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The unusual wet summer (July) of 2014 in Southern Europe

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ABSTRACT

Southern Europe (Italy and the surrounding countries) experienced an unusual wet summer in 2014. The monthly rainfall in July 2014 was 84% above (more than three standard deviation) normal with respect to the 1982–2013 July climatology. The heavy rainfall damaged agriculture, and affected tourism and overall economy of the region. In this study, we tried to understand the physical mechanisms responsible for such abnormal weather by using model and observed datasets. The anomalously high precipitation over Italy is found to be associated with the positive sea surface temperature (SST) and convective anomalies in the tropical Pacific through the atmospheric teleconnection. Rossby wave activity flux at upper levels shows an anomalous tropospheric quasi-stationary Rossby wave from the Pacific with an anomalous cyclonic phase over southern Europe. This anomalous cyclonic circulation is barotropic in nature and seen extending to lower atmospheric levels, weakening the seasonal high and causing heavy precipitation over the Southern Europe. The hypothesis is verified using the National Centers for Environmental Prediction (NCEP) coupled forecast system model (CFSv2) seasonal forecasts. It is found that two-month lead forecast of CFSv2 was able to capture the wet summer event of 2014 over Southern Europe. The teleconnection pattern from Pacific to Southern Europe was also forecasted realistically by the CFSv2 system.

1. Introduction

Southern Europe (Italy and neighboring countries) experienced an unusually wet and cold summer (June–July–August) during 2014. Much of these regions were hit by severe storms, flooding and unusually chilly weather. This unprecedented weather during the summer affected the socioeconomic conditions of these regions in terms of agriculture and tourism. The unusual wet and cold conditions delayed the grape ripening and harvest had been hindered that caused the Italian wine production fell by 15% as per the report of International Organization of Vine and Wine (OIV, 2014). The cool and wet summer contributed a drop of 34% in the Italian olive oil production according to International Olive Council (OIC, 2015). As per the report from the Food and Agriculture Organization of the United Nations, heavy summer rainfall drenched some of France's key wheat-growing areas during this summer (FAO, 2014). Entire tomato and lattice fields also have been destroyed by persistent torrential rains. The summer rain washed out family holidays and resulted in the loss of millions of euros in the tourism industry as reported in several news media (Pasquaré and Venturini, 2016).

Southern Europe is the part of Mediterranean region that lies in a transition zone between the arid climate of North Africa and the wet climate of central Europe. The transition zone climate is influenced by interactions between mid-latitude and tropical processes (Raicich et al., 2003; Giorgi and Lionello, 2008). This region experiences a hot, dry, sunny summer and a rainy winter season. In the boreal summer, the region is characterized by descending motion (Raicich et al., 2003) and a minimum in seasonal rainfall (Mariotti et al., 2002). The interannual variability of the circulation over the Atlantic-European sectors is affected by several teleconnections such as the North Atlantic Oscillation (Hurrell, 1995; Kutiel et al., 1996; Brunetti et al., 2002; Zveryaev, 2004; Folland et al., 2009), El Niño–southern oscillation (Fraedrich and Muller, 1992; Dai et al., 1997; Trenberth et al., 1998; Behera et al., 2013) and Asian summer monsoons (Rodwell and Hoskins, 1996; Tyrlis et al., 2013; Cherchi et al., 2014). While it is the tropical sea surface temperature (SST) that most directly affects the overlaying large-scale atmospheric circulations (Lau, 1985; Lau and Nath, 1994; Stern and Miyakoda, 1995), atmospheric teleconnections from the tropics to the extratropics may lead to some seasonal forecast skill in the extratropics via SST forcing of the tropical atmosphere (Barnston, 1994).

Due to its more northerly location and smaller spatial scale of the North Atlantic oscillation (NAO) during the summer, its influence over

