NEMO Model Test Run for ROFI in the Gulf of Trieste

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Abstract

Test runs for the Region of Freshwater Influence (ROFI) in the Gulf of Trieste were setup using the 'Nucleus for European Modelling of the Ocean' (NEMO) model. Two test simulations of plume spreading were performed: the first was run for the winter season with initially homogeneous water and a constant bora wind blowing along the Gulf's axis with a speed of 13 The second simulation was run for summer conditions with vertically stratified water and without wind forcing. The - turbulence scheme on an Arakawa C-type grid common for NEMO, was applied as described in (Madec, 2008). The modeled area of the Gulf, 31.8 33 km, is gridded in cells of dimension 0.6 km 0.6 km, similar to the model setup in (Žagar et al. 2013). A simplification of the OBC was achieved by extending the domain by 15 km in a westward direction, and by closing the simulation area. Along the vertical, 25 z-layers were inserted. The forcing of the river Soča (Isonzo) was simulated with the conversion of the volume flow-rates for the summer (120) and winter (150) situations to the vertical mass density flow through the topmost cell by applying discharges of 0.33 and 0.42 , respectively. The river temperature was set to the ambient temperature, while the salinity of the river runoff was set to 0 PSU. Both simulations run for the period of 48h, when the nearly 'steady' state was reached. The winter simulation revealed a strong outflow current in the form of a belt of fresher water, attached to the northern coastline of the Gulf. This is mainly a wind-driven process, and in this case the salinity acts as a passive tracer. The water mass returns through the deeper layers in the central and southern parts of the Gulf, according to the topographic control (Malačič et al. 2012). In the summer windless simulation, radial spreading of the freshwater stemming from the Soča River is present in the inertial plume area. The velocity vectors deflect due to the Coriolis force, forming outward spiraling paths of surface parcels. Once the scaling of terms in the equation of motion is completed, the transient situations with variable winds, tides, and the river flow rate can be tackled, as (Querin et al. 2007). Madec, G., 2008. Nemo Ocean Engine. Note du Pôle de modélisation, Institut Pierre-Simon Laplace (IPSL), France, pp. 396. Malačič, V., B. Petelin, and M. Vodopivec, 2012: Topographic Control of Wind-driven Circulation in the Northern Adriatic. Journal of Geophysical Research: Oceans, 117, 1–16. Querin, S., A. Crise, D. Deponte, and C. Solidoro, 2007: Numerical Study of the Role of Wind Forcing and Freshwater Buoyancy Input on the Circulation in a Shallow Embayment (Gulf of Trieste, northern Adriatic Sea). Journal of Geophysical Research, 111, 1–19. Žagar, D., E. Džebo, and G. Petkovšek, 2013: Comparison of Models MIKE3 and PCFLOW3D: Hydrodynamic Simulations in the Gulf of Trieste –Acta hydrotechnica, 26, 117–133.

