this presentation we will discuss a statistic collocation for selected events, large and local trigger mechanisms, the role of Sea Surface Temperatures anomaly. Special attention will be paid to the need for improving forecast by either using higher resolution forecast and/or different microphysics. Finally, a brief discussion on the role of using machine learning algorithm for improving high resolution Initial Condition will be presented.

3:15pm - 3:30pm

Impatto dell’assimilazione di dati a terra su una catena modellistica con WRF per le previsioni operative attraverso simulazioni ensemble

Luca Rovai[1,2], Andrea Antonini[1], Luca Fibbi[1,2], Valerio Capecchi[1], Samantha Melani[1,2], Andrea Orlandi[1], Alberto Ortolani[1,2], Bernardo Gozzini[1,2]
[1]Consorzio LaMMA, Via Madonna del Piano, 10, Sesto Fiorentino Italy; [2]Istituto di BioEconomia, IBE-CNR, Via Madonna del Piano, 10, Sesto Fiorentino Italy

Gli eventi meteorologici estremi che hanno colpito negli ultimi anni la nostra penisola, sono stati caratterizzati da una marcata localizzazione oltre che da una straordinaria intensità, e spingono la comunità meteorologica ad affinare gli strumenti sia diagnostici che prognostici. Nonostante i grandi progressi degli ultimi decenni, esiste ancora un gap importante fra la capacità dei modelli alla meso e microscala e le esigenze di previsioni operative in presenza di fenomeni convettivi estremi.

Nel presente lavoro, mostriamo i risultati ottenuti nell'esecuzione di test di sensibilità applicati a una catena modellistica operativa presso il Consorzio LaMMA e basata sul modello WRF (Weather Research and Forecasting) e sul relativo pacchetto di assimilazione dati (WRF-DA versione 4.4.2). Lo studio riguarda il significativo caso dell'alluvione delle Marche del 15 Settembre 2022, rivelatosi estremamente critico da prevedere nell'intensità e nella localizzazione. L'analisi è condotta sfruttando una combinazione fra tecniche di assimilazione e di ensemble, per valutare l'accuratezza della previsione in diverse condizioni iniziali e di DA. Sono stati utilizzati 50 membri del ciclo 47r3 dell'IFS (International Forecast System) dell'ECMWF. L'intervallo temporale di interesse è quello della previsione a breve termine (3 -6 ore) sul dominio spaziale italiano ad una risoluzione spaziale orizzontale di 3 km su 50 livelli verticali di modello.

I dati assimilati negli esperimenti numerici da WRF derivano da stazioni meteorologiche automatiche su scala regionale e nazionale, reti GNSS-meteo, radar meteo e stazioni meteo e GNSS aggiuntive gestite dal Consorzio LaMMA, anche su navi. Tali studi di sensibilità hanno lo scopo di testare l'impatto dei vari set di dati osservativi, il ruolo dei parametri di ottimizzazione disponibili nel pacchetto WRF-DA. I test hanno mostrato che la qualità dell'analisi alla scala globale è cruciale per la predicibilità dell'evento e che l'assimilazione delle osservazioni può modificare la dinamica degli eventi previsti con un impatto positivo sulla loro predicibilità.

3:30pm - 3:45pm

Algoritmi di Machine Learning per il miglioramento delle prestazioni di modelli meteorologici operativi nel Sud Italia

Luca Furnari[1], Umair Yousaf[2], Alessio De Rango[1], Donato D'Ambrosio[2], Giuseppe Mendicino[1], Alfonso Senatore[1]

[1]University of Calabria, Italy; [2]Dept. of Mathematics and Computer Science, University of Calabria, Italy

Sono presentati i risultati preliminari di un modello basato su tecniche di Intelligenza Artificiale (IA) avente lo scopo di avanzare le prestazioni del servizio di previsione operativa meteo-idrologica gestito dal Centro Studi per il Monitoraggio e la Modellazione Ambientale (CeSMMA) presso l'Università della Calabria. Per lo sviluppo del modello, che mira in particolare al miglioramento della previsione della distribuzione spaziale dei campi di precipitazione nelle 24 ore successive alla previsione, sono stati testati e validati due algoritmi basati rispettivamente su un approccio Random Forest (RF) e su Artificial Neural Network (ANN). Gli algoritmi sono stati addestrati su un anno di dati e validati su ulteriori 4 mesi. Le previsioni sono state confrontate con le osservazioni della rete pluviometrica della Regione Calabria (159 stazioni). I risultati mostrano la capacità di entrambi i modelli di IA di ridurre l'errore delle previsioni del modello meteorologico (WRF condizionato da GFS) soprattutto per i giorni piovosi, con MSE (Mean Square Error) calcolato rispetto WRF, ridotto mediamente del 29% e del 20% per ANN e RF, rispettivamente. I risultati del'AI preservano al contempo i pattern previsti dal modello fisicamente basato. Sono in corso studi relativi all'estensione degli algoritmi anche per orizzonti previsionali più ampi e all'utilizzo di algoritmi di IA più raffinati.

3:45pm - 4:00pm

A hybrid statistical-dynamical approach for seasonal predictions of the boreal winter stratosphere

Federico Gargiulo, Paolo Ruggieri, Luca Famooss Paolini, Silvana Di Sabatino

Alma Mater Studiorum - Università di Bologna, Italy

The variability of the stratospheric polar vortex (SPV) in the Northern Hemisphere is largely induced by the vertical propagation of Rossby waves. This can lead to the development of intense events of warming and reversal of zonal winds in the SPV area, known as Sudden Stratospheric Warmings (SSWs), with consequences that extend for several weeks even in the troposphere. The present work focuses on the predictability of the boreal winter stratosphere, with reference to a recent study by Portal et al. (2022) in which it has been demonstrated the importance of the prediction of low stratospheric wave activity (LSWA), described by eddy heat fluxes at 100hPa, for predicting the SPV intensity. The present work aims to improve the representation of LSWA and hence of the SPV intensity by considering their connection with the North Atlantic Oscillation (NAO). A poor representation of model variability in the North Atlantic area, a known problem referred to as the signal-to-noise paradox, limits the capacity of ensemble-based seasonal prediction systems (SPSs) in forecasting the NAO. To partially overcome this issue in this study is adopted a subsampling method firstly developed by Dobrynin et al. (2018). The idea is to apply statistical methods to a dynamical prediction reducing the ensemble size of a SPS. This is performed with the use of four variables studied during the autumn season strongly correlated with the wintertime NAO, referred as predictors. The results demonstrate one more time the effectiveness of this approach in increasing the predictability of NAO index and its variability within SPSs. Furthermore, the analysis evidences an enhanced ability of the models in predicting the intensity of the SPV and the number of SSW days. This study provides some signals about the connection of these improvements with a better representation of LSWA within critical regions across Eurasia.

4:00pm - 4:30pm

Coffee Break

Location: **Poster area, Atrio, Edificio 5, Studium 2000, Università del Salento**

4:30pm - 5:30pm

PREVISIONI II

Location: **Session room, Aula 7, Edificio 6, Studium 2000, Università del Salento**
Session Chair: **Valerio Capecchi**
Session Chair: **Angelo Finco**

4:30pm - 4:45pm

Il contributo dell'Intelligenza Artificiale alla previsione a medio termine dei fulmini

Mattia Cavaiola[1], Federico Cassola[2], Davide Sacchetti[2], Francesco Ferrari[3], Andrea Mazzino[3]
[1]CNR-ISMAR, Italy; [2]ARPA Liguria; [3]DICCA Università degli Studi di Genova

Gli algoritmi tradizionali deterministici sono stati per decenni la spina dorsale di molte discipline scientifiche. Questi algoritmi si basano su principi e leggi fisiche consolidate, consentendo un approccio sistematico alla risoluzione dei problemi. D'altro canto, le strategie basate sull'intelligenza artificiale (IA) risultano un potente strumento per gestire grandi quantità di dati ed estrarre modelli e relazioni che potrebbero essere difficili da identificare attraverso strategie tradizionali. In questo lavoro, abbiamo creato un ponte tra questi due ambiti utilizzando l'IA per trovare una mappatura ottimale di variabili meteorologiche previste, con due giorni di anticipo, dal modello deterministico ECMWF-HRES in relazione all'occorrenza dei fulmini. La capacità di previsione dell'algoritmo potenziato dall'intelligenza artificiale risulta significativamente superiore a quella dell'algoritmo completamente deterministico utilizzato nel modello ECMWF-HRES. Abbiamo ottenuto un valore molto alto di Recall di circa il 95% nell'intervallo di previsione 0-24 ore. Questa prestazione supera l'85% ottenuto da HRES con la stessa precisione dell'algoritmo IA.

4:45pm - 5:00pm

Assimilazione dati adattiva guidata da breeding: esperimenti numerici su modelli di bassa dimensionalità

Andrea Orlandi[1], Alberto Baldi[2], Franco Bagnoli[3,4], Alberto Ortolani[1,5], Samantha Melani[1,5]
[1]Consorzio LaMMA, Firenze; [2]SDG Group, Firenze; [3]Dip. di Fisica ed Astronomia, Università di Firenze; [4]Centro Interdipartimentale per lo Studio delle Dinamiche Complesse, Università di Firenze; [5]CNR-IBE, Firenze

L'adozione di strategie adattive all'interno del processo di Assimilazione Dati (Data Assimilation, DA) può consentire l'ottimizzazione del flusso d'informazione dalle osservazioni per la stima dello stato iniziale dei modelli di previsione numerica. Nel presente lavoro si sono valutate le potenzialità a tal fine del metodo di "breeding". Si è studiata la possibilità di ottimizzare l'attivazione della DA, nei domini temporale e spaziale, estraendo dalla dinamica dei Bred Vectors (BVs) informazioni sulla rapidità di crescita delle perturbazioni. Lo studio è stato sviluppato applicando tali approcci a modelli di bassa dimensionalità (Low Order Models, LOMs), che consentono di svolgere sperimentazione numerica vasta e sistematica ad un costo computazionale contenuto, pur mantenendo importanti aspetti di non linearità e forte dipendenza dalle condizioni iniziali. Per tale motivo i LOMs sono preziosi strumenti sia nella ricerca, per l'analisi iniziale di approcci innovativi di previsione numerica e DA, sia nella didattica come efficace via di primo approccio alle tecniche numeriche e di DA. Nel contesto di una tesi di Laurea Magistrale in Fisica, si è lavorato con due LOMs: Lorenz '63 (L63) e Lorenz-Emanuel '96 (LE96). In una prima fase, svolta su L63, è stato configurato uno schema di calcolo con sequenze di cicli assimilazione-previsione, in analogia con la reale previsione meteorologica operativa. In tale schema si sono valutate su L63 strategie di DA adattiva nel dominio temporale. In una seconda fase, dopo aver esteso lo schema di calcolo al modello spazialmente distribuito LE96, si sono definite e valutate su di esso strategie di DA adattiva nel dominio spaziale. La sperimentazione numerica è stata svolta con diversi metodi di DA: 3D-VAR, Extended Kalman Filter (EKF), Ensemble Kalman Filter (EnKF). I più rilevanti effetti dell'approccio adattivo si sono ottenuti aggiungendo il vincolo di "non ripetizione", ovvero di non assimilare sullo stesso sito nei successivi step temporali. Ciò suggerisce l'opportunità di includere, in ulteriori studi, un'analisi di correlazione spazio-temporale per migliorare la strategia adattiva di selezione dei siti di assimilazione. I più importanti effetti di ottimizzazione adattiva della DA si sono ottenuti con il metodo EnKF. Quest'ultimo è un risultato rilevante dato che l'EnKF è estesamente applicato nei reali sistemi di previsione operativa, sia in ambito meteorologico che oceanografico.

5:00pm - 5:15pm

A model intercomparison study of the thermally-driven wind system in an Alpine valley

Lorenzo Giovannini[1], Eric Bazile[2], Paolo Deidda[3], Silvia Ferrarese[4], Enrico Ferrero[5], Brigitta Goger[6], Alexander Gohm[7], Alessio Golzio[8], Martin Köhler[9], Dietmar Oettl[10], Lippin Pauly[5], Quentin Rodier[2], Juerg Schmidli[11], Yann Seity[2], Stefano Serafin[12], Peter Sheridan[13], Shweta Singh[11], Silvia Trini Castelli[14], Clemens Wastl[15], Stephanie Westerhuis[7], Andrea Zonato[16]
[1]Department of Civil, Environmental and Mechanical Engineering, University of Trento, Trento, Italy; [2]CNRM, University of Toulouse, Meteo-France, CNRS, Toulouse, France; [3]Institute for Earth Observation, Eurac Research, Bolzano, Italy; [4]Department of Physics, University of Torino, Torino, Italy; [5]Department of Science and Technological Innovation, University of Eastern Piedmont, Alessandria, Italy; [6]Center for Climate Systems Modeling, Institute for Atmospheric and Climate Science, ETH Zürich, Zürich, Switzerland; [7]Department of Atmospheric and Cryospheric Sciences, University of Innsbruck, Innsbruck, Austria; [8]Regional Environmental Protection Agency of Piedmont, Torino, Italy; [9]Deutscher Wetterdienst, Offenbach, Germany; [10]Air Quality Control, Regional Government of Styria, Graz, Austria; [11]Institute for Atmospheric and Environmental Sciences, Goethe University Frankfurt, Frankfurt, Germany; [12]Department of Meteorology and Geophysics, University of Vienna, Vienna, Austria; [13]Met Office, Exeter, UK; [14]Institute of Atmospheric Sciences and Climate, National Research Council of Italy, Torino, Italy; [15]GeoSphere Austria, Vienna, Austria; [16]Koninklijk Nederlands Meteorologisch Instituut, De Bilt, Netherlands

This contribution aims at presenting results from a model intercomparison study developed in the framework of the TEAMx programme, with the main objective of evaluating the ability of different numerical weather prediction models to reproduce the development of thermally-driven winds and the associated thermodynamic fields in a mountain valley in real-case simulations. The use of real-case simulations allows the assessment of model performance against observations using a setup representative of operational forecasts, giving the opportunity to better discriminate the reasons behind the differences between models and to identify the physical processes mostly responsible for such discrepancies.

Different meteorological models participate in this initiative, including both operational and research models, i.e., AROME, GRAMM-SCI, ICON, Meso-NH, the Unified Model and WRF. Simulations are performed with a common setup regarding horizontal and vertical resolution, domain extent, initial and boundary conditions, characteristics of land cover and orography datasets and duration of the simulation, in order to help the comparability and the interpretation of the results. In particular, one domain covering the entire Alps is used, with horizontal grid spacing of ~1 km and vertical grid spacing varying from ~20 m near the ground to ~400 m in the stratosphere. Initial and boundary conditions are provided by ECMWF Integrated Forecasting System (IFS) forecasts on model levels. Moreover, for some models, different simulations are performed, to evaluate the sensitivity to physics options or model settings.

Model results are compared with measurements collected during the Intensive Observational Period 8 (IOP8, 13 September 2019) of the CROSSINN field campaign, performed in the Inn Valley (Austria), about 20 km east of the city of Innsbruck. IOP8 was characterized by weak synoptic forcing and clear-sky conditions, with the full development of thermally-driven winds. A wide range of instruments is available for model evaluation, including standard surface weather stations, flux towers, radiosondes, Doppler lidars and microwave radiometers, allowing for an extensive assessment of model performance and the identification of the physical processes mainly responsible for simulation errors. Model results are evaluated mainly considering the surface energy budget, the diurnal cycle of temperature, pressure and wind near the surface, and the vertical profiles of temperature and wind within the mountain boundary layer.

5:15pm - 5:30pm

The –WIND RISK Project: nowcast and precursors of strong thunderstorm outflows

Massimiliano Burlando[1], Elena Avolio[2], Mario Marcello Miglietta[2]
[1]Università di Genova, Italy; [2]CNR-ISAC, Italy

The Project –WIND RISK is a research project of relevant national interest, funded by the Italian Ministry of University and Research, which deals with the measurement and modelling of thunderstorm outflows (i.e., downbursts and gust fronts) in the Ligurian Sea for nowcast purposes and will be developed in collaboration between the University of Genoa and the Institute of Atmospheric Sciences and Climate of the National Research Council. Despite wind is the most destructive natural phenomenon in Europe, accounting for more than 70% of damages and casualties yearly, a thorough knowledge of thunderstorm outflows and their impact on the natural and built environment does not exist yet. Accordingly, the general objective of this project is to advance the knowledge of the processes inside thunderstorm clouds that can bring about particularly strong outflows, as well as the identification of the environmental (synoptic and mesoscale) conditions favourable to their development. During the project, two field campaigns using coupled radar/lidar remote-sensing techniques will be carried out in Piedmont and Liguria region, and proper algorithms will be applied to reconstruct the high-resolution 4D (i.e., in space and time) wind fields within cumulonimbus clouds. In addition, ad-hoc numerical simulations will be performed to analyze a set of case studies that will be investigated to find common meteorological precursors and environmental conditions favorable to the development of gust fronts/downbursts. This conference contribution aims at presenting in detail the main activities and outcomes that are expected to be reached during the project.

6:30pm - 8:00pm

Incontro divulgativo
Location: **Convitto Palmieri**

Mercoledì, 07/Feb/2024

9:00am - 11:00am

CLIMA I

Location: **Session room, Aula 7, Edificio 6, Studium 2000, Università del Salento**
Session Chair: **Piero Lionello**
Session Chair: **Paolo Ruggieri**

9:00am - 9:15am

Added value of a multi-model ensemble of convection-permitting rainfall reforecasts over Italy

Antonio Giordani, Paolo Ruggieri, Silvana Di Sabatino
Department of Physics and Astronomy (DIFA), University of Bologna, Bologna

The interest towards the development of high-resolution reforecast datasets (hindcasts based on historical model integrations, or reanalyses including the additional assimilation of observational data) allowing an enhanced representation of past meteorological states has been progressively increasing. Convection-permitting (CP) datasets have demonstrated to improve rainfall representation compared to convection-parameterized counterparts in terms of the spatial structure of rainfall fields, the timing and peak of the diurnal cycle of summer precipitation, and the frequency of wet days/hours. However, the simulation of convective-related phenomena is highly model-dependent, implying the inability to sample the full range of natural variability with single-model experiments. This is exacerbated for km-scale simulations owing to the intrinsic chaotic behavior underlying convective processes.

Recently, the development of Multi-Model Ensembles (MMEs) of CP regional climate models over Europe has demonstrated to efficiently tackle this issue and reduce the simulation error associated with single models. This approach could benefit also reforecast estimates in order to retrieve a complete, homogeneous, and optimized assessment of past precipitation states, which additionally could be valuable for downstream modeling applications such as forcing hydrological forecasting systems to obtain improved historical series of flood events.

This work presents the first MME of reforecast CP datasets over north-central Italy based on four reanalyses/hindcasts recently produced, with the aim to assess the added value of their joint employment. The datasets are obtained by dynamically downscaling the global reanalysis ERA5 using different numerical models: MERIDA-HRES (based on WRF-ARW), the hindcast based on the model MOLOCH, and SPHERA and VHR_REA-IT (both based on COSMO). The reference dataset for comparison is GRIPHO, the first Italian pluviometer-based hourly analysis. The investigation over a decade included various aspects such as the annual and seasonal dependence of daily and hourly mean rainfall intensity and frequency, heavy precipitation occurrence, and their summer diurnal cycles. The ensemble aggregation systematically improves rainfall estimates over single datasets counterparts in terms of more adherent spatial fields and minimized root-mean-squared errors with the observations, at the expense of a reduction in the spatial variability of the distributions.

9:15am - 9:30am

Identifying climate extremes in Africa through advanced bias correction of seasonal forecasts

Laura Trentini[1], Sara Dal Gesso[1], Marco Venturini[1], Federica Guerrini[1], Sandro Calmanti[2], Marcello Petitta[1,3]
[1]Amigo s.r.l., Via Flaminia 48, 00196 Rome, Italy; [2]Energy & Environment Modeling Unit, Climate & Impact Modeling Laboratory, ENEA Agenzia Nazionale Per le Nuove Tecnologie, L'energia e lo Sviluppo Economico Sostenibile, Via Anguillarese 301, 00123 Rome, Italy; [3]Department of Enterprise Engineering, University of Rome Tor Vergata, 00133 Rome, Italy

When using climate simulation outputs, one critical issue to consider is the systematic bias affecting the modelled data. Bias correction methods are commonly employed in impact models to assess the effect of climate events on human activities. However, the efficacy of most of the currently available methods is reduced in the case of extreme events because of the limited number of data for these low-probability and high-impact events.

The present work is part of the European project Focus Africa, dedicated to advancing innovative climate services in the southern regions of Africa. Our primary objective is to respond to the needs of risk assessment studies, focusing on the impact of extreme events. To this end, we designed a novel bias correction method to consistently correct extreme events of temperature and precipitation. We conceptually extend one of the classic Quantile Mapping (QM) methods by improving the description of the tail ends of the distribution through a generalised extreme value distribution (GEV) fitting.

The technique was applied to the daily mean temperature and total precipitation data from three seasonal forecasting systems: SEAS5, System7 and GCFS2.1, developed respectively by ECMWF, Météo-France and DWD. The bias correction efficiency was tested over the Southern African Development Community (SADC) region, which includes 15 Southern African countries. The performance was verified by comparing each of the three models with a reference dataset, the ECMWF reanalysis ERA5. The results reveal that this novel technique significantly reduces the systematic biases in the forecasting models, yielding further improvements over the classic QM. For both the mean temperature and total precipitation, the bias correction produces a decrease in the Root Mean Squared Error (RMSE) and in the bias between the simulated and the reference data. After bias correcting the data, the ensemble forecasts members that correctly predict the temperature extreme increases. On the other hand, the number of members identifying precipitation extremes decreases after the bias correction, highlighting the challenge of obtaining robust statistics due to the lack of information about extreme events.

9:30am - 9:45am

Change in rainfall and temperature over northern Africa induced by four different Great Green Wall scenarios.

Roberto Ingrosso[1], **Francesco S.R. Pausata**[2]

[1]Centres ESCER (Étude et la Simulation du Climat à l'Échelle RÉgionale) and GEOTOP, Department of Earth and Atmospheric Sciences, University of Quebec in Montreal, Montreal, Canada.; [2]Centres ESCER (Étude et la Simulation du Climat à l'Échelle RÉgionale) and GEOTOP, Department of Earth and Atmospheric Sciences, University of Quebec in Montreal, Montreal, Canada.

The Great Green Wall (GGW) is a multibillion-dollar African initiative to combat desertification and drought in the Sahel, a semi-arid region south of the Sahara Desert. This region was ravaged by severe droughts during the '60's and the '70's and represents an important climatic hotspot, which affects the local communities. This geoengineering project involves a range of stakeholders including national governments, international organizations, economic sectors, and local communities. The idea of a physical green wall of trees has now been developed into the implementation of scattered green zones throughout arid areas, providing sustainable reforestation, revegetation, and land management. However, potential climate impacts of the most recent GGW plan on the northern Africa have not been adequately evaluated in previous studies. In West Africa, the most important climate feature is the West African Monsoon (WAM), which brings rainfall over the Sahel during the Northern Hemisphere summer. An increased understanding of regional climate dynamics associated with global changes and of the impact of the GGW on the WAM is fundamental in order to provide better information for policymakers and the population of that area. In our study, we simulate the regional impact of four GGW scenarios with different vegetation densities on mean temperature and rainfall as well as climate extremes by means of a high-resolution regional climate model under two extreme future emission scenarios. The results show an increase in rainfall extending well outside the GGW region, a reduction of the drought lengths and an increase in rainy days in the higher vegetation density GGW scenarios. However, no significant change is found for the lowest vegetation density case. While the temperatures decrease during summer, more extreme hot days and heat index values in the pre-monsoonal season are simulated along all the GGWs. Hence, the GGW could help reduce the aridity over the Sahel; however, it could significantly increase the heat intensity perceived by the local population.

9:45am - 10:00am

ClimaMeter: Putting Extreme Weather in Climate Perspective. (INVITED)

Davide Faranda, **Climameter Team**

CNRS, France

ClimaMeter offers a dynamic approach to contextualize and analyze weather extremes within a climate context. This framework provides both easily understandable immediate contextualization of extreme weather events as well as more in-depth technical analysis shortly after the events. The foundation of ClimaMeter's methodology lies in identifying weather conditions similar to those responsible for the extreme event of interest. Focusing on the satellite era since 1979, ClimaMeter dissects two distinct periods: the early decades (1979–2000, "past") and the more recent decades (2001–2022, "present"). Utilizing data from MSWX, the framework evaluates how selected weather conditions have evolved between these periods, distinguishing between changes driven by natural climate variability and those attributed to anthropogenic climate change. ClimaMeter's strength stems from its reliance on historical data rather than numerical model simulations. This makes the methodology swift and reproducible, enabling quick analysis and results dissemination. ClimaMeter has already delved into prominent events like the Mediterranean heatwave of July 2023 and Depression Rea. These analyses provide valuable insights into the climate context of these impactful occurrences. For comprehensive details on ClimaMeter's methodology, refer to the peer-reviewed paper: "A climate-change attribution retrospective of some impactful weather extremes of 2021" by Faranda et al., published in Weather and Climate Dynamics (2022, 3, 1311–1340). This paper outlines the framework's intricacies and findings, offering a deeper understanding of how ClimaMeter contributes to the field of climate attribution and extreme event analysis.

