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Impactful Tibetan Plateau Vortices: structure, lifecycle and environmental conditions

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The Tibetan Plateau (TP) and surrounding high mountains constitute an important forcing of the atmospheric circulation due to their height and extent, and thereby impact weather and climate in East Asia. Mesoscale Tibetan Plateau Vortices (TPVs) form over the TP and are one of the major systems generating TP precipitation. The majority of TPVs remain on the TP throughout their lifetime, while a fraction moves east off the TP. These “moving-off” TPVs can trigger extreme precipitation and severe flooding over large parts of eastern and southern China, for example in Sichuan province and the Yangtze River valley. Due to their potentially severe impacts downstream of the TP, it is first important to understand the conditions under which TPVs can move east off the TP.

In this study, we examine the vertical and horizontal structure of TPVs moving off the TP in contrast to those that do not using reanalysis in order to understand which local and/or large-scale atmospheric conditions lead TPVs to move off the TP. We use composites of atmospheric fields at different stages of the TPV lifecycle (e.g. genesis, maximum intensity, and maximum precipitation) and at different locations over and downstream of the TP, to account for the heterogeneous topography. Preliminary results suggest that the large-scale background flow, characterised by the strength and position of the subtropical westerly jet, is one of the factors determining whether a TPV moves off the TP or not.

Another important question is how and where moving-off TPVs trigger precipitation. Do TPVs transport moisture from the TP to the downstream regions? Do they move off while already precipitating? Do they trigger precipitation dynamically east of the TP? Results from a case study suggest that the TPV triggers precipitation as it moves over the edge of the TP, which then stays locked to the orography while the system is moving further east. The TPV appears to change the local atmospheric circulation in the Sichuan basin while moving off, thereby directing a flow of moist air towards the eastern slope of the TP.

Understanding how the combination of the right large-scale atmospheric conditions and a TPV-induced change in the local circulation downstream of the TP can create an impactful TPV may enable improved forecasts of TPVs and their impacts in the densely populated regions downstream of the TP.