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Irrigation as an important anthropogenic forcing on the mean and intra-seasonal variability of Indian summer monsoon

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Decreasing trend in rainfall in the last few decades over Indo-Gangetic Plains of northern India as seen from ground-based observations, parallels stressed ground water resources, with irrigation utilising up to 90%. The decrease in mean rainfall is co-incidental with an increasing trend in irrigation. In this work, we have analysed the effect of the extensive irrigation over Gangetic Plains (GP) on monsoon climate.

In the first step, the effect of irrigation on soil moisture was accessed using a high-resolution land surface model (JULES). The model was run over Gangetic basin in two scenarios: with and without irrigation. It was seen that the mean soil moisture over GP in the irrigated scenario is higher as compared to non-irrigated scenario. These soil moisture fields were then used as forcing to a state-of-the-art general circulation model with realistic land-atmosphere coupling. A decrease in June-September precipitation over GP, significant at 95% level, is noted in the model simulation with irrigation as compared to simulation without irrigation. In specific, these changes show a remarkable similarity to the long-term trend in observed rainfall spatial pattern. Moreover, weakening of the variability of intra-seasonal oscillations in the high (10-20 days) and low (30-60 days) frequency bands is noted with irrigation. Our results suggest that with shrinking ground water resources in the GP region and a decline in the summer precipitation, the water crisis could exacerbate, with irrigation contributing in a positive feedback mechanism on these tendencies.