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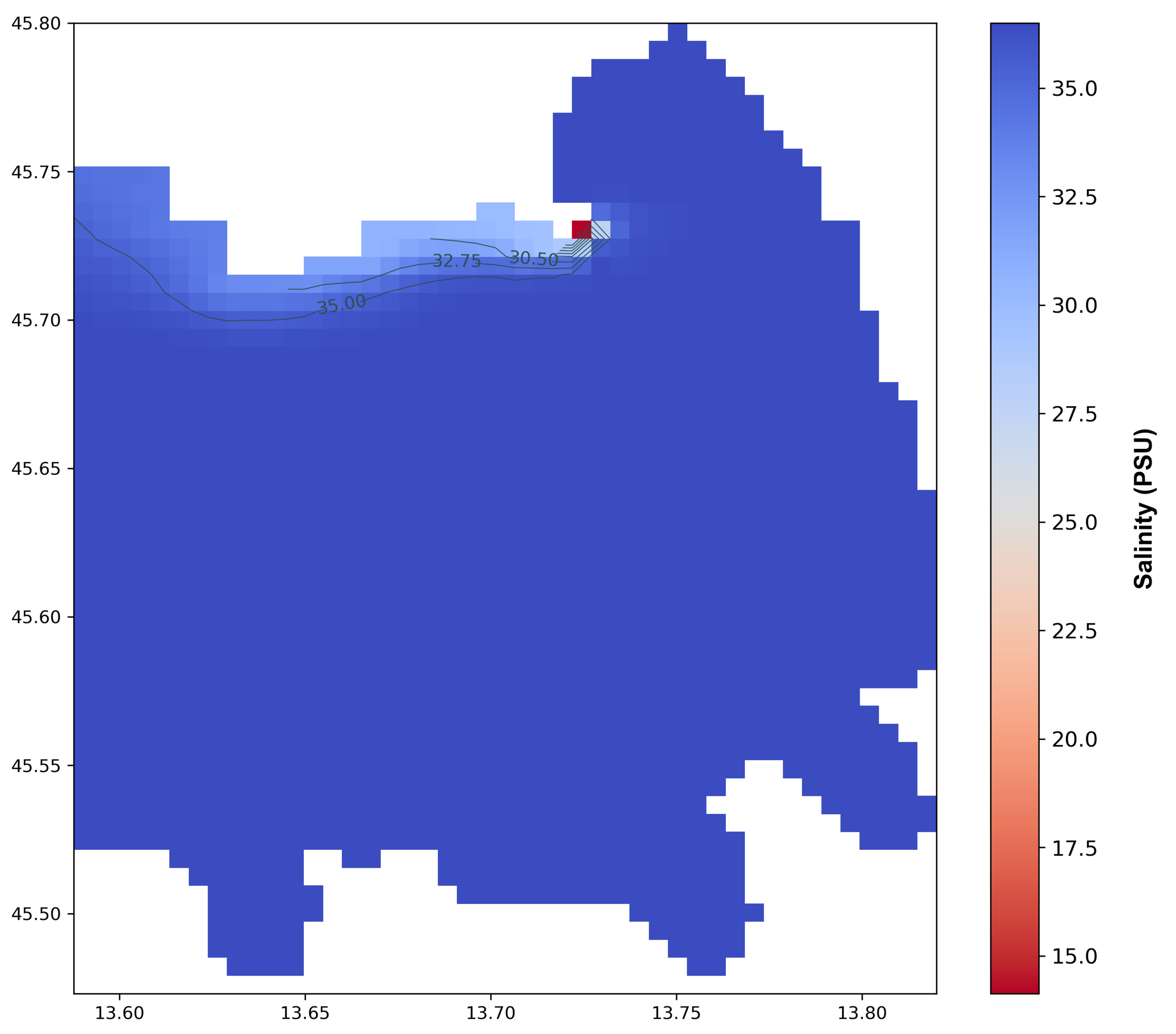
Photography encouraged

Test runs for the Region of Freshwater Influence (ROFI) in the Gulf of Trieste were setup using the ‘Nucleus for European Modelling of the Ocean’ (NEMO) model. We focused on the river Soča (Isonzo), that enters the Gulf of Trieste (northern Adriatic See) at its northern side (red dot). The modelled area of the Gulf, 31.8 × 33 km, was gridded in cells of dimensions 0.6 × 0.6 km, with 25 *z*-layers similar to the model setup in (Žagar et al. 2013). A simplification of the open boundary condition was obtained by extending the domain by 15 km in a westward direction, and by closing the simulation area. The forcing of the river Soča (Isonzo) was simulated with the conversion of the volume flow-rates of the summer (120 m^3/s) and winter (150 m^3/s) situations of the vertical mass density flow through the topmost cell by applying discharges of 0.33 kg/m^2s and 0.42 kg/m^2s, respectively. The river temperature was set to the ambient temperature, while the salinity of the river runoff was set to 0 PSU. Two simulations were performed with the *k-ε* turbulence scheme on an Arakawa C-type grid. Both simulations were run for the period of 48h. The program executed 17280 time steps of 10s and the data was saved in NetCDF files for every hour. After this period, the simulation reached the nearly ‘steady’ state.

