

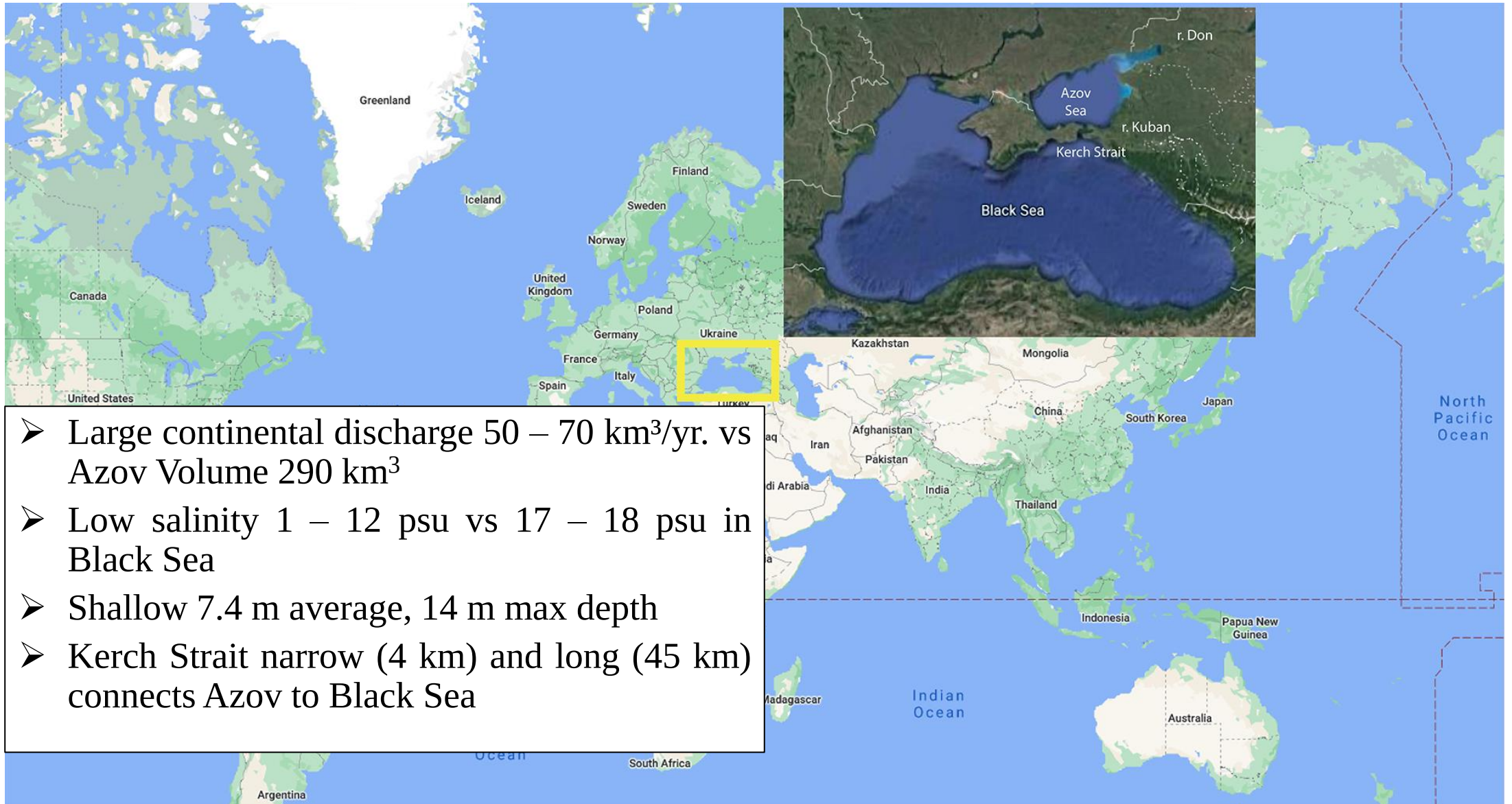


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Land-Sea Interactions Laboratory

Water exchange in Kerch strait using NEMO model of Black Sea

Sedakov R., Barnier B., Molines J.-M., Mershavka A.

