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Identifying hot-spots of climate change in the Eastern Mediterranean and Middle East

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We derive climate change hot-spots within Eastern Mediterranean and Middle East based on Giorgi's approach, published in 2006. In the original paper, Mediterranean emerged as the primary hot-spot among the other regions of the globe, having the highest Regional Climate Change Index (RCCI), indicating a, comparatively, more receptive region to climate change. RCCI calculation is based on temperature and precipitation mean changes and changes in their interannual variability. In more detail, change in mean surface air temperature is expressed by the Regional Warming Amplification Factor (RWAF) or change in regional mean surface air temperature relative to the global average temperature change, mean regional precipitation change (ΔP) is defined as the per cent difference between the future and the present climate total precipitation amount. Here, in the calculation of RWAF the global average temperature change is replaced by the domain's average temperature change. To derive changes in interannual variability of temperature and precipitation, the standard deviation ($\Delta\sigma$T) and the coefficient of variation ($\Delta\sigma$P) per cent changes of present value are calculated respectively. The coefficient of variation is defined as the standard deviation divided by the mean in order to remove the dependency of the precipitation standard deviation on the mean. All the above variables are calculated for both the wet (WS) and dry (DS) seasons. For this region the period October-March is considered as the wet and the period April-September as the dry season of the year. So, RCCI is defined as

RCCI = [n(ΔP) + n($\Delta\sigma$P) + n(RWAF) + n($\Delta\sigma$T)]WS + [n(ΔP) + n($\Delta\sigma$P) + n(RWAF) + n($\Delta\sigma$T)]DS

where the integer n varies from 0 to 4 depending in the magnitude of the changes. As a present day climate, the 30-year period 1961-1990 was selected, while future climate is referring to the period 2071-2099. We focus on the eastern part of Mediterranean (also extended to include the Middle East), a region with large climatic gradients (associated to variable orography and land surface characteristics). We apply Giorgi's method to identify hot-spots within this domain and reveal sub-regions potentially more responsive to climate change. The input data are obtained from multi-decadal simulations using the PRECIS regional climate model (RCM) under the A1B and A2 SRES emissions scenarios. PRECIS is based on UK Met. Office Hadley Centre's HadRM3P RCM and was used in order to dynamically downscale the HadCM3 atmospheric-ocean coupled general circulation model in an horizontal resolution of 0.22° x 0.22°. We explore the sensitivity of our results to emission scenarios and we discuss possible dynamical mechanisms related to the hot-spot sub-regions.