

Dry air intrusions: climatology and their relevance for strong surface winds in the Euro-Mediterranean region

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Dry air intrusions (DAIs) are large-scale descending airstreams, typically referred to as the coherent airstream in the cold sector of an extratropical cyclone. Emerging evidence suggests that DAIs are linked to severe surface wind gusts. However, there is yet no strict Lagrangian definition of DAIs, and so their climatological frequency, physical characteristics as well as their seasonal and spatial distributions are unknown. Furthermore, it is unclear how many of the DAIs occur together with a cyclone, and the dynamical interaction between DAIs and strong surface winds is not fully understood.

Here, we suggest a Lagrangian definition for DAI 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) detailed investigation of the processes underlying the interaction between DAIs and strong surface winds, shown with composite analysis and with case studies and meso-scale COSMO model simulation.

We find that DAIs occur predominantly in winter. DAIs coherently descend from the upper troposphere (its stratospheric origin is small), to the mid- and low levels, where they mix with their environment and diverge. Different physical characteristics typify DAIs in the different regions and seasons, and when occurring together with a cyclone. We demonstrate three plausible mechanisms by which DAIs can destabilize the boundary layer and facilitate the formation of strong surface winds. Finally, first results for setting these mechanisms in a climatological perspective are presented.