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Vb-type cyclones and their role in extreme precipitation events in Central Europe

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Extreme weather situations are of major relevance for society, since they lead to great economical and personal damage. In Central Europe, one important source of extreme precipitation accompanied by large flooding events is the so-called Vb-event, classified by W. J. Van Bebber in 1891. Vb-events are defined as cyclones developing over the western Mediterranean that move north eastward. They can uptake large amounts of moisture, which is then transported towards the Alps and Central Europe, inducing heavy precipitation and flooding events. Despite their importance the relevant processes triggering Vb-events and their impact in extreme precipitation are not yet fully understood. The overall goal of this study research is to understand the dynamics of the past events and to provide a reliable climatology, which would provide a first guess for future behaviour of these potentially disastrous situations.

A cyclone detection and tracking tool is applied to ERA Interim reanalysis (1979-2013) in order to identify the most prominent Vb-situations. Vb-events are detected and tracked in the geopotential height at 850 hPa. Subsequently, the cyclones are automatically filtered with criteria based on the origin and end of the track, which allows us discarding those paths that should not be considered as Vb-events. Precipitation in the ERA Interim and E-OBS database is used to evaluate the precipitation amounts corresponding to each case and to assess the consistency between datasets.

ERA Interim and E-OBS data consistently indicate that there is great variability in precipitation amounts within different Vb-events. While it is expected that Vb-events are associated with extreme precipitation, this is only true for about one quarter of all cases. Nevertheless around 15% of extreme precipitation days (99 percentile) over the Alpine region are triggered by Vb-events. In order to obtain a better understanding of the large variability in Vb-events, the ten heaviest and lowest precipitation Vb-events are studied in more detail. Results reveal noticeable differences in the state of the atmosphere that lead to heavy precipitation. These differences are most pronounced in the geopotential height and potential vorticity field. The associated differences in wind direction in different elevations are responsible for the moisture transport around the Alps and the orographical lifting along the Alps. These effects are the main reasons for the disastrous outcome of Vb-events and consequently are missing in the driest Vb-events. The results indicate that heavy precipitation is mainly related to large-scale dynamics rather than to thermodynamic processes, as could be expected.