Model Study of interannual variability of the North Atlantic Water mass in the Arctic Ocean

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GOAPP
Global Ocean-Atmosphere Prediction and Predictability

Canadian Foundation for Climate and Atmospheric Sciences (CFCAS)
Fondation canadienne pour les sciences du climat et de l'atmosphère (FCSCA)

Motivation

- Observations show strong interannual variability in recent two decades in the Arctic Ocean .
  - Water and heat exchanges between Arctic and Nordic Seas is often considered as the main cause of this variability.
- No significant increase of heat fluxes into the Arctic Ocean was observed
  - However there was an increase in temperature.

Objectives

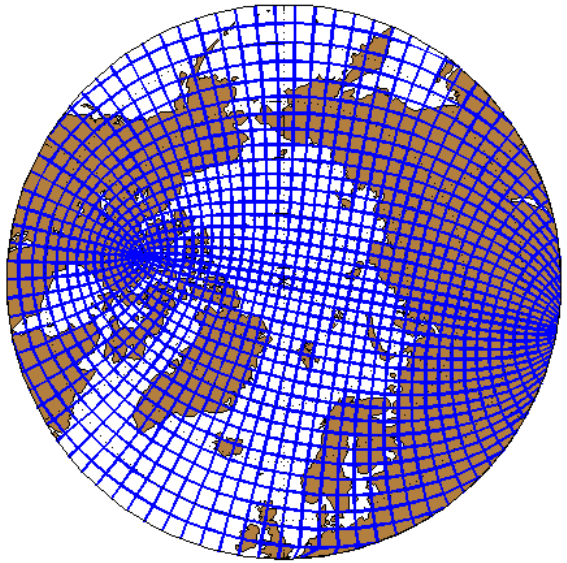
- To perform a model study of the Arctic Ocean variability.
- To assess the model skills in representation of
  - Existing observations and knowledge about Arctic variability
- And to study the mechanisms of recently observed interannual variability

Model Description

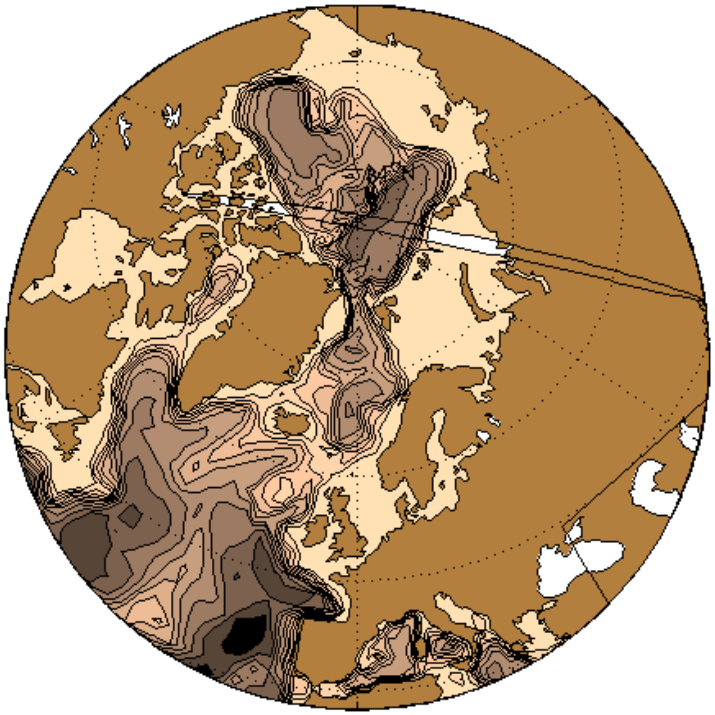
- **This hindcast study of the climate in the Arctic Ocean and Northern Seas is performed using OGCM simulations.**

- **We used a coupled ocean/sea-ice model**
  - NEMO-OPA(ocean model) and NEMO-LIM (sea-ice model) are configured on a 2^{o} with 31 vertical levels.
  - It is forced using 6 hourly atmospheric conditions from NCEP/NCAR reanalysis for the period 1948-2005.

- **Using 6 ensemble runs initialized from the control run for years with high, low and neutral NAO index**

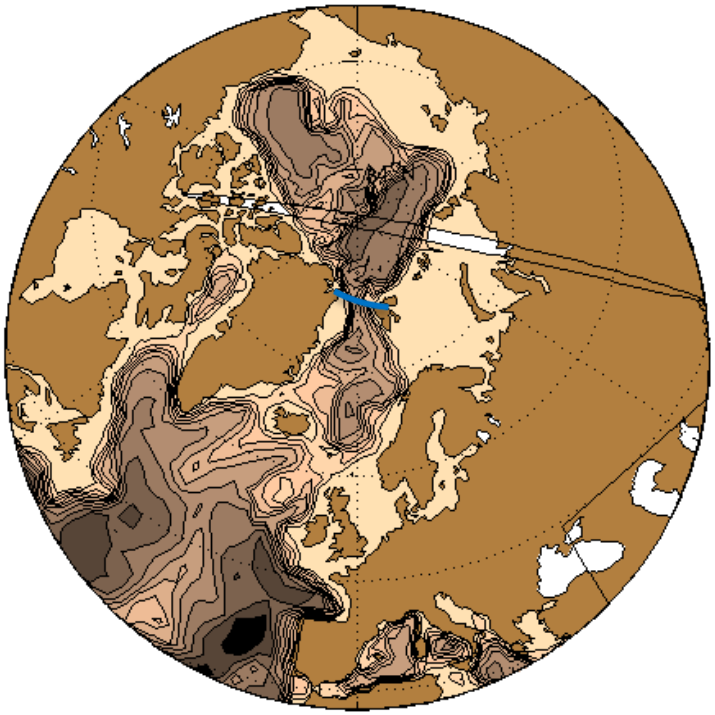


Model Data-Intercomparison



I will compare my model results with observations.

