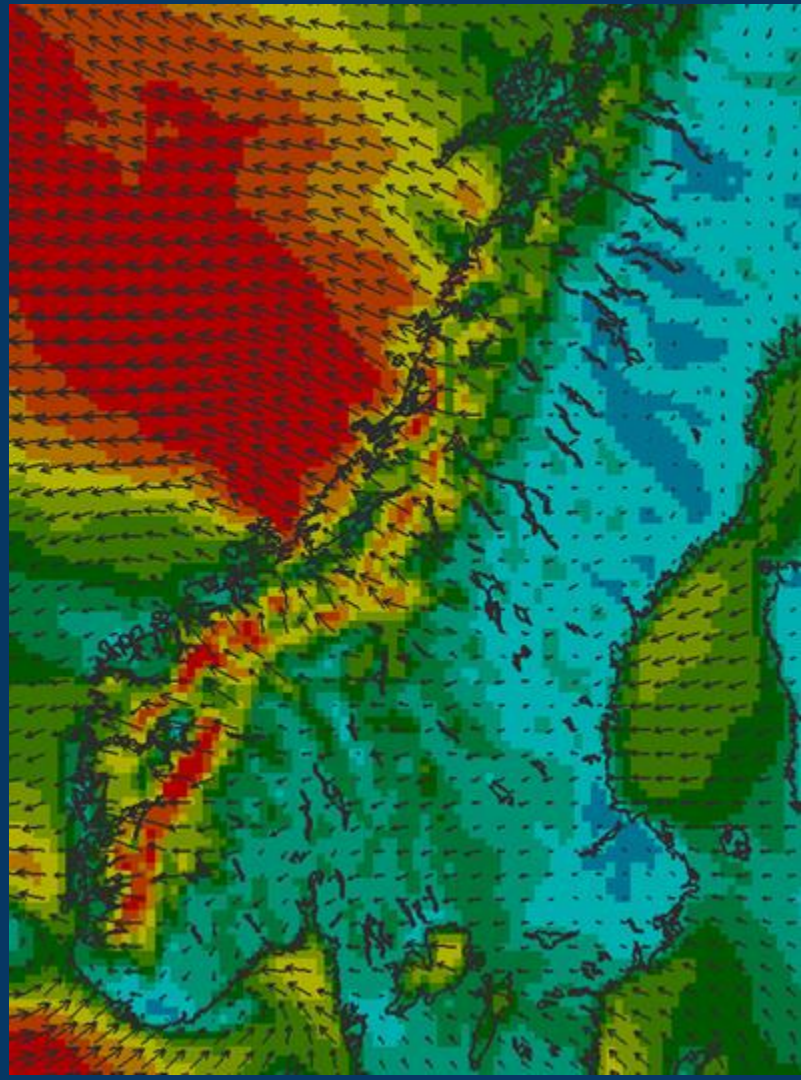
Regional data-driven weather forecasting with a global stretched-grid approach

Norwegian Meteorological Institute

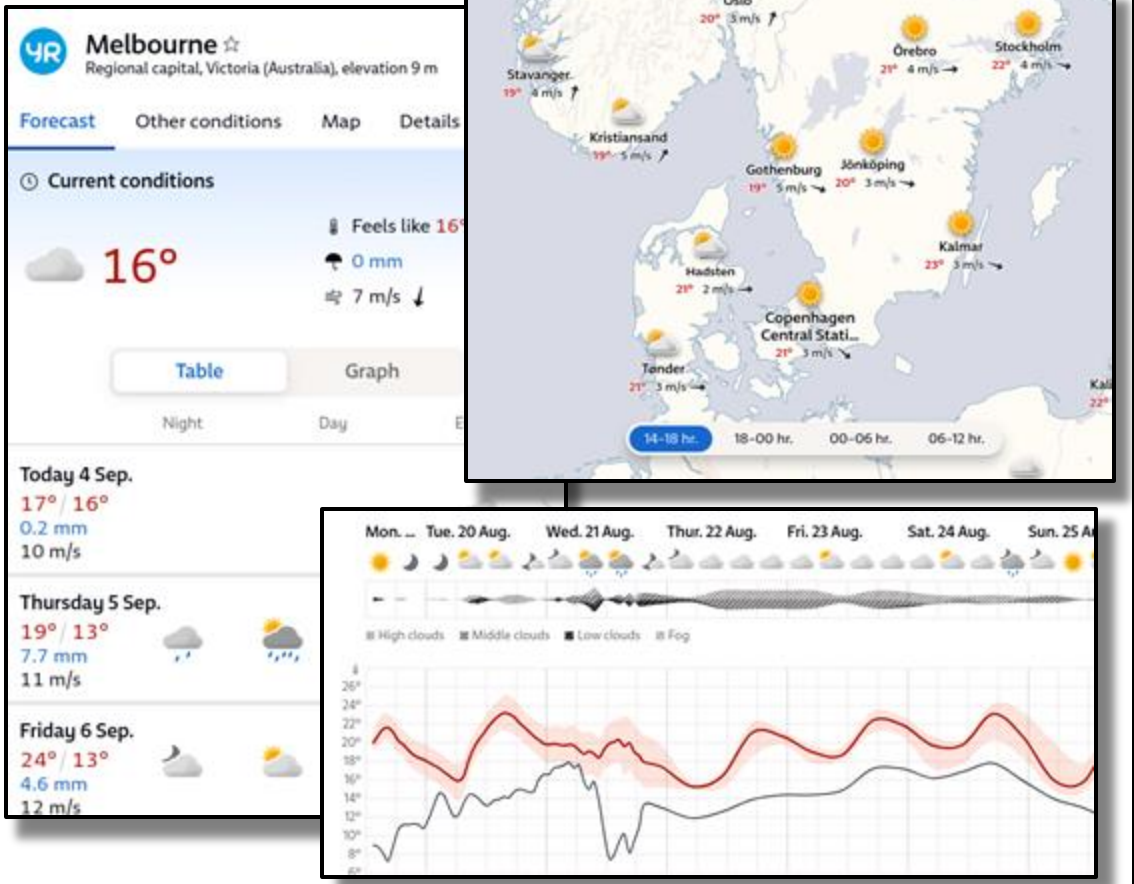
Thomas Nipen

With input from Håvard Homleid Haugen, Magnus Sikora Ingstad, Even Nordhagen, Aram Farhad Salihi, Ivar Seierstad, and Paulina Tedesco

This work is supported by computing and storage resources provided by Sigma2 – the National Infrastructure for High-Performance Computing and Data Storage in Norway.

