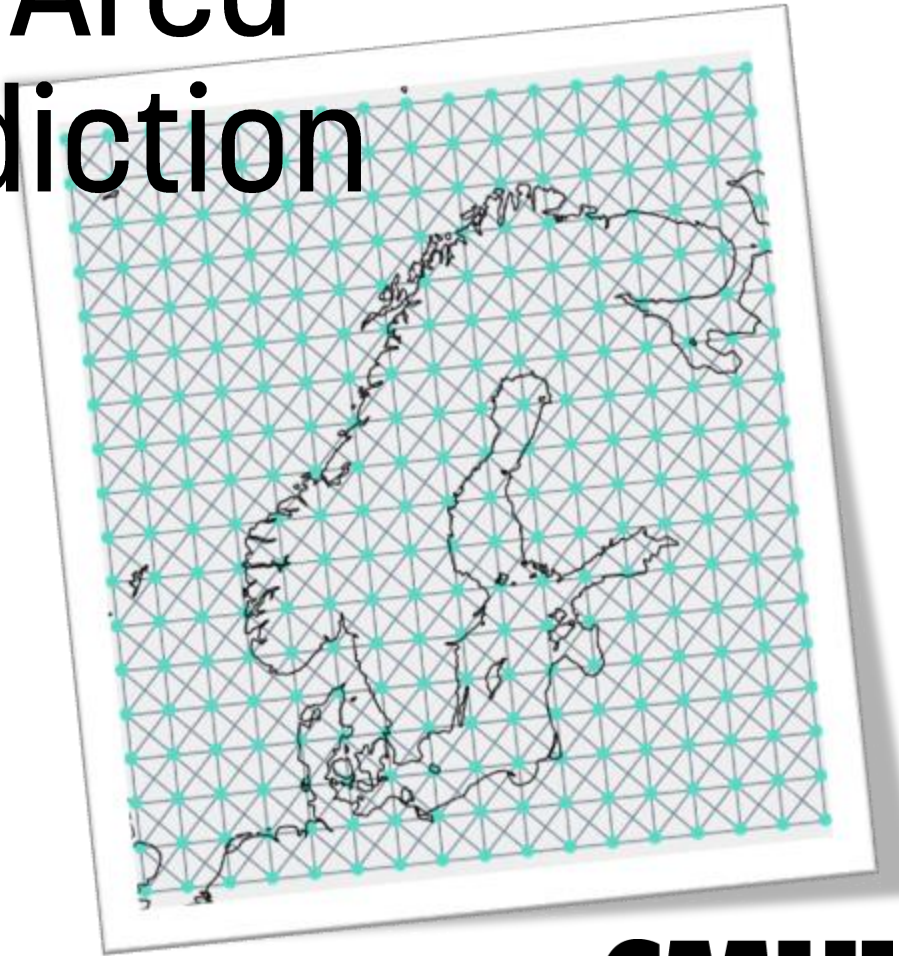


GraphCast for a Limited Area Numerical Weather Prediction Model

Joel Oskarsson¹, Tomas Landelius², Fredrik Lindsten¹

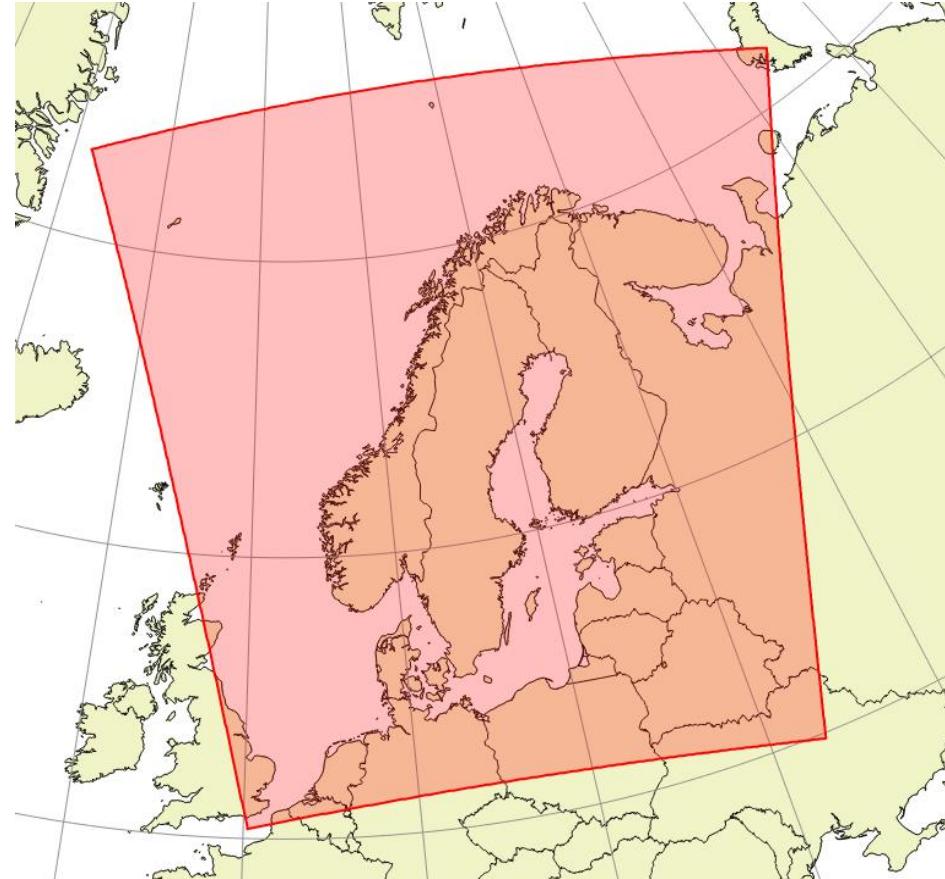
¹ Division of Statistics and Machine Learning,
Department of Computer and Information Science,
Linköping University, Sweden

² Swedish Meteorological and Hydrological Institute (SMHI)



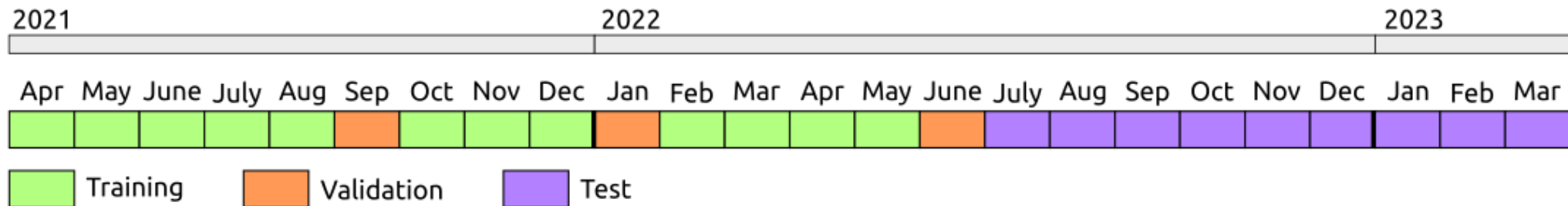
MetCoOp Ensemble Prediction System (MEPS)

- 960×1080 (2.5 km) x 65 vertical
- Non-hydrostatic dynamics
 - HARMONIE-AROME physics
- IFS HRES and IFSENS boundaries
- 66h forecasts run hourly with 5 ensemble members
- Idea: Emulate with fast deep learning model