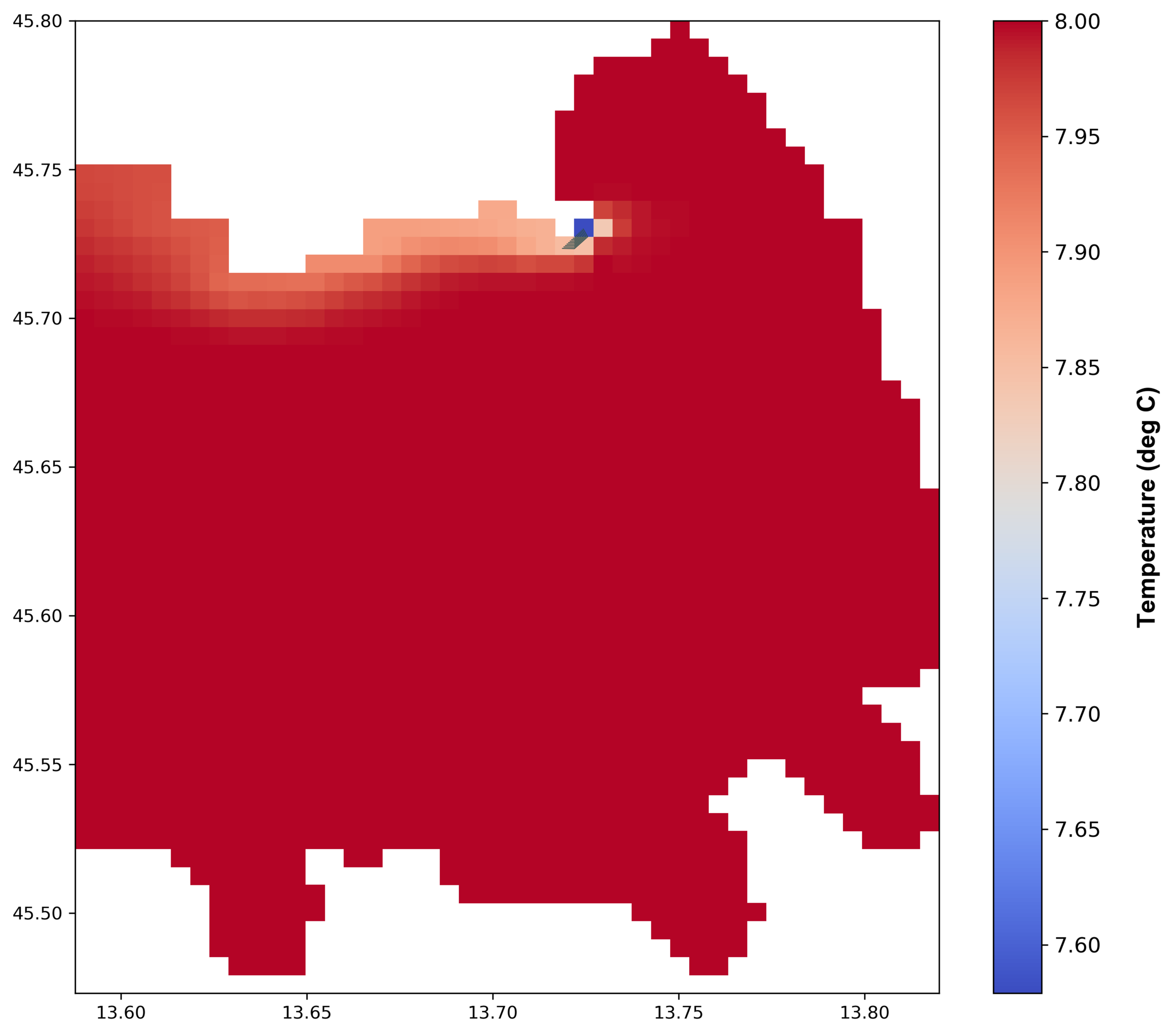
Winter situation

Surface salinity



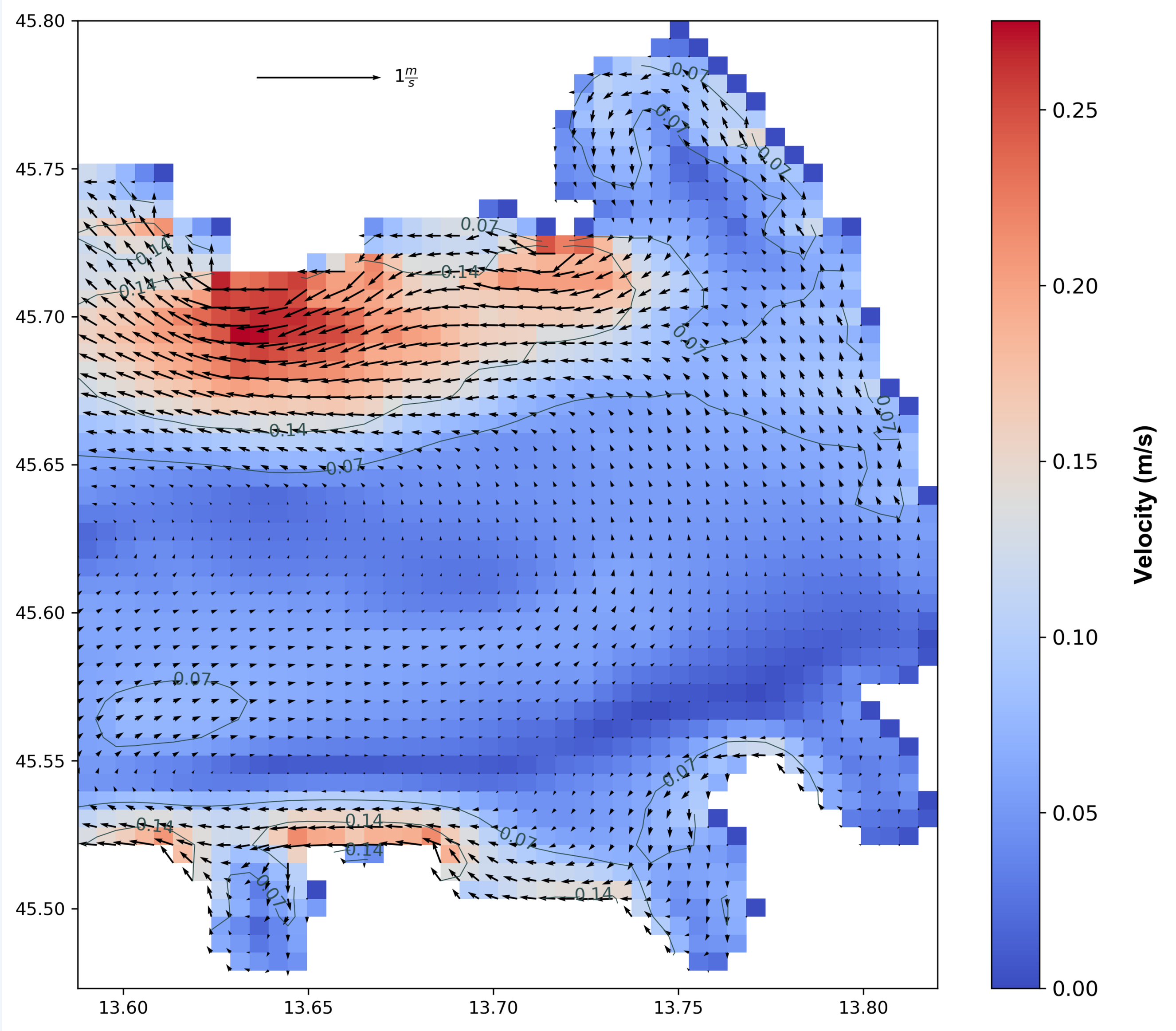
The simulation for the *winter season was* run with initially homogeneous water and a constant bora wind blowing along the Gulf’s axis with a speed of U = 13 m/s. The wind stress τ = 0.412 N/m^2 was obtained with $\tau = \rho_A C_D U^2$, where C_D = 0.002 and ρ_A = 1.22 kg/m^3.

