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Climate seasonal anomalies and jetstream dynamics in the Mediterranean

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The Mediterranean basin is located in southern part of the westerly atmospheric flow, where the rain season is in fall and winter, with a trend towards wetter falls and drier winters in the last decade, and a long warm season with a significative increase of the number of the heat waves in the last decade, with about half of the heat wave events within the period 1990-2000, and the longest and warmest event in 2003, as it results from observations.

Almost all the wintertime perturbations are of Atlantic origin, therefore, the cold season rainfall is strongly related to the NAO index: a strong NAO deflects the Atlantic storms northwards (more rain in north Europe), while a weak NAO is related to more rain in the Mediterranean. During this season, Mediterranean precipitation are generated by baroclinic instabilities, which are related to the Eady growth rate which is a function of the static stability and of the wind shear, which increases as the wind aloft becomes more intense.

In winter, the westerly jetstream aloft moves equatorwards, and, regionally, the jetstream in the Euro-Atlantic area is not continous: the Scandinavian-Baltic jetstream is generated by the thermal contrast between the Atlantic and the Artic air, while the Mediterranean jetstream is generated by the thermal contrast between the African and the cooler European air. When the Mediterranean jetstream resides along the Northern rim of Africa, the vorticity aloft is cyclonic and the pressure over the Mediterranean is low, and, if, in addition, the Scandinavian jetstream is not too far north, a large number of Atlantic perturbations enter into the Mediterranean basin bringing abundant rainfall.

During summer, there is a strong relationship between the position of the jetstream in the Mediterranean region and in the Scandinavian region and the warm (cool) spells

in the Mediterranean. In particular, during the warm season, an analysis of the upper airflow shows that the westerly jetstream moves polewards and the jetstream in the Euro-Atlantic region is not continous: the Scandinavian-Baltic branch of the jetstream is generated by the thermal contrast between the Atlantic and the Artic air, while the Mediterranean branch is generated by the thermal contrast between the African and the cooler European air. The meridional scale (meridional distance) of these two jets is large in winter and smaller in summer. Results show that the Mediterranean summer is anomalously warm when the meridional distance between the Scandinavian and the Mediterranean jetstream is at minimum. When the two jets almost merge over the Alpine region (northern border of Italy), then a strong anticyclonic vorticity aloft forces a strong tropospheric subsidence, with a warming of the order of 3 degrees Celsius over the Mediterranean. When the Mediterranean jetstream resides along the Northern rim of Africa and the meridional distance between the Scandinavian and the Mediterranean jetstream is relatively large, the vorticity aloft is cyclonic, and the summer is relatively cool in the Mediterranean.

Both, during summer and winter, the persistency of the upper airflow anomaly in the Mediterranean (and of the thermal anomaly) is of the order of 2-3 weeks. Since the atmospheric memory is relatively short, we are investigating the SST and ice and snow distribution (which have a longer memory) in order to understand if and how these persistencies are robust in the two seasons, and if they can be extended, and what is their relevance during the cold and the warm season respectively.