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Indian Monsoon Precipitation over Orography: Verification and Enhancement of understanding – Outcomes of the IMPROVE project

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IMPROVE is motivated by the effects of orography on Indian precipitation as part of the diurnal cycle of convection, contributing to water supply, as well as its role in extreme events. IMPROVE considers two focal regions. The Western Ghats, which intercept the monsoon flow across the Arabian Sea, receive some of the most frequent and heaviest rainfall during summer as well as being subject to extremes such as the 2018 Kerala floods. Meanwhile, the Himalayas play a vital role in separating dry midlatitude flows from tropical airmasses and are subject to extremes during the summer monsoon, as well as in winter due to the passage of western disturbances. This presentation summarizes the key results of IMPROVE. Firstly, we examine the impact of orography on the observed convective diurnal cycle and assess its simulation in models at a range of resolutions including convection-permitting scales. MetUM and WRF model experiments are used to identify key mechanisms and test their capability at simulating scale interactions between forcing at the large scale from the BSISO and newly identified regimes of on- and offshore convection near the Western Ghats. An additional aspect to this work is the construction of a two-layer analytical model to test the behaviour of sheared flow perpendicular to a ridge analogous to the Western Ghats. Secondly, the role of orography in extreme events is considered. For the Western Ghats, this focuses on the interaction between monsoon low-pressure systems and the southwesterly flow in enhancing local rainfall. For the Himalayas, we focus on characterising interactions between tropical lows and western disturbances in enhancing the orographic precipitation. The work in IMPROVE works towards a deeper understanding of orographic rainfall and its extremes over India and uncovering why such mechanisms may be poorly represented in models.