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Dry intrusions: Lagrangian climatology and impact on the boundary layer

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Dry air intrusions (DIs) are large-scale descending airstreams. A DI is typically referred to as a coherent airstream in the cold sector of an extratropical cyclone. Emerging evidence suggests that DIs are linked to severe surface wind gusts. However, there is yet no strict Lagrangian definition of DIs, and so their climatological frequency, dynamical characteristics as well as their seasonal and spatial distributions are unknown. Furthermore, the dynamical interaction between DIs and the planetary boundary layer is not fully understood.

Here, we suggest a Lagrangian definition for DI air parcels, namely a minimum pressure increase along a trajectory of 400 hPa in 48 hours. Based on this criterion, the open questions are addressed by: (i) a novel global Lagrangian climatology for the ECMWF ERA-Interim reanalysis dataset for the years 1979-2014; (ii) a case study illustrating the interaction between DIs and the boundary layer.

We find that DIs occur predominantly in winter. DIs coherently descend from the upper troposphere (their stratospheric origin is small), to the mid- and low levels, where they mix with their environment and diverge. Different physical characteristics typify DIs in the different regions and seasons. Finally, we demonstrate the different mechanisms by which DIs can destabilize the boundary layer and facilitate the formation of strong surface winds.