

Structure of the freshened surface layer in the Eastern Arctic during ice-free periods

Alexander Osadchiev and Dmitry Frei

Shirshov Institute of Oceanology, Russian Academy of Sciences, Moscow, Russia



Freshwater discharge to the Arctic Ocean

Arctic Ocean:

- 3% of area of the World Ocean
- 1% of volume of the World Ocean
- 11% of river discharge to the World Ocean



Freshwater discharge to the Arctic Ocean

Arctic Ocean:

- 3% of area of the World Ocean
- 1% of volume of the World Ocean
- 11% of river discharge to the World Ocean

Freshwater discharge



Stratification



Ice formation



Earth albedo



Global climate



Freshwater discharge to the Arctic Ocean

Arctic Ocean:

- 3% of area of the World Ocean
- 1% of volume of the World Ocean
- 11% of river discharge to the World Ocean

Freshwater discharge



Stratification



Ice formation



Earth albedo

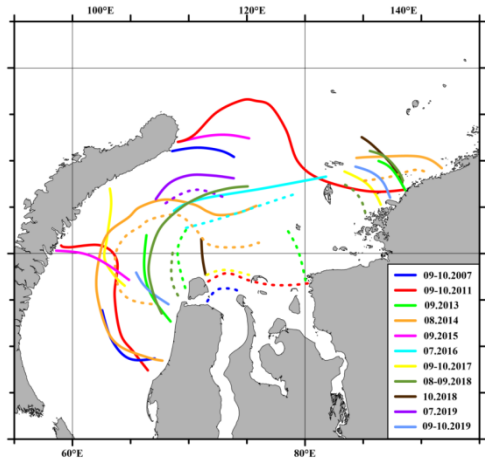


Global climate

And many important regional processes:

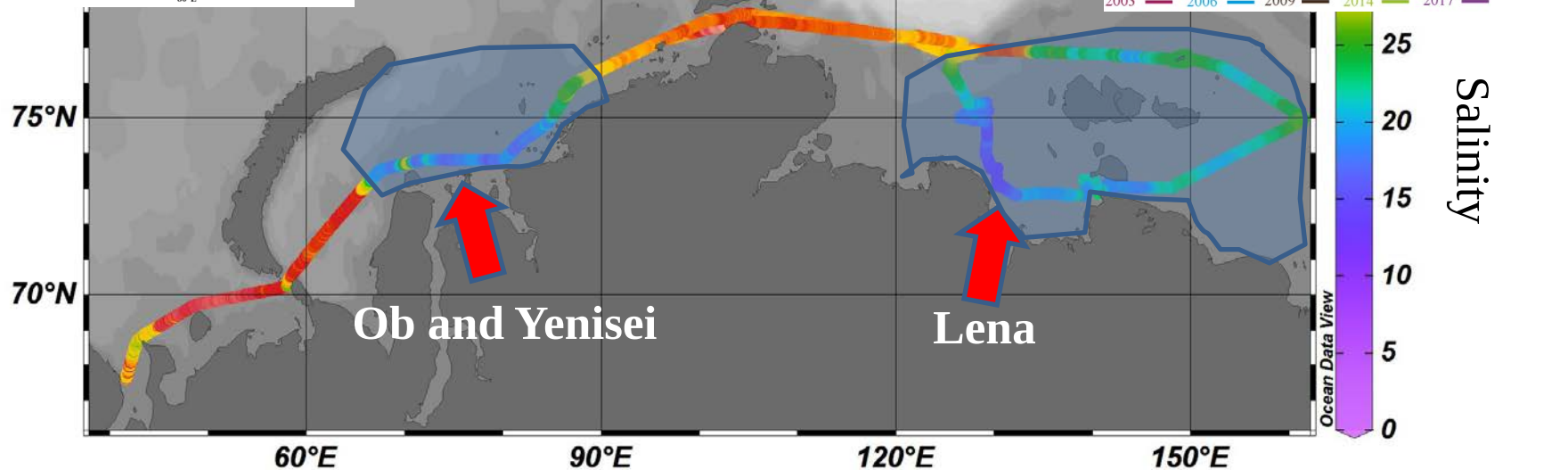
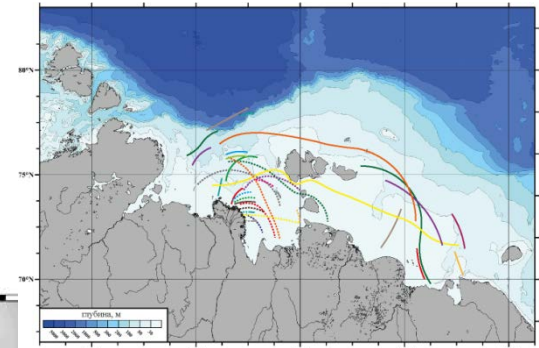
- biological productivity
- nutrient cycle
- carbon cycle
- acidification
- pollution
- ...