10:00am - 10:15am

On the non-stationarity of Atlantic multidecadal variability and underlying mechanisms

Chiara Ventrucci[1], **Paolo Ruggieri**[1], **Alessio Bellucci**[2]

[1]Department of Physics and Astronomy, University of Bologna, Bologna, Italy; [2]Consiglio Nazionale delle Ricerche, Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Bologna, Italy

The Atlantic Multidecadal Variability (AMV) is a climate mode of variability that affects the surface ocean state of the North Atlantic on the multidecadal time scale. It is characterized by a horse-shoe shaped pattern in the sea surface temperature (SST) anomalies, connecting the subpolar and subtropical regions. When only internal variability is considered, the Atlantic Meridional Overturning Circulation (AMOC) is recognized to be the main driver of AMV. However, models robustly simulate a non-stationary behavior of their connection on the multidecadal time scale. Two kinds of co-variability regimes can be identified, defined as correlated and non-correlated. It is worth exploring how the loss of AMOC-AMV correlation is generated by internal variability, due to its potential impact on the skill of decadal predictions in the Atlantic sector. In this thesis, a multi-centennial pre-industrial simulation from the CESM-LME suite of experiments is used to characterize the state of the ocean under the different AMOC-AMV co-variability regimes. Specifically, a change-point detection method is applied to identify the AMOC-AMV co-variability regimes. Next, an ocean heat budget analysis is used to identify the mechanisms underlying the change between regimes, focusing on the Ocean Heat Content (OHC) in the Subpolar Gyre (SPG) region, by evaluating the contributions from

thermodynamical and dynamical terms in the heat budget equation. The obtained results suggest that the loss of AMOC-AMV correlation can be related to changes in the ocean circulation features, with a key role being played by the meridional ocean heat transport convergence in the SPG region. In particular, during non-correlated regimes, the variability of the AMOC index appears to be less relevant to the variability of the SPG OHC and cannot explain the subtropical features of the SST pattern. This conclusion holds also for some additional pre-industrial simulations, run with state-of-the-art climate models.

10:15am - 10:30am

The impact of a weakened AMOC on the global monsoon system in EC-Earth3 climate model

Roberta D'Agostino[1], Katinka Bellomo[2,1], Simona Bordoni[3], Virna Meccia[1]

[1]CNR-ISAC, Lecce, Italy; [2]Politecnico di Torino, Italy; [3]Università di Trento, Italy

Changes in Atlantic Meridional Overturning Circulation (AMOC) affect tropical precipitation through the coupling with the Hadley Circulation and cross-equatorial atmospheric heat transport. Climate model simulations project a possible weakening of the AMOC under global warming, but the impacts of a weakened AMOC relative to the external radiative forcing are unclear. To address this issue, here we run model experiments with the CMIP6 generation EC-Earth3 under preindustrial conditions where we artificially weaken the AMOC through the release of a freshwater anomaly at high latitudes in the North Atlantic and Arctic oceans. The simulated AMOC collapse of ~57% for 60 model years allows us to investigate atmospheric heat and circulation readjustments to the AMOC weakening and related impacts on tropical precipitation, including the global monsoon. We find that the Inter Tropical Convergence Zone (ITCZ) shifts southward due to reduced northward oceanic heat transport. The global monsoon is also impacted by the AMOC weakening: northern hemisphere monsoons are weaker than the control experiment, while southern monsoons are stronger, albeit with different sensitivities in different regions, with the monsoons systems in the Atlantic sector being strongly impacted by the AMOC decline. We further explore interbasin anomalies in the zonal/meridional atmospheric heat transport and net energy input triggered by the AMOC decline by examining local Hadley and Walker circulation asymmetries. Given that a ~57% reduction in the AMOC strength is within the inter-model range of future projections by the end of the 21st century, our results have important implications for understanding the role of AMOC in future tropical precipitation response.

10:30am - 10:45am

Revisiting ENSO and IOD contributions to Australian Precipitation

Giovanni Liguori

University of Bologna, Italy

Tropical modes of variability, such as El Niño–Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD), exert a strong influence on the interannual variability of Australian precipitation. Nevertheless, commonly used indices of ENSO and IOD variability display significant co-variability that prevents a robust quantification of the independent contribution of each mode to precipitation anomalies. This co-variability issue is often addressed by statistically removing ENSO or IOD variability from the precipitation field before calculating teleconnection patterns. However, by performing a suite of coupled and uncoupled modelling experiments in which either ENSO or IOD variability is physically removed, we show that ENSO-only-driven precipitation patterns computed by statistically removing the IOD influence significantly underestimate the impact of ENSO on Australian precipitation variability. Inspired by this, we propose a conceptual model that allows one to effectively separate the contribution of each mode to Australian precipitation variability.

10:45am - 11:00am

Inter-comparison and validation of high-resolution surface air temperature reanalysis fields over Italy

Francesco Cavalleri[1], Francesca Viterbo[2], Michele Brunetti[3], Riccardo Bonanno[2], Veronica Manara[1], Cristian Lussana[4], Matteo Lacavalla[2], Maurizio Maugeri[1]

[1]Environmental Science and Policy Dept., University of Milan, Milan, Italy; [2]Sustainable Development and Energy Resources Dept., Climate and Meteorology Group, RSE s.p.a, Milan, Italy; [3]Institute of Atmospheric Sciences and Climate of the National Research Council, CNR-ISAC, Bologna, Italy; [4]Division for Climate Services, the Norwegian Meteorological Institute, Oslo, Norway

Since its release, ERA5 has represented the state-of-the-art for global reanalyses, supplying initial and boundary conditions for higher-resolution regional reanalyses designed to capture finer-scale atmospheric processes. This study analyzes the capability of different reanalysis products to reproduce the surface air temperature (t2m) over Italy during the 1991-2020 period. The analyses encompass ERA5, ERA5-Land, the Meteorological Reanalysis Italian Dataset (MERIDA), the Copernicus European Regional ReAnalysis (CERRA), and the Very High-Resolution dynamical downscaling of ERA5 REAnalysis over Italy (VHR-REA_IT). The validation we perform concerns both the spatial distribution of the 30-year seasonal and annual normal values and the daily anomaly records. Each reanalysis is validated by comparing it with observations projected onto its own grid positions and elevations, overcoming any model bias resulting from an inaccurate representation of the real topography. Key findings show that normal values in reanalyses closely match observational values, with deviations typically below 1°C. However, in the Alps, winter cold biases sometimes exceed 3°C, and show a relation with the elevation. Similar deviations occur in the Apennines, Sicily, Sardinia, and the Po Plain (for VHR-REA_IT), particularly in summer. Daily anomalies generally have lower errors, with MERIDA scoring the best skills. Moreover, when aggregating daily

anomalies to longer time scales (from monthly to annual), the errors of the anomaly records quickly decrease and, at the yearly scale, only a meagre fraction of them has errors exceeding 0.5 °C.

11:00am - 11:30am

Coffee Break
Location: **Poster area, Atrio, Edificio 5, Studium 2000, Università del Salento**

11:30am - 1:00pm

CLIMA II
Location: **Session room, Aula 7, Edificio 6, Studium 2000, Università del Salento**
Session Chair: **Paola Faggian**
Session Chair: **Roberta D'Agostino**

11:30am - 11:45am

Misura del flusso turbolento di CO2 e CH4 a Ny Alesund (Artico)

Antonio Donateo[1], Gianluca Pappaccogli[2], Mauro Mazzola[3], Stefano Decesari[4]
[1]Istituto di Scienze dell'Atmosfera e del Clima (ISAC-CNR), Lecce, Italy; [2]Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, Università del Salento, Lecce, Italy; [3]Istituto di Scienze Polari (ISP-CNR), Bologna,Italy; [4]Istituto di Scienze dell'Atmosfera e del Clima (ISAC-CNR), Bologna, Italy

Il metano e l'anidride carbonica sono due dei gas serra più significativi che contribuiscono al cambiamento climatico e i loro flussi nell'Artico sono stati di grande interesse per i ricercatori negli ultimi anni. Gli scambi di metano ed anidride carbonica tra la superficie (tundra e manto nevoso) e l'atmosfera sono stati misurati in modo continuo mediante la tecnica di eddy covariance (EC) per un periodo di 2 anni presso il sito sperimentale di Ny Ålesund (78°55'N, 11°56'E, Svalbard). Il sistema EC è composto da un anemometro sonico tridimensionale (WindMaster Pro), un analizzatore di metano (LI-7700) ed un analizzatore di anidride carbonica (LI-7500) a percorso aperto. Gli strumenti sono stati installati a un'altezza di 15 metri sulla "Climate Change Tower" (CCT). Il periodo di misura oggetto di studio va dal 9 aprile 2021 al 31 marzo 2023. I flussi turbolenti sono stati calcolati su base di 30 minuti utilizzando EddyPro®. La frazione molare media di CO_2 sul periodo di misura è pari a 410.74 mmol/mol mentre per il metano abbiamo una concentrazione media di 2.04 mmol/mol. I flussi turbolenti di scambio di CO_2 sono di bassa intensità, con un valore mediano pari a -0.11 mmol/m^{2}s, con fenomeni di assorbimento (valori negativi) nel periodo estivo da giugno ad agosto. La distribuzione dei flussi di CH_4 è in gran parte attorno allo zero con fenomeni di assorbimento più intenso nel periodo estivo, quando la temperatura media del suolo passa sopra lo zero. In particolare, la distribuzione dei flussi è compresa tra -0.014 e 0.010 µmol/m^{2}s, con un flusso mediano di -3.8303e-04 µmol/m^{2}s. Le osservazioni indicano dunque che il sito si comporta come un pozzo di CH_4 soprattutto nel periodo estivo (giugno-agosto) quando con lo scioglimento nello strato attivo ricomincia l'azione metanotrofica dei microbi.

11:45am - 12:00pm

L'attuale calo della persistenza del manto nevoso sulle Alpi non ha precedenti negli ultimi sei secoli

Marco Carrer[1], Raffaella Dibona[1], Angela Luisa Prendin[1], Michele Brunetti[2]
[1]UNIPD-TeSAF; [2]CNR-ISAC, Italy

La copertura nevosa nelle regioni di alta quota e alle alte latitudini ha forti effetti sul clima della Terra, sui processi ambientali e sulle attività socioeconomiche. Negli ultimi 50 anni le Alpi hanno registrato una riduzione del 5.6% per decennio nella durata del manto nevoso (Matiu et al., 2021), fenomeno che sta già facendo sentire i suoi effetti in una regione in cui economia e cultura ruotano, in larga misura, attorno alla stagione invernale.

Per inquadrare questa tendenza in un contesto plurisecolare di cambiamento climatico è necessario ricorrere a misure indirette. Tuttavia, sino a poco tempo fa, non erano mai stati individuati proxy sensibili a questa variabile in grado di fornire una sua ricostruzione robusta e con risoluzione annuale.

In un recente lavoro (Carrer et al., 2023), gli autori del presente abstract hanno individuato per la prima volta in un arbusto che cresce con portamento prostrato (Juniperus communis L.) nelle zone di alta quota, un proxy sensibile alla copertura nevosa.

Analizzando 572 serie di larghezza degli anelli di accrescimento di esemplari (vivi e morti) di ginepro comune campionati in alta quota nella Val Ventina, in provincia di Sondrio, è stato possibile ricostruire la durata del manto nevoso per gli ultimi seicento anni.

Questi dati mostrano come la durata dell'attuale copertura del manto nevoso sia più breve di oltre un mese rispetto alla media di lungo termine, un declino che non ha precedenti negli ultimi sei secoli.

Questi risultati evidenziano l'urgente necessità di sviluppare strategie di adattamento per alcuni dei settori ambientali e socioeconomici più sensibili di questa regione.

12:00pm - 12:15pm

Snowfall variability and trend in the Apennine Mountains, 1951-2001

Vincenzo Capozzi[1], Francesco Serrapica[1], Armando Rocco[1], Clizia Annella[2,1], Giorgio Budillon[1]
[1]Dipartimento di Scienze e Tecnologie, Università degli Studi di Napoli "Parthenope"; [2]CETEMPS Università degli Studi dell'Aquila

In light of recent climate changes, in the last two decades several research activities have been devoted to identifying changes in the duration and thickness of snowpack in various regions of the world. In the Mediterranean area, most the available studies are focused on the Alpine (e.g. Marcolini et al., 2017b; Matiu et al., 2021) and Pyrenean regions (e.g. López-Moreno et al 2020; Bonsoms et al 2021). This study aims to add a new contribution to this research field, investigating the snowfall variability and trends observed in the

period 1951-2001 in the Apennines Mountains. To pursue this aim, we used the monthly observations of the number of days with snow (hereafter, NDS), snow cover duration (hereafter, SCD) and total height of new snow (hereafter, HNS) collected at 129 stations located in the Central and Southern Apennines between 288 and 1750 m asl. Such data have been manually digitized from the Hydrological Annals of the Italian National Hydrological and Mareographic Service. The available dataset has been primarily analyzed to retrieve the common modes of spatial variability of the three investigated variables. To meet this goal, we used a methodology based on Principal Component Analysis and Cluster Analysis. After several sensitivity tests, four clusters have been chosen for NDS and SCD and three for HNS. Such clusters well represent the spatial variability of snowfall, which is mainly driven, in the target area, by altitude and, secondly, by the distance from the sea and by site exposure. Subsequently, we have carried out a linear trend analysis, employing the Theil-Sen estimator and the Mann-Kendall test. Preliminary results have shown an overall negative tendency for both NDS and SCD. In all considered seasons, a clear direct relationship between trend magnitude and elevation has emerged. For cluster including only stations above 1000 m asl, a significant (at 95% confidence level) trend has been found in winter season (i.e. from December to February): −1.8 days/10 year for NDS and −3.2 days/10 year for SCD. Regarding HNS, no relevant tendencies have been discovered (although the analysis for this variable is restricted to the period 1971-2001 for the limited data availability). In addition, we have applied a wavelet analysis to detect the main transient oscillations of the investigated parameters in the time-frequency domain and to search for relationships with large-scale patterns.

12:15pm - 12:30pm

Analisi delle tendenze e delle distribuzioni spaziali delle precipitazioni in un transetto compreso fra la Pianura Padana e lo spartiacque alpino sulla base di osservazioni giornaliere nel periodo 1923-2022

Sebastiano Carpentari, Dino Zardi
University of Trento, Italy

I dati meteorologici storici sono essenziali per comprendere il clima di una regione.

In questo studio, si analizzano le tendenze e la distribuzione spaziale delle precipitazioni in un settore compreso tra la Pianura Padana veronese e i rilievi settentrionali dell'Alto Adige. Per lo scopo, si è creato un set di dati comprendente le precipitazioni giornaliere provenienti da 36 stazioni pluviometriche per il periodo 1923-2022. Alcune stazioni hanno richiesto la digitalizzazione manuale dei dati.

Tutti i dati sono stati sottoposti a procedure di controllo qualità per garantirne l'accuratezza, mentre i valori anomali sono stati identificati e laddove possibile corretti utilizzando i metadati reperiti da varie fonti. I dati sono stati successivamente omogeneizzati utilizzando la libreria Climatol (Gujiarro 2021).

Si sono selezionati sette diversi indici climatici per evidenziare eventuali pattern climatici. Inoltre, alcuni di essi sono stati interpolati utilizzando l'algoritmo kriging con drift esterno (KED) per tre trentenni di riferimento, ovvero 1931-1960, 1961-1990 e 1991-2020. Dapprima è stata verificata la normalità dei dati tramite tre test statistici quali Shapiro-Wilks, D'Agostino-Pearson, e Kolmogorov-Smirnov. L'eventuale non normalità ha richiesto l'applicazione dei metodi Box-Cox e Yeo-Johnson. Successivamente, i variogrammi sperimentali sono stati ottenuti tramite una procedura iterativa, la quale ha permesso di determinare la migliore interpolazione tramite il modello teorico esponenziale. Infine, l'algoritmo KED è stato eseguito con due setup differenti: a 8 e 16 stazioni.

I risultati ottenuti mettono in mostra delle peculiarità climatiche tipiche di una ampia fascia prealpina. In futuro saranno necessarie ulteriori ricerche per approfondire alcuni pattern spaziali identificati durante questo studio, i quali si suppone essere strettamente legati alla variabilità dei regimi meteorologici tipici dell'area europea e mediterranea. Infine, i risultati suggeriscono l'importanza della valorizzazione dei dati storici, auspicando una digitalizzazione sistematica dei registri molti dei quali ancora ad oggi in forma cartacea.

12:30pm - 12:45pm

Climate report supporting the Strategy for Mitigation and Adaptation to Climate Change of the Autonomous Province of Trento

Anna Napoli[1,2], Michael Matiu[1], Lavinia Laiti[3], Roberto Barbiero[3], David Tombolato[4], Silvia Scarian Monsorno[4], Dino Zardi[1,2], Alberto Bellin[1], Bruno Majone[1]

[1]Department of Civil, Environmental and Mechanical Engineering (DICAM), University of Trento, Trento, Italy; [2]Center for Agriculture Food Environment (C3A), University of Trento, Italy; [3]Provincial Environmental Protection Agency (APPA), Trento, Italy; [4]Science Museum of Trento (MUSE), Trento, Italy

Climate change is impacting all the areas in the world, especially environments which are more sensitive. Among them, mountainous regions have been found to be particularly prone to severe impacts. Indeed, mountains appear to be climate "hotspots" where changes can anticipate or amplify what is occurring elsewhere, with a cascade of impacts deeply affecting ecosystems and environment, local socio-economic activities and communities. The complex orography implies different impacts of climate change at the local scale, where climatic conditions mainly change with elevation, which makes future projections of the mountain environment more difficult than in other areas.

For these reasons, the portion of the southeastern European Alpine region occupied by the Autonomous Province of Trento is exposed to the impacts of climate changes. To face the challenges arising from projected changes, the local government decided to adopt a multiannual work programme ("Trentino Climate 2021-2023") to develop a "Provincial Strategy for Climate Change Mitigation and Adaptation". As part of that, the Environmental Protection Agency of the Autonomous Province of Trento (APPA), the University of Trento (DICAM) and the Science Museum of Trento (MUSE) collaborated in the publication of an updated Trentino State of the Climate Report, to set the knowledge baseline for the future Strategy of mitigation and adaptation of the impacts of climate change in the different environmental systems and socio-economic sectors. The

work has been done by collecting, organising and summarizing climate change studies available in the scientific and technical literature and exploiting the wealth of data available from measurements and model outputs, identifying at the same time possible knowledge gaps. In this contribution, we present and discuss the results of this study.

12:45pm - 1:00pm

Water, sun and wind. How climate services have adapted to the demands of the energy market.

Marcello Petitta[1,2], Federica Guerrini[2], Laura Trentini[2], Dal Gesso Sara[2], Marco Ventirini[2], Sandro Calmanti[3]

[1]Department of Enterprise Engineering, University of Rome Tor Vergata, 00133 Rome, Italy; [2]Amigo s.r.l., Via Flaminia 48, 00196 Roma, Italy;; [3]Climate & Impact Modeling Laboratory SSPT-MET-CLIM, ENEA, Via Anguillarese 301 00123 Roma, Italy;

Since their inception, climate services have found a natural application in the renewable energy market. The continuous demand for predictive accuracy and extended forecasting timescales prompted energy market players to search for innovative and reliable methods of predicting weather and climate patterns.

Since renewable energy sources depend on the weather, they require sophisticated climate forecasts to ensure functional efficiency and minimal disruptions. As a result, hydrological, wind and solar forecasts have become critical not only for national power grids, but also for emerging renewable energy services for domestic use.

As renewable energies are increasingly used, accurate forecasts are even more crucial. Today, physical models, advanced statistical algorithms and machine learning technologies are used to adapt climate forecasts to meet the demands of fluctuating renewable energies. Real-time scenario analysis helps predict and strategically manage potential demand-related events such as summer heat waves, severe cold fronts or prolonged drought.

In this study, we aim to assess the accuracy of energy forecasts for three distinct climate services: SnowPower, ARIA and PENGUIN, addressing the hydroelectric, wind and solar power sectors, respectively. Our analysis focuses on the quality of these forecasts in terms of relative and absolute errors. In addition, we propose innovative methods to improve the forecast accuracy of both climate variables and energy production. By integrating physical modelling approaches with machine learning algorithms, our research aims to provide more reliable and accurate forecasts, ranging from minutes to an entire season ahead. With this analysis, we contribute to the advancement of climate services towards operational efficiency and minimization of disruptions in the energy market.

1:00pm - 2:00pm

Pausa Pranzo

Location: **Poster area, Atrio, Edificio 5, Studium 2000, Università del Salento**

2:00pm - 3:00pm

Poster Session 02

Location: **Poster area, Atrio, Edificio 5, Studium 2000, Università del Salento**

[1] The impact of volcanic forcing of different emission strengths on tropical hydroclimate

Roberta D'Agostino[1], Claudia Timmreck[2], Shih-Wei Fang[3]

[1]CNR-ISAC, Lecce, Italy; [2]Max Planck Institute for Meteorology, Hamburg, Germany; [3]Center for Climate Physics, Institute for Basic Science, Busan, Republic of Korea

The impact of volcanic forcing on tropical hydroclimate (e.g., monsoons, ITCZ, Hadley and Walker circulations, ENSO) is investigated in a new set of sensitivity experiments within the Max Planck Institute Grand Ensemble framework. Five ensembles are created, each containing 100 realizations for an idealized volcanic eruptions (tropical, Northern and Southern hemispheres) with emissions covering a range of 2.5-40 Tg sulfur (S). The ensembles provide an excellent database to disentangle the influence of volcanic forcing on monsoons and tropical hydroclimate over the wide spectrum of the climate's internal variability. Monsoons are generally weaker for two years after volcanic eruption and their weakening is a function of emissions. However, only a stronger than Pinatubo-like eruption (10 Tg S) leads to significant and substantial monsoon changes, and some regions (such as North and South Africa, South America and South Asia) are much more sensitive to this kind of forcing than the others. The decreased monsoon precipitation is strongly tied to the weakening of the regional tropical overturning. The reduced atmospheric net energy input and increased gross moist stability at the Hadley circulation updraft due to the equatorial volcanic eruption, require a slowdown of the circulation as a consequence of less moist static energy exported away from the intertropical convergence zone. The ITCZ swings according to the volcanic source (e.g., Northern or Southern hemisphere) and positive ENSO phase can be triggered by tropical and Northern volcanic eruptions.

---

[2] Monsoon trend and multi-scale variability changes over the last 6000 years

Roberta D'Agostino[1], Pascale Braconnot[2], Julien Crétat[3], Sandy Harrison[4], Olivier Marti[2]

[1]CNR-ISAC, Lecce, Italy; [2]LSCE-IPSL Orme des Merisiers, bât 714, 91191 Gif-sur Yvette Cedex, France,; [3]Centre de Recherches de Climatologie, UMR 6282 Biogéosciences, CNRS/Université de Bourgogne, France; [4]Department of Geography and Environmental Science, University of Reading, Reading, RG6 6AB, United Kingdom

The Holocene started about 10000 years before present and is the period during civilizations as we know them today emerged. However, during that time several regions such as Sahel-Sahara or the Indus valley

in the tropics experienced severe aridification and dramatic environmental changes for ecosystems and humans. There is general agreement that this has been caused by the southward shift of the boreal monsoon rain belt and that slow variations of Earth's orbital parameters are the long-term driver. In addition to insolation forcing, several feedbacks involving the ocean, sea-ice, or vegetation have had a profound impact on regional changes and on the multiscale monsoon variability, including extreme monsoon years. They have shaped the magnitude and the timing of environmental changes depending on monsoon systems. Although these feedbacks have been widely discussed, their relative strength is still under debate. These unknows prevent proper anticipation and simulation of future monsoon behavior. Long transient simulations of the Holocene climate allow us to revisit these questions by shedding light on monsoon multiscale variability and the representation of vegetation feedbacks. Using a set of transient mid to late Holocene simulations (last 6000 years), we will discuss the relative evolution of the Indian and African monsoon. Highlights will be on the relative responses to changes in insolation seasonality between African and Indian monsoons, the role of dynamical versus thermodynamical atmospheric feedbacks in monsoon precipitation, and on the relationship between long term trends, interannual and periods of extreme dry or wet monsoon seasons. Comparisons of model results with proxy reconstruction of climate variability over land and ocean from speleothems, coral and shells has been done considering the chaotic nature of multiscale monsoon variability. They provide us with indication of the consistency of model inferred trends in monsoon variability and the real climate trajectory.

