

Hindcast Simulations of Arctic and Sub-Arctic Oceans

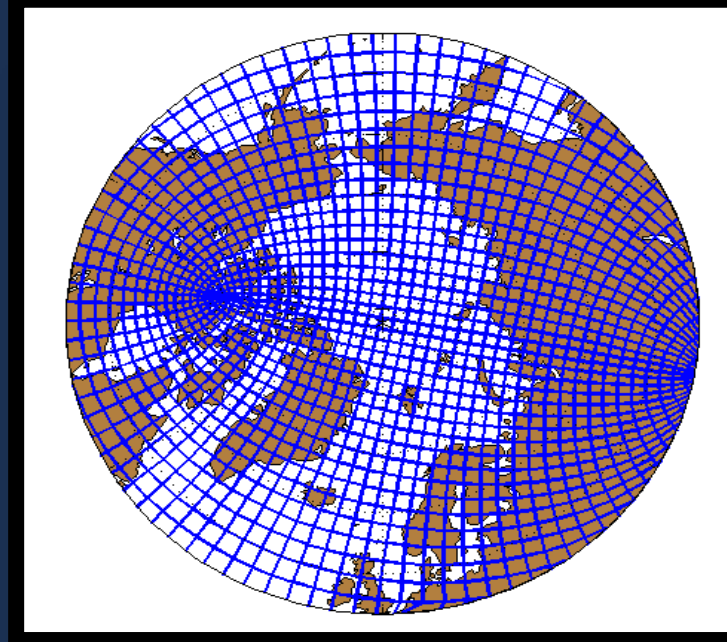
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Model and Experimental design

The ocean model NEMO-OPA and the sea-ice model NEMO-LIM are configured on a 2° grid with 31 vertical levels.

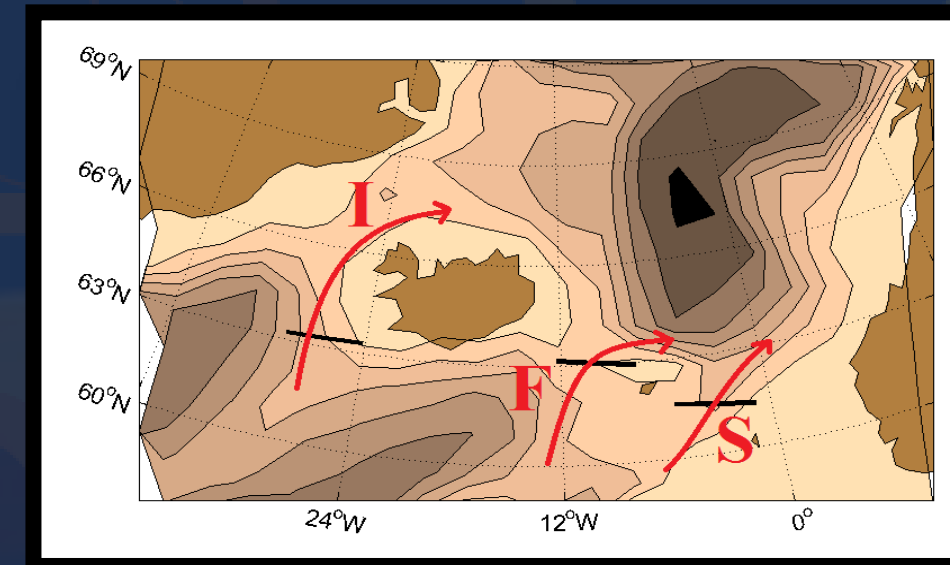


It is forced using 6 hourly atmospheric conditions from NCEP/NCAR reanalysis for the period 1948-2005. The results shown here are from six ensemble runs initialized from the control run model solution for years with high, low and neutral NAO index.

Model Validation

Greenland-Scotland Ridge

Volume fluxes of Atlantic Water (AW) calculated from model results over the Greenland-Scotland Ridge through the various branches shown in the table below, are within error of the volume fluxes of AW found using observations (Hansen 2008). The temperature of AW in all branches flowing over the Greenland-Scotland Ridge are colder in the model results than in the observations. The salinity from the model results are within error of the observed salinity.



