Impact of a realistic Greenland ice sheet melting on the North Atlantic over the period 1920-2014

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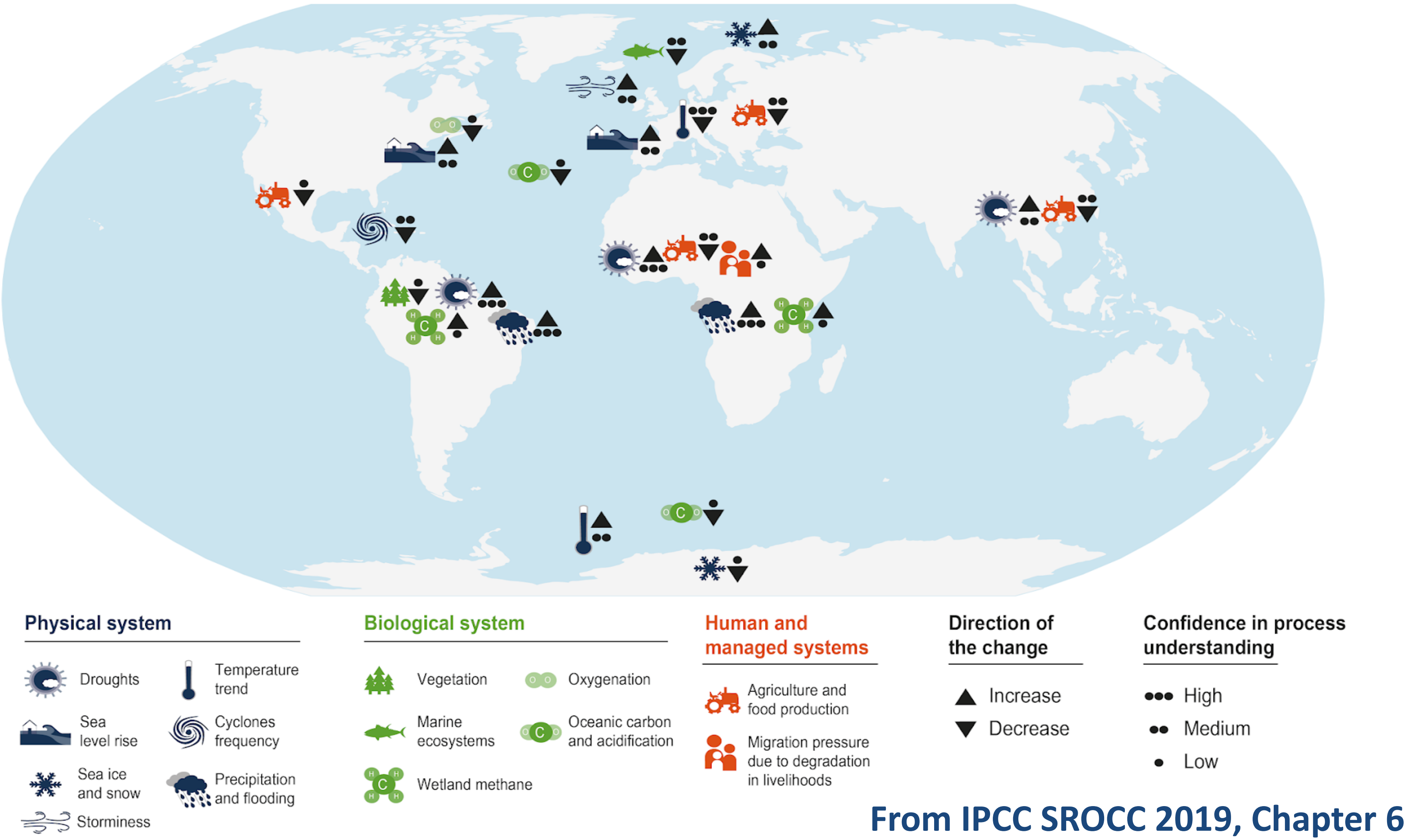
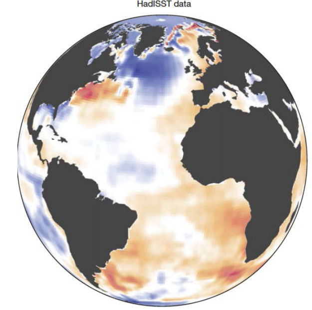
The AMOC, a key player for climate and society

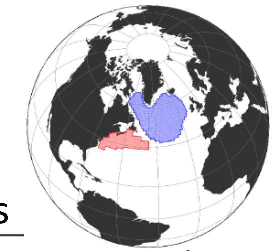
Impact of a substantial change in the Atlantic Meridional Overturning Circulation (AMOC)



