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16h15 – 18h00: Session 4. Interdisciplinary studies

(Chair: J Mazon, J.P. Montávez, V. Telesca)

5O1. Precision irrigation system for agricultural water management in changing climate.

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The conflicting use of water is becoming more and more evident, also in regions that are traditionally rich in water. With the world's population projected to increase to 8.5 billion by 2030, the simultaneous growth in income will imply a substantial increase in demand for both water and food. Climate change impacts will further stress the water availability also enhancing its conflictual use. The agricultural sector is the biggest and least efficient water user, accounts for around 24% of total water use in Europe, peaking at 80% in the southern regions. The presentation shows how a web-gis system for real-time operative precision irrigation water management at high spatial and temporal is able to monitor and forecast the crop water need reducing the irrigation losses without a reduction in crop production. This approach increases the water use efficiency according to different agronomic practices supporting different level of water users from irrigation consortia to single farmers. The system couples together satellite (land surface temperature LST and vegetation information) and ground data, with pixel wise hydrological soil water energy balance model using recent scientifically outcomes on soil moisture retrieval from satellite data and hydrological modelling. Discussion on the methodological approach based on the satellite LST, ground evapotranspiration measures, and pixel wise hydrological modelling is provided proving the reliability of the forecasting system and its benefits. The activity is part of the European Chinese collaborative project (SIM, Smart Irrigation Modelling, www.sim.polimi.it). The system is applied in different experimental sites which are located in Italy, China and Spain, which are characterized by different climatic conditions, water availability, crop types and irrigation schemes. Specific results are shown for two case studies in Italy: the Sud Fortore District of the Capitanata Irrigation consortium which covers an area of about 50'000 hectares with flat topography, hot summer and warm winter, mainly irrigated with pressurized aqueduct, mainly devoted to wheat, tomatoes and fresh vegetables cultivation; the Chiese irrigation consortium in Northern Italy with higher water availability, mainly cultivated with maize.

5O2. Assessment of the future climate potential for tourism over Spain using a combination of downscaling approaches and quantitative impact models

M.F. Cardell, A. Amengual, R. Romero

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Spain is recognized as one of the most visited tourist destinations worldwide but also as a climate change hot-spot. Climate is a key resource and even a limiting factor for many types of tourism. Owing to climate change, modified patterns of atmospheric variables such as temperature, rainfall, humidity, radiation and wind speed will likely affect the suitability of the Spanish destinations.

case of how the interaction between storm motion and drainage properties modulate hydrological response at different spatial scales.

2O9. 50-year wind record and rissaga event associated with a winter squall line in the Balearics

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During 22 January 2021, an active squall line associated with the intense cyclone Hortense, which travelled from the Atlantic to the Mediterranean region, was developed and swept across Mallorca and Menorca . Strong winds associated with this squall line affected the Balearic Islands. In particular, these intense winds broke the 50-year record wind at the Palma airport, with wind gusts of 130 km h-1. An outstanding long-lived pressure jump was associated with the squall line, giving rise to a moderate meteotsunami or rissaga event that reached 60 cm wave height in the port of Ciutadella (Menorca). Notably, this rissaga effect was also observed in other locations of the Balearics. An observational description of the event, using land-based and remote-sensing systems, is presented. In addition, an approach to the diagnosis of the processes involved is carried out. Finally, using atmospheric and marine numerical models, the predictability of the event is explored.

2O10. A neural network designed to predict meteotsunamis in Ciutadella harbour (Balearic Islands, Spain)