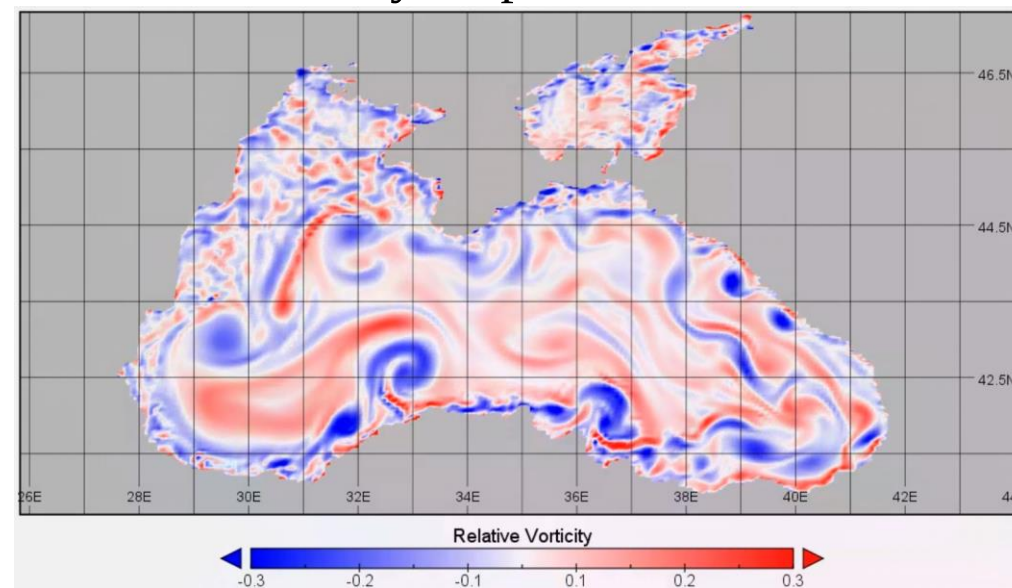
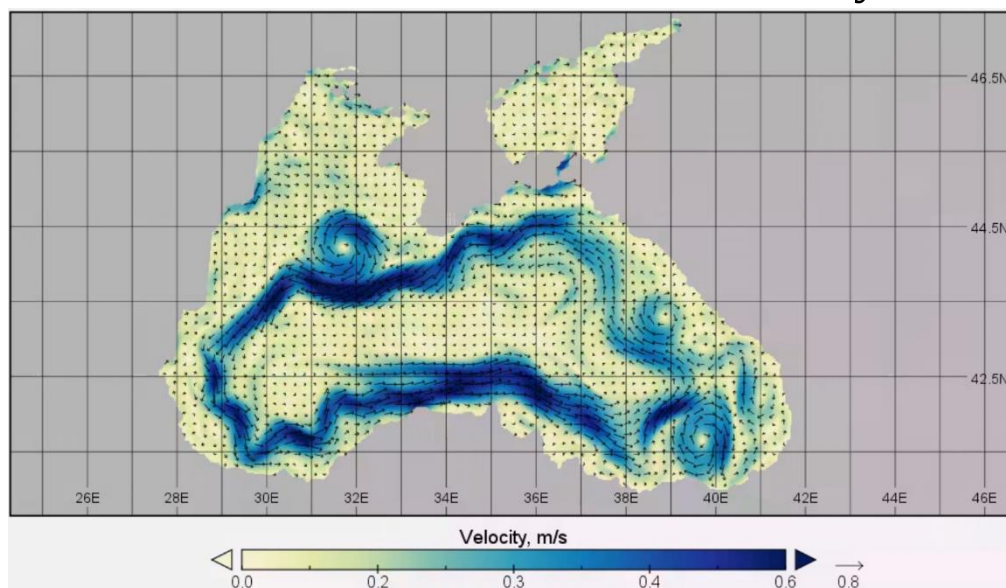
Sea of Azov a lagoon-type estuary



Numerical model of Black and Azov Seas BSAS12

- NEMO 4
- Horizontal resolution $1/12^\circ$ (~ 6.5 km); 174x172 grid – very cheap
- 57 vertical levels
- ERAInterim forcing
- No-slip bottom, open boundary at Bosphorus
- Integration period: 1 Jan 1992 – 31 Dec 2017
- Output: 3D fields 1 day averages; 2D surface fields 1 hour averages

