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Search method for methane accumulations in the World Ocean based on the transport of dissolved methane

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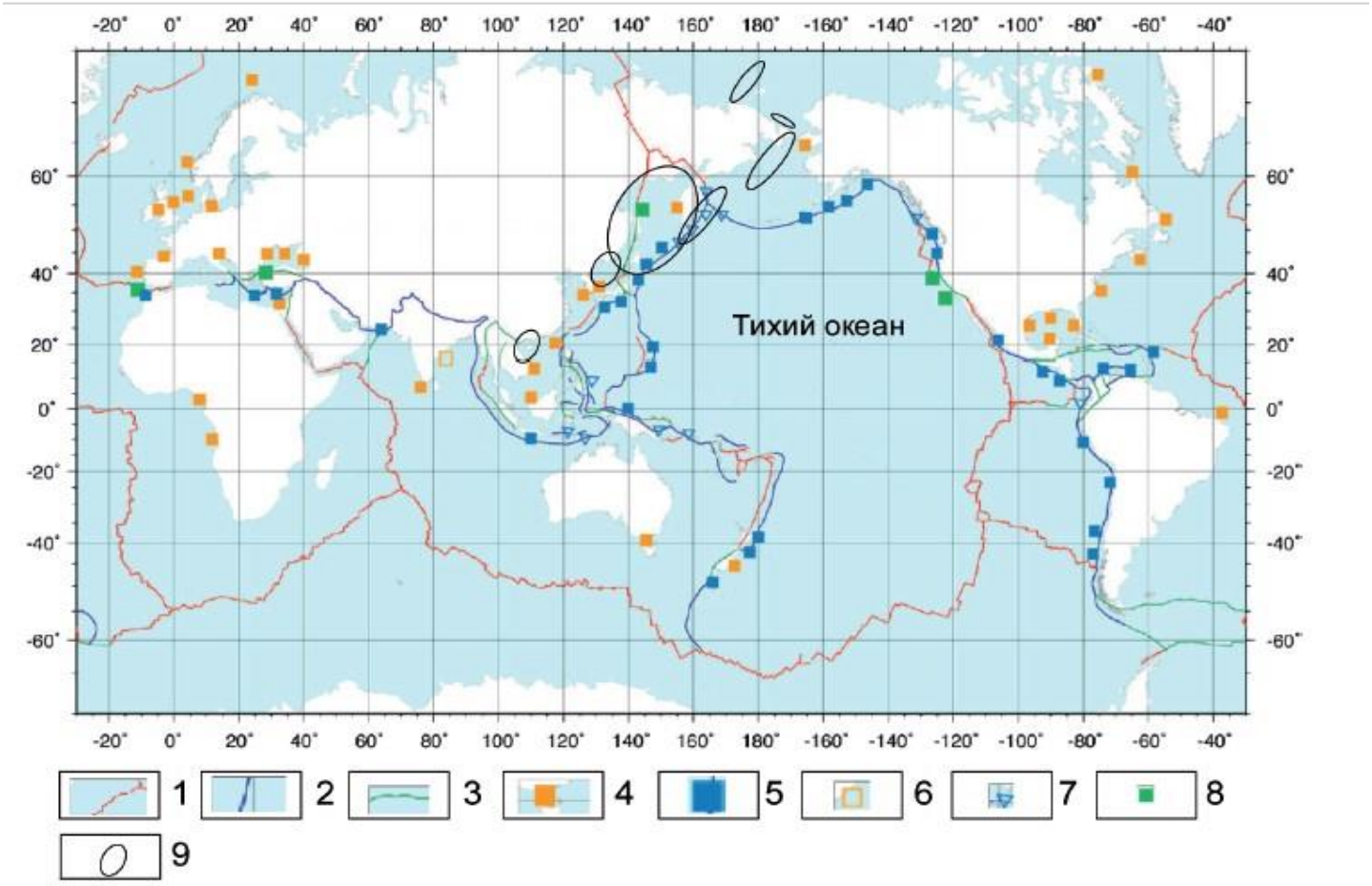
The most part of hydrocarbon deposits in the World Ocean are located within continental shelf

