Understanding and predicting Arctic and North Atlantic variability

Presented by

Rym Msadek

Geophysical Fluid Dynamics Laboratory Review

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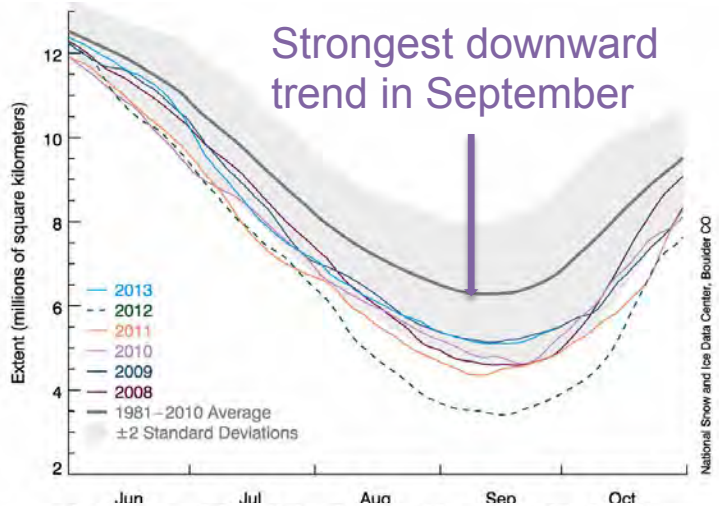
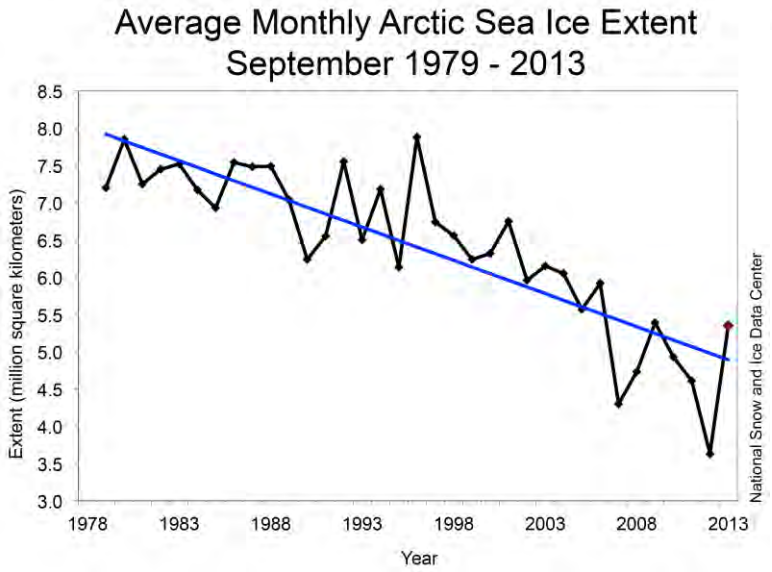
Arctic sea ice variability and trend

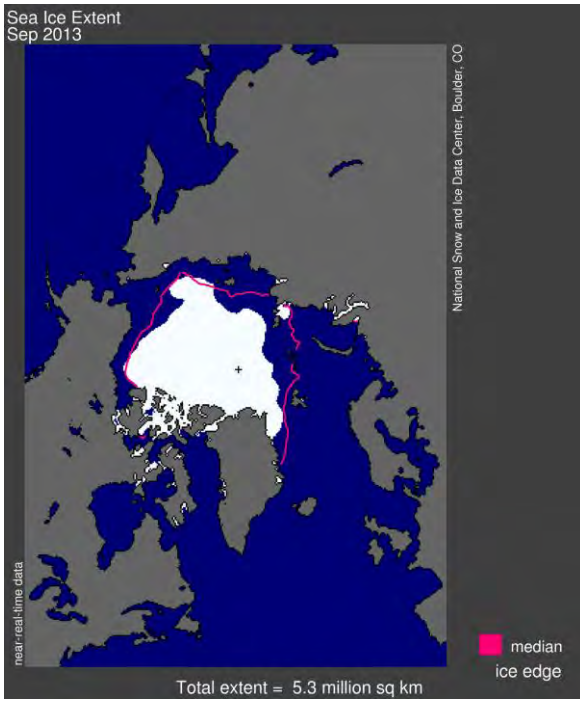
Arctic sea ice extent (area with at least 15% sea ice)