Freshened surface layer in the Eastern Arctic



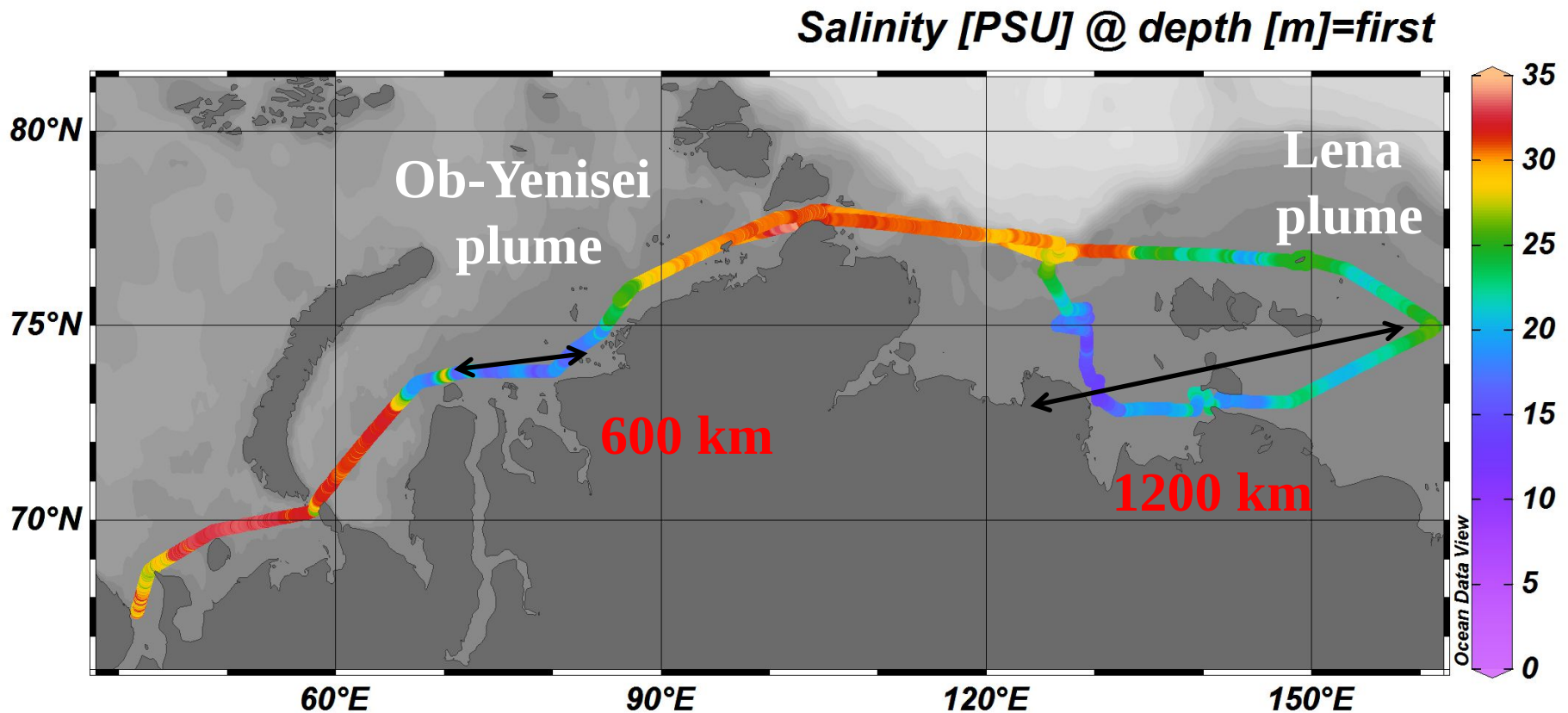
11 cruises in
2007-2019

17 cruises in
1999-2019



Ob-Yenisei plume in the Kara Sea
Lena plume in the Laptev and East-Siberian seas

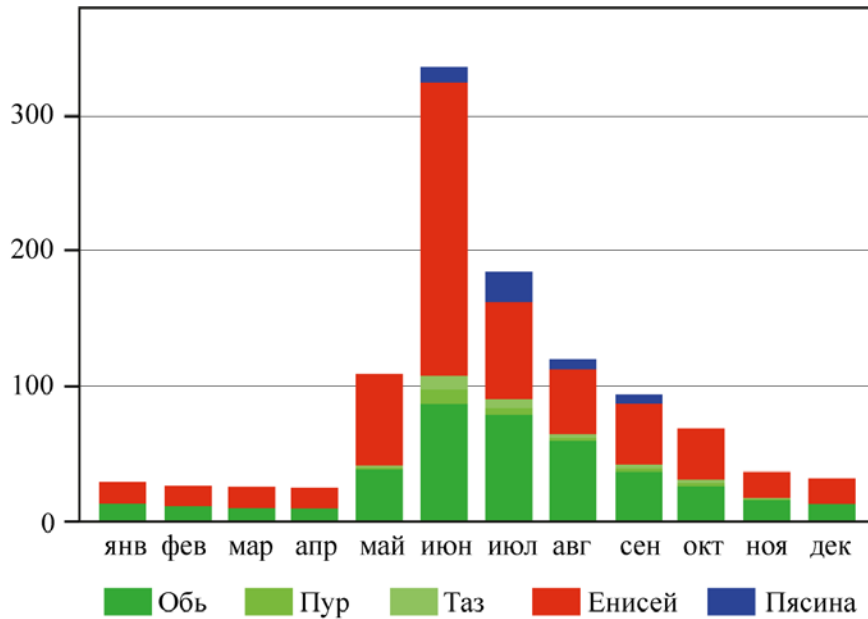
Ob-Yenisei and Lena plumes



September – October 2019

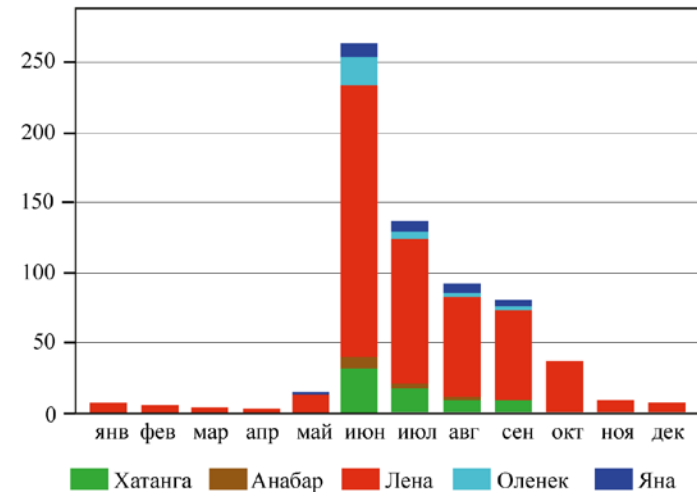
Ob, Yenisei, and Lena rivers

Kara Sea

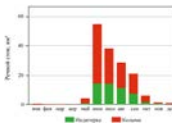


1600 km³ of annual river discharge to the **Kara Sea** from the Ob, Yenisei and smaller rivers

Laptev Sea

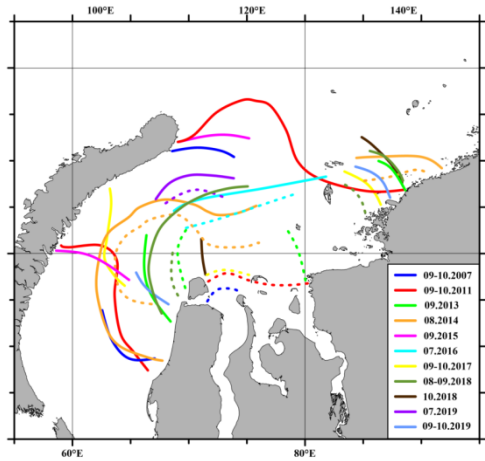


East-Siberian Sea



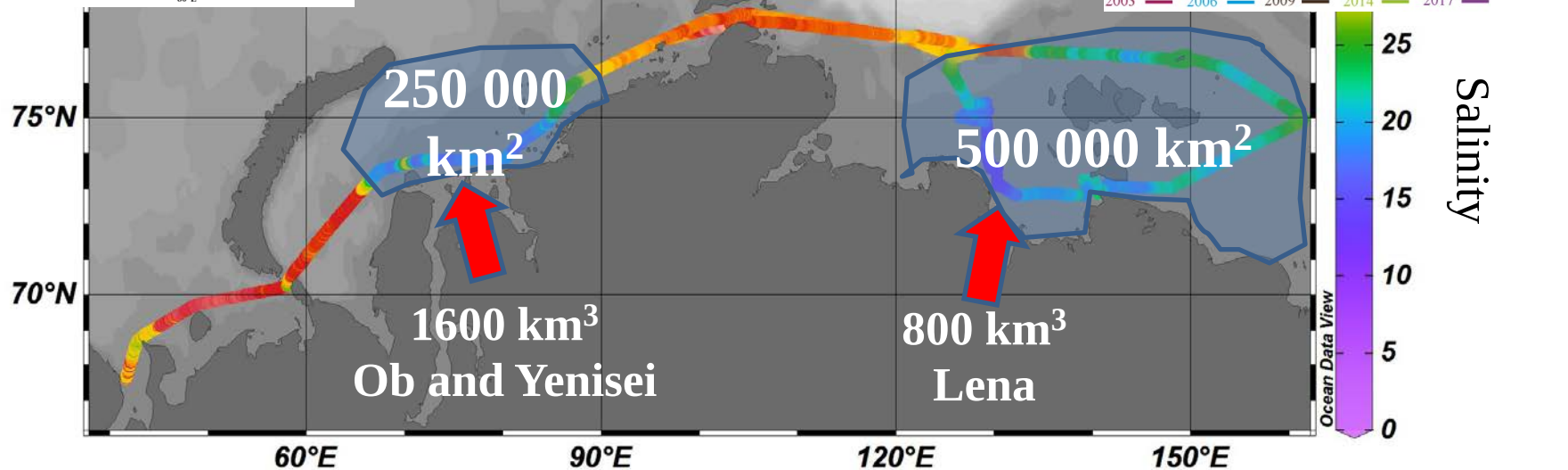
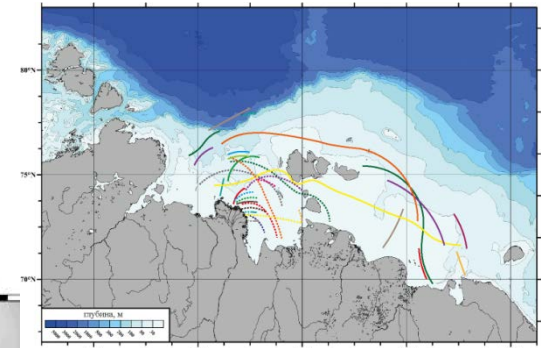
1000 km³ of annual river discharge to the **Laptev Sea** and the **East-Siberian Sea** from the Lena and smaller rivers