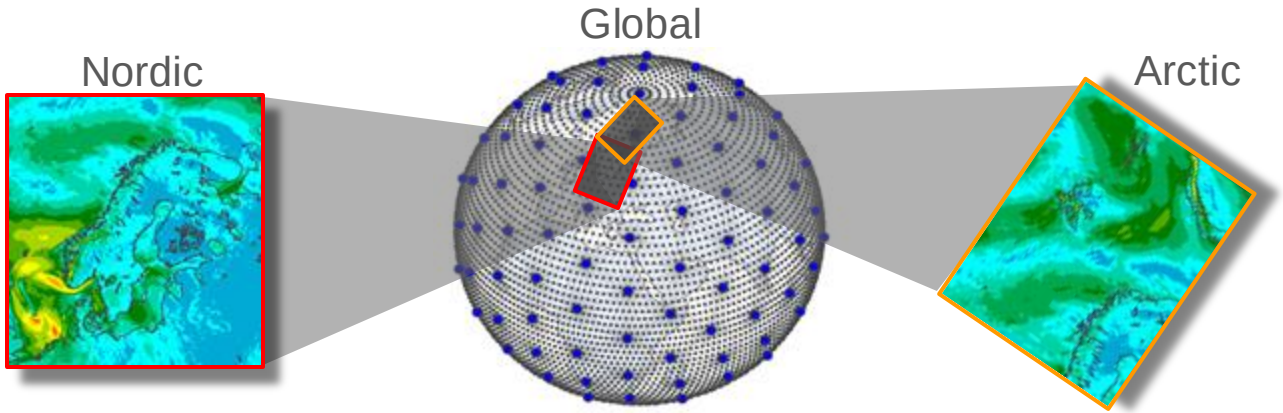


Weather forecasting for the public



Stretched-grid approach

- We are building a global model with high resolution over our focus areas
- Based on AIFS/GraphCast architecture
- Developed within ECMWF's Anemoi framework (https://anemoi.ecmwf.int)
- Goal is to cover nowcasting through extended-range (21 days)
- Add further domains around the world in the future



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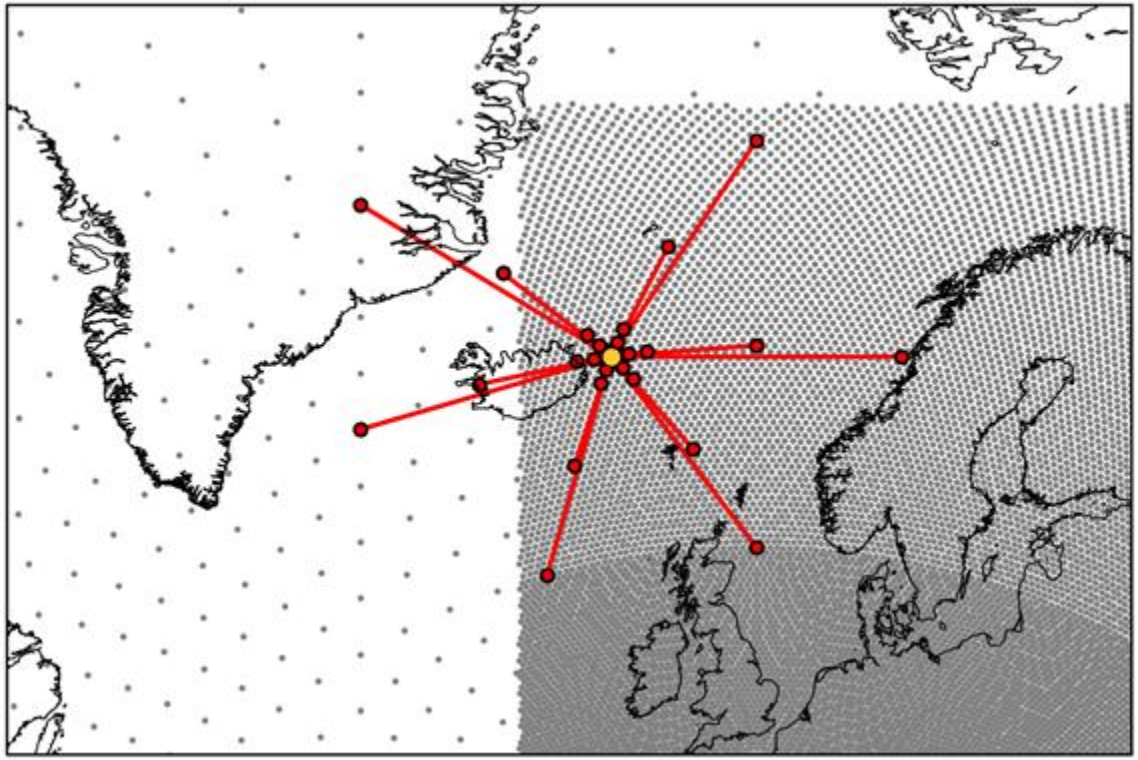
Stretched-grid approach