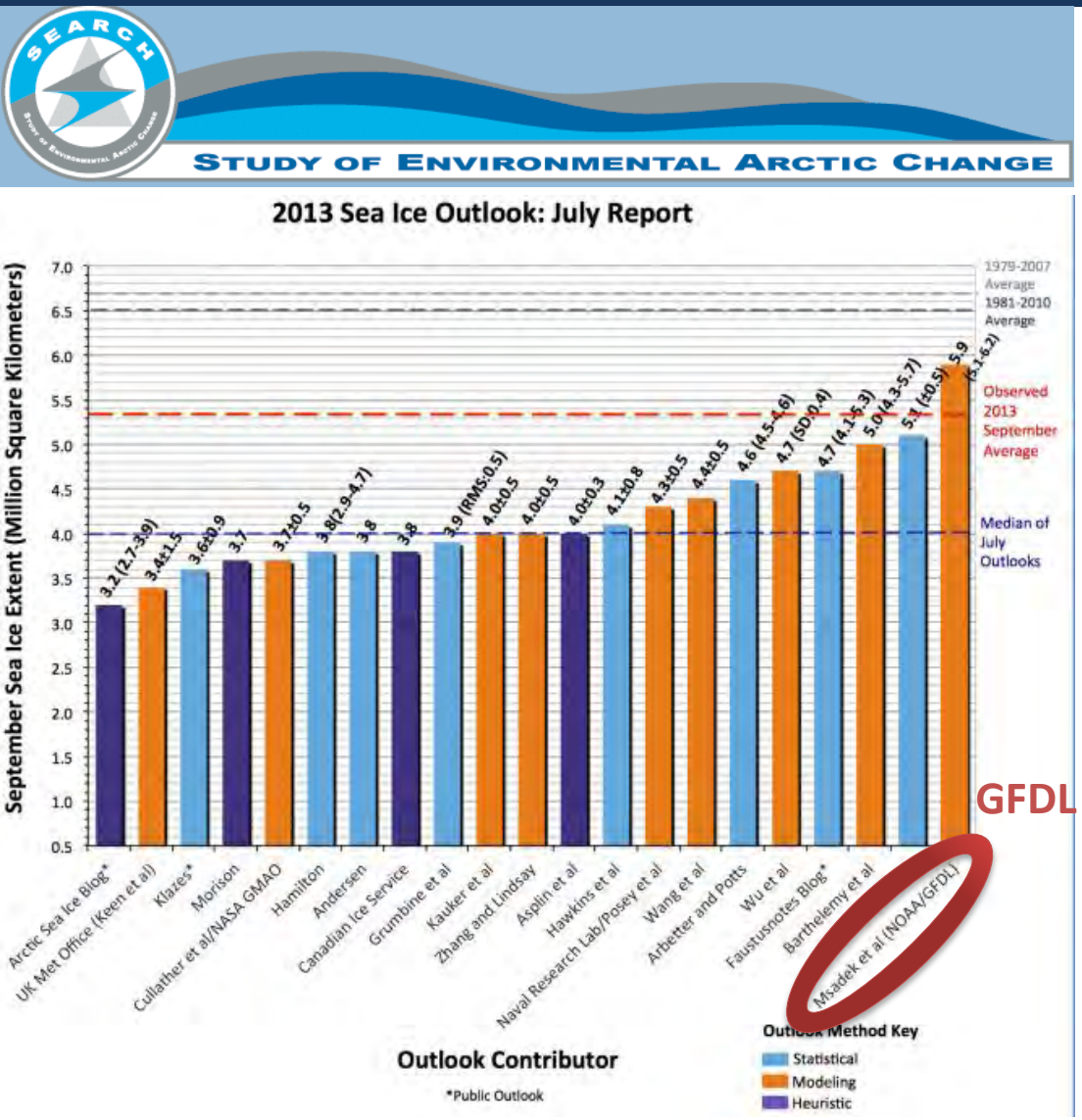


Growing need for improved sea ice predictions given the probability of a summer ice-free Arctic in the coming decades.

