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The role of mesoscale instabilities and frontolytic circulations in Sting-Jet dynamics: a case study

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Sting jets (SJ) occur as an additional region of low-level strong winds present in some Shapiro-Keyser extratropical cyclones. While it is now widely accepted that those winds are not part of the warm or cold conveyor belts, the precise mechanisms responsible for their occurrence are yet to be fully understood. The key aspect of the current research concerns the dependence of SJ generation and strengthening upon the release of mesoscale instabilities and upon the balanced dynamics in the frontolytic region.
The work to be presented tackles this question using a case study, windstorm Tini (affecting the UK on 12 February 2014), in which a SJ has been identified. The related investigation is carried out through simulations run with the MetUM and Lagrangian trajectories are used to gain further information on the dynamics of the SJ. Particular attention is devoted to the evolution of mesoscale atmospheric instabilities (e.g. symmetric and inertial instabilities) in the region where the descending airstream originates. The analysis of frontogenesis field, along with the use of vorticity budgets and of potential vorticity tracers, highlights the processes leading to the development of these instabilities and the banded structure in the cloud head.
The results of this case study suggest that the SJ undergoes a process of destabilisation that enhances its descent and acceleration, adding to the strong winds already generated by the balanced dynamics. The same destabilisation does not occur in a coarser-resolution simulation, resulting in a weaker wind jet in the frontolytic region. This analysis thus reveals the synergy between the balanced dynamics and mesoscale instabilities in SJ formation.