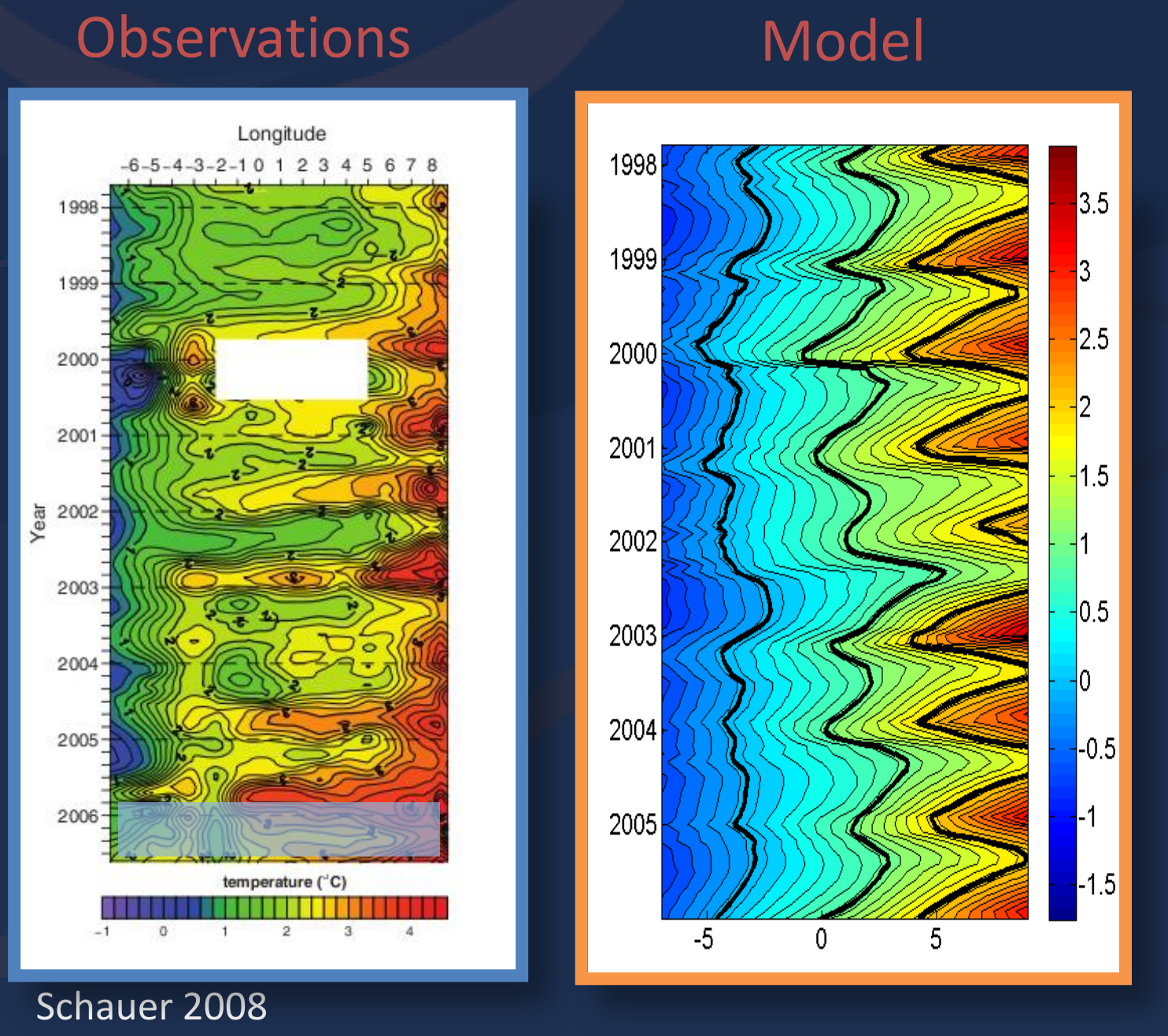
	Branch	Vol. Flux Sv	T °C	Salinity
Observations 1999-2001	Iceland (I)	0.8 ± 1	6.0	≤ 35.00
	Faroe (F)	3.8 ± 1	8.2	35.23
	Shetland (S)	3.8 ± 1	9.5	35.32
	Total Atl.	8.5 ± 3	8.5	35.25
Model 1999-2001	Iceland (I)	1.0 ± 0.1	5.3 ± 0.3	35.10 ± 0.01
	Faroe (F)	4.0 ± 1	6.7 ± 0.3	35.21 ± 0.04
	Shetland (S)	5.2 ± 1	8.3 ± 0.2	35.27 ± 0.01
	Total Atl.	10 ± 2	6.8 ± 0.3	35.19 ± 0.03