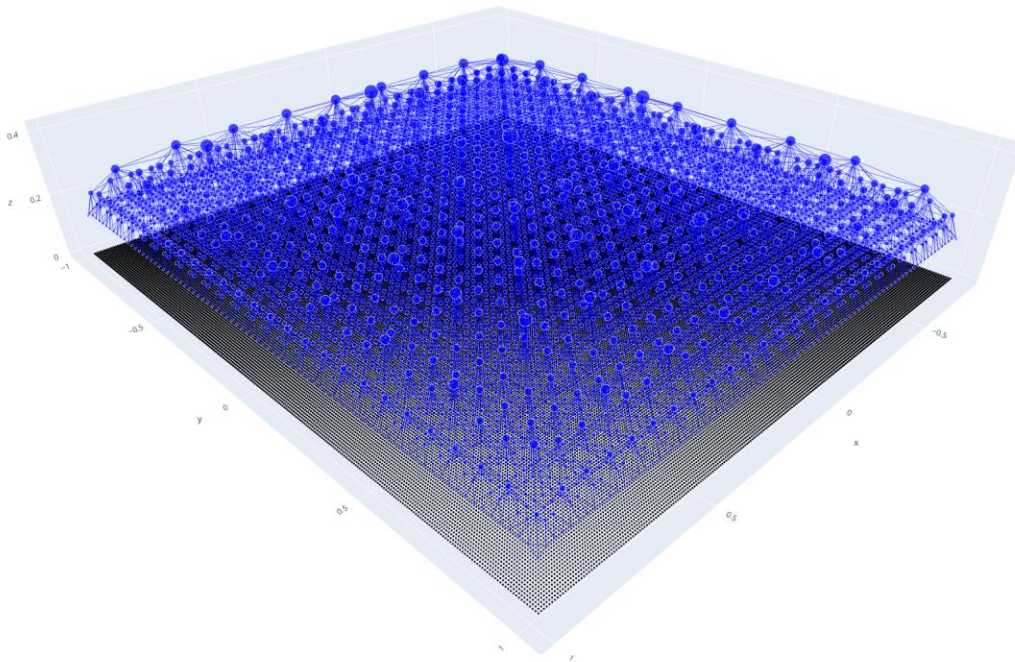
Dataset

- Subset of atmospheric variables used:
 - Pressure (surface, MSL)
 - Geopotential (500, 1000 hPa)
 - Wind (lev 65, 850 hPa)
 - Temperature (2m, lev 65, 500, 850 hPa)
 - Relative humidity (2m, lev 65)
 - Total water vapor column
 - Net short- and longwave 3h radiation
- Spatial down-sampling $\times 4$ (10 km)
- Forcing:
 - TOA radiation, time, land/water mask
 - Forecast as boundary forcing
- 10 forecasts per day from ~ 2 years
- 3h time-steps