Freshened surface layer in the Eastern Arctic



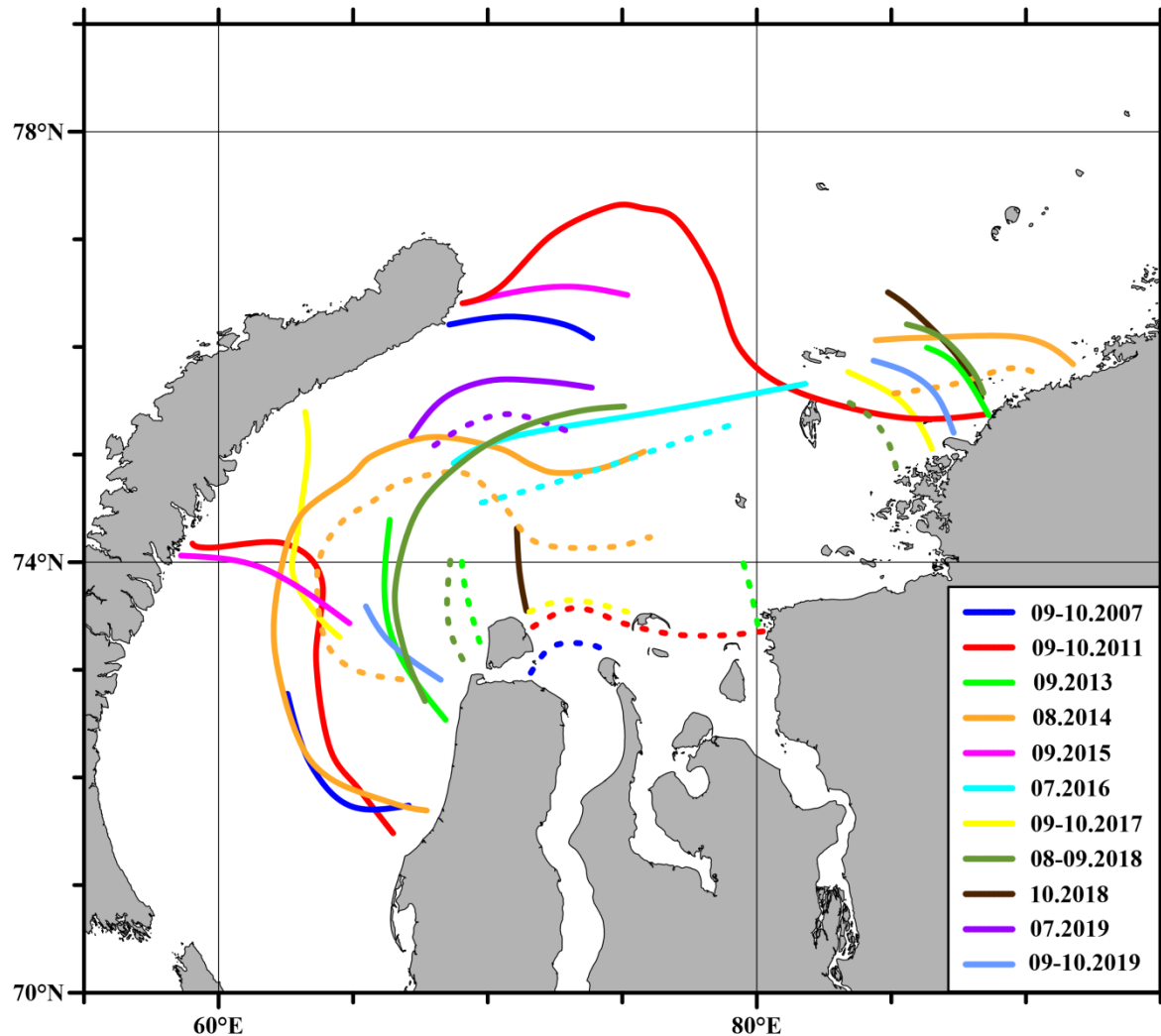
11 cruises in
2007-2019

17 cruises in
1999-2019



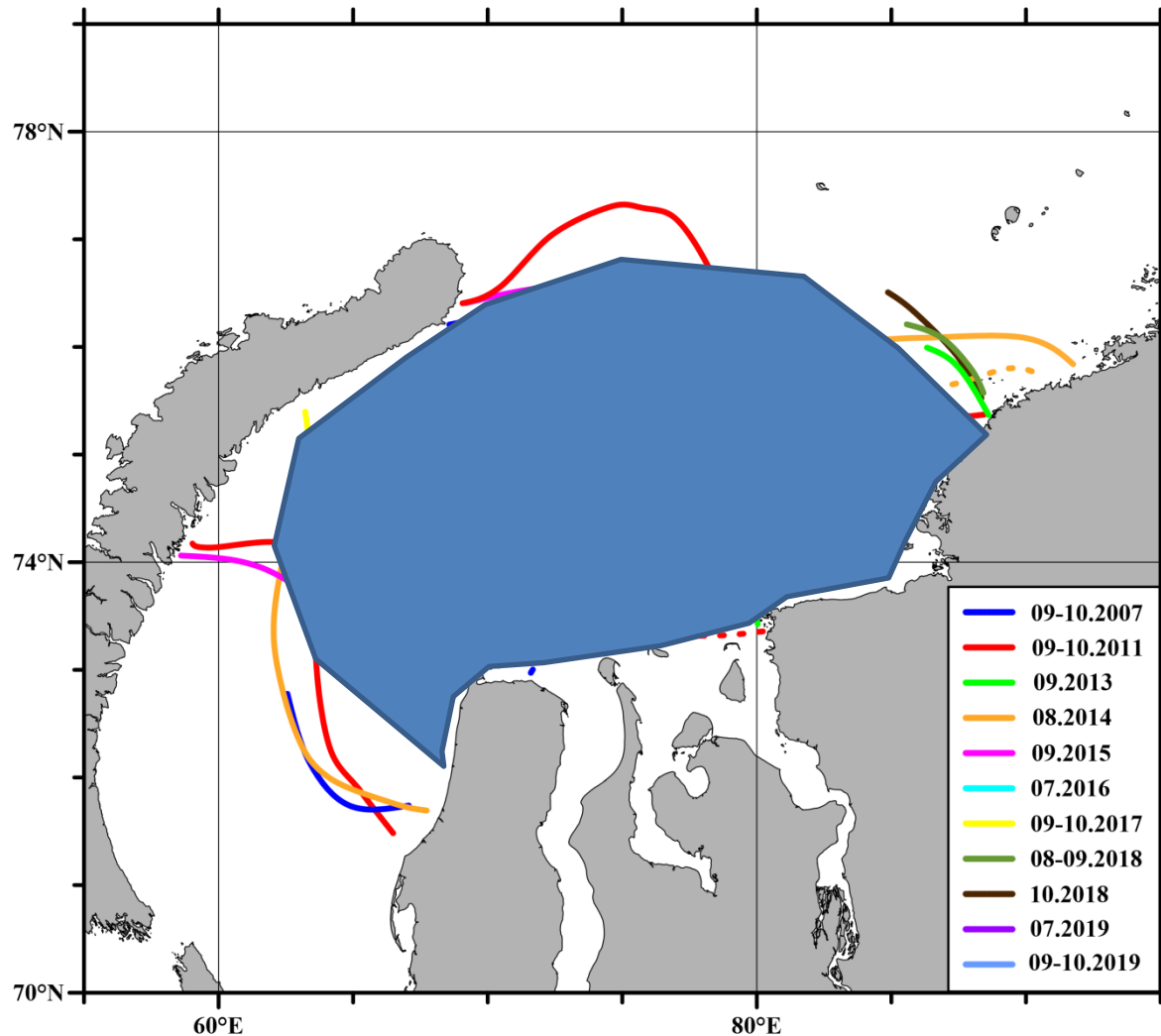
Area of the Lena plume is twice greater than area of the Ob-Yenisei plume
Actually the Lena plume is largest in the World Ocean

Ob-Yenisei plume



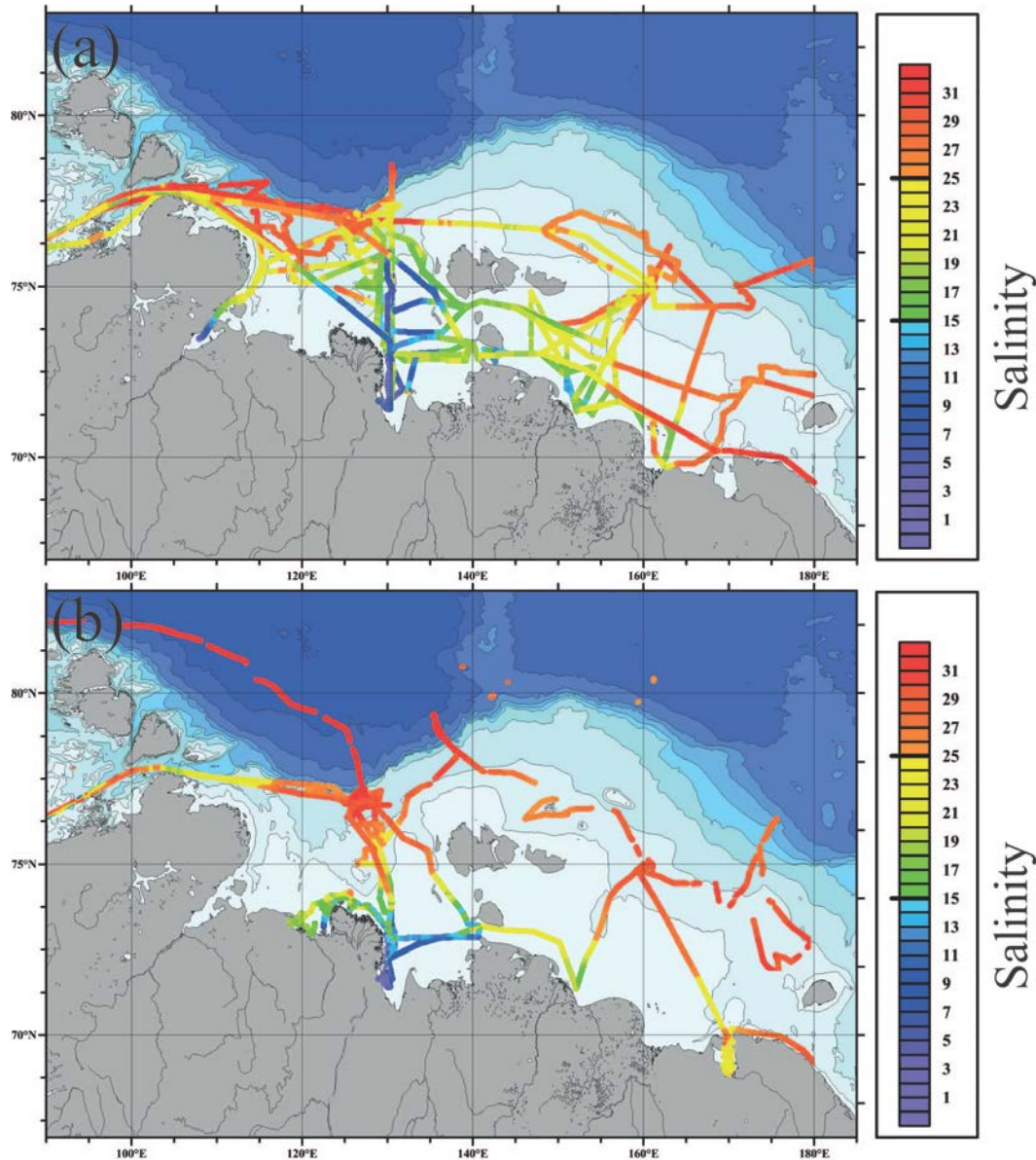
The Ob-Yenisei plume has very stable area and position