Model Data-Intercomparison



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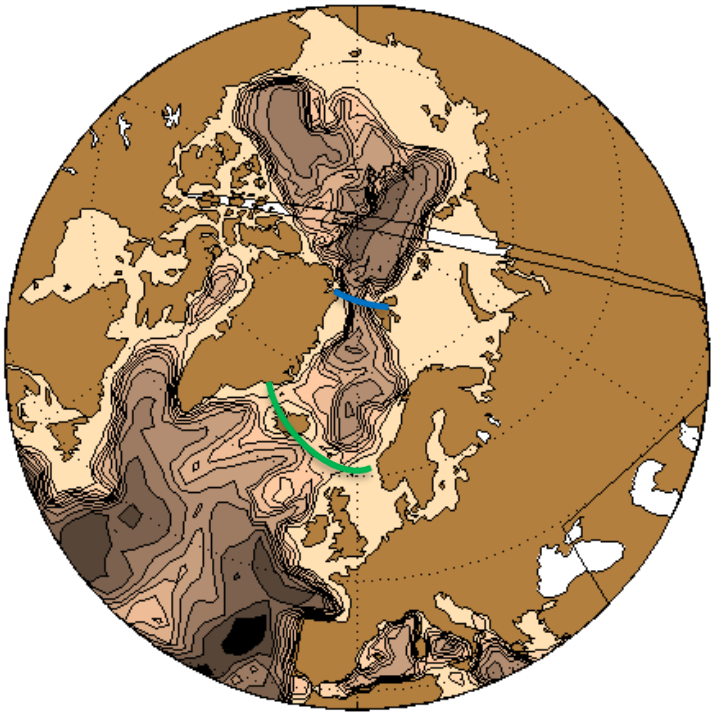
- **through the Fram Strait**

Model Data-Intercomparison



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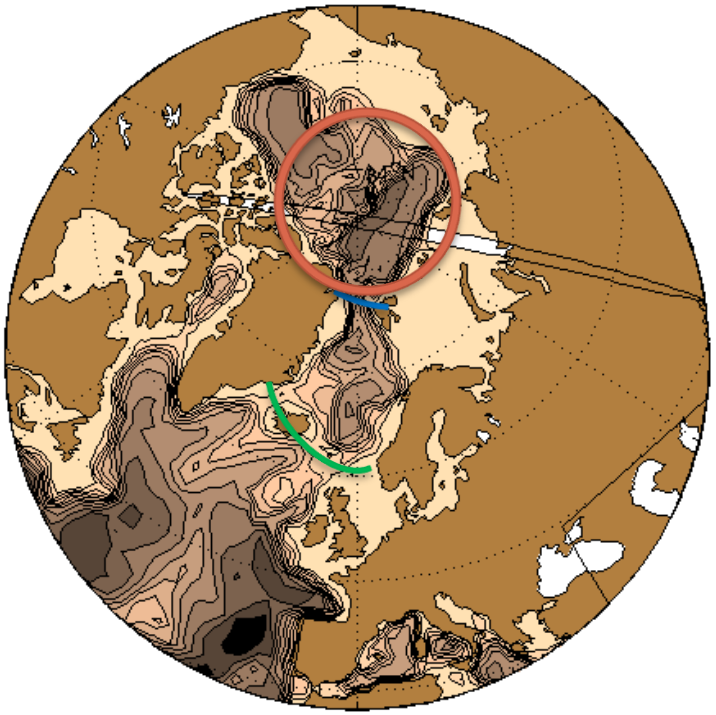
- **through the Fram Strait**
- **Over the Greenland-Scotland Ridge**

Model Data-Intercomparison



I will compare my model results with observations.

- **through the Fram Strait**
- **Over the Greenland-Scotland Ridge**
- **And in the Arctic Ocean**

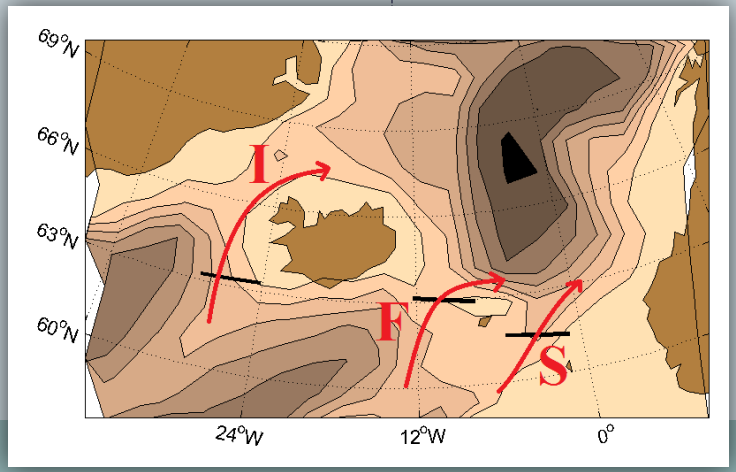
Volume flux of Atlantic Water

Observations (Hansen 2008)

Branch	Vol. Flux Sv	T °C	Salinity
Iceland	0.8 ±1	6.0	≤ 35.00
Faroe	3.8±1	8.2	35.23
Shetland	3.8±1	9.5	35.32
Total Atl.	8.5±3	8.5	35.25

My model

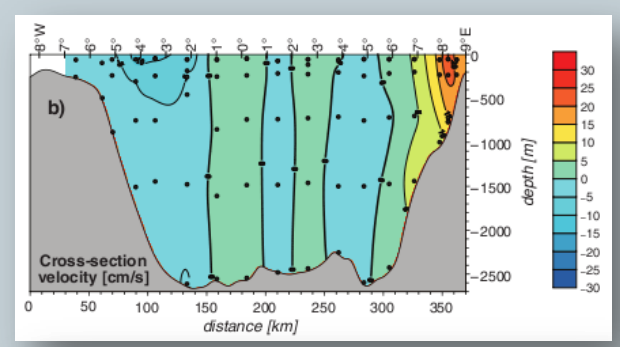
Branch	Vol. flux Sv	T °C	Salinity
Iceland	1.0 ±0.1	5.3±0.3	35.10±0.01
Faroe	4.0±1	6.7±0.3	35.21±0.04
Shetland	5.2±1	8.3±0.2	35.27±0.01
Total Atl.	10 ± 1	6.8±0.3	35.19±0.02