- Seamless information passing across boundaries

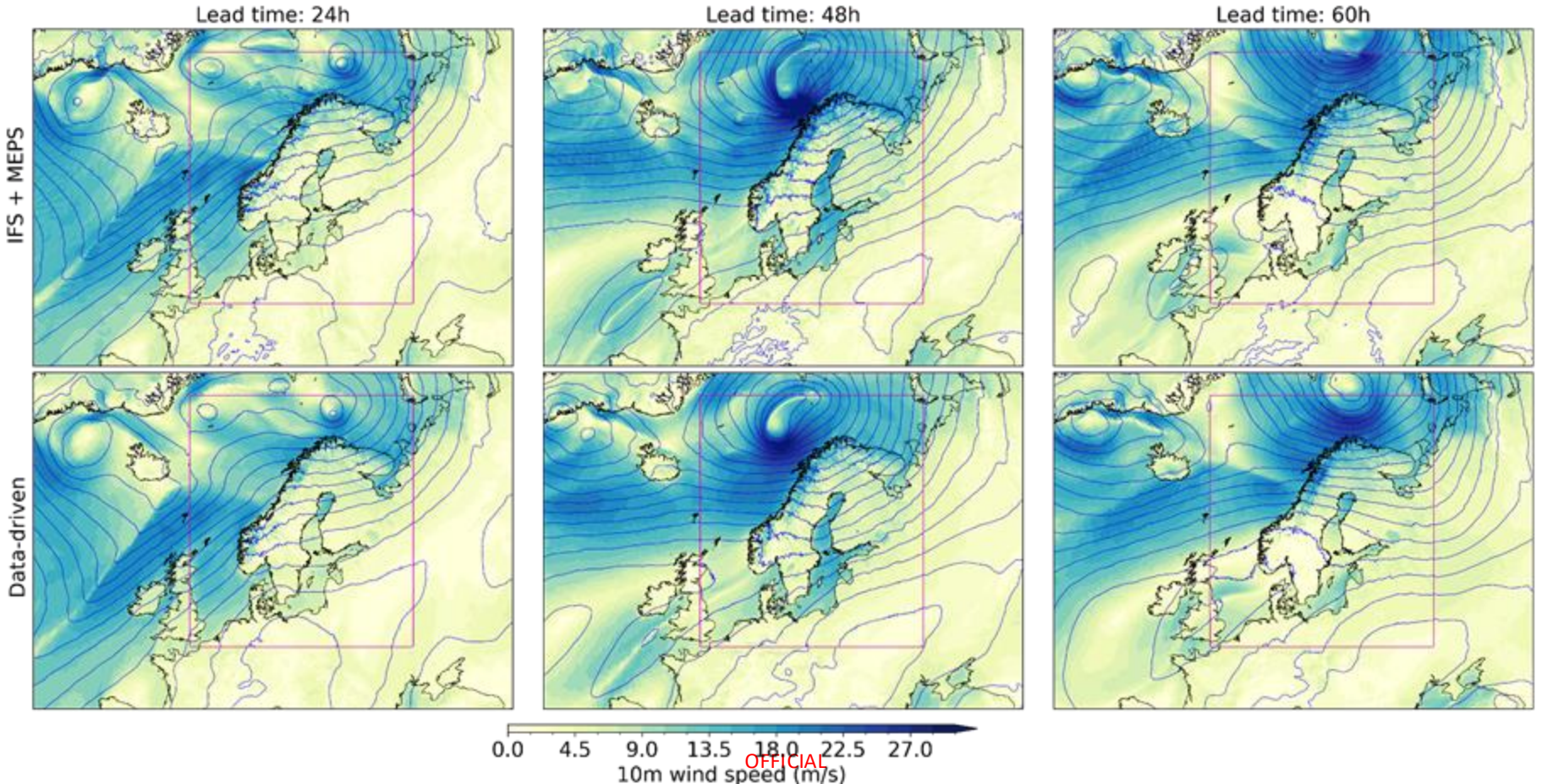


Training our data-driven model

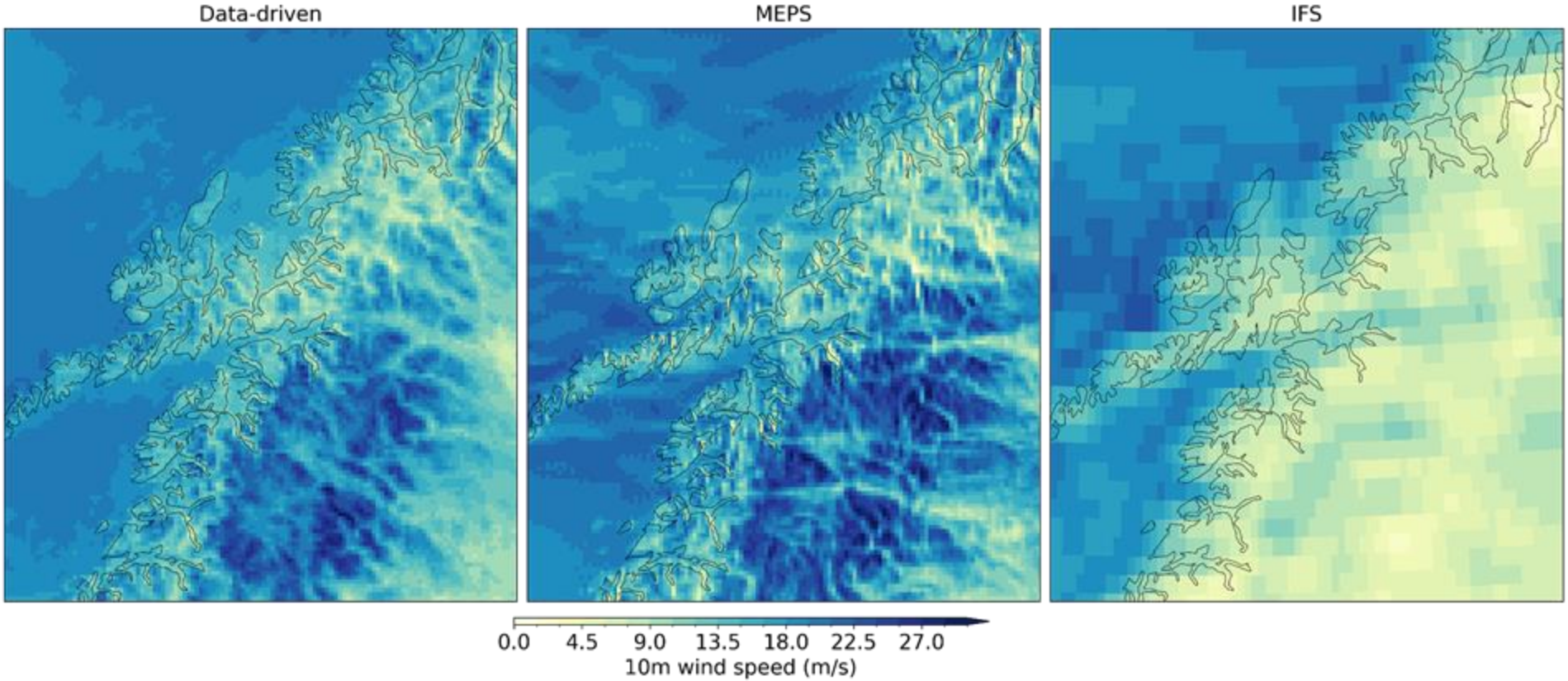
- Deterministic loss function (MSE)
- Training data:
  - 43 years of ERA5 (31 km)
  - 3 years of MEPS (2.5 km)
- Trained using 128 GPUs on LUMI
- 100,000 GPU-h to test/tune model
- 8,000 GPU-h to train the final model

