

Project Title

Forecasting of Oceanographic Conditions for Ensuring Environmental Safety in the Coastal Areas of the Black Sea and the Sea of Azov

Project Data

Duration	Funding	Project location/ Region
12 months	Ukraine Funding Initiative	Odesa, Ukraine

Project Partners

Who are the project partners?

- Odesa I.I. Mechnikov National University

What does each partner specifically contribute to the project?

- Project implementation

About the Project

What is the problem – and what do you want to change about it?

What are you doing specifically to achieve this goal?

The project aim is to create a computer model of the Black Sea (and the Azov Sea) that can predict things such as:

- sea currents and water levels;
- sea water temperature;
- sea water salinity;
- wind waves and their direction;
- water stratification and upwelling;
- potentially, the movement of pollutants.

Ukraine previously had an Experimental Centre of Marine Forecasting for the Black Sea. However, in 2014, this capability was lost, leaving Ukraine dependent on marine forecasts produced in other countries. These forecasts have not always been sufficiently accurate or detailed with regard to the north-western part of the Black Sea and the Sea of Azov.

This problem became particularly obvious after the destruction of the Kakhovka Hydroelectric Power Station dam in summer of 2023. Polluted waters entered the Black Sea via the estuaries of the Dnieper and Bug rivers, while the ongoing war made extensive direct measurements at sea extremely difficult. Consequently, numerical modelling became especially important for assessing the state of the marine environment.

What is special or new about your approach?

Here are the key features of this approach:

1. It is a coupled modelling approach. The system combines the following models:

- Delft3D Flow Flexible Mesh – for currents, water levels, sea water temperature and salinity, thermohaline stratification etc.;
- SWAN – for wind waves.

The system is supposed to reproduce the interaction of hydrodynamic and wave processes in one forecasting framework. That's important for coastal forecasting, as waves, currents and water levels are interrelated phenomena that depend on one another.

2. The model is specifically adapted to the Ukrainian part of the Black Sea.

A major feature is the nested and variable spatial resolution of the model. The coarse Azov–Black Sea model uses a computational grid with cell sizes ranging from about 85 m near the coast to 5 km offshore, while a separate, much more detailed grid is constructed for the northwestern Black Sea. This serves a specific purpose: to ensure a high level of detail where it matters most and maintain a lower resolution where excessive detail is not required.

For a system intended to support ports of Odesa, Chornomorsk and Pivdennyi, local refinement is far more important than simply running a very large uniform-resolution model.

3. The system uses a two-stage modelling strategy.

First, the entire Azov–Black Sea basin is modelled. Then the results from that large model are used as boundary conditions for a much higher-resolution model of the northwestern Black Sea.

That makes it possible to capture the influence of the overall Black Sea conditions without having to run the entire basin at extremely high resolution, which demands higher computational resources.

4. The forecast system combines ocean modelling with real meteorological forcing.

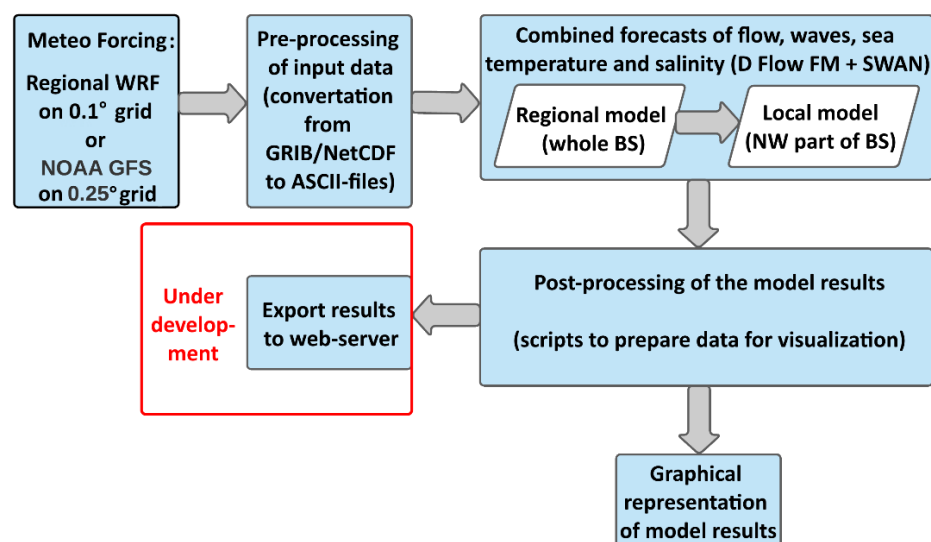
The modelling system receives atmospheric forcing from global weather forecast models (such as GFS and ERA5) or regional high-resolution WRF model, including wind, atmospheric pressure, air temperature, humidity, cloud cover, rainfall and evaporation. This creates a workflow similar to the actual forecasting chain: weather forecast – sea waves and currents – sea water temperature and salinity – coastal environmental conditions.