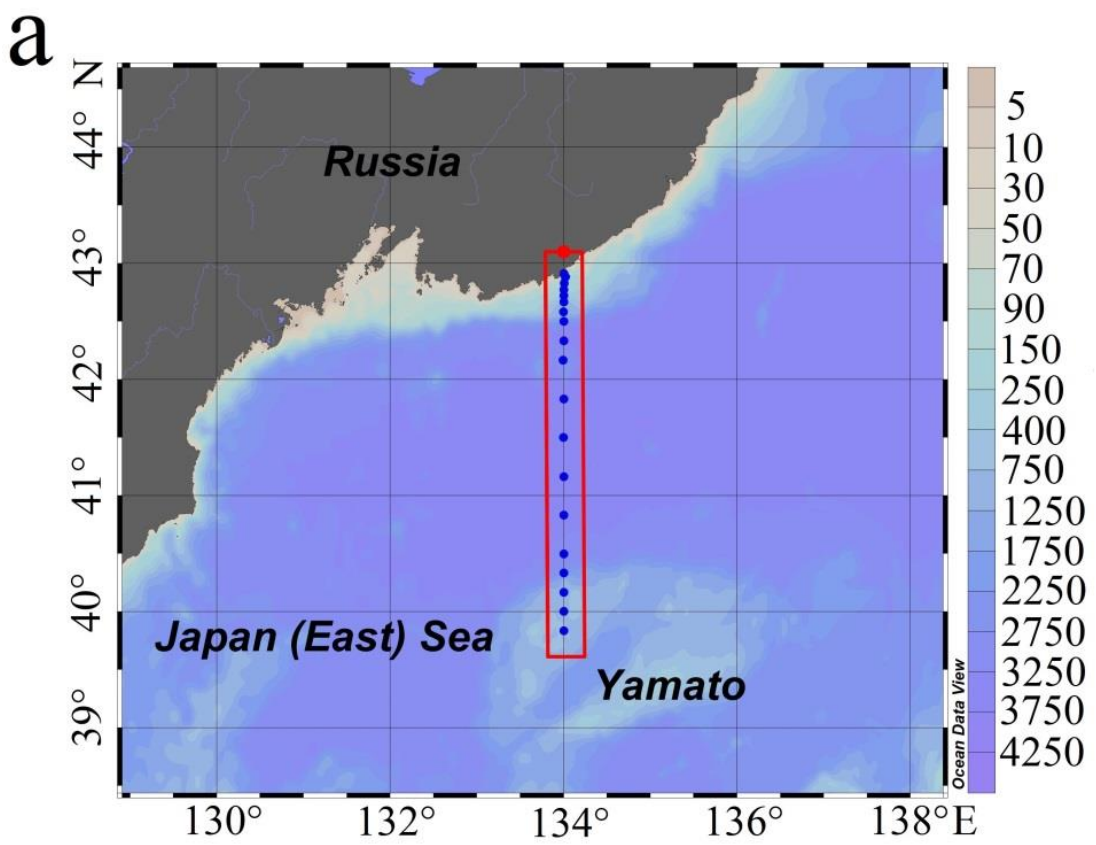


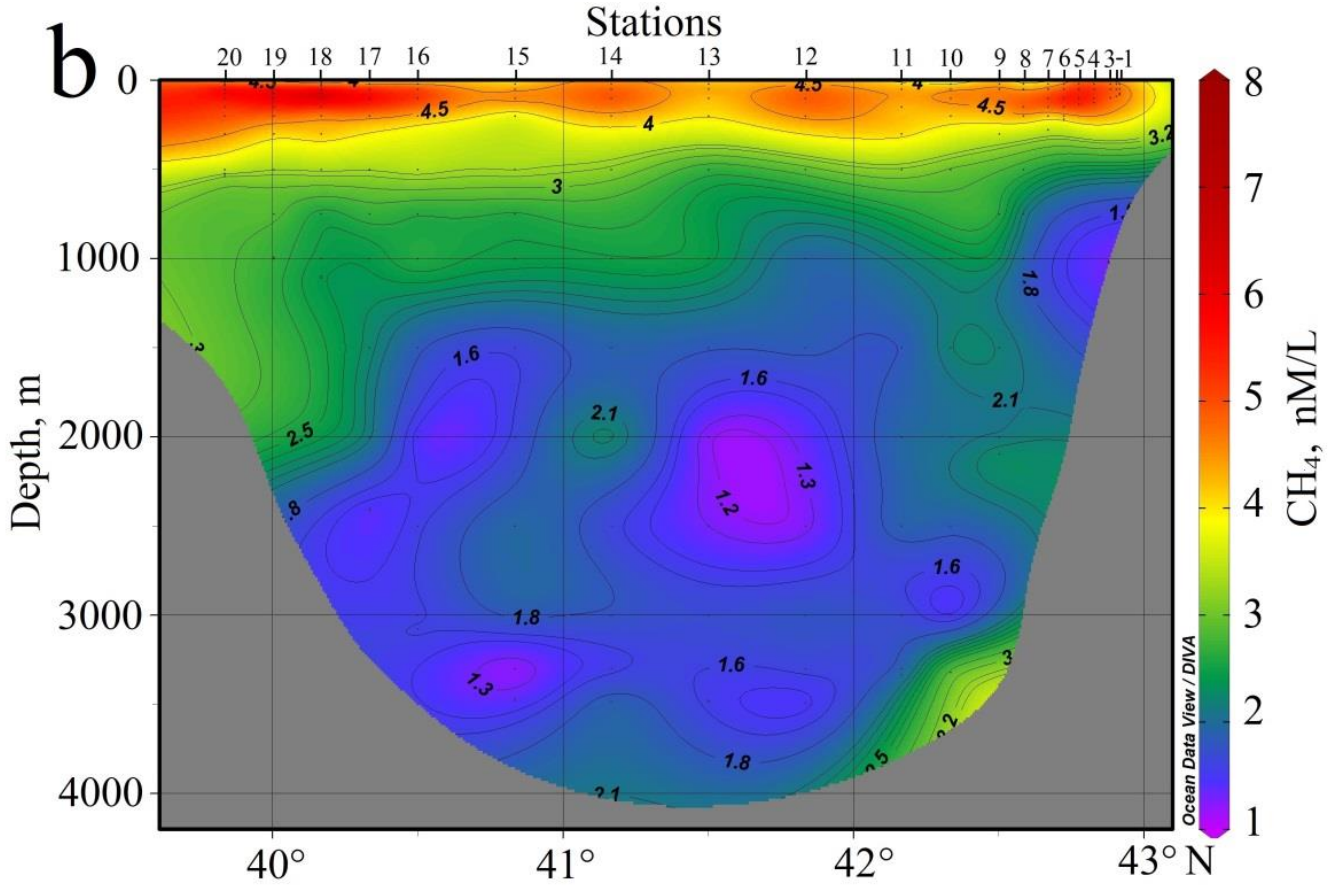
Methane flows and methane hydrates [Suess, 2014]

However, we often find high concentrations of methane in the Ocean, many kilometers away from its sources

Sea of Japan, Western Pacific Ocean

The distribution of methane along the meridional section during cruise 54 RV Academic Oparin in October 2017