Model domain, velocity field and relative vorticity snapshots

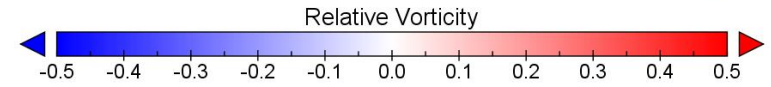
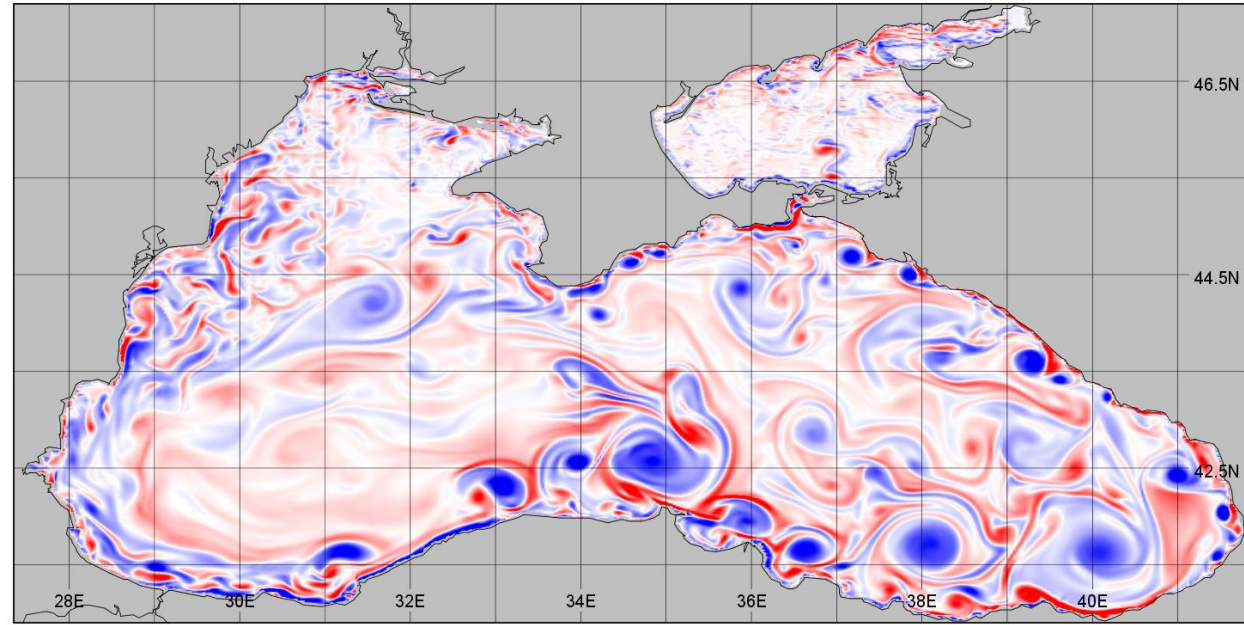
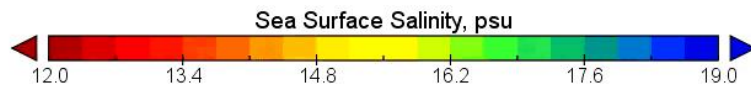
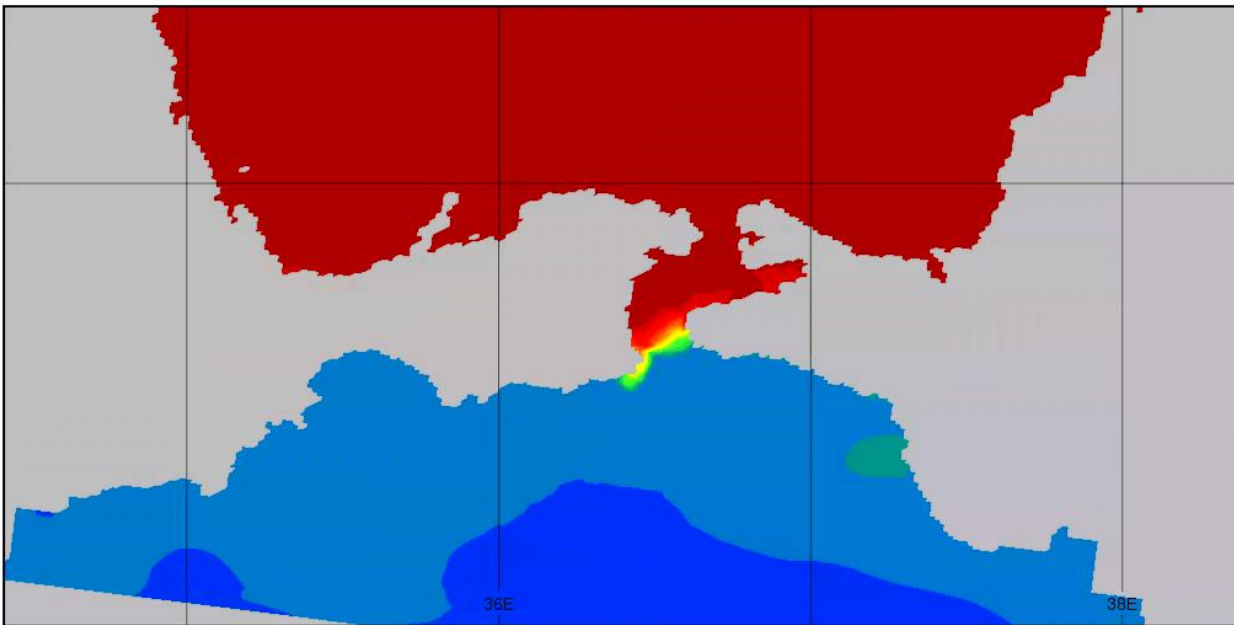