5. The system was tested against the actual natural phenomenon. The coastal upwelling event in summer 2024 was chosen as a verification case. The modelled temperature, salinity and sea water level were compared against observation data from coastal stations near ports of Chornomorsk, Odesa and Pivdennyi. That's important part of the project because upwelling is a physically meaningful stress test: it involves changes in wind, circulation, stratification and temperature.

6. The model complex is designed to be an operational system, not just a research simulation. The resulting product is intended to be something that can repeatedly assimilate new weather/ocean information and generate forecasts.

The figure: What does the project actually do?

This figure represents the workflow of the developed forecasting system:



What remains?

What concrete results are achieved, and who can use them in the future?

The project has moved beyond the conceptual stage: the core physical forecasting system has been built, configured and tested.

The project has produced a working physical ocean forecasting framework, rather than just a theoretical model.

The important achievement is that now we can run a coupled model that takes meteorological/oceanographic information and produces predictions of the physical state of the sea, with particular attention to the Ukrainian northwestern Black Sea.

A main concrete result already achieved is a validated physical oceanographic modelling complex for the Azov–Black Sea region. The next stage is to transform that into a complete operational marine environmental forecasting system.

The eventual goal of the project is an operational forecasting system that could help ports, environmental authorities, maritime infrastructure, and other users understand what is happening in the sea and what is likely to happen over the next several (up to 10) days.

See the project images
on the following pages



Project images

Image 1 of 2



Photo: © Dmytro Kushnir

Project images

Image 2 of 2

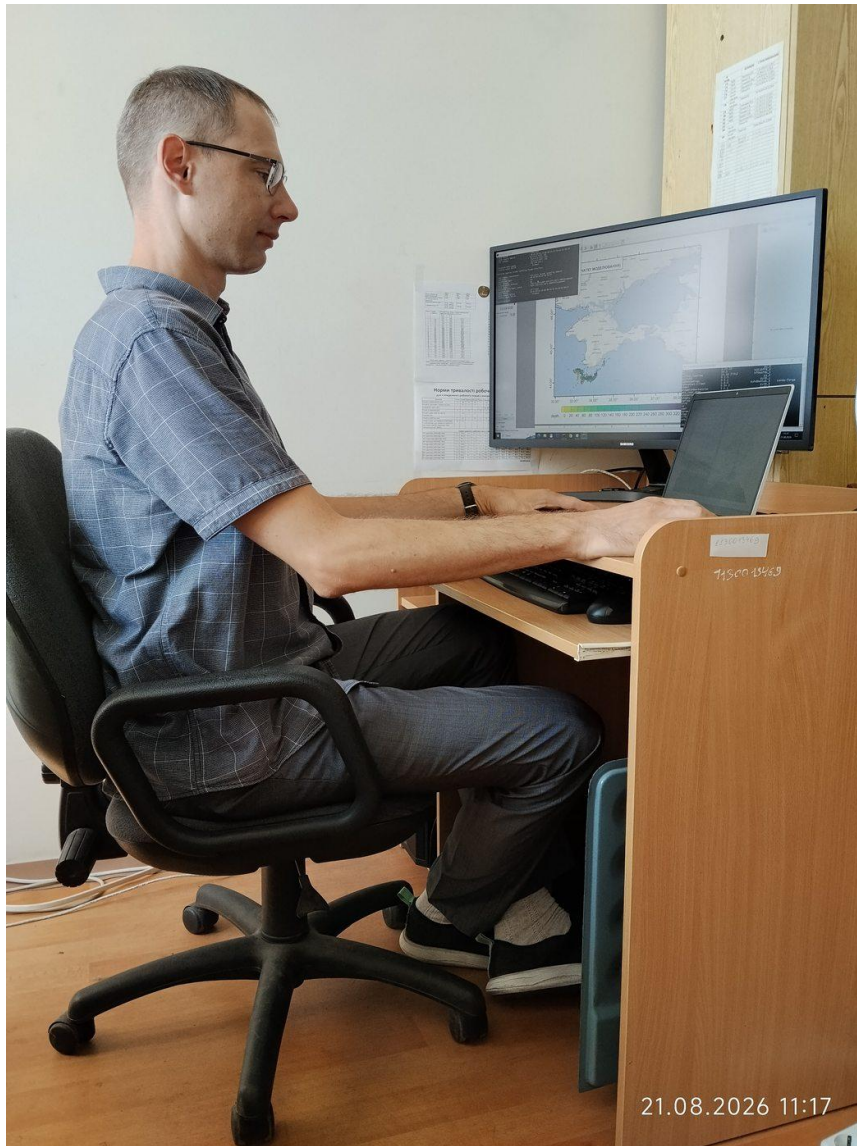


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