J. Black Sea/Mediterranean Environment
Special Issue: 89-92 (2015)

Modeling of near future air temperature and precipitation climatology of Turkey and surrounding regions

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Abstract

Projected future changes in mean air temperature and precipitation for 2020 – 2050 were assessed with respect to the control period 1970 – 2000 via regional climate model simulations, using a regional climate model driven by three different global climate models, dynamically downscaled to 50 km for Turkey and surrounding regions, using the IPCC emission scenario outputs of global climate models.

Keywords: Turkey, climate change, regional climate model

Introduction

Estimating future climatic conditions is crucial for the Mediterranean region including Turkey, a region most sensitive to impacts of climate change (Öztürk *et al.* 2013; Önol and Semazzi 2009; Şen *et al.* 2012; Trigo *et al.* 2006; Türkeş *et al.* 2011; Türkeş 2012).

Materials and Methods

Expected changes in air temperature and precipitation were assessed for the region surrounding Turkey for the period 2020-2050 with respect to the control period 1970-2000. The output of the Regional Climate Model (RegCM4.3.5) of ICTP (International Centre for Theoretical Physics) was used to analyze future

projections with respect to simulated present climate conditions. HadGEM2 global climate model of the Met Office Hadley Centre, MPI-ESM-MR of the Max Planck Institute for Meteorology, GFDL-ESM2M of the National Oceanic and Atmospheric Administration Geophysical Fluid Dynamics Laboratory were downscaled to 50 km for Turkey and surrounding regions by using the regional climate model (Taylor *et al.* 2012). Two emission scenarios were considered in this study: the high-emission scenario RCP8.5 and the mid-range mitigation emission scenario RCP4.5 of the IPCC. To validate model performance, mean air temperature and precipitation obtained from the regional climate model forced by the above global circulation models were compared with the observational datasets of the Climatic Research Unit (CRU) for the reference period of 1970-2000. For parameterization, best agreement with observational data was obtained by using the Grell scheme with the Fritsch-Chappell type closure.

Results

Even though the model outputs show warm and/or cold biases for the different seasons, the magnitude of the biases is low and results can be accepted as reasonable and reliable when the domain's geographical and climatic features were taken into account (Figure 1).

Based on spatial mean biases with respect to the CRU dataset, HadGEM2 displays better performance amongst the three global circulation models. According to the different model and scenario results, an increase between 0.5 °C and 4 °C in seasonal mean air temperatures of Turkey is expected for the period of 2020 – 2050 with respect to the period of 1970-2000. This warming will be more severe in warm than in cold seasons. We only present mean air temperature for 2020 – 2050 with respect to 1970-2000 according to the RCP 8.5 scenario outputs of global climate model HadGEM2 (Figure 2). Seasonal mean of total precipitation is expected to decrease by -0.4 mm/day and -2 mm/day. Increases in precipitation are expected at coastlines of the region especially in the winter season.

Discussion

In accordance with the different model outputs, it is obvious that in the near future Turkey will be exposed to the warmer and drier climate conditions compared to that in the reference period and Turkey is in the group of most vulnerable countries to climate change. These results are of crucial importance mostly in terms of hydrological systems, forestry and agricultural production, among others.

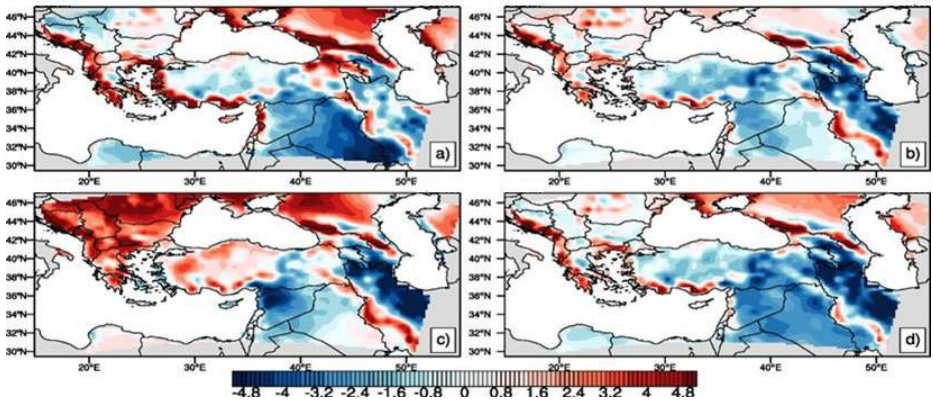

Figure 1. Comparison of the seasonal air temperatures of the RegCM4.3.5, which is forced by the HadGEM2, with respect to CRU dataset for the period 1970 - 2000: (a) winter, (b) spring, (c) summer and (d) autumn

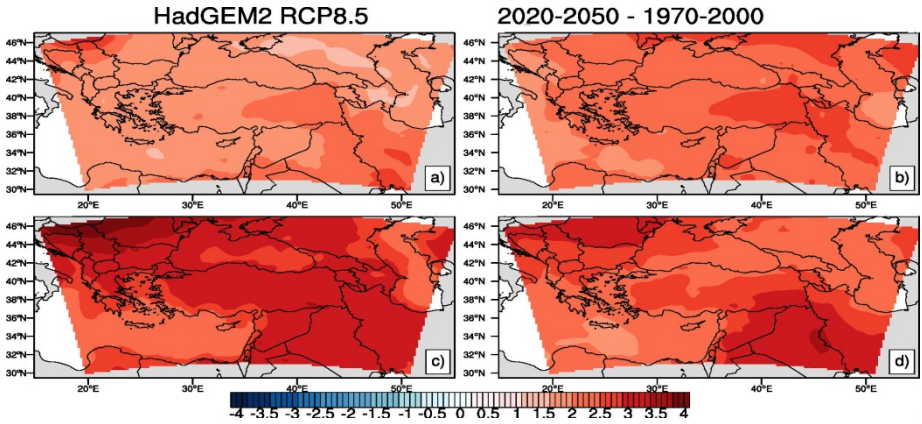

Figure 2. Geographical distribution patterns of changes in projected mean air temperatures over Turkey and surrounding regions from the RegCM4.3.5, which is forced by the HadGEM2 with RCP8.5 scenario for the climatology of 2020 - 2050 period with respect to 1970 - 2000: (a) winter, (b) spring, (c) summer and (d) autumn seasons

Acknowledgements

This study was supported by BAP 7362.

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