https://lumi-supercomputer.eu/

Comparison against NWP

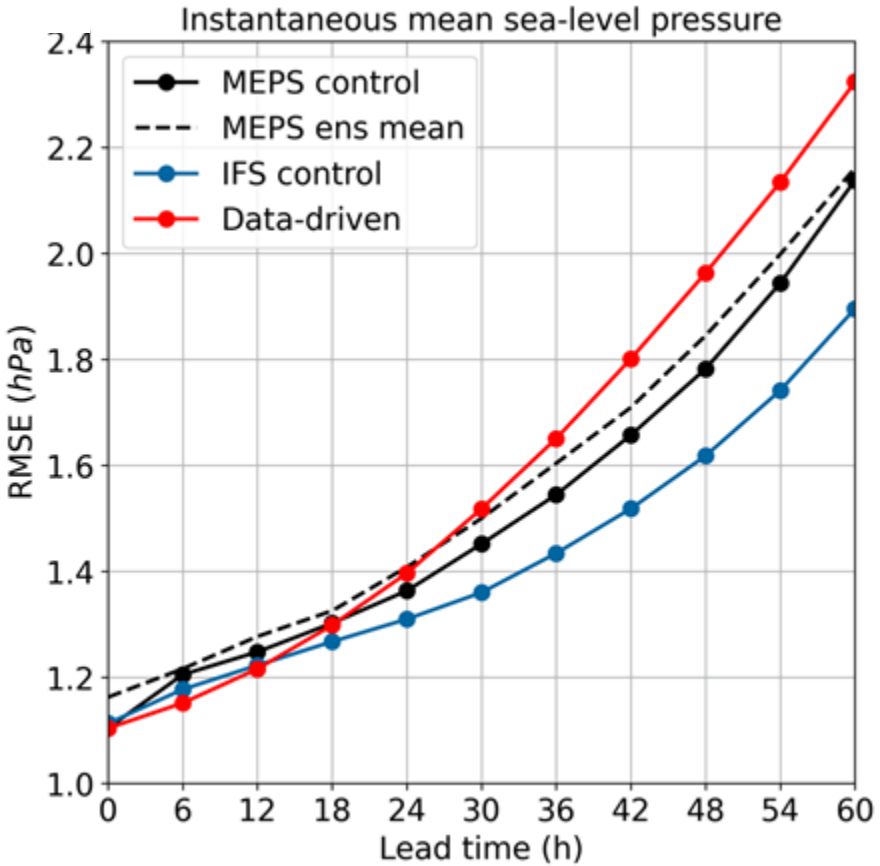


Comparison against NWP



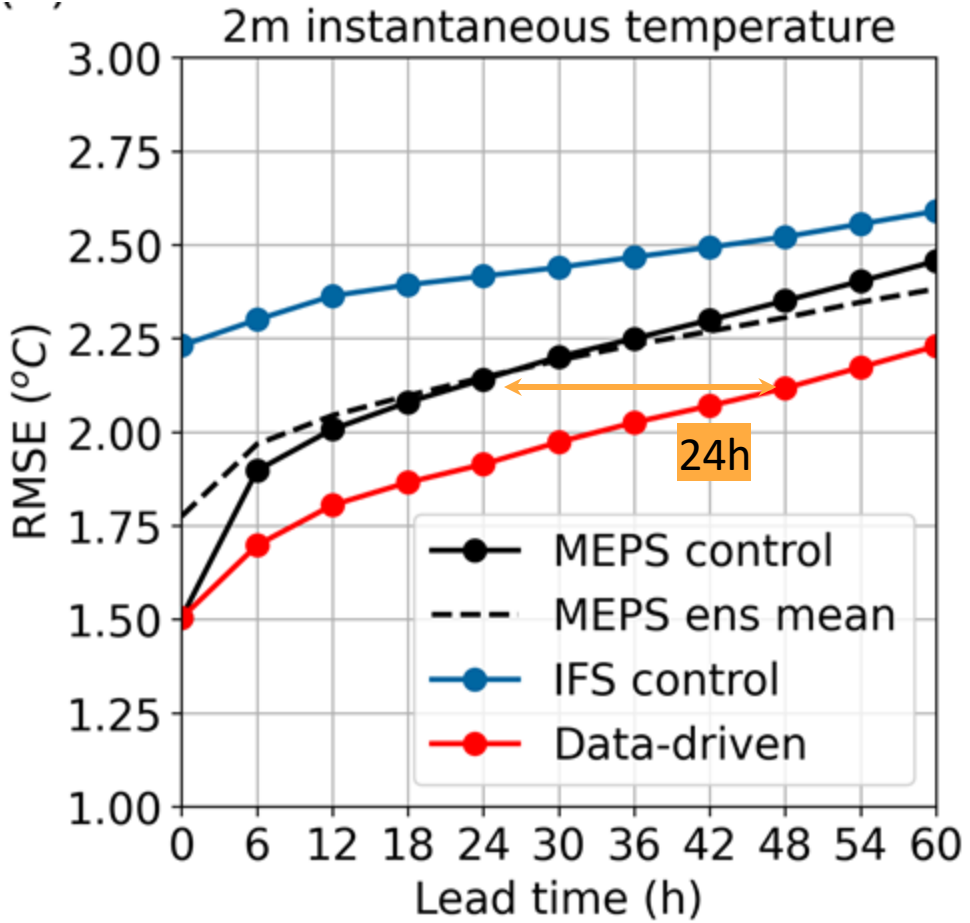
Results - Mean sea level pressure

- Evaluation against SYNOP stations
- June 2023-May 2024
- Gridded forecasts are bilinearly interpolated to observation points



