Landfast ice in the Kara Sea reduces the subsurface salinity in the central Arctic Ocean

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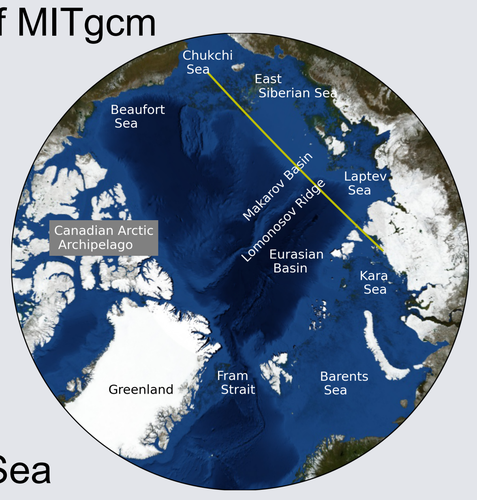
Introduction

Landfast ice is sea ice that is attached to the coast and nearly immobile. Fast ice is a platform used by local communities for hunting, traveling and a place for oil and gas drilling and scientific observation. Properly representing land fast ice in coupled sea ice-ocean models improves the simulation of the halocline and thermohaline circulation by changing the location of new ice formation and brine rejection at the edge of landfast ice in coastal polynya. Here we show, that the landfast ice distribution in the Kara Sea, obtained by applying a new parameterisation for landfast ice, reduces the salinity in the central Arctic.

Methods

❖ Model data

- Model: regional Arctic configuration of MITgcm
- 36 km Spatial resolution
- 50 layers in the vertical
- Viscous-plastic dynamics solver
- CTRL: control run
- BD: run with landfast ice grounding scheme for shallow seas
- LD: landfast ice lateral drag scheme, also for deep seas like the Kara Sea



Results

The landfast ice cover inhibits new ice formation, and less salt is released into the ocean, thus surface upper ocean gets fresher with the fast ice parameterization.

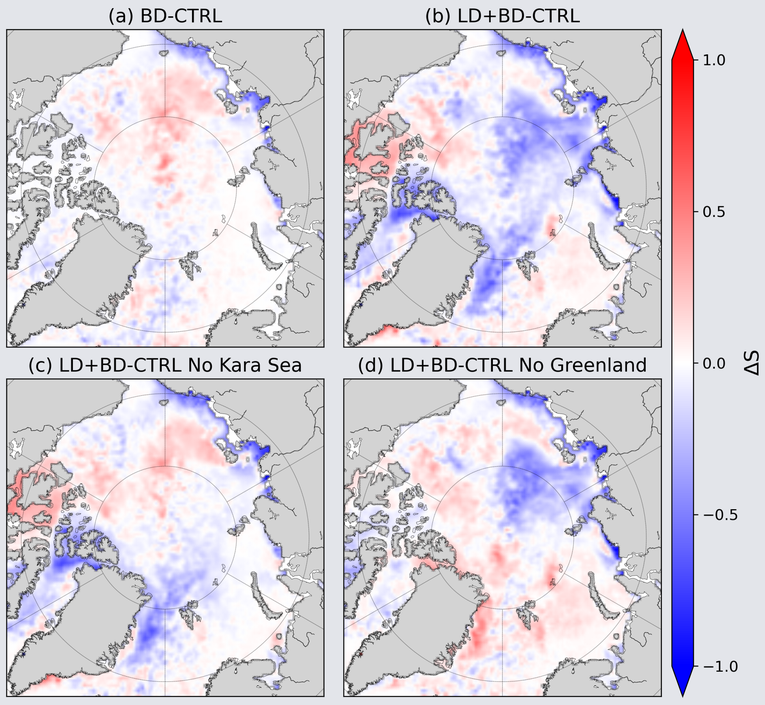


Figure 1. 2006-15 10--40m salinity anomaly between simulations

- **Landfast ice strongly modifies the hydrodraphy in the Arctic on decadal time scales.**
- The negative salinity anomaly in Makarov Basin and Greenland Sea is related to the fast ice in the Kara Sea and near Greenland.

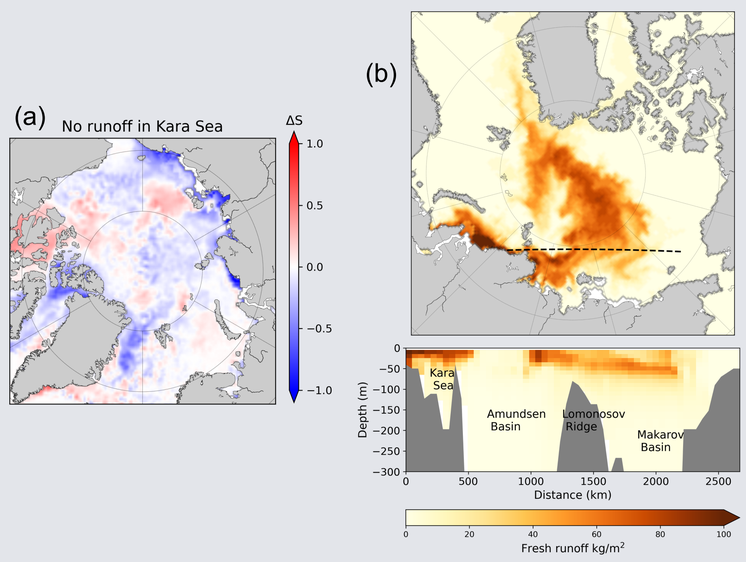


Figure 2. (a) Salinity difference disabling river runoff in the Kara Sea. (b) 2015 April passive tracer (Ob and Yenisey River) concentration

- The passive tracer distribution illustrates the path of the fresh upper ocean water out of the Kara Sea into the central Arctic.