Black Sea and Sea of Azov model: Advanced configurations

BSAS12 + AGRIF zoom $1/60^\circ$ (~ 1 km) in Kerch strait and surrounding aquatorias of Black and Azov Seas

BSAS36 with horizontal resolution $1/36^\circ$ (~ 2.5 km) and 109 vertical levels

Time axis: 1992-01-01 16:30:00



Neither of models has been used in research yet

Modeling results: Water exchange through Kerch Strait

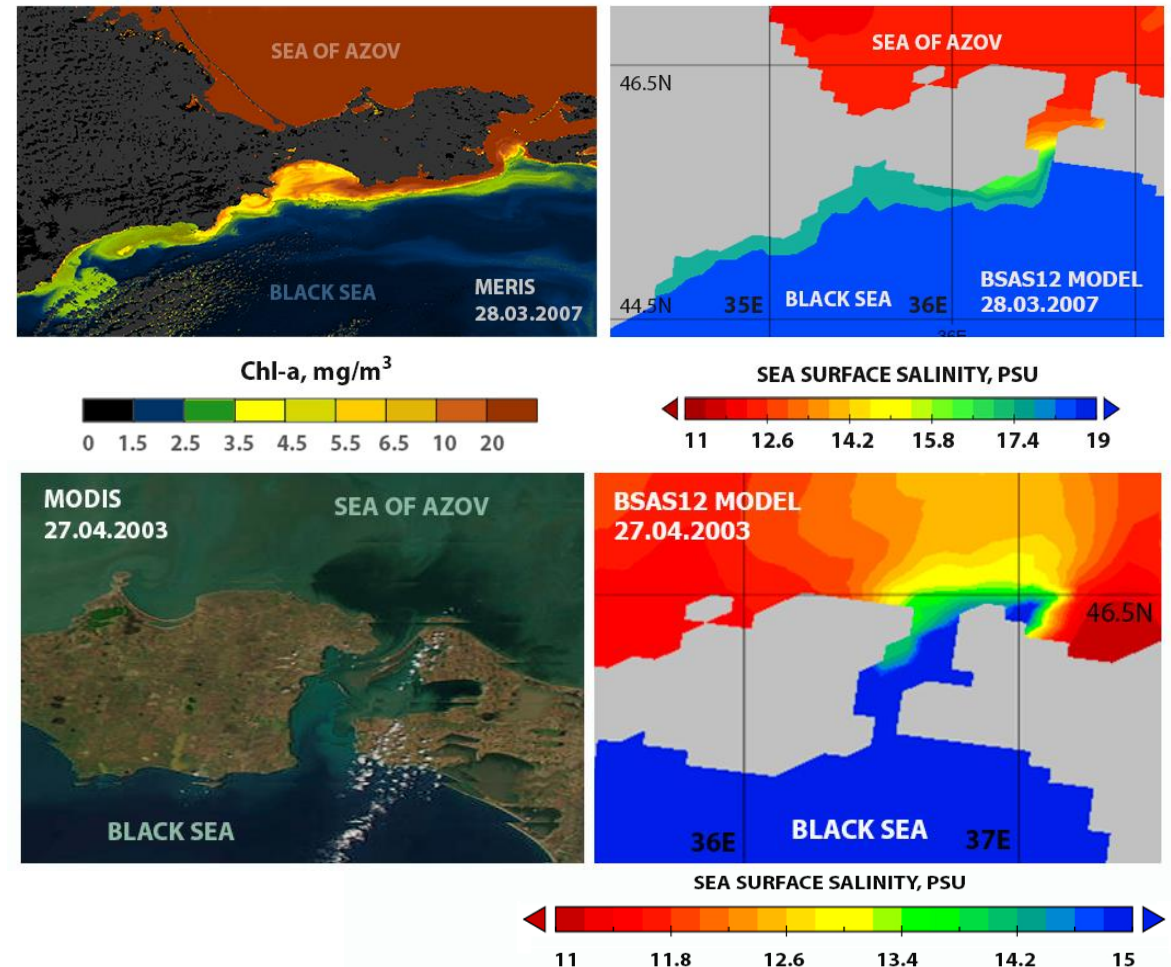
Scientific questions

- How water flow in Kerch strait organized: two-layer exchange flow?
- What drives currents in strait: wind, continental discharge?

Modeling shows