Fram Strait

Northward and southward model volume flux through the Fram Strait are close to those calculated from observations (Schauer 2008). However there are smaller magnitudes in the model results than in observations.

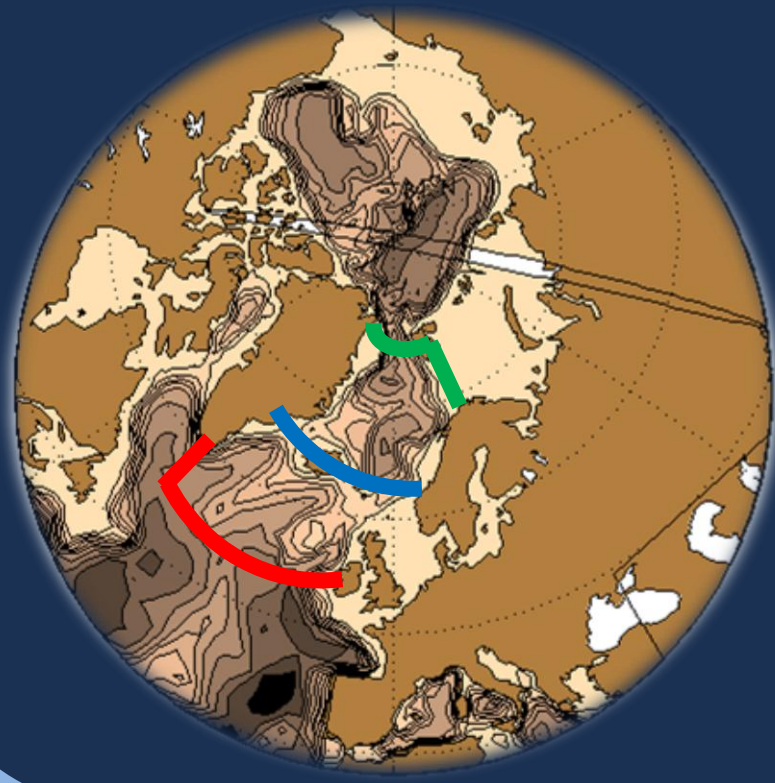
	Branch: Fram Strait	Vol. Flux Sv
Observations 1997-2003	Northward Flux	12 ± 1
	Southward Flux	14 ± 1
	Total	2 ± 1 South
Model 1997-2005	Northward Flux	7.5 ± 0.7
	Southward Flux	10.7 ± 0.6
	Total	3.1 ± 0.5 South

The model reproduces correctly the seasonal time variability of the temperature in the Fram Strait. The warm season in both the model and observations occurs in the late fall early winter. The year 2003 was an anomalously warm year and in 2002 there was a westward cold intrusion in both model and observations.