M. Vich, R. Romero

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Atmospherically-driven large-amplitude sea level oscillations in the tsunami frequency band are common in Ciutadella harbor . These meteotsunamis can lead to wave heights of around 1 m and several episodes in modern history have reached 2-4 m, with catastrophic consequences. A timely and skilled prediction of these phenomena could significantly help to mitigate the damages inflicted to the port facilities and moored vessels. This work tests the applicability of neural networks (NN) for forecasting rissagues (meteotsunamis local name). To feed the NN with suitable inputs, we explore the key physical mechanisms that drive meteotsunamis in Ciutadella harbour. Particularly, two different NNs are built: a dry and wet scheme. The dry scheme focuses on the development of atmospheric gravity waves (governed by temperature and wind profiles across the tropospheric column), while the wet scheme also takes into account the occasional influence of moist convection by incorporating the humidity variable. Both NNs are trained using resilient backpropagation with weight-backtracking method. Their performance is tested with deterministic verification indices. The NNs results show a skill comparable to that of computationally expensive approaches based on coupled ocean-atmosphere simulations. However, the expected greater versatility of the wet scheme cannot be clearly proved owing to

genesis and evolution of deep moist convection. In this context, ensemble prediction systems represent a feasible approach to sample the inherent uncertainties of numerical weather forecasts.

In this work, we investigate the properties of perturbations to initial conditions and model parameterizations of subgrid processes in a convection-permitting setting for a set of heavy precipitation episodes over the western Mediterranean. In particular, (i) dynamical downscaling from a coarser resolution global model and (ii) tailored bred vectors, are applied to sample initial condition uncertainties; whereas (iii) stochastic parameterizations are introduced to perturb model parameterization. The characteristics of individual perturbations (i.e., initial conditions or model parameterizations) and combined perturbations, considering both error sources, are analysed in terms of ensemble diversity and skill. This study contributes to the identification of the most significant error sources for the prediction of Mediterranean heavy precipitation events, providing valuable guidance to design efficient and skilful convection-permitting EPSs.

4O11. Coastal risks induced by Mediterranean hurricanes

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Medicanes, for Mediterranean hurricanes, are mesoscale cyclones with morphological and physical characteristics similar to tropical cyclones. Although less intense, smaller and rarer than their Atlantic counterparts, Medicanes remain very hazardous events threatening islands and continental coasts within the Mediterranean Sea. The latest strong episode Medicane Ianos, resulted in severe damages in Greece and several casualties. This work investigates the oceanic response to these extreme events along the Mediterranean coasts under present-day and future (21st century) conditions. To this end, a coupled hydrodynamic-wave model is used to simulate both storm surges and wind-waves generation and propagation in the Mediterranean Sea at high resolution (~2 km) along the coastlines. A dataset of thousands of Medicanes synthetically generated from twenty global climate models and two reanalyses is used to derive the atmospheric forcing fields. Regional coastal risks assessment is performed for the present and future climate. We found increased coastal extreme sea levels in line to the reported changes in Medicane activity, with fewer events but of larger intensity projected by late 21st century.

4O12. TRAM with Physics: A New Numerical Model Suited for All Kinds of Atmospheric Applications

R. Romero

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A dynamical core of our own model in the context of a dry-adiabatic atmosphere, had been previously released. It uses a nonhydrostatic and fully compressible version of the Navier-Stokes equations. Advection terms are solved using a Reconstruct-Evolve-Average (REA) strategy over

the computational cells. These cells consist of equilateral triangles in the horizontal. The classical z-coordinate is used in the vertical, allowing arbitrary stretching (e.g. higher resolution in the PBL). Proper treatment of terrain slopes in the bottom boundary conditions allows for representing accurately the orographic forcing. To gain computational efficiency, time-splitting is used to integrate separately fast and slow terms and acoustic modes in the vertical are solved implicitly. For real cases on the globe, the Lambert map projection is applied and all Coriolis and curvature terms are retained. No explicit filters are needed.

Now we have completed TRAM with a proper set of physical parameterizations of cloud microphysics, cumulus convection, short and long-wave radiation, PBL processes and surface fluxes. The model is suitable to simulate circulations ranging from small-scale thermal bubbles ($\asymp$ 100 m scale) to synoptic-scale baroclinic cyclones (> 1000 km size), including orographic circulations, thermally-driven flows, squall lines, supercells, all kinds of precipitation systems and medicanes. Various examples of the great versatility offered by TRAM will be presented in this talk, with special emphasis on Mediterranean case studies. Besides opening a myriad of academic and research applications, TRAM regional forecasts at different resolutions will soon be disseminated in the web.