Large year-to-year fluctuations above the trend which are challenging to predict



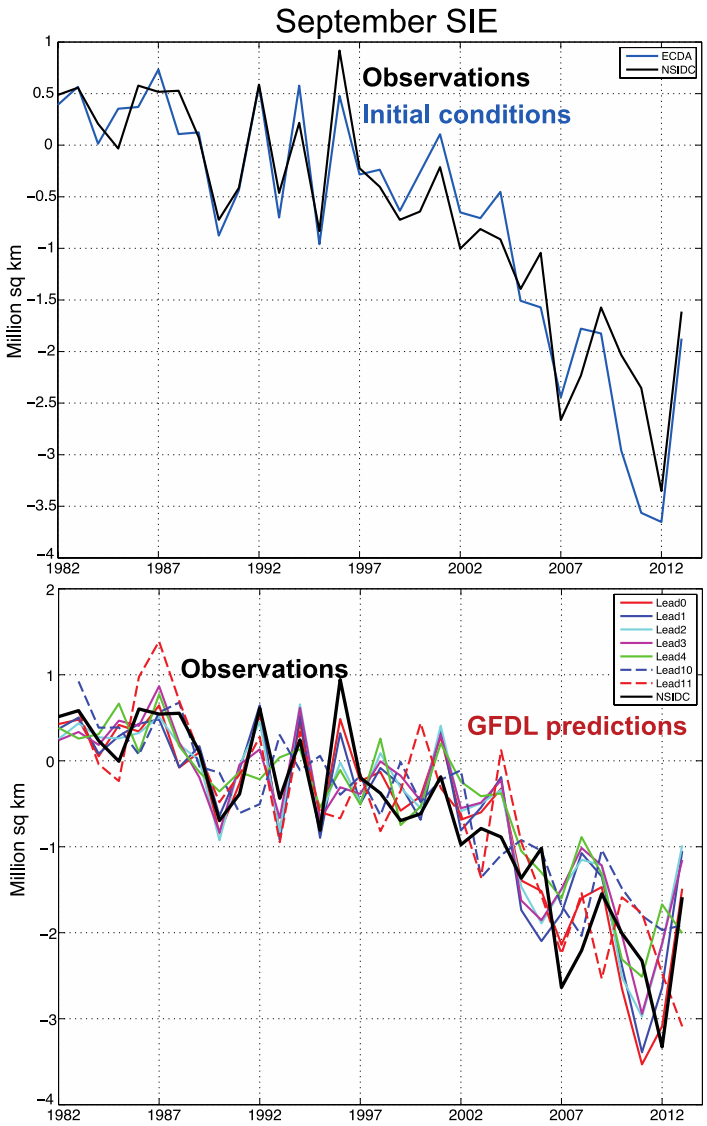
GFDL contribution to SEARCH sea ice outlooks

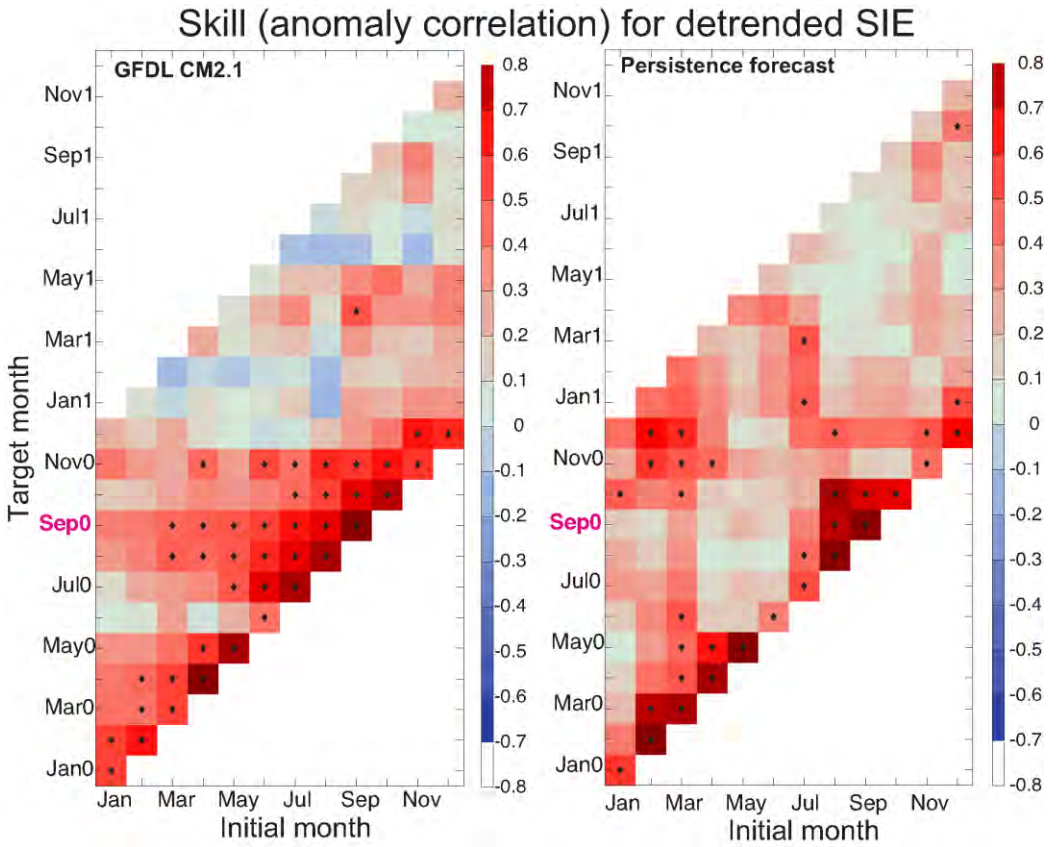


- Outlooks of September Arctic SIE have been provided since 2008 as part of an international effort
- The median of SEARCH outlooks do well when observations lie near the trend
- SEARCH underestimated the 2013 value.
- GFDL predictions successfully predicted a value above the trend that verified well.

