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# Future of water resources in the Aral Sea Region, Central Asia – Reality-checked climate model projections

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Abstract
The future of water resources in a region invariably depends on its historic as well as present water use management policy. In order to understand the past hydro-climatic conditions and changes, one needs to analyze observation data and their implications for climate and hydrology, such as Temperature, Precipitation, Runoff and Evapotranspiration in the region. In addition to the changes in climate, human re-distribution of water through land- and wateruse changes is found to significantly alter the water transfer from land to atmosphere through an increase or decrease in evapotranspiration. The Aral region in Central Asia, comprising the Aral Sea Drainage Basin and the Aral Sea, is an example case where the human induced changes in water-use have led to one of the worst environmental disasters of our time, the desiccation of the Aral Sea. Identification of the historical hydro-climatic changes that have happened in this region and their drivers is required before one can project future changes to water and its availability in the landscape. Knowledge of the future of water resources in the Aral region is needed for planning to meet increasing water and food demands of the growing population in conjunction with ecosystem sustainability. In order to project future scenarios of water on land, the Global Climate Model (GCM) ensemble of the Coupled Model Intercomparison Project, Phase 5 (CMIP5) was analyzed for their performance against hydrologically important, basin-scale observational climate and hydrological datasets. We found that the ensemble mean of 22 GCMs over-estimated the observed temperature by about 1°C for the historic period of 1961-1990. For the future extreme climate scenario RCP8.5 the increase in temperature was projected to be about 5°C by 2070-2099, the accuracy of which is questionable from identified biases of GCMs and their ensemble results compared with observations for the period 1961-1990. In particular, the water balance components precipitation, runoff and evapotranspiration simulated by the GCM ensemble for the 1961-1990 period yielded an increase in average annual water storage change of 7 mm/year, which for example greatly contradicts the known major drop in Aral Sea water level by 46 mm/year during the same period. Such inadequacies in climate model performance with regard to the system of water on land emphasizes a major need for better representation of that system in climate models.

Key words: Climate, Hydrology, Hydroclimate, Aral Sea, Land water, CMIP5, Climate model performance