Ob-Yenisei plume



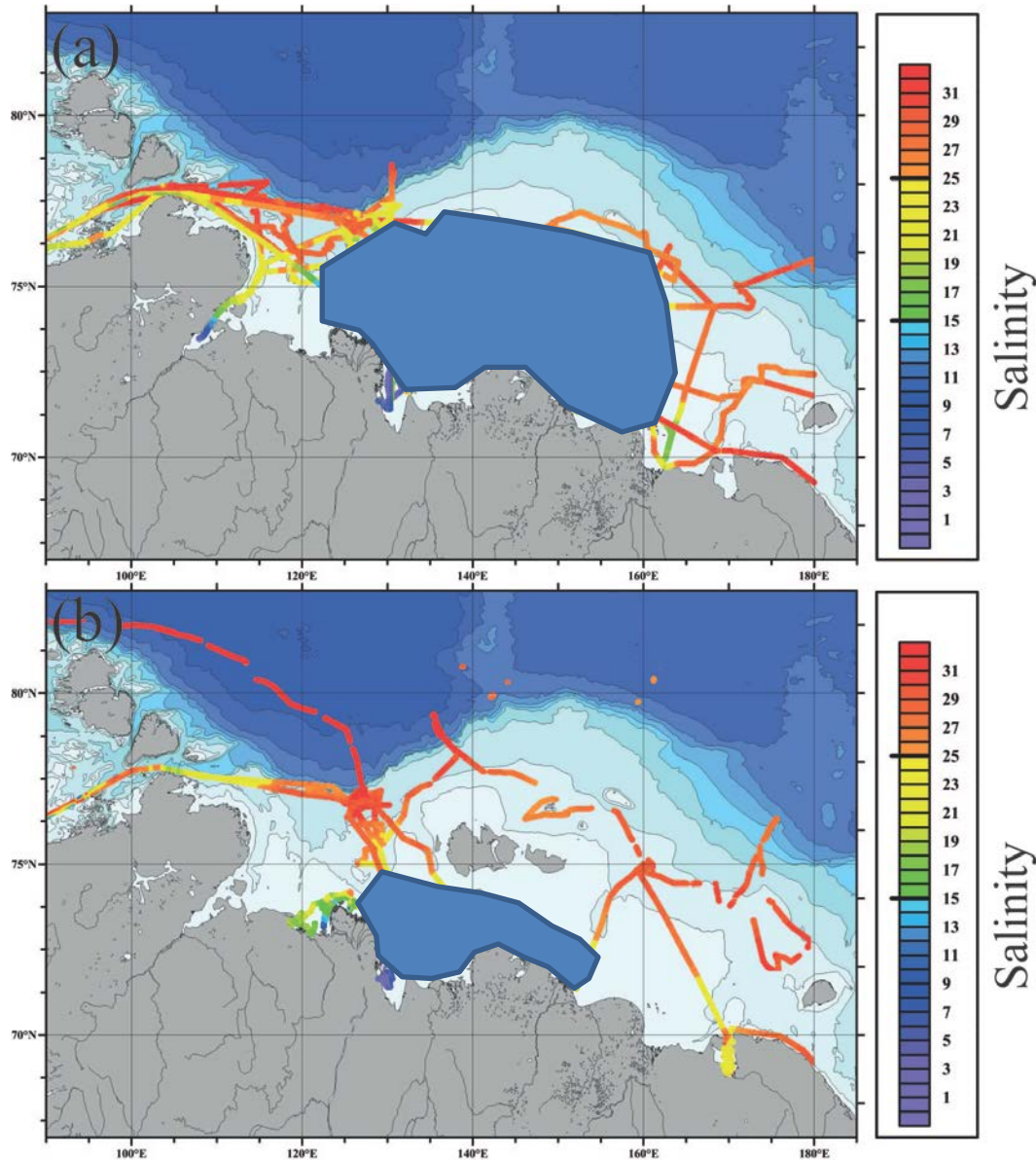
The Ob-Yenisei plume has very stable area and position

Lena plume



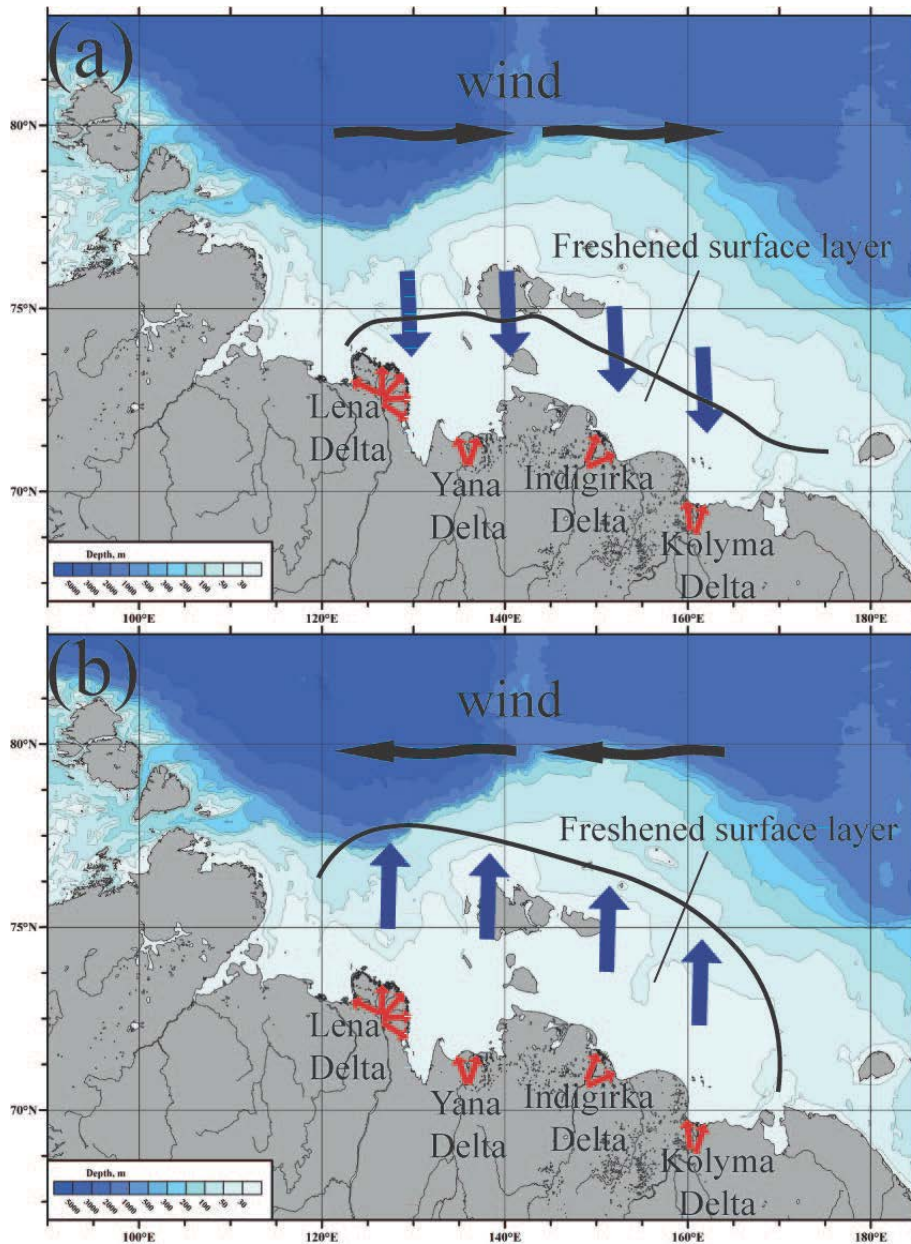
The Lena plume has large inter-annual variability of area and position

Lena plume



The Lena plume has large inter-annual variability of area and position

Lena plume



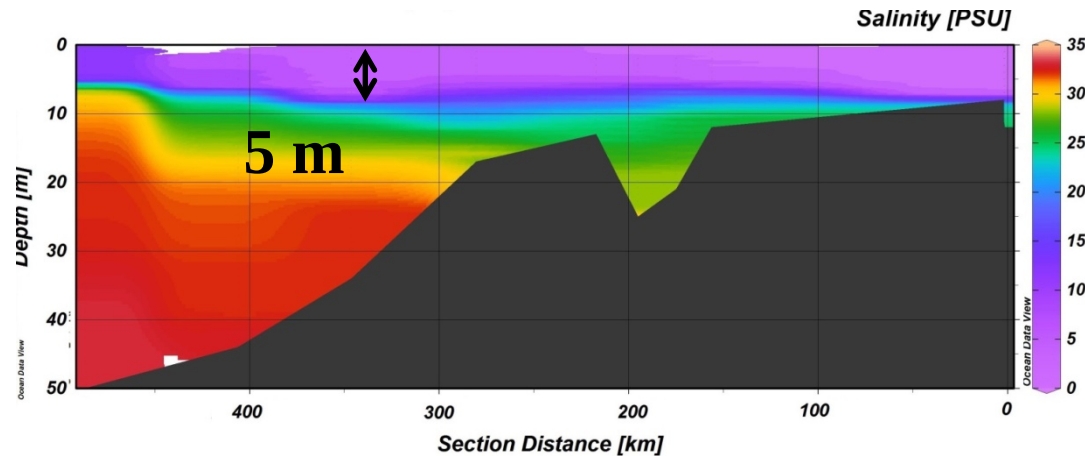
The Lena plume has large inter-annual variability of area and position.

