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Large-scale dynamics associated with clustering of extratropical cyclones affecting Western Europe

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Some recent winters in Western Europe have been characterized by the occurrence of multiple extratropical cyclones following a similar path. The occurrence of such cyclone clusters leads to large socio-economic impacts due to damaging winds, storm surges, and floods. Recent studies have statistically characterized the clustering of extratropical cyclones over the North Atlantic and Europe and hypothesized potential physical mechanisms responsible for their formation. Here we analyze 4 months characterized by multiple cyclones over Western Europe (February 1990, January 1993, December 1999, and January 2007). The evolution of the eddy driven jet stream, Rossby wave-breaking, and upstream/downstream cyclone development are investigated to infer the role of the large-scale flow and to determine if clustered cyclones are related to each other. Results suggest that optimal conditions for the occurrence of cyclone clusters are provided by a recurrent extension of an intensified eddy driven jet toward Western Europe lasting at least 1 week. Multiple Rossby wave-breaking occurrences on both the poleward and equatorward flanks of the jet contribute to the development of these anomalous large-scale conditions. The analysis of the daily weather charts reveals that upstream cyclone development (secondary cyclogenesis, where new cyclones are generated on the trailing fronts of mature cyclones) is strongly related to cyclone clustering, with multiple cyclones developing on a single jet streak. The present analysis permits a deeper understanding of the physical reasons leading to the occurrence of cyclone families over the North Atlantic, enabling a better estimation of the associated cumulative risk over Europe.