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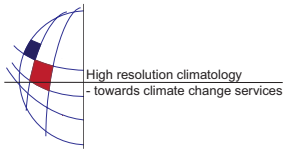

The life-cycle of upper-tropospheric jet streams identified with a novel data segmentation algorithm

S. Limbach (1,2), E. Schömer (1), H. Wernli (2,3)

(1) Institut für Informatik, Universität Mainz, Germany (limbach@uni-mainz.de), (2) Institut für Physik der Atmosphäre, Universität Mainz, Germany, (3) Institute for Atmospheric and Climate Science, ETH Zurich, Switzerland

Jet streams are prominent features of the upper-tropospheric atmospheric flow. Through the thermal wind relationship these regions with intense horizontal wind speed (typically larger than 30 m/s) are associated with pronounced baroclinicity, i.e. with regions where extratropical cyclones develop due to baroclinic instability processes. Individual jet streams are non-stationary elongated features that can extend over more than 2000 km in the along-flow and 200-500 km in the across-flow direction, respectively. Their lifetime can vary between a few days and several weeks. In recent years, feature-based algorithms have been developed that allow compiling synoptic climatologies and typologies of upper-tropospheric jet streams based upon objective selection criteria and climatological reanalysis datasets.

In this study a novel algorithm to efficiently identify jet streams using an extended region-growing segmentation approach is introduced. This algorithm iterates over a 4-dimensional field of horizontal wind speed from ECMWF analyses and decides at each grid point whether all prerequisites for a jet stream are met. In a single pass the algorithm keeps track of all adjacencies of these grid points and creates the 4-dimensional connected segments associated with each jet stream. In addition to the detection of these sets of connected grid points, the algorithm analyzes the development over time of the distinct 3-dimensional features each segment consists of. Important events in the development of these features, for example mergings and splittings, are detected and analyzed on a per-grid-point and per-feature basis. The output of the algorithm consists of the actual sets of grid-points augmented with information about the particular events, and of the so-called event graphs, which are an abstract representation of the distinct 3-dimensional features and events of each segment. This technique provides comprehensive information about the frequency of upper-tropospheric jet streams, their preferred regions of genesis, merging, splitting, and lysis, and statistical information about their size, amplitude and lifetime.

The presentation will introduce the technique, provide example visualizations of the time evolution of the identified 3-dimensional jet stream features, and present results from a first multi-month „climatology“ of upper-tropospheric jets. In the future, the technique can be applied to longer datasets, for instance reanalyses and output from global climate model simulations – and provide detailed information about key characteristics of jet stream life cycles.