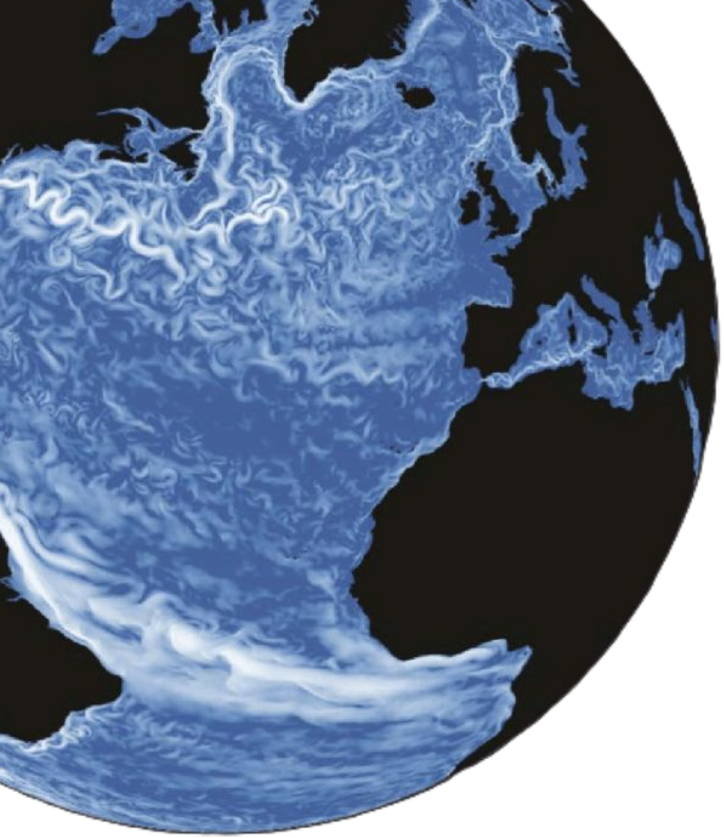
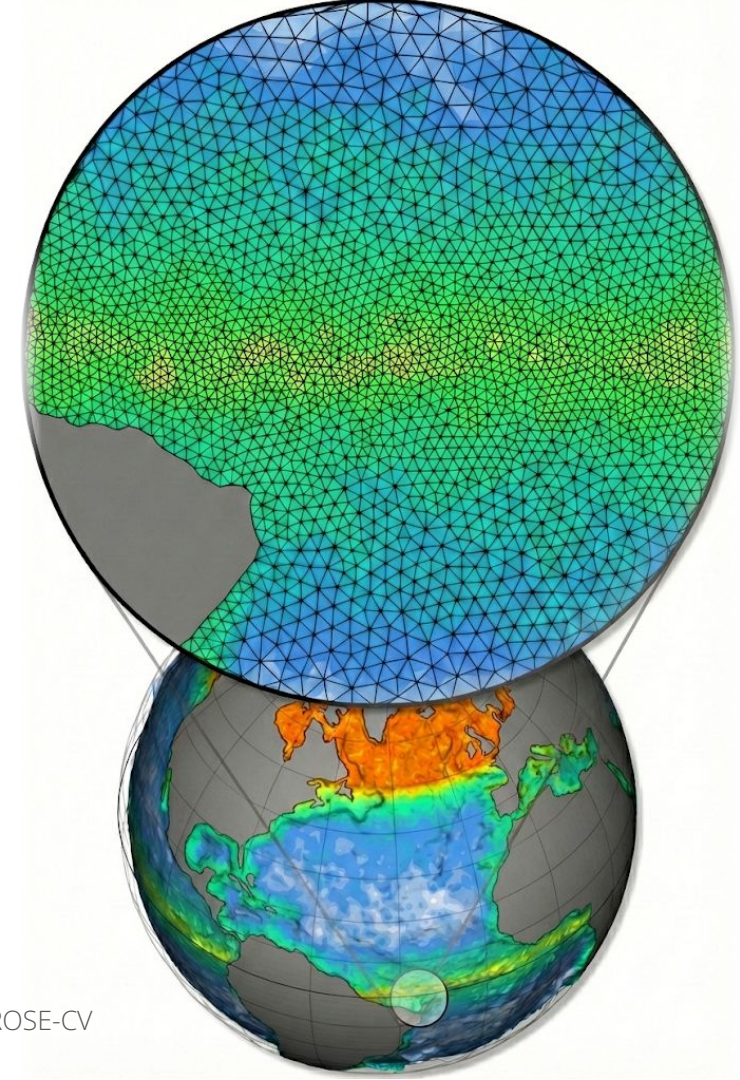