From IPCC SROCC 2019, Chapter 6

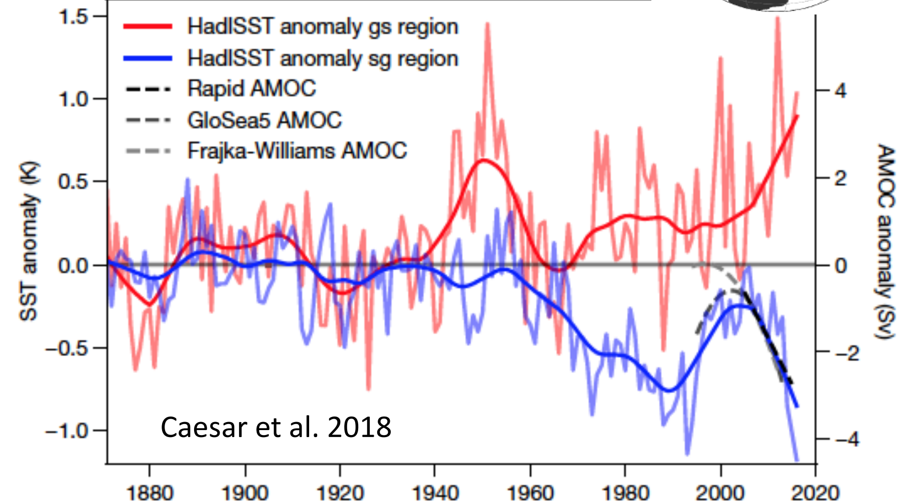
Is the AMOC weakening?



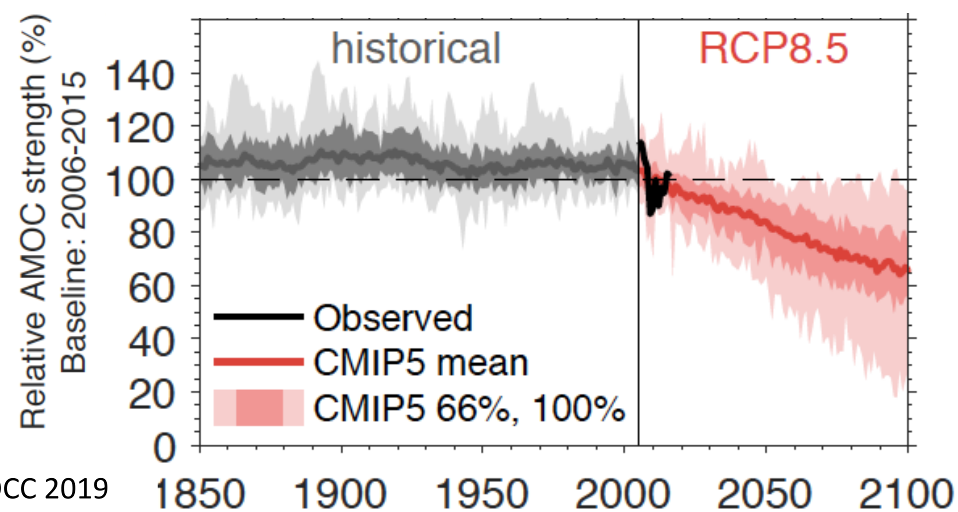


- Is the AMOC already weakening?
- Paleodata (Thornalley et al. 2018) and SST fingerprints (Caesar et al. 2018) say « possibly » (estimate of **3±1 Sv weakening or 15% decrease**)
- CMIP5 models exhibit **-1.4 ±1.4 Sv** of decrease between 2006-2015 and 1850-1900
- No Greenland ice sheet (GrIS) melting included in the historical simulations
- **What is the forced signal from GrIS melting?**