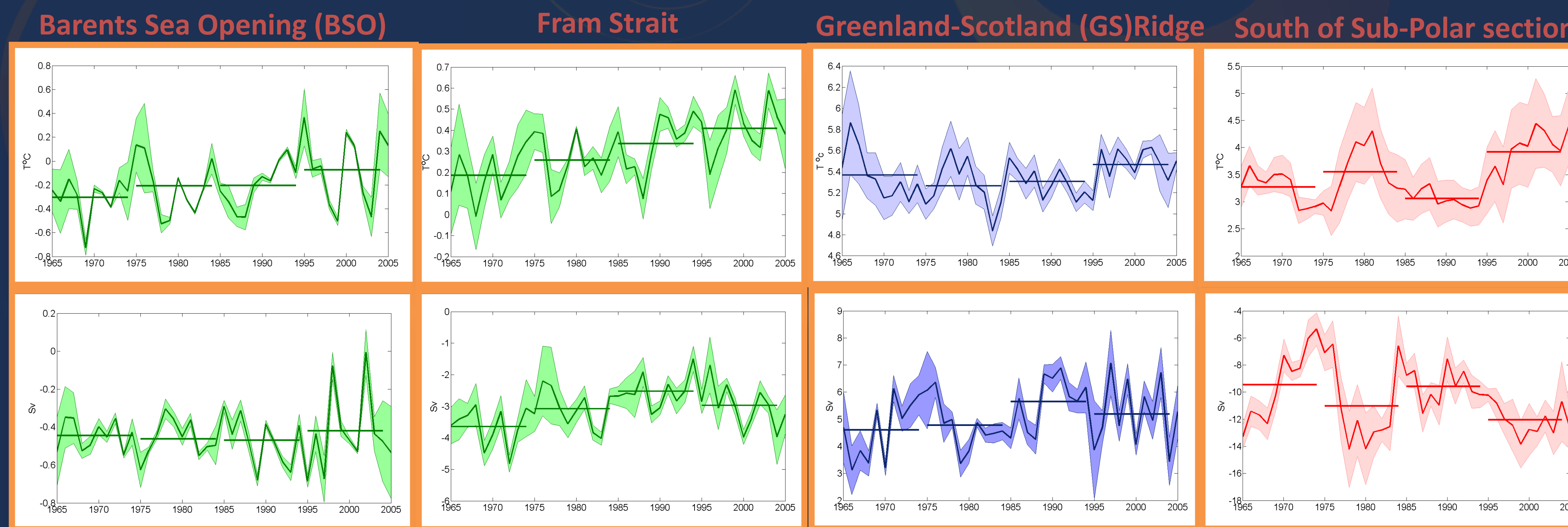
Interannual Variability

There was an increase in the decadal mean of the temperature during the studied period in the Barents Sea Opening and Fram Strait while the temperature over the Greenland-Scotland Ridge showed no long term trend. The decadal mean of volume flux through BSO did not show a strong interannual variability. There was increase in volume flux in both the Fram Strait and over the GS Ridge for the period 1985-1995.



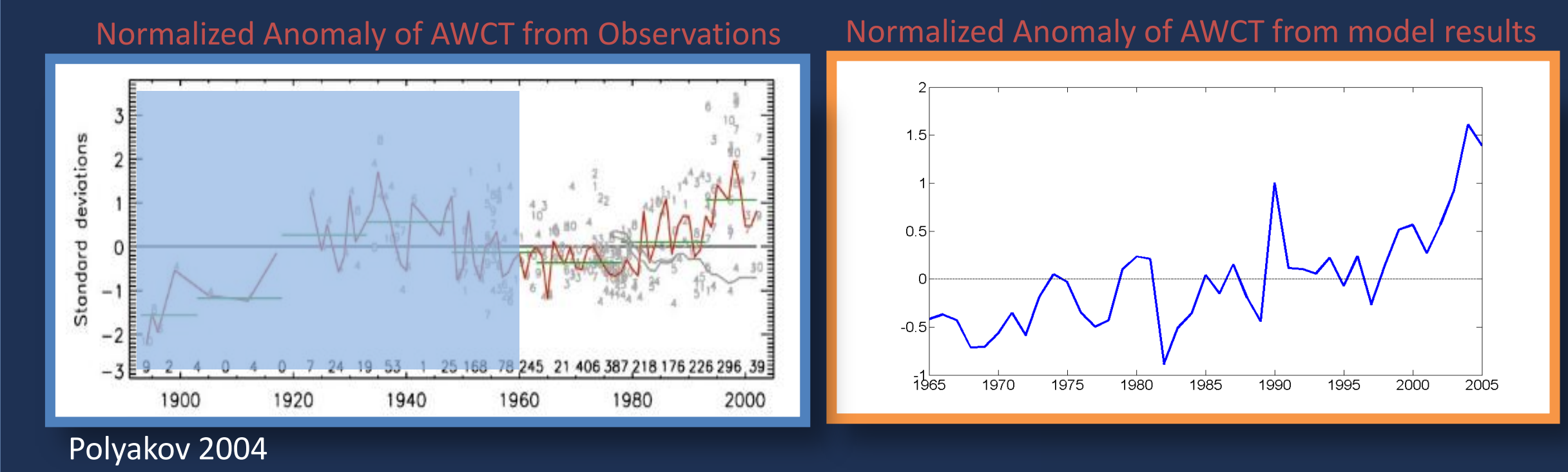
The BSO and Fram Strait were the only straits that showed a monotonic increase in their decadal mean temperatures.