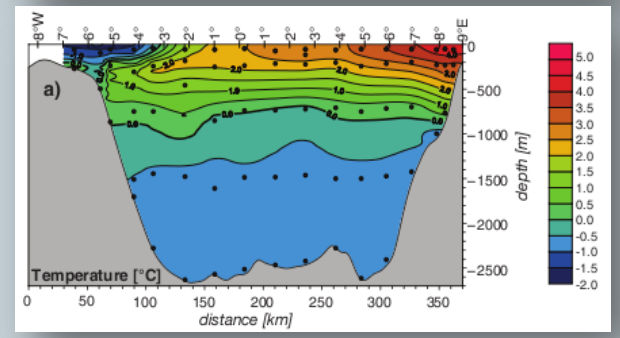


Volume flux through the Fram Strait

Observations – 97-2006

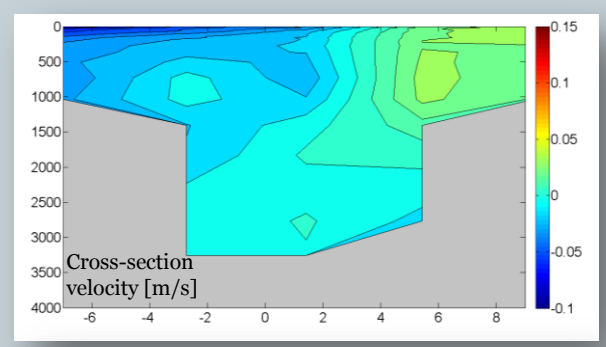
Northward Flux	12± 1 Sv
Southward Flux	14 ± 1 Sv
Total	**2 ± 2 Sv south**

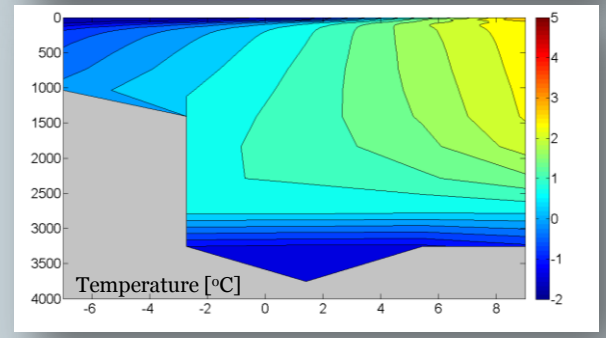




My model – 97-2005

Northward Flux	7.5 ± 0.7 Sv
Southward Flux	10.7 ± 0.6 Sv
Total	**3.1 ± 0.5 Sv south**



