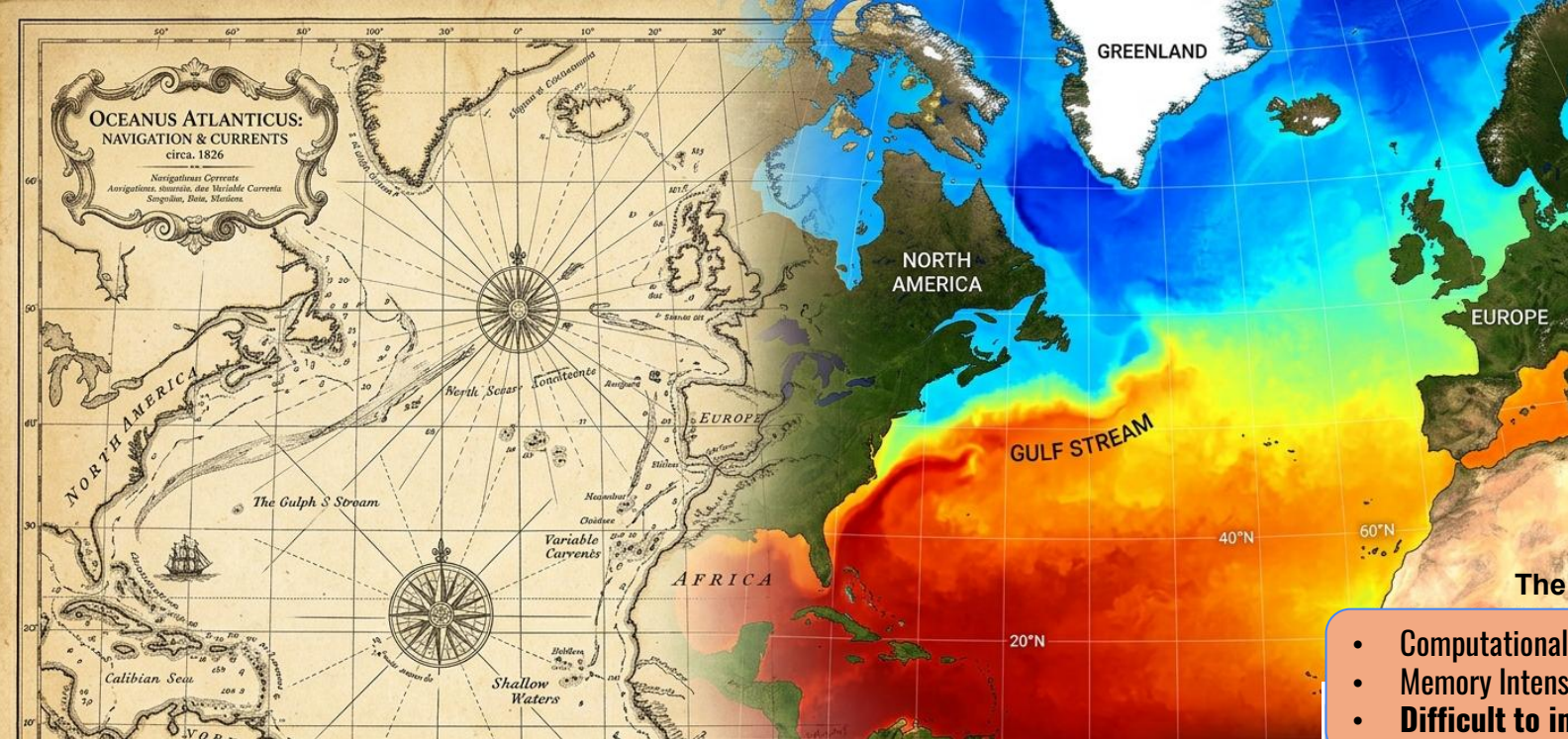


AI transformation

Anass El Aouni (MOI) & Rachel Furner (ECMWF)

OPST12, Montréal, 15-17 April 2026

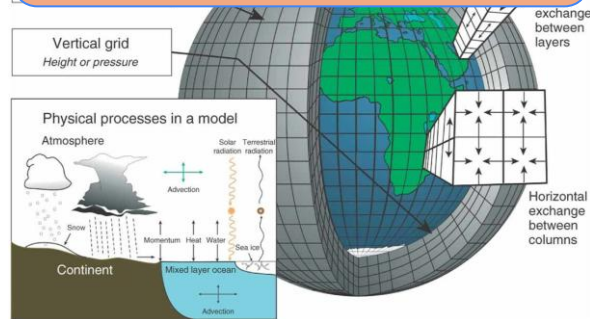


The Problem (2026 Reality)

- Computationally expensive
- Memory Intensive
- Difficult to improve given more data

For as long as we've sailed, we've tried to predict the ocean. In the last 50 years, we moved from intuition to doing physics.