The decadal mean of the volume flux and temperature of the water entering into the south of the sub-polar section fluctuated between positive and negative anomalies. However a positive anomaly in temperature corresponds with a negative anomaly in volume flux and vice versa.



Atlantic Water Core Temperature (AWCT) in the Arctic Ocean

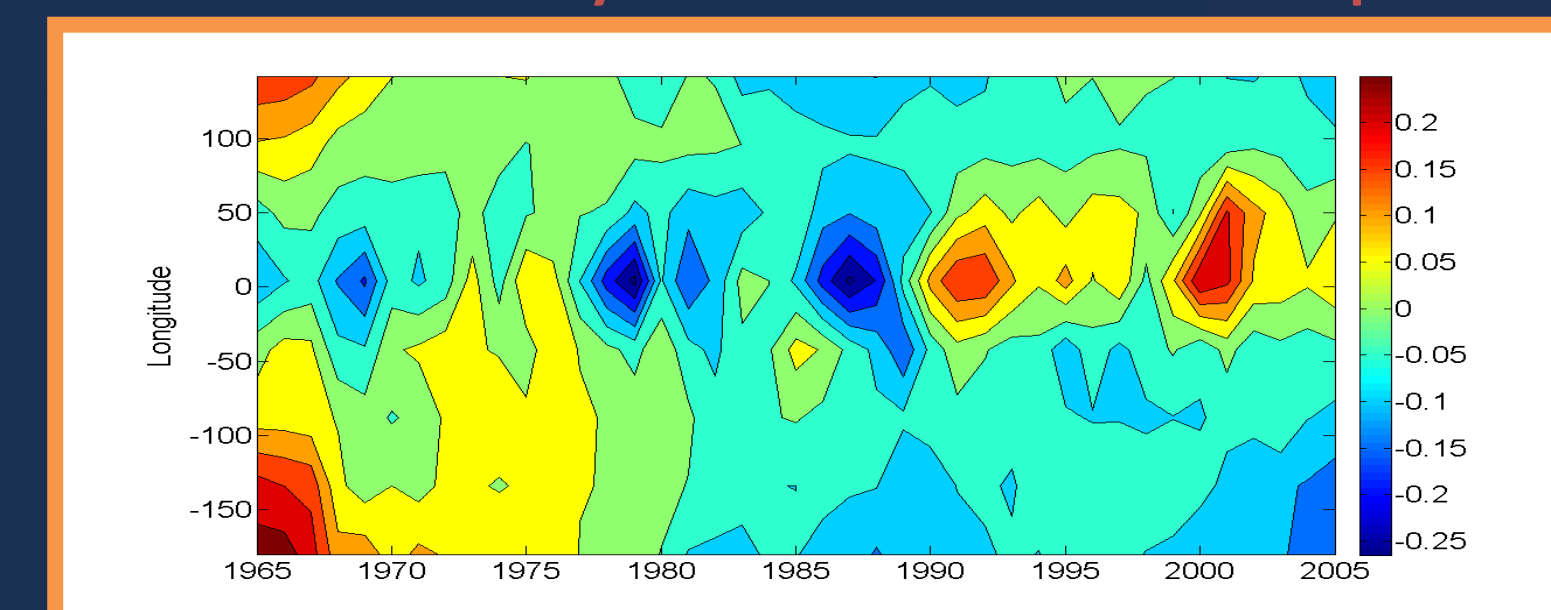
The trend in the AWCT in the Arctic Ocean produced by the model is close to that of the observations. The normalized anomaly of the AWCT is steady and negative between 1965 and 1990 and sharply increases after 1990.