Regional Ocean Surface Emulator - Cape Verde (ROSE-CV)

Ocean Surface Emulator Team

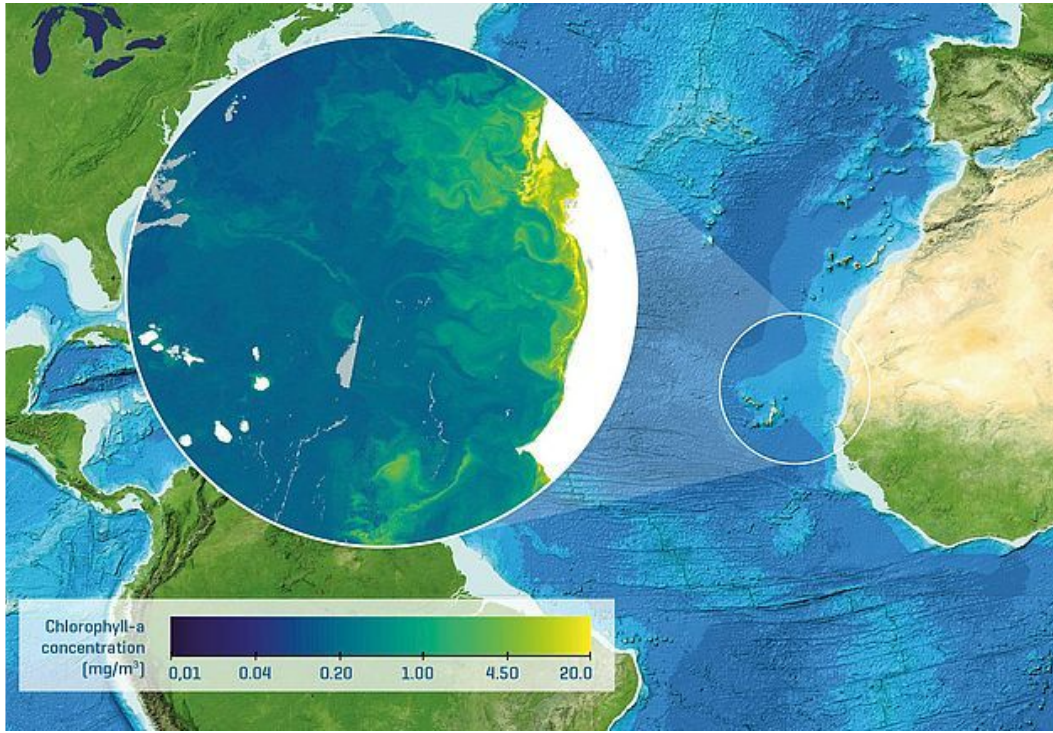
Motivation

- **The Bottleneck:** High-resolution ocean simulations are computationally very expensive. Machine Learning provides a **powerful, low-cost alternative**.
- **Feasibility:** Studies (Dheeshjith et al. 2025, El Aouni et al. 2025) confirm the feasibility of global low-to-medium resolution ocean emulators.
- **Our Goal:** Develop a regional ocean surface emulator for low-cost, rapid experimentation of local ocean dynamics.