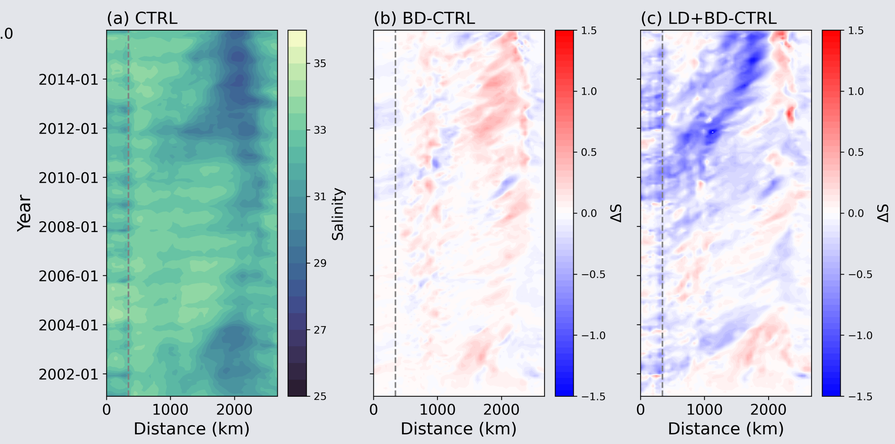


Figure 3. Hovmöller diagram of salinity and salinity anomaly

- Negative salinity anomaly emerges from the Kara Sea after 2009.

In the LD+BD simulation, more fast ice is formed in the Kara Sea. The fresh upper ocean signal generated in the Kara Sea is transported via the Vilkitsky Strait to the Laptev Sea and Makarov Basin.

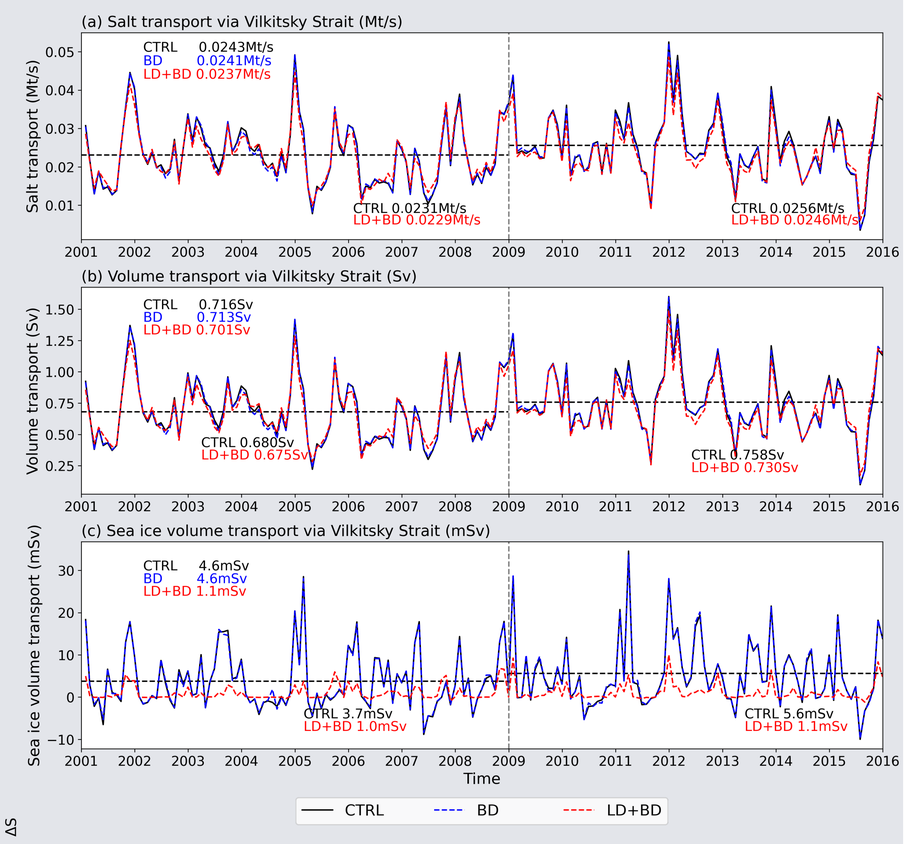


Figure 4. Time series of salt flux, volume and sea ice transport via Vilkitsky Strait.

- The mean values of salt, volume, and sea ice transport in 2009-15 are larger than the values in 2001-08 in CTRL.

Conclusion

❖ Stable fast ice cover leads to a fresher upper ocean, and the fresher upper ocean signal is transported from the Kara Sea to the central Arctic in episodic events.

❖ The landfast ice distribution in the Kara Sea has a strong effect on the sub-surface salinity in the central Arctic because it determines the salinity and the amount of the export through the Vilkitsky Strait. Around 765 Gt salt is transported out the Kara Sea via Vilkitsky Strait per year in CTRL, and around 747 Gt salt per year is transported out in LD+BD.

❖ The decreased sea ice volume transport in LD+BD explains approximately 20% of the reduced salt transport in LD+BD.

❖ River runoff in the Kara Sea participates in transporting the fresh upper ocean signal from the Kara Sea to the central Arctic.

❖ A proper landfast ice simulation in the Kara Sea reduces the salinity in the central Arctic sub-surface waters.