http://nsidc.org/arcticseaicenews

Seasonal skill of Arctic sea ice extent in GFDL-CM2.1



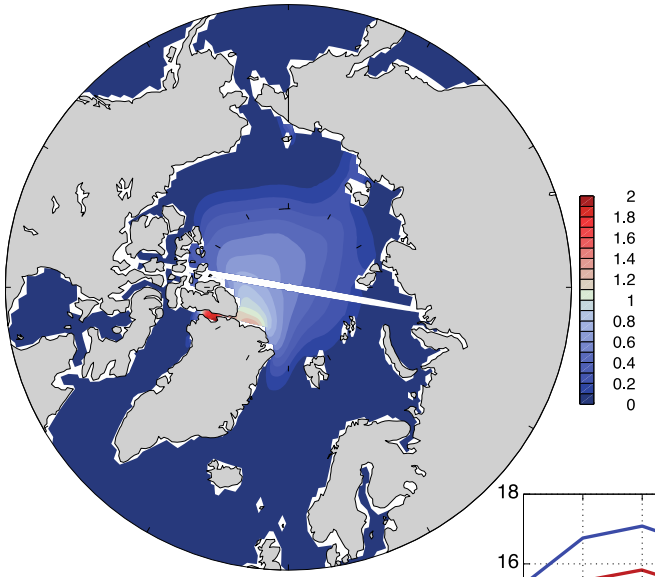


Overall better skill than persistence, significant up to 7 months ahead during summer.

September interannual variations better predicted in the 1990s than in the 2000s.

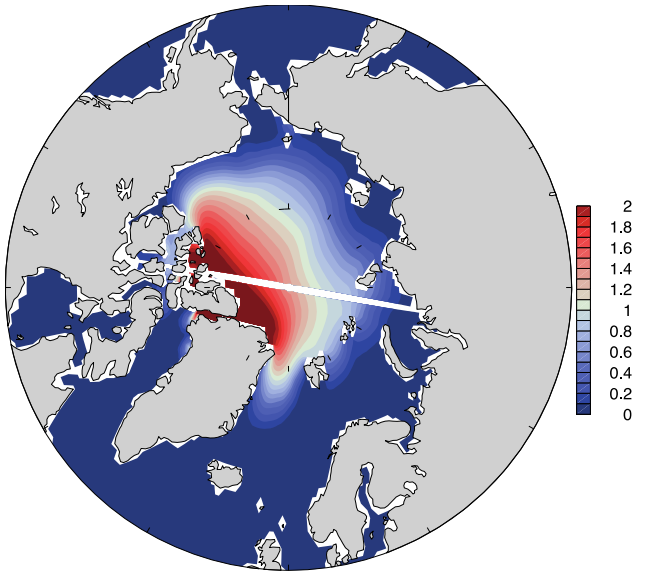
Improved Arctic with higher atmospheric resolution

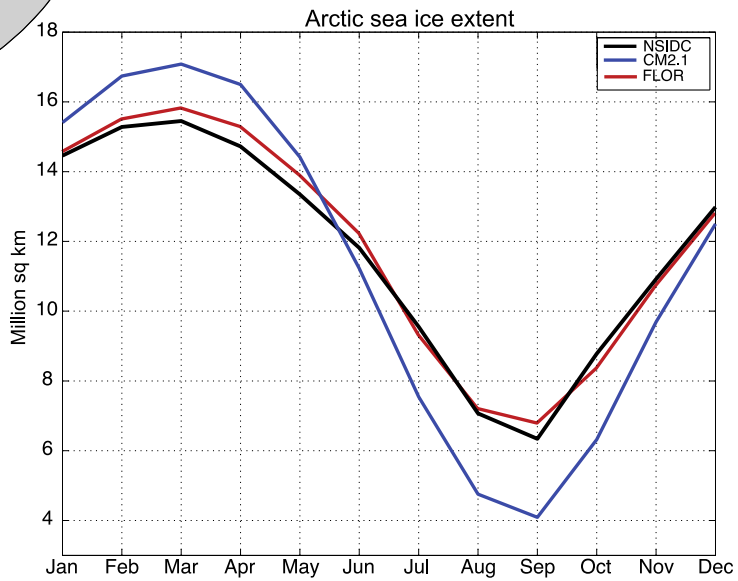
CM2.1 Sept ice thickness



Does a better mean state yield improved predictions?