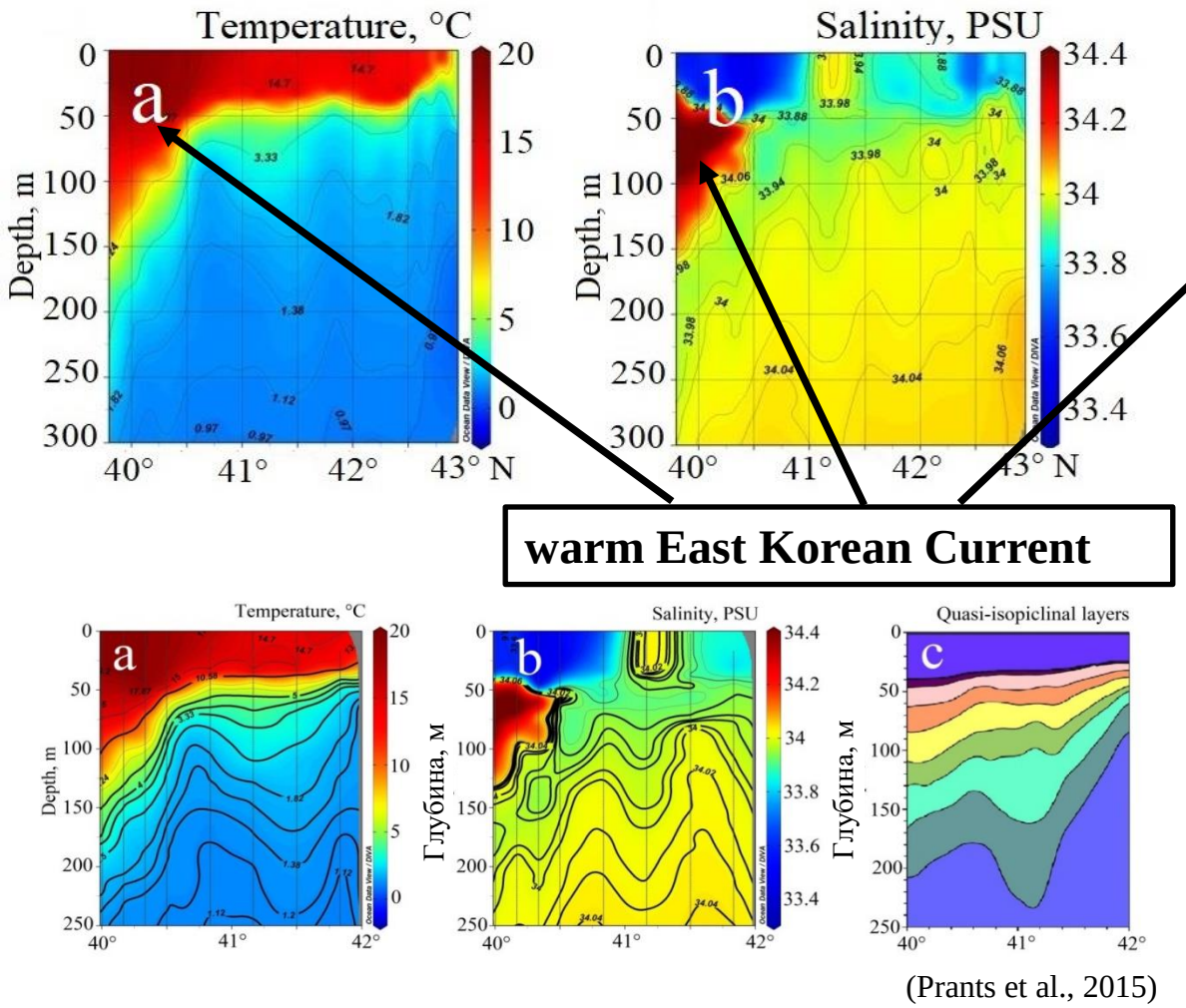




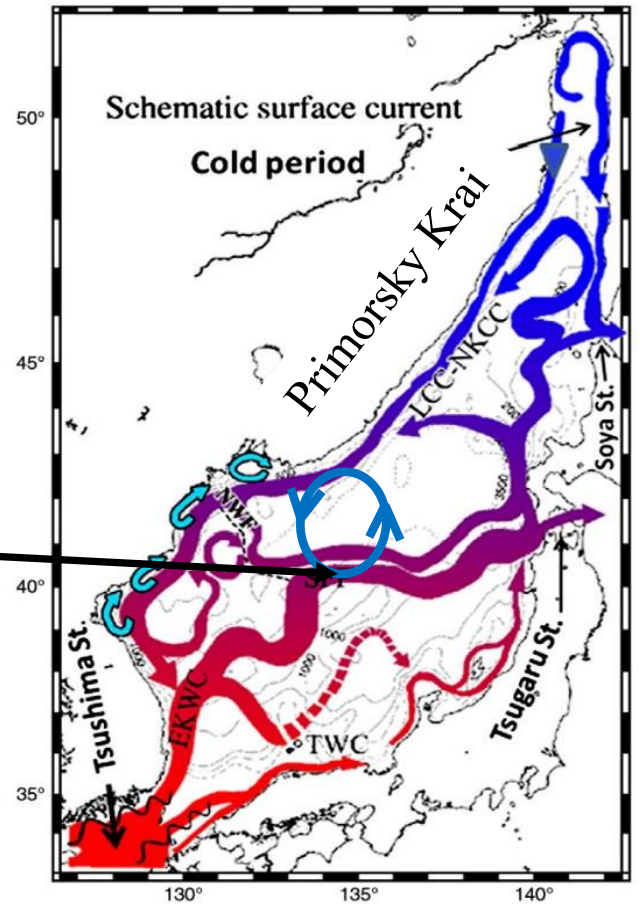
The section shows the lack of bottom sources of CH_4

Sea of Japan, Western Pacific Ocean

The distribution of CH_4, temperature, and salinity along the meridional section



(Prants et al., 2015)

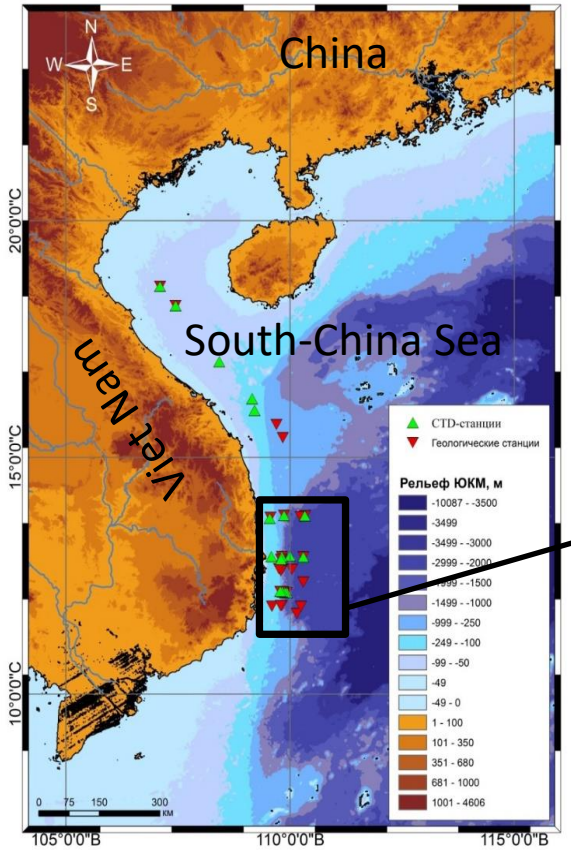


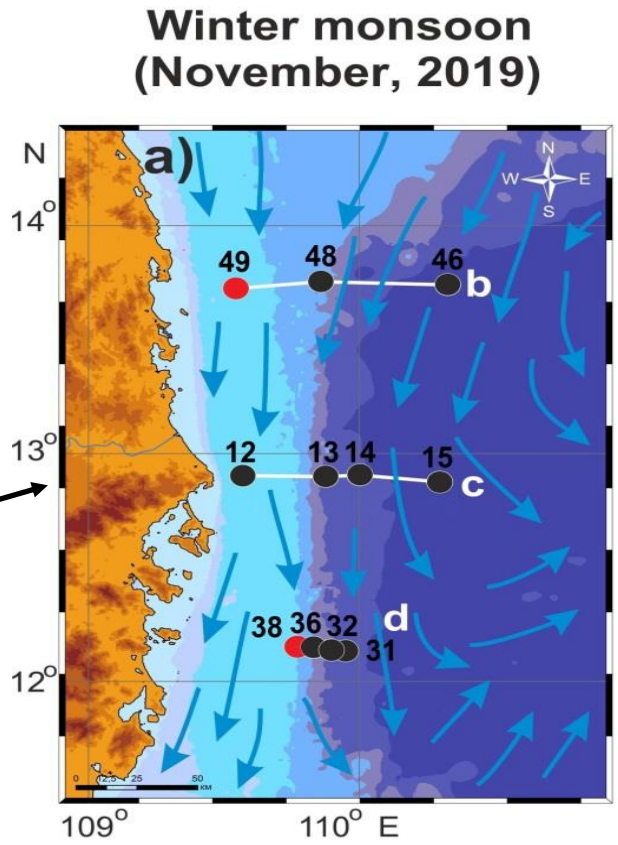
Currents of Japan (East) Sea (Yoon, Kim, 2009)

