Using the multivariate feature-based diagnostic capability in METplus to identify the predictable large-scale synoptic drivers for flood-producing rains

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The concept of Atmospheric Rivers (ARs) is well known in the mid-latitudes. ARs are defined as long narrow channels of very moist air that flow through the atmosphere, transporting vast amounts of water vapour that eventually fall as heavy rain or snow. They can be several hundreds of miles wide and persist for several days. The phrase was first coined in the context of the prolonged high-impact events that affected the W coast of North America.

Subsequent research has shown ARs to be responsible for many extreme hydrologic events. Noting the similarity in the orientation and geographical setup to the W coast of N America this work looks at whether the moist low-level air streams impinging on the Western Ghats (which run parallel to the W coast of India), behave like (quasi-) atmospheric rivers, and leading to high-impact events such as the Kerala floods in 2018, 2019 and 2020. The key question is whether a multivariate feature-based approach can identify these features and thus highlight some inherent predictability in terms of the potential location of heavy rainfall associated with a specific juxtaposition of wind & humidity. Here the focus is on predictability, i.e. on the medium range, using the tools used available in the METplus library.

The GridDiag tool was used to identify suitable thresholds from the bivariate relationships between variables that appear to be clear contributors at the synoptic scale. Following on from this the complex use case for running the multivariate version of MODE (called MvMODE) was developed. MODE is the Method for Object-based Diagnostic Evaluation. The tool was then applied to the 5-day forecasts and analyses of the operational Met Office Global Model (GM) for the 00UTC initialisations during July and August 2018, 2019, and 2020.

In each of the seasons MvMODE identified persistent and continuous episodes of rains along the Western Ghats which coincided with the periods of heavy rainfall and flooding, even 5 days ahead. The peak rainfall was not necessarily captured by the super objects, noting that the GM coast definition and orography has some deficiencies compared to reality. The large-scale drivers were well captured. From the similarity of the evolution of events across the three consecutive seasons, a conceptual model for the evolution of a quasi-AR event can be proposed.