FLOR Sept ice thickness

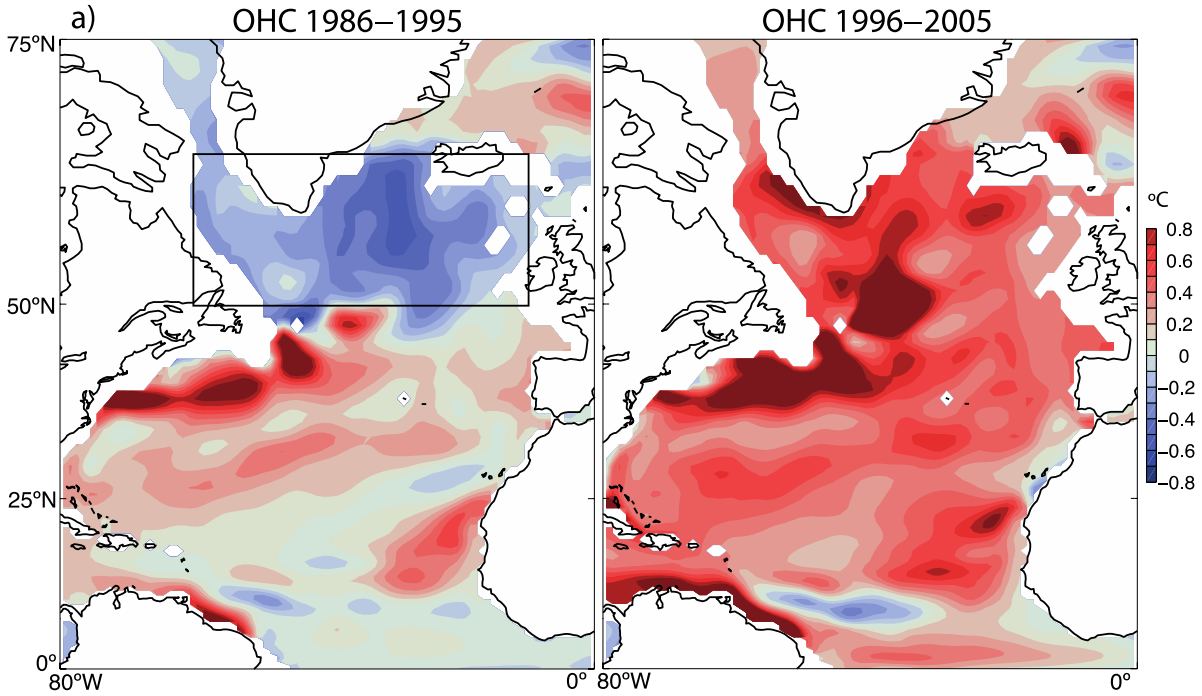


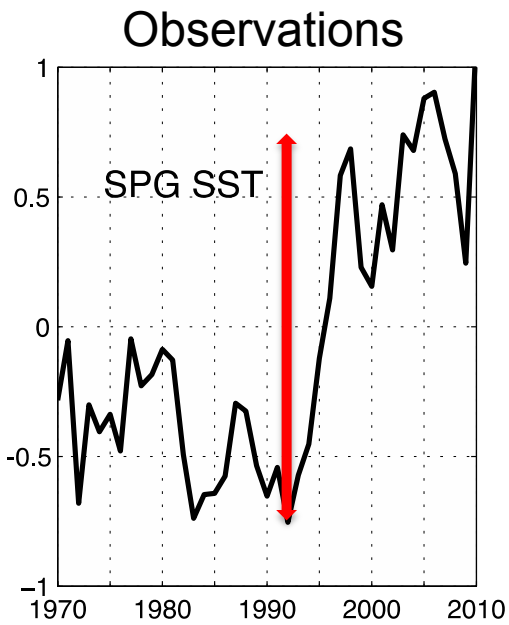


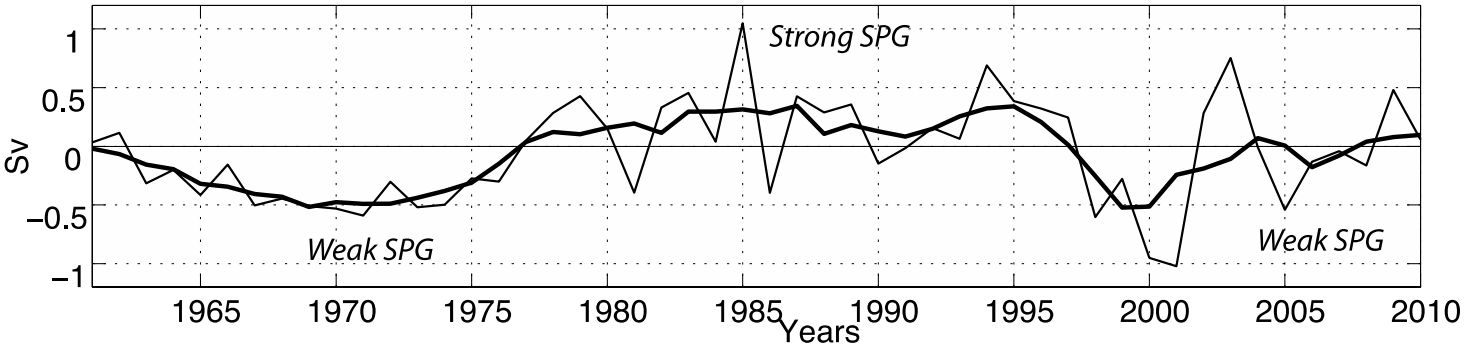
Collaborations with European partners to better understand the mechanisms: APPOSITE and SPECS projects.

