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Northward expansion and rainfall seasonality amplification of the mediterranean climate zones projected in 21st century scenario

Andrea Alessandri (1,2), Annalisa Cherchi (5,6), Matteo De Felice (1), Annarita Mariotti (3,4), Yutong Pan (3), Ning Zeng (3,4)

(1) Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA), C.R. Casaccia, UTMEA-CLIM, Santa Maria di Galeria, Rome, Italy (andrea.alessandri@enea.it), (2) International Pacific Research Center, University of Hawaii at Manoa, Honolulu, HI, USA, (3) University of Maryland, Department of Atmospheric and Oceanic Science, College Park, MD, USA, (4) Earth System Science Interdisciplinary Center, College Park, MD, USA, (5) Istituto Nazionale di Geofisica e Vulcanologia, Bologna, Italy, (6) Centro Euromediterraneo sui Cambiamenti Climatici, Bologna, Italy

The Mediterranean climate is a major climate type of the Köppen classification that is characterized by hot, dry summers and cool, wet winters and located between about 30° and 45° latitude on the western sides of the continents (Koppen, 1900; Lionello 2012). By applying the latest development of the Koppen-Geiger classification scheme, we assessed the projected change of Mediterranean climate areas in the 21st century under the RCP4.5 stabilization scenario. The capability of the CMIP5 models in reproducing realistic Mediterranean climate regions is firstly assessed globally for the historical period (1980-2005). The projected multi-model change in the 21st century with respect to the historical period is then evaluated with particular focus on the Euro-Mediterranean region.

In the northern hemisphere over both the Euro-Mediterranean and the Western-US regions, the Mediterranean climate zones expand considerably during the 21st century. In particular, over Europe, the expansion is accompanied by a northward shift of the Mediterranean climate in countries like UK, France, even Scandinavia, while its southern margins being replaced by the arid climate types. This behavior characterizes some part of southern Italy, southern Greece and Middle East, where the annual mean precipitation decreases below the threshold that characterizes arid climates.

In the Euro-Mediterranean sector, the poleward expansion of the Mediterranean-type climate zone is related to the amplification of the rainfall seasonal cycle. In fact, the difference between winter and summer precipitation increases to fulfill the Mediterranean climate seasonality in more regions towards the north. By applying a vertically-integrated moisture budget analysis we show that the amplification of rainfall seasonality is primarily related to the "direct moisture effect" (i.e. the increase of moisture transport by assuming no change in atmospheric circulation), thus consistent with a "poor-get-poorer" mechanism during summer. Contributions from the dynamical feedback in the atmosphere and the surface evaporation are found to be important as well.

References:

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Koppen, W., 1900: Versuch einer Klassifikation der Klimate, vorzugsweise nach ihren Beziehungen zur Pflanzenwelt. Geogr. Zeitschr. 6, 593–611, 657–679.