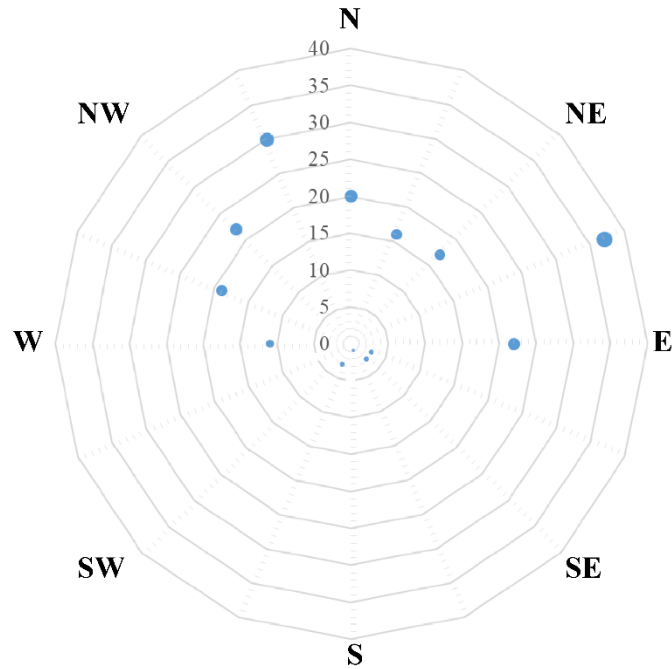
- Two-layer vertically stratified flow with bottom counter-flow never present
- Instead 46.5% days/year one-way flow from Azov to Black Sea and 41% days/year one-way flow from Black Sea to Azov.
- Pressure gradient along strait is governed on 70% by barotropic (due to SSH gradient) component rather than baroclinic (due to density gradient) 30%

Azov water plume in Black Sea (top) and Black Sea water in Azov (bot) on satellite images and in model

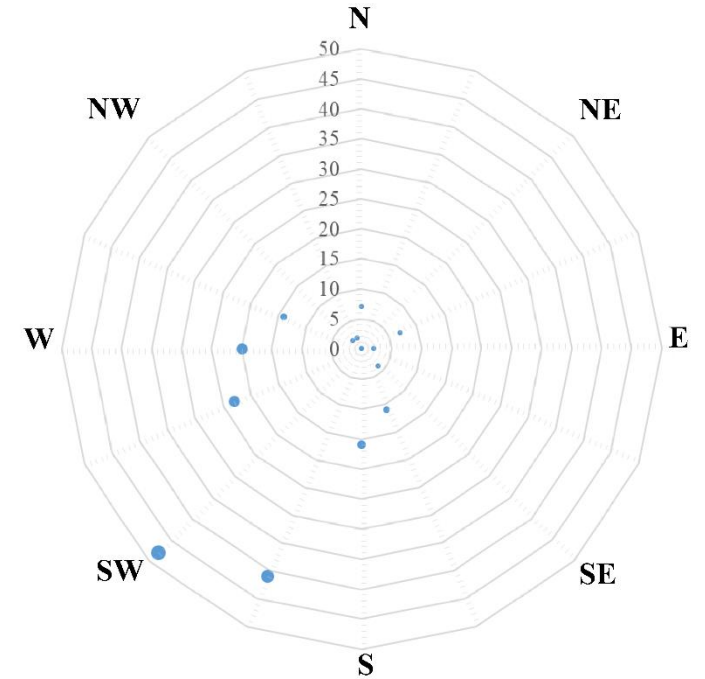


Modelling results: Water exchange through Kerch Strait.