Observed relative SST changes



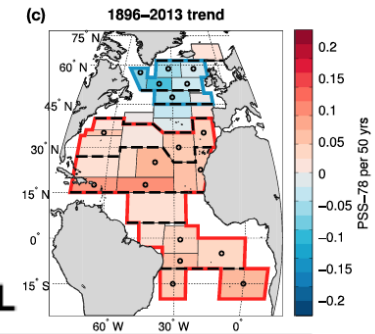
AMOC in CMIP5 models

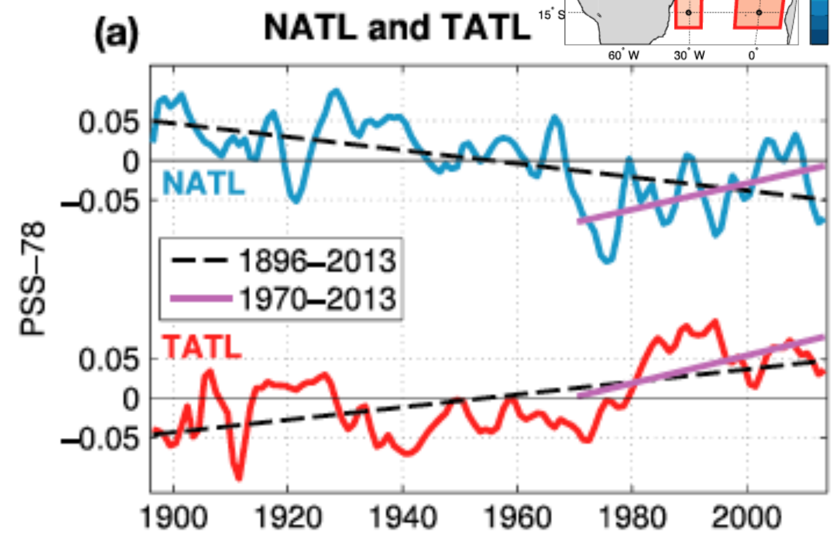


IPCC SROCC 2019

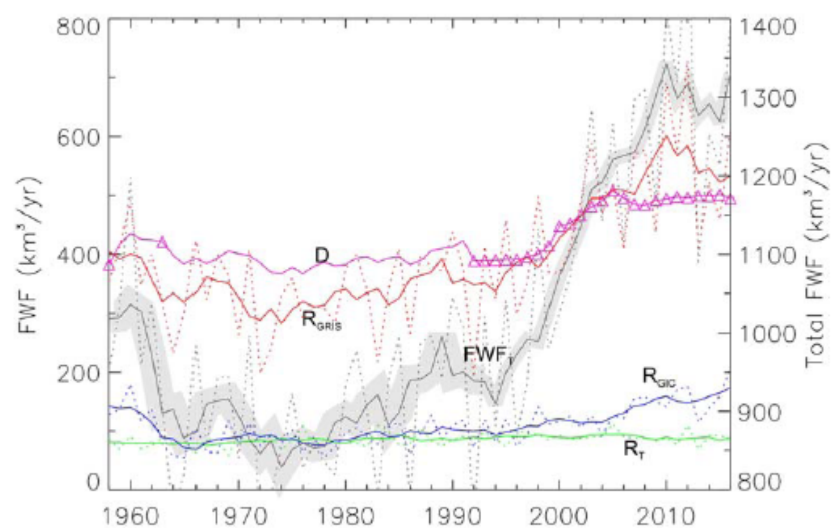
GrIS melting and SSS trend

- There is a decreasing trend in SSS in the North Atlantic (Friedman et al. 2017)
- The freshwater release from the Greenland ice sheet is strongly increasing (Bamber et al. 2018) in the recent decades but also in the 1920s (Box and Colgan 2013)
- Is there a link between the two? (not clear, e.g. Yang et al. 2016 vs. Dukhovskoy et al. 2019)





