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MORE: High-Resolution MOLOCH-downscaled ERA5 REanalysis – Validation and Applications in Weather, Climate, and Hydrology

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This study presents a comprehensive assessment of a very high-resolution reanalysis dataset developed for the entire Italian territory and the broader Alpine domain, spanning the 30-year period from 1990 to 2020. The dataset was produced via dynamical downscaling of the ERA5 reanalysis using the convection-permitting non-hydrostatic model MOLOCH, implemented at a spatial resolution of 1.8 km. This fine-scale resolution enables a more accurate representation of local-scale atmospheric processes, particularly in areas with complex terrain.

Validation was conducted against multiple high-resolution observational datasets, including GRIPHO, ARCIS, and the ISAC-CNR precipitation and temperature datasets. Additionally, comparisons were made with other state-of-the-art downscaled reanalysis products such as ERA5-LAND, CERRA-LAND, and MERIDA-HRES. Results confirm the dataset's high reliability in reproducing key meteorological variables like near-surface temperature and precipitation, as well as its superior ability to capture higher-order statistical features such as event intensity, frequency, and extreme values.

The dataset's utility is further demonstrated through a variety of multi-disciplinary applications. In hydrology, it allows for detailed drought monitoring and water balance assessments. In meteorology, it supports investigations into orographic effects and high-impact weather events. In the context of climate science, the dataset provides robust input for trend and variability analysis at local and regional scales.

This work highlights the critical role of very high-resolution reanalysis data in supporting both scientific research and decision-making processes. The dataset lays the groundwork for future applications in disaster risk reduction, infrastructure planning, and climate adaptation.

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