

EU Coastal Use Cases Workshop

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Developing High-Resolution Models for Forecasting Sea Surface Currents and Marine Effluent Dispersion



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- **Project in a nutshell**



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- The overall objective of this project is to offer service for facilitating the implementation of maritime policy and supporting Blue growth and scientific innovation in the **northern Adriatic region**. It consists of two use cases:
 - **Use case 1:** a high-resolution operational numerical model (**250 m horizontal resolution**) for operational forecast of the distribution of sea surface currents in the Gulf of Trieste. The model is nested within the **Copernicus "Mediterranean Sea Physics Analysis and Forecast"** model. Daily updates and graphical representations of the forecasts are available on the National Institute of Biology's website, offering free access to all interested users. This information is crucial for entities like the **Slovenian Maritime Administration**, responsible for navigation safety, maritime traffic management, safety facility maintenance, and waterway oversight and the **Administration for Civil Protection and Disaster Relief**, which is responsible for interventions in the event of oil spills at sea.
 - **Use case 2:** the service offers two-day hourly forecasts of the dispersion of effluents from The Koper Central Wastewater Treatment Plant into the Gulf of Koper (the southeastern part of the Gulf of Trieste). The service uses a high-resolution Delft3D circulation model (**150 m horizontal resolution**) nested within the **Copernicus "Mediterranean Sea Physics Analysis and Forecast"** model. The service is crucial for entities like the **Administration for Civil Protection and Disaster Relief**, **Slovenian Environment Agency** and the **National Laboratory of Health, Environment and Food**. The forecasts of the effluent dispersal provide society with an early warning system for potential pollution events. These are extremely important for bathing water, marine protected areas and the conservation of marine biodiversity.



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- Project team:

- **Dr. Boris Petelin** (Principal Investigator and Project Leader), National Institute of Biology¹
- **Ddr. Matjaž Ličer** (Co-Investigator), Slovenian Environment Agency², National Institute of Biology¹
- **Dr. Martin Vodopivec** (Co-Investigator and the Head Physical Oceanography Group), National Institute of Biology¹
- **Dr. Branko Čermelj** (Co-Investigator), National Institute of Biology¹

- Relevant publications:

- Malačič, V., B. Petelin, and M. Vodopivec, Topographic control of wind-driven circulation in the northern Adriatic. *Journal of Geophysical Research: Oceans*, 2012. 117(C6): p. 1-16.
- Ličer, M., et al., Modeling the ocean and atmosphere during an extreme bora event in northern Adriatic using one-way and two-way atmosphere–ocean coupling. *Ocean Sci.*, 2016. 12(1): p. 71-86.
- Genov, T., et al., Mid-distance re-sighting of a common bottlenose dolphin in the northern Adriatic Sea: insight into regional movement patterns. *Journal of the Marine Biological Association of the United Kingdom*, 2015. 96(4): p. 909-914.
- COSOLI, S., et al., Surface circulation in the Gulf of Trieste (northern Adriatic Sea) from radar, model, and ADCP comparisons. *Journal of geophysical research*, 2013. 118(11): p. 6183-6200.

¹<https://www.nib.si/mbp/en/>

²www.gov.si/en/state-authorities/bodies-within-ministries/slovenian-environment-agency/



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- **Copernicus Marine Products and Coastal model**



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- Surface currents in the Gulf of Trieste
 - used to predict sea currents at the surface and compares them with real-time measurements from HF radars.
 - based on Deltares Open Source Delft3D FLOW
 - Initial and boundary conditions:
 - Elevation, 3D currents and salinity from the nesting models:
 - **CMEMS Mediterranean Sea Physics Analysis and Forecast** →
 - **NEMO v4.2** for Adriatic Sea ($1/111^\circ$ or 1000 m) →
 - **NEMO NADR** - NEMO v4.2 for North Adriatic Sea ($1/216^\circ$ or 500 m) →
 - **Delft3D** for Gulf of Trieste (250 m)
 - Surface forcing: **ALADIN SI** (surface wind and air pressure at sea level with a resolution of 4.4 km)
 - Discharge of the **Soča/Isonzo river**: hourly operational HFS (hydrological forecasting system) forecasts