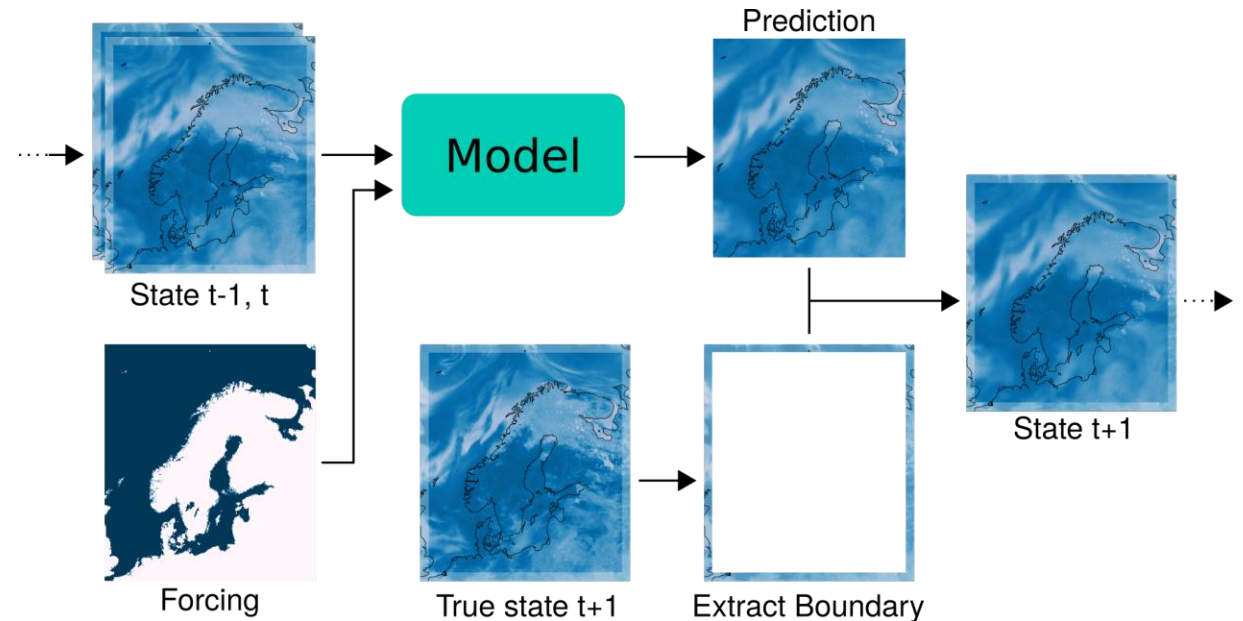


The model

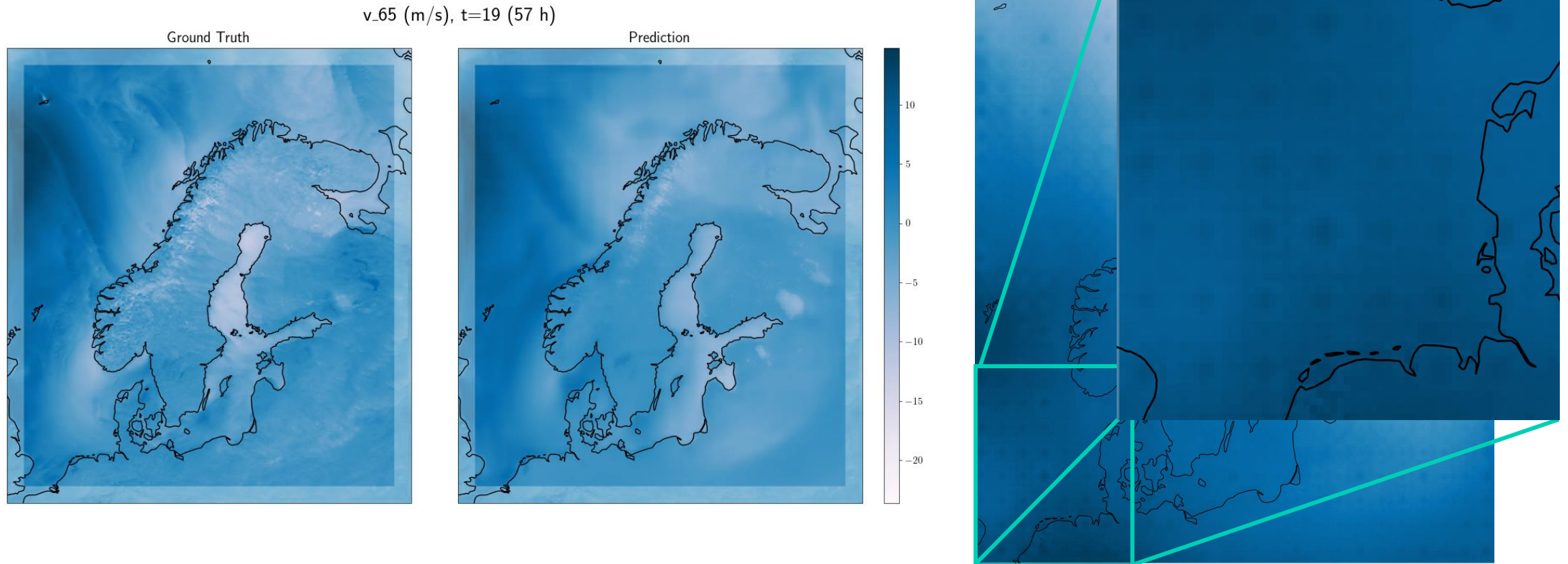
- Graph-based neural weather forecasting¹
- Adapting GraphCast² graph to limited area