Possible Regime Shift In Heat Transport

The bottom water core temperature (minimum temperature) close to the Fram Strait is anomalously warm after 1990 and close to the Bering Strait is anomalously cold after 1990 and vice versa before 1990.

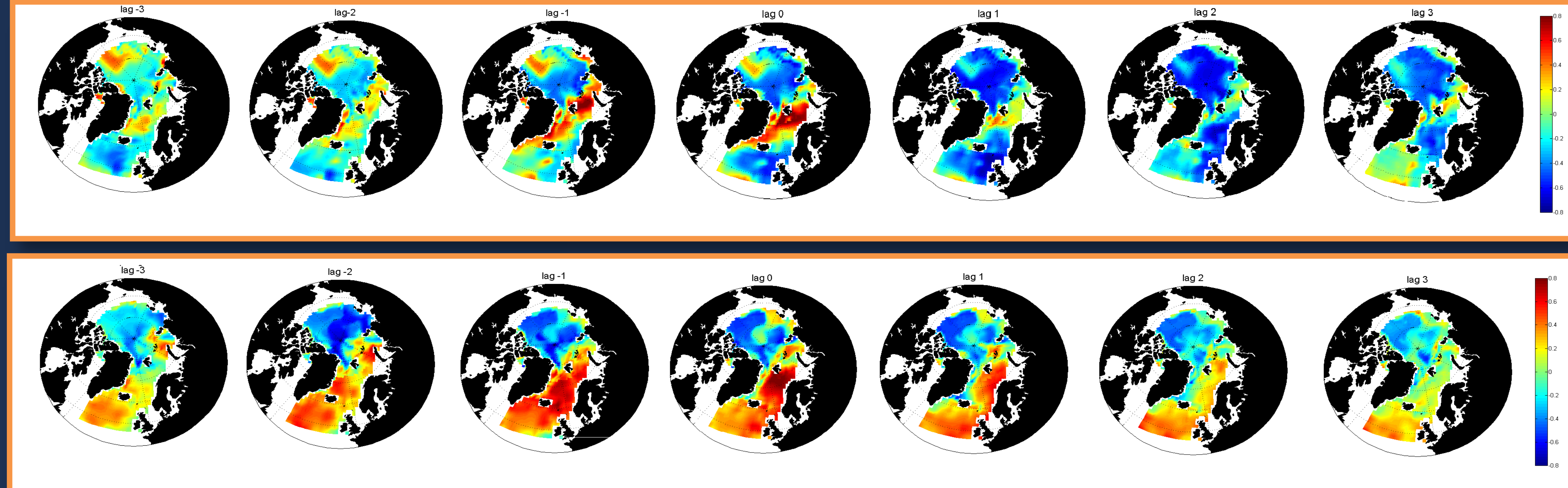
Normalized Anomaly of Bottom water core temperature



1965-1985

1986-2005

Correlation between maximum temperature of the water mass and maximum temperature in Fram Strait (lagged) for two time periods.



The correlation between maximum temperature of the water mass and maximum temperature in Fram Strait (lagged) changed between the two time periods. Before 1985 there is only a strong correlation between the max temperature of the water and the max temperature in the Fram Strait at zero and one year lags. After 1985 the correlation increases at lags larger than a year. The propagation of anomalies of the AW temperature follow a counter-clockwise pattern the Nordic Seas and partly into the Arctic Ocean for the period 1986-2005. This pattern is not present in the period 1965-1985.

Conclusions

The model represents realistically the volume and temperature transport into the Nordic Seas over the Greenland-Scotland Ridge and through the Fram Strait. It also reproduces the trend in the AWCT in the late 1990s. The decadal mean temperature through the Fram Strait and southern boundary of the sub-polar section increased between 1965 and 2005. The temperature in the rest of the straits remained relatively constant. In all straits except the BSO there was an increased volume flux for the period 1985-1995. Between the period 1965-1985 and 1986-2005 there was a change in the correlation between maximum temperature in the Fram Strait and in the ocean; with a stronger, lag correlation for the later period. Before 1990 the BWCT was anomalously cold near where the Atlantic water enters and anomalously warm where the Pacific water enters. After 1990 this tendency switched.

References

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