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Rainfall over the Hoggar massif, Algeria: analysis of driving mechanisms using ECMWF outputs and observations

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The Hoggar Massif is a comparatively populated region in the Sahara, where water supply is a critical societal problem due to the lack of nearby sources and unaffordable water pumping. Water is mainly supplied by rare rainfall events (typically 5 to 6 days of precipitation in the city of Tamanrasset from July to September) which are mainly linked to southerly moisture advection associated with the West African monsoon (WAM). Adequate quantitative forecast of such rainfall events would significantly improve water management and rationalization for the ∼80,000 inhabitants of Tamanrasset located at 1370 m above mean sea level (msl) and at 22.8°N, 5.5°E.
In the present paper, we study the mechanisms regulating the occurrence and the intensity of precipitation over the Hoggar using different European Center of Medium Weather Forecast (ECMWF) forecast outputs (from operational analysis, ERA AMMA reanalysis and ERA Interim reanalysis) and meteorological observations. We focus in the events of summer 2006. We analyse ECMWF capabilities to reproduce rainfall events in this desert area. Our results show large differences (in occurrence and magnitude) between each ECMWF run and in all cases a significant underestimation with respect to observations. ERA AMMA reanalysis present the best performance with a fairly good reproduction of the four principal events of 2006. Although Tamanrasset radiosounding is assimilated in the ECMWF model, we find systematic underestimation of the peaks in low-levels water vapour mixing ratio and total column cloud cover over the Hoggar for all three ECMWF runs. Such underestimation is considered to be critical for rainfall forecasting, since previous observational studies showed a clear link between small changes in low-level moisture, deep convection and the occurrence of precipitation. Diurnal convective development of the Saharan atmospheric boundary layer (SABL), which transports upwards low-level moisture, strongly changes between runs and no simultaneous match with observations is found both for SABL height and surface sensible heat fluxes. Differences in the cloud microphysics scheme between each ECMWF runs may as well play an important role in the accuracy changes of precipitation occurrence. Depending on the ECMWF run, moist convection deepens differently and such factor is presumably needed for the hygrometeors to reach the ground.