

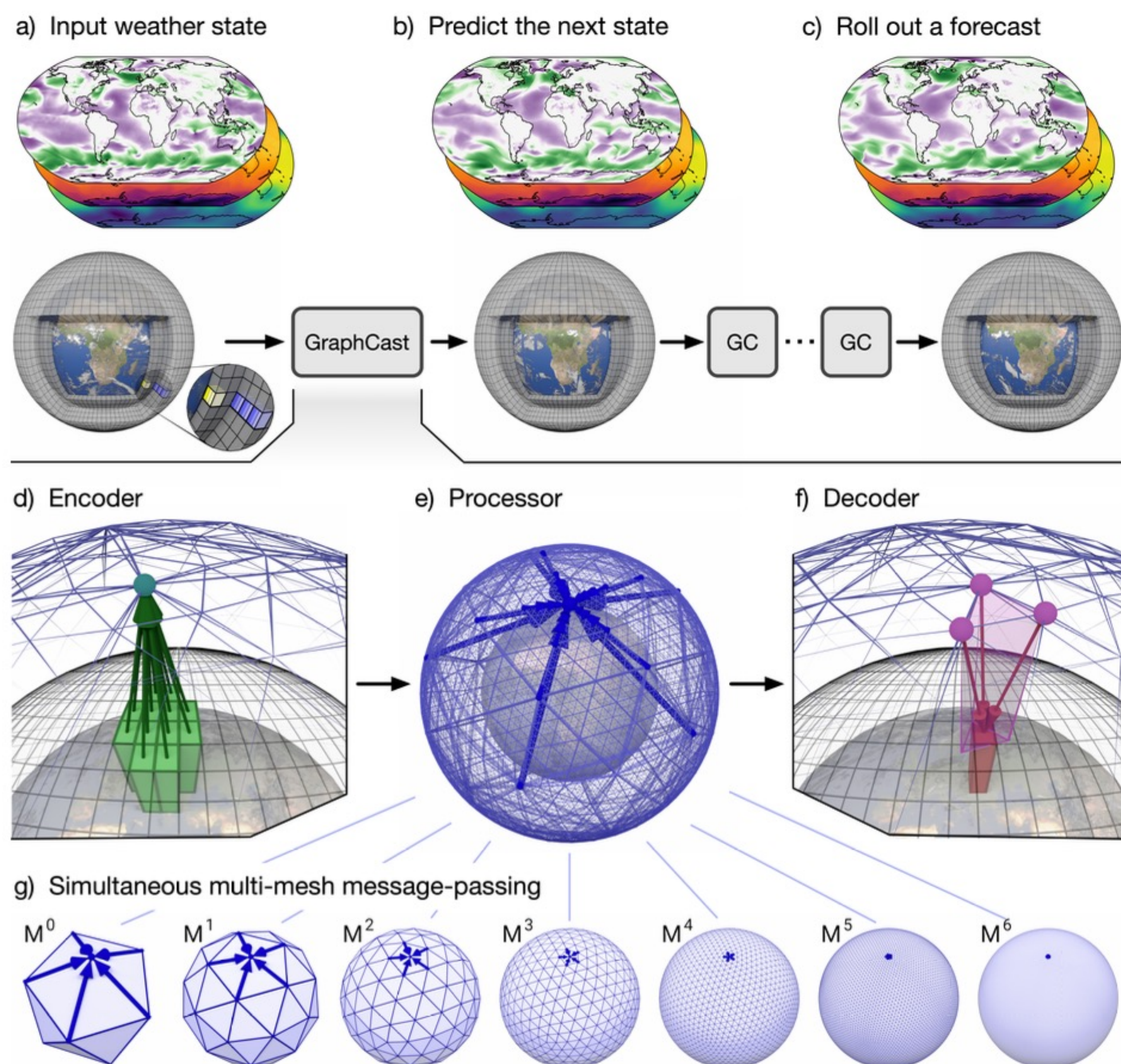


High-Resolution Weather Prediction with GraphCast and Implicit Neural Representations