- Add on boundary forcing after each time step

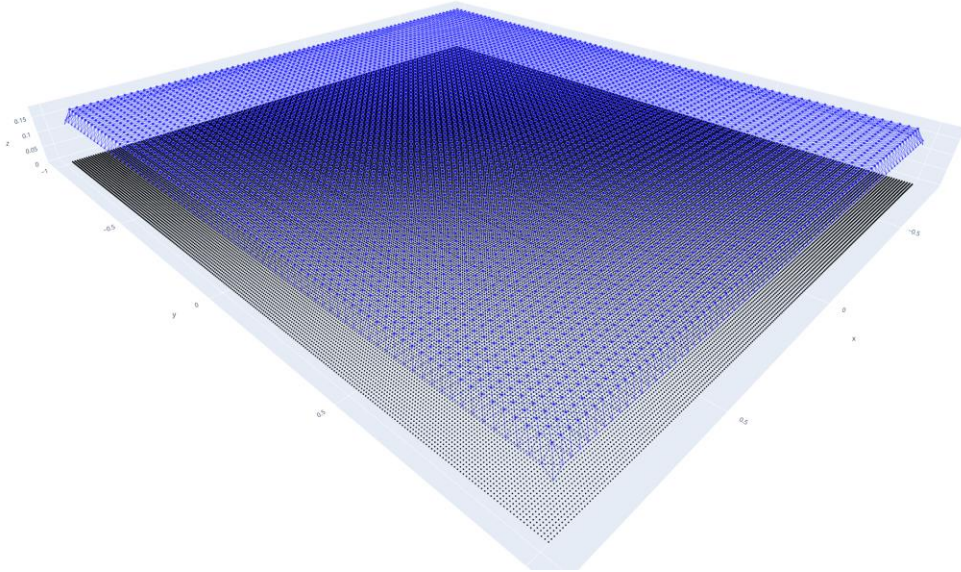


First results and artefact issues



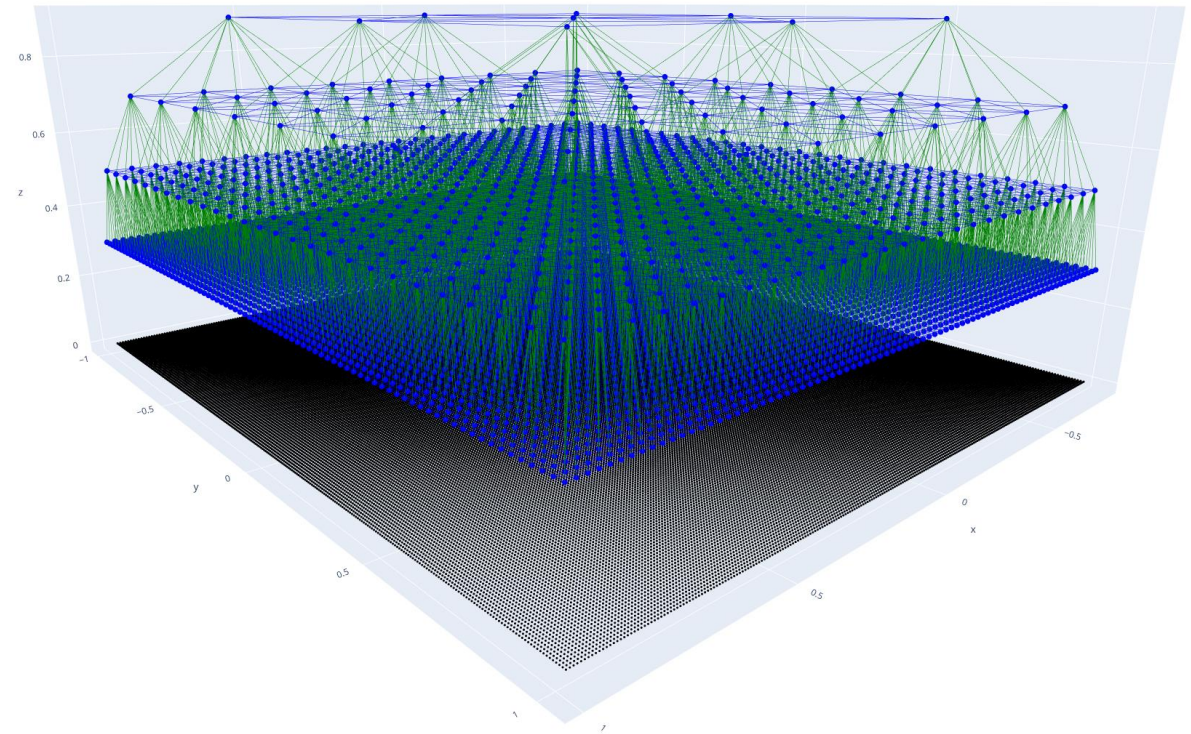
Dealing with the artefacts

- Remove multi-scale edges¹



- Poor predictions :(