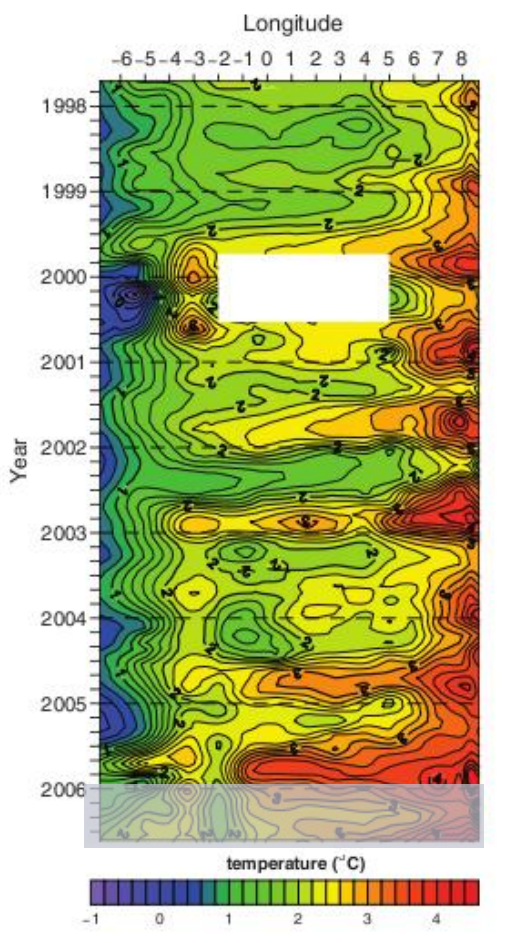


Schauer 2008

Time variability of Temp in Fram Strait

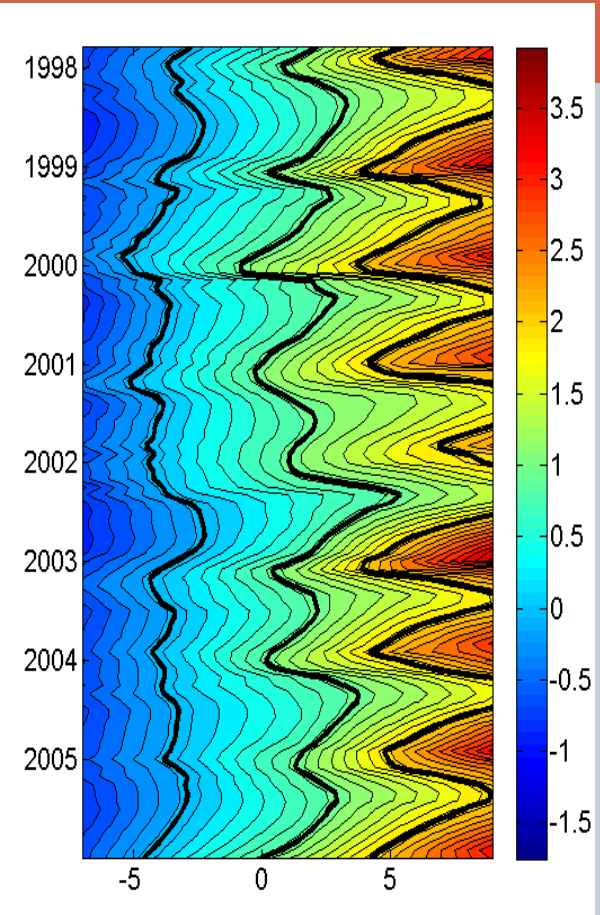
For the period 1998-2005

Observations



Schauer 2008

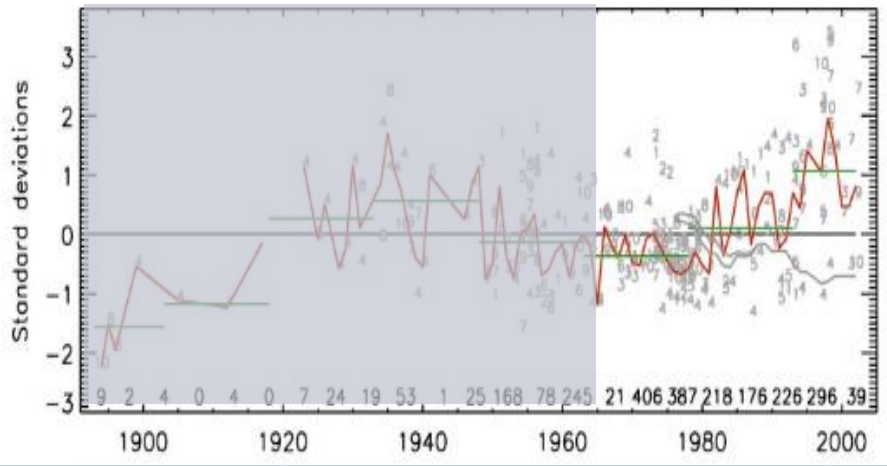
My model



Variability of Atlantic Water Core Temperature

Observations

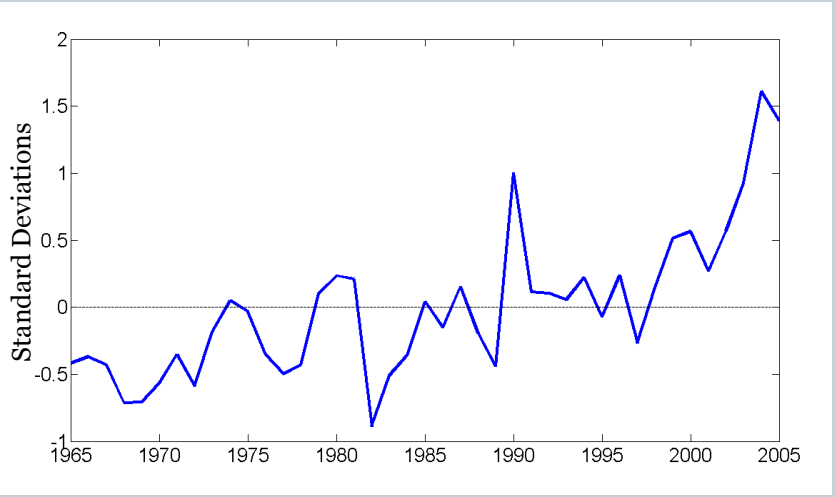
Normalized Anomaly of AWCT from Observations



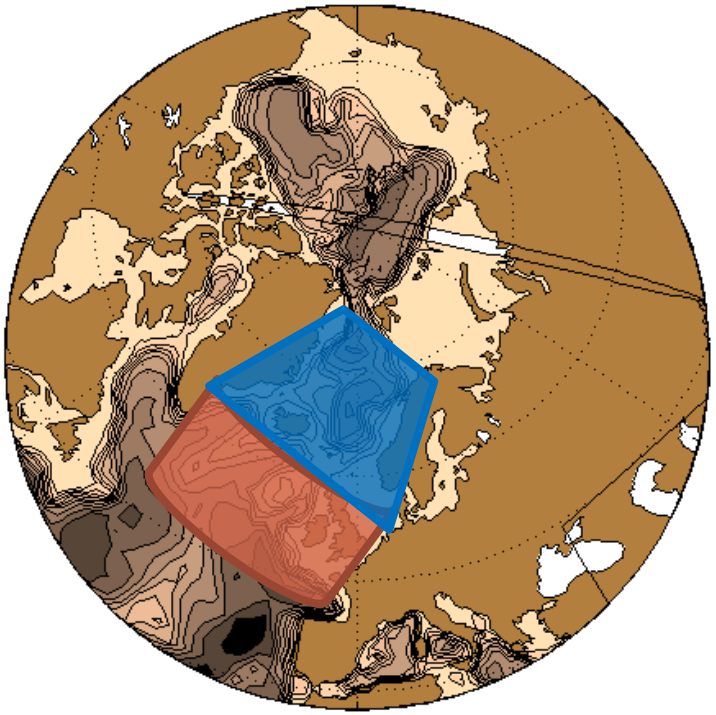
Polyakov 2004

My Model

Normalized Anomaly of AWCT from model results



Changes in Heat Flux into the Arctic Ocean

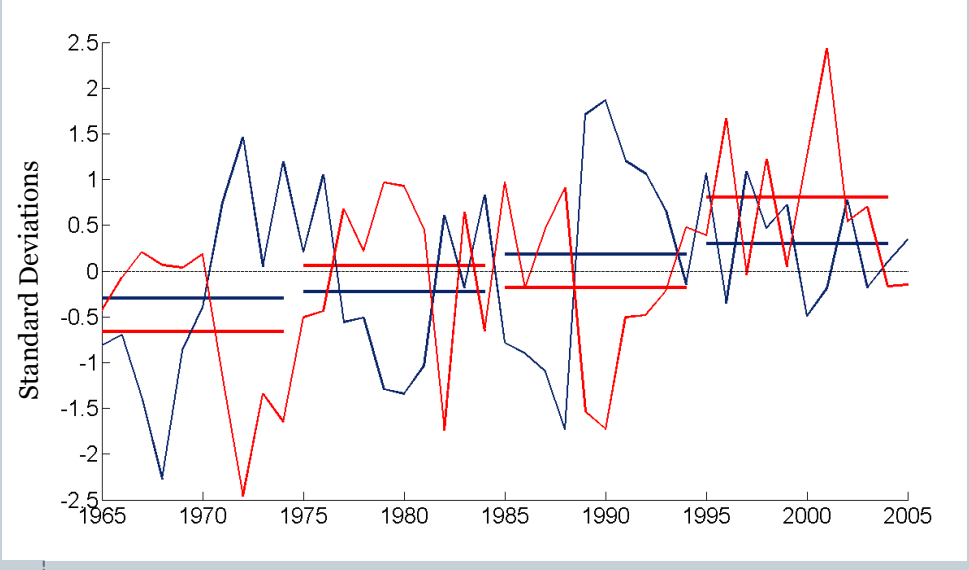


- Into the sub-polar ocean
- And into the Nordic Seas

Total Heat flux into Nordic and Sub-polar seas

- Increasing decadal trend in both areas.
- There is an increase in the decadal mean heat flux of the Nordic Seas after 1985 and in the sub-polar North Atlantic after 1995