Results - 2 m temperature

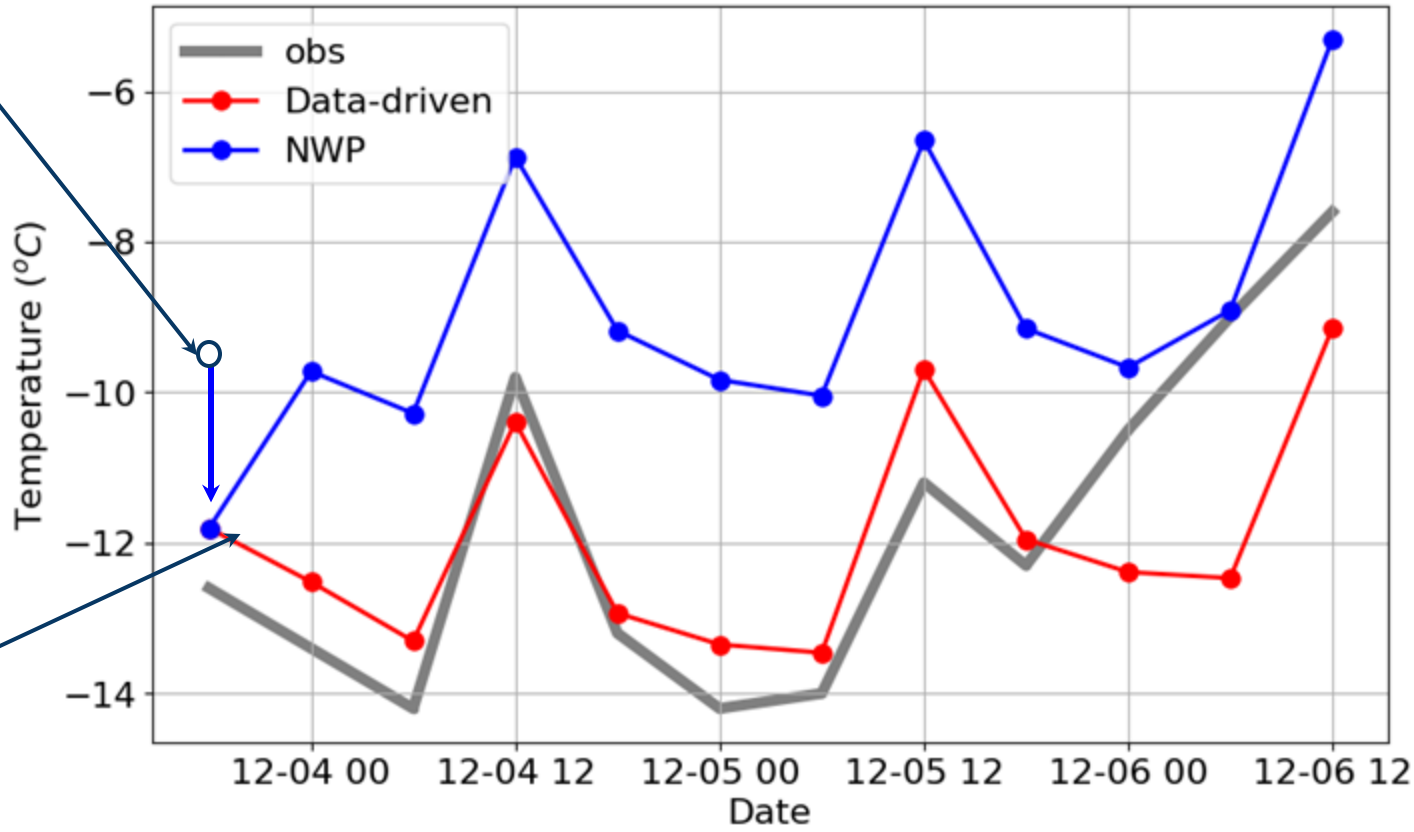
- Evaluation against SYNOP stations
- June 2023-May 2024
- Gridded forecasts are bilinearly interpolated **and elevation corrected (6.5°/km)** to observation points