Predictions have been extended to FLOR: initial results show similar skill for SIE at short time-leads.
(Msadek et al. submitted)

Atlantic decadal predictions: case study

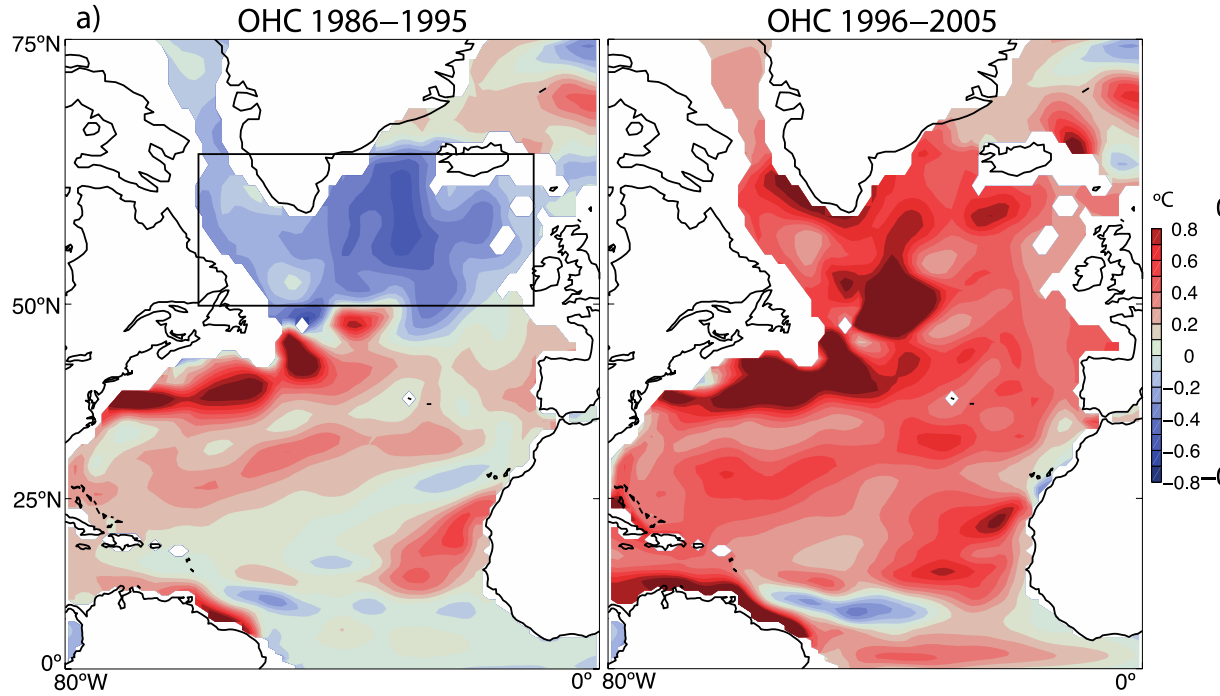


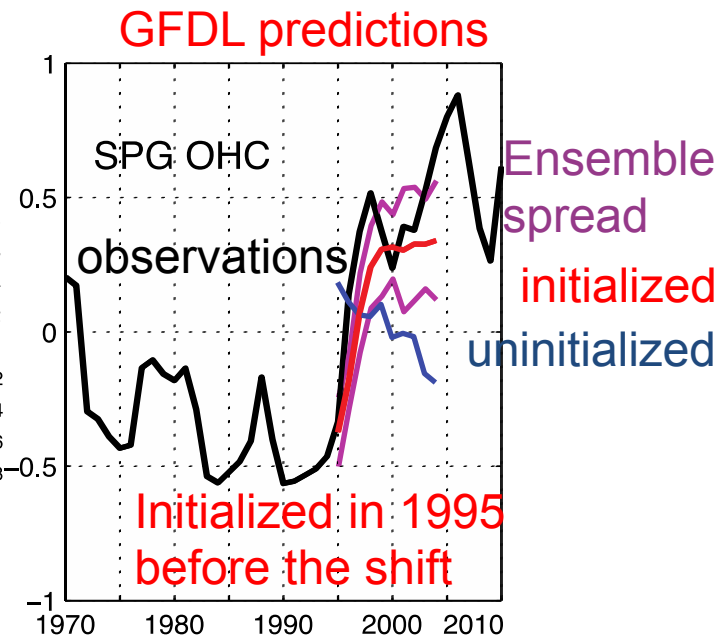




Abrupt warming and decline of the SPG observed in the mid-90's

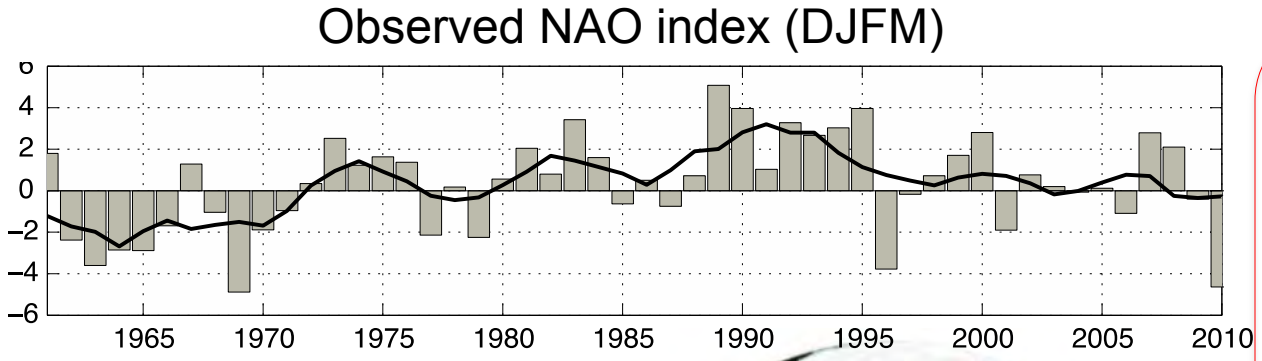
Atlantic decadal predictions: GFDL results





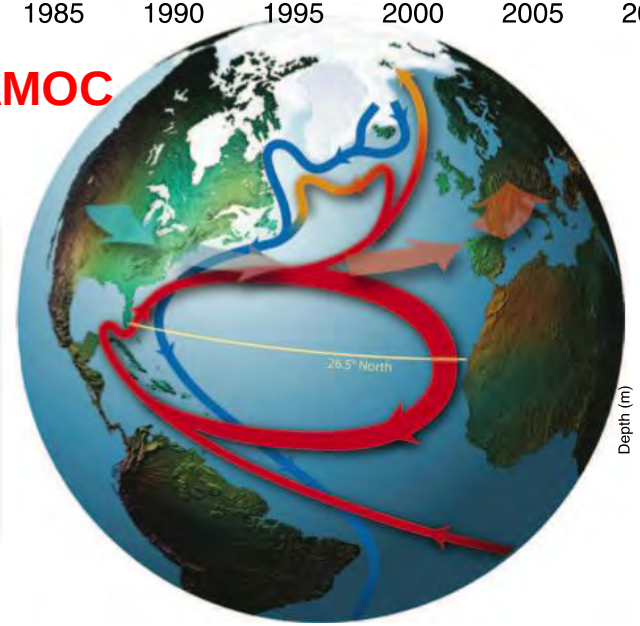