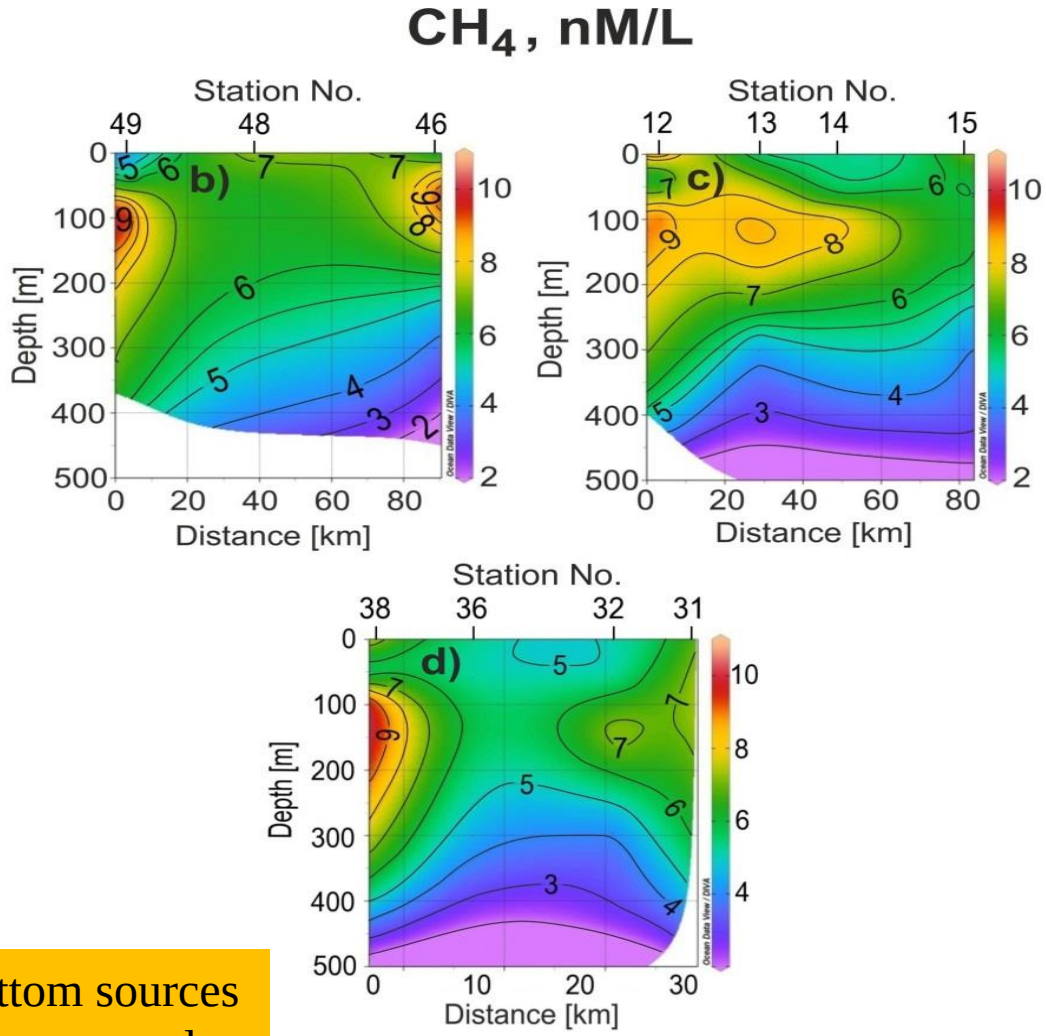
Increased concentrations of methane are found on the periphery of the eddy, with the absolute maximum in the waters of the East Korean Current