- Dispersion of pollutant in the Gulf of Koper
 - used to monitor the concentration of a fictitious pollutant discharged from the Central Wastewater Treatment Plant in Koper.
 - based on Deltares Open Source Delft3D FLOW
 - Initial and boundary conditions:
 - Elevation, 3D currents and salinity from the nesting models:
 - **CMEMS Mediterranean Sea Physics Analysis and Forecast** →
 - **NEMO v4.2** for **Adriatic Sea** (1/111° or 1000 m) →
 - **NEMO NADR - NEMO v4.2** for **North Adriatic Sea** (1/216° or 500m) →
 - **Delft3D** for **Gulf of Koper** (150 m)
 - Surface forcing: **ALADIN SI** (surface wind and air pressure at sea level with a resolution of 4.4 km)
 - Discharge of the **Rižana river**: monthly climatological
 - Continuous wastewater discharge into the **Rižana River at the Koper Central Sewage Treatment Plant** with a continuous concentration of 0.1 kg/m³





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- **Seamless Coastal Marine Service**



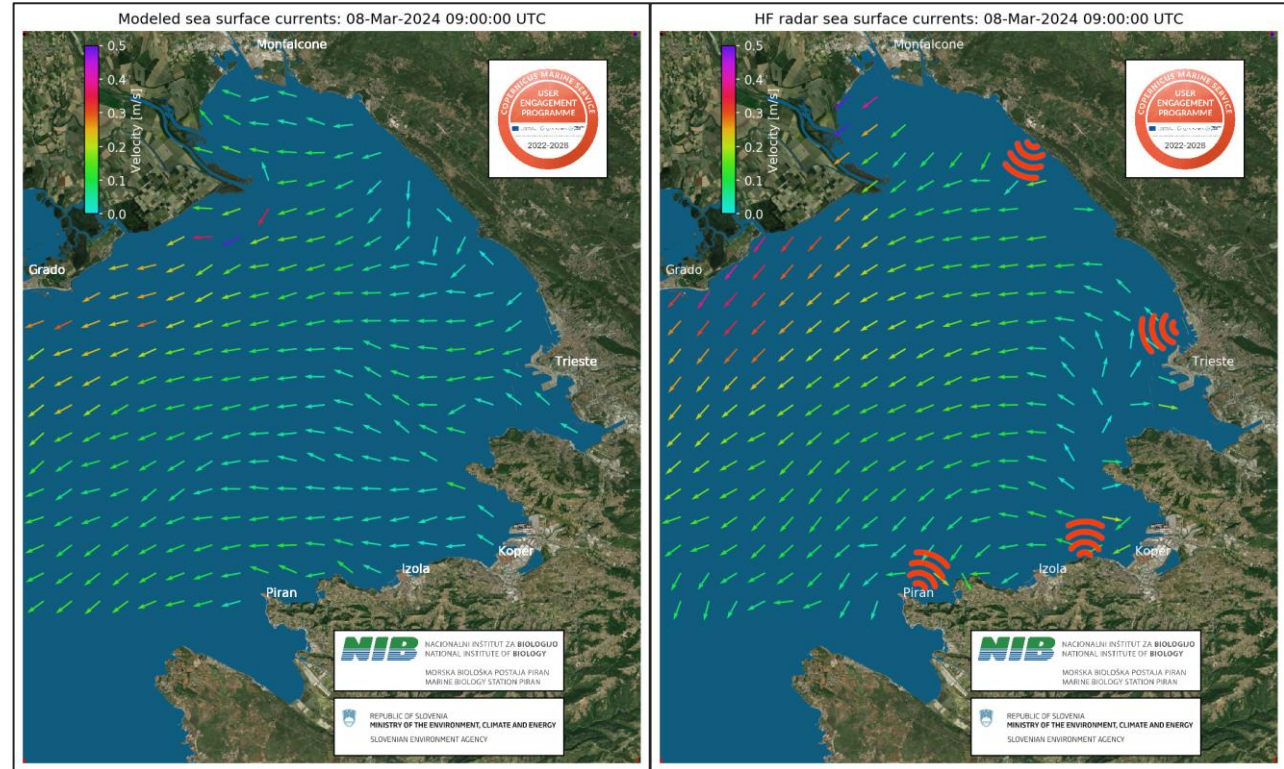
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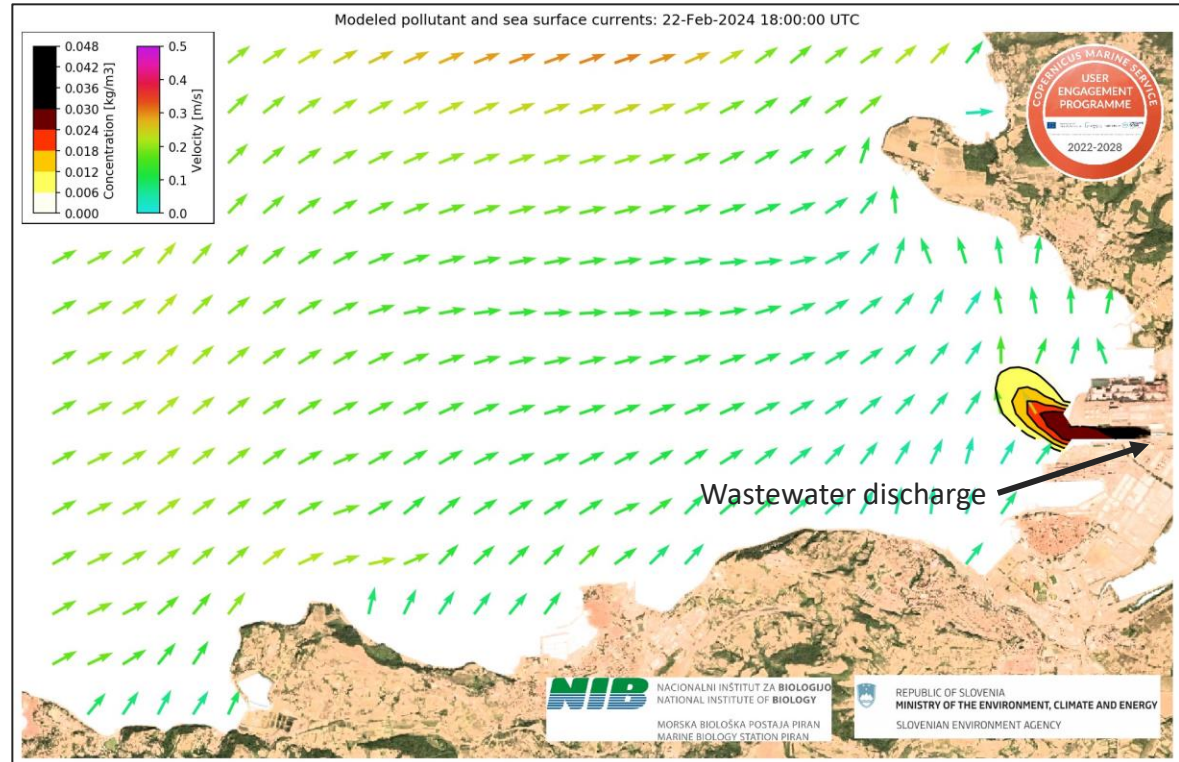
Use case 1: Currents in the Gulf of Trieste