It depends on wind forcing and shows no relation to river discharge rate

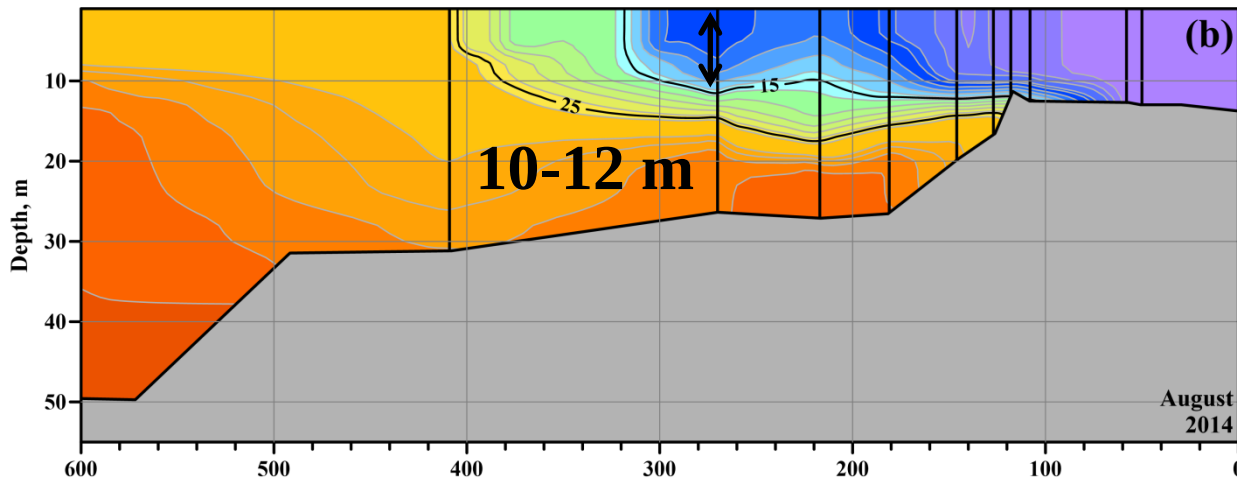
1. The Lena plume receives less freshwater discharge than the Ob-Yenisei plume, but area of the Lena plume is much larger
2. The Ob-Yenisei plume has low inter-annual variability of area and position, while the Lena plume has very large variability.
3. The Lena plume is much more sensitive to wind forcing than the Ob-Yenisei plume

WHY?

Ob-Yenisei and Lena plumes



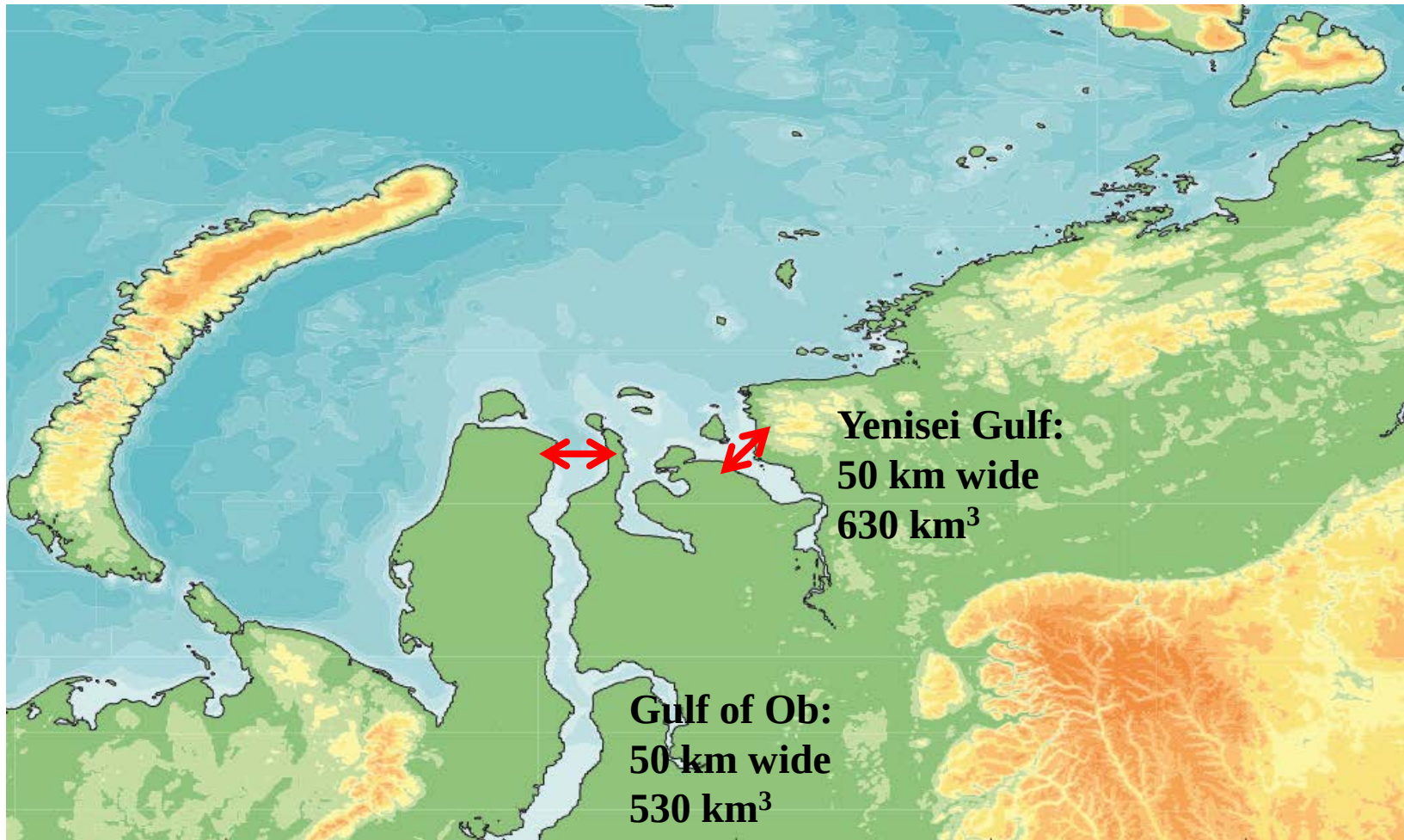
**Lena plume
~5 m deep**



**Ob-Yenisei plume
~10-12 m deep**

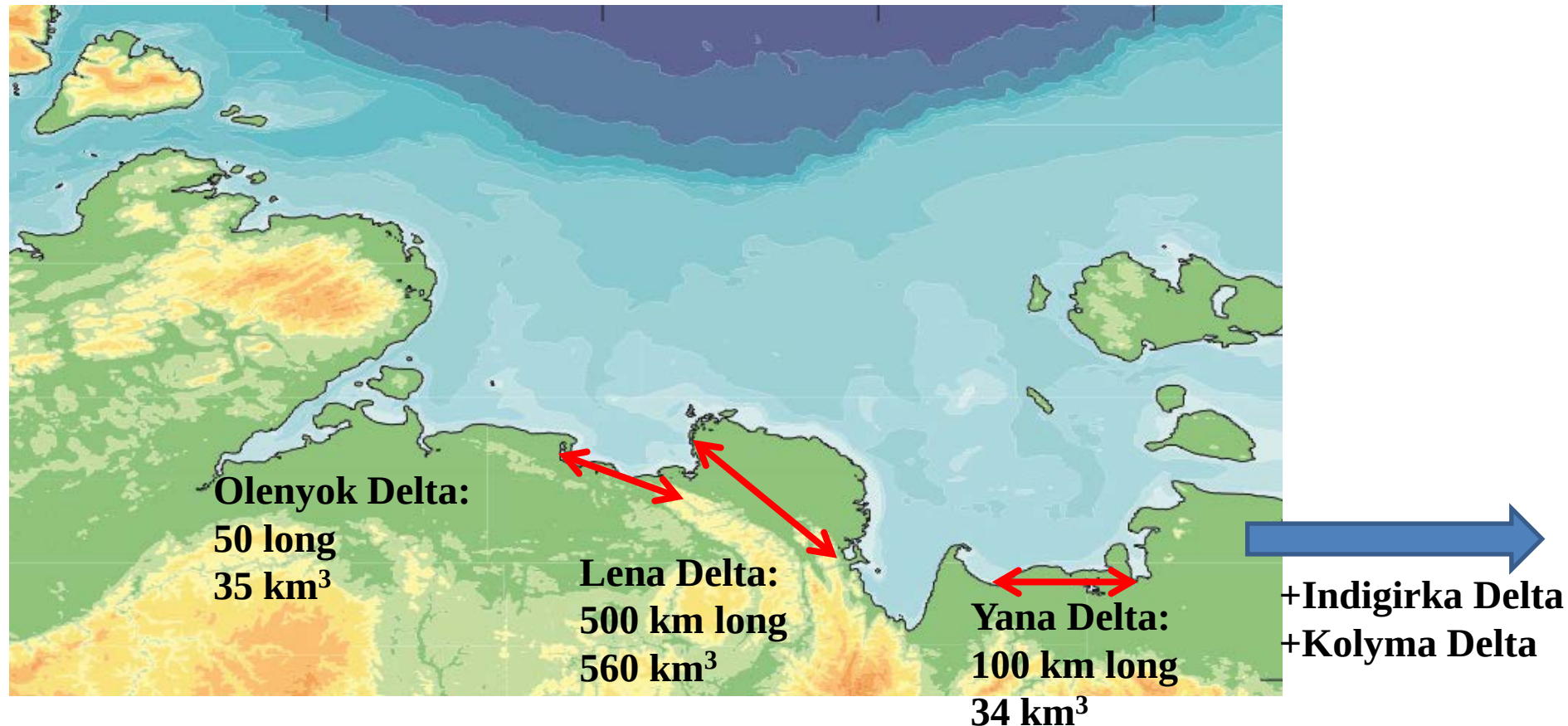
The Lena plume is more shallow than the Ob-Yenisei plume, therefore it occupies greater surface area at the sea shelf