Surface temperature



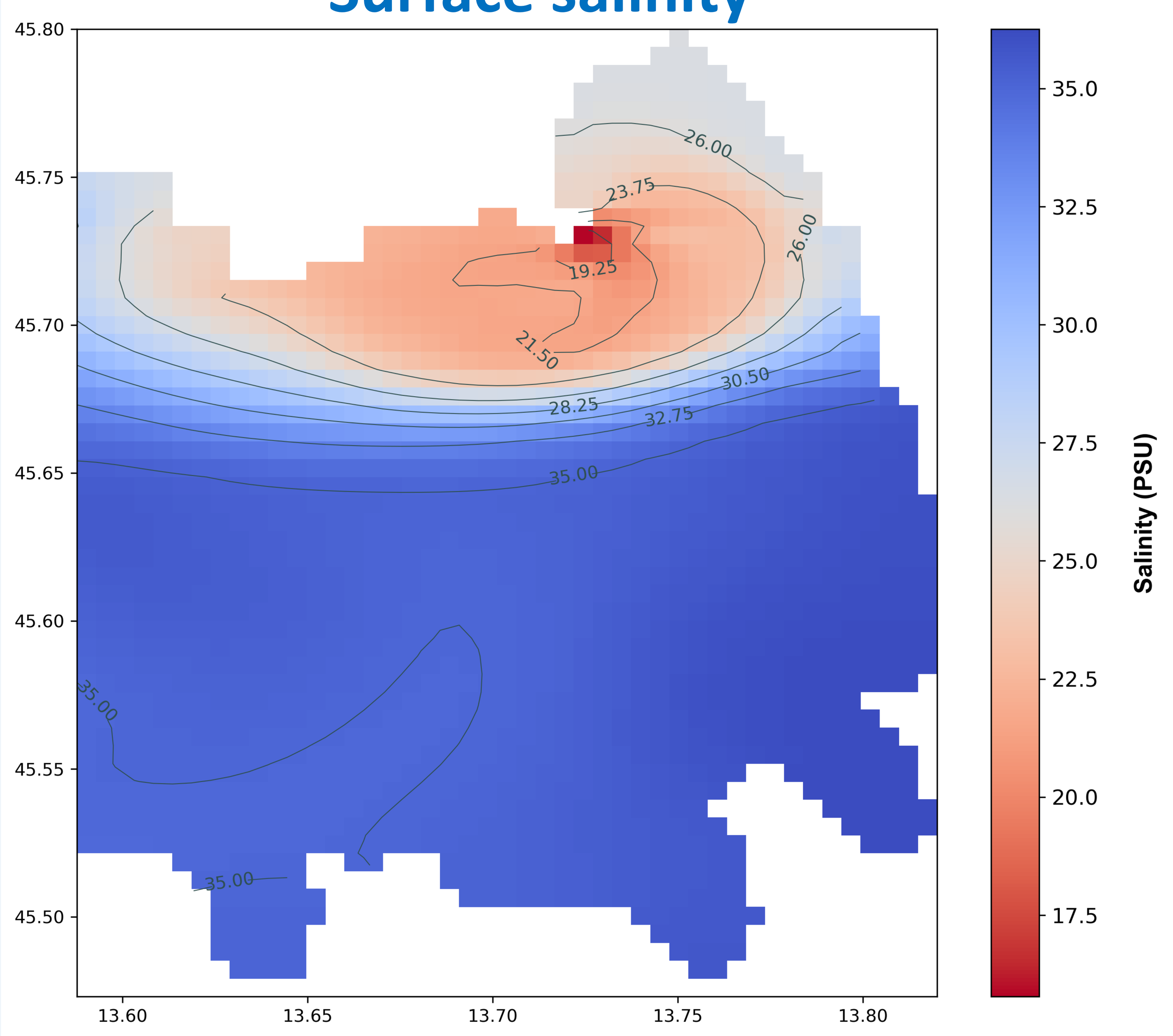
A strong outflow current is present in the form of a belt of fresher water, attached to the northern coastline. This was to be expected, since it is mainly a wind-driven process. The salinity acts as a passive tracer. The water mass returns through the deeper layers in the central and southern parts of the Gulf, according to the topographic control (Malačič et al. 2012).