This abrupt event is successfully predicted by the ensemble GFDL CM2.1 predictions initialized in early 1995. Not captured by the forced uninitialized projections *(Msadek et al. 2014).*

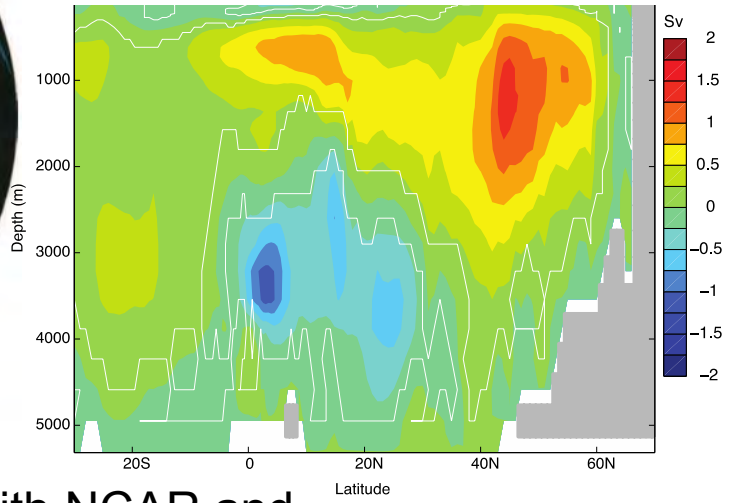
Role of the AMOC in the successful predictions



The predicted AMOC anomalies drive a stronger transport of heat northward leading to a warming, spin down and contraction of the SPG *(Msadek et al. 2014)*

Mechanism: preconditioning of the ocean overturning circulation by a persistent positive NAO.