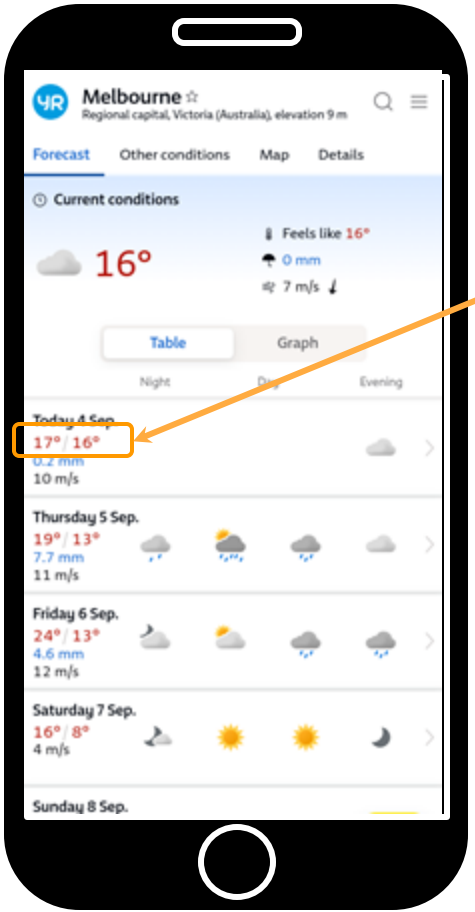
Example temperature time serie

Background from previous NWP run

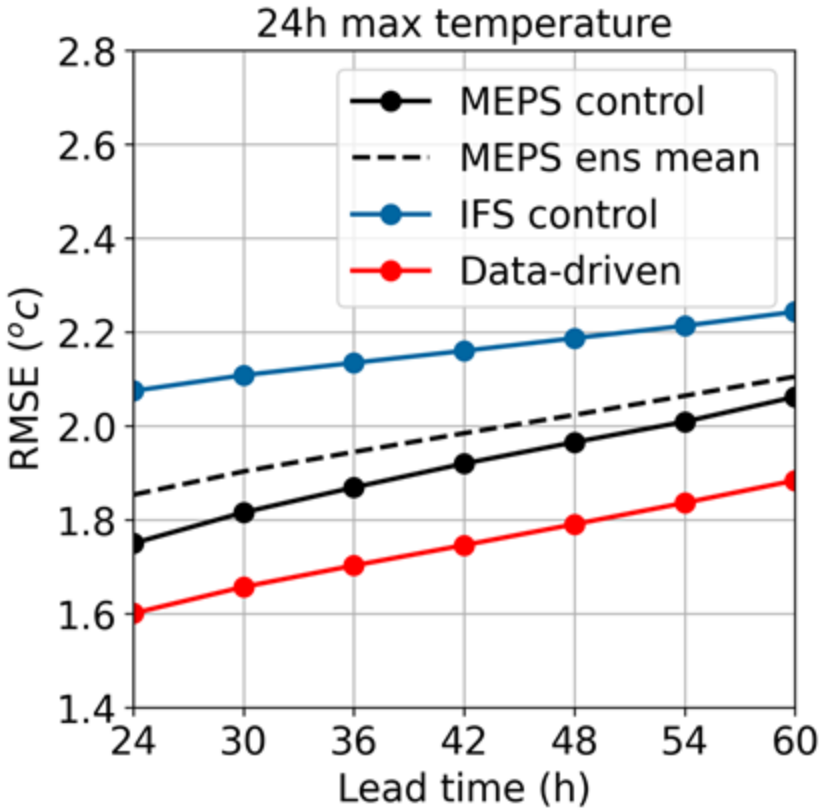
After surface assimilation



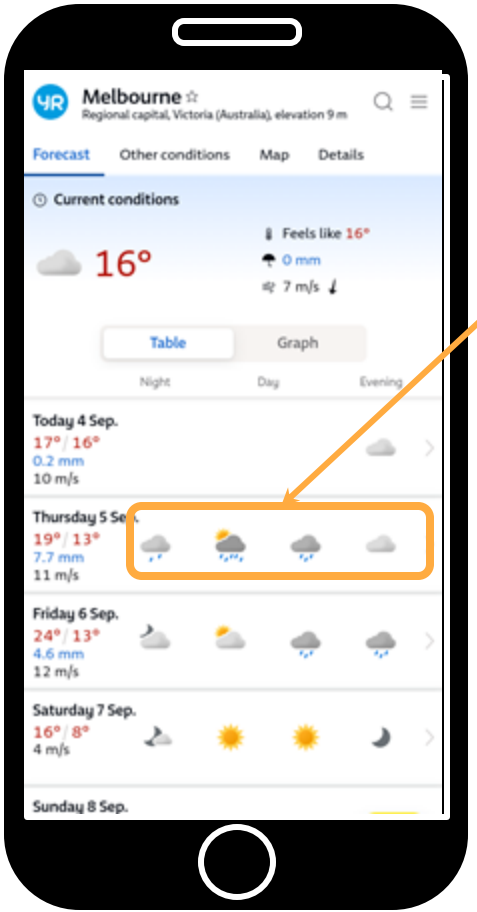
Results - Daily min/max temperature



Important parameters for our end-users

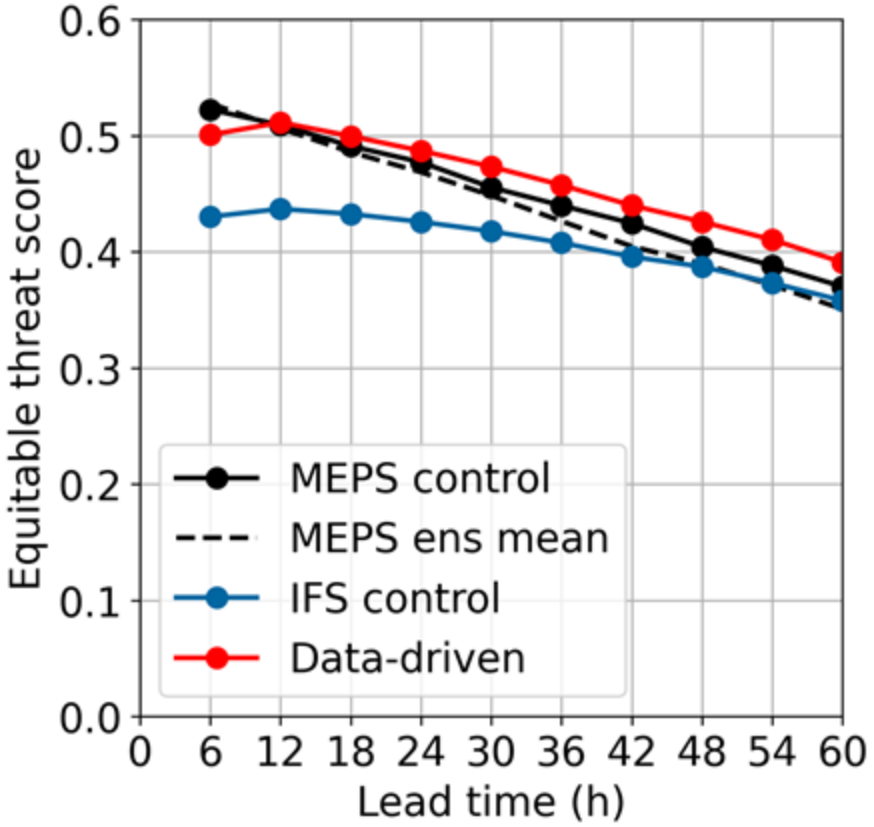


Results - 6 h precipitation



Distinguishing “rain” from “no rain”