South-China Sea (Bien Dong Sea), Pacific Ocean

Results of methane sampling in water in the Phu Khan sedimentary basin



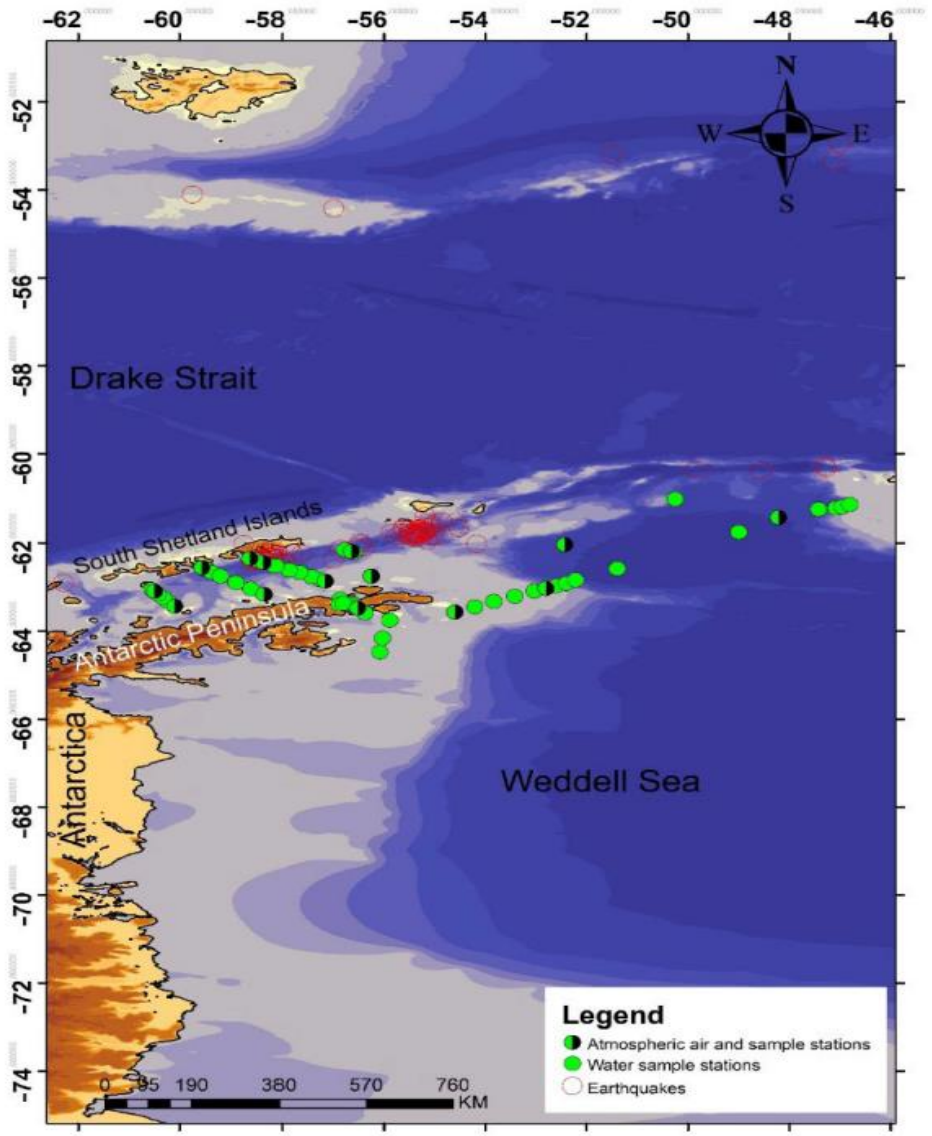


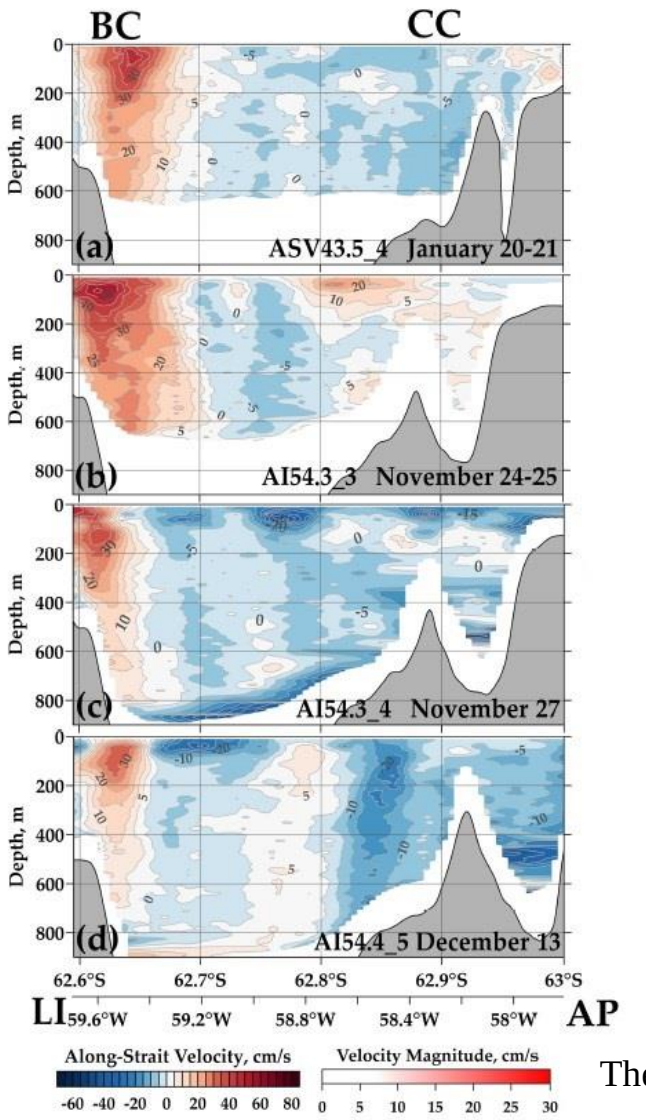


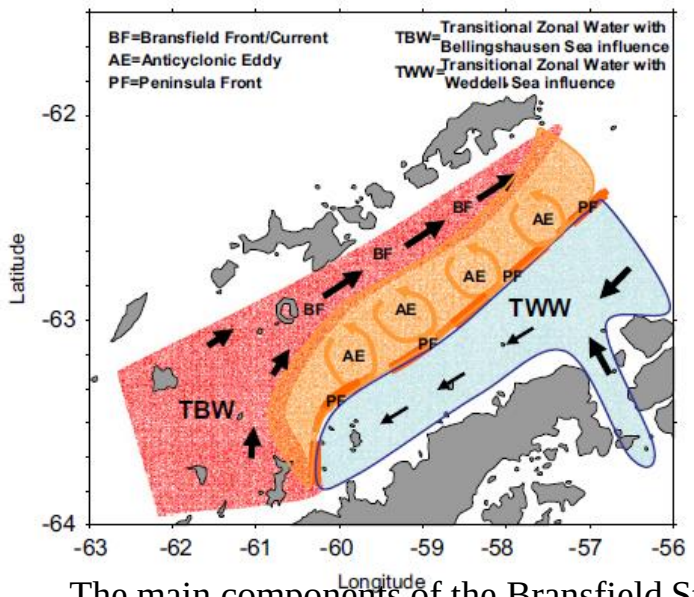
- The sections show the absence of vertical methane migration from bottom sources
- Methane is transported along the shelf under the lower boundary of the seasonal pycnocline by the Vietnamese current from the north to south

Bransfield Strait, South Ocean

The distribution of methane concentrations in the Bransfield Strait is largely controlled by the hydrological regime







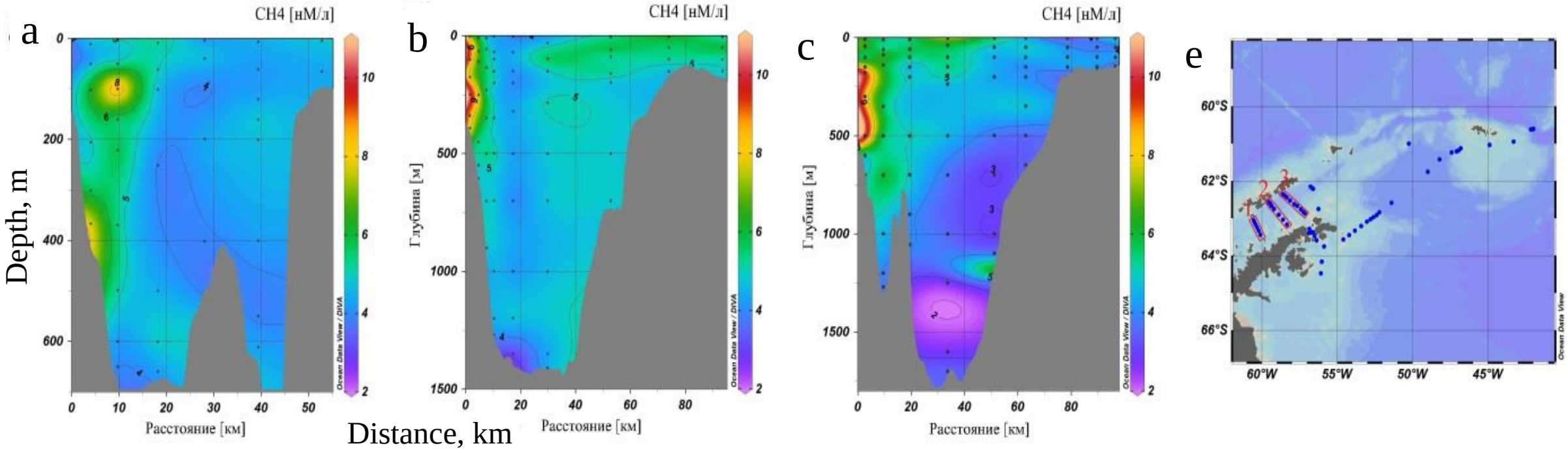
The main components of the Bransfield Strait current system [Sangrà et al., 2011]

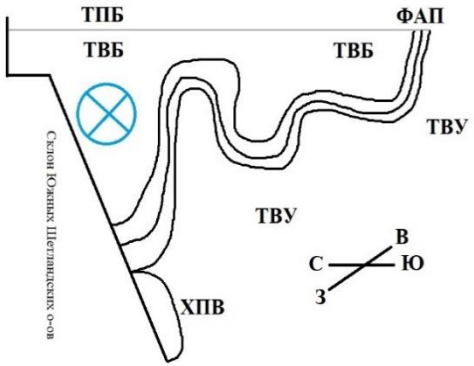
The increase in methane concentration is associated with the movement of water masses from the deep-sea part of the Antarctic Strait, where there are areas of gas discharge at the bottom.