Surface currents



Summer situation

Surface salinity



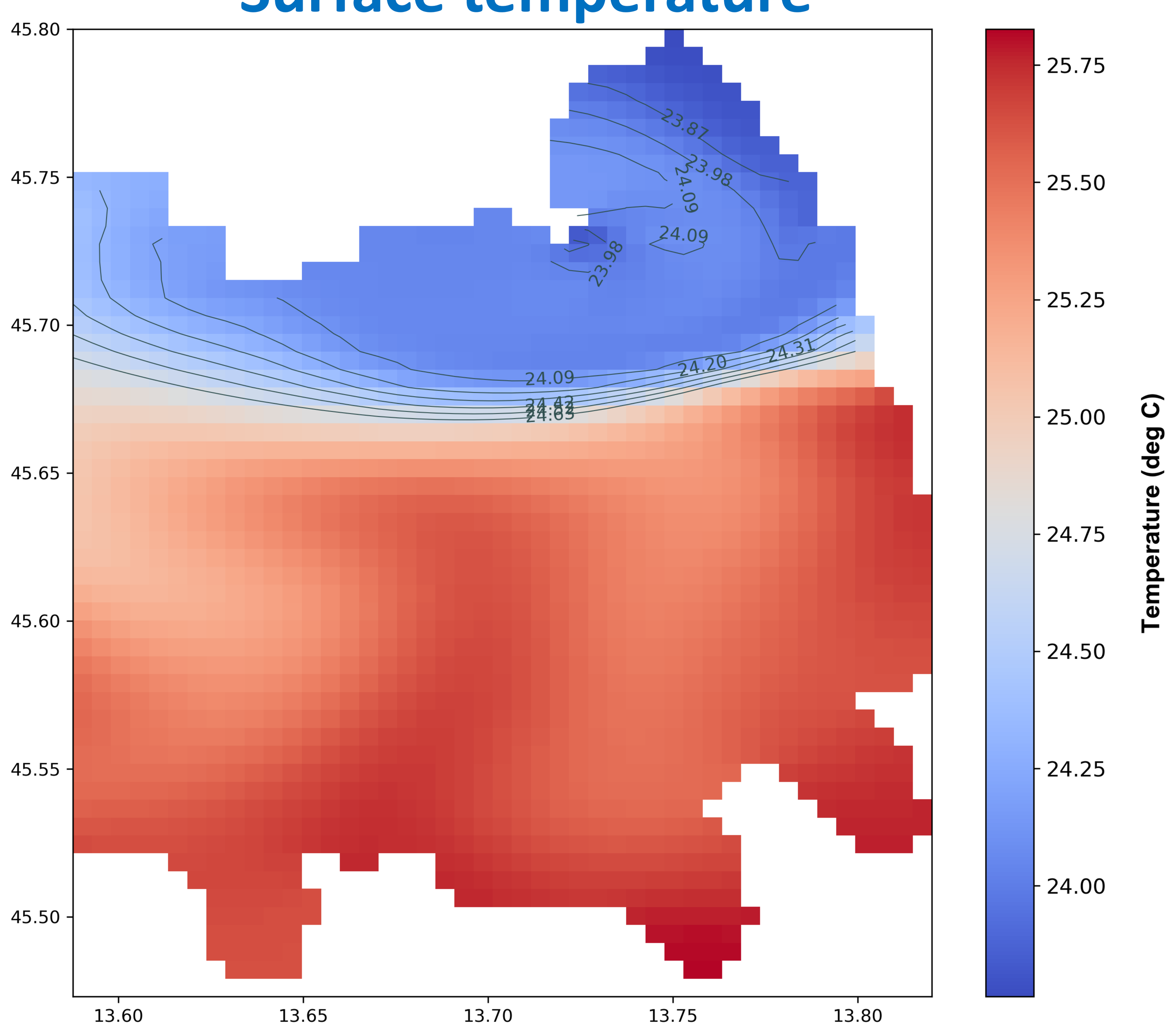
Vertically stratified water, without wind. The water mass was pushed in motion by the river inflow. The freshwater plume is noticed. Once the scaling of terms in equation of motion is complete one can track quantities as (Querin et al. 2007).

Conclusions

Winter: the wind would greatly affect the movements of the water mass.