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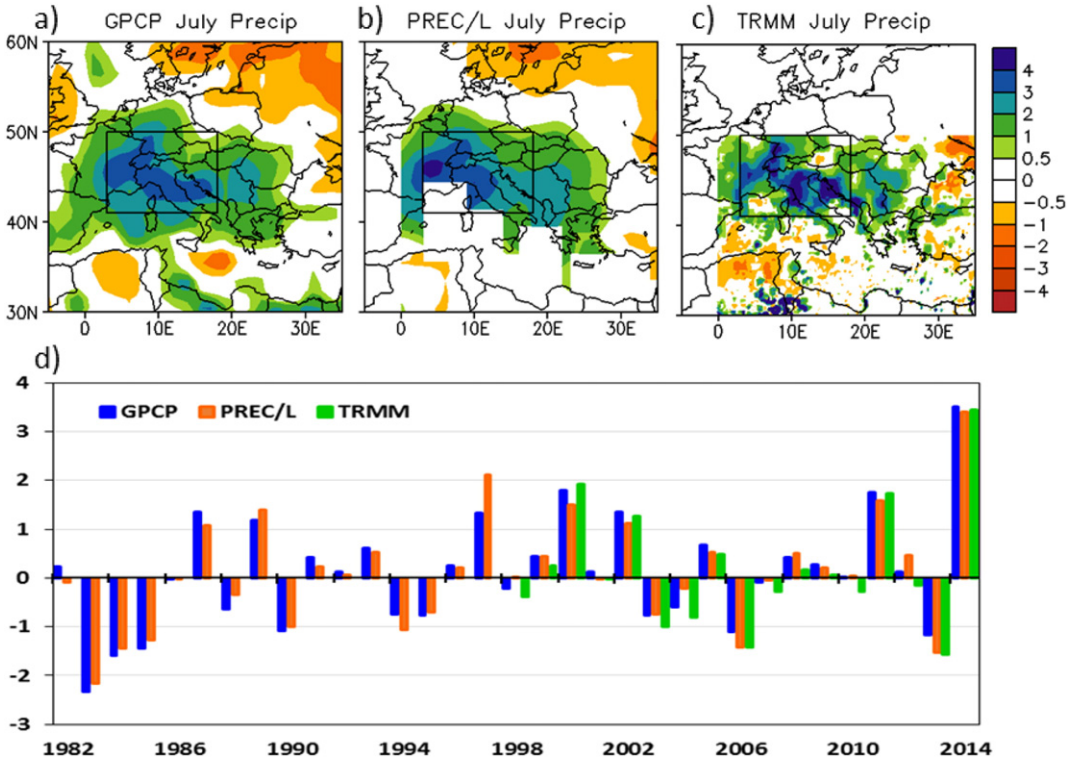

Fig. 1. Standardized precipitation anomaly for July 2014 for (a) GPCP (b) PREC/L and (c) TRMM 3B43 data. (d) Interannual variability of standardized precipitation anomaly (mm/day) averaged over the area 3°E–18°E and 41°N–50°N (marked as a box in a, b and c) for July month during the period 1982–2014. TRMM data is available over the latitude band 50S–50N and for the period 1998–2014. The anomalies are calculated with respect to the July climatology for the period 1982–2013 (1998–2013 for TRMM).

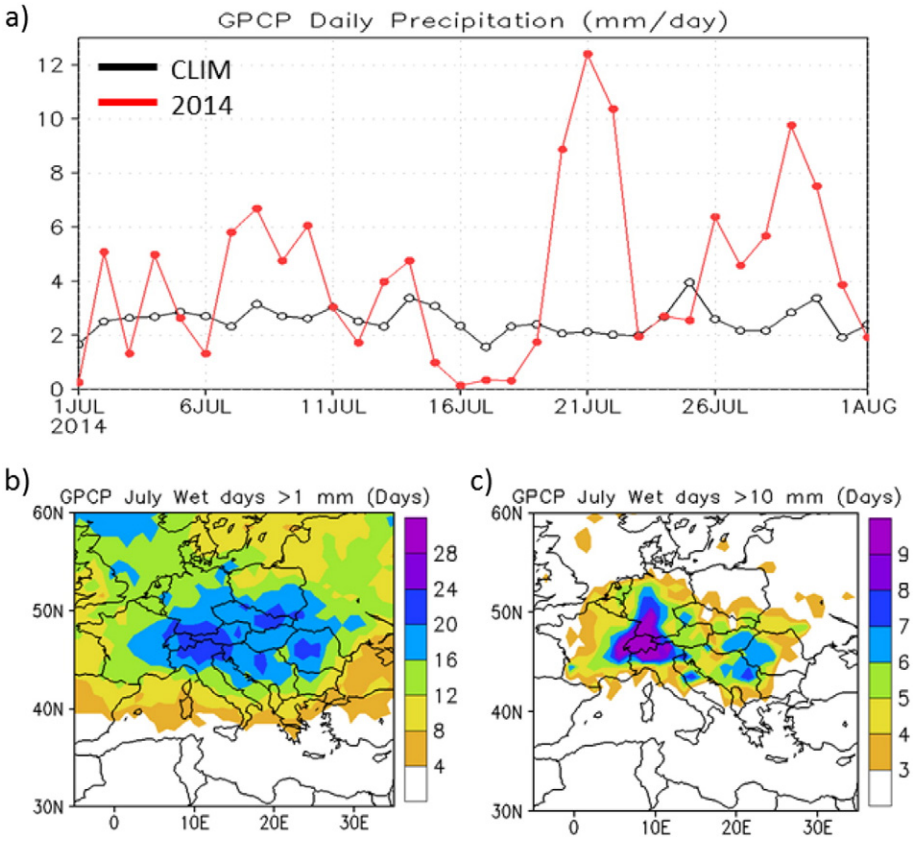

Fig. 2. (a) Daily precipitation (mm/day) averaged over the area 3°N–18°N and 41°N–50°N for July 2014 (red line) and daily climatology for July (black line). (b) Number of wet days >1 mm in July and (c) Number of wet days >10 mm in July. The climatology for the GPCP daily precipitation is obtained for the period 1997–2014.