Ob-Yenisei plume in the Kara Sea



The Ob-Yenisei plume is formed by two large estuarine rivers.
The Ob-Yenisei plume experiences intense mixing in deep estuaries.
The Ob-Yenisei plume is deep (12-16 m) and have “small” area.

Lena plume in the Laptev and East-Siberian seas



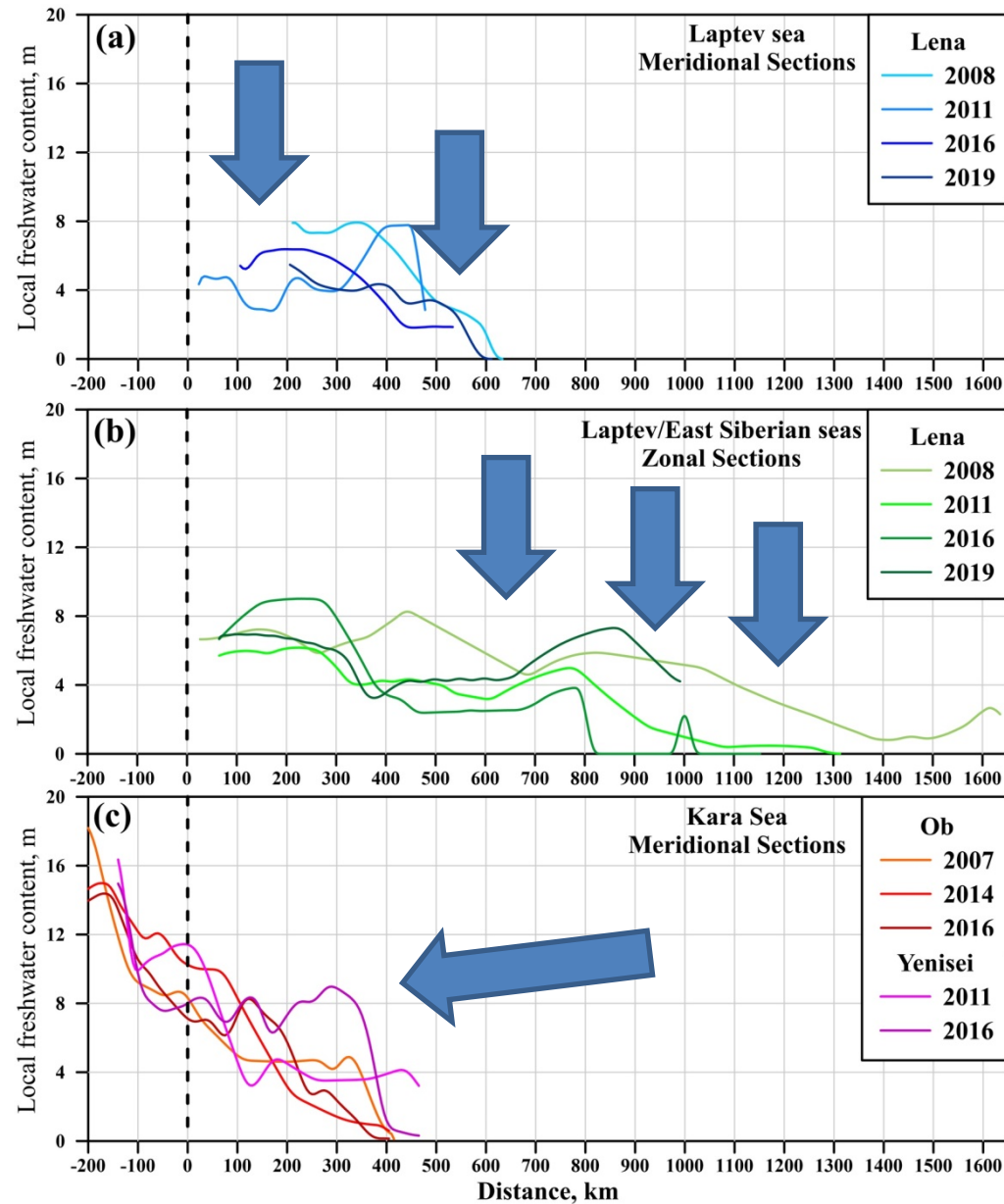
The Lena plume is formed by discharges from deltaic rivers, i.e., numerous shallow and narrow deltaic channels = small rivers.

The Lena plume experiences low mixing in the deltaic channels

The Lena plume is shallow (5-8 m) and has very large area.

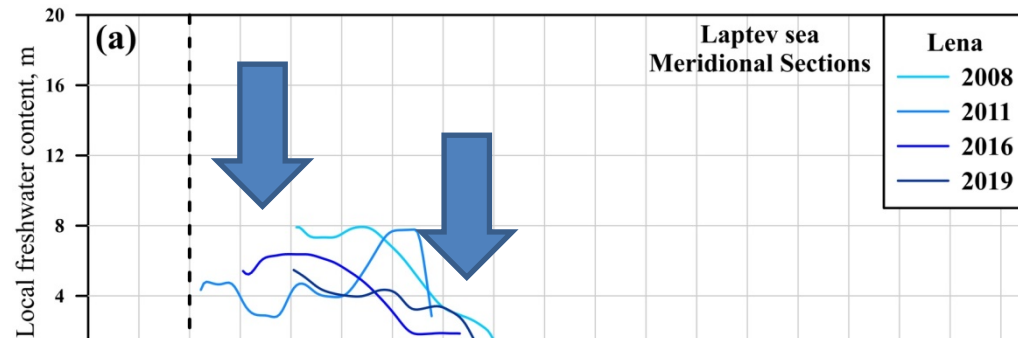
Ob-Yenisei and Lena plumes

Stable freshwater content within the Lena plume



Abrupt decrease of freshwater content in the Ob and Yenisei estuaries

Ob-Yenisei and Lena plumes



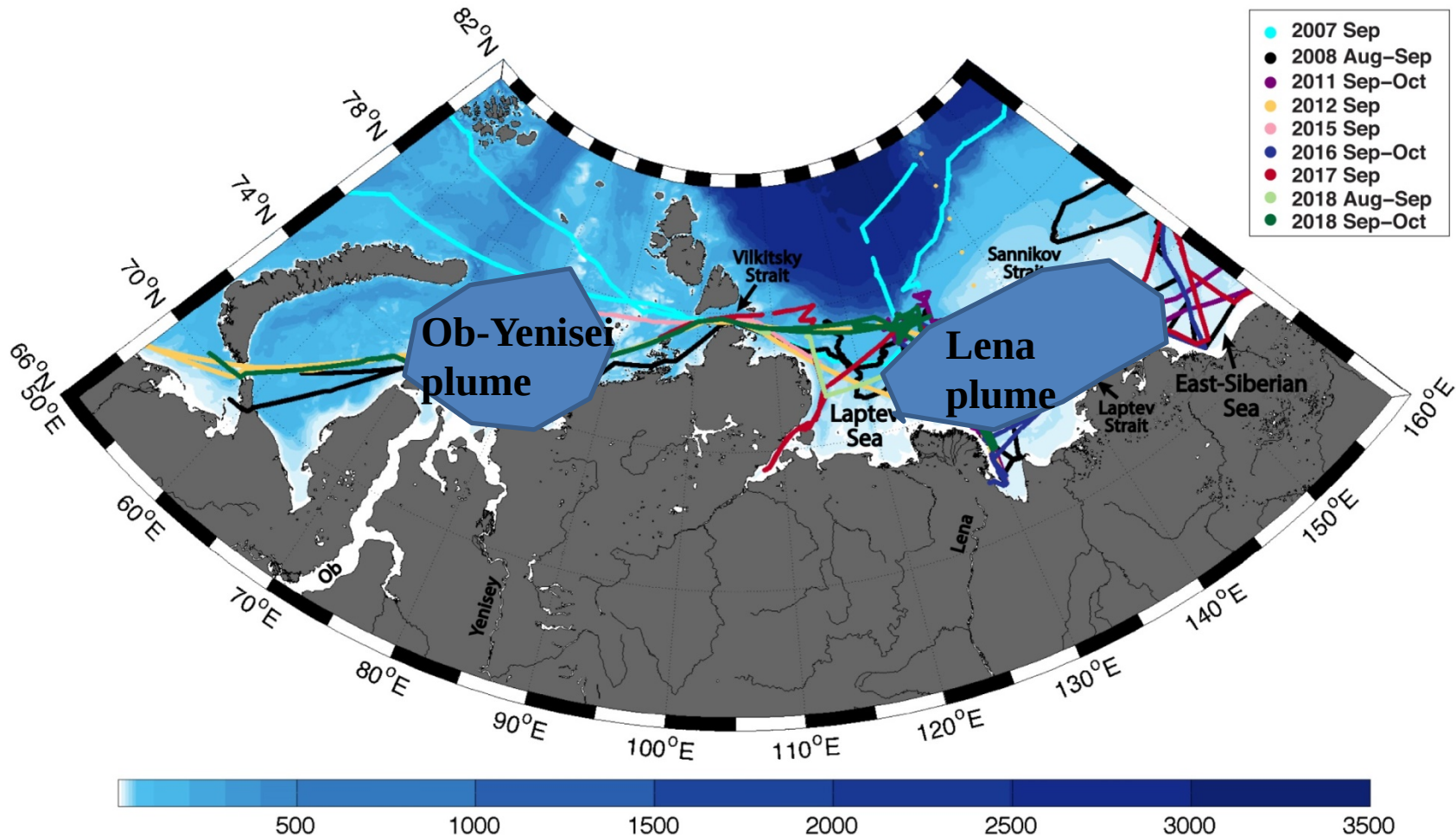
Structure of the freshened surface layer in the Kara Sea during ice-free periods

