Contribution ID: **11** Type: **Oral presentation**

Automatic detection of weather events in high-resolution NWP outputs

Wednesday, 7 October 2020 09:00 (30 minutes)

Since the number of available NWP forecasts is rapidly increasing, especially with the development of ensemble prediction systems, there is a need to develop innovative forecast products that provide a synthetic view of the weather situation and potential risks. A promising option is to identify different weather patterns in NWP outputs, that can then be used to delimit areas of interest, to provide a diagnostic of occurrence of a given event, or to issue pattern-based probability maps. The detection of weather objects has been performed for several years, mainly with algorithmic approaches based on a set of simple rules. In recent years, machine learning and deep learning algorithms have provided powerful tools to segment objects, that can overcome some limitations of standard algorithms and allow for the detection of more complex and finer-scale objects. In this presentation we show that the well-known U-Net convolutional neural network, a typical encoder-decoder architecture with skip connections, can be successfully applied to the high-resolution Arome model outputs for the detection of several weather features with different spatial scales, including continuous and intermittent rainfall areas, weather fronts, and two extreme weather events, tropical cyclones and bow echoes. The performance of these detections strongly relies on the availability and accuracy of large training and testing datasets. Since no off-the-shelf data are available, a time-consuming human labelling exercise has been performed for each pattern considered. In order to extend the application of our U-Net to a wider range of outputs, without increasing labelling and training steps, transfer learning has been successfully used. It is shown in particular that a network trained on a specific geographic region can be applied to other domains, and networks trained on NWP outputs can properly detect similar objects in corresponding observations.

Thematic area

1. Machine Learning for Product development - Including NWP Post-processing, Non-linear Ensemble Averaging, Development of new NWP Products

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Session Classification: Session 4 (cont.): ML for Product Development

Track Classification: ECMWF-ESA Workshop on Machine Learning for Earth System Observation and Prediction