The results of measurements of flow velocities [Frey et al., 2023]

Bransfield Strait, South Ocean

Methane transport by the Bransfield Strait current

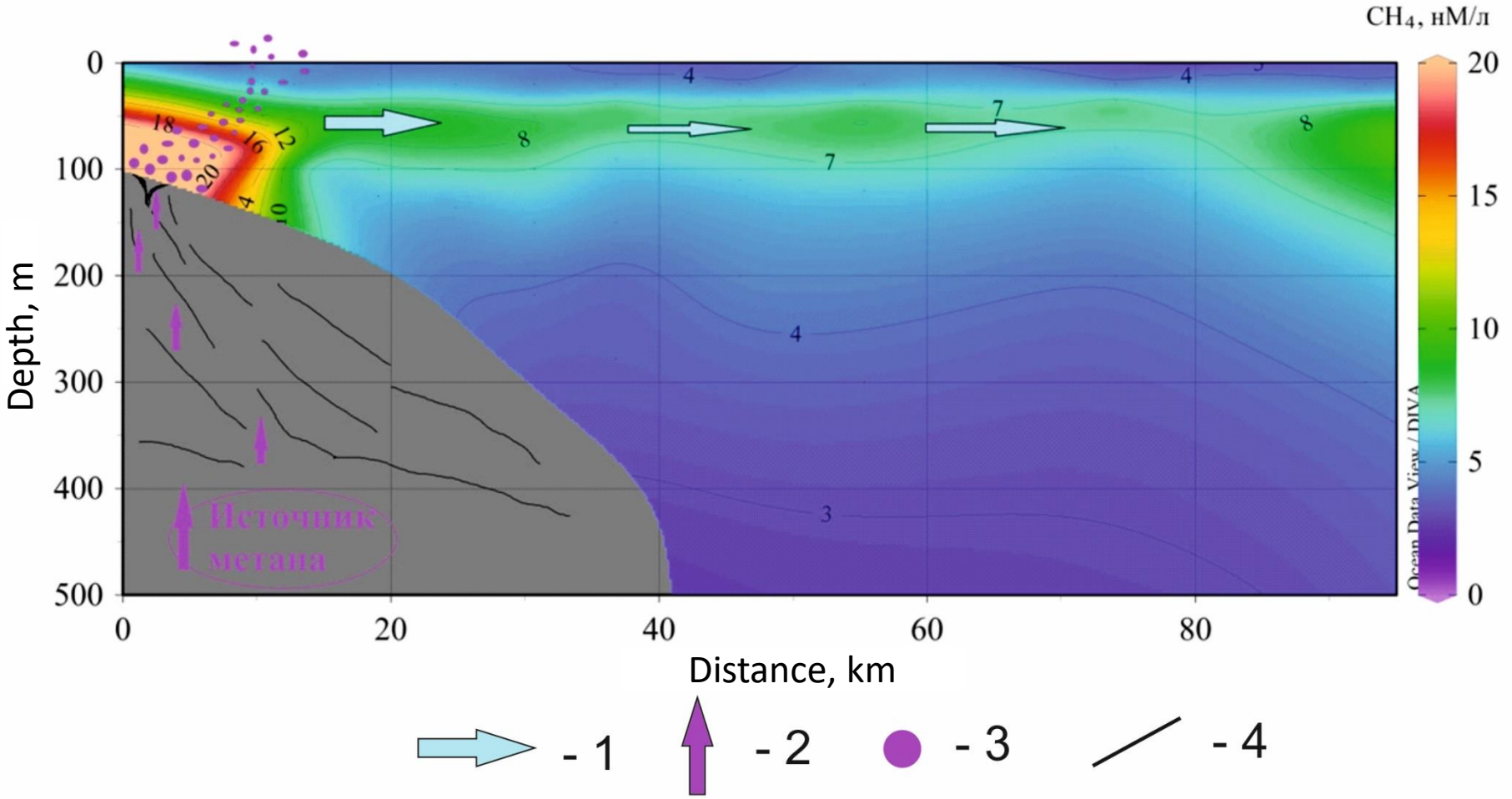




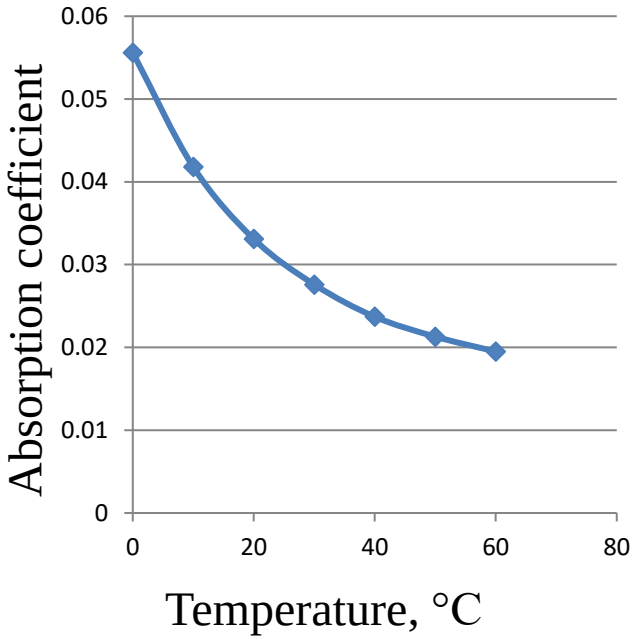
Dissolved methane is transferred in the jet of warm waters of the Bellingshausen Sea to the east

Kholmogorov, A.; Syrbu, N.; Shakirov, R. Influence of Hydrological Factors on the Distribution of Methane Fields in the Water Column of the Bransfield Strait: Cruise 87 of the R/V “Academik Mstislav Keldysh”, 7 December 2021–5 April 2022. Water **2022**, 14, 3311. https://doi.org/10.3390/w14203311

The mechanism of transport of dissolved methane in the area of the highest current velocity



The solubility of methane in water depends on temperature



Methane dissolves more easily in cold water, below the surface layer, and is carried by sea currents over long distances, below the lower boundary of the seasonal picnocline

The origin of local maxima of methane content under the seasonal pycnocline in the rings of the South Atlantic current

- We found well-defined **local maximum of methane concentration** within the oceanographic section through the anticyclonic and cyclonic rings. This maximum was located under the seasonal pycnocline, and its origin was investigated **using the Lagrangian modeling method**.