The "Physics" Era: We translated the laws of nature (Navier-Stokes) into millions of lines of code.



AI Revolution

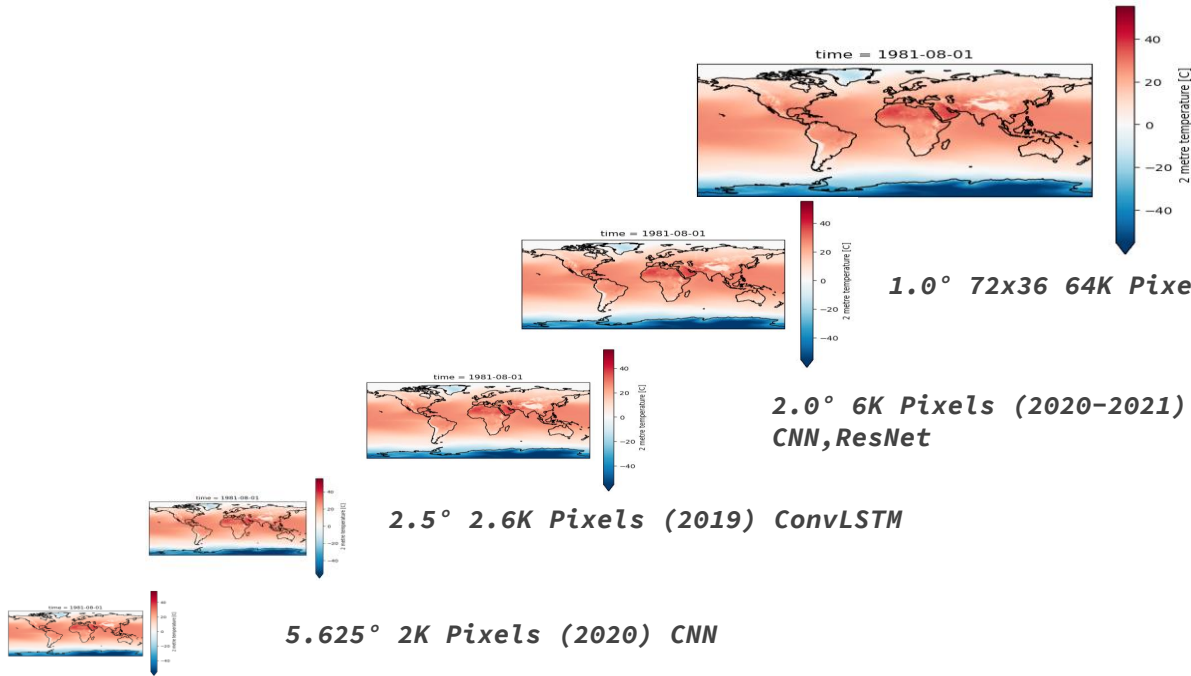
0.25° ~1M Pixels (2022-2026) FNO, Transformer, GNN, Diffusion

1.0° 72x36 64K Pixels (2022) GNN

2.0° 6K Pixels (2020-2021) CNN, ResNet

2.5° 2.6K Pixels (2019) ConvLSTM

5.625° 2K Pixels (2020) CNN

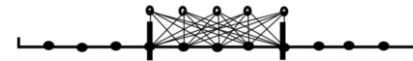


We often treat AI as a "Black Box" alien, but it shares the same mathematical DNA as our classic schemes.