---

[3] The Maintenance of the Hydrological Cycle in the Mediterranean: Assessing the Role of Different Circulations on Net Precipitation Patterns from ERA5 Reanalysis and CMIP6 Models

Roshanak Tootoonchi[1,2], Simona Bordoni[1], Roberta D'Agostino[3]

[1]University of Trento, Italy; [2]Edmund Mach Foundation (FEM-C3A), Italy; [3]National Research Council, Institute of Atmospheric Sciences and Climate (ISAC-CNR), Italy

The maintenance of the hydrological cycle in the Mediterranean region is studied using the 5th generation European Centre for Medium-Range Weather Forecasts (ECMWF) Re-Aanalysis (ERA5) and historical simulations from the 6th phase of the Coupled Model Intercomparison Project (CMIP6). We revisited the atmospheric moisture budget in the Mediterranean region to assess the role of different circulations, namely the mean flow, stationary and transient eddies, in the maintenance of the observed climatological net precipitation (P – E) in the annual mean and zonal mean over land and sea.

Our analyses show that the annual-mean P - E is positive over the northern Mediterranean land regions and negative over the Mediterranean Sea. According to ERA5, the long-term zonal-mean moisture flux, associated with the descending branch of the Hadley cells in lower latitudes, causes drying and subsidence across the southern Mediterranean. The sub-monthly transient eddies are the predominant mechanism sustaining positive P - E over land on an annual basis, while the stationary eddies diverge moisture away from the region. A clear exception from this pattern is northwestern Africa, where the divergent transient eddies are opposed by convergent total stationary eddies.

The divergent total stationary-eddy moisture flux arises from divergent zonally anomalous circulations and is opposed and mediated by the convergent pure stationary eddies. The contribution by the zonal-mean moisture flux is quite small, revealing how moisture flux and the associated convergence by stationary eddies dominates the time mean flow in the region.

These general features are overall well captured in the ensemble-mean of ten CMIP6 models, apart from some regional features that models fail to successfully simulate. Whilst the CMIP6 models capture the strong P – E over the Alps, they fail to simulate the heavy P – E over Balkans. In comparison to the observations, the models underestimate the transient eddies over the northern Mediterranean. Similar limitations have been reported in recent studies using CMIP5 models (Ziv et al. 2013; Seager et al. 2014). We attribute the models biases relative to ERA5 to their coarse spatial resolution, which leads to their inability to model a region of complex orography such as the Mediterranean.

Whilst some regional biases can be witnessed in simulations by the CMIP6 models, the large-scale picture is captured very well. Therefore, the CMIP6 models are reliable enough for analysing the response of the climate to the projected scenarios of climate change (Martel et al., 2022).

---

[4] The European summer 2022 flash drought

Roberta D'Agostino[1], Hanh Nguyen[2], Jordan Christian[3], Aglae Jezequel[4], Matthew Wheeler[2], Jean-Philippe Duvel[4], Hugo Bellenger[4], Xavier Perrot[4], Ghyslaine Boschat[2], Sally Lavender[5]

[1]CNR-ISAC, Lecce, Italy; [2]Bureau of Meteorology, Melbourne, Victoria, Australia; [3]School of Meteorology, University of Oklahoma, Oklahoma, United States of America; [4]Laboratoire de Météorologie Dynamique, Institut Pierre-Simon Laplace, Guyancourt, France; [5]Met Office, Exeter, United Kingdom

The role of prolonged soil moisture and precipitation deficit for preconditioning the European 2022 flash droughts and compound heatwaves are investigated in ERA5-Land dataset. Flash droughts are detected using the standardized evaporative stress ratio (SESR) index, defined as the standardized ratio between evapotranspiration and potential evapotranspiration. This metric allows a robust identification of dry episodes within the season that could damage agriculture. The 2022 summer was characterized by two prolonged drought episodes, with different starting and ending time depending on the considered areas: drought started earlier in Southern Europe (June 2022) and then in the Northwest later on (July/August). We have investigated the physical mechanisms responsible for recent extreme dry events (2022, 2003, 2018 and 1980): the large scale atmospheric conditions (e.g., prolonged anticyclonic blocking conditions) are found to be key ingredients for flash droughts in 2022 and 2003, which exhibit a similar Rossby wave pattern. However a direct comparison of the anomalies in the two episodes, reveals that that 2022 was

unprecedented and much stronger and longer than 2003 because of an extreme anticyclonic blocking event. On the other hand, the flash drought of 2018 was due to high North Atlantic Oscillation values.

[5] Venice Acqua Alta events in a changing climate: dynamical diagnostic and effectiveness of the MoSE

Tommaso Alberti[1], Davide Faranda[2], Erika Coppola[3], Mireia Ginesta[2], Marco Anzidei[1]
[1]Istituto Nazionale di Geofisica e Vulcanologia, Italy; [2]Laboratoire des Sciences du Climat et de l'Environnement, France; [3]International Centre for Theoretical Physics, Italy

Extreme events are becoming more frequent due to anthropogenic climate change, posing serious concerns on societal and economic impacts and asking for mitigating strategies, as for Venice.

Here, we firstly utilize a dynamic diagnostic approach, combining extreme value theory and dynamical systems, to assess extreme sea level (ESL) events. Two key indicators, the instantaneous dimension and inverse persistence, are employed to analyze the localization and underlying processes of these events concerning sea level fluctuations and atmospheric contributions.

Furthermore, we examine four specific devastating Acqua Alta events occurred in 1966, 2008, 2018, and 2019, revealing a link between changes in atmospheric circulation and event severity. We also assess the efficacy of the MoSE (Experimental Electromechanical Module) safeguarding system in mitigating extreme flooding events. Our findings show that the MoSE system has provided protection against analogues of the most extreme event, the 1966 flood.

These insights carry substantial implications for Venice and other coastal cities facing rising sea levels due to more frequent and intense extreme events, also serving as a valuable tool for evaluating adaptation strategies in the face of potential higher global warming levels, emphasizing the need for proactive mitigation measures.

[6] Assessment of TC Hazard and Risk in a Changing Climate by meansof a new Hybrid Tropical Cyclone Global Model

Roberto Ingrosso[1], Mathieu Boudreault[2], Francesco S.R. Pausata[1]
[1]University of Quebec in Montreal (UQAM), Department of Earth and Atmospheric Sciences, Montréal, Canada (ingrosso.roberto@courrier.uqam.ca); [2]University of Quebec in Montreal (UQAM), Department of Mathematics, Montréal, Canada

The future evolution of tropical cyclones (TCs) in a warming world is an important issue, considering their potential socio-economic impacts on the areas hit by these phenomena. Modelling the impacts of TCs remains an important challenge as climate projections do not always provide robust responses about their future evolution. Risk management and regulatory actions require more robust quantification in how the climate change affects TCs dynamics. A probabilistic hybrid TC model based upon statistical and climate models, physically coherent with TC dynamics, is being built to investigate the potential impacts of climate change. Several physical predictors associated with the TC formation and motion and produced by reanalysis (ERA5) and the Community Earth System Model (CESM) ensemble are considered in this study. Here, we provide a preliminary assessment of climate change impact on the frequency and location of cyclogenesis, on maximum sustained winds and the whole wind structure of full TC tracks under a high emissions scenario (RCP8.5) for the period 2021-2060.

[7] Assessing the vulnerability to climate change of tree species for urban afforestation

Cristiano Gala
Università degli Studi dell'Aquila - CETEMPS, Italy

Nature-based solutions are now a key part in climate change adaptation, particularly for urban environments. The integration of natural systems within the urban fabric has the potential to increase cities' resilience to the predicted changes in climate. Urban forests are one of the most used methods for adding ecosystem services to an urban environment and at the same time address urban-specific climate change challenges such as heat-island effect, intense rainfall and water management. However, the effects of climate change in the long-term on urban forests are not often taken into account when planning interventions such as afforestation. Species selection for urban forests should, among other factors, be based on an assessment of local future climatic conditions, so to ensure the long-term viability of the project. Here we propose a methodology easily applicable to any place in Europe. We use data from interpolated publicly available climate datasets and species distribution data from the European Tree Atlas in order to analyse climatic niches for tree species in Italy. These climatic ranges are then compared to local climatic data, obtained from homogenised time-series measured by a weather station in the city of L'Aquila. The results are summarised in a suitability matrix providing vulnerability scores for each species based on predicted climate changes for the local area. The analysis ranks the species which are less vulnerable to projected future climate conditions. The application to the pilot area of L'Aquila suggests that some species already present will still be suitable also in future climate (e.g. *Quercus pubescens*) while others will not (e.g. *Quercus petraea.*), and species not traditionally present may become suitable (e.g. *Quercus ilex*). The importance of obtaining accurate local climate data from observations is a key aspect for municipalities to consider as results of this analysis are greatly dependent on this.

[8] Modelli climatici decadali: valutazioni del cambiamento climatico a breve termine a livello sub-regionale

Marco D'Oria, Valeria Todaro, Maria Giovanna Tanda
Università di Parma, Italy

Il cambiamento climatico in atto richiede l'implementazione di strategie di mitigazione e adattamento sia a breve che a lungo termine. Per questo scopo è stato profuso un notevole impegno nello sviluppo di modelli climatici con proiezioni a lungo termine, mentre le simulazioni a breve termine hanno ricevuto meno attenzione. Un passo significativo verso la realizzazione di previsioni decadali è stato compiuto con il quinto Coupled Model Intercomparison Project (CMIP5). Il Decadal Climate Prediction Project (DCPP), come parte del CMIP6 e del World Climate Research Program (WCRP) Grand Challenge on Near-Term Climate Prediction, ha presentato importanti progressi nell'ottimizzazione dei modelli decadali. Diversi studi hanno utilizzato le previsioni dei modelli del DCPP per valutare le loro capacità predittive ed esaminare i cambiamenti climatici a breve termine su scala globale. Tuttavia, la ricerca a livello regionale e ancor di più a livello di bacino idrografico è rimasta limitata. Questo studio si concentra sulla valutazione dell'affidabilità dei modelli decadali per la previsione del cambiamento climatico a breve termine in Emilia-Romagna. In particolare, sono state analizzate le precipitazioni e le temperature massime e minime con l'obiettivo di valutare quanto accuratamente i modelli climatici decadali riescano a riprodurre le caratteristiche delle variabili climatiche locali. Per ottenere stime delle variabili climatiche su una griglia più dettagliata ('downscaling'), si è utilizzato un metodo di interpolazione di tipo conservativo. Inoltre, per tenere conto delle incertezze nelle previsioni, è stato utilizzato un insieme di modelli climatici ('ensemble') con la massima risoluzione disponibile. Comparando i dati di 'hindcast' forniti dai modelli con le osservazioni storiche, è stato possibile individuare e analizzare la presenza di distorsioni ('bias' e/o 'drift') nelle previsioni dei modelli climatici. Sono stati quindi sperimentati diversi metodi di correzione di tali distorsioni, dai più semplici ai più complessi, per identificare quelli che mostrano le migliori prestazioni nella riproduzione delle caratteristiche climatiche medie e dei loro estremi.

---

[9] Long-term trend and variability in surface temperatures over Emilia-Romagna from 1962 to 2022

Davide Sabatani[1,2], Federico Grazzini[3,4], Valentina Pavan[3], Gabriele Antolini[3]
[1]Department of Physics and Astronomy, University of Bologna, Bologna, Italy; [2]Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC), Bologna, Italy; [3]Arpae-SIMC, Hydro-Meteo-Climate Service of the Regional Agency for Prevention, Environment and Energy (ARPAE), Bologna, Italy; [4]Ludwig-Maximilians-Universität, Meteorologisches Institut, Munich, Germany

Scientific interest is increasingly drawn towards regional and global meteorological extremes, given their impacts on populations, infrastructure, and ecosystems. These extremes are shaped by a complex interaction between internal variability and long-term trends. The aim of the present work is to evaluate changes in high frequency variability and the influence of long-term trends on the occurrences of extremes, with focus on surface temperatures over the period from 1962 to 2022 in Emilia-Romagna, a region of Northern Italy. Daily data of 2m temperatures averaged over the region are retrieved from ERACLITO4, a high-resolution climate analysis. The distributions of daily temperature anomalies, obtained by applying a low band-pass filter, show a general broadening in 1992-2022 with respect to 1962-1991. This is true for maximum, minimum, and mean daily surface temperatures, especially during the summer and spring seasons. A significant warming trend of 0.37 °C/decade is detected in annual mean surface temperatures over the period considered. The observed frequency of record-breaking annual temperature events is compared with values derived from both a hypothetical stationary climate distribution and a theoretical derivation that accounts for changes in trends and variability. During the last decade the theoretical count of extreme events reached a value of 1.26, which yields a likelihood of 86% that this is owed to the warming trend rather than interannual variability. Furthermore, idealized forcing experiments demonstrate that the expected occurrences of record-breaking events in future decades depends on the warming rate rather than the warming level. There is evidence indicating the likelihood of records decreases in proportion to the short-term interannual variability. Finally, an analysis performed at seasonal level shows that the majority (minority) of record-breaking temperatures are occurring in the summer (spring) seasons.

---

[10] Cli-DaRe@School: a Citizen Science project for the digitization of Italian meteorological records involving high school students

Maurizio Maugeri[1], Maria Carmen Beltrano[2], Giacomo Bertoldi[3], Yuri Brugnara[2], Michele Brunetti[4], Daniele Cat Berro[5], Alessandro Ceppi[6], Alice Crespi[3], Veronica Manara[1], Federico Stefanini[1], Francesco Sudati[2], Dino Zardi[7]
[1]Università degli Studi di Milano - Dipartimento di Scienze e Politiche Ambientali, Italy; [2]AISAM - Associazione Italiana di Scienze dell'Atmosfera e della Meteorologia, Italy; [3]Eurac Research, Italy; [4]CNR - Istituto di Scienze dell'Atmosfera e del Clima, Italy; [5]Società Meteorologica Italiana, Italy; [6]Politecnico di Milano - Dipartimento di Ingegneria Civile e Ambientale, Italy; [7]Università di Trento - Dipartimento di Ingegneria Civile Ambientale e Meccanica, Italy

Cli-DaRe@School is a citizen science project initiated in Spring 2022. Its goal is to contribute making available in a computer-readable format the great amount of Italian past meteorological observations which are available only on paper or as scanned images.

In the first year, we focused on some monographs reporting long-term records of monthly temperature and precipitation data. More than 350 students from 10 high schools were involved. Each school received a pdf copy of the pages to digitize along with a tutorial and a spreadsheet template for data entry. Then, each student had to digitize the assigned data and the schools provided with the filled spreadsheets. Students also had the opportunity to join a training program consisting in seminars and specific training activities to

make them aware of the potentialities of the recovered data. The project activities were performed within double training (PCTO).

The contribution from students in terms of data digitization was about 5000 man-hours. Besides the contribution of students, the project also required a great effort from their teachers and from the authors for organising and coordinating the activities and to revise the data.

We could realize that high school students can really give a great contribution for the rescue of past meteorological observations in Italy. The project can also have a great educational value, offering young students an easy hands-on experience with climate data and making them more aware on how science investigates past climatic trends.

We decided, therefore, to continue the project setting up a working plan for the next years. Current activities focus on both the monographs already considered in the last school year and the yearbooks with the daily data. Moreover, the students can work on a project module based onto OCR techniques. We are also working on improving the training activities we offer to the students.

---

[11] Multi-scale assessment of regional high-resolution reanalyses precipitation fields over Italy

Francesco Cavalleri[1], Cristian Lussana[2], Michele Brunetti[3], Francesca Viterbo[4], Riccardo Bonanno[4], Veronica Manara[1], Matteo Lacavalla[4], Maurizio Maugeri[1]

[1]Environmental Science and Policy Dept., University of Milan, Milan, Italy; [2]Division for Climate Services, the Norwegian Meteorological Institute, Oslo, Norway; [3]Institute of Atmospheric Sciences and Climate of the National Research Council, CNR-ISAC, Bologna, Italy; [4]Sustainable Development and Energy Resources Dept., Climate and Meteorology Group, RSE s.p.a, Milan, Italy

Climate reanalyses play a crucial role in understanding past climate variability, assessing atmospheric weather model performances, and serving various applications. In this context, we are undertaking an extensive validation of high-resolution regional reanalyses and their effectiveness in reproducing meteorological fields over Italy. The focus of the proposed poster is on precipitation.

Specifically, we will present the initial results of our analyses on the performances of these reanalyses in representing precipitations across spatial scales, ranging from a few kilometres to the Italian average, and across time scales, spanning from daily to climatological periods.

Our investigation employs a comprehensive approach to assess the accuracy of reanalyses compared to ground-based observations. This includes the evaluation of both climatological averages and day-to-day variability through contingency-table-based scores. Central to this evaluation is determining the scale at which a reanalysis demonstrates skills, obtained with wavelet scale-separation techniques. Additionally, the study explores the affordability of reanalyses in computing trends, aiming to evaluate the impact of time-varying observational networks assimilated by reanalyses on their temporal consistency.

In our study, we consider several reanalyses, with the ECMWF state-of-the-art ERA5 serving as the global reanalysis reference. In addition to CERRA, a regional reanalysis covering Europe, we examined many high-resolution regional products obtained through dynamical downscaling of ERA5: MERIDA, MERIDA-HRES, VHR-REA-IT, and SPHERA. The parametrization optimized for a specific location, along with enhanced resolution, can be crucial factors to better capture physical processes occurring at smaller scales (e.g., convection), providing a more accurate depiction of precipitation patterns.

The outcomes of this research will contribute valuable insights into the strengths and limitations of high-resolution regional reanalyses in the context of reproducing precipitation fields. We hope that our findings will enhance the understanding of the reanalysis datasets compared to ground observations and shed light on their ability to capture temporal trends.

---

[12] WRF simulations of the time evolution of weather events in Italy in the framework of climate change

Serena Falasca, Annalisa Di Bernardino

University of Rome La Sapienza, Italy

Official reports of national and international institutions (e.g., Intergovernmental Panel on Climate Change, US National Oceanic and Atmospheric Administration, European Environment Agency) and a plenty of recent scientific publications have been focused on observed and projected trends of temperature and precipitation, heat waves and other extreme weather events. In particular, several studies have highlighted the exposure of the Mediterranean basin to climate change. This work aims at investigating the evolution of weather variables (e.g., temperatures and rainfall series) and extreme events in Italian cities both in the past (year 1997) and in the future (years 2050 and 2100). Two different “Representative Concentration Pathways” (RCP) scenarios designed by the Intergovernmental Panel for Climate Change in the Fifth Assessment Report (AR5) have been considered for climate projections, namely an intermediate scenario (RCP4.5) and a scenario with very high greenhouse gases emissions (RCP8.5). The Weather Research and Forecasting (WRF) model will be used to perform the simulations with the innermost domain over Italy at a horizontal resolution of few kilometers, with initial and boundary conditions provided by a proper dataset including global bias-corrected climate model output data. The use of the WRF model in this application represents a plus as previous studies on the topic have been based on lower spatio-temporal resolution datasets. In particular, the rainfall series throughout Italy extracted by the WRF output would allow the identification of the most vulnerable areas.

---

[13] Caratterizzazione climatologica della città di Verona da osservazioni meteorologiche storiche nel periodo 1920-2022

Sebastiano Carpentari[1], Nicola Pierotti[2], Marco Falda[1], Dino Zardi[1]
[1]University of Trento, Italy; [2]Meteoblue

L'utilizzo dei dati meteorologici può non sembrare molto utile a prima vista. Tuttavia, consente di trarre conclusioni notevoli sul clima locale delle diverse aree e sui suoi cambiamenti. Un esempio è fornito dai risultati del presente studio che si è concentrato sulla città di Verona e sulle aree ad essa limitrofe. Qui negli ultimi decenni si sono effettuate regolarmente molte misurazioni di variabili meteorologiche (in particolare temperatura dell'aria e precipitazioni) in vari punti, sia della città che dei dintorni, producendo lunghe serie storiche di dati. Tuttavia nessuna di queste copre un periodo che superi i 50 anni.

Il progetto "Percorsi Digitali Veronesi" ha avviato una ricerca accurata delle serie di misurazioni meteorologiche disponibili al fine di riassumere la disponibilità di dati storici nell'area urbana della Città di Verona. Ad oggi sono state recuperate 19 serie, estese dal 1920 ai giorni nostri. Non tutte le serie di misurazioni si sono rivelate ugualmente valide per scopi climatici. Tuttavia, per un gran numero di esse sono stati valutati degli indici climatici (secondo le raccomandazioni dell'Organizzazione Meteorologica Mondiale), come ondate di calore, ondate di freddo, giorni caldi, giorni freddi, giorni secchi, ecc. La serie composta dalle osservazioni effettuate dal meteorologo Emilio Bellavite nella propria stazione meteorologica in centro città nel periodo 1945-1996 è stata adottata come base per tutte le altre stazioni, in particolare per definire la media nel periodo compreso tra il 1961 e il 1990.

Dai risultati preliminari, le tendenze climatiche sono chiare per le temperature, che evidenziano un chiaro aumento, mentre lo sono meno per le precipitazioni. L'obiettivo per le fasi future è quello di estendere al passato le suddette serie e recuperare il maggior numero di dati possibile al fine di costruire una serie di misurazioni giornaliere delle precipitazioni e della temperatura che copra almeno in maniera omogenea 100 anni.

---

[14] Application of the Weather Research and Forecasting model to the investigation of the time evolution of outdoor thermo-hygrometric comfort in Italy

Serena Falasca, Anna Maria Siani, Virgilio Ciancio, Ferdinando Salata
University of Rome La Sapienza, Italy

Several climatological studies underline that the Mediterranean region is heavily affected by global warming and also for the Italian peninsula a warming trend in terms of temperature and daily extremes has been found.

Although air temperature is the main driver of the Outdoor Thermal Comfort (OTC), other biometeorological and personal conditions contribute to human thermal perception. Many indices have been defined to quantify the outdoor thermo-hygrometric sensations of people. However, since physiological thermoregulation mechanisms strongly depend also on psychological and cultural elements, using an index specifically conceived for each geographic/climatic region and the resident population is desirable. Among these, the Mediterranean Outdoor Thermal Comfort Index (MOCI) allows the quantification of thermal sensations of a Mediterranean normotype and has been obtained thanks to a robust statistical survey and a subsequent Subsets Analysis. It is based on an a 7-point scale (from -3 to +3, with thermal comfort conditions corresponding to values between -0.5 and 0.5) and takes into accounts weather quantities (temperature, radiation, wind speed and direction, relative humidity) and personal factor (i.e., the clothing). MOCI has been chosen for this work among the existing metrics since it is focused on Italy.

This work aims to investigate the time evolution of the OTC over Italy for the next decades (i.e., 2050 and 2080) according to RCP4.5 and RCP8.5 IPCC emission scenarios. To this end, a MOCI database for the May-October period is built employing the output of the Weather Research and Forecasting model (WRF) produced through the dynamic downscaling technique. WRF simulations are run over three nested domains, the innermost with a horizontal resolution of 12 km, and a proper input climate model-based dataset. Results of such simulations are particularly suitable for evaluating the future evolution of OTC conditions of the Italian population due to their high spatio-temporal resolution.

---

[15] Osservazioni meteorologiche nelle stazioni dell'Università di Torino

Claudio Cassardo[1], Valentina Andreoli[1], Davide Bertoni[1], Gennaro Di Napoli[2], Daniele Cat Berro[2], Luca Mercalli[2]
[1]Università di Torino, Torino, Italy; [2]Società Meteorologica Italiana, Torino, Italy

A cavallo delle due guerre mondiali, l'istituto di fisica dell'università di Torino ha ospitato una capannina meteorologica eseguendo osservazioni regolari di alcuni parametri meteorologici (temperatura, umidità, pressione). Dalla fine del 1991, il Dipartimento di Fisica ha allestito una capannina meteorologica e acquisisce regolarmente i principali parametri meteorologici. Nonostante il dataset non sia continuo, la diversa collocazione temporale permette l'effettuazione di un paragone tra i dati termometrici delle due stazioni meteorologiche collocate nella stessa zona e in due periodi climatici caratterizzati entrambi da trend di temperatura in aumento. Il dataset più recente è inoltre quasi completo nei dati, nonché orario, ed ha permesso, mediante tecniche modellistiche, la valutazione dei flussi di calore e di altre grandezze rilevanti nello strato superficiale atmosferico nel trentennio climatico più recente.