- Hierarchical graph

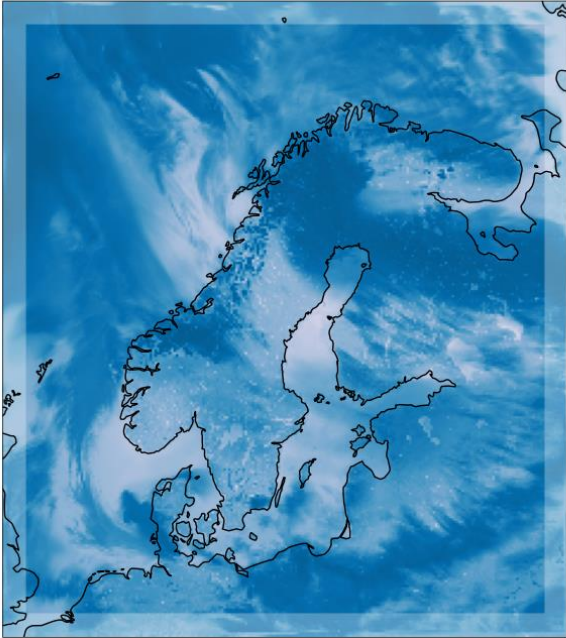


¹ A similar model to: R. Keisler. *Forecasting global weather with graph neural networks*, 2022.

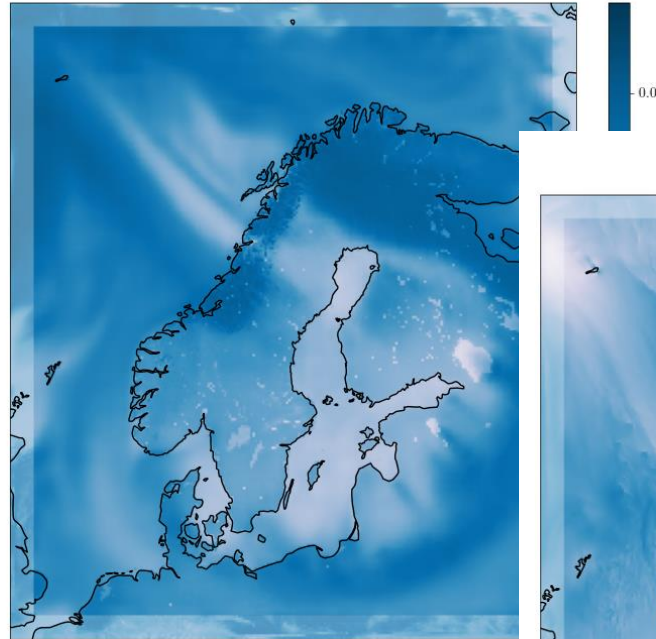
Results: Example prediction

nlwrs_0 (W/m^2), t=19 (57 h)

