Deep learning for extreme wind speed prediction with CyGNSSnet
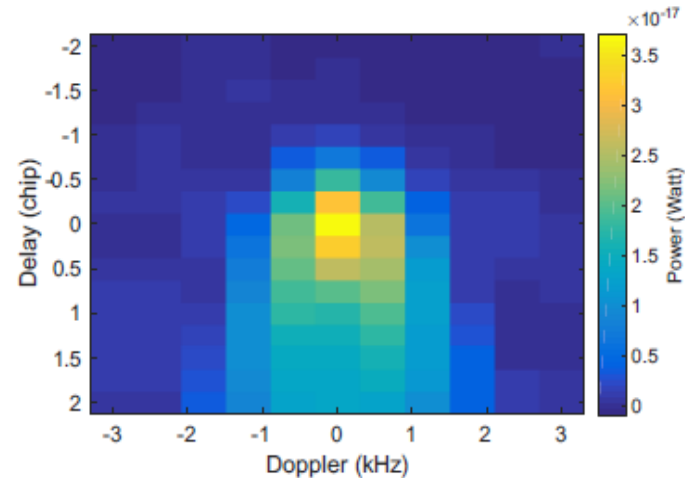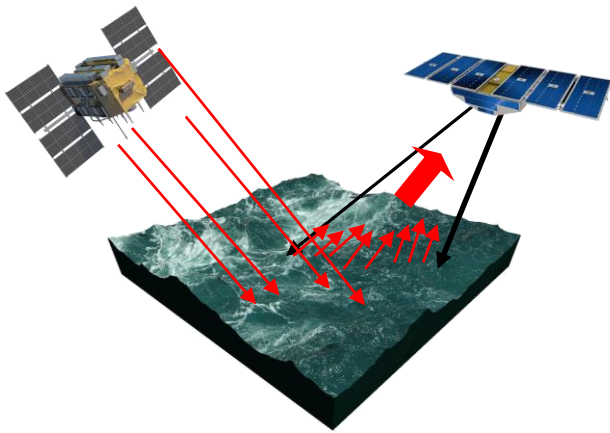
Caroline Arnold, Daixin Zhao, Tianqi Xiao, Lichao Mou, and Milad Asgarimehr

EGU Vienna, 27.05.2022

Remote sensing of ocean wind speeds

## The Cyclone GNSS satellite mission

- Ocean surface roughness ↔ wind speed

- CyGNSS: 8 microsatellites

- → measure reflection of GNSS (19 cm)

- Main measurement: Delay-Doppler map

- Up to 10^9 samples / year

- Ancillary parameters available

CyGNSSnet

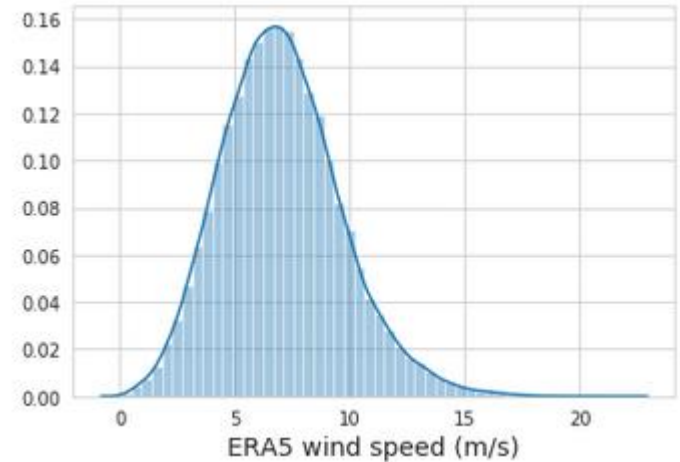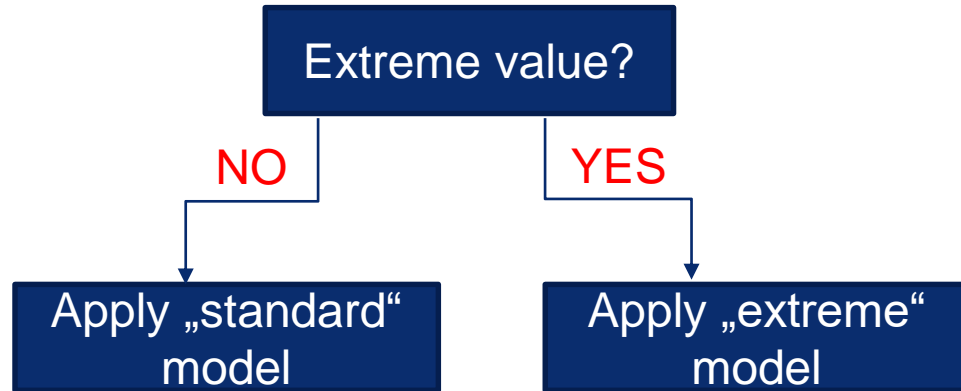## Deep learning for global ocean wind speed prediction

- Supervised learning

- Ground truth: ERA5 wind speed labels

- Train with data from 320 days (2019/2020)

- Overall RMSE = 1.36 m/s

- 27 % improvement to conventional method

- Challenge: predict high wind speeds

HELMHOLTZ AI
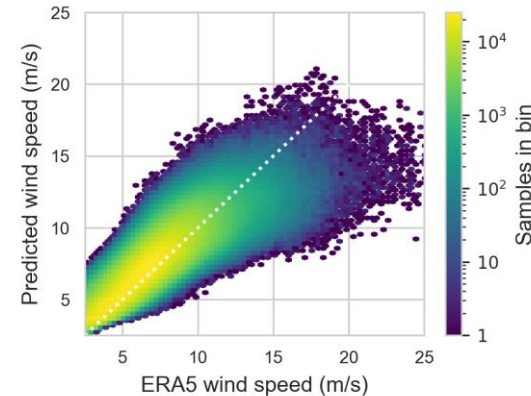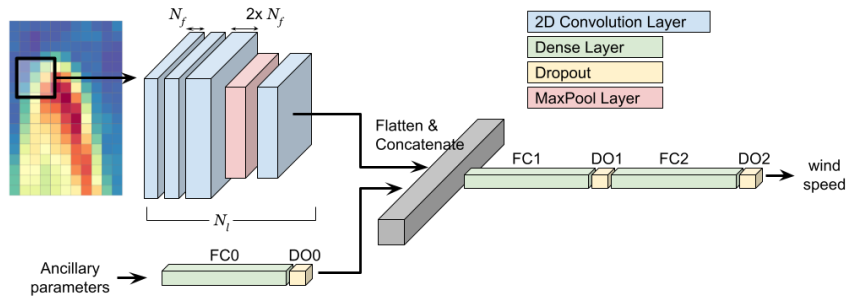
Hierarchical CyGNSSnet

Dealing with the imbalanced wind speed distribution

- Train two CyGNSSnet instances
    - „Standard" including all samples
    - „Extreme" including $v > v_{crit}$

- Train XGBoost classifier

```
           ┌─────────────────────┐
           │   Extreme value?    │
           └─────────────────────┘
         NO                      YES
    ┌──────────────┐       ┌──────────────┐
    │ Apply „standard"│    │ Apply „extreme"│
    │     model     │     │     model     │
    └──────────────┘       └──────────────┘
```

Evaluate the combined CyGNSSnet

Test set: 266 days (2020 / 2021)

- Classifier performance: $F_1 = 0.71$

- Combined CyGNSSnet
  - Comparable performance across all wind speeds
  - Up to 20% improvement at high wind speeds