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Association of large scale circulation with climatic extremes over the Mediterranean: validation of three regional models

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The large scale atmospheric circulation greatly determines the occurrence of extreme events, and therefore, it is very important to explore the ability of the climatic models to represent this relationship. In a previous study, the impact of the large scale circulation on precipitation and temperature extremes over the Mediterranean was investigated using three regional climatic models: CNRM-RM4 (RM4), C4IRCA3 (RCA3) and KNMI-RACMO2 (RACMO2), along with the corresponding parental GCMs: ALADIN and ECHAM5. Here, an attempt is made to validate these three models in the present climate.

The models are validated against a gridded observational dataset of daily precipitation and temperature, developed on the basis of a European network of high quality station series. The daily datasets cover the period 1950-2006 and are available on a 0.22 and 0.44 degree rotated pole grid that corresponds to the grid used in most ENSEMBLES Regional Climate Models. All datasets became available in the framework of the EU project ENSEMBLES. For the linkage with the upper level large scale circulation, 500 hPa geopotential height data were employed from the NCEP/NCAR Reanalysis database that provided data for the whole examined period 1950-2006.

Four climate extreme indices were calculated to identify climate extremes in the study region. These indices were particularly chosen to best represent the duration and intensity of extreme temperature and precipitation events at each grid. More specifically, the 95th precipitation percentile (Pxq95), the consecutive dry days (CDD), the 90th percentile of maximum temperature (Txq90) and the 10th percentile of minimum temperature (Tnq10) were employed. The indices were calculated on a seasonal and annual basis for the present period over the Mediterranean, separately for the three regional models and for the gridded observations.

To explore the relationship between the large scale circulation and the climatic extremes Regularised Canonical Correlation Analysis (RCCA) was applied which allows the investigation of the linear relationship between two different fields and determines optimal pairs of concomitant spatial patterns that account for the maximum amount of variance within the two time series separately, and at the same time, their optimally correlated time components. The RCCA was applied between each index dataset for each season and the 500 hPa geopotential height datasets.

It was found that the upper tropospheric circulation patterns together with the related climatic extremes, as produced by the climatic models, present differences compared to the gridded observational data, although the associated large scale patterns are well captured by all models. The validation analysis of the models showed that they underestimate extreme warm temperatures (Txq90), while the extreme cold temperatures (Tnq10) seem to be better reproduced. The models exhibit lower skill in simulating precipitation indices, but despite their dry characteristics, they underestimate the CDD index. The CNRM and KNMI exhibit more coherent patterns for Txq90 in summer and Tnq10 in winter. The CNRM seems to provide more consistent results for CDD in winter and autumn.

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