Ground Truth



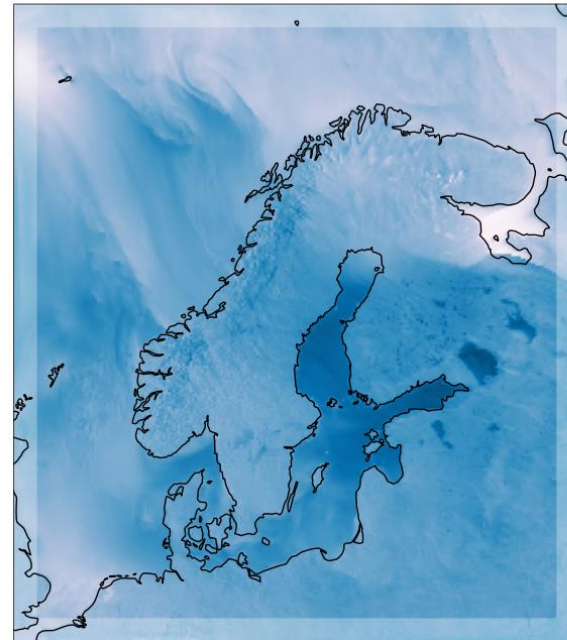
Prediction



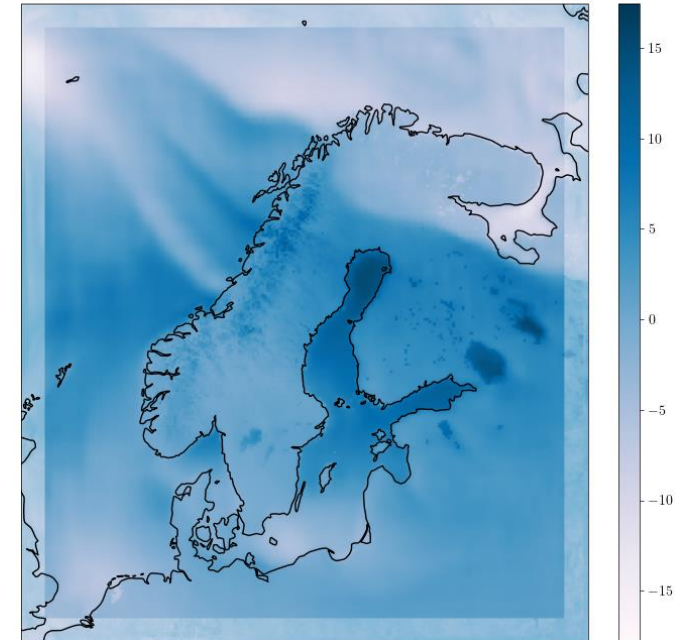
Net longwave radiation

u_65 (m/s), t=19 (57 h)