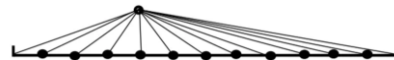
Finite Difference



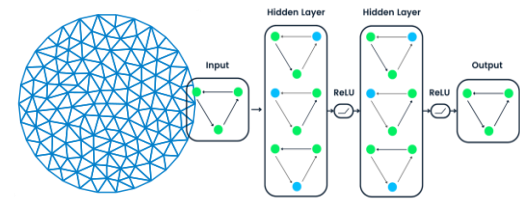
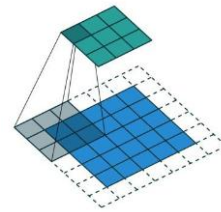
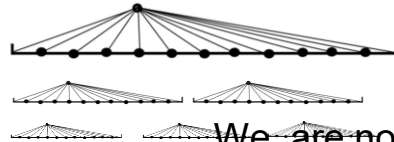
Finite Element



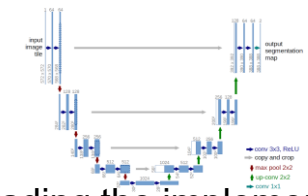
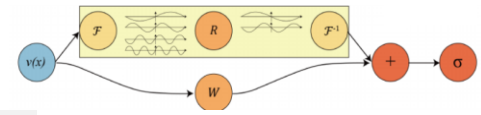
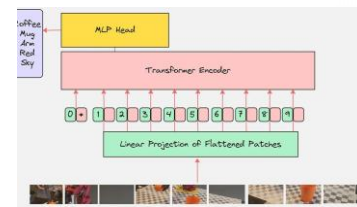
Spectral Methods