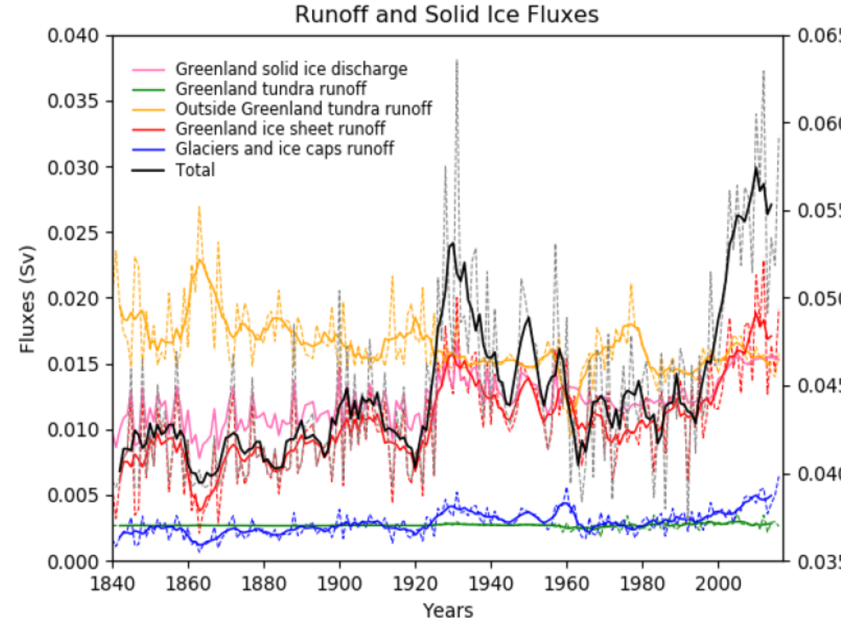
Friedman et al. 2017

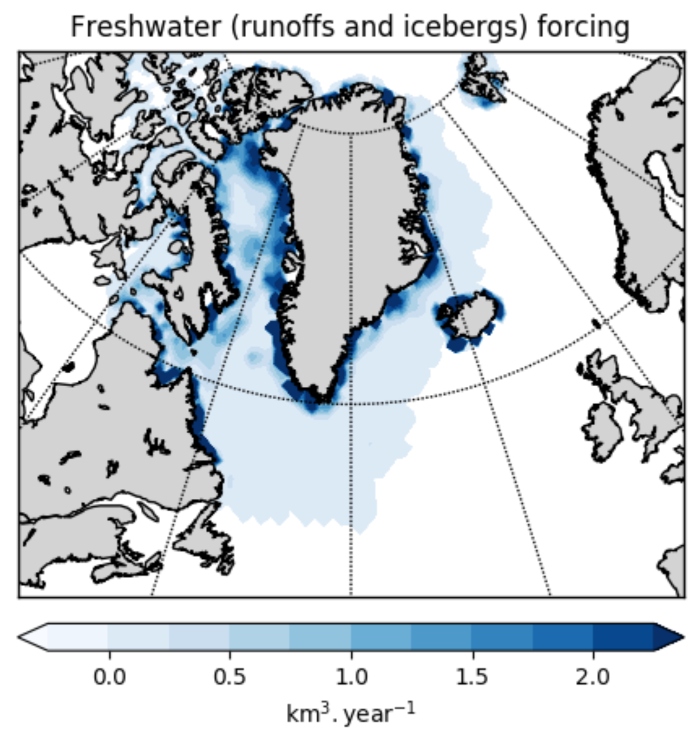


Bamber et al. 2018

Experimental design

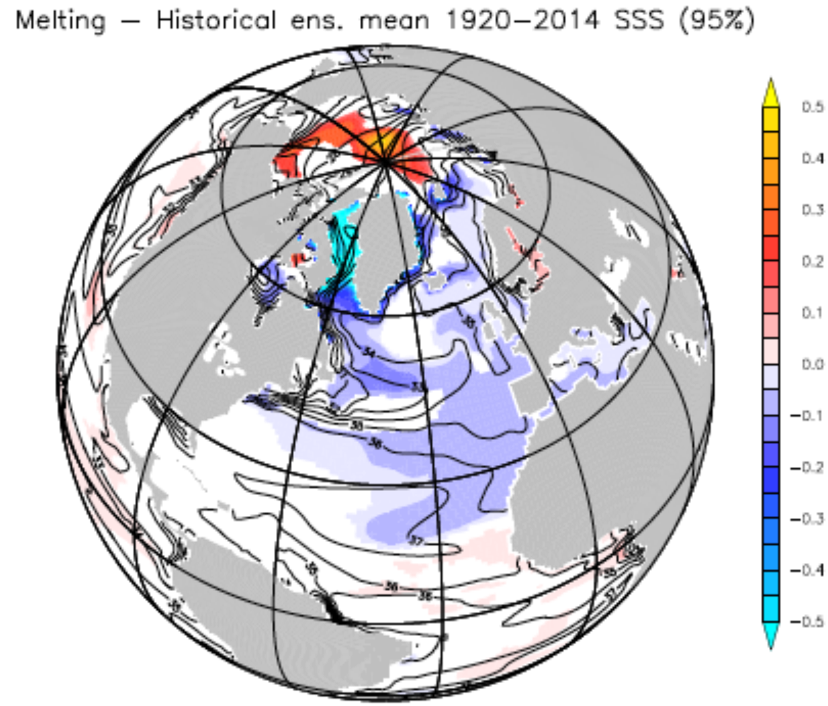
- Use of Bamber et al. (2018) recent reconstruction
- Extension back to 1840 following Box and Colgan (2013)
- Overwrite runoff and calving in the the Greenland region by those observation-based fluxes
- Use of 10 members of historical simulations including this melting since 1920 (**Melting ensemble**)
- Comparison with historical simulations from IPSL-CM6 starting from same initial conditions (**Historical ensemble**)