CSED499I: Research Project I @ ML Lab

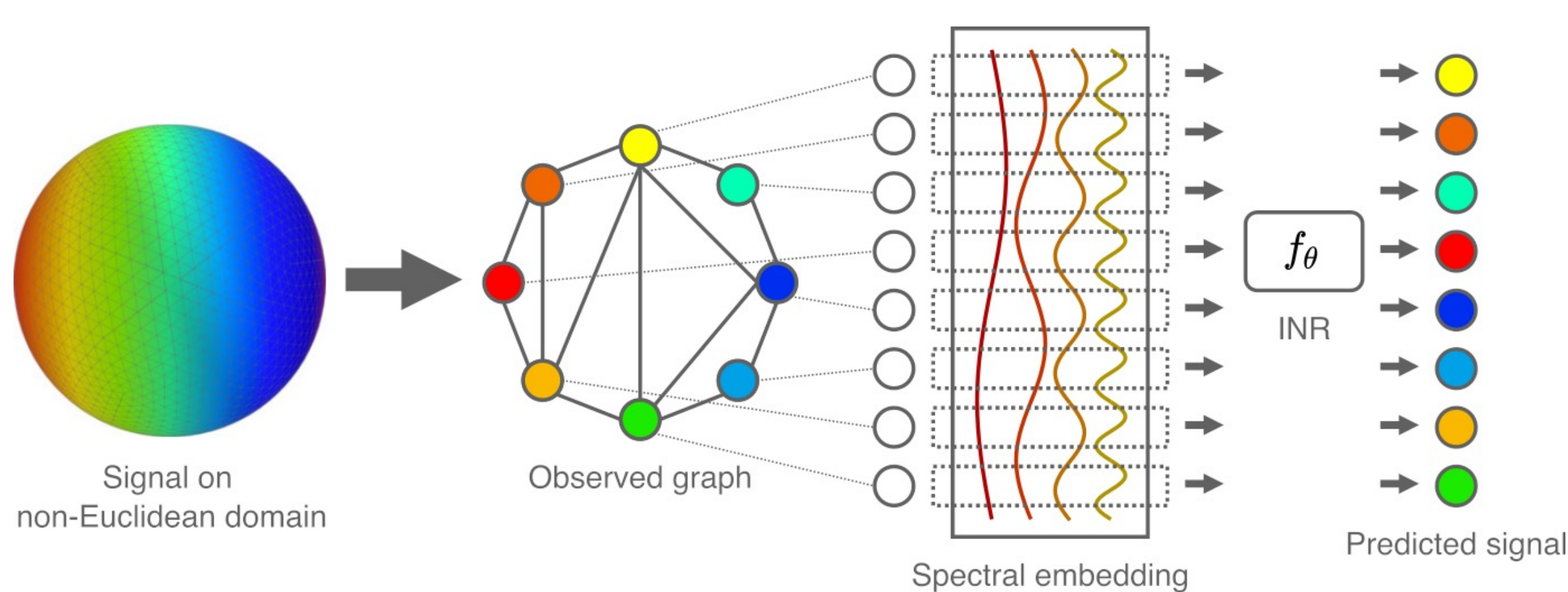
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• Graphcast



- GNN-Based Weather Prediction System
- Multiple Resolutions from meshes M^0 to M^6
- M^6 (40,962 nodes) is the highest resolution available

• Generalised Implicit Neural Representations (GINR)



- Learn implicit neural representations for signals on non-Euclidean domains
- Train a neural network which maps the spectral embedding of the graph to corresponding signal values

• Research Topic

- Enhance high-resolution weather forecasting by training GINR to predict weather conditions on a finer Graphcast mesh, using input from a coarser mesh

• Original Dataset: ERA5

- ECMWF atmospheric reanalysis of the global climate
 - resolution: 0.25°
 - number of time: 3
 - number of pressure levels: 37

• Processed Dataset (using Graphcast)

