Deep learning for extreme wind speed prediction with CyGNSSnet

Caroline Arnold¹,², Daixin Zhao³, Tianqi Xiao⁴, Lichao Mou³, and Milad Asgarimehr⁴

¹German Climate Computing Center DKRZ, Hamburg, Germany (arnold@dkrz.de)
²Helmholtz Artificial Intelligence Cooperation Unit
³German Aerospace Center (DLR), Wessling, Germany
⁴German Research Centre for Geosciences GFZ, Potsdam, Germany

The CyGNSS (Cyclone Global Navigation Satellite System) satellite system measures GNSS signals reflected off the Earth’s surface. A global ocean wind speed dataset is derived, which fills a gap in Earth observation data and can improve cyclone forecasting. We proposed CyGNSSnet(1), a deep learning model for predicting wind speed from CyGNSS observables, and found an improved performance of 29% compared to the current operational model. However, the prediction of extreme winds remained challenging: For wind speeds exceeding 12 m/s, the operational model outperformed CyGNSSnet.

Here, we explore methods to improve the performance of CyGNSSnet at high wind speeds. We introduce a hierarchical model that combines specialized CyGNSSnet instances trained in different wind speed regimes with a classifier to select an instance. In addition, we explore strategies to improve the wind speed predictions by emphasizing extreme values in training, and we discuss the potentials and shortcomings of the approaches.