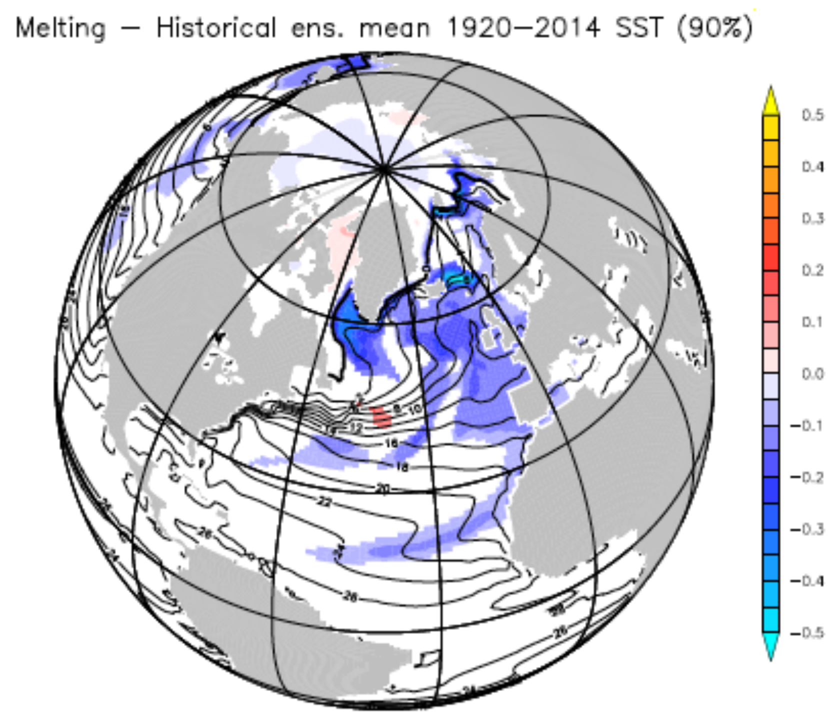




Impact on SSS and SST

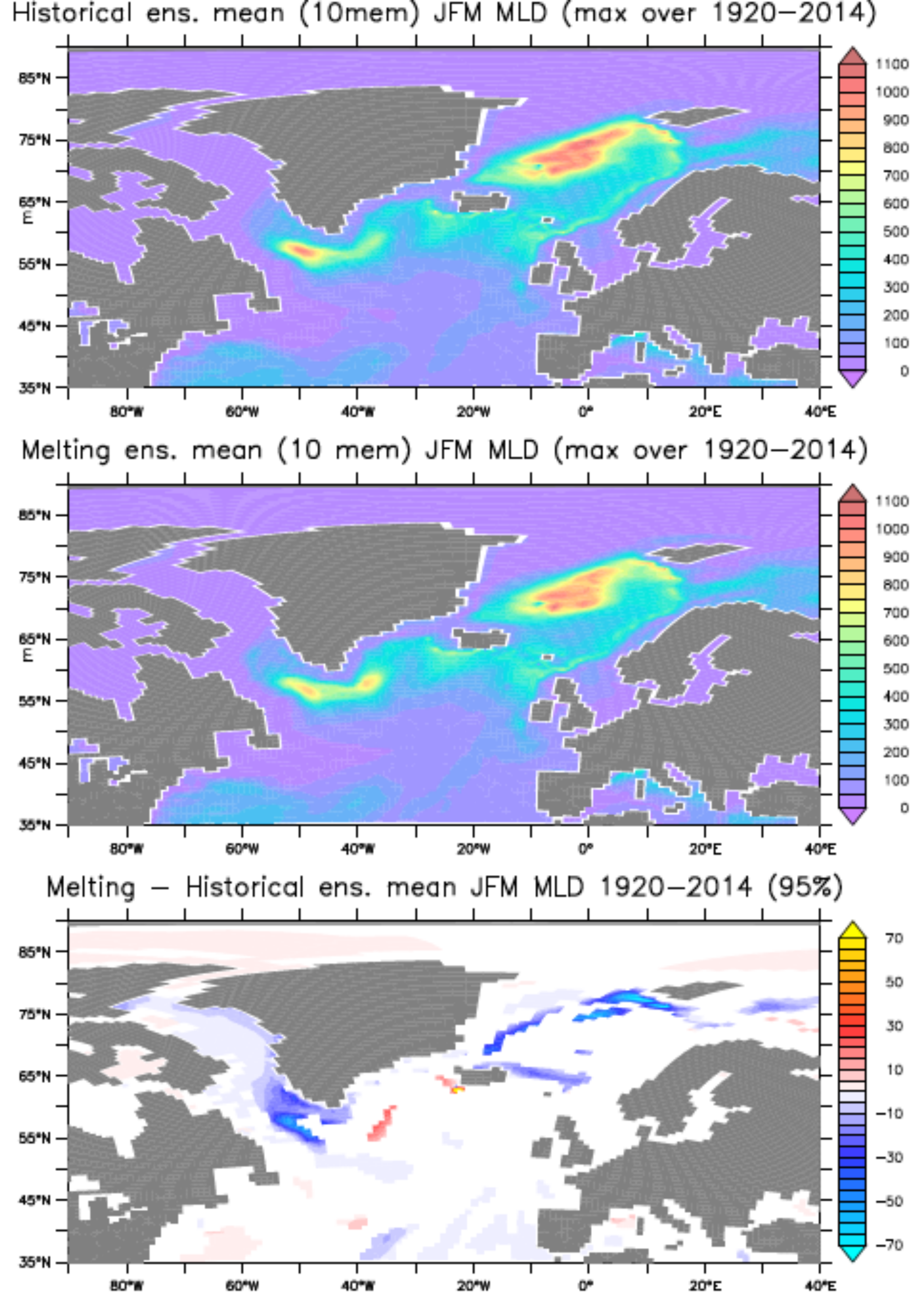
- Spread of the SSS salinity negative signal
- Positive SSS signal in the Arctic, consistent with other « hosing experiment » (e.g. Swingedouw et al. 2013)
- Slight impact on SST with a cooling signal in the subpolar gyre