- Weather prediction by Graphcast on ERA5 dataset
 - Predictions on meshes M^4 , M^5 , M^6
- Converted to GINR input (graph coordinates, spectral embeddings, and signals)

• Training

- Each with 300/1k epochs, 0.001 learning rate, 8 layers

- Model '45e300/45e1k'
Input: Prediction results on M^4 ,
Output: Signals on M^5

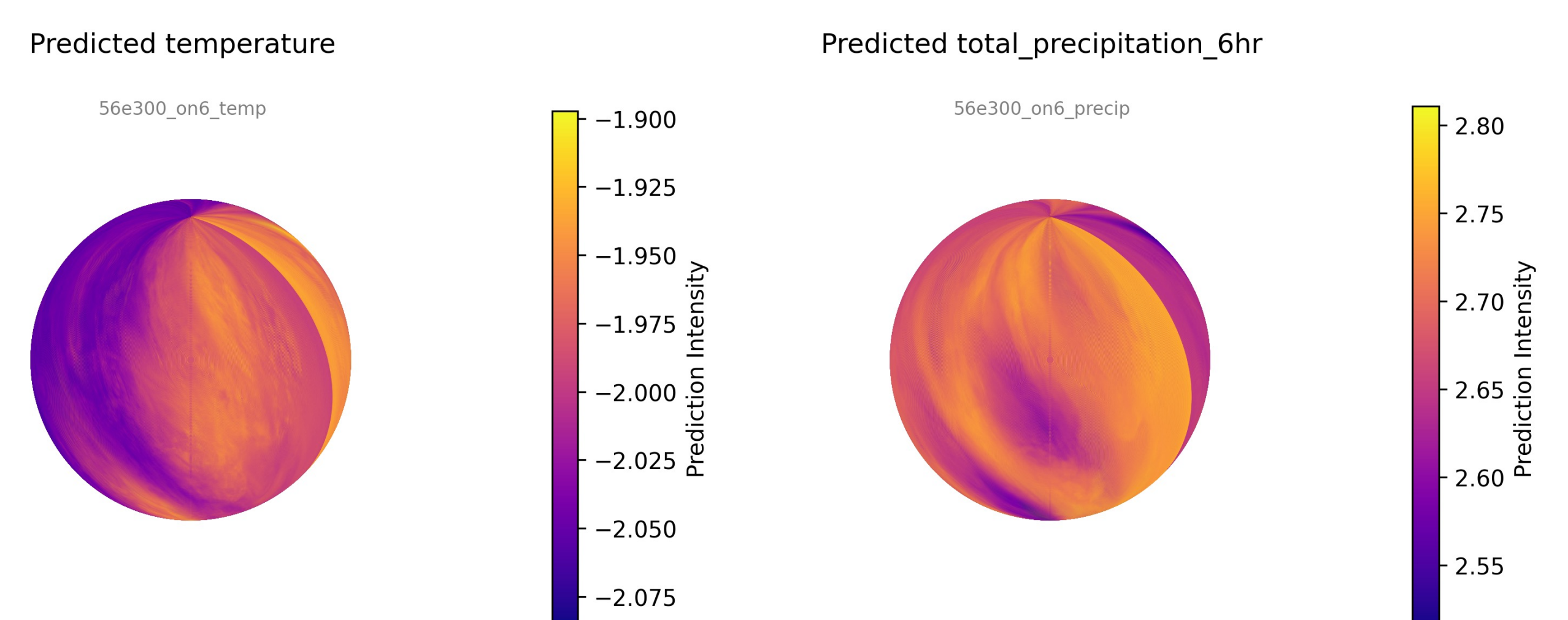
- Model '56e300/56e1k'
Input: Prediction results on M^5 ,
Output: Signals on M^6

