



ECSS2025-129, updated on 17 Apr 2026

<https://doi.org/10.5194/ecss2025-129>

12th European Conference on Severe Storms

© Author(s) 2026. This work is distributed under the Creative Commons Attribution 4.0 License.



Ingredient-Based Analysis and Simulation of Violent European F4/F5 Tornadoes between 1965 and 1971

Jerome Schyns¹, Lisa Schielicke^{2,3}, and Christoph Gatzert³

¹Institute of Geosciences, University of Bonn, Bonn, Germany

²Department of Physics and Astronomy, Western University, London, Ontario, Canada

³Canadian Severe Storms Laboratory, Department of Civil & Environmental Engineering, Western University, London, Ontario, Canada

Between 1965 and 1971, Europe experienced an unusually high number of violent tornadoes, including six confirmed F4 events in Switzerland, France (2), Italy (2), and Germany, as well as one F5 tornado in France. This exceptional cluster of events provides a unique opportunity to investigate the synoptic and environmental conditions associated with high-end tornadoes in Europe.

Using data from the European Severe Weather Database (ESWD), ERA5 reanalysis, and historical surface and upper-air weather maps, we analyze the synoptic and mesoscale patterns associated with these tornadoes. Particular attention is given to large-scale synoptic processes such as the jet stream positioning, the presence of synoptic and mesoscale boundaries (such as cold fronts, drylines, and prefrontal convergence zones), and the strength of large-scale forcing.

Our analysis follows an ingredients-based approach focusing on thermodynamic and kinematic conditions, including the spatial alignment of low-level moisture, lapse-rates, lifting mechanism, and vertical wind shear. We find that many of these tornado events occurred under a favorable combination of strong low-level wind shear and enhanced CAPE, often within confined regions ("sweet spots") of overlapping ingredients. A recurring pattern emerges, characterized by the presence of strong low-level streamwise vorticity and low lifted condensation levels (LCLs), which likely contributed to efficient storm organization and tornadogenesis by limiting evaporative cooling and thus cold pool strength.

ERA5 vertical profiles near the convective developments reveal consistent signatures of storm-favorable environments, including strong streamwise vorticity in the lowest kilometers, as well as low LCL heights indicative of surface-based convection with limited downdraft cooling. These findings are further supported by proximity soundings used to initialize idealized supercell simulations in Cloud Model 1 (CM1). Simulated storms develop robust mesocyclones, exhibit realistic storm motion vectors, and confirm the sensitivity of storm structure to variations in cold pool intensity and vertical shear.

Overall, the study suggests that the violent tornadoes of this period were not purely coincidental, but rather the result of rare yet repeatedly favorable synoptic and mesoscale configurations. These insights contribute to a better understanding of the environmental conditions supporting violent tornadoes in Europe and may aid in refining future risk assessments and forecasting strategies.