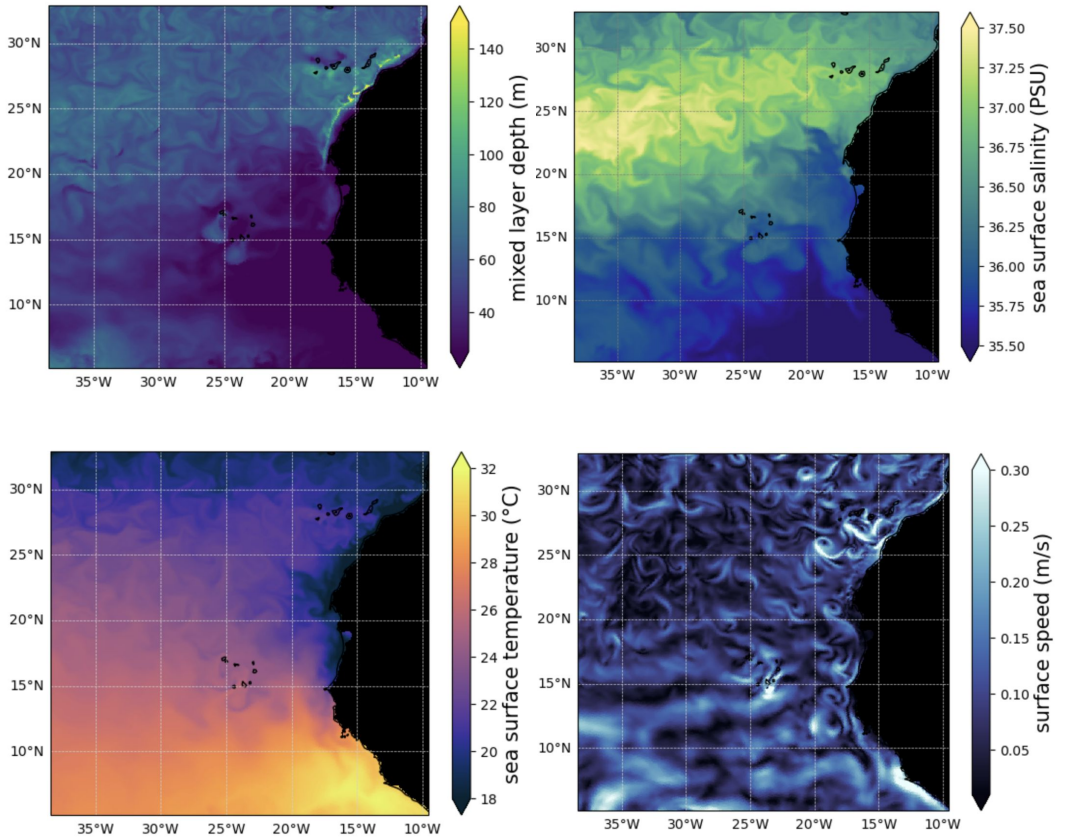
The Region

- **Target Region:** We focus on the **West African Upwelling System** (off the coast of Mauritania), a key part of the Canary Current.
- **Physical Motivation:** Driven by strong alongshore trade winds, this upwelling region is **highly dynamic**, featuring complex eddies and very high biological productivity.
- **Project Relevance:** This work could directly support **FUTURO**, an upcoming year-long GEOMAR field campaign, by testing modeling tools needed for the mission.