- Model '46e300/46e1k'
Input: Prediction results on M^4 ,
Output: Signals on M^6

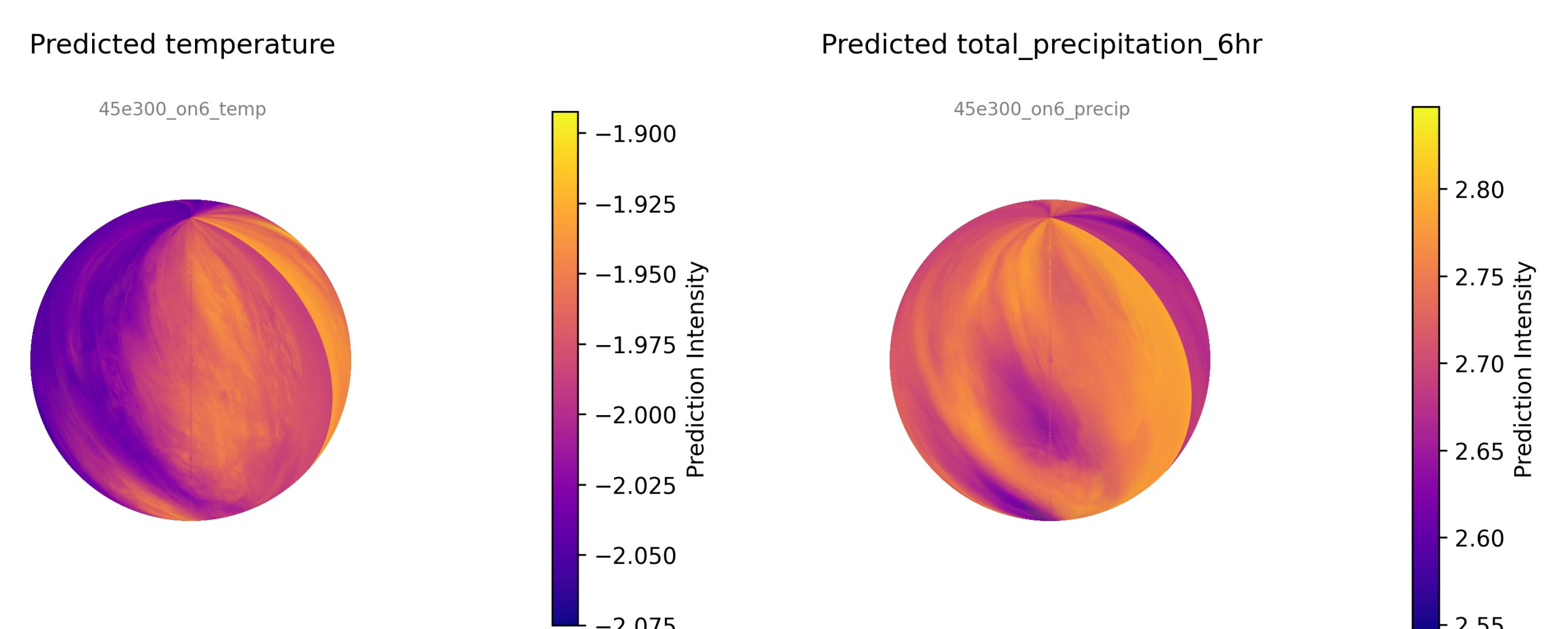
• Results

- Loss has converged to $\sim 1e5$ for all models

- Model '56e300' Train Results (on M^6):



- Model '45e300' Predictions on M^6 :



- MSE of Train Result & Prediction between target
 - epoch = 300

- Train Result MSE = 107370.383

- Prediction MSE = 107358.695

- epoch = 1k

- Train Result MSE = 111771.875

- Prediction MSE = 111715.977

→ Prediction is as accurate as the trained result

• References

- Remi Lam *et al.*, Learning skillful medium-range global weather forecasting. *Science* 382, 1416-1421 (2023). DOI: 10.1126/science.adi2336
- Daniele Grattarola, Pierre Vanderghenst, Generalised Implicit Neural Representations. *NeurIPS 2022*. arXiv:2205.15674

• Code, Details

- github.com/jiwooh/CSED499I