Normalized Anomaly of Total Heat Flux

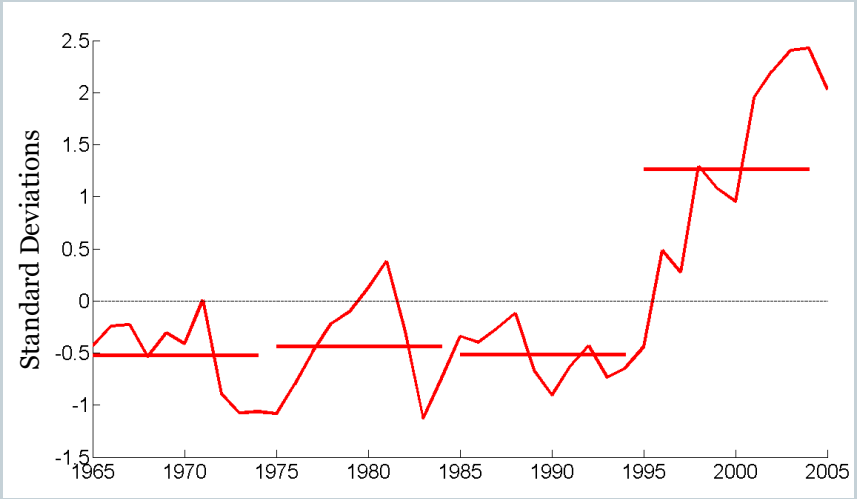


- Sub-polar sea
- Nordic sea

Heat flux into the Sub-polar Sea

Mean Temperature

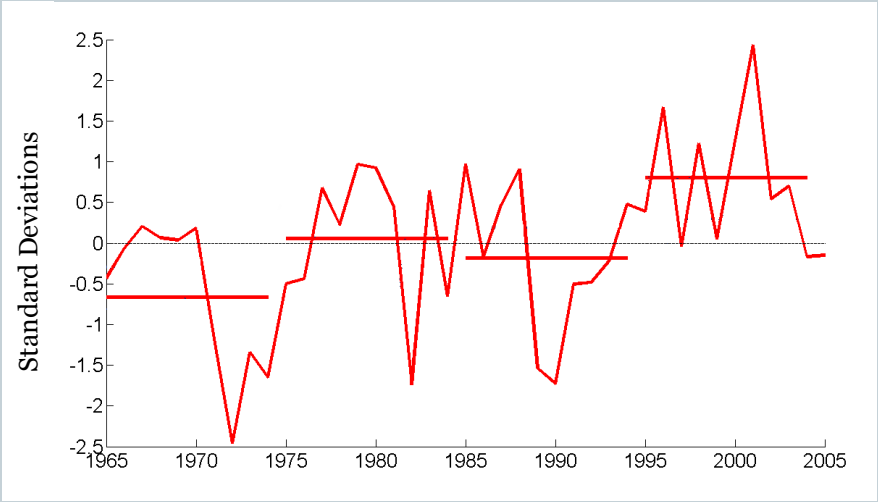
Normalized Anomaly Mean Temperature



Total Heat flux

Red: Sub-polar

Normalized Anomaly of Total Heat Flux



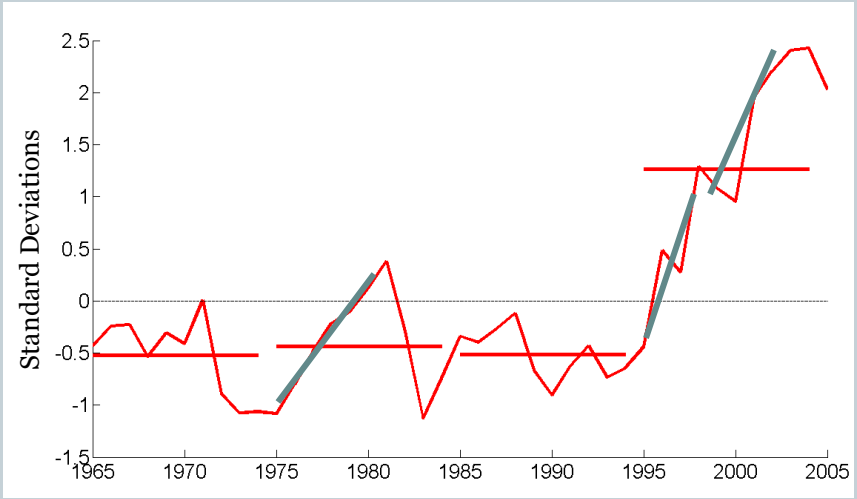
Heat flux into the Sub-polar Sea

Mean Temperature

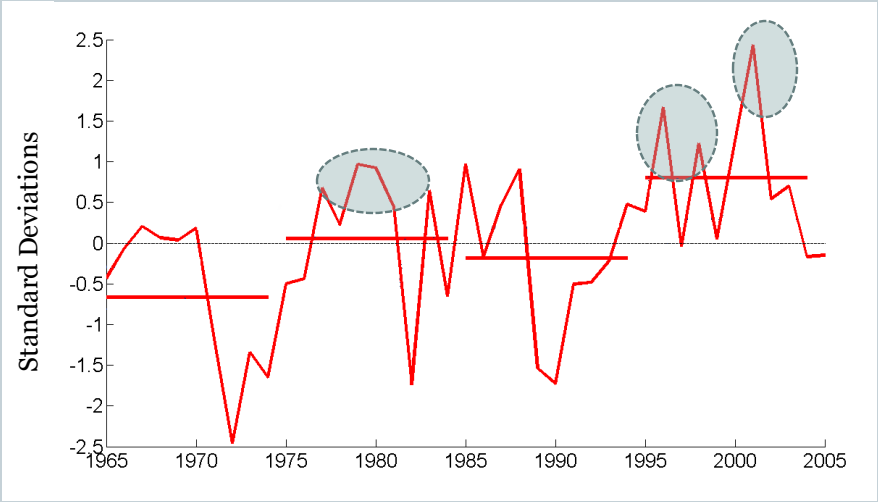
Total Heat flux

Red: Sub-polar

Normalized Anomaly Mean Temperature



Normalized Anomaly of Total Heat Flux

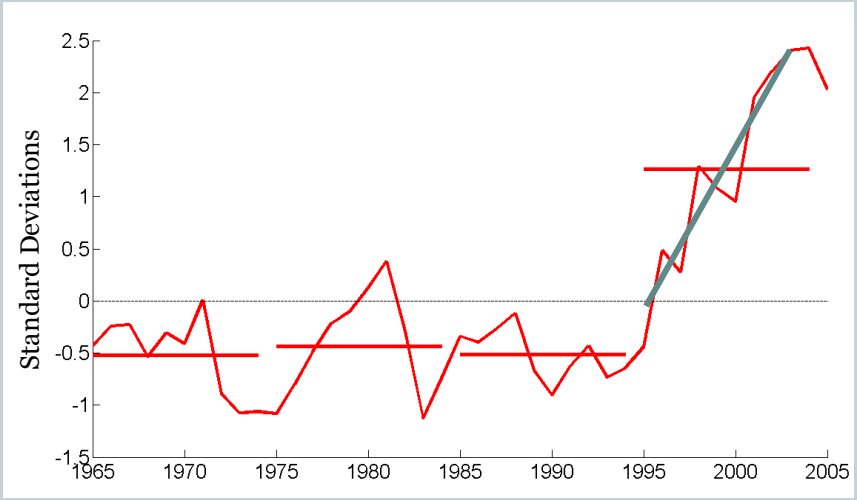


- Peaks in heat flux in 1980,1997 and 2003 lead to sharp temperature changes.

