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Summer atmosphere response to extreme soil conditions in the Mediterranean region

Stefano Materia (1), Marianna Benassi (1), Paolo Ruggeri (1), Constantin Ardilouze (2), Chloé Prodhomme (3,4), and Silvio Gualdi (1)

(1) Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici, Bologna (Italy), (2) CNRM, Université de Toulouse, Météo France, CNRS, Toulouse, France, (3) Group of Meteorology, Universitat de Barcelona (UB), Barcelona, Spain, (4) Barcelona Supercomputing Center (BSC), Barcelona, Spain

The land and atmosphere are interlocked by coupled hydrologic and energy cycles that are a major part of the Earth's climate system, but the feedback from soil moisture to precipitation via the return path through evapotranspiration (latent heat flux) is weak. Nevertheless, a few studies have addressed the crucial role of soil moisture feedbacks in European droughts, while others assessed the effect of dry soils in amplifying and prolong hot temperatures associated with heat waves in Europe. Surface moisture deficits are a relevant factor for the occurrence of hot extremes in many areas of the world, then the effects of soil moisture-temperature coupling are geographically more widespread than commonly assumed. This suggests that hot day predictions could be substantially improved in operational forecasts with the aid of soil moisture initialization. In this work, several sensitivity experiments were performed to assess the role of key climate components on Mediterranean weather at the seasonal time-scale. Specifically, six experiments have been designed to evaluate the impact of soil moisture on the variability of the summer season. In a region often hit by summer heat waves, the main goal is the assessment of the land-atmosphere response to heat waves hitting a pre-existing a) dry soil or b) wet soil. To do that, land and atmosphere have alternatively been coupled and uncoupled. When hot air advections hit a wet soil, the moisture mitigating effect lasts shortly, then high temperatures rapidly dry the terrain and other heat waves follow. Instead, if wet conditions are prescribed for the entire season, heat wave chance is basically nullified. Hot air striking dry terrains induces more durable and frequent heat waves, but the effect is more pronounced if atmosphere and land are coupled. If soil is artificially maintained dry for the entire season, temperatures are not allowed to grow as much. This highlights the crucial role of active air-soil feedbacks on the magnitude of heat waves.