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Mid-Latitude Controls on Monsoon Onset and Progression (the MiLCMOP project)

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The monsoon onset typically starts in southern India by 1 June, taking around 6 weeks to cover the country. During the monsoon, intraseasonal variations give rise to active and break periods in the rains. Being able to better predict the monsoon onset, its progression, and active and break events would be of great interest to society. The onset timing is already known to be influenced by tropical intraseasonal variability, but new research has shown that the mid-latitudes exert a powerful control, the full extent of which is not properly quantified or understood.

The MiLCMOP project aims to answer the following: (1) How are the pace and steadiness of monsoon progression affected by interactions with the extratropics? (2) What are the mechanisms of extratropical control on monsoon progression and variability? (3) How do the causal extratropical and tropical drivers of monsoon progression offset or reinforce each other?

Our initial work has tested a new hypothesis that monsoon progression can be described as a “tug-of-war” between tropical and extratropical airmasses. This “tug-of-war” is unsteady, with a back and forth of the two airmasses before the moist tropical flow takes over for the season. We demonstrate this for a case study of the 2016 season for India, while also drawing analogies with other monsoon regions, such as for the East Asian monsoon, in which we show the competition between extratropical and tropical flows in establishing the Mei Yu front as it progresses across China.

Current activities revolve around the identification of statistical relationships between monsoon onset and progression and perturbations to the subtropical westerly jet, including blocking anticyclones, meridionally propagating troughs and cyclonic features near the Tibetan Plateau. Additional focus is also devoted to the relationship between the monsoon advancement and the strength, extent and orientation of the intrusion of mid-tropospheric dry air flowing towards India from westerly and northwesterly quadrants.

Other methods will include use of vorticity budgets and Lagrangian feature tracking in case studies of fast and slow onsets, to suggest the dominant mechanisms by which extratropical drivers affect monsoon onset and progression. Model experiments will help isolate these mechanisms. Finally, novel causal inference techniques will help disentangle the effects of extratropical drivers from

those in the tropics.