Osadchiev et al., 2021; *JGR-Oceans*

Structure of the freshened surface layer in the Laptev and East-Siberian seas during ice-free periods

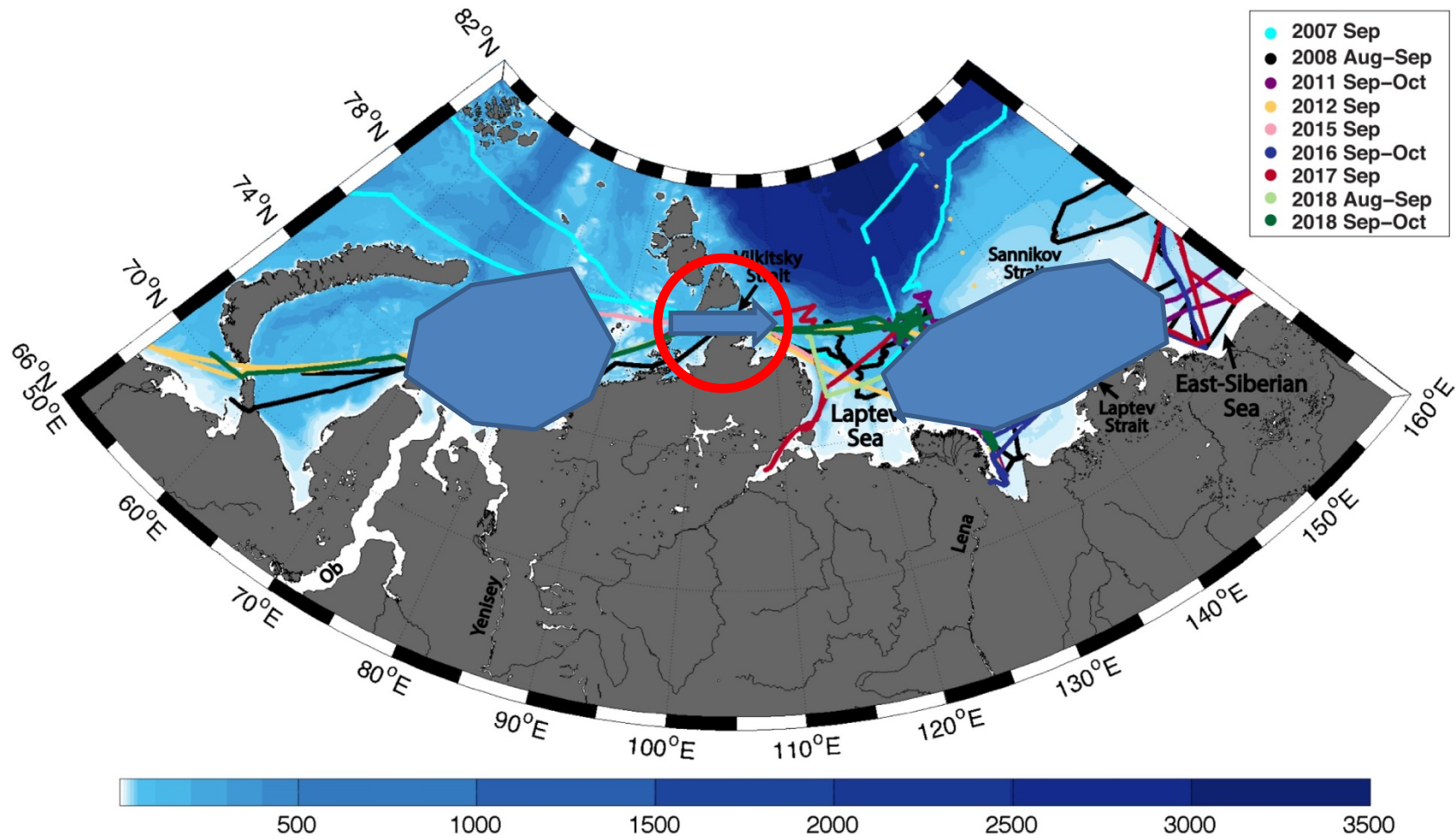
Osadchiev et al., 2021; *FMS*, under revision

Large-scale freshwater transport



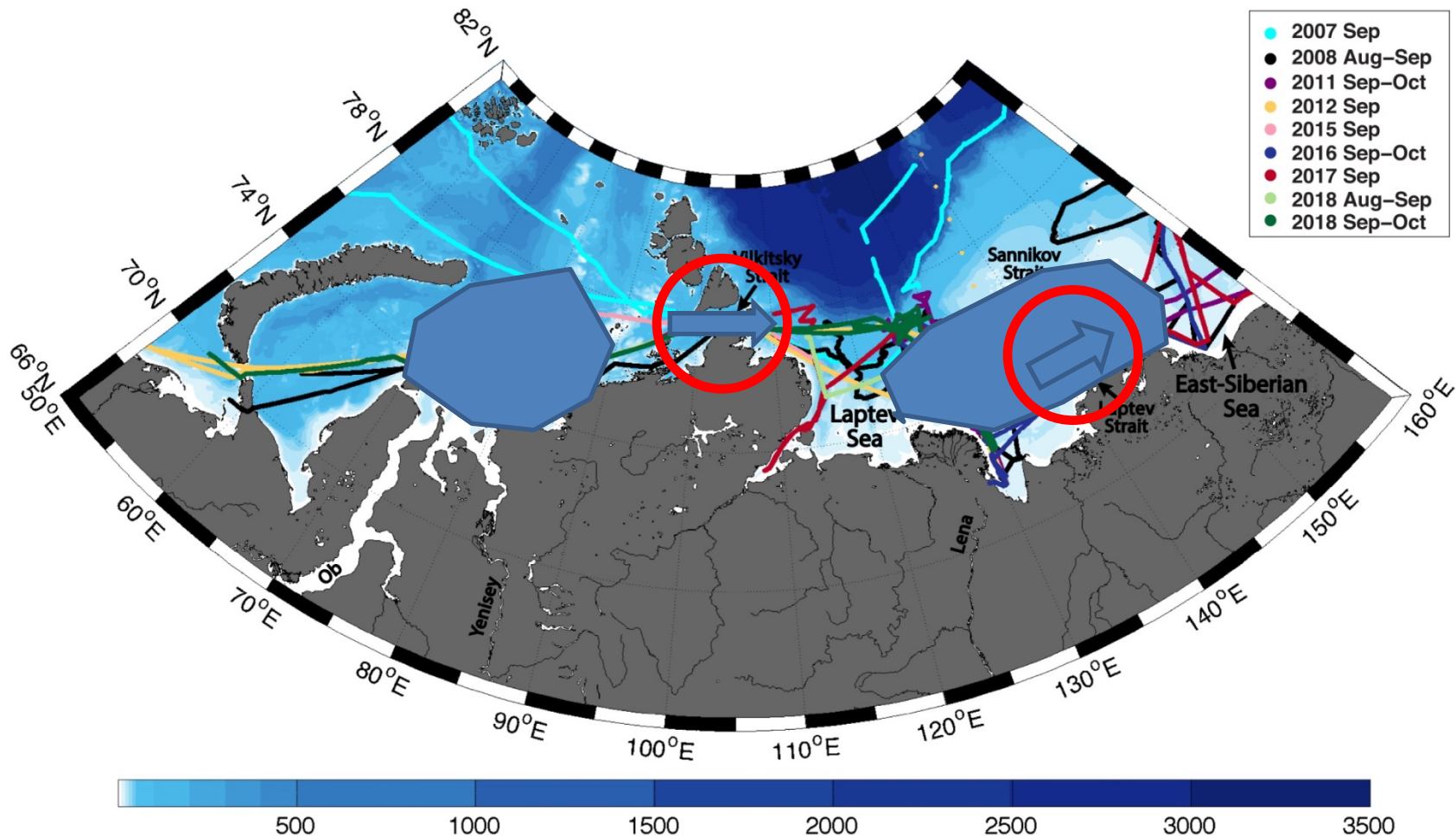
1. Freshwater transport from the Kara Sea to the Laptev Sea
2. Freshwater transport from the Laptev Sea to the East-Siberian Sea

