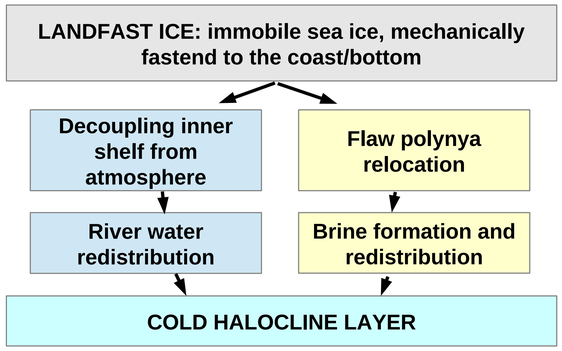
Role of the landfast ice in the Arctic Ocean circulation

Polona Itkin, Rüdiger Gerdes, Martin Losch, Michael Karcher
Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany
contact: Polona.Itkin@awi.de

Motivation

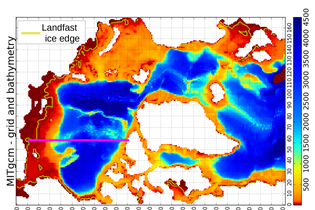
Landfast ice is not represented in the state-of-the-art sea ice-ocean models and this results in underestimating the amount of the brine formed in polynyas and in unrealistic river water distribution on the shelf and in the Arctic Ocean. In our study we use a simple parametrization with a maximal extent and duration of the landfast season to get an **upper estimate of the role of the landfast ice for the cold halocline layer (CHL) formation**.



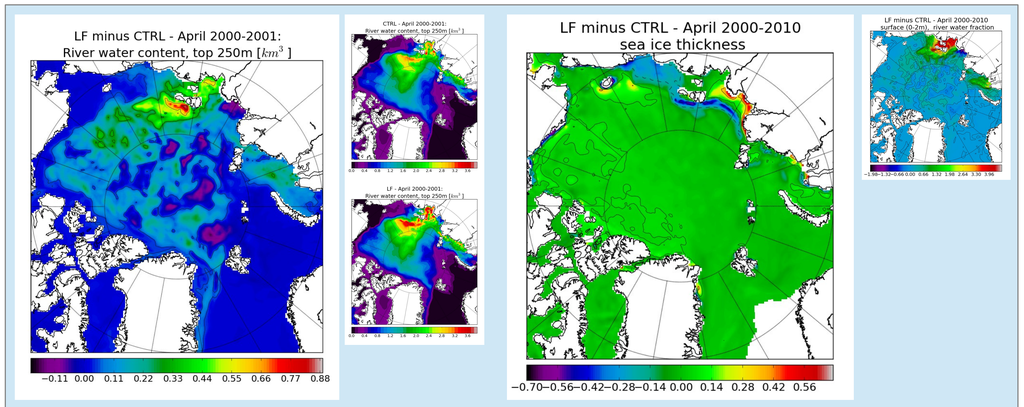
Experiment setup

MITgcm (MIT General Circulation Model) ocean model [1] **coupled to a sea ice model** [2] with linear free surface, C-grid, volume river runoff and :

- horizontal grid spacing of 1/4°, 36 vertical levels
- **rescaled vertical coordinate – z*** [3]
- **realistic shelf topography**
- **atmosphere forcing:** NCEP CSFR (1979-2010)
- **fast ice parametrization**: doubled maximum compressive strenght of sea ice (p*) in the inner shelf (where ocean depth is lower than 30 m) and tensile strenght [4].
- Comparison of control (CTRL) and landfast run (LF)