Heat flux into the Sub-polar Sea

Mean Temperature

Normalized Anomaly Mean Temperature



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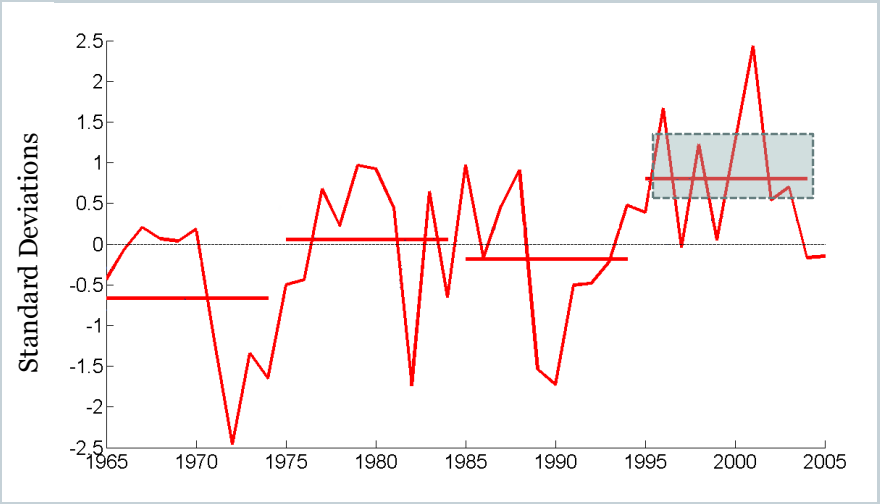
Normalized Anomaly of Total Heat Flux

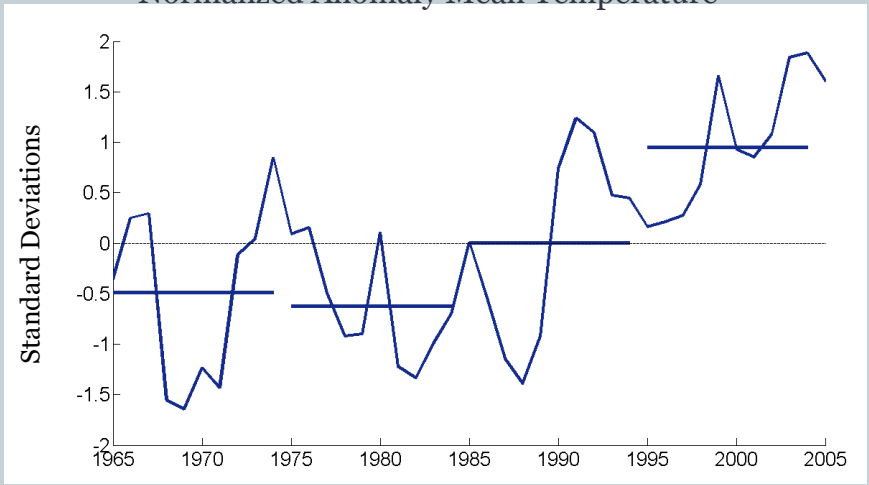


- Trend in temperature in late 1990s and 2000s is related to constant positive heat flux anomaly during this time.

Heat flux into the Nordic Seas

Mean Temperature

Normalized Anomaly Mean Temperature

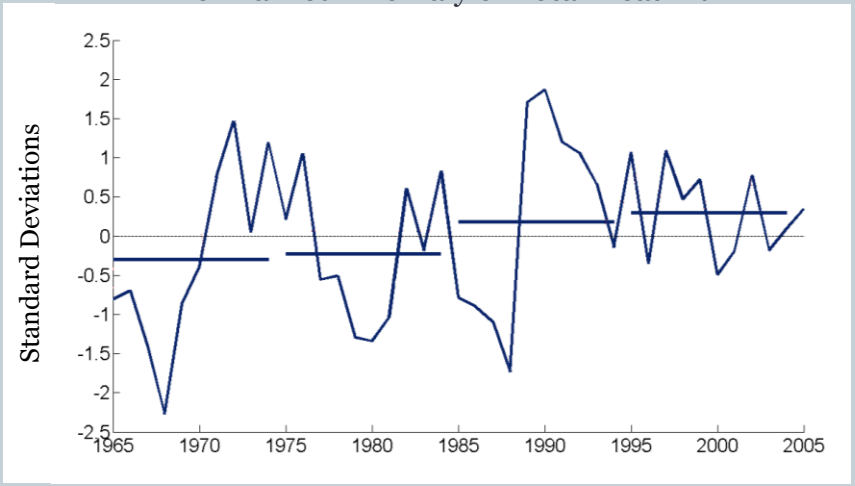


- Temperature anomaly was positive from 1990-2005 and was majorly negative from 1965-1990

Total heat into Nordic

Blue: Nordic

Normalized Anomaly of Total Heat Flux

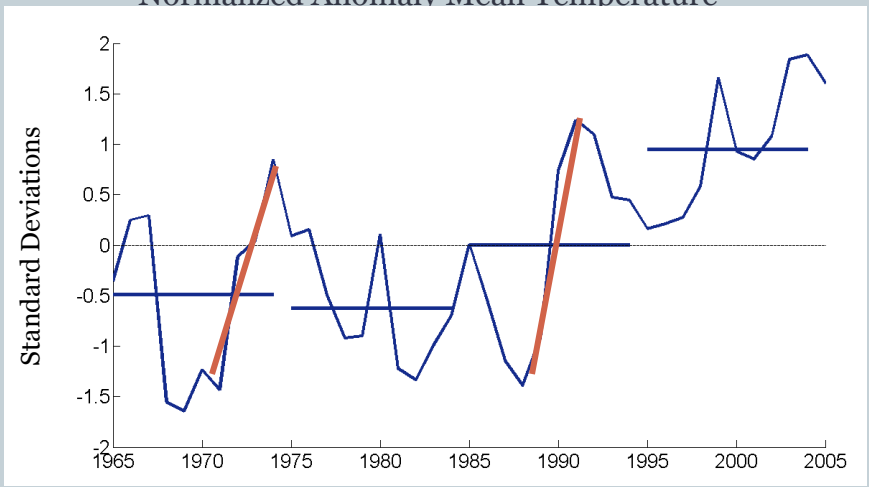


- Heat Flux anomaly was positive from 1985-2005 and oscillated between negative and positive for 1965-1990