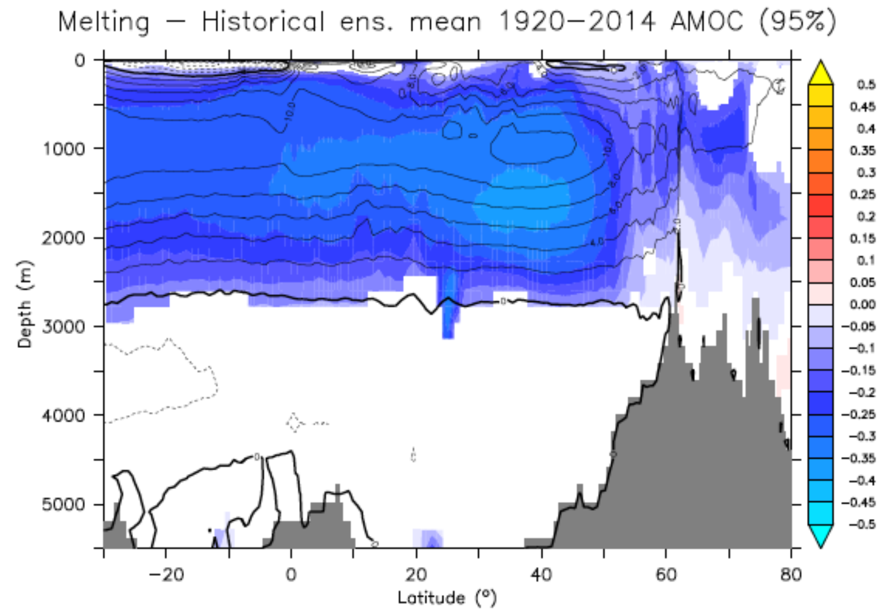
Convection sites modifications

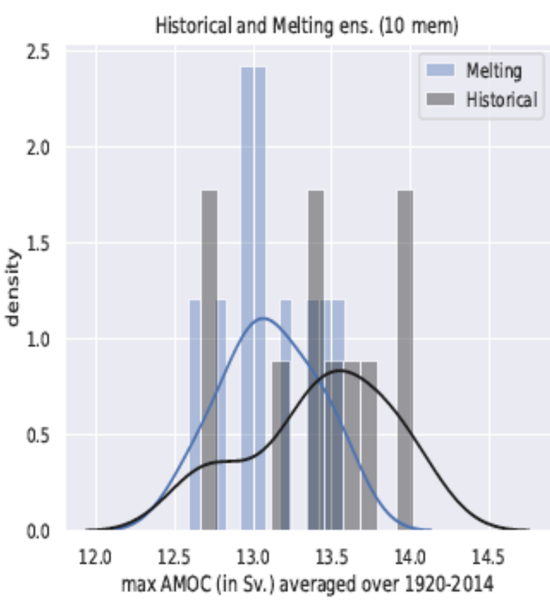
- There are two main convection sites in IPSL-CM6A: one in the Nordic Seas and one in the Labrador Sea
- Sporadic convection in the Irminger Sea, which seems to be reinforced by the addition of melting
- Opposing effects from Labrador and Nordic Seas vs Irminger Sea for deep water formation

