Quantifying the relevance of cyclones and warm conveyor belts for precipitation extremes

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Cyclones are typically associated with substantial surface precipitation and can cause extreme precipitation and flooding, as shown in many case studies. Here statistical measures are applied for quantifying the climatological relevance of cyclones and associated flow features for precipitation extremes, using the ERA-Interim reanalysis data set as a reference. It is shown that a huge percentage of precipitation extremes, widely exceeding 70-80%, is directly associated with cyclones in the main extratropical storm track regions, but also in areas where cyclones are less abundant, e.g., around the Mediterranean and in several regions affected by tropical cyclones. In addition to their direct impact (through ascending motions and moisture convergence), cyclones can affect precipitation extremes at remote locations, e.g., by directing moist air flow towards the Alpine ridge in Central Europe. Precipitation events further away from the pressure minimum are often associated with warm conveyor belts (WCBs). These WCBs ascend mainly in the cyclones' warm sectors and thus trigger heavy precipitation equatorward of the cyclone center, which is particularly obvious in the Southern Hemisphere. In spite of the strong connection between cyclones and heavy precipitation, it is not easy to identify those cyclones that cause precipitation extremes at a certain location from a forecaster's perspective. More process-oriented research is needed to clarify this issue.

The quantitative results on the relationship between cyclones and precipitation extremes are used for the evaluation of a present-day climate simulation from CCSM4. Regions are identified where the GCM properly represents the major importance of cyclones for precipitation extremes, like the Southern Hemisphere and most parts of the North Atlantic storm track regions. Larger deficiencies are found, e.g., over the North Atlantic west of Northern Africa. These results may be used as a starting point for model improvement, and for assessing the reliability of future projections of precipitation extremes on regional scales.