Heat flux into the Nordic Seas

Mean Temperature

Normalized Anomaly Mean Temperature

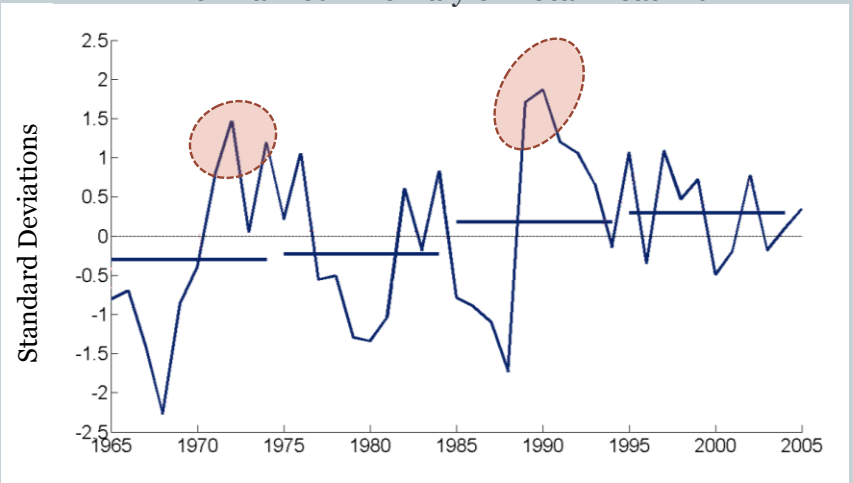


-Very high peaks in early 1990s and 1970s lead to rapid increase of T
-No strong peaks after, but the temperature anomaly remained positive and was highest for the period.

Total heat into Nordic

Blue: Nordic

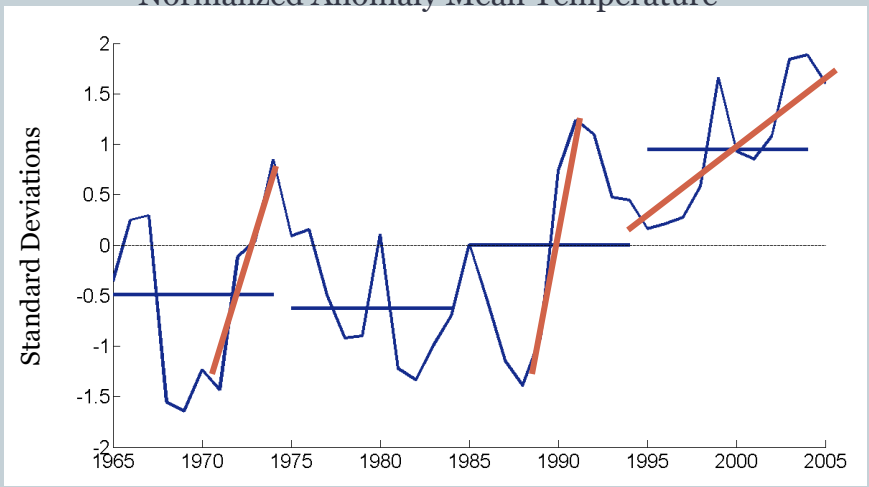
Normalized Anomaly of Total Heat Flux



Heat flux into the Nordic Seas

Mean Temperature

Normalized Anomaly Mean Temperature



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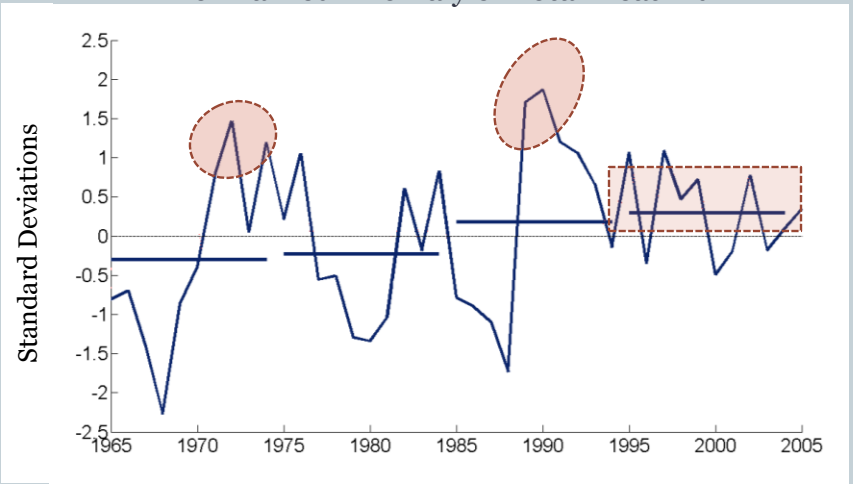
Total heat into Nordic