Multi-Grid
Methods

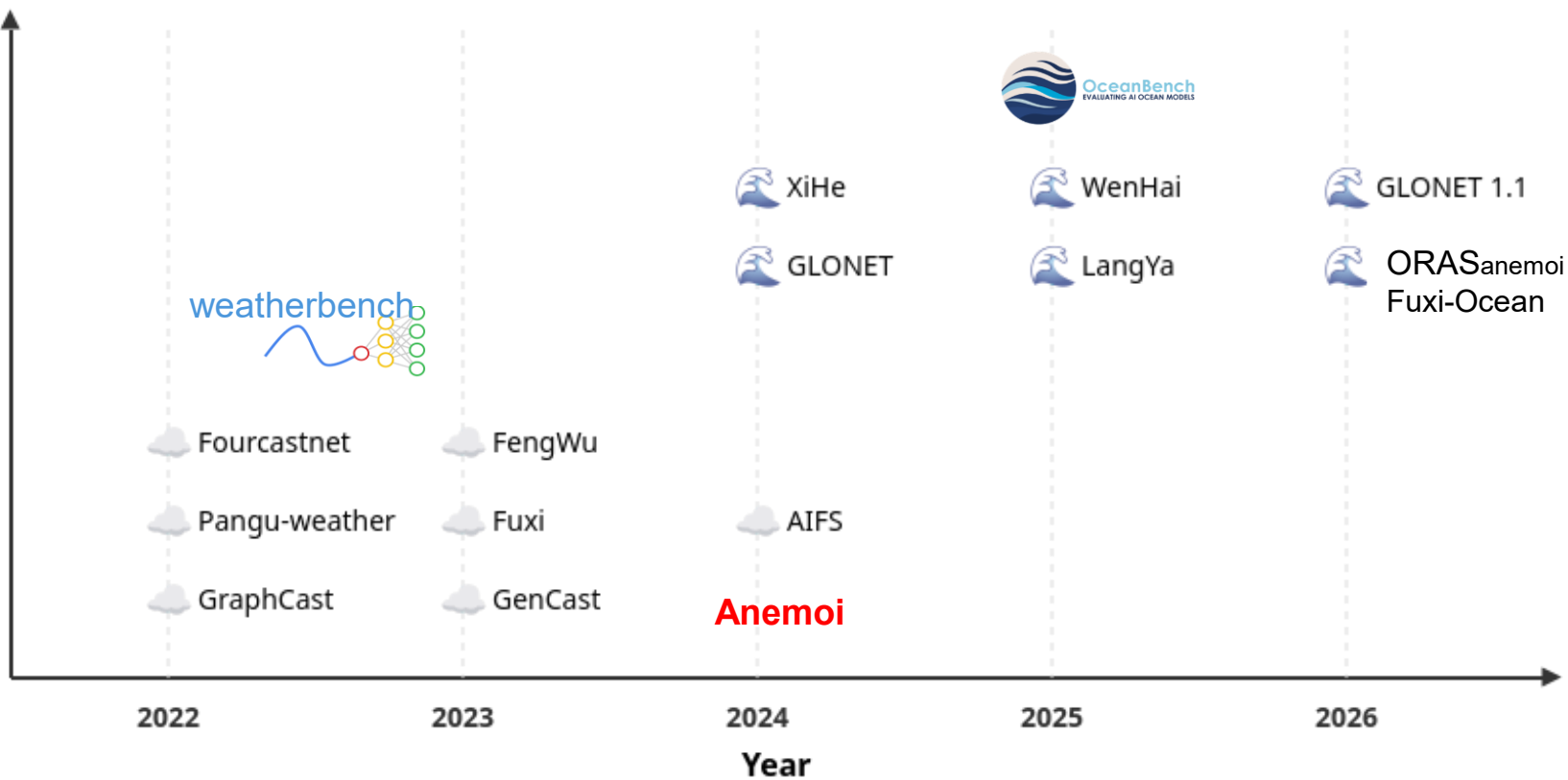


Attention



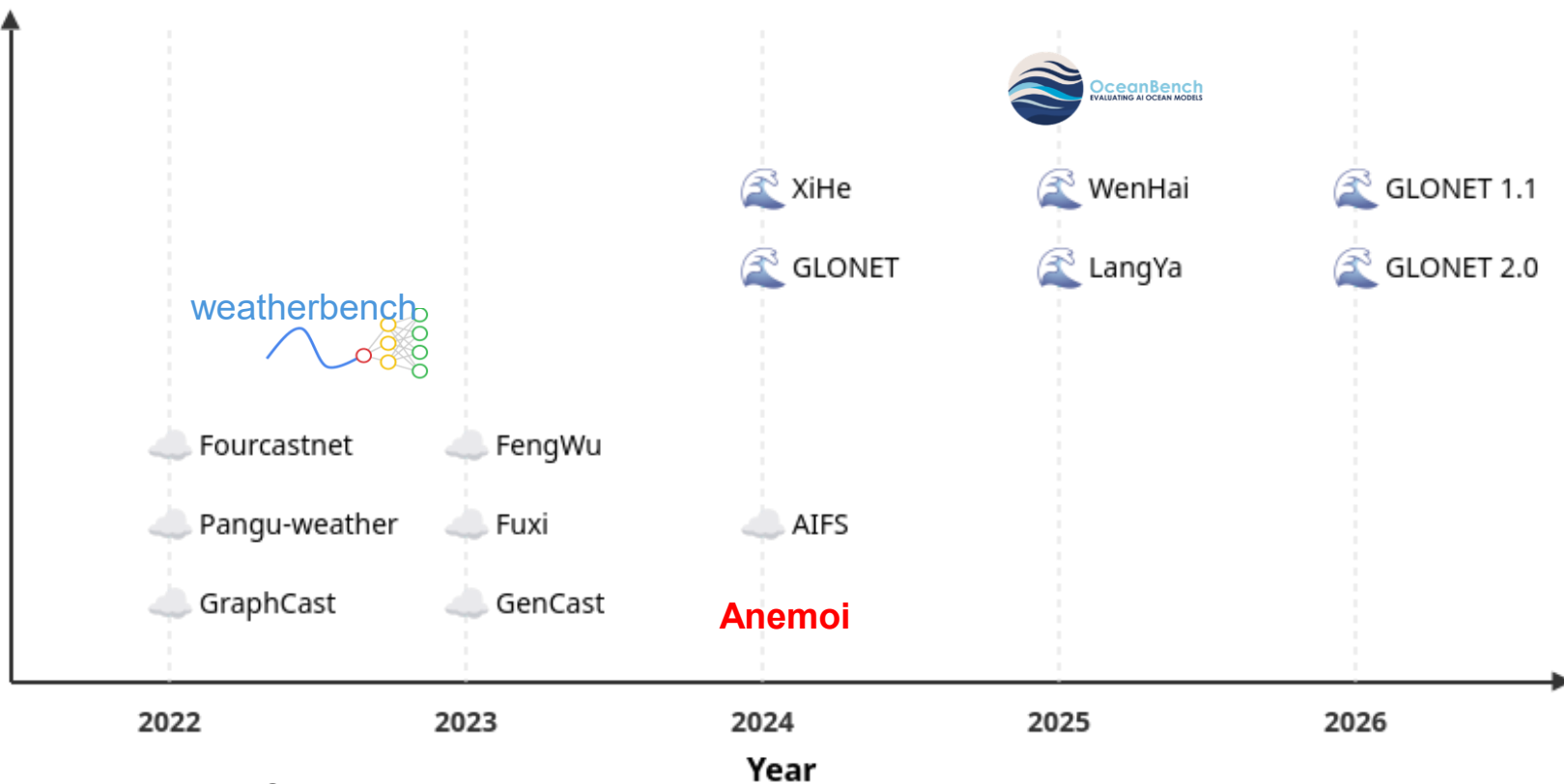
We are not abandoning, we're just upgrading the implementation.