- Model operation:
 - Model **forecast** for **two days** in advance (**updated daily**) and comparison with the latest HF radar measurements (**updated hourly**)
 - The model runs daily in the morning hours and the new forecast is available between 12 and 1 pm
 - The model results are available on the NIB-MBP website: <https://www.nib.si/mbp/en/oceanographic-data-and-measurements/other-oceanographic-data/copernicus/currents-in-the-gulf-of-trieste>
- Model performance:
 - Comparison with buoy Vida and HF radar measurements: the model performs **well in moderate and strong winds** (bora and southerly winds), but **worse in calm conditions**
- Dissemination:
 - announcements on the Copernicus, NIB, MBS, Facebook and LinkedIn websites
 - a webinar in Slovenian on the coastal service for participants from Slovenian institutions directly related to the sea
 - poster on EGU 2024
 - lectures for students

Use case 2: Wastewater discharge in the Gulf of Koper

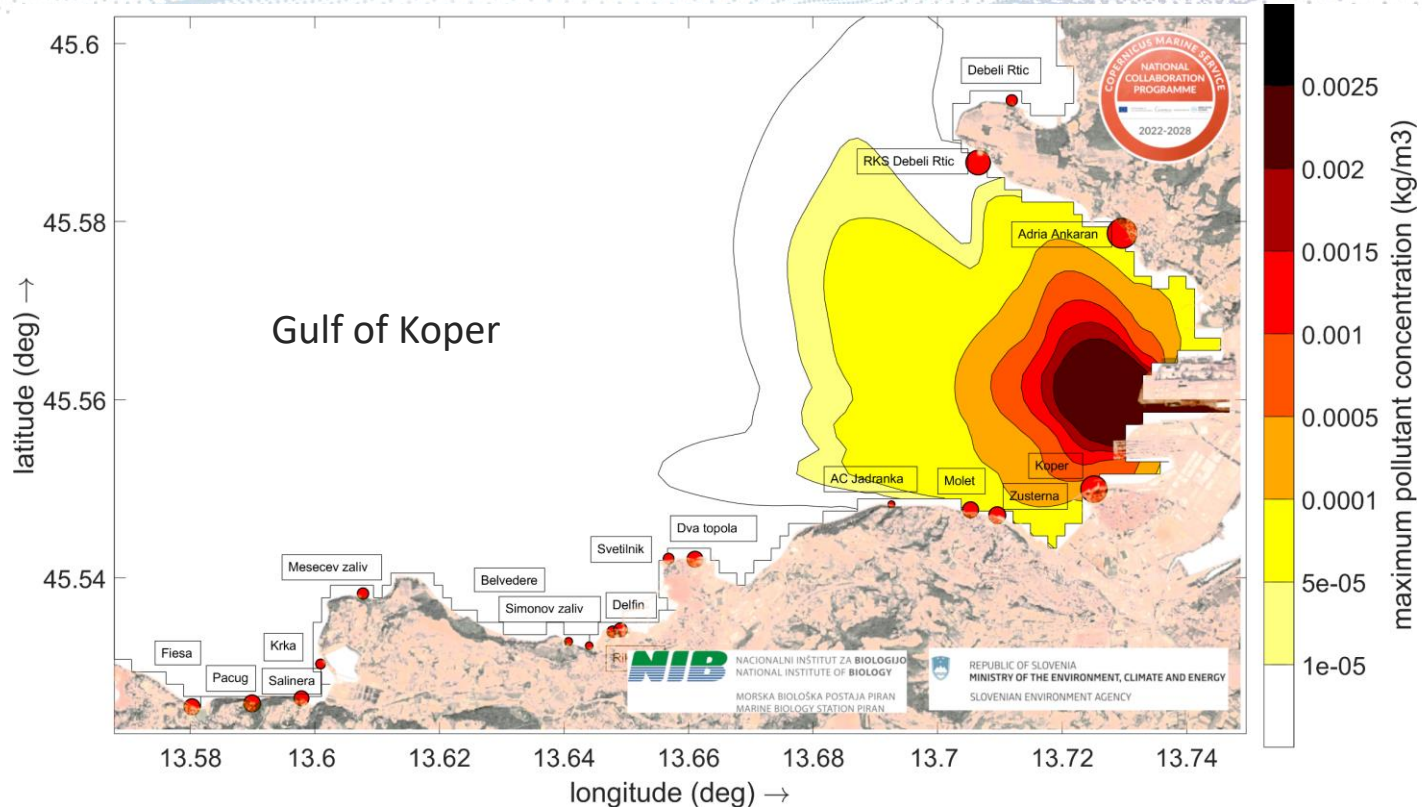
- <https://www.nib.si/mbp/en/oceanographic-data-and-measurements/other-oceanographic-data/copernicus/spreading-of-a-pollutant-in-the-gulf-of-koper>



Use case 2: Wastewater discharge in the Gulf of Koper

Comparison with measurements:

- maximum modeled pollutant concentration from 18. 5. 2024 to 20. 8. 2024
- Maximum observed *Escherichia coli* (*E. coli*) on beaches (count/100 ml)
- Only 6 out of 18 beaches were affected with modeled pollutants, three of which are more polluted based on measurements





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- **Thank you for your attention**



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