Event threshold: 0.5 mm / 6 h



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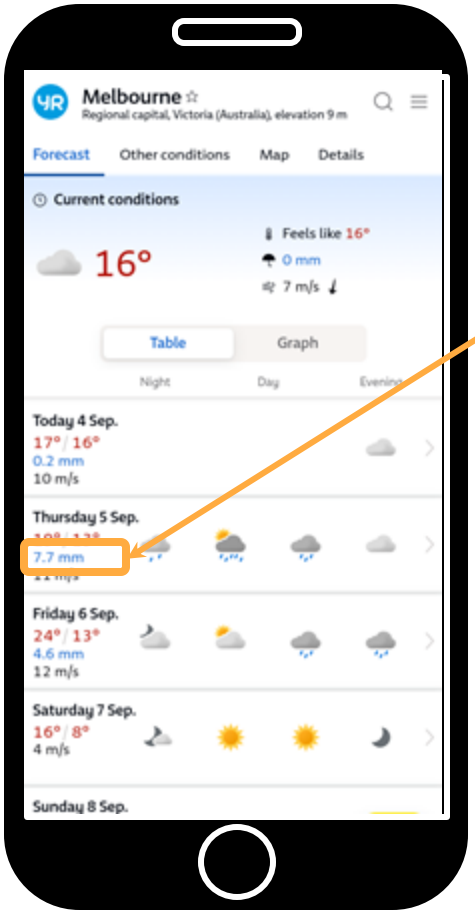
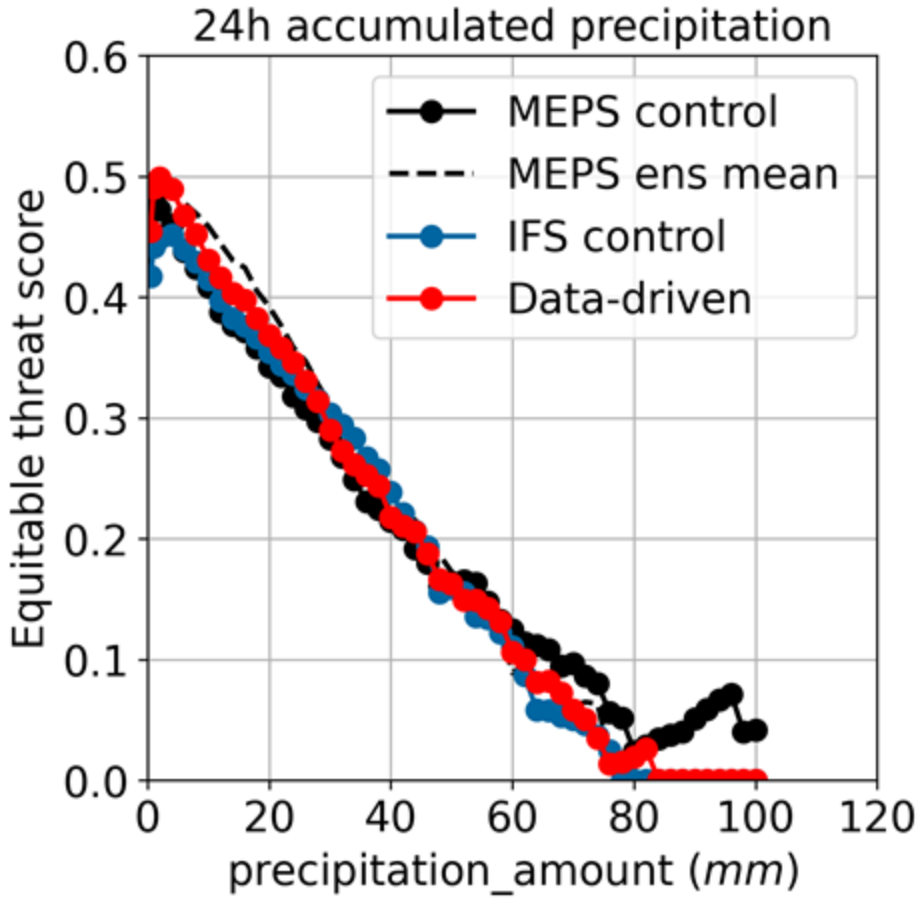
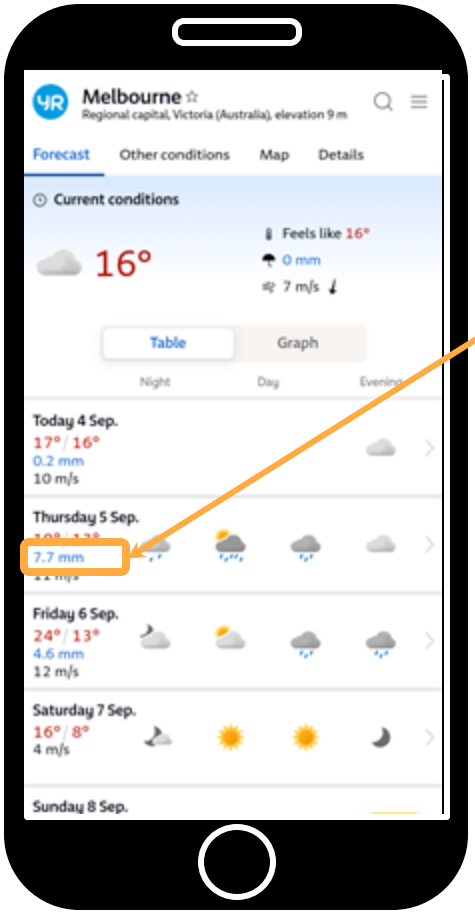