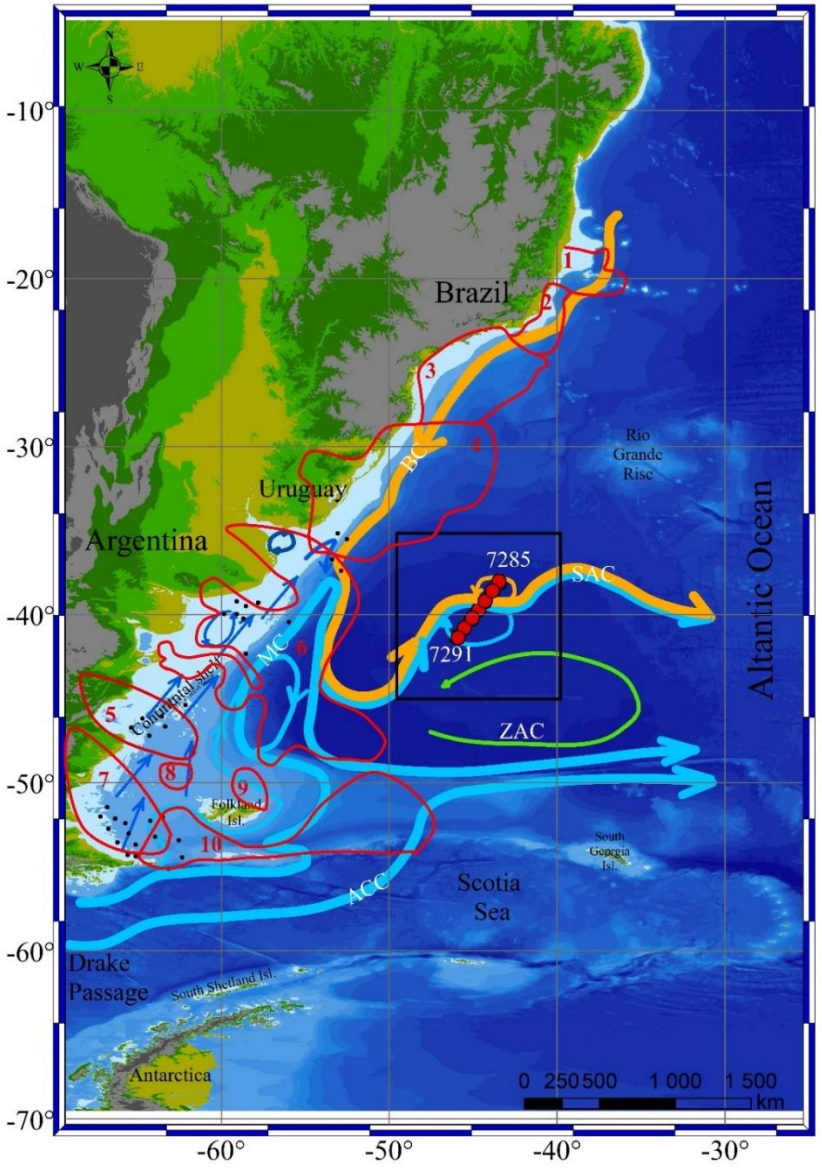
- To determine the possible sources of methane in the Argentine Basin, virtual particles were projected back in time from a starting point to segments of straight lines that crossed the current branches in areas with known oil and gas potential.

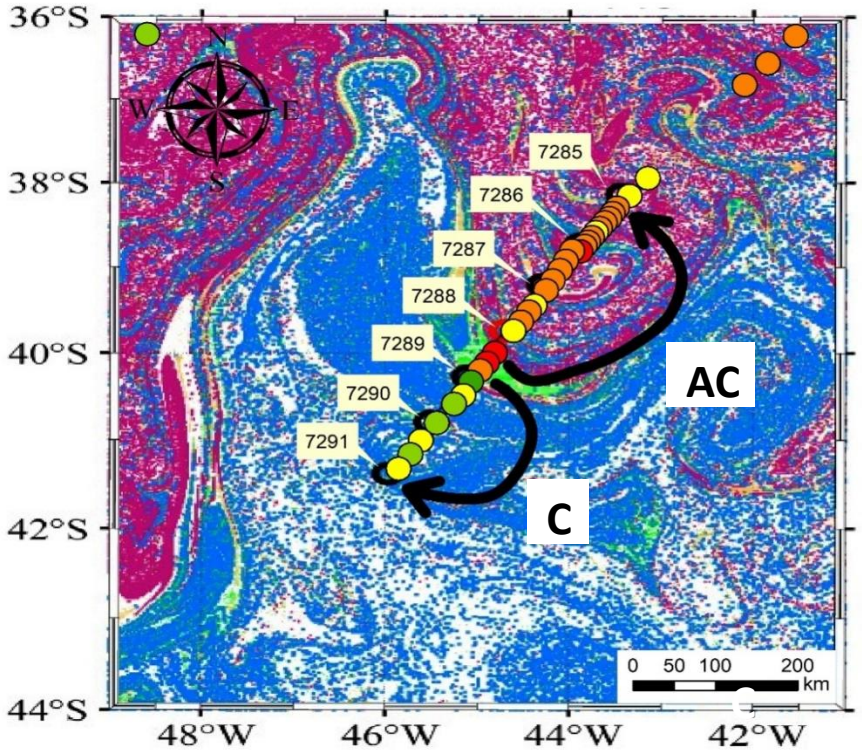
- Lagrangian modeling of the trajectories of passive markers using forward and backward time integration based on the AVISO velocity field (modelling by Budyansky M.V. and Uleysky M.Y., POI FEB RAS)

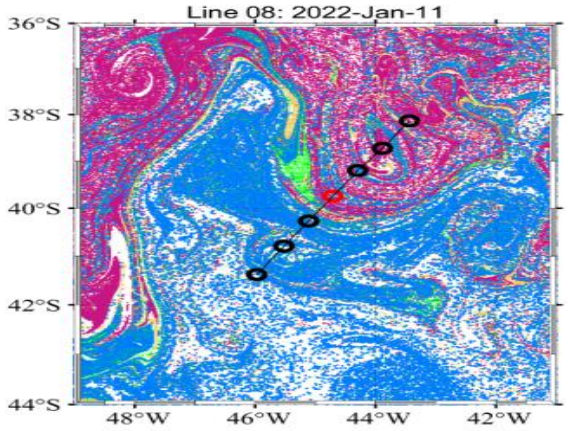
This is our new search method to find seabed methane sources using gas geochemistry, oceanology and Lagrangian modeling

The southern sector of the Atlantic Ocean

Methane distribution







Brazil Current

Malvina Current (ocean branch)

Malvinas Current (shelf branch)

Lagrangian map of different waters (Budyansky M.V.)