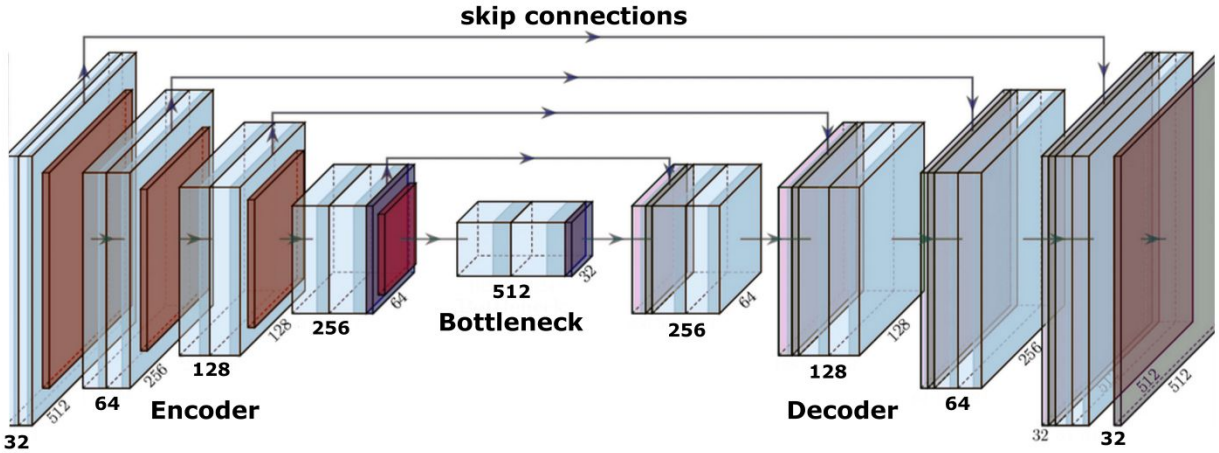
The Dataset

- **Numerical Model:** FESOM2 (using the NG5 mesh) coupled to IFS
- **Data Format:** netCDF
- **Temporal Resolution:** daily averages
- **Horizontal Resolution:** original mesh: unstructured 5km - 13km, regridded to ~7km
- **Input/Output Variables:** Potential Temperature, Salinity, Sea Surface Height, Sea Surface Velocity (zonal and meridional) and Mixed Layer Depth
- **Train Period:** 2020-2022
- **Test Period:** 2024
- **Validation:** 2023
- **Normalization:** z-Score



Model architecture

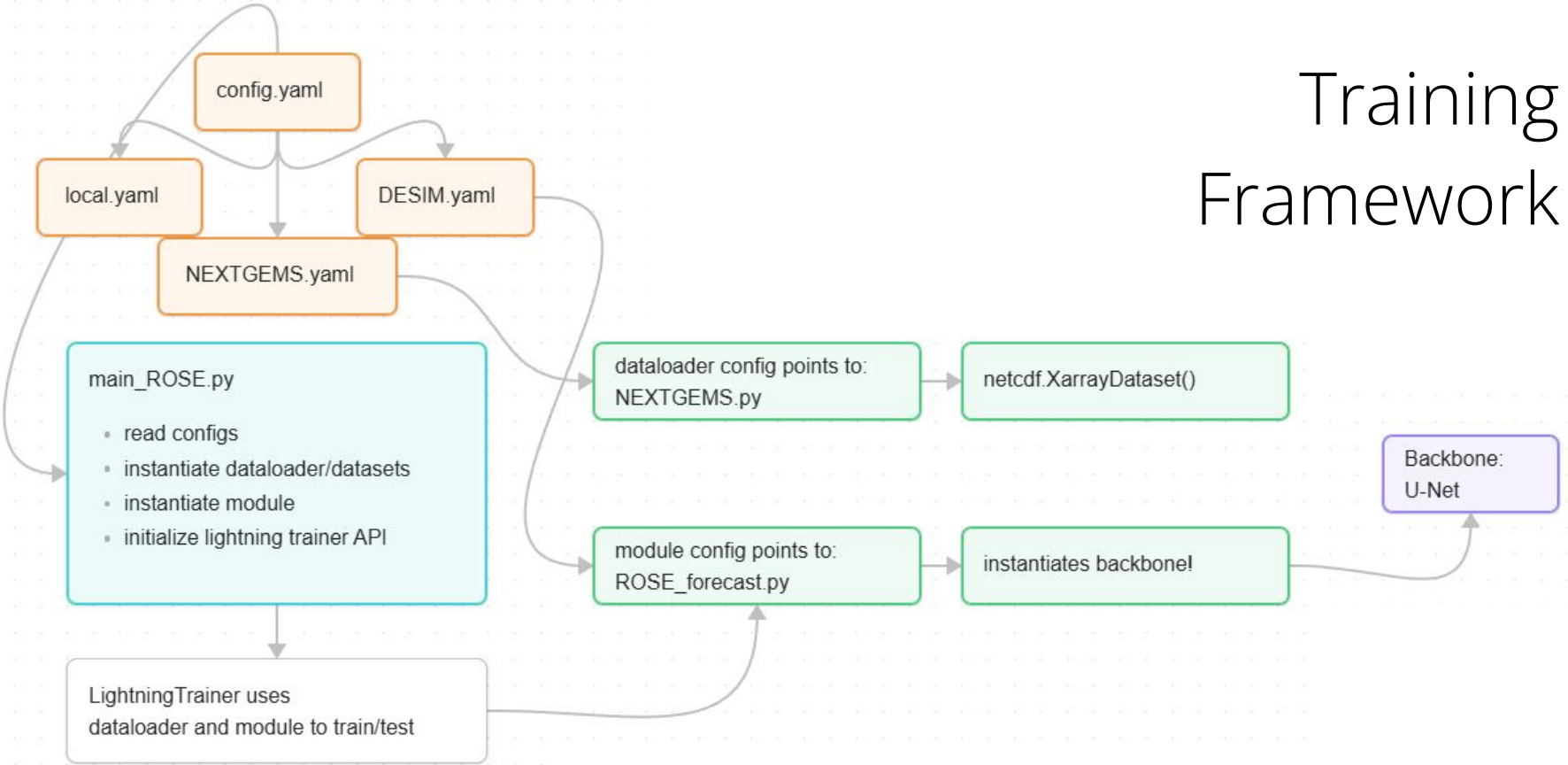
4-layer modular U-Net with partial convolutional blocks and **SwinTransformer bottleneck**



