Title: The Evolution, Seasonality and Impacts of Western Disturbances

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Abstract: Western disturbances (WDs) are upper-level synoptic-scale systems embedded in the subtropical westerly jet stream (STWJ), often associated with extreme rainfall events in north India and Pakistan during boreal winter. Here, a tracking algorithm is applied to the upper-tropospheric vorticity field for 37 years of ERA-Interim reanalysis data, giving a catalogue of over 3000 events. These events are analysed in a composite framework: the vertical structure is explored across a large number of dynamic and thermodynamic fields, revealing a significant northwestward tilt with height, strong ascent ahead of the centre, which sits above the maximum surface precipitation, and a warm-over-cold, dry-over-moist structure, among other signatures of strong baroclinicity. Evolution of the structures of cloud cover and vertical wind speed are investigated as the composite WD passes across northern India. Cloud cover in particular is found to be particularly sensitive to the presence of the Himalayan foothills, with a significant maximum at 300 hPa approximately 1 day after the WD reaches peak intensity. k-means clustering is used to classify WDs according to both dynamical structure and precipitation footprint and the relationship between the two sets of WDs is explored. Finally, the statistical relationship between the STWJ position and WDs on interannual time-scales is explored, showing that WD frequency in north India is highly sensitive to the jet location over Eurasia. Years with a greater number of WDs feature a STWJ shifted to the south, a pattern that is substantially more coherent and reaches as far west as North America during boreal winter. This suggests that it may be possible to predict the statistics of western disturbance events on seasonal time-scales if suitable indicators of jet position can also be predicted.