---

[16] Signals of change in the Campania region rainfall regime: an analysis of extreme precipitation indices (2002-2021)

Vincenzo Capozzi, Armando Rocco, Clizia Annella, Giannetta Fusco, Giorgio Budillon
Università degli Studi di Napoli "Parthenope", Italy

It is widely known that the precipitation is a key variable of the hydrological cycle that is strongly affected by recent climate changes. Therefore, there is a growing interest in research activities focused on alteration of rainfall regime, especially at regional scale, as it conditions the planning of countermeasures against flood and landslide hazards as well as water resources management. The available literature about precipitation tendencies over the Italian peninsula offers a limited number of studies about recent changes of extreme events and precipitation intensity. This work aims at adding a contribution to fill this research gap, investigating the changes in rainfall regime observed over 2002-2021 period in the Campania region (Southern Italy). The latter is an area very vulnerable to the effects of extreme precipitation events due to its complex orography, to the very high population density and to the intrinsic fragility of its territory. To investigate rainfall regime variations in this area, a dataset including daily precipitation records collected at 107 stations managed by different institutions was adopted. After a quality control check, the rainfall dataset was analyzed both through eleven indices developed by the Expert Team on Climate Change Detection and Indices and through the Standardized Precipitation Index in order to detect signals of changes in frequency, duration and magnitude of extreme precipitation events and to assess tendencies towards drier or wetter conditions. The Theil-Sen method and the Mann-Kendall non-parametric test were employed to evaluate the trends and their statistical significance. The main results emerging from this work are (i) an increasing tendency in precipitation intensity and in the frequency of occurrence of heavy rainfall events in autumn, mainly localized the northern part of the region and in the mountainous areas, (ii) an upward trend in the duration of the longest wet spell in the coastal areas and (iii) an increasing trend in the duration of dry periods in spring and a decreasing tendency in precipitation amounts in summer in the Gulf of Salerno.

---

[17] Spatial-temporal variation of winter warm spells in Italy over the period 1993-2022

Annalisa Di Bernardino[1], Anna Maria Iannarelli[2], Stefano Casadio[2], Anna Maria Siani[1]
[1]Physics Department, Sapienza University of Rome, Rome, 00185, Italy; [2]SERCO Italia SpA, Frascati, Rome, 00044, Italy

This contribution presents the analysis of temporal and spatial variability of winter warm spells (WWS) occurred over the Italian peninsula during the period 1993-2022. The WWS events are detected according to the definition proposed by the Expert Team on Climate Change Detection and Indices (ETCCDI), i.e., "a WWS is a sequence of at least six consecutive days when the daily maximum air temperature exceeds the calendar day 90th percentile of the probability density distribution of the reference period".

The identification of WWS is carried out by examining the wintertime (December, January, February) maximum daily temperatures measured in eight Italian airport sites, which are selected based on the different Köppen-Geiger climatological classes.

The WWS events involving the whole Italian territory or only northern/central/southern Italy are detected. It is interesting to note that although exceeding the 90th percentile of the daily maximum temperature is quite frequent, over the period 1993-2020 only one winter warm spell that affected the entire Italian territory is identified.

In the period examined, the synoptic conditions associated with WWS over Italy or over a portion of the peninsula are, on average, characterised by anticyclonic systems centred on western Mediterranean, responsible for persistent high-pressure conditions over Italy, subsidence and, therefore, exceptional warming.

Finally, the period length threshold used for the detection of WWS is reduced from six to three days. The outcomes suggest that, in orographically heterogeneous areas such as Italy, the definition of WWS provided by ETCCDI allows for capturing only synoptic scale events, losing information on moderate warm spells, which can have important implications on health and natural ecosystems. Therefore, for regional studies, it would be advisable to reduce the time threshold for the identification of WWS to three days.

3:00pm - 4:30pm

CLIMA III - Cicloni, Medicane e Tornado

Location: **Session room, Aula 7, Edificio 6, Studium 2000, Università del Salento**
Session Chair: **Roberta D'Agostino**
Session Chair: **Piero Lionello**

3:00pm - 3:15pm

Detecting cyclones with seasonal forecasts: Early warning and impact-oriented analysis of extreme wind events with a novel Standardized Windstorm Index

Federica Guerrini[1], Laura Trentini[1], Sara Dal Gesso[1], Marco Venturini[1], Sandro Calmanti[2], Marcello Petitta[1,3]
[1]Amigo s.r.l., Via Flaminia 48, 00196 Roma, Italy; [2]Climate & Impact Modeling Laboratory SSPT-MET-CLIM, ENEA, Via Anguillarese 301 00123 Roma, Italy; [3]Department of Enterprise Engineering, University of Rome Tor Vergata, 00133 Rome, Italy

Preparedness to cyclones, severe windstorms, and extreme weather events in general is crucial to enhance societal resilience to climate change. To enable effective early warnings, climate information has to provide a comprehensive view of climate risks while also delivering clear inputs to decision-making processes. Multi-hazard extreme climate indicators could be pivotal in this endeavour, as they summarise climate risks and their co-occurrence into an easily interpretable metric.

In this work, we introduce a Standardized Windstorm Index (SWI) designed to account for both the probability of occurrence and the impact of extreme wind events. SWI is conceived as a versatile tool, capable of

operating as a key component of multi-hazard extreme climate indicators or as a stand-alone indicator. From a technical standpoint, the definition of SWI resembles that of the Standardized Precipitation Index (SPI), a widespread drought indicator. Differently from existing wind indicators, such as the Storm Severity Index (SSI), the similarity with the SPI calculation procedure not only enhances its applicability across different geographic domains, with each location being standardised according to its own climatology, but also guarantees coherence with existing indicators like SPI itself, facilitating the interpretability and integration into multi-hazard indicators.

In terms of early warning applications, we showcase the efficacy of SWI across two use cases. The first involves an impact-oriented analysis of historical extreme wind events, obtained by calculating SWI on ECMWF's ERA5 climate reanalyses, to assess the exposure of areas of interest to such events in the past. The second case entails the use of SWI on SEAS5 seasonal forecasts to detect the upcoming extreme wind events with months of advance. We also discuss a methodology for assessing the accuracy of SWI in detecting cyclones and severe windstorms depending on lead time, using up-to-date disaster databases such as the EM-DAT dataset and ReliefWeb for validation.

3:15pm - 3:30pm

A satellite analysis on the comparison between two Medicanes

Giuseppe Ciardullo, Leonardo Primavera, Fabrizio Ferrucci, Fabio Lepreti, Vincenzo Carbone
Department of Physics, University of Calabria, Italy

Recently, in the general atmospheric circulation framework, a significant increasing of extreme events, interpreted and related to the climate change effects, is occurring across the globe. Different regions around all the latitudes undergo strong variations from the weather standard conditions. For instance, if we look at the peculiar morphological predisposition of the Mediterranean Sea basin to the cyclogenesis phenomena, we can observe the significant development of rotating air masses that leads to the formation of mesoscale vortices. Strong intensification of its cyclonic behaviour can evolve into events having similar characteristics to large-scale tropical cyclones. Generally, they are less intense, with smaller size and duration, thus are called Medicanes, short name for Mediterranean hurricanes, or tropical-like cyclones (TLCs).

Many different kind of studies are carrying on about TLC formation, frequency and intensification, focusing on environmental impact and the relationship with climate changes. In this paper, we propose a new perspective of cyclonic events study and analysis, starting from data and images acquired from satellite and focusing on the diagnostics of the atmospheric parameters evolution of these events. More precisely, some techniques of satellite remote sensing are used for the elaboration of different high spatial-resolution satellite images of the events, at a given acquisition time (sensing time). Two case studies are examined: Ianos, which was formed from a low pressure area in the Gulf of Sidra and developed into a Medicane category in the middle of the Ionian Sea, reaching the coast of Greece, between 14 and 21 September 2020; Apollo, recently object of observation, in life indicatively between 24 October and 2 November 2021, and with a more extended tracking, between the Balearic Islands (formation of the low pressure area) and the Turkish coasts, and peak of intensity in the south-east coast of Sicily.

For these events, 20 images are acquired from two different satellite sensors, onboard two Low-Earth Orbit (LEO) platforms. Every image contains from which an useful extraction of significant physical information is carried out, highlighting several atmospheric quantities (temperature and altitude layers from the top of the cloud, vertical temperature gradient, atmospheric pressure field and deep convection cloud). Using this new observative approach, based on satellite datasets, the diagnostics of the two events is investigated in order to obtain some promising results, about the spatial scale capabilities of the instruments and the spatio-temporal evolution of the cyclones, either by comparing satellite data with recording data from the BOLAM forecasting model.

3:30pm - 3:45pm

Recent results on Mediterranean tropical-like cyclones (medicanes)

Mario Marcello Miglietta[1], Juan Jesus Gonzalez-Aleman[2], Jesus Gutierrez-Fernandez[3], Miguel Angel Gaertner[3]
[1]CNR-ISAC, Italy; [2]Spanish State Meteorological Agency, Department of Development and Applications, Madrid, Spain; [3]University of Castilla La-Mancha, Toledo, Spain

Due to its peculiar morphology, the Mediterranean basin is one of the main cyclogenetic areas in the world. While most of these cyclones are synoptic-scale and baroclinic in origin, intense mesoscale vortices have sometimes been observed. The terms medicane, a portmanteau for Mediterranean hurricane, and Mediterranean tropical-like cyclone have been adopted in the scientific literature to identify these vortices. They are baroclinic cyclones that evolve into vortices with structural characteristics similar to tropical cyclones, i.e., axisymmetric, deep warm core with a windless center surrounded by strong winds. Thus, the synergy of baroclinic instability and diabatic processes is fundamental for their intensification. While several papers, based on the analysis of single case studies, have shed some light on the mechanisms of formation and intensification, several questions are still subject of debate in the scientific community, ranging from the criteria for a reliable definition of medicanes to their classification.

In recent years, a strong interest in this topic has emerged due both to the important social impact of these vortices, which may affect the coasts with intense winds and heavy precipitation, and the implications of climate change for their intensity and location. A certain consensus has been reached in considering medicanes only those cyclones with the development mechanisms typical of tropical cyclones in the mature phase of their lifetime, separating them from the wider category of Mediterranean subtropical cyclones, which develop via a synergy of baroclinic and diabatic forcing.

In the present study, ERA-5 reanalysis fields are used for studying fourteen medicane occurrences in the past decades. Different parameters have been identified to discriminate among the two categories: in particular, the cyclones showing a reduction of the radius of maximum wind during their transition to the tropical phase show the characteristics of the former category. In fact, they are characterized by higher instability, lower baroclinicity, lower values of coupling index, shorter interaction with the jet stream. The difference between the two categories is also investigated using other parameters.

3:45pm - 4:00pm

Un progetto di confronto tra modelli per il miglioramento della previsione dei cicloni Mediterranei

Silvio Davolio[1], Florian Pantillon[2], MIP Team[3]

[1]CNR-ISAC, Italy; [2]LAERO - Univ de Toulouse, France; [3]AAVV

I cicloni Mediterranei sono i principali modulatori della variabilità meteorologica a scala sinottica nel Mediterraneo e ricoprono anche un ruolo importante nella variabilità climatica, regolando il ciclo idrologico e la circolazione oceanica. Rappresentano anche un rischio ambientale, essendo spesso associati a eventi intensi, forti venti, precipitazioni e mareggiate.

Nell'ambito dell'azione COST-CA19109 "MedCyclones", una rete europea per lo studio dei cicloni Mediterranei e del loro impatto a diverse scale spazio-temporali, si è sviluppato un progetto di confronto tra modelli (Model Intercomparison Project - MIP) con lo scopo di investigare la dinamica e la predicibilità di eventi particolarmente intensi. Diverse catene modellistiche sono state implementate seguendo un setup comune, non sempre disponibile in modalità operativa nei vari centri partecipanti, al fine di effettuare simulazioni numeriche a diversa risoluzione orizzontale e utilizzando differenti condizioni iniziali e al contorno.

Lo studio si è focalizzato sul ciclone "Ianos" sviluppatosi nel settembre 2020 e caratterizzato da una limitata predicibilità. E' stato il più intenso ciclone Mediterraneo con caratteristiche tropicali (Medicane o Tropical-like cyclone) osservato nell'area ed ha colpito in particolare la costa ionica della Grecia con precipitazioni estreme, venti intensi e mareggiate distruttive.

Le simulazioni effettuate in ambito MIP hanno mostrato una accuratezza sistematicamente migliore inizializzando i modelli con analisi operative IFS-ECMWF piuttosto che con rianalisi ERA5. Inoltre, la riduzione del passo di griglia da 10 km a 2 km, con passaggio da convezione parametrizzata a convezione risolta esplicitamente, ha prodotto un ulteriore miglioramento sia in termini di intensità che di traiettoria previste.

L'analisi delle simulazioni ha evidenziato come l'organizzazione della convezione, sia prima che durante l'approfondimento del ciclone, e la sua interazione con il jet in alta troposfera abbiano controllato lo sviluppo di Ianos. Quindi la corretta simulazione dell'intensa ed organizzata attività convettiva è risultata essere il fattore determinante per prevedere l'evoluzione del ciclone. Il confronto tra le simulazioni numeriche ha fornito risultati robusti e ha rivelato anche specifici aspetti modellistici di potenziale interesse in ambito previsionale e per lo sviluppo dei modelli.

4:00pm - 4:15pm

Extreme severe storms in Italy in two weeks of July 2023: hail records and tornadoes

Francesco De Martin[1], Agostino {Tino} Manzato[2], Nicola Carlon[3], Federico Pavan[4], Sebastiano Carpentari[5], Guido Cioni[6], Mario Marcello Miglietta[7]

[1]University of Bologna, Department of Physics and Astronomy, Italy; [2]OSMER - ARPA Friuli Venezia Giulia, Italy; [3]Radarmeteo, Due Carrare, Italy; [4]Ca' Foscari University, Venice, Italy; [5]University of Trento, Trento, Italy; [6]Airbus, Blagnac, France; [7]nstitute of Atmospheric Sciences and Climate (CNR-ISAC), Italy

During 12-25 July 2023 Northern Italy was affected by six severe storm outbreaks, that caused about 4.0 billion of euros of economical damages, at least 280 injuries and 3 deaths. The European record of the largest hailstone was broken two times: the first one in Carmignano del Brenta (Veneto region) on 19 July 2023 (16 cm-large hailstone), the second one in Azzano Decimo (Friuli Venezia Giulia region) on 24 July 2023 (19 cm-large hailstone). Moreover, on 22 July 2023 a IF3 tornado developed close to Alfonsine in the Emilia-Romagna region.

The extreme events during this relatively short period were studied by means of reanalysis, surface weather stations, soundings and radar data, in order to provide a comprehensive observational overview of the events. During all the severe storm outbreaks, a sub-tropical ridge was located over the Mediterranean, while a trough was present over Western Europe. A strong southwesterly flow blew over Northern Italy. Storms were triggered in the Alps, and then they moved into the Po Valley, where they intensified. Violent hailstorms were generated in a environment characterized by strong wind shear and a warm and moist advection in the 1-3 km layer of the atmosphere. On the other hand, the IF3 tornado developed in correspondence of a triple point, in a environment characterized by a significant instability.

The severe storm events have been expected by PRETEMP, a volunteer group of students and forecasters, already two days in advance. Also the regional weather service of the Friuli Venezia Giulia region (OSMER - ARPA FVG) was able to forecast in particular the possibility of 'relevant hail' on 24 July 2023. Numerical Weather Prediction (NWP) models simulated already two days ahead the development of supercells.

The high impacts of the convective events of July 2023 and the good forecasting skill highlighted, suggest that time has come for the establishment of a dedicated warning system of convective severe storms in Italy.

4:15pm - 4:30pm

Application of an analytical expression to the likelihood of occurrence of tornadoes

Piero Lionello, Aqsa Muhammadi
Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, University of Salento, S.P. 6 Lecce-Monteroni, 73100 Lecce, Italy

Tornadoes are a meteorological hazards that can produce victims and huge damages to buildings, vehicles and structures. Their scale (their diameter is generally less than 2 km), life cycle (their duration is of the order of 1000s) and chaotic dynamics prevent their explicit representation in operational weather prediction and climate models. In this study we apply a recently developed probabilistic approach that provides the probability of tornadoes occurrence as a function of basic thermodynamics and kinematic meteorological parameters to investigate the variation of the number of tornadoes. Our application is based on the formula

$log10P=-6.6+WMAX3.1+5.2WMAXWS700$,

Where WMAX is the updraft maximum parcel vertical velocity, which depends on the Convective Available Potential Energy CAPE and WS70, the mid-level wind shear. This formula allows to describe the complex environment where tornadoes develop and to distinguish well among condition with low and high probability of occurrence of tornadoes. The methodology supporting this formula is extensively described in Ingrosso, R., Lionello, P., Miglietta, M. M., and Salvadori, G.: Brief communication: *Towards a universal formula for the probability of tornadoes, Nat. Hazards Earth Syst. Sci., 23, 2443–2448, https://doi.org/10.5194/nhess-23-2443-2023, 2023.* In our application we computed WMAX ans WS700 using variables extracted from the from the hourly fields of ERA5 (ECMWF ReAnalysis 5) considering fields at a 25 km resolution and compare the evolution of the likelihood of tornadoes development in two selected areas.

4:30pm - 5:00pm	**Coffee Break** Location: **Poster area, Atrio, Edificio 5, Studium 2000, Università del Salento**
5:00pm - 7:00pm	**ASSEMBLEA AISAM** Location: **Session room, Aula 7, Edificio 6, Studium 2000, Università del Salento**
8:00pm - 11:00pm	**Cena sociale** Location: **Palazzo Tamborino Cezzi**

Giovedì, 08/Feb/2024

9:00am - 11:00am

OSSERVAZONI I

Location: **Session room, Aula 7, Edificio 6, Studium 2000, Università del Salento**
Session Chair: **Pierina Ielpo**
Session Chair: **Daniela Cava**

9:00am - 9:15am

A multi-sensor technique in support to the nowcasting of severe weather and hailstorms

Sante Laviola[1], Giulio Monte[2], Federico Vermi[3], Elsa Cattani[4]
[1]CNR-ISAC, Italy; [2]CNR-ISAC, Italy; [3]Università di Napoli Parthenope; [4]CNR-ISAC, Italy

The Multi-sensor Approach for Satellite Hail Advection (MASHA) is a new multi-instrument technique conceived for real-time tracking of hail-bearing clouds. MASHA is able to identify hail clouds from satellite measurements and monitor the evolution of hail-bearing systems every 5 min, combining the strength of the MicroWave Cloud Classification-Hail (MWCC-H) method to detect hail through the whole GPM sensor constellation (Laviola et al., 2020a-b) with the high temporal rate of the Meteosat Rapid Scan Service (MSG-RSS). This opens the way to operational applications of MASHA method by offering an unprecedented support to the nowcasting of hailstorms and to regional numerical weather predictions.

Recent applications experimented the ingestion in the MASHA scheme of lightning strikes and radar hail indices. This new configuration of the final products significantly refines the reconstruction of hail maps when the GPM constellation overpasses are missing. The result is a near-real time, more consistent and high-resolution hail map described by a proper Hail Severity Index (HSI). Recent applications demonstrate the ability of the MASHA technique to identify severe flash flood events in mountain catchments. These results draw new perspectives to optimally investigate hydro-meteorological events over mountain areas where more traditional methodologies might underestimate the severity of events. Thus, the MASHA scheme provides a useful tool in support to nowcasting systems of hailstorms and severe weather over complex areas.

9:15am - 9:30am

Lightning jump as precursor signature of hail occurrence: first evidence in the Italian territory

Federico Vermi[1,2], Vincenzo Capozzi[1], Giulio Monte[2], Giorgio Budillon[1], Sante Laviola[2]
[1]Dipartimento di Scienze e Tecnologie, Università degli studi di Napoli “Parthenope”, Centro Direzionale di Napoli, Isola C4, CAP 80143, Italia;; [2]Consiglio Nazionale delle Ricerche, Istituto di Scienze dell’Atmosfera e del Clima (CNR-ISAC), Bologna, Italia;

The hailstorms are one of the most dangerous atmospheric phenomena for people and can cause significant damage to agriculture, infrastructures and cars. Many studies demonstrated that an increase in lightning activity is generally associated with severe atmospheric conditions (large hail, tornado, flash floods, strong wind gusts…). Starting from the total number of lightning strikes (TL), which is the most common variable related to lightning activity (e.g. Schultz et al., 2011; Williams et al., 1999), this work investigates about the relationship between hail occurrence and flashes in the Italian territory by analyzing two indicators: the lightning jump (LJ) and the percentage of cloud-to-ground strikes (CG%) (Wapler., 2017; Montanyà et al., 2007). To meet the goals of this study, two different and independent dataset have been analyzed: the first one includes 10 thunderstorm events and lightning data from LAMPINET network, the second one 16 thunderstorm events and strokes observations from LIghtning NETwork (LINET) (Betz et al., 2009). The main results show that the LJ is strictly related to the TL and correctly performs in 90% and 75% of the events analyzed. It reveals some difficulties in recognizing hailstorms especially during the winter season, when, on average, the size of the hailstones and TL are lower. The CG% appears to be independent from the TL and, consequently, from the LJ. For this reason, it could represent an information complementary to them: in particular, the CG% correctly identifies also the winter hail events and it shows greater sensitivity with respect to the TL and LJ, increasing progressively as the hailstorms get stronger and more severe.

Such preliminary results encourage to experiment a proper combination of TL, LJ and CG% to improve retrieval algorithms currently working to identify and track of the hailstorm systems (e.g. Laviola et al., 2020a-2020b).

9:30am - 9:45am

Performance Evaluation of MeteoTracker Mobile Sensor for Outdoor Applications

Francesco Barbano[1], Erika Brattich[1], Carlo Cintolesi[1], Abdul Ghafoor Nizamani[1], Massimo Milelli[2], Esther Peerlings[3], Sjoerd Polder[3], Gert-Jan Steeneveld[3], Antonio Parodi[2], Silvana Di Sabatino[1]
[1]University of Bologna, Dept of Physics and Astronomy, via Irnerio 46, 40126 Bologna, Italy; [2]CIMA research Foundation, Via A. Magliotto, 2 17100 Savona, Italy; [3]Wageningen University, Meteorology and Air Quality Section, P.O. box 47, 6700 AA, Wageningen, The Netherlands

The morphological complexity of urban environments lies in the high spatial and temporal variability of the urban microclimate. The consequent demand for highly resolute atmospheric data remains a challenge for atmospheric research and operational application. The recent widespread availability and increasing adoption of mobile sensing offers the opportunity to integrate observations from conventional monitoring networks with microclimatic and air pollution data at a finer spatial and temporal scale. So far, the lower quality of the measurements and outdoor performance with respect to conventional instrumentation has discouraged the full deployment of mobile sensors for routine monitoring. The present study addresses the

performance of a commercial mobile sensor, the MeteoTracker (IoTopon Srl), recently launched on the market and used within the H2020 project I-CHANGE. The outdoor performance is evaluated through tests aimed at quantifying (i) the intra-sensor variability under similar atmospheric conditions and (ii) the outdoor accuracy with respect to a reference weather station under sub-optimal (in fixed location) and optimal (mobile) sensor usage. Data-driven corrections are developed and successfully applied to improve the MeteoTracker data quality. A recursive method for the simultaneous improvement of relative humidity, dew point, and humidex index proves crucial for increasing the data quality. The results mark an intra-sensor variability in the range of the declared sensor accuracy. The sensor also captures the same atmospheric variability as the reference sensor during both fixed and mobile tests, showing positive biases (overestimation) for both variables. After the validation, a crowdsourcing test experiment is performed to capture hints of the thermal environment in the city of Bologna, with possible application to the assessment of the urban heat island effect. The experiment proves resourceful in mapping a conspicuous area of the city with high spatial resolution, opening new possibilities for research and applications.