Complexity



The Atmospheric echo (2020-2024)

Complexity



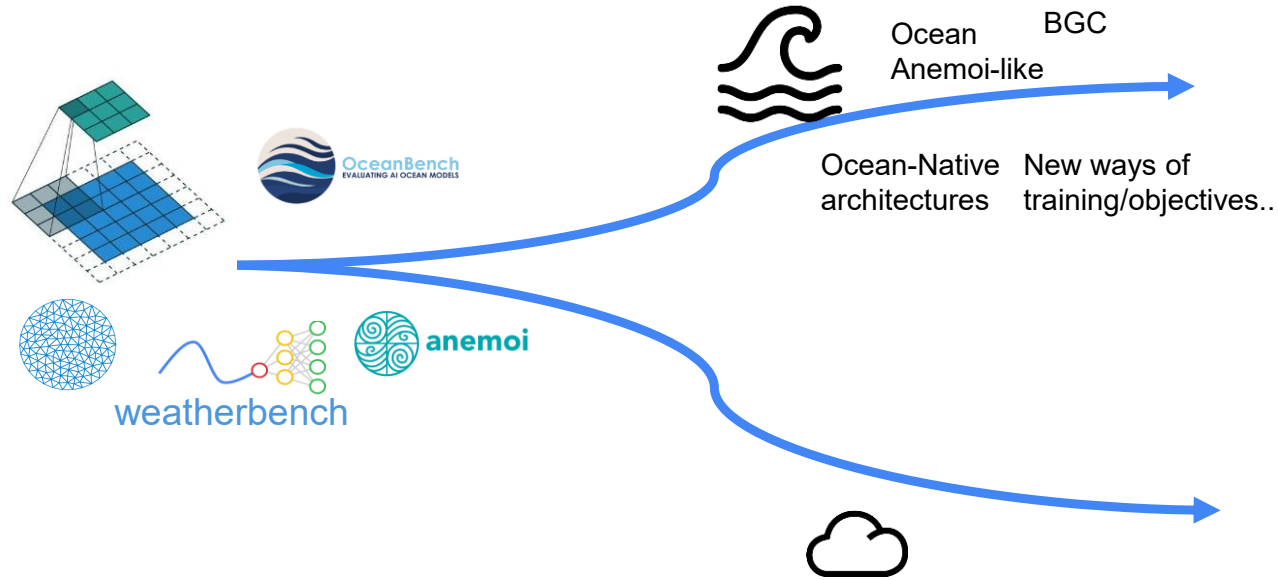
Unique Challenges

- Coastlines break standard AI kernels
- Sparse observations
- 3D structure more critical
- Different dominant physics (mixing, stratification)
- ...