Ground Truth

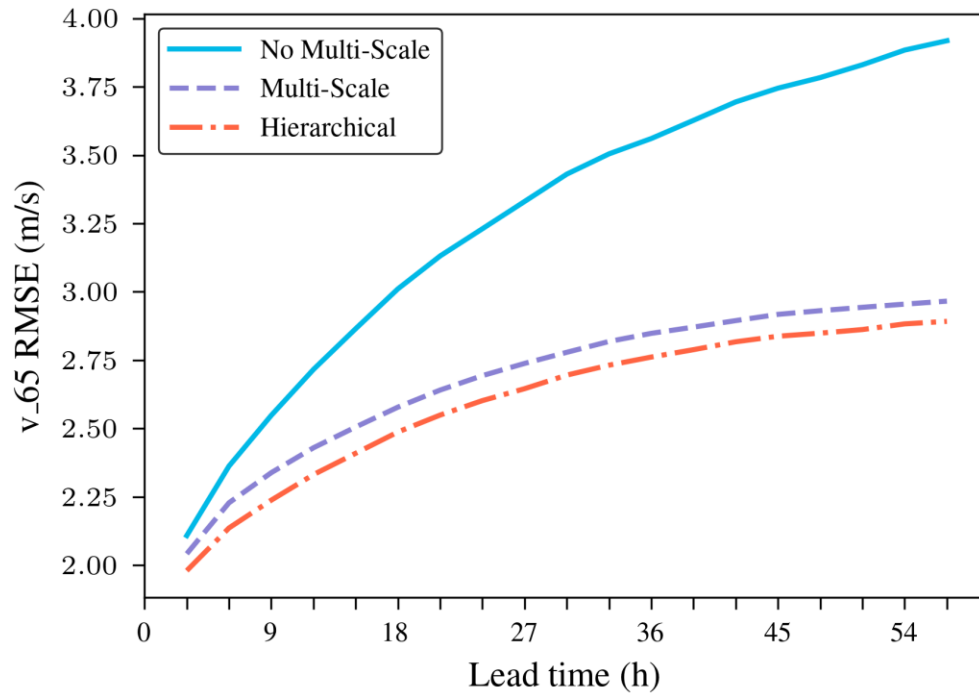


Prediction

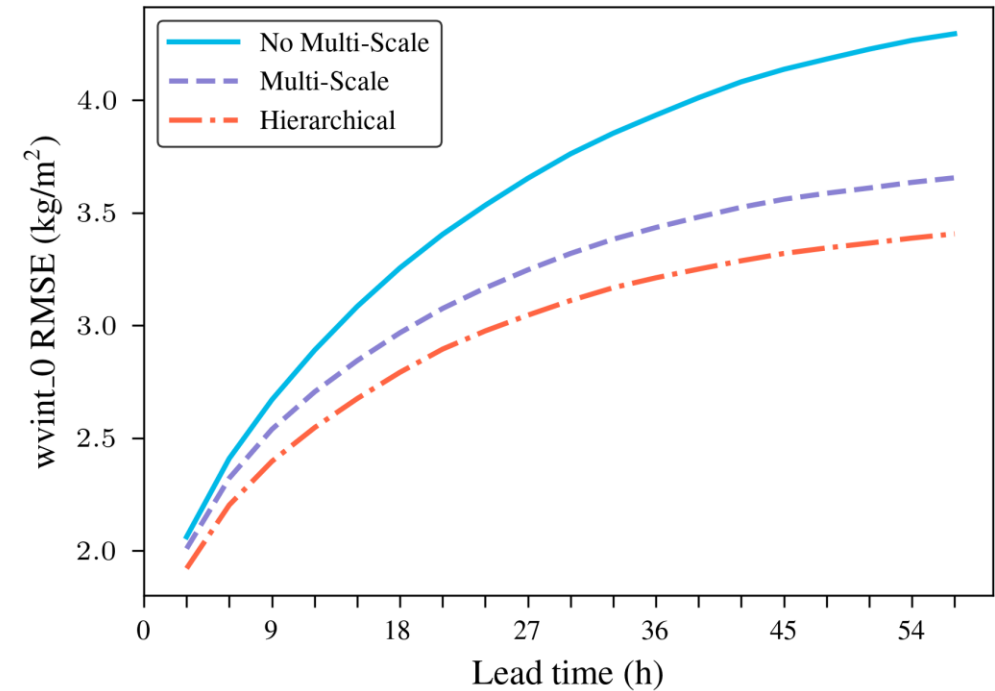


U-component of wind (lowest model level)

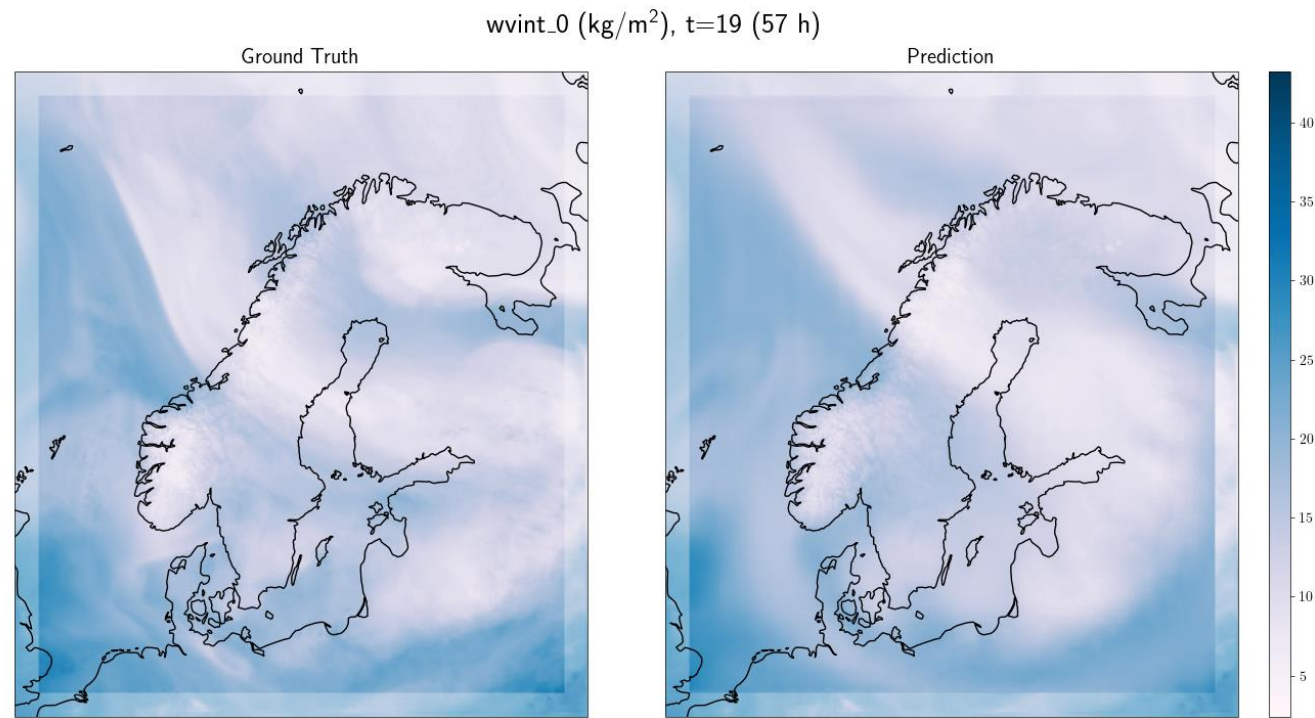
Results: Errors over time



V-component of wind



Total water vapor column



GraphCast for a Limited Area NWP Model

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