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Synoptic- and Mesoscale Weather Situations Associated with Tornadoes in Europe

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Tornadoes are mainly associated with the United States, but they occur all over the world. In this study, focus is given to the synoptic- and mesoscale environment which leads to tornadoes in Europe. Three aspects are discussed: (a) Which weather situation is found during severe tornado events?; (b) Are the US tornado indices applicable in Europe?; and (c) What specific synoptic- and mesoscale forcing mechanisms are discernible in the European setting, and how do they compare to the US mechanisms.

Tornado data for Europe are taken from the European Severe Weather Database (ESWD), which includes the date, time, location and intensity on the Fujita scale of the event. Consideration is given only to 23 major events (here defined to be of scale F2) between 2005 and 2006 and in a band north of the Alps and extending from eastern France to Poland, with focus on Germany. The synoptic- and mesoscale weather situation is analysed with the the ECMWF operational analysis and the German Weather Service surface weather charts (for frontal locations).The appropriateness of ECMWF is validated by comparison of near-tornado radio-soundings with ECMWF pseudo-soundings.

In a first part, each of the 23 tornadoes is characterised with respect to upper-level (jet streaks, PV anomalies) and low-level (fronts) forcings. Moreover, the synoptic-scale situation is analysed. Then, consideration is given to typical tornado indices used in the US: convective available potential energy (CAPE), storm-relative helicity (SRH) and the energy helicity index (EHI). It will be shown that the indices are only partly applicable in a European settings. Finally, some very distinctive dynamical signals related to potential vorticity and vorticity are shown and their interpretation discussed.