Mirroring/adapting

Leading



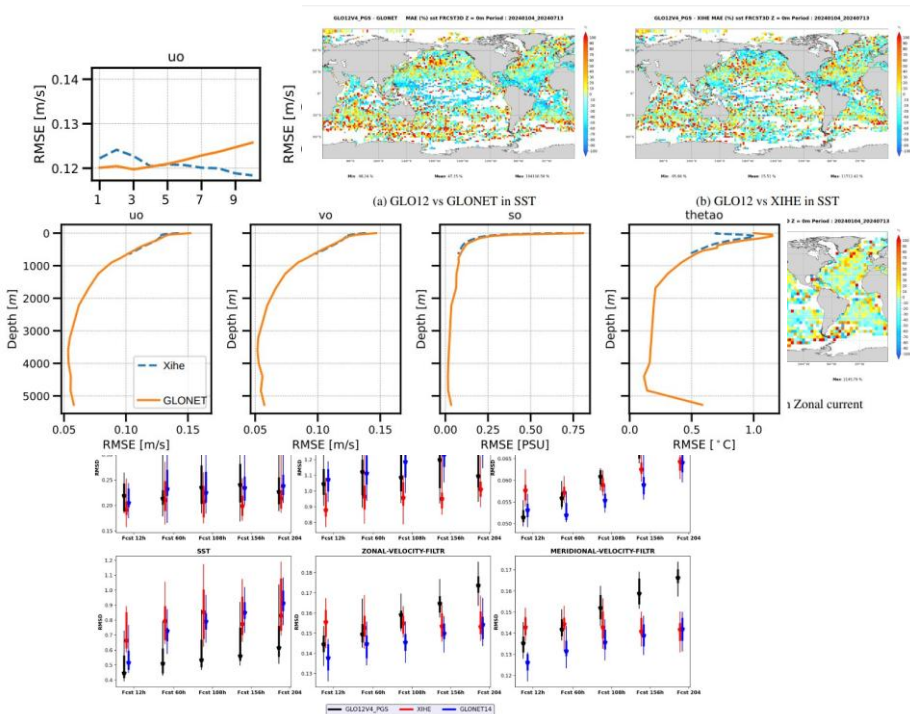
Unique Challenges

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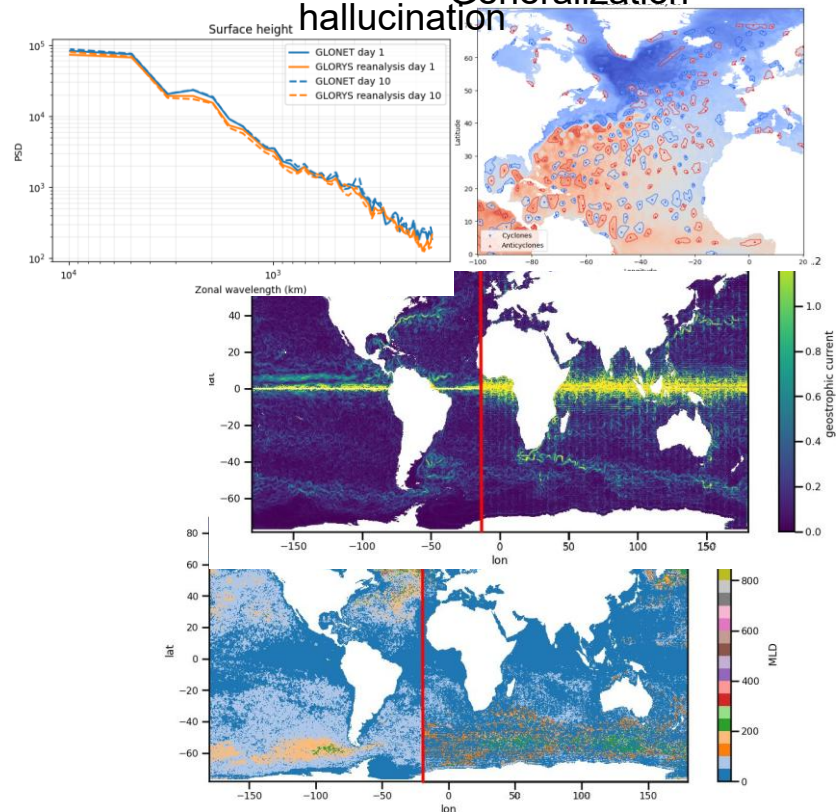


Evaluation in AI era

Point-wise, aka class-IV



Physical Consistency
Feature-based Generalization
hallucination



Operations: Compute vs. Storage

- Infrastructure: hpc, cloud..
- Storage, trade off between time and space?
- from netcdf to cloud native to lossy compression?

arXiv > cs > arXiv:2405.03376

Search

Computer Science > Machine Learning

[Submitted on 6 May 2024 (v1), last revised 8 May 2024 (this version, v2)]

CRA5: Extreme Compression of ERA5 for Portable Global Climate and Weather Research via an Efficient Variational Transformer

Tao Han, Zhenghao Chen, Song Guo, Wanghan Xu, Lei Bai

Recap



Mirroring/adapting

Leading

