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Precipitation modes over the Western Ghats orography during the summer monsoon season

Jayesh Phadtare^{1,2}, Jennifer Fletcher³, Andrew Ross⁴, Andy Turner⁵, Thorwald Stein⁶, and Reinhard Schiemann⁷

¹School of Earth and Environment, University of Leeds, Leeds, UK (j.phadtare@leeds.ac.uk)

²National Centre for Atmospheric Science, University of Leeds, Leeds, UK (jayesh.phadtare@ncas.ac.uk)

³School of Earth and Environment, University of Leeds, Leeds, UK (j.k.fletcher@leeds.ac.uk)

⁴School of Earth and Environment, University of Leeds, Leeds, UK (a.n.ross@leeds.ac.uk)

⁵Department of Meteorology, University of Reading, Reading, UK (a.g.turner@reading.ac.uk)

⁶Department of Meteorology, University of Reading, Reading, UK (t.h.m.stein@reading.ac.uk)

⁷Department of Meteorology, University of Reading, Reading, UK (r.k.schiemann@reading.ac.uk)

Precipitation distribution around an orographic barrier is controlled by the Froude Number (Fr) of the impinging flow. Fr is essentially a ratio of kinetic energy and stratification of winds around the orography. For $Fr > 1$ ($Fr < 1$), the flow is unblocked (blocked) and precipitation occurs over the mountain peaks and the lee region (upwind region). While idealized modelling studies have robustly established this relationship, its widespread real-world application is hampered by the dearth of relevant observations. Nevertheless, the data collected in the field campaigns give us an opportunity to explore this relationship and provide a testbed for numerical models. A realistic distribution of precipitation over a mountainous region in these models is necessary for flash-flood and landslide forecasting. The Western Ghats region is a classic example where the orographically induced precipitation leads to floods and landslides during the summer monsoon season. In the recent INCOMPASS field campaign, it was shown that the precipitation over the west coast of India occurred in alternate offshore and onshore phases. The Western Ghats received precipitation predominantly during the onshore phase which was characterized by a stronger westerly flow. Here, using the radiosonde data from a station over the Indian west coast and IMERG precipitation product, we show that climatologically, these phases can be mapped over an Fr -based classification of the monsoonal westerly flow. Classifying the flow as 'High Fr ' ($Fr > 1$), 'Moderate Fr ' ($0.5 < Fr \leq 1$) and 'Low Fr ' ($Fr \leq 0.5$) gives three topographical modes of precipitation -- 'Orographic', 'Coastal' and 'Offshore', respectively. Moreover, these modes are not sensitive to the choice of radiosonde station over the west coast.