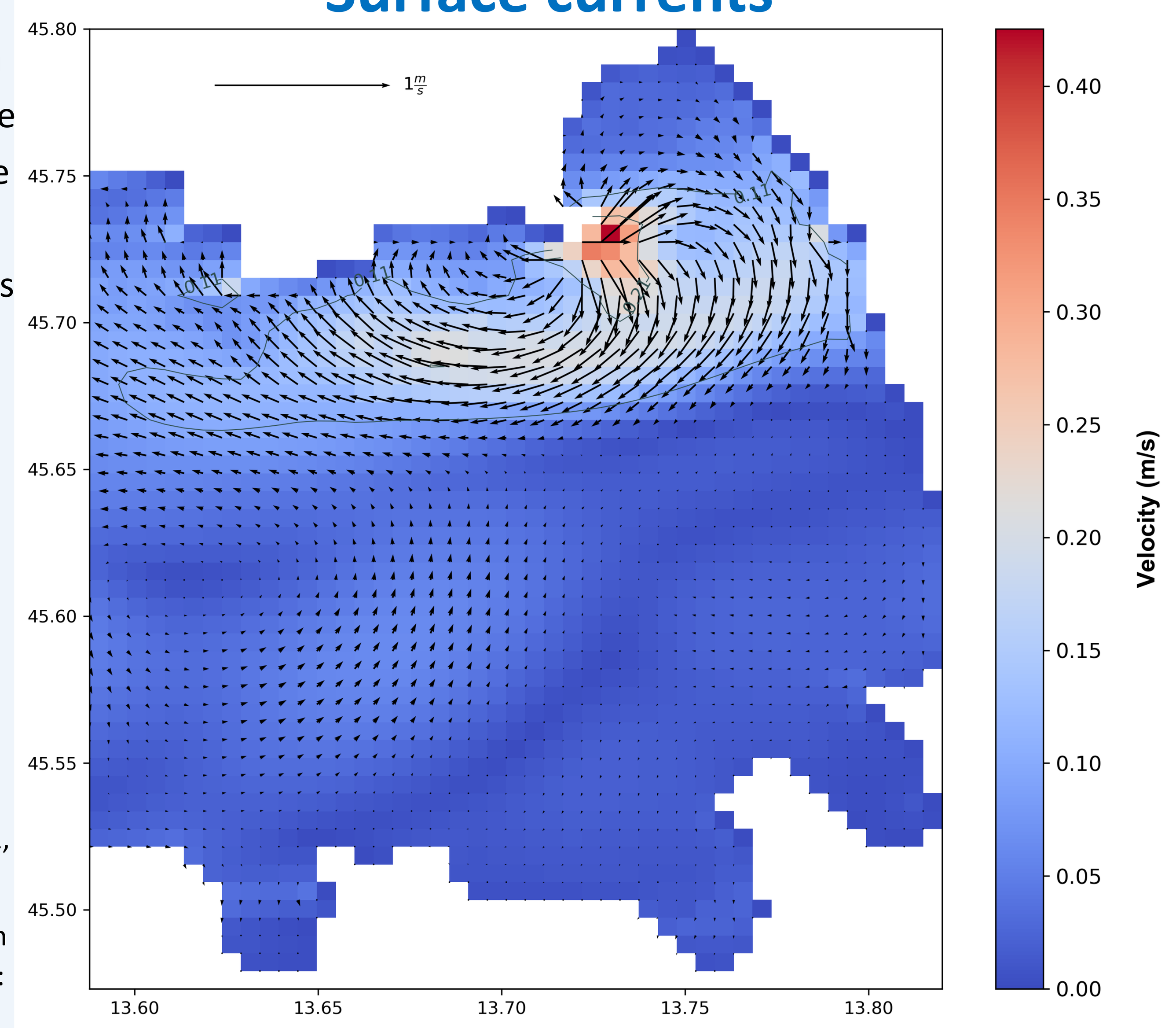
Summer: the Soča river runoff plays the role in the dynamics of the Gulf.

Surface temperature



The radial spreading of the freshwater stemming from the Soča River is present in the inertial plume area. The velocity vectors deflect due to the Coriolis force, forming outward spiralling paths of surface parcels.

Surface currents



Literature:

Malačič, V. et al. , 2012: Topographic Control of Wind-driven Circulation in the Northern Adriatic. JGR C, 117, 1–16.

Querin, S. et al., 2007: Numerical Study of the Role of Wind Forcing and Freshwater Buoyancy Input on the Circulation in a Shallow Embayment (Gulf of Trieste, northern Adriatic Sea). JGR C, 111, 1–19.

Žagar, D. et al., 2013: Comparison of Models MIKE3 and PCFLOW3D: Hydrodynamic Simulations in the Gulf of Trieste –Acta Hydrotechnica, 26, 117–133.

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