Here comes the new generation of climate models: The future of rainfall in the Alps

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Less intense mean daily precipitation, more intense and localized extreme events. This is what future climate scenarios indicate for the Eastern Alps, according to the study "Evaluation and Expected Changes of Summer Precipitation at Convection Permitting Scale with COSMO-

CLM over Alpine Space," published by the CMCC Foundation in the journal *Atmosphere*.

The research is conducted in the context of the European project H2020 EUCP (European Climate Prediction system) and contributes to the work of the international scientific community for the development of climate models that can support decision makers in a proper assessment of extreme events and their evolution considering climate change, with the ultimate goal of limiting its negative impacts on societies and economies.

Climate change adaptation plans and measures existing worldwide are based on future scenarios made available to decision-makers by the world of research. These scenarios currently provide a good representation of extreme events at daily scale, but still have limited predictive capabilities at sub-daily time scale. For some sectors, such as infrastructure, there is insufficient with which to develop adequate climate change adaptation policies: very intense and rapid rainfall, concentrated in small areas and in a few hours, can have strong impacts on infrastructure, causing the overflow of water bodies and flooding, undermining systems and revealing the inability of sewerage to handle large flows of water. Some extreme events can last for a few hours and affect very small areas (in the order of a few kilometers). The need to understand such phenomena is even greater in some specific geographical contexts, such as the Alpine area, where extreme rainfall events—typical of the summer season—can have serious consequences.

"In recent decades there has been an ongoing debate among climatologists about the added value of very high-resolution climate simulations, representing the next generation of the regional climate-models'" explains Paola Mercogliano, director of the REMHI (Regional Models and geo-Hydrological Impacts) division at the CMCC Foundation.

"These climate simulations, which are run with regional models at a very high spatial and temporal resolution, have a high computational cost and require significant investments in terms of research time. Given the high costs, the scientific community is questioning whether this is the right way to go to better support climate change adaptation policies. Our study demonstrates the added value of this direction and confirms that it is worth investing in it, especially in areas with complex orography or where uncertainty is still wide, such as the Alps. With these new generation models, we can not only observe what happens at very high resolutions in terms of mean daily precipitation, but we can also make statistical analyses on a sub-daily basis, looking at different hours of the same day. These models will also be able to provide information on the effects of climate change on hourly precipitation: results that would have been unthinkable just two or three years ago."

The study shows a better representation of precipitation frequency and intensity in very high-resolution simulations ('convection permitting') than in lower resolution simulations, especially at sub-daily scale.

"In agreement with existing literature, our preliminary results for the Alpine area in the summer season show a decrease in mean daily precipitation, especially at high altitudes, and localized intensifications of extreme events along the Eastern Alps. It will rain less frequently but more intensely, both on a daily and hourly time scale. Given the increased intensity of these events, it is clear that understanding the distribution of rainfall at hourly scale can bring great added value in our support for decision-makers," explains Marianna Adinolfi, CMCC researcher and lead author of the paper.

Next generation climate models are developed and applied by the CMCC Foundation in several international projects and contexts. Some examples include the study of urban heatwaves and the evolution of rainfall extremes in support of adaptation policies on an urban scale: all

contexts that will benefit from having simulations on hourly scales.

Furthermore, to support adaptation policies, the CMCC created products such as the Climate Scenarios for Italy, which allows visualizing in maps the expected climate until the end of the century using high-resolution climate models, and climate services such as Dataclime, which provides customized climate analysis on multiple temporal and spatial scales.

This study was carried out within the Horizon 2020 research project EUCP—European Climate Prediction system, in which the CMCC Foundation participates. The project aims to support the scientific community in the development of high-quality climate data and projections on a European scale to be provided to policy makers, stakeholders and planners to address the challenges and opportunities brought by climate change.

More information: Marianna Adinolfi et al, Evaluation and Expected Changes of Summer Precipitation at Convection Permitting Scale with COSMO-CLM over Alpine Space, *Atmosphere* (2020). DOI: 10.3390/atmos12010054

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