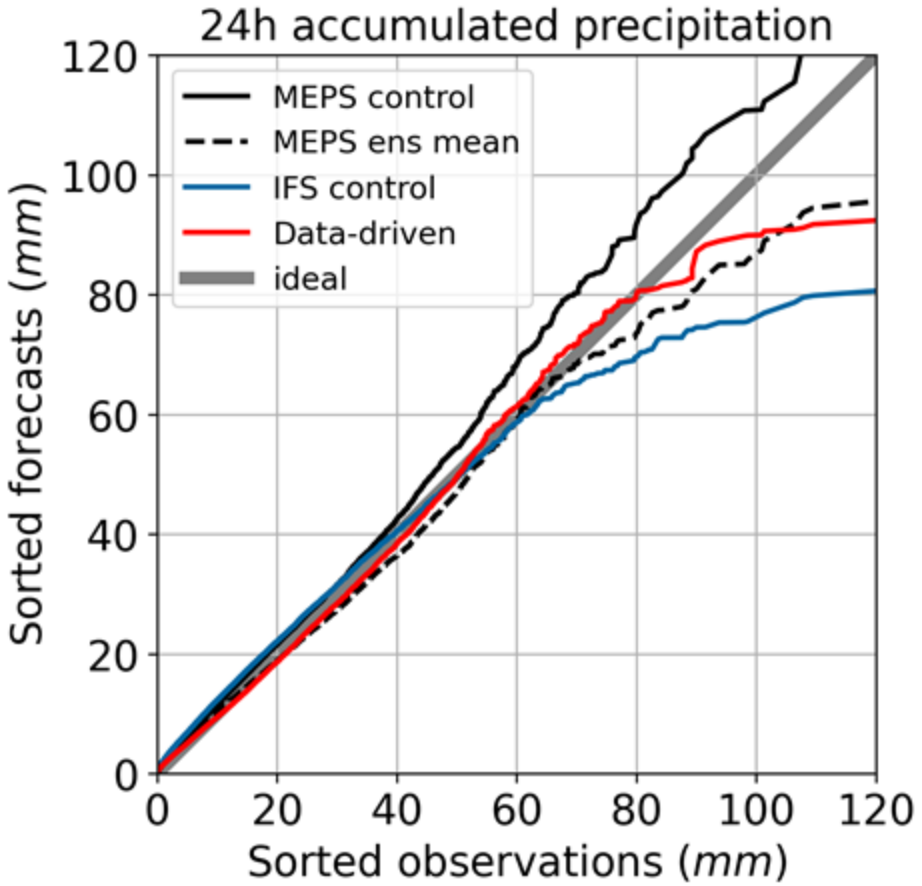
24 h precip is competitive with NWP models



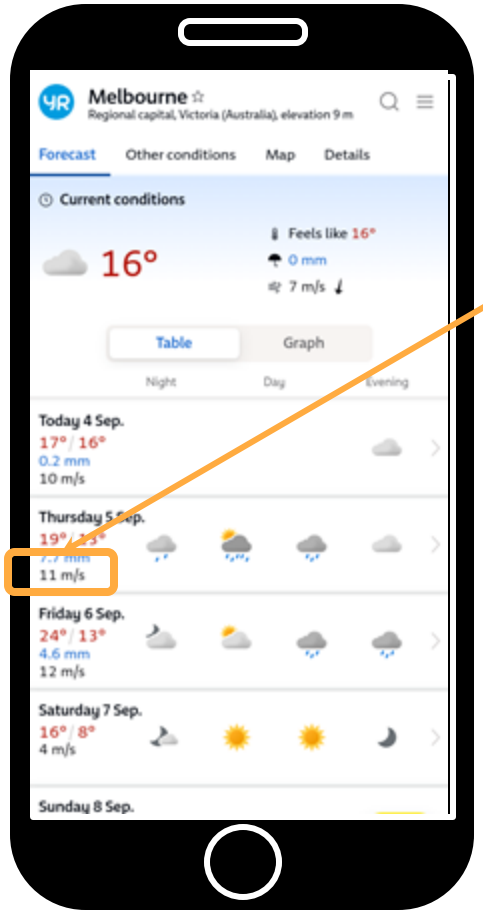
Results - 6 h precipitation



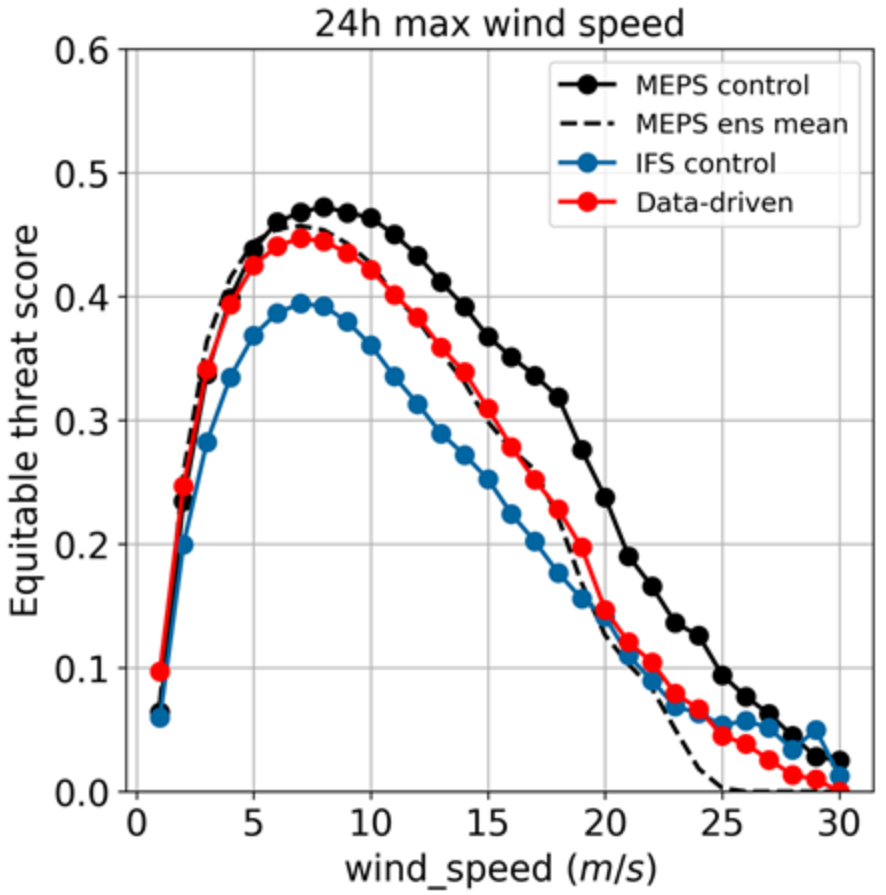
However some underestimation of extremes



Results - 10 m wind speed



Daily max wind speed



Conclusions and further work

- Stretched-grid data-driven models are promising for public weather forecasting
- Remaining challenges for integrating data-driven models for us
  - Moving from 6 hourly to 1 hourly forecasting
  - Improve prediction of extremes (moving from deterministic to probabilistic modelling)

To read more: Nipen et al., 2024: Regional data-driven weather modeling with a global stretched-grid. arXiv.org

Anemoi framework: https://anemoi.ecmwf.int

Contact: Thomas Nipen (thomasn@met.no)

Extra slides

Stretched-grid simulation