Large-scale freshwater transport



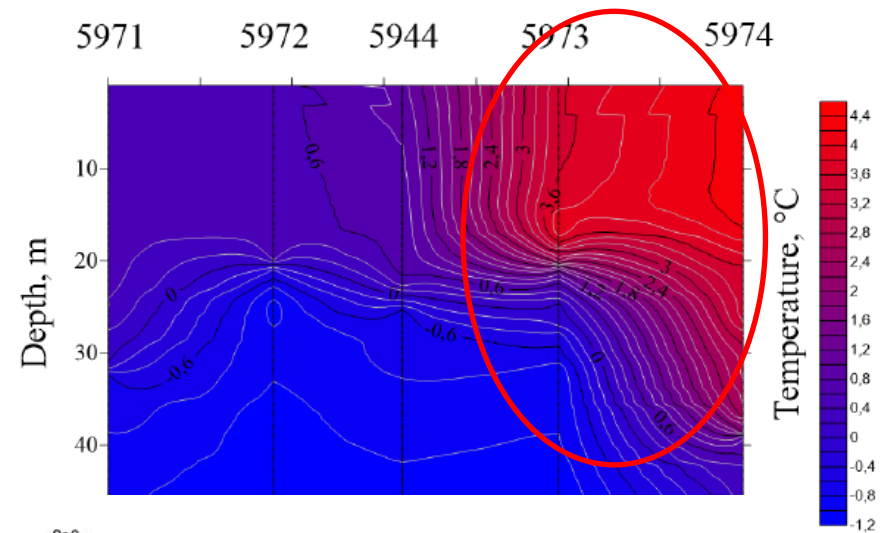
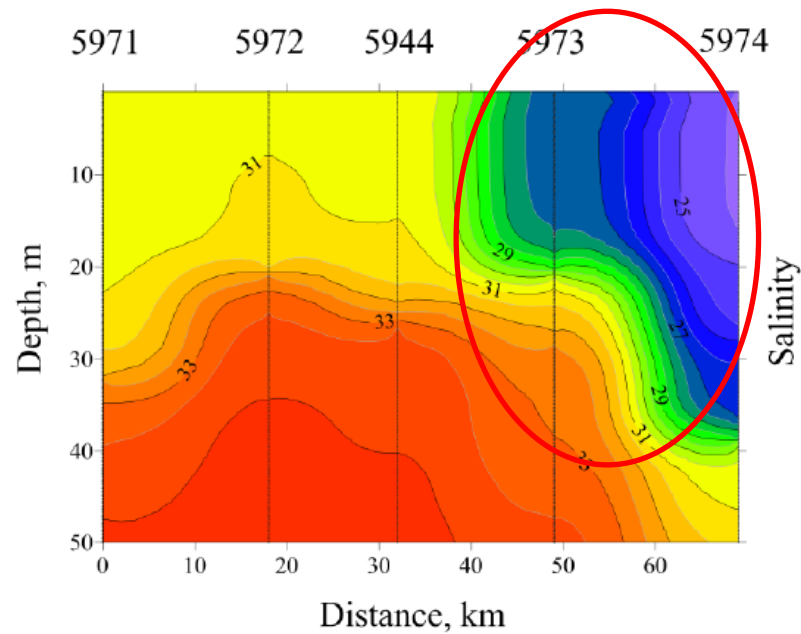
1. Freshwater transport from the Kara Sea to the Laptev Sea –
very rare, requires very specific wind forcing

Large-scale freshwater transport

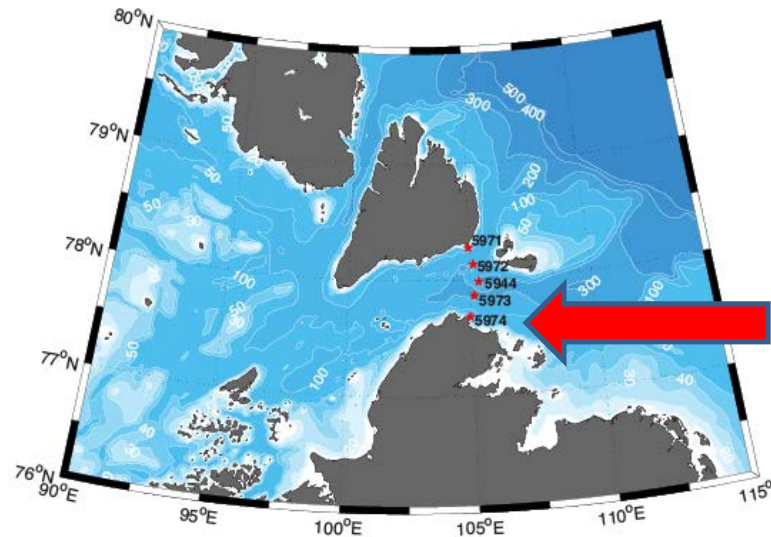


1. Freshwater transport from the Kara Sea to the Laptev Sea –
very rare, requires very specific wind forcing
2. Freshwater transport from the Laptev Sea to the East-Siberian Sea –
almost constant

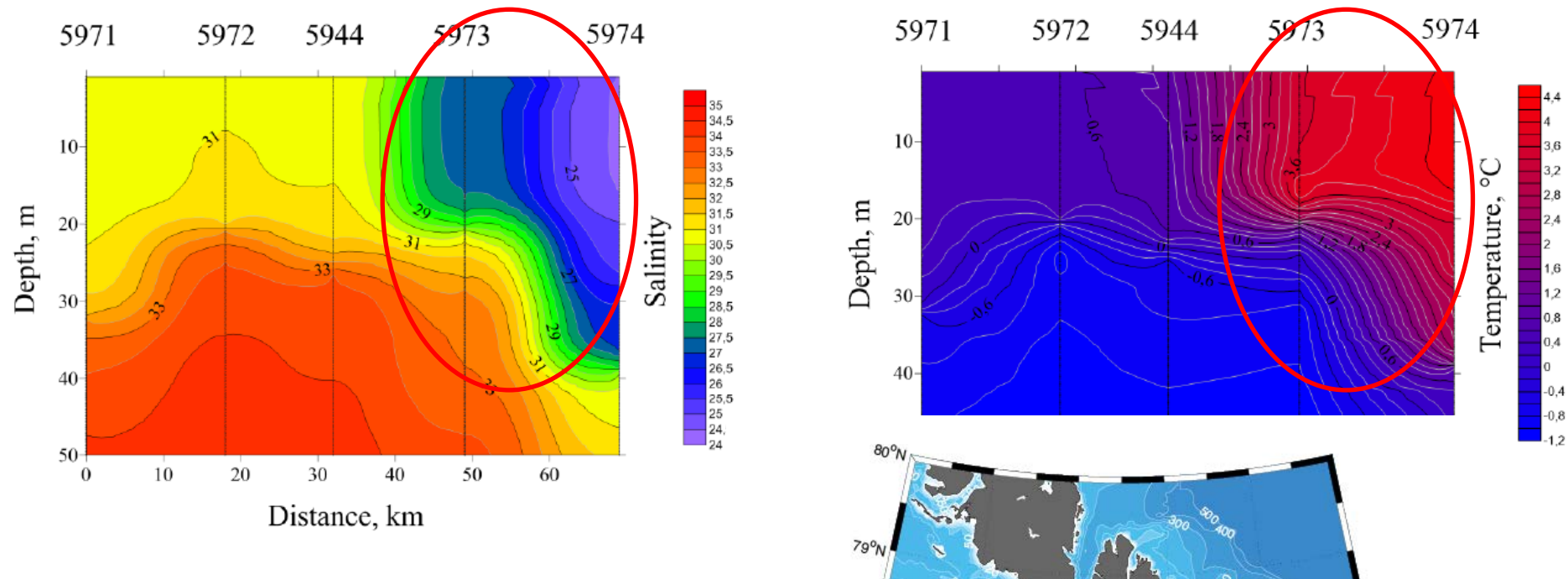
Freshwater transport through the Vilkitsky Strait



Freshwater coastal current in the Vilkitsky Strait:
very narrow (10-20 km wide)
and shallow (20-25 m deep)



Freshwater transport through the Vilkitsky Strait



**Freshwater transport between the Kara,
Laptev, and East-Siberian seas**
Osadchiev et al., 2020; *Scientific Reports*

Thank you for your attention!