Wind



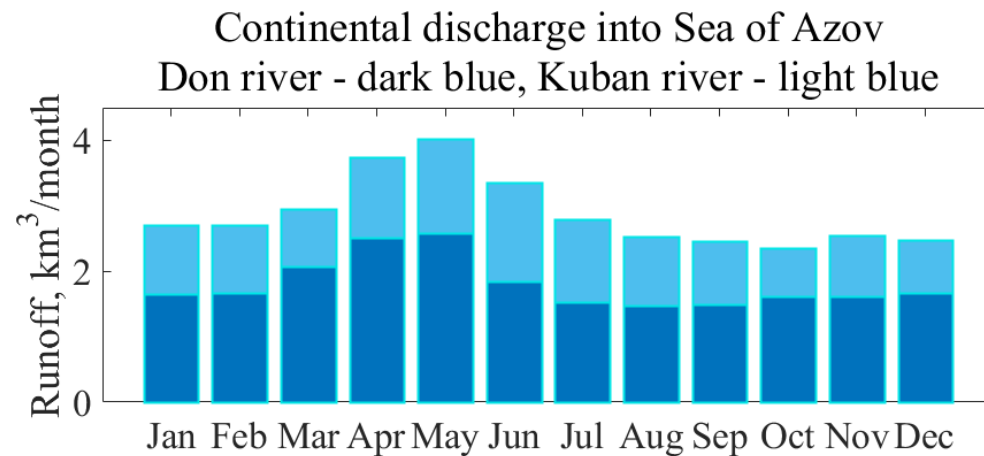
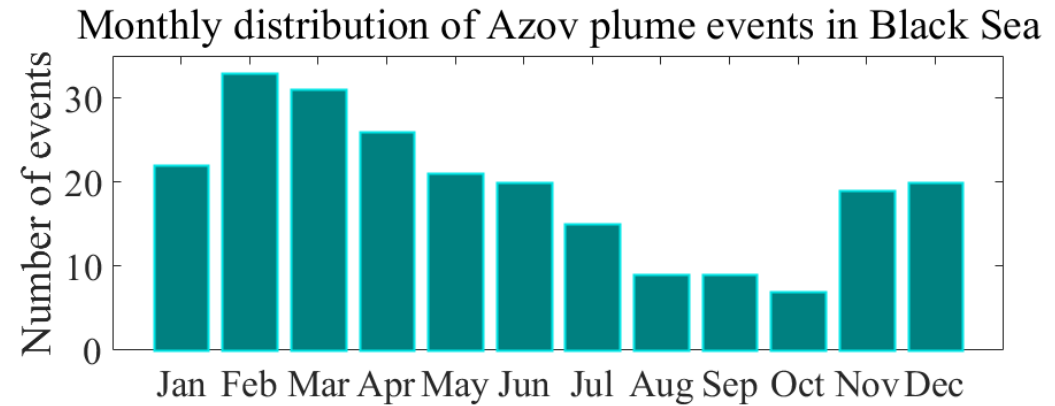
- We considered all events of Azov plume in Black Sea with respect to acting wind forcing (chart on left). Favorable wind conditions: NW, N, NE, E directions; average wind speed 5 – 9 m/s
- We considered all events of Black Sea plume in Sea of Azov with respect to acting wind forcing (chart on right). Favorable wind conditions: S, SW, W directions; average wind speed 5 – 9 m/s



Modelling results: Water exchange through Kerch Strait.

River runoff

Continental discharge into Sea of Azov has high variability due to spring freshet and summer-autumn drought. Distribution of Azov plume events within a year also shows high seasonal variability, but we see no correlation between two ($R = 0.4$). Maximum of Azov plume events in Feb – Mar is related to intensification of strong northerly winds in the region.