9:45am - 10:00am

Profili radar in banda-W e in banda-K di nubi e precipitazione in Italia

Mario Montopoli[1,3], Alessandro Bracci[2], Elisa Adirosi[1], Marco Iarlori[3,4], Saverio Di Fabio[3], Raffaele Lidori[3], Andrea Balotti[3,4], Vincenzo Rizi[3,4], Luca Baldini[1]

[1]CNR-ISAC, Roma; [2]CNR-ISAC, Bologna; [3]CETEMPS, L'Aquila; [4]Dip. Scienze Fisiche e Chimiche, L'Aquila

I profilatori radar a puntamento zenitale sono strumenti utili per studiare la struttura verticale dei sistemi nuvolosi precipitanti quando essi transitano sul sito del profilatore. In particolare, essi sono in grado di estrarre informazioni sulla distribuzione dimensionale delle idrometeore, della loro velocità di caduta, ed in alcuni casi, della velocità dell'aria (updraft, downdraft) lungo la colonna osservata. Tale opportunità è data principalmente dal fatto che tali radar misurano l'intero spettro delle potenze retrodiffuse dalle idrometeore in caduta, catturandone così, per ogni classe dimensionale, lo spostamento Doppler. A seconda della lunghezza d'onda utilizzata, (tipicamente nell'intervallo da 3 mm a 12 cm) si hanno differenti sensibilità alle dimensioni delle idrometeore (gocce in fase liquide, cristalli di ghiaccio o particelle in nube).

In questo lavoro verranno mostrate le analisi di una campagna sperimentale iniziata nel Dicembre del 2022 e ad oggi in corso, denominata "Combined Observations of Radar Experiments in L'AQuila" (CORE-LAQ) in cui sono stati coinvolti un profilatore radar in banda W (lunghezza d'onda 3.2 mm) uno in banda K (lunghezza d'onda 12.5 mm) e disdrometri di riferimento al suolo al fine di caratterizzare le proprietà microfisiche della precipitazione sia in fase liquida che in fase solida. L'iniziativa, unica nel suo genere in Italia, è frutto di una collaborazione tra il centro di eccellenza CETEMPS dell'Università Dell'Aquila che nel 2020 si è aggiudicata un finanziamento nell'ambito del consorzio "Aerosols, Clouds, and Trace Gas Research Infrastructure - Italy" (ACTRIS-IT) per il potenziamento dell'infrastruttura di ricerca di Casale Calore (L'Aquila) dell'Università dell'Aquila, acquisendo, tra gli altri, il profilatore radar in banda-W, e il CNR-ISAC che ha messo a disposizione il profilatore in banda-K e i disdrometri della rete nazionale GID.

Le misurazioni presentate in questo lavoro sono di particolare rilievo in questo momento storico perché contribuiscono a testare ipotesi e algoritmi nell'ambito delle attività di calibrazione e validazione di profilatori radar dallo spazio di prossimo lancio (es. radar in banda W a bordo del satellite ESA-Jaxa EarthCARE il cui lancio è previsto nel primo trimestre del 2024). In particolare verranno discusse tecniche di stima dei profili della velocità dell'aria (up-draft e down-draft) in nube ricavate del radar in banda W, al fine di migliorare le stime delle dimensioni delle idrometeore sia in singola frequenza (W-band) che in doppia frequenza K- e W-band.

10:00am - 10:15am

MEDUSA-GC/MS solution, the most recent cryotechnology applied to the continuous analysis of climate-altering substances in air samples

Jgor Arduini[1,2], Michela Maione[1,2], Saurabh Annadate[3], Umberto Giostra[1]

[1]Università degli Studi di Urbino, Italy; [2]ISAC-CNR, Bologna; [3]IUSS Pavia

The Italian Climate Observatory "Ottavio Vittori" at Monte Cimone carries out automated routine measurements of the main HFCs, HCFCs and other key halocarbons, including the most volatile perfluorocarbon compounds, with the collaboration of the University of Urbino. Fully automated monitoring began in 2003, using the Markes-Agilent TD-GC/MS-based SRA instrument solution.

To overcome the practical limitations related to the volatility of lighter perfluorocarbon compounds, the Medusa-GC/MS system was implemented. The technical solutions of the MEDUSA system include a powerful and efficient Stirling engine based technology to cool and fine control the sampling probe and the use of double traps, which make it possible:

- the analysis of a wide range of compounds thanks to the achievement of extremely low temperatures, also avoid potential reactions between analytes and traps
- the use of appropriate adsorbent materials
- the application of wide programmable temperature ranges
- purification of the analytes by fractional distillation and refocusing.

The Medusa-GC/MS system analyzes air samples with a frequency of 60 minutes, using a 2 liter volume of sample air per measurement.

The implementation of this advanced instrumentation provides important information on the atmospheric concentration of these compounds in the southern European and northern Mediterranean basin, contributing

to the understanding and management of climate change. The long-term measurements provided by this system, combined with atmospheric transport models and inversion technique, contribute to the quantification of the emissions and trend of climate-altering substances and atmospheric pollutants -top down estimates- providing and independent verification tool for the bottom-up official estimates that every country submit regularly to UNFCCC..

10:15am - 10:30am

Use of Spaceborne Passive Microwave Radiometry for the identification and characterization of Mediterranean Tropical-Like Cyclones (Medicanes)

Valentina Di Francesca, Leo Pio D'Adderio, Paolo Sanò, Daniele Casella, Stefano Sebastianelli, Jean-François Rysman, Giulia Panegrossi
CNR-ISAC, Rome, Italy

The Mediterranean Sea is a well-known hot-spot for cyclogenesis with hundreds of cyclones of variable structure, lifetime and intensity forming every year. Mediterranean cyclones are high-impact weather phenomena, being responsible for significant amounts of precipitation, strong winds and storm surges. This motivates great research effort that has been made over the last decades to study these phenomena, in order to improve predictability and mitigate their impact on the Mediterranean regions and on its population. Recently, a renewed interest has emerged in the investigation of peculiar Mediterranean warm core (WC) cyclones which show remarkably similarities to tropical cyclones for their appearance in satellite imagery and for some dynamical and microphysical features. Such cyclones are called Tropical-Like Cyclones (TCLs) or MEDIterranean hurriCANES (Medicanes). This study aims to analyse, through an observational, satellite-based approach, 23 *potential* Medicanes occurred over the past two decades, from 2000 to 2021. Spaceborne passive microwave (PMW) radiometry diagnostic tools, along with both well-established and newly-developed techniques, is used to identify and inspect Medicanes' unique characteristics. The methodology originally developed for tropical cyclones to characterize WC depth, intensity, and symmetry using the 50-60 GHz temperature sounding channels, is applied. High frequency channels are exploited to retrieve cloud properties such as cloud top height and ice water path and detect deep moist convection (DC). Furthermore, a new detection method of the "closed eye" feature has been developed in order to investigate the possibility to carry out a fully-PMW-based analysis of tropical-like cyclones. The results shed light on the role of convection and on the relevance of diabatic vs. baroclinic processes in the WC origin and development. The significant number of inspected case studies, conveys reliability and robustness to a new PMW-based classification of TLCs which complements previous model-based classifications. The results of this study contribute to the "*Medicane's definition"* activity in the context of the MedCyclones COST Action 19109 (https://medcyclones.eu/).

10:30am - 10:45am

Added value of amateur observational network for high-resolution climatological analysis: a case study in the Aterno Valley, Abruzzo, Italy

Gabriele Curci[1,2]
[1]Department of Physical and Chemical Sciences, Università degli Studi dell'Aquila, Via Vetoio, 67100 L'Aquila (AQ), Italy; [2]Center of Excellence in Telesensing of Environment and Model Prediction of Severe events (CETEMPS), Università degli Studi dell'Aquila, Via Vetoio, 67100 L'Aquila (AQ), Italy

The ecological transition calls for an increasing need for local climate services. A fine spatial characterization of atmospheric relevant quantities (temperature, precipitation, humidity, wind, solar radiation, etc.) at long-term climatological scales is typically based on observational networks run by public entities such as the European Union (e.g. Copernicus services) and national and regional Agencies (e.g. National Met Office, Hydrographic Offices). The aim of this work is to verify if the density of these networks is adequate to represent the variability over the territory, with particular regard to a complex terrain area such as the Aterno river Valley in Abruzzo, Central Italy. We use a combination of public networks and the available dense amateur network of weather stations. We subject the database to careful data quality check both in terms of temporal and spatial anomalies. We found that the public network is generally adequate to represent the spatial and temporal variability over the area in terms of temperature, but is less effective when dealing with precipitation and wind. We suggest that an integration of public and amateurs' observational networks is desirable for a finer climatological characterization of a complex territory, in order to better inform adaptation measures with respect to climate change.

10:45am - 11:00am

Il telerilevamento attivo da terra per lo studio della composizione del particolato in atmosfera e dei processi dinamici connessi: dalla ricerca all'applicazione operativa e viceversa. (INVITED)

Francesca Barnaba, & team ALICENET
Consiglio Nazionale delle Ricerche - CNR, Istituto di Scienze dell'Atmosfera e del Clima - ISAC

Prendendo spunto dalla descrizione della crescente rete cooperativa nazionale di sistemi automatici lidar-ceilometer ALICENET, la presentazione intende dare una overview del progresso nell'uso operativo di sistemi di telerilevamento attivo per il monitoraggio 4D del particolato atmosferico in Italia e non solo, dei vantaggi e dei limiti, delle potenzialità e delle applicazioni, delle sinergie con altri tipi di osservazioni (il telerilevamento passivo da terra, il telerilevamento da satellite, le misure in situ) e con la modellistica

numerica. Si forniranno esempi concreti di come la ricerca scientifica di settore possa interfacciarsi in modo virtuoso con agenzie e istituzioni ambientali più operative traendone mutuo beneficio.

11:00am - 11:30am

Coffee Break
Location: **Poster area, Atrio, Edificio 5, Studium 2000, Università del Salento**

11:30am - 1:00pm

OSSERVAZIONI II
Location: **Session room, Aula 7, Edificio 6, Studium 2000, Università del Salento**
Session Chair: **Ferdinando De Tomasi**

11:30am - 11:45am

Anatomia dell'incertezza nel confronto tra simulazioni e osservazioni satellitari: applicazione a MetOp-SG e prototipi aviotrasportati

Domenico Cimini[1,2], Francesco Di Paola[1], Francesco De Angelis[3], Donatello Gallucci[1], Sabrina Gentile[1], Salvatore Larosa[1], Fabio Madonna[4], Vinia Mattioli[3], Mario Montopoli[5], Elisabetta Ricciardelli[1], Filomena Romano[1], Marco Rosoldi[1], Mariassunta Viggiano[1]

[1]CNR-IMAA, Potenza; [2]CETEMPS, Università dell'Aquila; [3]EUMETSAT, Darmstadt; [4]Università di Salerno; [5]CNR-ISAC, Roma

Le osservazioni radiometriche da satellite forniscono il maggior contributo informativo tra le osservazioni della Terra assimilate nei modelli di previsione meteorologica e nelle reanalisi climatologiche. Sia la validazione dei sensori che l'assimilazione delle osservazioni che infine i prodotti che dalle osservazioni vengono ricavati passano attraverso l'applicazione di modelli diretti di trasferimento radiativo. L'incertezza di tali modelli è raramente considerata, sebbene necessaria sia per un confronto metrologicamente valido tra simulazioni ed osservazioni che per una completa caratterizzazione dell'assimilazione dati e dei prodotti derivati. Questa comunicazione presenta un approccio generale per quantificare l'incertezza dei modelli di trasferimento radiativo in atmosfera, partendo dall'incertezza dei parametri più basilari, come ad esempio quelli spettroscopici e di emissività. L'approccio è applicato ad un modello di assorbimento a microonde nell'intervallo 16-700 GHz, utile per il sondaggio atmosferico mediante radiometria a microonde da terra e da satellite. L'analisi di sensibilità mostra che dei 2260 parametri considerati, 135 risultano dominanti. Per questi è stato calcolato l'impatto dell'incertezza sulle simulazioni di osservazioni satellitari in diverse zone climatiche. Tali risultati contribuiscono alla caratterizzazione di sensori radiometrici utilizzati in campagne di misure da aereo in preparazione della missione European Polar Satellite - Second Generation dell'organizzazione europea per lo sfruttamento dei satelliti meteorologici (EUMETSAT) dal 2025 in poi.

11:45am - 12:00pm

K2W, una nuova metodologia per la validazione delle misure satellitari di precipitazione da radar in banda W usando dati ground-based di Micro Rain Radar e disdrometro: risultati dalla stazione Antartica "Mario Zucchelli"

Alessandro Bracci[1], Kaori Sato[2], Luca Baldini[1], Federico Porcù[3], Hajime Okamoto[2]

[1]Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC); [2]Research Institute for Applied Mechanics, Kyushu University, Fukuoka, Japan; [3]Dipartimento di Fisica e Astronomia "Augusto Righi" , Alma Mater Studiorum Università di Bologna

La validazione delle misure e dei prodotti satellitari tramite l'uso di strumentazione al suolo è una componente basilare di ogni missione satellitare ma è, allo stesso tempo, un compito molto impegnativo, soprattutto nelle regioni remote scarsamente strumentate ma di estremo interesse per specifiche climatologie. In Antartide, infatti, le osservazioni da satellite sono essenziali per lo studio e la quantificazione della precipitazione su tutto il Continente ma l'ottenere misure al suolo per la validazione delle misure satellitari si scontra con le oggettive difficoltà logistiche, la frequente manutenzione degli strumenti necessaria per assicurare la qualità delle misure e gli alti costi operativi che rendono complicata l'installazione e la gestione della strumentazione per la misura della precipitazione e ne impediscono una diffusione capillare.

Il satellite NASA CloudSat fornisce i profili di riflettività radar in banda W (94 GHz) delle nubi e delle precipitazioni attraverso il Cloud Profiling Radar (CPR) e viene utilizzato attualmente per la stima delle precipitazioni su tutto il continente Antartico, mentre il radar, sempre a 94 GHz della missione ESA/JAXA EarthCARE di prossimo lancio (primavera 2024) fornirà, oltre ai profili di riflettività, anche i profili Doppler.

In diverse stazioni Antartiche le misure di precipitazione nevosa al suolo vengono attualmente affidate ad un profilatore radar in banda-K (Micro Rain Radar-MRR) accoppiato con disdrometri laser e pluviometri a pesata, mentre non ci sono, al momento, installazioni fisse di profilatori radar in banda-W. Presso la stazione di ricerca Italiana in Antartide "Mario Zucchelli" sono operativi dal 2016 un disdrometro Parsivel2 ed un MRR all'interno del progetto APP (Antarctic Precipitation Properties) finanziato dal PNRA.

In questo lavoro viene proposta una nuova metodologia di validazione chiamata K2W che, combinando i profili di riflettività in banda K (24 GHz) forniti dall'MRR e le osservazioni disdrometriche, consente di simulare i profili di riflettività radar e Doppler in banda W che possono quindi essere sfruttati per validare le misure radar satellitari a 94 GHz.

Questa metodologia è stata testata presso la stazione "Mario Zucchelli" sfruttando un *overpass* di CloudSat durante un evento precipitativo. Il confronto tra i profili di riflettività satellitari e i profili ottenuti con K2W ha mostrato una differenza media di 0,2 dB nel range più basso del radar satellitare considerando una finestra temporale di ±12,5 minuti rispetto al passaggio di CloudSat e una distanza entro i 25 km dalla stazione Antartica.

I profili simulati con la metodologia K2W possono contribuire a migliorare la quantificazione delle precipitazioni in Antartide permettendo la validazione delle misure satellitari sia perché sono meno affetti da attenuazione rispetto ai radar terrestri in banda W, sia perché questa metodologia utilizza dati di MRR e

disdrometro, ovvero due strumenti disponibili in diverse stazioni di ricerca antartiche aumentando, quindi, i possibili siti di validazione delle misure satellitari. La metodologia è stata sviluppata in collaborazione con la Kyushu University nell'ambito del programma JAXA di validazione di EarthCARE supportata dal progetto EORA3-JAXA.

12:00pm - 12:15pm

Performance del nuovo disdrometro 3D Stereo (Thies Clima) durante eventi di pioggia e neve

Sabina Angeloni[1], Elisa Adirosi[1], Alessandro Bracci[1], Mario Montopoli[1,2], Luca Baldini[1], Samantha Melani[3,4], Andrea Antonini[4]

[1]Consiglio Nazionale delle Ricerche, Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Roma, Italia; [2]Center of Excellence for Telesensing of Environment and Model Prediction of Severe events (CETEMPS), Università dell'Aquila, L'Aquila, Italia; [3]Consiglio Nazionale delle Ricerche, Istituto di Bioeconomia (CNR-IBE), Sesto Fiorentino (Firenze), Italia; [4]Laboratorio di Monitoraggio e Modellistica Ambientale per lo sviluppo sostenibile (LaMMA), Sesto Fiorentino (Firenze), Italia

Il 3D Stereo (3DS) è un disdrometro laser commerciale, reso disponibile recentemente dalla casa produttrice Thies Clima e su cui al momento non sono presenti studi scientifici in letteratura. La caratteristica più innovativa del 3DS risiede nel catturare immagini delle particelle che attraversano il volume di misurazione. Questa capacità è di cruciale importanza per fornire una classificazione accurata delle idrometeore, soprattutto nel caso di precipitazione solida. Il disdrometro è destinato alla stazione Antartica Mario Zucchelli nell'ambito del progetto PNRA APP (Antarctic Precipitation Properties).

Prima dell'installazione in Antartide, le performance del nuovo dispositivo sono state analizzate tramite il confronto con il Laser Precipitation Monitor (LPM) dello stesso produttore, che è uno strumento diffuso ed utilizzato in molti lavori di ricerca. I dati usati sono ottenuti da misurazioni dei due strumenti effettuate nel sito di Casale Calore (42.383081 N, 13.314806 E, 683 m ASL) a L'Aquila, gestito dal CETEMPS. I disdrometri LPM e 3DS sono operativi nella campagna CORE-LAQ (Combined Observations of Radar Experiments in L'Aquila). Un set-up disdrometrico simile a quello dell'Aquila è presente anche a Sesto Fiorentino presso l'Istituto per la BioEconomia (IBE) del CNR.

L'obiettivo dell'analisi di confronto tra i due disdrometri Thies Clima è quello di analizzare le differenze di prestazione in termini di classificazione di idrometeore, numero e velocità di caduta delle particelle, intensità di precipitazione e precipitazione cumulata totale per ogni evento considerato. Per quanto riguarda la classificazione della precipitazione, i due strumenti sono in ottimo accordo nell'identificazione della pioggia e della neve; maggiori differenze si notano in caso di particelle in fase mista (pioggia e neve) o ghiacciata (grandine). A causa delle differenti aree di misurazione e della geometria di misura dei due disdrometri, il 3DS rileva in generale più particelle rispetto all'LPM. Le differenze di prestazione dipendono anche dalle dimensioni delle idrometeore (la differenza è massima nel caso di particelle di piccole dimensioni). Nel caso di eventi di pioggia, i due strumenti sono in accordo se si considera il modello di velocità terminale di Gunn e Kinzer applicato alle misure per gocce con diametro inferiore a 3 mm, mentre per particelle più grandi si ha una sottostima da parte di entrambi i disdrometri rispetto al modello; l'accordo tra i due strumenti in termini di precipitazione cumulata totale su base di evento è molto buono.

Per quanto riguarda la capacità del 3DS di catturare le immagini delle idrometeore, particolarmente interessanti sono quelle relative agli eventi nevosi. I raw data forniscono informazioni sulle dimensioni della particella e sulla sua classificazione. Possono essere rilevate fino a quattro immagini al minuto, ma generalmente non tutte forniscono una buona rappresentazione dell'idrometeora.

12:15pm - 12:30pm

Studio delle relazioni tra temperatura superficiale e parametri urbani: implicazioni per l'isola di calore urbana

Antonio Esposito[1], Gianluca Pappaccogli[1], Antonio Donateo[2], Teodoro Semeraro[1], Riccardo Buccolieri[1]

[1]Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, University of Salento, S.P. 6 Lecce-Monteroni, 73100 Lecce, Italy; [2]National Research Council of Italy, Institute of Atmospheric Sciences and Climate (CNR-ISAC), S.P.6 Lecce-Monteroni, 73100, Lecce, Italy

Data la carente disponibilità di osservazioni della temperatura dell'aria da stazioni meteorologiche, spesso poco rappresentative della variabilità climatica delle aree urbane. il presente lavoro si focalizza sull'utilizzo del remote sensing per studiare la correlazione tra la Land Surface Temperature (LST) e i parametri morfologici che definiscono le città. In questo studio sono stati considerati: l'altezza media, l'aspect ratio (AR) (rapporto tra altezza degli edifici e larghezza della strada), lo sky view factor (SVF) e la frazione di superficie occupata dagli edifici (BSF), la percentuale di superficie impermeabile e permeabile (ISF ed BSF) (ricavate dalla mappa CLC+Backbone 2018).

La LST è stata estrapolata da immagini satellitari SENTINEL 3 Level 2 LST con risoluzione spaziale di 1km e dati LANDSAT 9 con risoluzione spaziale 100m. Lo studio riguarda diverse città italiane, caratterizzate da geometrie e con condizioni climatiche differenti, al fine di valutare la scalabilità delle relazioni indagate. Dai risultati preliminari emergono relazioni significative tra LST e parametri morfologici. In particolare, si evidenziano relazioni quadratiche tra AR-SVF-BSF e LST mentre relazioni lineari si riscontrano tra ISF ed LST. Infine, l'altezza media degli edifici influenza LST solo se con denso tessuto urbano. In questa analisi, emergono chiaramente la ciclicità diurna e notturna che caratterizzano le zone urbane e rurali. L'analisi dettagliata delle ondate di calore ha dimostrato che queste correlazioni sono più marcate, dimostrando l'abilità di questo metodo a descrivere la dinamica dei processi in ambiente urbano. Questa metodologia può

essere utilizzata per lo studio della vulnerabilità delle differenti aree urbane in un contesto di cambiamento climatico.

12:30pm - 12:45pm

The Cloud Aerosol Lidar for Global Scale Observations of the Ocean-Land-Atmosphere System – CALIGOLA

Paolo Di Girolamo[1], Noemi Franco[1], Davide Dionisi[2], Marco Di Paolantonio[1,2], Donato Summa[3], Simone Lolli[3], Tiziana Scopa[4], Valentina Sacchieri[5], Alessandro Perna[5], Alberto Cosentino[5]

[1]Scuola di Ingegneria, Università della Basilicata, Potenza, Italia; [2]ISMAR-CNR, Roma, Italia; [3]IMAA-CNR, Tito Scalo (Potenza), Italia; [4]Agenzia Spaziale Italiana, Roma, Italia; [5]Leonardo S.p.A, Pomezia (RM), Italia

The Cloud and Aerosol Lidar for Global Scale Observations of the Ocean-Land-Atmosphere System (CALIGOLA) is a space lidar mission with a focus on atmospheric and oceanic monitoring and the characterization of the Ocean-Earth-Atmosphere system and the mutual interactions within it. This mission has been conceived by the Italian Space Agency with the aim to provide the international atmospheric and ocean science communities in the time frame 2030-2031 with an advanced multi-purpose space lidar sensor capable to provide an unprecedented dataset of geophysical parameters to be collected over a time window presently not aimed to be covered by other space lidar missions. Exploiting the three Nd:YAG laser emissions at 354.7, 532 and 1064 nm and the elastic (Rayleigh-Mie), depolarized and Raman lidar echoes from atmospheric constituents, CALIGOLA will carry out 3□ profile measurements of the particle backscatter coefficient and depolarization ratio and 1 □ profile measurements of the particle extinction coefficient from aerosols and clouds. These measurements allow aerosol typing and the determination of aerosol size and microphysical properties. Furthermore, measurements of the elastic and depolarized backscattered echoes from the sea surface and the underlying layers will be exploited to characterize the optical properties of the marine surface (ocean color) and the suspended particulate matter. Fluorescent scattering measurements at 460 nm from marine chlorophyll and atmospheric aerosols will be exploited to characterize ocean primary production and for aerosol typing. CALIGOLA will also allow accurate measurements of the small-scale variability of the earth's surface elevation, primarily associated with variations in the terrain, vegetation and forest canopy height. The space mission CALIGOLA is explicitly included the on-going ASI Three-Year Activity Plan (2021-2023), with a scheduled tentative launch window of 2026-2028. This contribution intends to provide an overview of the different scientific objectives, with a primary focus on atmospheric and ocean sciences, and a preliminary assessment of the mission observational requirements in terms of observable quantities, their vertical/horizontal resolution and their degree of precision (RMS)/accuracy (BIAS) to be fulfilled by space sensors to address the identified scientific goals of the mission. The contribution also aims at illustrating the technical and technological solutions identified in the design of the space lidar system during the pre-feasibility study carried out by the University of Basilicata in 2021 and 2022, in corporation with other Italian research institutions. Expected system performance in a variety of environmental conditions are also provided through the application of an end-to-end simulator developed at Università della Basilicata.