Input: 2D, 512 x 512 regular grid

Loss: only data-driven **MSE & RMSE** for now (no physics terms yet)

Training Framework



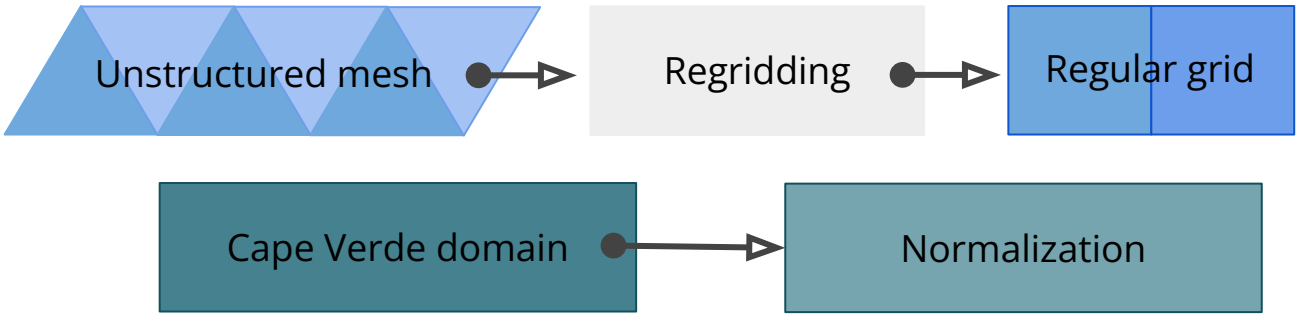
Model features…

PyTorch Lightning wrapping the DESIM U-Net backbone

Input: multi-channel **ocean surface fields** (Θ, S, SSH, u, v, MLD)

Output: **next-step ocean surface state**

…and pre-processing



Challenges & (tons of) problems

- complex model and infrastructure,
- different level of experience,
- computational demands of such a project
- Time
- Data problems

Summary & discussion

What We Did: Built an AI tool that predicts ocean behavior in coastal West African waters using data from 2020-2024.

The Model: A U-Net architecture with SwinTransformer components trained on ocean temperature, salinity, currents, and other variables.

The Region: Dynamic upwelling zone off West Africa with complex eddies and rich marine life.

The Challenges: Complex infrastructure, high computational demands, data issues, and varying team expertise levels.

References

Dheeshjith, Surya et al. (2025). “Samudra: An ai global ocean emulator for climate”. In:Geophysical Research Letters 52.10, e2024GL114318.

El Aouni, Anass et al. (2025). “GLONET: Mercator’s end-to-end neural Global Ocean forecasting system”. In: Journal of Geophysical Research: Machine Learning and Computation 2.3, e2025JH000686.