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Can we predict Dry Air Intrusions using an Artificial Neural Network?

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Dry-air intrusions (DIs) descending from the upper troposphere toward the surface are often associated with abrupt modification of the atmospheric boundary layer,air-sea interface, and high impact weather events. Understanding the triggering mechanism of DIs is important to predict the likelihood of their occurrence in both weather forecasts and future climate projections.

The current identification method of DIs is based on a systematic costly Lagrangian method that requires high vertical resolution of the wind field at sub-daily intervals. Therefore, the accurate prediction of surface weather conditions is potentially limited. Moreover, large case to case variability of these events makes it challenging to compose an objective algorithm for predicting the timing and location of their initiation.

Here we test the ability of deep neural networks, originally designed for computer vision purposes, to identify the DI phenomenon based on instantaneous 2-dimensional maps of commonly available atmospheric parameters. Our trained neural network is able to successfully predict DI origins using three instantaneous 2-D maps of geopotential heights.

Our results demonstrate how machine learning can be used to overcome the limitations of the traditional identification method, introducing the possibility to evaluate and quantify the occurrence of DIs instantaneously, avoiding costly computations and the need for high resolution data sets which are not available for most atmospheric data sets. In particular, for the first time, it is possible to predict the occurrence of DI events up to two days before the actual descent is complete.