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Synoptic analysis and hindcast of an intense bow echo in Western Europe: The 09 June 2014 storm

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On Pentecost Monday of 09 June 2014, a severe mesoscale convective system (MCS) hit Belgium and Western Germany. This storm was one of the most severe thunderstorms in Germany for decades. The synoptic-scale and mesoscale characteristics of this storm are analyzed based on remote sensing data and in-situ measurements. Moreover, the forecast potential of the storm is evaluated using sensitivity experiments with a regional climate model. The key ingredients for the development of the Pentecost storm were the concurrent presence of low-level moisture, atmospheric conditional instability and wind shear. The synoptic and mesoscale analysis shows that the outflow of a decaying MCS above northern France triggered the storm, which exhibited the typical features of a bow echo like a mesovortex and rear inflow jet. This resulted in hurricane-force wind gusts (reaching 40 m/s) along a narrow swath in the Rhine-Ruhr region leading to substantial damage. Operational numerical weather predictions models mostly failed to forecast the storm, but high-resolution regional model hindcasts enable a realistic simulation of the storm. The model experiments reveal that the development of the bow echo is particularly sensitive to the initial wind field and the lower tropospheric moisture content. Correct initial and boundary conditions are therefore necessary for realistic numerical forecasts of such a bow echo event. We conclude that the Pentecost storm exhibited a comparable structure and a similar intensity to the observed bow echo systems in the United States.