12:45pm - 1:00pm

XMed-Dry network: results of the first year and a half of monitoring at the Lecce site

Pierina Ielpo[1], Kilian Schneiders[2,3], Melanie Eknayan[3], Ferdinando De Tomasi[4], Konrad Kandler[3]

[1]Institute of Atmospheric Sciences and Climate - Italian National Research Council (CNR ISAC), 73100 Lecce, Italy; [2]German Weather Service (DWD), Offenbach, Germany; [3]Institute for Applied Geosciences, Technische Universität Darmstadt, 64287 Darmstadt, Germany; [4]Department of Mathematics and Physics, University of Salento, 73100 Lecce, Italy

Dry deposition is one of the two major routes for aerosol particles to be removed from the atmosphere. Aerosol dry deposition processes are not yet fully understood, as well as aerosols impact on cloud processes and earth's radiation budget. For these reasons, measurements of size distribution, composition and mixing state on single aerosol particles are mandatory. Since April 2017 a set of seven newly developed dry deposition-only collectors were installed at different locations across the Mediterranean (two sites in Spain, one in France, Malta, Italy, Greece and Cyprus) to capture spatial and temporal variability (XMed-Dry first phase until March 2018). The second phase of XMed-Dry is aiming for long-term monitoring at three sites: Lecce (Italy), Nicosia (Cyprus) and a new one at Alicante (Spain). Particles deposited were collected on pure carbon adhesive that was subject to SEM-EDX analysis to obtain size, shape and elemental composition of single particles. Results show that dry deposition consists of a highly variable mixture of sea-salt, sulfate, mineral dust, metal oxides and biological material, depending on location, season and meteorological situation. Results of samples collected in Lecce during the first one and a half years show total aerosol deposition in the range of 4–25 mg m-2 d-1, which is comparable to other locations in the medium range outflow of a desert. Expectedly, during Saharan intrusions the values are at the upper end of the range. Most of the mass is contributed by particles >15 µm in diameter, whereas the super-micron (coarse) PM10 size range contributes approximately 10%. Most of the particles are silicates with a comparatively high 20% of carbonates, which might be in part of local origin. In the coarse PM10 range, sea-salt contributes about half of the mass between 2–10 µm, and sulfate contributes half in the range 1–2 µm. In particular the sulfate contribution is highly variable. Measurements of dry deposition with sub-weekly time resolution are rare. In our study, a data set of more than 150 samples of dry deposition collected in Lecce and analyzed for size, shape and composition for single particle provide relevant information not only for spatial and temporary variability, but also for deposition processes and its sources provenance.

1:00pm - 2:00pm **Pausa Pranzo**

Location: **Poster area, Atrio, Edificio 5, Studium 2000, Università del Salento**

2:00pm - 3:00pm

Poster session 03

Location: **Poster area, Atrio, Edificio 5, Studium 2000, Università del Salento**

[1] Efficient identification of meandering and other low-frequency phenomena in raw ultrasonic anemometer data

Patrizia Favaron[2], Simone Zintu[1], Cristiana Morosini[1]

[1]Università dell'Insubria; [2]Servizi Territorio srl, Italy

Meandering, and more generally low-frequency phenomena, are under scrutiny for their effects on pollutant and odor dispersion. Methods have recently been introduced in literature for detecting their presence in raw data set using statistics like auto-correlation. Evaluation of auto-correlation evolution with lag allows to identify a time scale for the low-frequency components in horizontal wind, provided these exist. Meanwhile, a new family of recursive filtering procedures has been devised, overcoming the limitations of McMillen algorithm and allowing to separate fluctuations of turbulent origin from non-linear trends. Filters in this family are characterized by different time constants, whose value can be selected at user will.

This work introduces an integrated approach in which the filtering time constant is chosen in accordance with indications from the low-frequency components detection criteria, and not on community habit, as normally made. Use of residuals (original minus filtered data) is used in *eddy-covariance*. The new method has been applied to data collected by the fixed station of Cinisello Balsamo Parco Nord, part of the SHAKEUP micro-meteorological network by ARPA Lombardia and equipped with a 3D ultrasonic anemometer.

Results obtained show low-frequency components are indeed present in many cases, and that their removal is possible using an efficient combination of commercially available hardware and properly-written algorithms. An accessible open-source implementation of the method is also given.

---

[2] MEMS temperature sensors: a practical investigation from a micro-meteorologist' viewpoint

Patrizia Favaron

Servizi Territorio srl, Italy

A recent addition to the sensor toolbox, MEMS (*Micro-Electronic-Mechanical Systems*) thermometers have gained momentum and now constitute the de-facto standard for automatic temperature measurements. Low cost, power consumption close to zero, ease of integration in custom PCB (printed circuit board) and mass availability makes them very attractive to manufacturers. But what about us scientific users?

In this work some questions are addressed based on use cases met by the author in her role of measurement systems designer and micro-meteorologist:

- Do turbulent fluctuations affect sensor performances?
- Can MEMS temperature devices be user-calibrated?
- To what extent is user-calibration (if any) retained under changing environmental conditions?
- In the very end, may MEMS-sampled temperature observations have a scientific value?

Of course no definitive answers may come from an individual endeavor. The subject, however, is of importance in view of meteorological and climatological applications, and a wide-spectrum discussion is likely essential.

---

[3] Performance Evaluation of Low-Cost Smart Citizen Kits to Monitor Urban Air Pollution

Maryam Sarfraz, Erika Brattich, Francesco Barbano, Silvana Di Sabatino

Department of Physics and Astronomy, University of Bologna, Bologna, 40126, Italy

Keywords: Air quality; Low-cost sensor; field evaluation; particulate matter; NO2; CO2

Abstract: Low-cost air quality sensors are gaining popularity due to their accessibility, affordability, and potential to enhance regulatory network monitoring. However, given the possibility of increasing the spatial and temporal resolution of observations; their data quality continues to be scientifically debated (Vogt et al., 2021).

This study is a part of the EU H2020-funded project 'I-CHANGE' and presents a comprehensive performance evaluation of low-cost Smart Citizen Kits (SCKs) for monitoring air pollutants. The SCKs are equipped with different sensors to measure particulate matter (PM10, PM2.5, and PM1), particle number counts (particle diameter=0.3, 0.5, 1, 2.5, 5 & 10 µm), air temperature, relative humidity, CO2, O3 and NO2. First, SCKs were tested in an indoor environment to assess their sensitivity, precision, and intra-sensor variability across temporal resolutions of 1 min, 5 min, 30 min, and 1-hour. To evaluate performance in outdoor environments, SCKs were then deployed in colocation with reference sensors for measuring air pollutants owned and hosted by the Emilia-Romagna Environmental Protection Agency (ARPAE) in Reggio Emilia (44°41 N, 10°39'E) for two months in the summer of 2023. SCKs performed well in the outdoor environment, however, in the ambient environment they presented higher intra-sensor variability than in the indoor environment due to varying meteorological factors (e.g., relative humidity). Correction methods (e.g., Köhler correction & ambient RH correction) are implemented to improve the SCKs data quality, which suggests that they would be suitable devices for applications where the spatial variability in particle concentration needs to be determined. Regular calibration, temporal averaging and enhanced data post-processing are key to maximise their potential in outdoor field monitoring.

Acknowledgement: Agenzia Prevenzione Ambiente Energia Emillia-Romagna (ARPAE)

[4] Multiscale analysis on 14 years of lightning strokes over Italy and the Central Mediterranean

Marco Petracca[1], Stefano Federico[1], Nicoletta Roberto[2], Silvia Puca[2], Leo Pio D'Adderio[1], Rosa Claudia Torcasio[1], Stefano Dietrich[1]

[1]CNR-ISAC, Italy; [2]DPC, Italy

Interest in lightning has grown to unprecedented levels, as highlighted by the recent Meteosat Third Generation (MTG) mission conducted by EUMETSAT, equipped with the Lightning Imager (LI) sensor. For the first time in Europe, we will soon have lightning stroke data collected by a geostationary satellite, available in Near Real Time (NRT). Satellite observations integrated with ground-based observation will give a vertical structure of the lightning phenomena. A comprehensive understanding of lightning climatology in a specific area is crucial to enable accurate interpretation and validation of the new data. In this regard, ISAC is developing the *MyLightning* database (DB) for lightning strokes. The goal is to collect, organize, manage, and classify lightning strokes from various networks, including both ground- and space-based sources. Currently, the DB structures and archives LINET network data available in NRT over Italy and the Central part of the Mediterranean area. Interesting features regarding the density, the geographic distribution, the intensity and the altitude of electrical discharges based on surface type (land/sea), terrain altitude, and seasonality will be presented analyzing over 180 million strokes, occurred in 14 years of continuous data acquisition.

[5] Satellite operational products for precipitation, soil moisture and snow: applications and case studies

Nicoletta Roberto[1], Alexander Toniazzo[1], Marco Petracca[2], Luca Brocca[3], Luca Ciabatta[3], Simone Gabellani[4], Francesco Avanzi[4], Silvia Puca[1]

[1]Dipartimento Protezione Civile, Italy; [2]CNR-ISAC, Roma, Italy; [3]CNR-IRPI, Perugia, Italy; [4]CIMA Foundation, Savona, Italy

For more than 15 years the EUMETSAT Satellite Application Facility on Support to Operational Hydrology and Water Management (H SAF) has been providing near real-time operational products to supply the main hydrological variables: precipitation, soil moisture and snow. A continuous quality assessment service is also provided for all products generated and a hydro-validation program evaluates the benefits of satellite data in hydrological models. Satellite data series have been collected since the beginning of the program, allowing for the generation of several data records, which are delivered as operational products. More than 20 operational products are provided, characterized by different spatial coverages (Europe, MSG Full-disk or global) and temporal frequencies (ranging from 15 minutes for instantaneous products, to hourly or daily accumulated ones, up to monthly averages).

The Fourth Continuous Development and Operation Phase (CDOP-4), started in 2022, has as main objectives the promotion of products usage among the user community by providing applications, case studies, tools and training and the development of new products to fully exploit primary EUMETSAT missions (MTG and EPS-SG).

The usage of H SAF products will be present for meteorological, hydrological and climate applications. Droughts, severe floods, intense rainfall events, and evaluation of water resources are some of the fields of application of available operational products.

[6] Caratterizzazione dello strato limite atmosferico mediante combinazione ottimale di dati da rete di smart-sensors e da modellistica ad alta risoluzione

Andrea Orlandi[1], Francesca Calastrini[1,2], Gianni Messeri[1,2], Riccardo Benedetti[1], Alessandro Zaldei[2], Giovanni Gualtieri[2], Alice Cavaliere[2], Carolina Vagnoli[2], Lorenzo Brilli[2], Simone Potzolu[2], Tommaso Giordano[2], Federico Carotenuto[2]

[1]Consorzio LaMMA, Firenze; [2]CNR-IBE, Firenze

La caratterizzazione ad elevato dettaglio spazio-temporale dello strato limite atmosferico risulta indispensabile per la corretta valutazione delle dinamiche che in esso si realizzano, a partire dai regimi termici e di circolazione locale, sino ai flussi ed ai molteplici aspetti di qualità dell'aria. Le risorse disponibili a tal fine sono da un lato la strumentazione osservativa e dall'altro la modellistica numerica, che presentano punti di forza e limitazioni in buona misura complementari. La combinazione ottimale dei dati di entrambe le tipologie ha la potenzialità di realizzare sinergie tra i reciproci punti di forza, compensando e minimizzando le rispettive limitazioni, consentendo la generazione di dataset di elevata qualità ed affidabilità. In questo contesto, è stato svolto uno studio preliminare combinando i dati raccolti da una innovativa rete di smart-sensors (Sensors 2018, 18, 2843; doi:10.3390/s18092843) con le stime prodotte da un modello alla mesoscala. La rete di monitoraggio è costituita da un elevato numero di stazioni di rilevazione di dati meteorologici e di qualità dell'aria distribuite su tutto il territorio nazionale italiano (www.airqino.it) e da alcune torri di misura urbane dei flussi di CO2 (Eddy-Covariance). La rete integra rilevazioni dei principali inquinanti atmosferici (CO, O3, NO2, PM2.5, PM10) a misure di concentrazione di gas serra (CO2) oltre a rilevazioni micrometeorologiche (Temperatura e umidità dell'aria), coprendo vari comuni del territorio nazionale (360 punti di monitoraggio totali). Per quanto riguarda la modellistica atmosferica si utilizza una implementazione ad elevata risoluzione del modello WRF, configurato su un dominio di calcolo che copre l'intero territorio nazionale. L'integrazione ottimale delle due tipologie di dati offre una descrizione molto dettagliata delle dinamiche rilevanti nello strato limite atmosferico delle aree di interesse studiate. Le già rilevanti potenzialità applicative dell'approccio proposto, potrebbero essere ulteriormente potenziate dall'adozione sistematica di

opportune tecniche di Machine Learning, che hanno dimostrato negli anni recenti una crescita ingente e molto rapida.

---

[7] Comparazione e validazione dei dati di temperatura, umidità e vento nella bassa troposfera, in seguito allo spostamento del radiosondaggio atmosferico da Milano Linate a Novara Cameri.

Francesco Sudati[1,2,3], Marco Arienti[2], Lorenzo Locatelli[2]

[1]Università degli Studi di Milano, Italy; [2]Università degli Studi di Milano Bicocca, Italy; [3]Centro Nazionale di Meteorologia e Climatologia Aerospaziale

La radiosonda di Milano Linate è rimasta operativa dal 1947 al 24 Maggio 2021, costituendo la serie storica di misure in libera atmosfera più lunga in Italia; successivamente è stata spostata e automatizzata a Novara Cameri. La distanza tra i due siti di misura risulta di circa 50 km e viene considerata dalle norme OMM come piccola, dal punto di vista sinottico e quindi tale da non risentire di un sensibile cambiamento nelle misure effettuate. Tuttavia, la particolarità del nuovo sito di misura, in prossimità della Valle del Ticino, rende quanto meno dubbia la rappresentatività per quote più basse di 700 hPa. Due recenti lavori di tesi hanno analizzato i dati TEMP di temperatura, umidità e vento dal 1 Maggio 2020 al 31 Maggio 2022, proponendosi come obiettivo quello di confrontare i dati misurati dalle radiosonde alle 00Z e alle 12Z, con quelli del modello climatologico di riferimento ERA5, elaborato dal Centro Europeo per le Previsioni Meteorologiche a Medio Termine, al fine di verificare l'equivalenza di rappresentatività meteorologica tra i due siti di misura.

Si sono considerati cinque livelli standard: 1000 hPa/SFC, 925 hPa, 850 hPa, 700 hPa, 500 hPa e al fine di allargare l'analisi differenziale del comportamento ad altri siti, si sono considerate anche le radiosonde di Bologna San Pietro Capofiume e Cuneo Levaldigi.

Le elaborazioni dimostrerebbero che, soprattutto nei bassi livelli, vi siano significative differenze tra i dati misurati e quelli di ERA5, in seguito allo spostamento della radiosonda da Milano Linate a Novara Cameri. Tale differenza, indagando sulla tipologia di fenomeno meteorologico in atto nei giorni con i valori dai delta più elevati, sembra essere dovuta al fenomeno del vento di favonio in discesa dalle Alpi, di difficile previsione per i modelli numerici per le sue caratteristiche di turbolenza e manifestazione talora improvvisa, che interessa in modo particolare il sito di misura di Novara Cameri.

---

[8] Analisi dell' Isola Urbana di Calore e del Comfort Termico in una Città Mediterranea: Il Caso di Studio di Lecce, Italia

Gianluca Pappaccogli[1], Antonio Donateo[2], Olga Palusci[1], Antonio Esposito[1], Alberto Martilli[3], Jose Luis Santiago[3], Riccardo Buccolieri[1]

[1]Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, University of Salento, Laboratory of Micrometeorology, S.P.6 Lecce-Monteroni, 73100 Lecce, Italy; [2]National Research Council of Italy, Institute of Atmospheric Sciences and Climate (CNR-ISAC), S.P.6 Lecce-Monteroni, 73100, Lecce, Italy; [3]Atmospheric Modelling Unit, Environmental Department, CIEMAT, 28040 Madrid, Spain

L'obiettivo di questo studio è analizzare l'intensità dell' Isola Urbana di Calore (IUC) della città di Lecce, per valutare gli effetti dell'urbanizzazione sul comfort termico e sul microclima urbano, con particolare attenzione agli impatti delle ondate di calore. Le misure sono state effettuate attraverso una rete di stazioni meteorologiche dislocate in cinque punti differenti della città, comprendendo aree urbane e suburbane. L'analisi è stata condotta su un periodo di nove anni, dal 2013 al 2021. I risultati indicano che l'intensità dell'IUC raggiunge un picco notturno (mediamente da 1,1 a 1,6 °C) nelle zone più densamente urbanizzate, con un impatto relativamente più moderato durante le ore centrali del giorno. Il picco diurno dell' IUC varia mediamente tra 1 e 3 °C, ma in condizioni sfavorevoli può superare anche i 5-6°C. Tuttavia, è stato osservato che l'intensità e il massimo giornaliero dell' IUC diminuiscono quando la velocità del vento proveniente da nord supera i 3 m/s. L'analisi del comfort termico ha identificato condizioni critiche in agosto, con un notevole disagio e un rischio elevato di stress da calore nel primo pomeriggio. Nel complesso, si è registrato un significativo deterioramento delle condizioni di comfort termico nel periodo in esame. I risultati sottolineano l'importanza di adottare misure di mitigazione del disagio termico, soprattutto in presenza di temperature già elevate e amplificate dall'effetto UHI.

---

[9] Derivation of surface aerosol concentration from satellite AOD over the city of Bologna

Giorgia Proietti Pelliccia, Tiziano Maestri, Erika Brattich, Federico Porcù, Maryam Sarfraz, Mohammad Reza Shirzad, Silvana Di Sabatino, Francesco Barbano

University of Bologna, Italy

The presence of aerosol pollution in urban areas has been linked to short- and long-term health effects in many studies. The main difficulty in monitoring urban aerosols is the sparsity of data: aerosol mass concentration near the surface is typically monitored through ground-based measurements of Particulate Matter mass concentration (PM) at fixed or mobile stations, that leave huge areas without measurements even within the same city. Satellite retrieval of columnar aerosol spectral properties, such as Aerosol Optical Depth (AOD), can improve the spatial resolution and fill the gaps between ground-based stations, thanks to the large areas covered during each overpass. In the last decades, many studies attempted to derive surface PM concentrations from satellite AOD (eg. Chu et al. 2016).

The relationship between the two quantities can be approximated as linear in case of well-mixed aerosols within the Boundary Layer, considering PM2.5 (mass concentration of particles with diameter less than 2.5μm) and AOD at VIS wavelengths (Koelemeijer et al. 2006). The linear approximation holds relatively well when considering fine aerosol particles in urban areas. Coefficients can be calibrated through statistical linear regression and are dependent on location and time (Di Nicolantonio et al. 2009).

In this study, the linear approximation between AOD and PM is investigated over the city of Bologna, using MAIAC AOD (550 nm) (Qin et al. 2021) and ground based PM2.5 from local environmental agency (ARPAE) and from low-cost sensors. Data is analyzed considering the meteorological conditions and the assumptions on chemical composition of local aerosols.

---

[10] On the combined use of rain gauges and GPM IMERG satellite rainfall products: testing cellular automata-based interpolation methodology on the Tanaro river basin in Italy.

Annalina Lombardi[1,2], Barbara Tomassetti[1], Valentina Colaiuda[1], Ludovico Di Antonio[3], Paolo Tuccella[1,2], Mario Montopoli[6], Giovanni Ravazzani[5], Frank Silvio Marzano[1,4], Raffaele Lidori[1], Giulia Panegrossi[6]

[1]CETEMPS, Centre of Excellence University of L'Aquila, via Vetoio, 67100 Coppito (L'Aquila), Italy; [2]Department of Physical and Chemical Sciences, University of L'Aquila, via Vetoio, 67100 Coppito (L'Aquila) Italy; [3]Univ Paris Est Creteil and Université Paris Cité, CNRS, LISA, F–94010 Créteil, France; [4]Department of Information Engineering, Electronics and Telecommunications, Sapienza University of Rome, 00184 Rome, Italy; [5]Department of Civil and Environmental Engineering, Politecnico di Milano; [6]Institute of Atmospheric Sciences and Climate (ISAC), National Research Council (CNR) 00133, Rome, Italy

Satellite-based remote sensing significantly contributes to hydrological predictions due to its wide coverage and increasing tempo-spatial resolutions. The uncertainty of the hydrological simulations is connected to one of the rainfall fields, and the rainfall patterns strongly affect the runoff calculation in hydrological models. Although current observed areal precipitation estimation is mainly based on point rain gauge measurement interpolation, the ability to deduce spatially distributed data from point measurement depends on the design and density of the sensor network.

A possible approach to have a correct representation of the rain field at the hydrological scale (up to a few hundred meters) could be to merge rain gauge data with gridded rainfall data obtained from remote sensing techniques, and the availability of such data in near-real time is a unique opportunity for the operational hydrology community. In this study, we propose the application of advanced assimilation techniques based on the Cellular Automata Algorithm for rainfall spatialisation using satellite precipitation products for hydrological applications.

The study focuses on a sub-basin of the Po River located in northern Italy: the Tanaro River. The work wants to prove that the areal precipitation estimation including satellite information in addition to surface observations has a high performance compared to that which uses only the rain gauge data: the different data sources are used to obtain a mutual correction of the implicit error characteristic of the different data and the rainfall spatial distribution obtained can overcome the specific lack of information of the single data source for hydrological applications. Indirect validation of the reliability of the spatialization of precipitation data is carried out using the CETEMPS Hydrological Model (CHyM). Hourly hydrological simulations were carried out to evaluate three different case studies, where the hydrological model has been forced with Rain Gauge data, available on DEWETRA platform (every 1h) and the Global Precipitation Measurement (GPM) Integrated Multi-Satellite Retrievals for GPM (IMERG), half-hourly 0.1°x0.1° 125 (roughly 10 km x10 km). The results confirm that the use of merged gauge-satellite data using the Cellular Automata algorithm improves the performance of the hydrological simulation, as also confirmed by the statistical analysis performed for seventeen selected quality scores.

---

[11] Open source precipitation dataset from CML and conventional measurement networks

Elia Covi[1], Giacomo Roversi[2,4], Pier Paolo Alberoni[1], Stefania Nanni[3], Federico Porcù[4]

[1]Struttura Idro-Meteo-Clima (SIMC), Agenzia regionale per la prevenzione, l'ambiente e l'energia dell´Emilia-Romagna (Arpae), Bologna, Italy; [2]Istituto di Scienze dell'Atmosfera e del Clima (ISAC), Consiglio Nazionale delle Ricerche (CNR), Rome, Italy; [3]Lepida ScpA, Bologna, Italy; [4]Dipartimento di Fisica e Astronomia "Augusto Righi" (DIFA), Università di Bologna, Italy

Precipitation has a strong impact on many human activities, however measuring rainfall is challenging because of its high spatial and temporal variability. Standard approaches involve the use of monitoring networks of conventional instruments, which are usually expensive and, therefore, limited in number. An alternative approach relies on opportunistic sensors (OS) from telecommunication networks, specifically Commercial Microwave Links (CML). They are not primarily intended for precipitation monitoring, but useful information can be extracted from their working parameters. Access to this virtually free source of environmental data can enhance the information gathered from a given territory. However, private companies, which in most cases own the OS and their data, frequently do not share them free of charge or without heavy restrictions, so there is a huge interest in open-source OS databases from the research community.

A favorable situation stands in Emilia Romagna (IT) with Lepida ScpA, a company with public participation, which owns a CML network in the region. Lepida has an ongoing scientific collaboration about CML with the local weather service Arpae SIMC and the Department of Physics and Astrophysics “Augusto Righi” of the University of Bologna.

Their network covers most of the mountainous territory of the Emilia Romagna region. It accounts for more than 100 CML, usually comprising two sub-links (forward and backward) with different frequencies (24.5 and 25.5 GHz). The data consist of couples of instantaneous transmitted (TSL) and received (RSL) signal power levels (expressed in dBm) at one minute resolution, integrated by metadata about the locations of the antennas and the signal properties.

Here, we present the publication of the first two years (2021 and 2022) of the CML dataset of Lepida ScpA. The dataset follows the format and naming standards recently defined by the OpenSense COST Action CA20136 (Fencl et al. 2023). Alongside the CML data, the dataset hosts conventional precipitation products, namely, rain gauge measurements and gauge-adjusted radar rain rate estimates. Processed radar reflectivity from the regional composite and ancillary weather stations data are also included and shared. A statistical analysis of the dataset is also presented.

The publication of this new dataset will facilitate development, testing and validation of new and existing algorithms for precipitation retrieval from CML signals, as endorsed by the OpenSense collaboration. The dataset can be integrated with the complete set of environmental and atmospheric variables of the ERG5 analysis from Arpae SIMC (Antolini et al. 2016) and data from a laser disdrometer located over the University of Bologna (Adirosi et al. 2023), both downloadable open-source.

