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Atmospheric rivers in the Mediterranean basin and heavy precipitation over northern Italy

Silvio Davolio[1,2], Isacco Sala[1], Alessandro Comunian[1], Daniele Mastrangelo[2], Sante Laviola[2], Giulio Monte[2], Barbara Tomassetti[3], Annalina Lombardi[3], Marco Verdecchia[4], Federico Grazzini[5], and Valentina Colaiuda[6]

[1]University of Milan, Department of Earth Sciences , Milano, Italy (silvio.davolio@unimi.it)
[2]Institute of Atmospheric Sciences and Climate, National Research Council of Italy, (ISAC-CNR), Bologna, Italy
[3]Center of Excellence CETEMPS, University of L'Aquila, Coppito (L'Aquila), Italy
[4]Department of Physical and Chemical Sciences, University of L'Aquila, Coppito (L'Aquila), Italy
[5]Arpae Hydro-Meteorological and Climate Service, Bologna, Italy
[6]Regional Civil Protection Agency - Abruzzo Region, L'Aquila, Italy

Recent studies of extreme precipitation and flood events affecting the Alpine area in northern Italy have revealed that besides the local contribution due to evaporation from the Mediterranean Sea, a relevant amount of moisture may move from remote areas towards the Mediterranean within long and narrow filament-shaped structures, known as atmospheric rivers.

High-resolution numerical simulations have demonstrated that the presence of an intense atmospheric river, whether coming from Africa tropical areas or from the Atlantic, represented a distinguishing aspect of those events, superimposed on the well-known mesoscale dynamic mechanisms of heavy precipitation over the Alps. The orographic uplift of water vapour transported by the atmospheric rivers represented a critical ingredient for the occurrence of extreme rainfall, and the characteristics of the atmospheric rivers determined the distribution and the intensity of the precipitation.

In order to investigate further the possible link between atmospheric rivers across the Mediterranean basin and high-impact weather, a detection algorithm, designed for the open oceans, has been adapted to the peculiar complex morphology of the region. It has been applied to conduct a climatological analysis on the presence of atmospheric rivers in the Mediterranean, exploiting ERA5 reanalysis, and to assess their relationship with extreme rainfall events over northern Italy during the last decades, exploiting a precipitation dataset with raingauge observations aggregated over civil protection warning areas. The study is undertaken in the framework of the national project ARMEX, funded by the Italian Ministry of Universities and Research, which involves also expertise in remote sensing and hydrological modelling to fully investigate characteristics and hydro-meteorological impact of atmospheric river over the national territory.