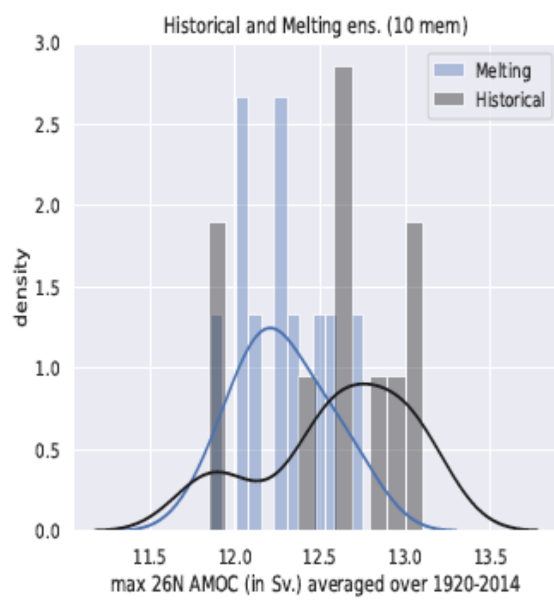


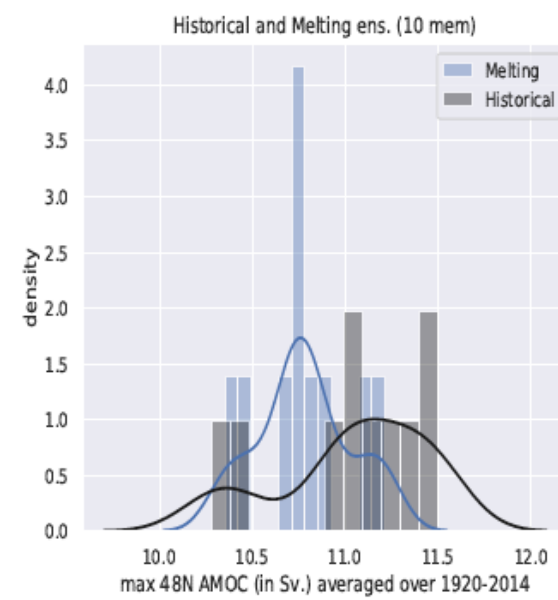
Impacts on the AMOC

- The AMOC is slightly affected by the freshwater trends
- It weakens by less than 1 Sv