---

[12] Satellite remote sensing of winter hail events

Sante Laviola[1], Giulio Monte[2], Areti Angeli[3], Elsa Cattani[4]

[1]CNR-ISAC, Italy; [2]CNR-ISAC, Italy; [3]University of Ioannina, Greece; [4]CNR-ISAC, Italy

Hail is a form of frozen precipitation typically forming in the warm seasons. In fact, the highest number of hail occurrences is registered from late spring to fall season due the progressive increasing of air temperature triggering vigorous convections, where hailstones might to be formed.

The lower temperatures during the winter months significantly facilitate the formation of ice hydrometeors but also create unfavourable synoptic and local conditions to form hailstones. However, several hail events can also be observed during wintertime. Despite the general adverse weather conditions, hail formation can be triggered by the combination of still warm surface conditions (usually surrounding sea), cold air in the upper atmosphere, and possibly forced by the presence of dust particles usually acting on the hail formation processes.

In this work we investigate winter hail events occurring in the Mediterranean basin from 2014 onwards by exploiting the whole Global Precipitation Measuring (GPM) satellite constellation. The hail patterns, inferred by the MicroWave Cloud Classification-Hail (MWCC-H) method (Laviola et al., 2020a-b), have been also correlated to large-scale transport of mineral aerosol particles to evaluate their role in the ice nucleation and ice crystal formation.

---

[13] Studio della velocità di deposizione del particolato atmosferico in un sito Artico

Antonio Donateo[1], Gianluca Pappaccogli[2], Federico Scoto[1,3], Francesca Lucia Lovisco[1,3], Mauro Mazzola[4], Stefano Decesari[5]

[1]Istituto di Scienze dell'Atmosfera e del Clima (ISAC-CNR), Lecce, Italy; [2]Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, Università del Salento, Lecce, Italy; [3]Joint Research Center – ENI-CNR Aldo Pontremoli, Lecce, Italy; [4]Istituto di Scienze Polari (ISP-CNR), Bologna, 40129; [5]Istituto di Scienze dell'Atmosfera e del Clima (ISAC-CNR), Bologna, Italy

Gli aerosol nelle regioni fredde hanno un impatto diretto sul sistema climatico. La deposizione di aerosol sul manto nevoso può influenzare significativamente le proprietà ottiche e fisiche della neve, riducendo la sua riflettività e aumentando i processi di fusione. Esistono pochi casi di misura di deposizione di aerosol su neve o superfici ghiacciate. Lo scopo del presente lavoro è analizzare la velocità di deposizione delle particelle atmosferiche su superficie innevata a Ny-Ålesund (Svalbard) in relazione alle condizioni micrometeorologiche locali. Le misurazioni sono state effettuate mediante un sistema eddy covariance presso il laboratorio degli aerosol di Gruvebadet da marzo ad agosto 2021 (Donateo et al, 2023; doi.org/10.5194/acp-23-7425-2023). Il sistema di misurazione è basato su un contatore di particelle a condensazione (CPC) in grado di rilevare particelle da 5 nm di diametro e un contatore ottico (OPC) per valutare i flussi nella moda di accumulo ($0.25 < dp < 0.58$ µm) e nella moda quasi-coarse ($0.65 < dp < 3$ µm). La concentrazione media di particelle misurata è di 595 cm^{-3}, 25 cm^{-3} e 0.47 cm^{-3} rispettivamente per le particelle ultrafini, di accumulo e quasi-coarse. I flussi turbolenti per le particelle ultrafini risultano prevalentemente diretti verso il basso (in media -16.99 cm^{-2} s^{-1}) soprattutto in estate. Al contrario, i flussi delle particelle nella moda di accumulo (0.64 cm^{-2} s^{-1}) e quasi-coarse (0.07 cm^{-2} s^{-1}) risultano spesso positivi. I valori mediani della velocità di deposizione (V_d^+) sono rispettivamente di 0.90, 0.62 e 4.42 mm s^{-1} per le particelle ultrafini, di accumulo e quasi-coarse. Le velocità di deposizione sono in media più basse sulla superficie innevata, con valori mediani stimati di 0.73, 0.42 e 3.50 mm s^{-1}. È stata riscontrata una buona concordanza con i modelli predittivi, in particolare con il modello di Slinn (1982, https://doi.org/10.1016/0004-6981(82)90271-2).

---

[14] Wind field characterization of Medicane by using satellite observations

Stefano Sebastianelli, Leo Pio D'Adderio, Paolo Sanò, Daniele Casella, Giulia Panegrossi

ISAC-CNR, Italy

Recent studies exploiting satellite observations characterized both the thermodynamic and the microphysical structure of Mediterranean cyclones supposed to go through a tropical transition (Medicanes) with particular reference to the warm core and the deep convection features. These studies also shed light on the role of

deep convection in the development of the warm core. Another feature is the surface wind field, which, in analogy with what happen during tropical cyclones, could give additional information on their evolution.

This work aims to characterize the wind field associated within the different phases of a Medicane highlighting the differences between the development and the tropical-like phase. A key feature characterizing a Medicane wind field is the radius of maximum wind (RMW), which investigation, based on a methodology developed for tropical cyclones, could provide information about the intensification vs the steady-state of a Medicane. For that purpose, data from onboard satellite sensors are essential to retrieve the surface wind field over the sea. While the Advanced SCATterometer (ASCAT – onboard MetOp satellites) is a real-aperture radar, the Sentinen-1exploits the Synthetic Aperture Radar (SAR). For both instruments, the surface winds field (i.e., speed and direction) estimation is related to the roughness of the sea surface through the back-scattered electromagnetic signal.

Compared to other instruments, Sentinel-1 SAR has the potential to provide a more precise estimations thanks to its greater spatial resolution. However, the Sentinel-1 revisiting time is quite low (about 6 days) to be able provide a comprehensive characterization of the whole lifetime of a Mediterranean cyclone. In the present work, we exploited all the available ASCAT and Sentinel-1 SAR overpasses for the medicanes occurred in the Mediterranean basin in the last decade. In addition, we explored the effect of the increasing spatial resolution on the surface wind field retrieval.

---

[15] Test dimostrativo di una rete Italiana di Cosmic Ray Neutron Sensing per monitorare le dinamiche di umidità del suolo

Enrico Gazzola[1], Stefano Gianessi[1], Luca Stevanato[1], Cinzia Alessandrini[2], Stefano Ferraris[3], Francesca Ragazzi[4], Silvia Obber[4], Daniele Andreis[5], Fabio Zottele[5], Christian Ronchi[6], Roberto Cremonini[6], Secondo Barbero[6], Barbara Biasuzzi[1], Luca Morselli[1], Federica Lorenzi[1], Marcello Lunardon[1,7]

[1]Finapp srl, via del Commercio 27, Montegrotto Terme; [2]ARPA Emilia-Romagna, Bologna; [3]Dipartimento interateneo di Scienze, Progetto e Politiche del Territorio (DIST), Politecnico e Università di Torino; [4]ARPA Veneto, Unità Organizzativa Qualità del Suolo, Padova; [5]Technology Transfer Centre, Fondazione Edmund Mach, San Michele all'Adige; [6]ARPA Piemonte, Torino; [7]Dipartimento di Fisica e Astronomia, Università di Padova

Il Cosmic Rays Neutron Sensing (CRNS) è diventato una tecnologia sempre più importante in Idrologia grazie alla sua capacità di misurare direttamente la quantità d'acqua nell'ambiente circostante, in profondità e su una vasta area. Si basa sulla rivelazione di neutroni, particelle che fluiscono naturalmente dallo spazio e interagiscono fortemente con le molecole d'acqua. Una singola sonda CRNS può fornire un valore di Soil Moisture (SM) rappresentativo per un'area di una dozzina di ettari, in tempo reale, coprendo il gap di scala spaziale e temporale tra le sonde puntuali e i satelliti.

Mentre l'originale applicazione trainante di questa tecnologia è stata l'agricoltura di precisione (gestione dell'irrigazione) alla scala del campo agricolo, l'approccio si sta muovendo verso l'idea di reti regionali di sensori strategicamente distribuiti, in cui la raccolta ed elaborazione dei dati siano armonizzate e l'informazione finale sia condivisa. Si può così apprezzare la variabilità spaziale e temporale della SM su scala nazionale, permettendo di analizzare trend di grande scala o la risposta ad eventi climatici estremi. Certamente tenendo traccia delle peculiarità significative di ogni sito, l'evoluzione dinamica della SM può essere rappresentativa della risposta di quel tipo di suolo e coltura ai trend meteorologici.

Complessivamente un tale network porterebbe informazioni preziose sia per la gestione della risorsa idrica (necessità di irrigazione, rischio alluvioni) sia per lo studi dell'evoluzione del clima, inoltre può fungere anche da validazione dei dati satellitari. Reti di questo tipo esistono nel mondo (ad esempio UK, USA, Australia), inoltre molti enti spingono per lo sviluppo di una rete dello stesso tipo a livello europeo.

In Italia un crescente numero di sonde CRNS prodotte da Finapp sono installate dalle ARPA e da enti di ricerca. Presenteremo un test di come questi sensori distribuiti possano essere integrati in una preziosa rete.

---

[16] Challenges and perspectives in time of changing climate for the indoor climate control in Italian archives

Francesca Frasca[1], Chiara Bertolin[2], Anna Maria Siani[1]

[1]Dipartimento di Fisica, Sapienza Università di Roma, P.le A. Moro 5, 00185 Roma, Italia; [2]Department of Mechanical and Industrial Engineering, Norwegian University of Science and Technology, Richard Birkelands vei 2B, Trondheim 7491, Norway

A changing climate is impactful for the preservation of cultural heritage both outdoors and indoors. Notwithstanding buildings can have a good buffering effect for short-term fluctuations of outdoor climate conditions, the latter strongly affect the long-term evolution of the indoor climate making challenging its control. Indeed, the control of indoor climate to keep constant specific temperature and relative humidity conditions is becoming less and less sustainable due to the intense use of heating and air conditioning systems, contributing in the local carbon footprint. This study investigates the potential changes of the indoor climate control in Italian archives under the low and intermediate Shared Socio-economic Pathways climate scenarios (SSP1-2.6 and SSP2-4.5). The evaluation will be carried out through the application of "degree-days" and "gram-days" using as reference values the temperature and relative humidity thresholds suggested by standards for limiting climate-induced degradation in cellulose-based collections. The expected increase of the outdoor temperatures will be responsible for the decrease in the heating degree days as well as an increase in the cooling degree days and dehumidification gram days at different extent throughout Italy. "Degree-days" and "gram-days" can then be used to derive the energy demands of archives. These outcomes can serve as basis for planning how to leverage and adapt to the expected warming induced by ongoing the changing climate, finetuning the indoor climate control to safeguard library collections while

enhancing energy saving, or pathing the way towards novel standards and codes for archives which incorporate the estimates of future warming and climate change adaptation. Further investigations will be needed for an accurate design process aimed at improving the indoor air ventilation to reduce overheating issues at building level and at optimising the re-use of waste heat and other natural-based improvements at neighbourhood level.

[17] A novel AI-assisted forecasting strategy for the energy imbalance sign in the day-ahead electricity market

Daniele Carnevale[1], Mattia Cavaiola[2], Andrea Mazzino[1]

[1]University of Genova, Italy; [2]CNR-ISMAR Institute of Marine Sciences

In today's fast-paced and technology-driven world, electricity markets play a pivotal role in meeting the ever-increasing energy demands of a growing global population. However, the integration of renewable energy sources and the decentralization of power generation has introduced a complex challenge: energy imbalance. Accurate forecasting of the sign of this energy imbalance (positive or negative) has emerged as a critical factor in ensuring grid stability, efficient energy allocation, and optimal market operation. In this study, we propose a novel AI-assisted strategy that demonstrates remarkable skill in forecasting the energy imbalance sign 48 hours ahead. The strategy leverages an optimized neural network, specifically designed to capture temporal dependencies and patterns in historical energy market data. The model incorporates various input features, including weather data, historical load patterns, and renewable energy generation forecasts, to create a comprehensive and informative representation of the electricity market dynamics. To ensure the robustness and reliability of the proposed strategy, a vast dataset spanning multiple regions and diverse energy market conditions is utilized for training and validation. The performance of the model is benchmarked against traditional forecasting methods to demonstrate its superior predictive capabilities.

[18] Characterization of outdoor thermo-hygrometric conditions in two Italian cities in recent years

Serena Falasca[1], Ferdinando Salata[1], Annalisa Di Bernardino[1], Stefano Casadio[2], Anna Maria Iannarelli[2], Anna Maria Siani[1]

[1]University of Rome La Sapienza, Italy; [2]SERCO SpA

Outdoor thermo-hygrometric conditions are differently perceived by humans since they are driven by biometeorological variables and individual conditions in addition to air temperature. To account for all these parameters, thermo-hygrometric stress events need to be detected and monitored, similarly to the heat waves (HWs). The aim of the present study is suggesting a method for the identification and characterization of thermo-hygrometric stress events, based on new indices and indices derived from the HWs. The empirical Mediterranean Outdoor Thermal Comfort Index (MOCI) is employed as the reference variable instead of the air bulb temperature since it accounts for local weather (temperature, relative humidity, wind speed and solar radiation) and personal conditions (i.e., clothing). A thermo-hygrometric stress event is detected based on a MOCI threshold of 0.5. Furthermore, cumulative air temperature and MOCI are introduced to describe the thermo-hygrometric load affecting the human body.

In the present study, this approach is applied to two Italian cities, namely Milan and Rome, for the May-September period of recent years. To this end, hourly data of the meteorological variables collected at the stations of the local regional environmental protection agencies (ARPA) of Lombardia and Lazio are used to retrieve daytime MOCI values.

The present tool has proved to be useful and effective in the identification of thermo-hygrometric stress events in the urban environment, affected by the local overheating and high population density. Furthermore, the proposed method overcomes the main limit of an approach based only on extreme thermal conditions by including cumulative thermal and thermo-hygrometric loads also in the absence of critical heating conditions.

[19] Climate-induced risk assessment of the quarantine room in a University Library

Giulia Boccacci[1], Francesca Frasca[2,3], Chiara Bertolin[4], Claudio Chimenti[5], Erlend Lund[6], Tonje Dahlin Sæter[6], Anna Maria Siani[2,3]

[1]Dept. of Earth Sciences, Sapienza University of Rome, Rome, Italy; [2]Dept. of Physics, Sapienza University of Rome, Rome, Italy; [3]CIABC Research Center, Sapienza University of Rome, Rome, Italy; [4]Dept. of Mechanical and Industrial Engineering, Norwegian University of Science and Technology, Trondheim, Norway; [5]Dept. of Biology and Biotechnologies “Charles Darwin”, Sapienza University of Rome, Rome, Italy; [6]Library Section for Collections, Resources and Digital Services, NTNU University Library, Dora, Trondheim, Norway

The quarantine room of the University Library in Norwegian University of Science and Technology (NTNU) is an area located within the World War II U-boat facility of Dora I (Trondheim, Norway, Lat. 63.4°N Long. 10.4°E, 3 m a.s.l.). Within this space, cultural objects part of the library (e.g., books, maps, drawings, archival documents, photographs, collections) are temporarily isolated (e.g., for a period from 2 weeks to 40 days), to monitor for signs of infestation or contamination before being transferred to the permanent conservation space. Microclimate (i.e., temperature and relative humidity) and entomological monitoring have been conducted over the past 3 years (i.e., 2021-2023). The Risk Index (RI) for the estimation of climate-induced chemical and biological risks on vulnerable artifacts was applied to compute the percentage of time for which temperature and relative humidity could favour cellulose hydrolysis and biodeteriogens proliferation on a yearly and seasonal basis. Outcomes were compared among the three selected years to assess any change that eventually occurred in the conservation conditions over time. Moreover, the buffering capacity of the

massive building envelope to smooth out the largest outdoor thermal variability was evaluated using the Normalized Diurnal Range (NDR). To this aim, outdoor climate data from a ground-based meteorological station close to the case study (SN65050 – Lat. 63.4°N Long. 10.4°E, 13 m a.s.l.) were analysed.

---

[20] Comparison of a novel wearable electronic UV dosimeter with reference instrumentation and first on-field campaign for personal exposure assessment

Leonardo Di Tommaso[1], Annachiara Bellini[2], Henri Diémoz[2], Anna Maria Siani[3]

[1]Liceo Scientifico E. Bérard, Aosta, Italy; [2]Agenzia Regionale Protezione Ambiente (ARPA) Valle d'Aosta, Aosta, Italy; [3]Dipartimento di Fisica, Sapienza Università di Roma, Italy

Environmental solar UV irradiance is typically measured using radiometers with reference to a fixed horizontal surface, which may not accurately represent human body exposure. To address this issue, various types of personal dosimeters have been developed to better characterize individual exposure. In this study, the performances of a recently wearable electronic dosimeter (EUV) developed by M. Allen at the University of Canterbury (New Zealand) were evaluated. This study was conducted in the framework of an internship of a high school student at the Environmental Protection Agency (ARPA) of the Aosta Valley. To our knowledge, it is the first time that this specific type of dosimeter is tested in Italy. Three field campaigns under different cloudy conditions were conducted to fine-tune the original calibration coefficients. To this aim the EUVs were co-located close to the reference instrumentation physically traceable to the SI system operated at the solar and atmospheric observatory of ARPA at Aosta (570 m a.s.l.). It is demonstrated that the dosimeters provide the global solar UV index within 10% accuracy to the reference instrument and 10% precision (among the dosimeters) after the calibration. Subsequently, the dosimeters were used to assess the personal exposure of two individuals in their day-to-day life on the valley floor (550-700 m a.s.l) and that of another individual hiking at high altitudes (1700-2400 m a.s.l.). It is found that UV exposure of the former group is very low even in summer (which can ultimately lead to vitamin D deficiency), while prolonged exposure at high altitudes can easily cause erythema even after a single application of a UV sunscreen. In conclusion EUV dosimeters are useful for their design purpose to help to understand the relative differences in human UV exposure, however in the accurate quantification of personal UV exposure a careful control of the EUV stability is recommended.

---

[21] Confronto del dato satellitare con le stime e le misure di NO2 attraverso il toolbox CSO in Toscana

Francesca Guarnieri[1], Caterina Busillo[1], Samantha Melani[1,2]

[1]LAMMA, Toscana, Italy; [2]Consiglio nazionale delle Ricerche - istituto per la BíoEconomia (CNR-IBE), Italy

L'utilizzo dei dati satellitari nel monitoraggio della qualità dell'aria, sta rivestendo un ruolo di notevole importanza. In particolare, dal satellite Sentinel-5P della European Space Agency, attraverso il sensore TROPOMI (TROPOspheric Monitoring Instrument – algoritmo 2.3), è possibile ottenere il totale colonnare di biossido di azoto.

Il Copernicus Atmospheric Monitoring Service (CAMS) fornisce il toolbox CSO (CAMS Satellite Operator), che ha il duplice scopo di scaricare e convertire i dati satellitari e facilitarne l'assimilazione all'interno dei modelli regionali, rendendo il dato satellitare fruibile per la modellistica regionale.

Per la regione Toscana, viene stimata annualmente la concentrazione di NO2 con la run modellistica del modello fotochimico CAMx, inizializzato con il modello meteorologico WRF, utilizzando come condizioni iniziali e al contorno le stime provenienti dal modello CHIMERE e come dato emissivo le stime provenienti dall'inventario regionale delle emissioni. In particolare, per l'anno 2022 a partire dalla distribuzione verticale delle concentrazioni di NO2 stimate della catena modellistica, il dato satellitare attribuito al suolo attraverso l'utilizzo del CSO, è stato confrontato con quello misurato presso alcune centraline della rete regionale Toscana gestita da ARPAT. Questo confronto ha mostrato ottime correlazioni e offre quindi un'importante opportunità nell'applicazione del tool anche nell'ottica della data-assimilation.

---

[22] Inquinamento da PM10: condizioni critiche e tipi di tempo

Andrea Orlandi[1], Francesca Calastrini[1,2], Gianni Messeri[1,2], Riccardo Benedetti[1], Roberto Vallorani[1,2], Bianca Patrizia Andreini[3], Chiara Collaveri[3]

[1]Consorzio LaMMA, Firenze; [2]CNR-IBE, Firenze; [3]ARPAT, Livorno

Gli episodi acuti di inquinamento da PM10 si verificano prevalentemente nel semestre freddo, quando, alla presenza di sorgenti locali, si associano condizioni meteo favorevoli all'accumulo delle sostanze emesse nei bassi strati dell'atmosfera. In sintesi, possiamo identificare tali condizioni con la presenza di una forte stabilità verticale ed un regime circolatorio molto debole, condizioni connesse con uno spessore molto limitato dello strato di rimescolamento, generalmente in presenza di configurazioni bariche di alta pressione. Ulteriori fattori possono acuire gli effetti di tali condizioni, tra esse la forte escursione termica giorno notte, dovuta al raffreddamento radiativo notturno concomitante con scarsa copertura nuvolosa, a cui corrisponde inoltre l'assenza di eventi di precipitazione con effetti dilavanti. Meccanismi di blocco possono indurre la persistenza per diversi giorni delle condizioni critiche, con una graduale crescita della severità dei fenomeni a cui si possono aggiungere effetti di amplificazione legati all'orografia locale, come in corrispondenza di valli o pianure. Da ciò segue l'interesse per un'analisi di correlazione degli episodi acuti di inquinamento da PM10 con le configurazioni meteorologiche più ricorrenti nell'area 'interesse. A tal fine, nel presente lavoro, si è utilizzata una metodica implementata presso il Consorzio LaMMA per l'individuazione e la classificazione dei "tipi di tempo" (https://www.lamma.toscana.it/clima-e-energia/climatologia/tipi-di-circolazione-eobs) e già utilizzata in altri ambiti applicativi. Si riportano qui alcuni risultati dello studio preliminare, svolto applicando tale metodica all'analisi delle serie storiche di dati di concentrazione del PM10 rilevati, nel quinquennio 2018-

2022, in alcune stazioni poste in aree vallive fortemente antropizzate. Tali stazioni fanno parte della Rete Regionale Toscana di monitoraggio della qualità dell'aria gestita da ARPAT (https://www.arpat.toscana.it/temi-ambientali/aria/qualita-aria), e sono state selezionate per lo studio perché rappresentano le aree regionali più critiche per l'inquinamento da PM10. Ulteriori sviluppi del presente studio potrebbero emergere dall'integrazione di approcci basati sulla teoria della probabilità con tecniche di Machine Learning (ML), in modo da individuare schemi di correlazione attendibili ed applicabili in contesto operativo, grazie al rigore della prima ed all'efficienza computazionale delle tecniche di ML.

---

[23] Matched Filter algorithm limits in detecting greenhouse gases emissions from satellite

Fabrizio Masin, Tiziano Maestri, Giorgia Proietti Pelliccia, Michele Martinazzo
Università di Bologna, Italy

As global warming continues to be one of the greatest threats to Earth environment, the detection and monitoring of natural and anthropogenic emissions of greenhouse gases holds a critical role as the first step of any danger reduction policy. New generation spaceborne hyperspectral instruments cover large portions of the Earth while maintaining a high enough spectral and spatial resolution to investigate the contribution of single molecular species and accurately localize their emission source. The Matched Filter method is used to search enhanced concentrations of methane in the atmospheric column. PRISMA (Cogliati et al., 2021), ASI's newest hyperspectral sensor, data are analysed. Both strong and weak CH4 emissions, in multiple scenarios, are investigated. It is demonstrated that PRISMA data allows the identification of methane non-punctual sources for gas emission of the order of 4000 kg/h. A theoretical study on the methodology is performed, to assess the detection threshold for different atmospheric conditions and to devise improvement strategies to be applied in the most common scenarios (which include a general scene homogenisation and false-positives detection policies). In the simulation, the radiative transfer equation at shortwave is solved by means of a home-made model based on gaseous optical depths computed from LbLRTM (http://rtweb.aer.com/lblrtm.html), while the homogenous background reflectance is derived from PRISMA images. Starting from simplistic assumptions on the scene, to assess the theoretical limits of the algorithm, the scenario is gradually complicated to mimic PRISMA observational conditions and evaluate the detection limit in real data.

