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Assessment of projected changes in air temperature and precipitation over the Mediterranean region via multi-model ensemble mean of CMIP5 models

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Abstract

A multi-model ensemble mean approach was followed in order to investigate the projected changes in near surface air temperatures and precipitation total over the Mediterranean region. Among sixty seven different models of thirty modeling groups all around the world participating in the World Climate Research Programme (WCRP) Coupled Model Intercomparison Project (CMIP5), fourteen models were used. In this respect, we focused on two distinct scenarios (i.e. RCP4.5 and RCP8.5) for three different future periods (i.e. 2016-2035, 2046-2065 and 2081-2100) to examine accurately the foreseen changes in two fundamental climate variables (near surface air temperature and precipitation total) for the Mediterranean region.

Keywords: Mediterranean, climate change, CMIP5, ensemble mean

Introduction

Harmful impacts of climate change have been becoming more severe on different spatial and temporal scales in this century. The results of climate change and variability studies for the Mediterranean basin indicate that Mediterranean basin will be affected adversely by climate change in the future (Giorgi and Lionello 2008; Lelieveld *et al.* 2012; Ozturk *et al.* 2014; Türkeş *et al.* 2011). Because of the importance of the region and its vulnerability to global climate change, the studies including the investigation of projected changes in

the climate of Mediterranean basin play a crucial role in order to struggle with the negative effects of climate change.

Materials and Methods

The projected changes in air temperature and precipitation over the Mediterranean region are examined based on the multi-model ensemble mean of the Coupled Model Intercomparison Project Phase 5 (CMIP5) historical, RCP4.5 and RCP8.5 experiments with 14 different coupled global climate models (GCMs) (Taylor *et al.* 2012). The models used in this study are ACCESS1.0, ACCESS1.3, CMCC-CMS, CNRM-CM5, EC-EARTH, HadGEM2-AO, HadGEM2-CC, HadGEM2-ES, MIROC-ESM, MIROC-ESM-CHEM, MPI-ESM-MR, MPI-ESM-LR, MRI-CGCM3, CMMC-CM. Among the studied models, the CMCC-CM has the highest resolution. So, model outputs interpolated bilinearly 0.75 degree grid resolution. In the 14 models used in this study, CMMC-CM's horizontal resolution was the highest, hence we interpolated all the models to the highest resolution available. Firstly, to detect biases in the data, we calculated the temperature difference (and precipitation ratio) between the observational dataset from the Climatic Research Unit (CRU) for the reference time period (1981-2000) and the outputs of each model and the ensemble averages of them. Thereafter the projections of each model and their ensemble means were computed using delta bias correction method for near- (2016-2035), mid- (2046-2065), and long-term (2081-2100), respectively.

Results

With regard to multi-model ensemble mean, a mainly cold bias was found for the southern parts of the study region (North Africa - Levant) and a warm bias characterizes the Caucasus and Alpine areas. Besides, for precipitation overestimated results for winter and spring over North Africa, the Central Anatolia region of Turkey, and Western Spain were seen. Seasonal projected changes obtained by the GCM ensembles are given in Figure 1. In average, more dry seasons in all three future periods for both scenarios (up to 0.18 mm/day) were found with the exception of the Caucasus region on winter for the mid- and far future periods. Generally, temperature is expected to increase in all seasons and projections (between 1.1 and 6.2 °C). Temperature rise was found particularly strong in the summer season.

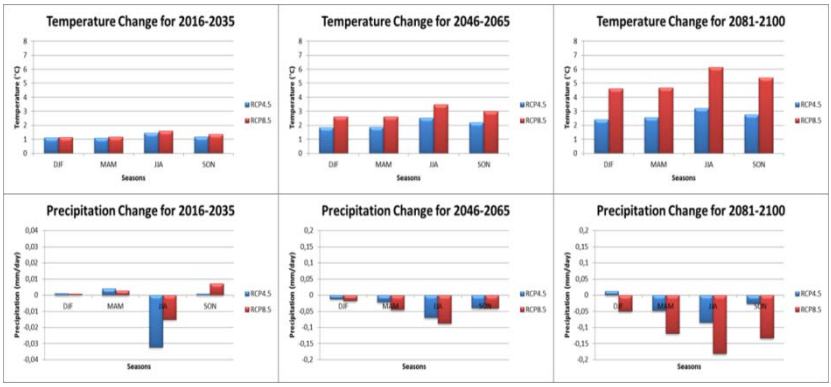

Figure 1. Projected temperature and precipitation changes for three different future periods based on two different scenarios by GCM ensembles. DJF, MAM, JJA and SON denote winter, spring, summer and autumn, respectively.

Discussion

The results briefly shown above indicate that the Mediterranean region is expected to experience warmer and drier climate conditions in the near to far future study periods. Since the Mediterranean basin already has a semi-arid, semi-humid with strong and long summer dryness climate, any decrease in precipitation strongly affects the region. One should also consider the adverse effects on hydrology, ecosystems among others. Therefore especially the changes in the rainy season have stronger impacts. Furthermore, hotter and drier conditions might enhance the desertification processes which can also stimulate the erosion, salinization and forest fires.

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