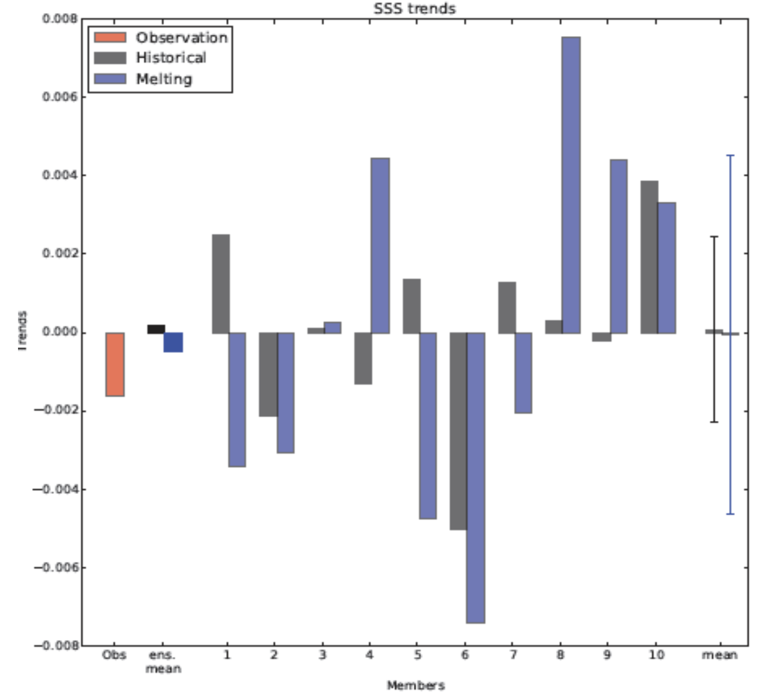


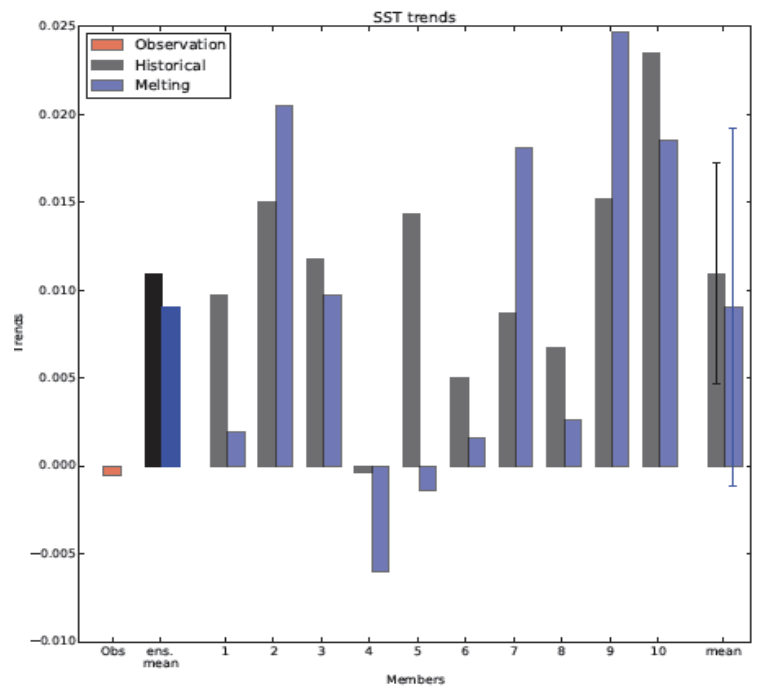




Impacts on the centennial trend in active tracers

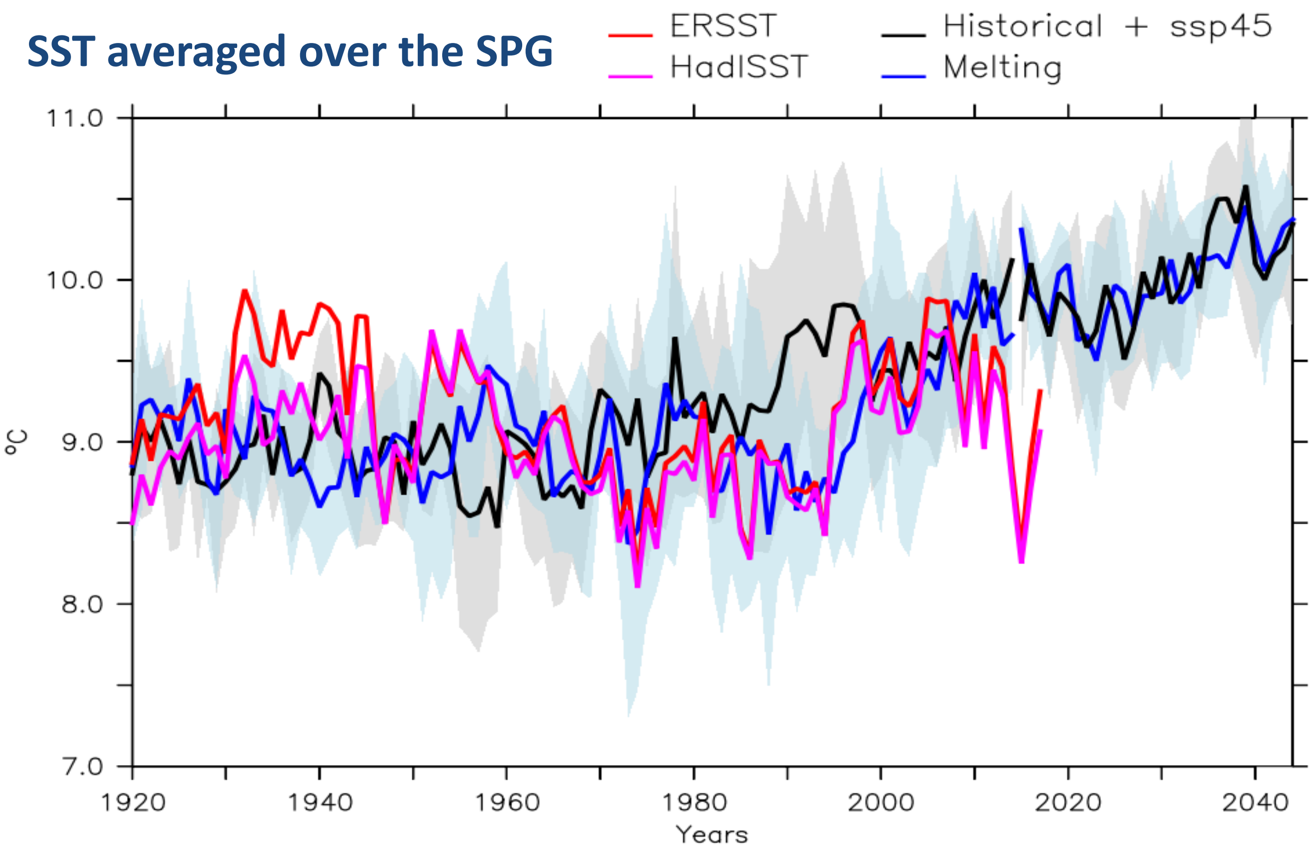
- We compare the simulations trends over 1920-2014 with observations in the subpolar gyre (SPG)
- The SSS trend is negative in the Melting ensemble as in observation, but the change is very slight and the spread very large
- The same is true for SST trend. There is a decrease in the trend in Melting ensemble, more in line with observations, but the change is very small, and the observations are more likely explained by internal variability of the model.





Impacts on decadal variability in the SPG

- The ensemble Melting is better reproducing the 1995 abrupt warming event in the subpolar gyre than the Historical ensemble.
- Not much difference concerning the 2015 cold blob



Conclusions and outlooks

- Including a better representation of GrIS freshwater input impacts the on-going trends in the North Atlantic
- It brings forced SSS trend in the same direction as observation (but still compatible with internal variability) and slightly improve SST trend (if forced…)
- A very slight impact on the AMOC (< 1 Sv)
- Observed trends over the historical era are more likely explained by internal variability than by forced signal in the IPSL-CM6A-LR model
- An impact on decadal variability of the AMOC? Mechanisms need to be eluciated.

Thank you!

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Courtesy of Bruno Ferron, OVIDE 2010