---

[24] Miglioramento della qualità dell'aria urbana attraverso la gestione del traffico veicolare: scenari emissivi e implicazioni

Chiara Metrangolo[1], Adelaide Dinoi[2], Antionio Esposito[1], Gianluca Pappaccogli[1], Antonio Donateo[2], Riccardo Buccolieri[1]
[1]University of Salento, Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, Laboratory of Micrometeorology, S.P.6 Lecce-Monteroni, 73100 Lecce, Italy; [2]National Research Council of Italy, Institute of Atmospheric Sciences and Climate (CNR-ISAC), S.P.6 Lecce-Monteroni, 73100, Lecce, Italy

L'inquinamento atmosferico causato dal traffico veicolare è una grave minaccia per ambiente e salute in zone urbane. Nonostante azioni recenti, alcune sostanze inquinanti rimangono troppo elevate, richiedendo soluzioni urgenti. Nell'ambito del progetto PNRR CN Mobilità Sostenibile - SPOKE 7 (CUP F83C22000720001 - Codice Progetto: CN00000023), saranno condotte delle campagne sperimentali intensive con l'obiettivo di quantificare l'impatto delle emissioni da traffico sulle concentrazioni di inquinanti all'interno di specifici ambienti urbani. Si prevede lo sviluppo di un sistema basato sull'integrazione di dati (parametri meteo e concentrazione di diversi composti), raccolti attraverso misure in situ, utilizzando una rete di sensori a basso costo, con la modellazione della dispersione di inquinanti su scala locale. L'utilizzo del modello di dispersione ADMS-Roads (https://www.cerc.co.uk) permetterà di sviluppare scenari emissivi a partire da variabili cruciali quali la meteorologia, la configurazione stradale, la morfologia urbana, il comportamento del traffico, generando mappe approfondite che illustrano la distribuzione degli inquinanti atmosferici nelle immediate vicinanze delle strade. Grazie alla definizione e l'analisi di scenari emissivi appropriati mediante l'implementazione di strategie di gestione del traffico come la regolamentazione delle strade, la creazione di zone a basse o nulle emissioni e la modifica dei flussi di traffico, ci si attende che si verifichino significativi miglioramenti nella qualità dell'aria urbana in alcune città italiane considerate come casi di studio. Inoltre, l'analisi dei parametri morfologici permetterà di individuare schemi comuni nelle città, consentendo la trasferibilità di tali strategie efficaci ad altre realtà cittadine. Questo studio costituisce una risorsa preziosa per le autorità locali, offrendo una base solida per l'attuazione di piani di risanamento della qualità dell'aria nelle aree più sensibili.

---

[25] Spatial-temporal distribution of Nitrogen Dioxide (NO2) Using Pandora, TROPOMI and In Situ Measurements in a rural area

Cristiana Bassani[1], Annalisa Di Bernardino[2], Serena Falasca[2], Giulio Esposito[1], Antonietta Ianniello[1], Francesca Vichi[1], Anna Maria Iannarelli[3], Monica Campanelli[4], Stefano Casadio[3]
[1]Italian National Research Council - Institute of Atmospheric Pollution (CNR-IIA), Italy; [2]Department of Physics, Sapienza University of Rome, 00185 Rome, Italy; [3]SERCO Italia SpA, Frascati, 00044 Rome, Italy; [4]Italian National Research Council - Institute of Atmospheric Sciences and Climate (CNR-ISAC), Italy

The spatial-temporal distribution of NO_2 surface concentration (SC) and tropospheric columnar density (TrCD) was investigated over one year (March 2022–February 2023) using remote sensing and in situ data in a rural area with both agri-food production and anthropic activity.

The SCs were provided by a Pandora-2s spectrometer (P138) and an analyzer both operated at the Liberti Observatory located at the CNR Research Area RM1 (40km North of Rome). P138 belongs to Pandonia

Global Network (PGN) and to Boundary Layer Air Quality-Analysis Using Network of Instruments (BAQUNIN) supersite. The SC of P138 was estimated along the line-of-sight at a fixed azimuth including the primary local urban emission sources.

During spring and winter, comparable high levels of SC were observed by P138 as well as usual seasonal cycle was detected by analyzer. Consequently, local emission sources were spread making the SC homogeneous in the surroundings in winter and autumn, while in spring and summer the pollution was mainly confined near the emission sources since measured by P138 and not by analyzer.

The TROPOspheric Monitoring Instrument (TROPOMI) TrCD was considered in seven sites representative of local land uses (agricultural, urban, and industrial). The results showed the potential of TROPOMI to characterize TrCD at local scale over rural areas detecting the pollution variability in agricultural and industrial sites only 7km apart.

The TROPOMI maps highlighted that southernmost sites were totally exposed to moderate air pollution from local sources and Rome. Interesting results about the increasing of TrCD in the central weekdays were also obtained and further analysis are going.

Finally, events with high NO_2 levels were simulated by Weather Research and Forecasting (WRF) model examining wind vertical profiles. The results suggested that high level was mainly due to local emissions and, to a lesser extent, to the pollutants transport from Rome.

---

[26] The uRban hEat and pollution iSlands inTerAction in Rome and possible miTigation strategies (RESTART) project

Annalisa Di Bernardino[1], Erika Brattich[2], Stefania Argentini[3], Francesco Barbano[2], Monica Campanelli[3], Giampietro Casasanta[3], Andrea Cecilia[3,4], Silvana Di Sabatino[2], Margherita Erriu[1], Serena Falasca[1], Tiziano Maestri[2], Anna Maria Siani[1]

[1]Physics Department, Sapienza University of Rome, 00185, Rome, Italy; [2]Department of Physics and Astronomy “Augusto Righi”, University of Bologna, 0126, Bologna, Italy; [3]CNR, Institute of Atmospheric Sciences and Climate (ISAC), 00133, Rome, Italy; [4]Physics Department, University of Rome Tor Vergata, 00133 Rome, Italy

The activities envisaged in the framework of the project “uRban hEat and pollution iSlands inTerAction in Rome and possible miTigation strategies” (RESTART) are presented. The 2-year project, started in October 2023, is funded by the Italian Ministry for University and Research as a Project of National Interest (PRIN2022).

RESTART aims at investigating the connection between the Urban Heat Island (UHI) and the Urban Pollution Island (UPI) in Rome, offering a series of mitigation strategies including tailored Nature-Based Solutions (NBS), such as green areas/walls/roofs, trees, and ready-to-use guidelines for the improvement of well-being and livability in urban environments.

The project’s activities are divided into two main phases.

The first phase is focused on determining the state of the art of the UHI and UPI in Rome, analysing the meteorological processes affecting these two phenomena and identifying possible links between them, analysing how severe pollution events and heat waves interact and possibly trigger their occurrence. These phenomena are investigated by using ground-based atmospheric monitoring instruments, belonging to international observatories and dense networks of instruments and providing quality-checked datasets of WMO-compliant meteorological and air quality measurements in the Rome territory.

In the second phase, the environmental vulnerabilities identified will drive the numerical investigation of city-scale ventilation, heat transport, and air pollutants removal/accumulation. The most up-to-date numerical modelling chains will combine cutting-edge numerical simulations with mesoscale and dispersion models to simulate the connection between UHI and UPI, both in the ex-ante and ex-post NBS implementation scenario. The thermodynamic and chemical processes that govern UHI and UPI will be analysed, focusing on thermal comfort, pollutants dispersion and photochemical tropospheric ozone reactions.

The outcomes, obtained from the combination of numerical and experimental analyses, will provide general recommendations and guidelines that will be disseminated within the scientific community, population, and policymakers.

---

[27] Rain motion vectors da mosaico radar nazionale: confronto di metodologie e statistiche pluriennali

Mario Montopoli[1,2], Clizia Annella[2,3], Vincenzo Capozzi[3], Gianfranco Vulpiani[4], Elisa Adirosi[1], Luca Baldini[1]

[1]ISAC, Roma Italy; [2]CETEMPS Università Dell’’Aquila; [3]Dip. di Scienze e Tecnologie Università Napoli Parthenope, Napoli; [4]Presidenza del Consiglio dei Ministri, Dipartimento della Protezione Civile

La stima del campo di moto orizzontale della precipitazione (rain motion vectors) è la controparte in pioggia delle più consolidate metodologie note con il nome di Atmospheric Motion Vectors (AMV) che vengono prodotte a partire da misure radiometriche satellitari su piattaforme geostazionarie. Mentre gli AMV, data la geometria di vista satellitare, forniscono una visione su domini più ampi e sono rappresentativi del moto del top delle nubi, i RMV solo legati alle osservazioni radar di terra e sono più sensibili al trasporto della precipitazione (idrometeore in fase liquida o ghiacciata) alla scala chilometrica.

In questo lavoro verranno confrontate diverse tecniche di letteratura per la stima di RMV che si basano sulla soluzione approssimata dell’equazione del flusso ottico, utilizzando il campo di riflettività radar come massa tracciante del campo di moto. Verrà inoltre mostrato un approccio innovativo che sfrutta il mosaico radar del campo Doppler per trasformare quest’ultimo (che è rappresentativo del movimento delle idrometeore solo

lungo la linea di vista del radar) in RMV vincolati al Doppler. Le tecniche proposte verranno confrontate tra loro sia in termini qualitativi (casi di studio) che statistici con i campi di vento ERA5 alle stesse quote osservate dal radar. Il dataset considerato comprende 1.5 anni di dati dal 1 Gennaio 2022.

I risultati mostrano come l'aggiunta dell'informazione Doppler aumenti in modo apprezzabile la dinamica delle intensità dei RMV stimati, mentre la direzione resta confrontabile tra i vari metodi testati. I confronti con i campi ERA5 sono in generale buon accordo in termini di bias con miglioramenti nel caso di utilizzo del Doppler.

Nel complesso l'analisi proposta, che riguarda l'ottimizzazione delle risorse radar esistenti in Italia, può essere di interesse anche dal punto di vista applicativo per la generazione di un prodotto operativo sulla dinamica delle precipitazioni.

3:00pm - 4:30pm

APPLICAZIONI

Location: **Session room, Aula 7, Edificio 6, Studium 2000, Università del Salento**
Session Chair: **Riccardo Buccolieri**
Session Chair: **Micaela Menegotto**

3:00pm - 3:15pm

Sviluppo dello schema di parametrizzazione BEP+BEM Offline

Gianluca Pappaccogli[1], Andrea Zonato[2], Alberto Martilli[3], Riccardo Buccolieri[1], Piero Lionello[1]
[1]Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, University of Salento, S.P. 6 Lecce-Monteroni, 73100 Lecce, Italy; [2]Royal Netherlands Meteorological Institute (KNMI), De Bilt, The Netherlands; [3]Atmospheric Modelling Unit, Environmental Department, CIEMAT, 28040 Madrid, Spain

Il veloce processo di urbanizzazione ed il crescente impatto dei cambiamenti climatici rendono imperativo studiare il clima nelle aree urbane. Gli effetti delle aree urbane sull'atmosfera e sui bilanci di energia e massa sono integrati nei modelli climatici mediante parametrizzazioni urbane. Il modello multi-layer sviluppato da Martilli et al. (2002), conosciuto come BEP+BEM, costituisce attualmente la modellazione urbana più avanzata nei modelli di Previsione Numerica, simulando l'interazione diretta tra la struttura urbana e lo strato limite planetario (PBL).Tuttavia, l'esecuzione di simulazioni climatiche a lungo termine è stata sino ad oggi limitata dall'alto sforzo computazionale, rappresentando una seria restrizione per le proiezioni climatiche, le previsioni meteorologiche e sulla qualità dell'aria in tempo reale. Questo studio propone l'implementazione del modello BEP+BEM offline, consentendo simulazioni a lungo termine per esaminare gli impatti dei cambiamenti climatici sulle aree urbane e valutare possibili misure di mitigazione e l'ottimizzazione nell'uso dell'energia. Lo schema di parametrizzazione offline BEP+BEM è stato accoppiato con un modello di flusso nello strato limite urbano (MLUCM v2.0, Nazarian et al., 2020) per stimare coefficienti di diffusione e lunghezze di scala basati sulla densità e geometria della struttura urbana. In questo studio, il modello urbano è stato forzato con dati di rianalisi ERA5 al fine di comprendere gli impatti dei cambiamenti climatici su differenti Local Climate Zones. Si valuta l'impatto di varie condizioni climatiche sulle LCZ più comuni, quantificando l'effetto sul microclima e sui consumi energetici. I risultati evidenziano la capacità del modello di rappresentare accuratamente il bilancio energetico urbano e catturare gli scambi tra atmosfera ed edifici, conferendogli valore come strumento per studi sugli impatti climatici, pianificazione urbana e processi decisionali.

3:15pm - 3:30pm

Contributo del traffico stradale alla qualità dell'aria nella città di Milano: confronto tra approcci modellistici multiscala

Andrea Piccoli[1], Valentina Agresti[1], Elena De Angelis[1], Fabrizio Ferrari[2], Giuseppe Maffeis[2], Guido Pirovano[1], Giovanni Lonati[3]
[1]RSE spa,Sviluppo Sostenibile e Fonti Energetiche, Milano, Italy; [2]TerrAria srl, Milano, Italy; [3]Politecnico di Milano, Dipartimento di Ingegneria Civile e Ambientale, Milano, Italy

Il trasporto stradale è una delle principali fonti inquinanti in ambito urbano. La sua caratterizzazione è di fondamentale importanza per quantificare l'impatto della qualità dell'aria sulla popolazione. Questo lavoro presenta il confronto tra due differenti approcci modellistici applicati alla città di Milano. Il primo consiste nella modellazione ibrida Euleriana-Lagrangiana con il modello CAMx-LPiG (Linear Plume in Grid). LPiG è un modulo sviluppato da RSE per valutare la dispersione da sorgenti lineari con approccio lagrangiano a puff. LPiG è un modulo interamente online, con un'integrazione completa tra il modello a scala locale e il modello Euleriano. Il modello è confrontato con i risultati di una applicazione di UTAQ (Urban Tool for Air Quality), un modello per la simulazione della qualità dell'aria a scala urbana ad alta risoluzione sviluppato in un progetto finanziato da ECMWF. In UTAQ le concentrazioni locali sono calcolate attraverso specifiche funzioni sorgente-recettore (kernel orari) addestrate attraverso il modello lagrangiano a puff CALPUFF per differenti condizioni meteorologiche. L'utilizzo dei kernel permette di rendere il calcolo delle concentrazioni veloce ed affidabile anche per griglie di calcolo ad alta risoluzione (20x20m).

Le due applicazioni, relative all'intero anno 2017, permettono di confrontare il ruolo del traffico stradale rispetto alle concentrazioni di fondo e alle altre sorgenti locali milanesi sia sull'intero territorio della città di Milano che presso i principali recettori di tipo traffico. In UTAQ tutte le sorgenti locali della città sono trattate alla scala locale, mentre in CAMx-LPiG la componente ad alta risoluzione riguarda solamente le emissioni da traffico dei principali archi stradali cittadini. Dato che i due sistemi modellistici condividono le stesse concentrazioni di background, ma approcci indipendenti nella stima del ruolo delle sorgenti locali, il confronto ha permesso di evidenziare sia gli elementi di maggiore coerenza che le principali criticità delle due implementazioni.

3:30pm - 3:45pm

Modellistica meteorologica per la valutazione dell'impatto sulla salute da emissioni industriali in siti ad orografia complessa.

Cristina Mangia[1], Marco Cervino[1], Elisa Bustaffa[2], Fabrizio Minichilli[2]
[1]CNR-ISAC Istituto di Scienze dell'Atmosfera e del Clima, Lecce e Bologna; [2]CNR-IFC- Istituto di Fisiologia Clinica, Pisa

Negli studi di valutazione dell'impatto sulla salute da emissioni in siti ad orografia complessa un ruolo determinante è assunto dalla caratterizzazione meteorologica del sito e della previsione dell'evoluzione degli inquinanti attraverso modelli meteo-dispersivi. In questo lavoro si presenta un caso di studio riguardante la valutazione di impatto sanitario di emissioni industriali in una valle in Molise, con sorgenti ubicate nei due estremi della valle, a ridosso di rilievi orografici. Lo studio prevedeva la ricostruzione della coorte di popolazione residente nell'area e la valutazione dell'esposizione alle emissioni industriali su un periodo di 14 anni. La ricostruzione dei campi medi annui di concentrazione di inquinanti è stata effettuata attraverso il sistema meteodispersivo WRF/CALMET/CALPUFF. I dati meteorologici ottenuti con WRF hanno consentito da una parte di ricostruire le circolazioni a larga scala e quelle locali indotte dai rilievi orografici, dall'altra di mettere in evidenza, in collaborazione con le associazioni del territorio, l'inadeguatezza della rete meteorologica disponibile sul territorio. Con i modelli CALMET/CALPUFF in cascata a WRF è stato possibile stimare i campi di concentrazione degli inquinanti, necessari per una valutazione dell'esposizione della popolazione. I risultati hanno messo in evidenza come la complessità dell'orografia determinasse la distribuzione degli inquinanti al suolo, con valori massimi registrati sui pendii opposti, anche a notevole distanza dai punti di rilascio degli inquinanti. Dalle conseguenti analisi epidemiologiche è emerso come alcuni eccessi di rischio per diverse patologie si verificassero nelle aree a massima esposizione.

3:45pm - 4:00pm

IL TOOL MODELLISTICO DI ARPA-PUGLIA PER LA VALUTAZIONE DEGLI IMPATTI DEGLI INCENDI: APPLICAZIONE A UN CASO STUDIO

Annalisa Tanzarella[1], Angela Morabito[1], Francesca Intini[1], Ilenia Schipa[1], Vincenzo Campanaro[1], Nicolò Verando[2], Daniela Barbero[2], Umberto Giurato[2], Nicola Pepe[2]
[1]ARPA Puglia, Italy; [2]ARIANET, Italy

Quando si verificano incendi, le ARPA sono chiamate a svolgere nell'immediato misure in aria ambiente utili a valutare la qualità dell'aria e, in fase di post emergenza, a supportare le Autorità Sanitarie nella esecuzione dei campionamenti sul suolo e sulle colture per valutazioni più dettagliate degli impatti sugli ecosistemi e sulla salute della popolazione. Un modello di dispersione può costituire un valido strumento di supporto, utile a definire l'area di impatto di un incendio. Presso ARPA Puglia, nell'ambito dell'attività di aggiornamento e potenziamento (revamping) del sistema modellistico operativo, sono state messe a punto due catene modellistiche, basate sul modello lagrangiano a particelle SPRAY, in grado di supportare il personale in fase di emergenza e di post-emergenza. La prima catena è alimentata con le informazioni che ARPA acquisisce nell'immediato (coordinate, estensione e durata dell'incendio, prima stima della tipologia e quantità del materiale incendiato, orario dell'intervento dei vigili del fuoco), la seconda utilizza invece informazioni più dettagliate e precise (tipologia e quantità del materiale incendiato, durata reale dell'incendio, eventuali fattori di emissione). Questo tool modellistico è stato testato su un caso studio relativo ad un incendio verificatosi in un'area del Barese, durato diverse ore e che ha prodotto uno sviluppo imponente di fumo. Allo scopo, sono state eseguite alcune simulazioni utilizzando le due catene modellistiche, considerando, a diversi gradi di dettaglio, le informazioni relative sia alle caratteristiche dell'evento, sia alle diverse ipotesi circa la modalità di sviluppo ed evoluzione dell'incendio (per es. presenza dell'effetto di smouldering).

4:00pm - 4:15pm

The RISKADPAT project: Green and Resilient Structures in the Face of Climate Change Induced Extreme Events Considering the Interactions between Adaptation and Mitigation Options

Silvana Di Sabatino, Carlo Cintolesi, Petros Ampatzidis
University of Bologna, Italy

The RISKADAPT project is an EU HORIZON-RIA Action started in January 2023. The project aims to generate an integrated platform collecting several tools and guidelines to reduce the risk of damage or loss of functionality to buildings and infrastructures subject to strong meteorological phenomena (e.g. strong winds, intense icing, extensive flooding) that can occur rarely but strongly damaging socio-economic infrastructures; and that are expected to be more energetic or more frequent in future due to the actual trend of climate change.

In this framework, the research group of Atmospheric Physics is conducting a detailed study of the public Hospital of Cattinara in Trieste, a tall building placed at the top of an isolated hill and subject to the strong Bora wind. Hence, this is a prototypical case to study forcing by strong wind and rain. The analyses are performed by high-resolved numerical simulations of the CFD type, complemented by an experimental campaign scheduled for winter 2024. The aim is to better understand the impact of atmospheric forces on building facades and derive semi-empirical functions for their estimation. Information about climatic projections will be investigated through high-resolved simulations. This step is particularly challenging since it required to adopt an effective downscaling strategy from mesoscale to building scale; a topic on which there are few studies in literature while much more work has been done to downscale from climate scale to mesoscale. The link from meso- to building-scale is necessary to have an effective comprehension of the local impact of climate change but poses multiple fundamental issues regarding the modelling and the

reconstruction of boundary layer processes, as well as technical problems due to the large computational cost required by small-scale simulations.

The present contribution wants to give an overview of the strategy adopted and to document the preliminary results and solutions that have been adopted in the RISKADAPT project.

4:15pm - 4:30pm

Application of an artificial neural network to assess geo physical parameters evolution of mediterranean coastal lagoons in response to Climate Change.

Fabio Bozzeda, Piero Lionello

Department of Biological and Environmental Sciences and Technologies, University of Salento, DiSTeBA, S.P. Lecce-Monteroni, 73100 Lecce, Italy

This study investigates the utilization of artificial neural networks (ANNs) to evaluate the changes in geophysical parameters in Mediterranean coastal lagoons in response to climate change. Coastal lagoons are ecosystems with notable vulnerability and considerable ecological and socio-economic importance. Understanding their response to climate change is imperative for conservation and sustainable management. The Mediterranean region hosts numerous coastal lagoons, unique ecosystems crucial for the environmental, social, and economic aspects of the region. Given the unprecedented challenges posed by climate change, comprehending the response of these vulnerable lagoons to environmental shifts becomes essential. This essay underscores the significance of studying Mediterranean coastal lagoons, emphasizing their ecological importance, socio-economic value, and potential implications for global sustainability. We employ ANNs to model the relationships between climate variables and key geophysical parameters, enabling the estimation of future responses to climate change.

Coastal lagoons serve as i) Biodiversity Hotspots, supporting diverse ecosystems, including wetlands, marshes, seagrass beds, and unique fauna. These waters act as critical nurseries for various marine species, fostering biodiversity and promoting ecosystem resilience. Additionally, Mediterranean coastal lagoons function as exceptional carbon sinks, sequestering substantial amounts of atmospheric carbon dioxide. Studying their response to climate change provides insights into their ability to act as carbon storage systems or potentially become sources of greenhouse gas emissions. Coastal lagoons also act as Hydrological Regulators, serving as natural buffer zones during extreme weather events, regulating hydrological cycles and minimizing the impacts of flooding. Lastly, in terms of Water Quality and Purification, coastal lagoons act as natural filters, enhancing water quality by trapping pollutants and sediments.

Mediterranean coastal lagoons hold significant socio-economic value, providing essential fishing grounds and supporting local fishing communities, contributing significantly to the regional economy. They are popular tourist destinations, attracting millions of visitors annually, generating revenue for local economies. Coastal lagoons act as natural defenses against storm surges and coastal erosion, safeguarding infrastructure and coastal communities. Understanding their response to climate change is crucial for coastal planning and adaptation strategies. Finally, coastal lagoons have been integral to Mediterranean cultures for centuries, holding historical and cultural significance. Preserving these ecosystems amid climate change ensures the continuity of traditional practices and indigenous knowledge.

Our study aims to develop a modeling approach suitable for reconstructing the response of the biota of Mediterranean coastal lagoons to changes in salinity and temperature induced by climate change. Modeling the response of coastal lagoon biodiversity to climate change faces several challenges, including the complexity and heterogeneity of these ecosystems and the lack of comprehensive biodiversity data. To overcome these challenges, we have established an analytical framework consisting of three main steps: i) constructing a representative database of coastal lagoons on a Mediterranean scale; ii) analyzing the database using machine learning pattern recognition techniques; and iii) explaining the identified dynamics through stochastic differential equations.

Coastal lagoons, unlike seas and oceans within the Copernicus service, are not subject to continuous and large-scale observations. To address this limitation, we will use available field observations in conjunction with large-scale data from the Copernicus Marine Services' reanalysis and projections to train a neural network. This approach aims to produce an estimation of the response of the main physical and chemical parameters of the lagoons to anticipated changes in key atmospheric and climatic factors. Time series data from the Copernicus system will be utilized to reconstruct corresponding time series of the main physico-chemical parameters of each considered lagoon and the corresponding time series and projections of lagoon biodiversity parameters (abundance, number of species, and diversity).

4:30pm - 5:00pm

Chiusura della conferenza
Location: **Session room, Aula 7, Edificio 6, Studium 2000, Università del Salento**

5:00pm - 5:30pm

Goodbye Coffee Break
Location: **Poster area, Atrio, Edificio 5, Studium 2000, Università del Salento**