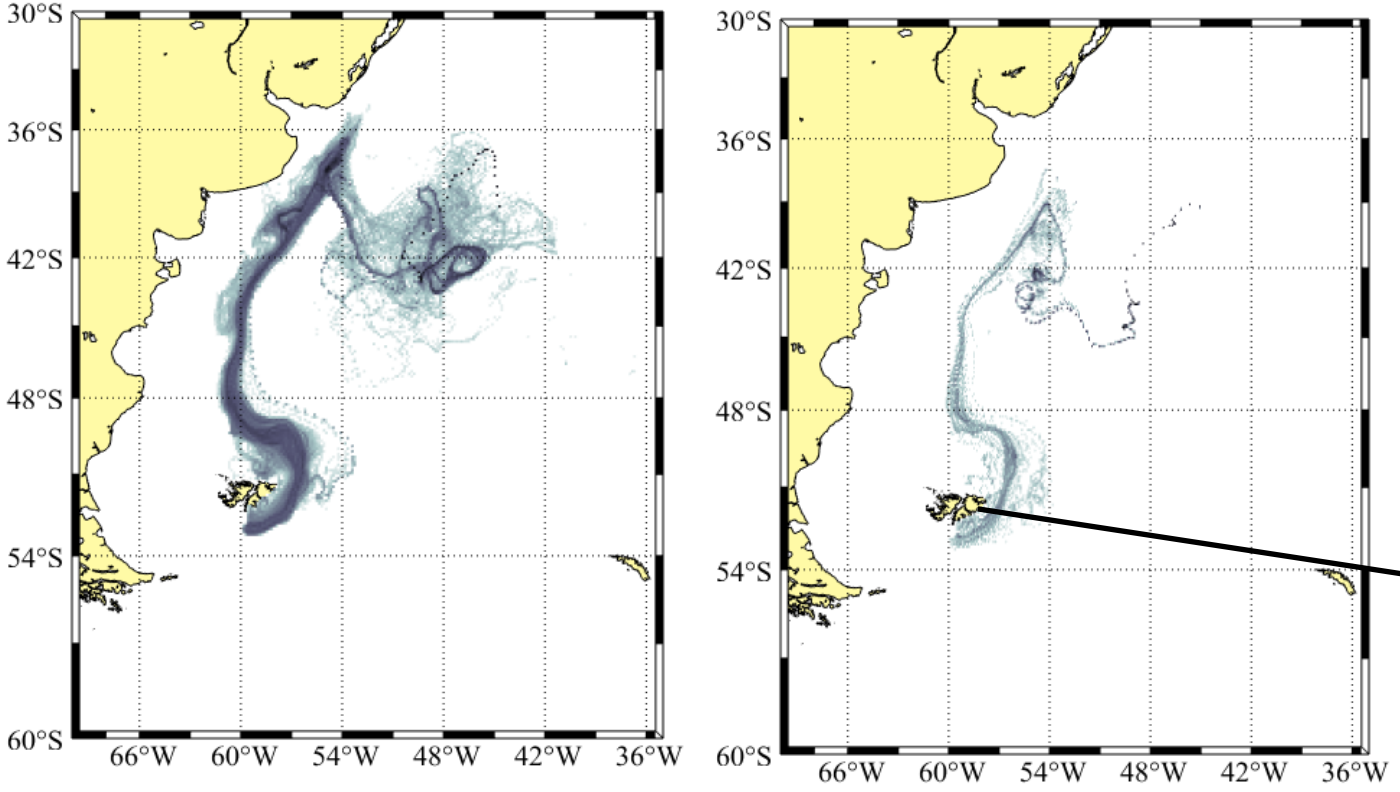
- ✓ **Elevated methane concentrations are carried by Brazil Current.**
- ✓ **Absolute methane maximum has a compact form and is carried by the shelf branch of Malvinas current.**

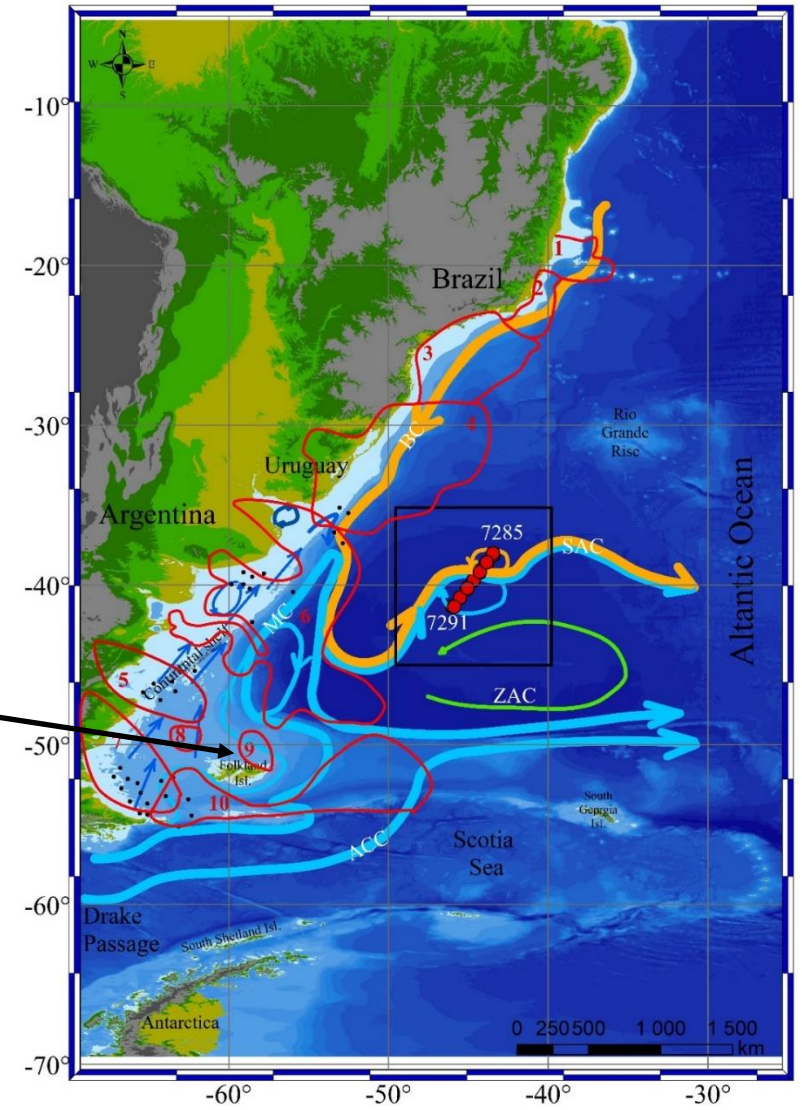
Ocean currents [Piola, Matano, 2001; Frey, Kubryakov, 2023]

The southern sector of the Atlantic Ocean

Modelling results

Virtual particles transport to Malvinas oil basin





Ocean currents transport dissolved methane for a long distance

The mechanisms of methane distribution and transport are of the great importance

- **identifying indirect signs of hydrocarbon deposits**
- **solving problems of methane emission as a greenhouse gas**

Elevated concentrations of methane are transported under the lower boundary of the seasonal pycnocline by currents from its source, which makes it possible to determine areas of potential hydrocarbon deposits **without using complex techniques**

Methane dissolved in seawater can also indicate areas of concentration of microbiological communities, including those that are the food base of commercial biological species

The study corresponds to the main directions of The United Nations Decade of Ocean Science for Sustainable Development

Thank you for your attention