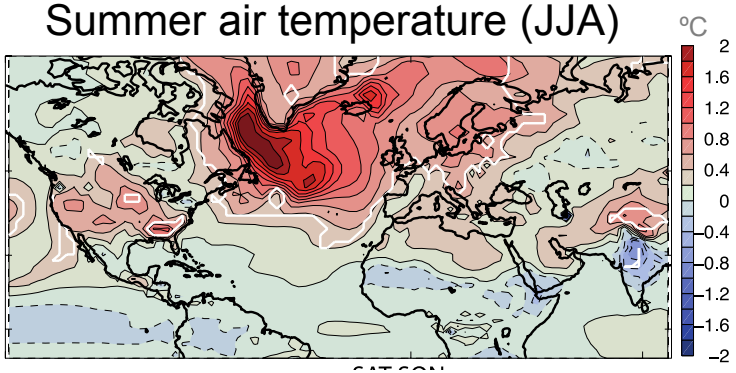




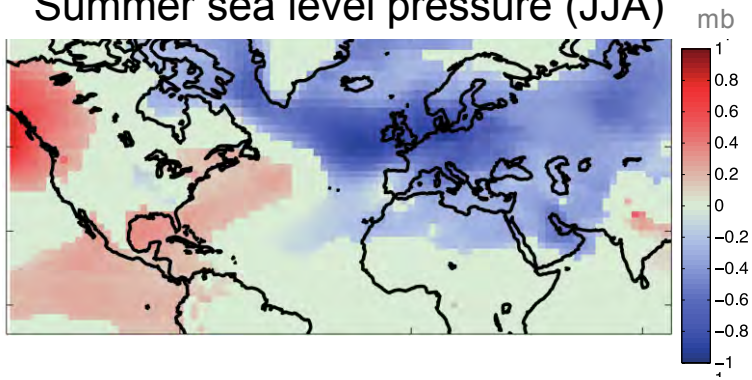
Robustness across models: GFDL results consistent with NCAR and MetOffice predictions (Yeager et al. 2012, Robson et al. 2013)

Climate impacts associated with the abrupt warming in the successful predictions

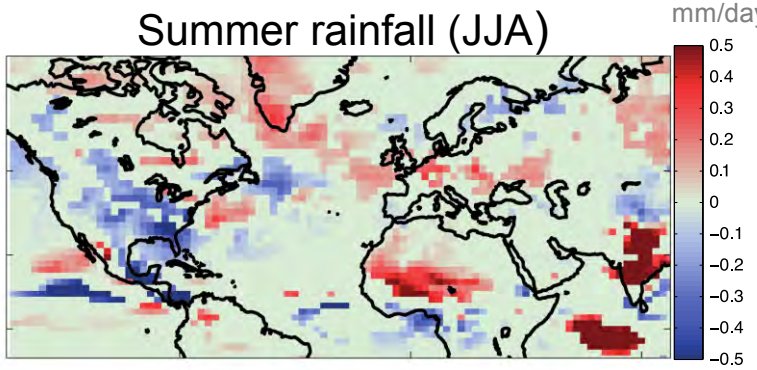
Summer air temperature (JJA)



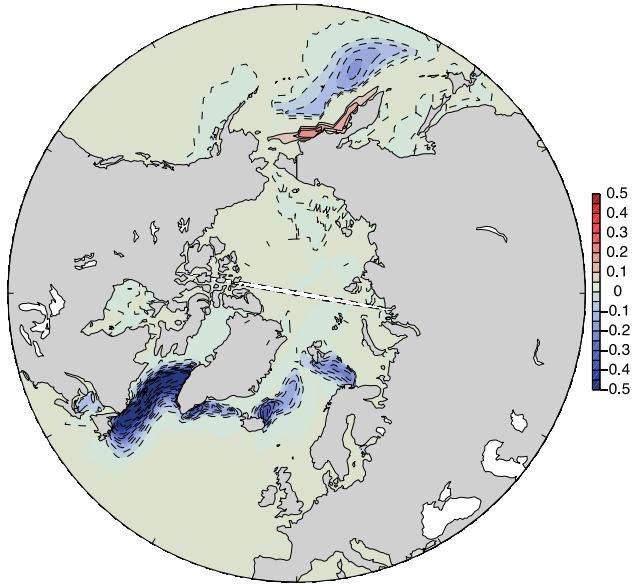
Summer sea level pressure (JJA)



Summer rainfall (JJA)



Winter sea-ice concentration (FMA)



GFDL predictions that capture the mid 90's abrupt warming are associated with climate impacts similar to those observed and simulated during positive AMO *(Sutton and Hodson 2005, Zhang and Delworth 2005, 2006, Mahajan et al. 2011).*

Summary

- Encouraging results are found in predicting seasonal Arctic sea ice variations in the GFDL CM2.1 and FLOR initialized forecasts.
- Decadal predictions show overall limited skill over land beyond the anthropogenic trend, except for few specific regions like the North Atlantic and specific events like the mid 90's abrupt warming.
- From seasonal to decadal time scales, improved initialization, model mean state, and understanding are key for better predictions.