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Observation and Modeling of Clear Air Turbulence (CAT) over Europe

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CAT represents a very relevant phenomenon for aviation safety. It can lead to passenger injuries, causes an increase in fuel consumption and, under severe intensity, can involve structural damages to the aircraft. The physical processes causing CAT remain at present not fully understood. Moreover, because of its small scale, CAT cannot be represented in numerical weather prediction (NWP) models. In this study, the physical processes related to CAT and its representation in NWP models is further investigated.

First, 134 CAT events over Europe are extracted from a flight monitoring data base (FDM), run by the SWISS airline and containing over 100'000 flights. The location, time, and meteorological parameters along the turbulent spots are analysed. Furthermore, the 7-km NWP model run by the Swiss National Weather Service (Meteoswiss) is used to calculate model-based CAT indices, e.g. Richardson number, Ellrod & Knapp turbulence index and a complex/combined CAT index developed at NCAR. The CAT indices simulated with COSMO-7 is then compared to the observed CAT spots, hence allowing to assess the model's performance, and potential use in a CAT warning system. In a second step, the meteorological conditions associated with CAT are investigated. To this aim, CAT events are defined as coherent structures in space and in time, i.e. their dimension and life cycle is studied, in connection with jet streams and upper-level fronts. Finally, in a third step the predictability of CAT is assessed, by comparing CAT index predictions based on different lead times of the NWP model COSMO-7