Blue: Nordic

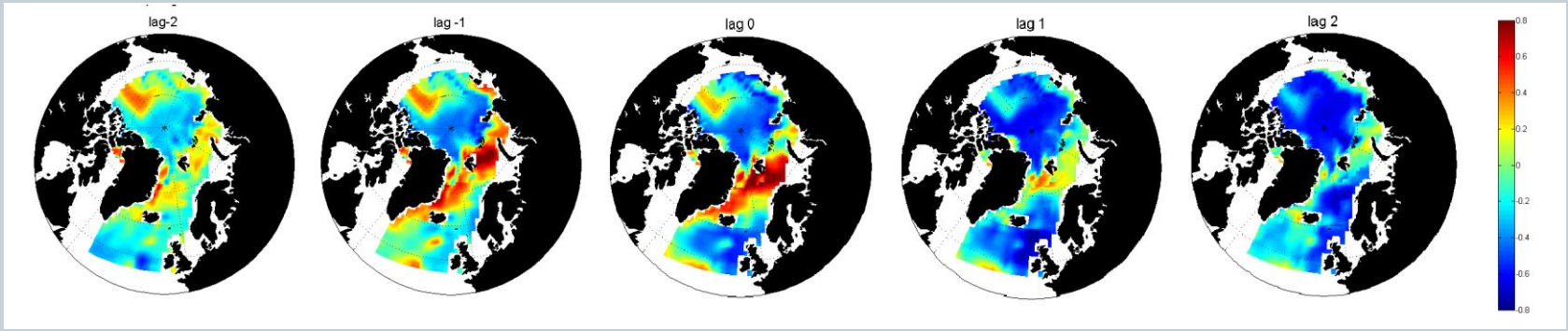
Normalized Anomaly of Total Heat Flux



- note the positive trend in temperature after 1990

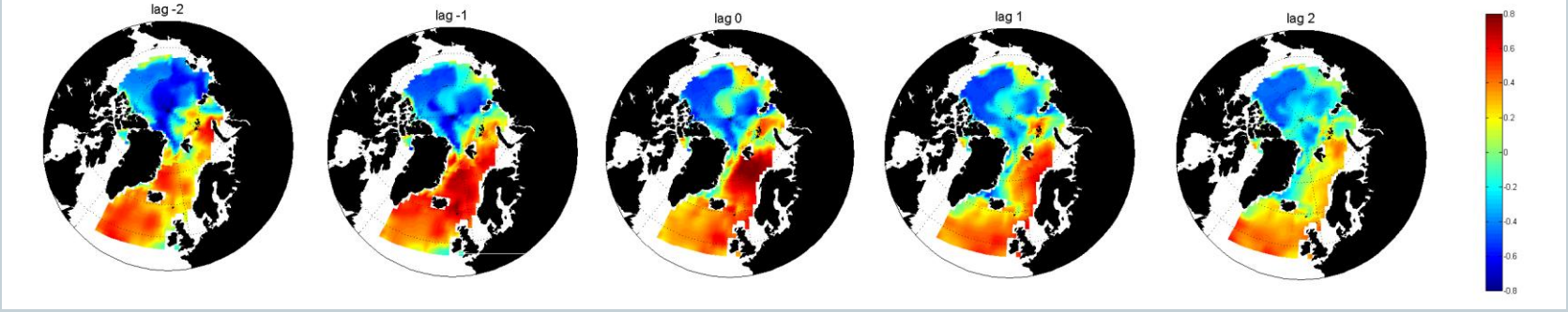
Correlation between maximum water temperature and maximum temperature through Fram Strait

1965-1985



• Only correlations at lag-zero

1986-2005



•Strong correlations at all lags

•The propagation of AW can be followed from the Sub-polar to Arctic Seas.

Conclusions

-The model was able to represent the volume and temperature transport of the Nordic Sea and the AWCT in the Arctic Ocean

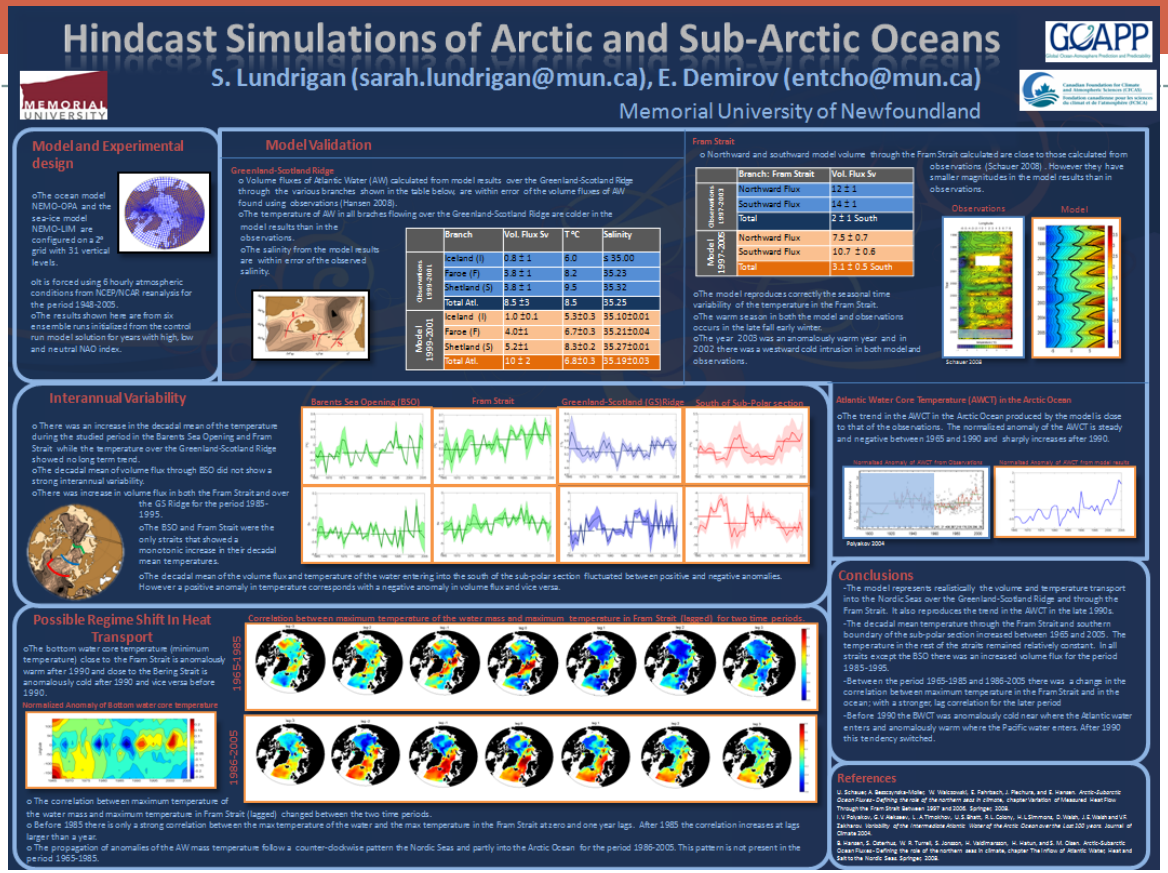
-Before 1985

- -No trend in decadal heat transport into Nordic Seas
- -Little correlation of temperature to the maximum temperature through Fram Strait

-After 1985

- -There is a trend in decadal heat transport into Nordic and Sub-polar seas
- -There is a stronger correlation to the temperature and the propagation of the NAW is clearer.

My Poster – 1P30-0404.2



Questions?