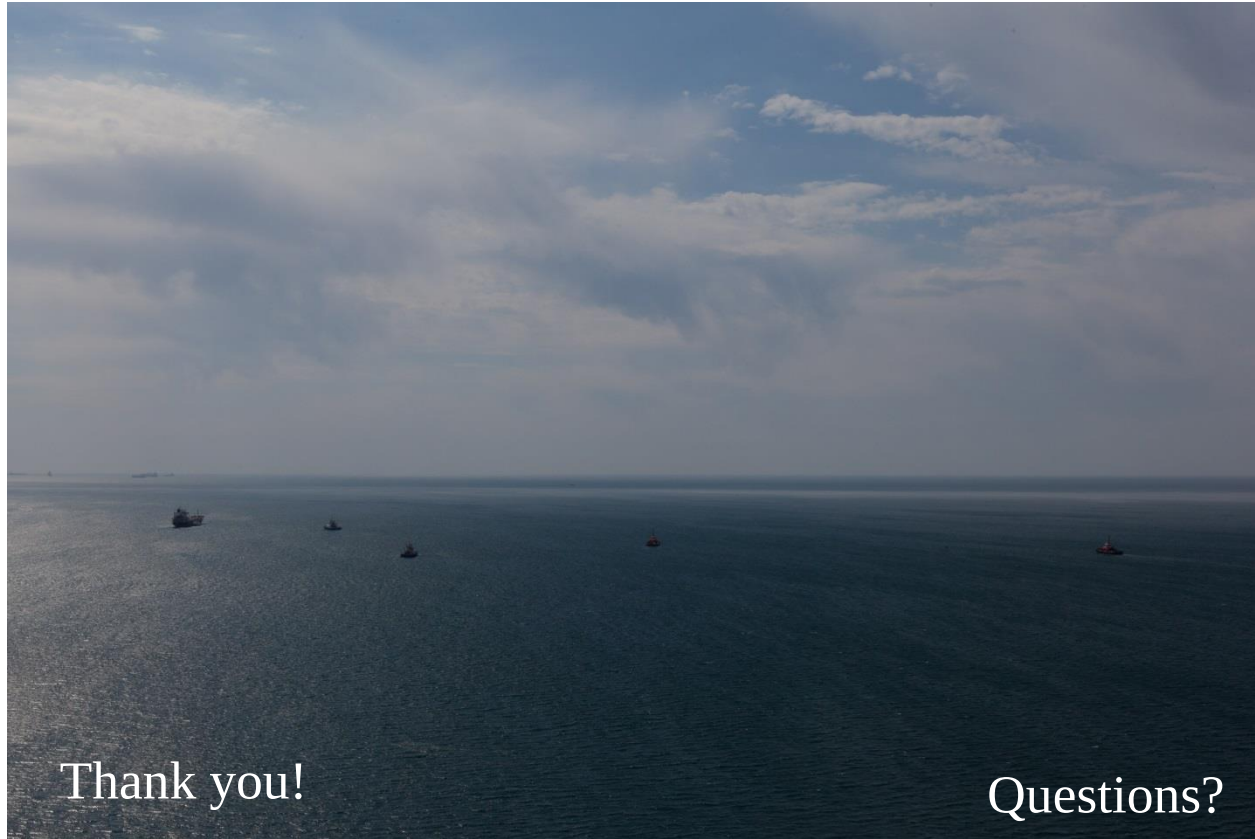


Future work

- Consider data from BSAS12 + 1/60 AGRIF zoom and BSAS36 configurations
- Study spatial and temporal scales of Azov plumes in Black Sea and Black Sea plumes in Sea of Azov
- Study influence of saline Black Sea water on Sea of Azov circulation
- Study transport of pollutants from Black Sea into Sea of Azov and from Azov to Black Sea

Summary

- Water exchange between Black and Azov Seas is in general a sequence of inflows of freshened water from Sea of Azov (Azov plume) and saline water from Black Sea (Black Sea plume)
- Wind induced SSH gradient at opposite ends of strait is a greater factor than density gradient
- Strong Northerly winds favorable conditions for Azov plumes
- Strong Southerly winds favorable conditions for Black Sea plumes
- There is seasonal variability of occurrence of Azov plumes with max at cold months
- It does not correlate with seasonal variability of continental discharge into Sea of Azov



Thank you!

Questions?