The Life Cycle of Cyclones, Dry Intrusions, Cold Fronts and their Modulation by the Stratosphere

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The weather in the midlatitudes is governed by the passage of extratropical cyclones. A conceptual model for the cyclones spatial structure and their associated air flows was developed using case studies, with three main features associated with extreme surface weather: fronts, dry-air intrusions (DIs), and warm conveyor belts (WCBs). As the cyclone case-to-case variability is high, understanding the co-occurrence is important for extreme weather, especially in regions not usually associated with frequent frontal activity.

A climatological study quantifying the co-occurrence of fronts and DIs (Raveh-Rubin and Catto, 2019) found it to be associated with more extreme surface weather. Our goal is to extend the climatological study of the relationship between cyclones, fronts and DIs, and interpret it in light of the time evolution of the cyclones and its constituents. We identify and relate DIs and cold fronts to cyclone tracks, follow their co-evolution throughout the lifetime of a cyclone, and consequently their regional impact on the surface weather.

Preliminary climatological analysis using the ERA-Interim reanalysis shows that most of the cyclones are related to trailing fronts in the North Atlantic region (90%), while in the North pacific and North Scandinavia cyclones are less likely to be found with trailing fronts (70%). Cyclones that were matched with both fronts and DIs occur at the same frequency in both the North Atlantic and North Pacific (~50%). To understand the meaning of these non-trivial results we study the evolution of these features by compiling a representative lifecycle of cyclones and their influence on surface weather, for different regions. We further inspect how these features are modulated by the large scale circulation in the stratosphere represented by the polar vortex. This will provide as a metric for the performance of climate models, and in studies of climate trends of extreme events.