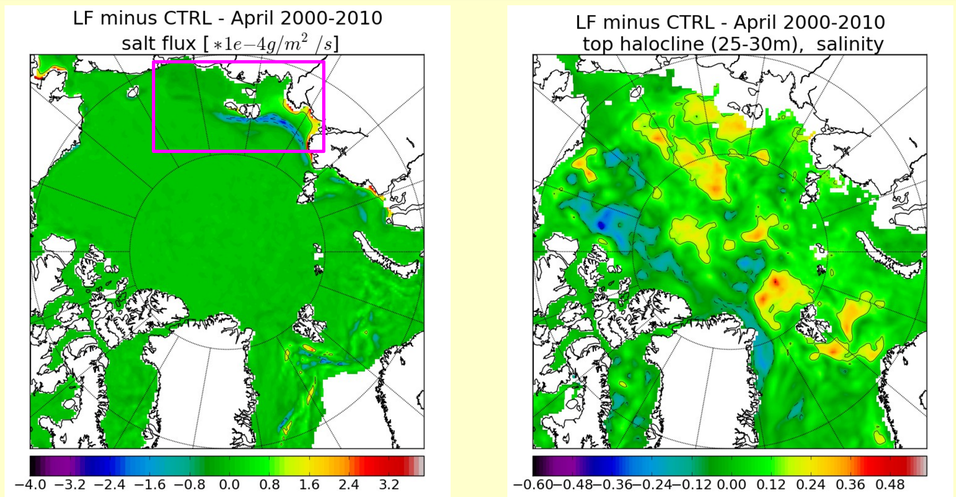


River water distribution



Left: In the LF there is more river water in the Beaufort gyre and in the CTRL there is more river water in the Transpolar drift. But total there is about 10% more river water in the LF. Right: The tracer does not trace the river water after freeze-up into the sea ice: sea ice is a stronger river water sink in CTRL.

Brine formation and distribution



Left: Salt fluxes in the flaw polynya area: average over Eurasian shelf, April 2000/10: CTRL: -407.4 t/s; LF: -415.4 t/s

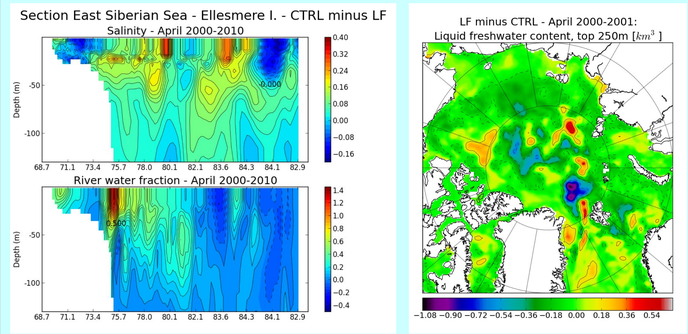
Right: Salinity differences do not reflect the river water distribution. CHL is for about 0.2 saltier in the LF. CHL is also warmer (not shown), another evidence that the salty water masses originate from the shelf

ACKNOWLEDGEMENTS:
We thank Cornelia Köberle, Ursula Schauer, Jens Hölemann and Frank Kauker, all AWI, for fruitful comments and suggestions. Polona Itkin would like to express her gratitude to Municipality of Ljubljana, Slovenia for supporting her PhD studies with a scholarship.

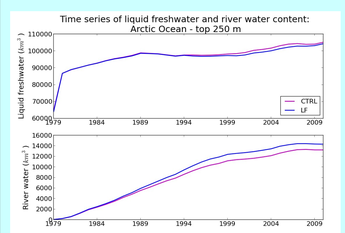
Conclusions

- Landfast ice **limits the freeze-up of the river water** and instead **channels it from the Transpolar drift into the Beaufort Gyre**. But the amount of river water is too low to have a significant effect on the halocline salinity or liquid freshwater content.
- With the landfast ice the position of the flaw polynya in the more saline open ocean yields **larger salt fluxes and saltier CHL**. (Even if the average amount of the sea ice produced on the shelf is smaller.)
- The **local effect** of the landfast ice on the halocline is not reflected in the Fram Strait volume exchange and bears no significance on the global ocean scale.

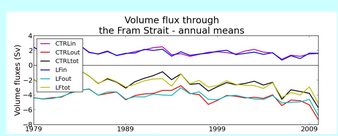
Cold halocline layer



Left: The differences are concentrated in the CHL (mixed layer depth is similar in both runs). Right: The liquid fresh content differences are similar to the salinity differences at the HCL depth.



Time series of river and liquid fresh water show a stable off-set for CTRL and LF.



The volume fluxes through Fram Strait are very similar for both runs.