An endless story: salinity restoring and freshwater budget

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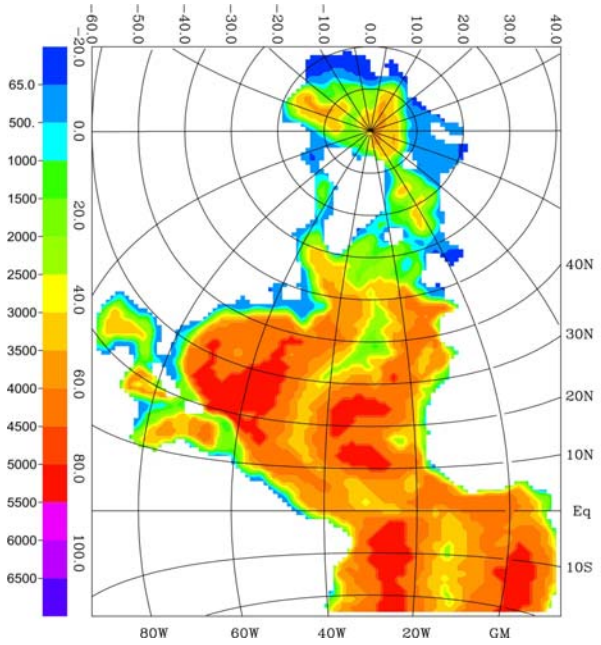
Bremerhaven



What´s new in the LRM model?

- Surface forcing: wind stress from NCEP 10m-wind velocities, as AOMIP´s seems to be it bit too strong and consequently result in too high (Fram Strait) transports
- 54 years of forcing repeated four times
- flux correction instead of salinity restoring
- Bering Strait with an open boundary

Montreal, June 7, 2005

What´s new in the model?

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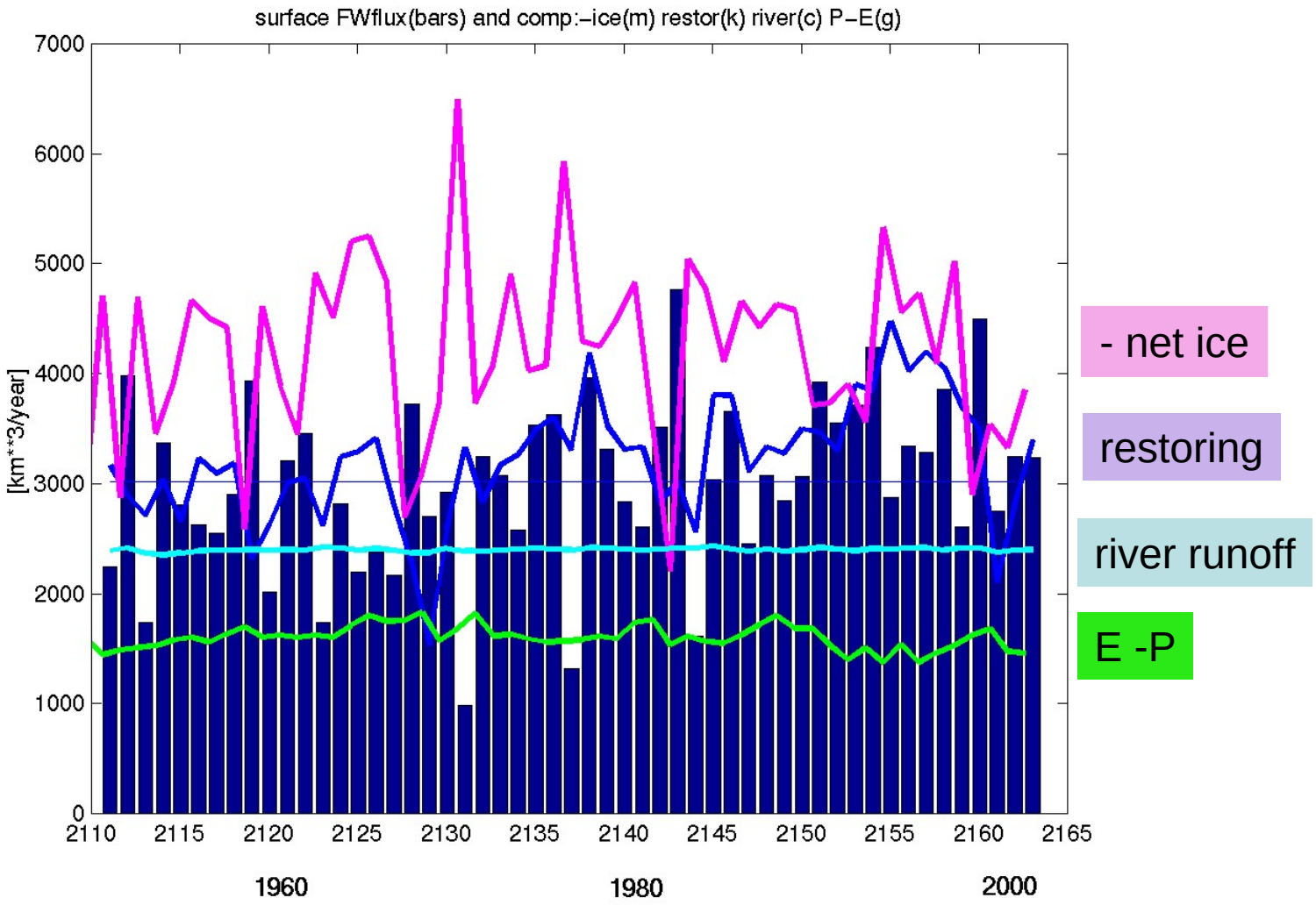
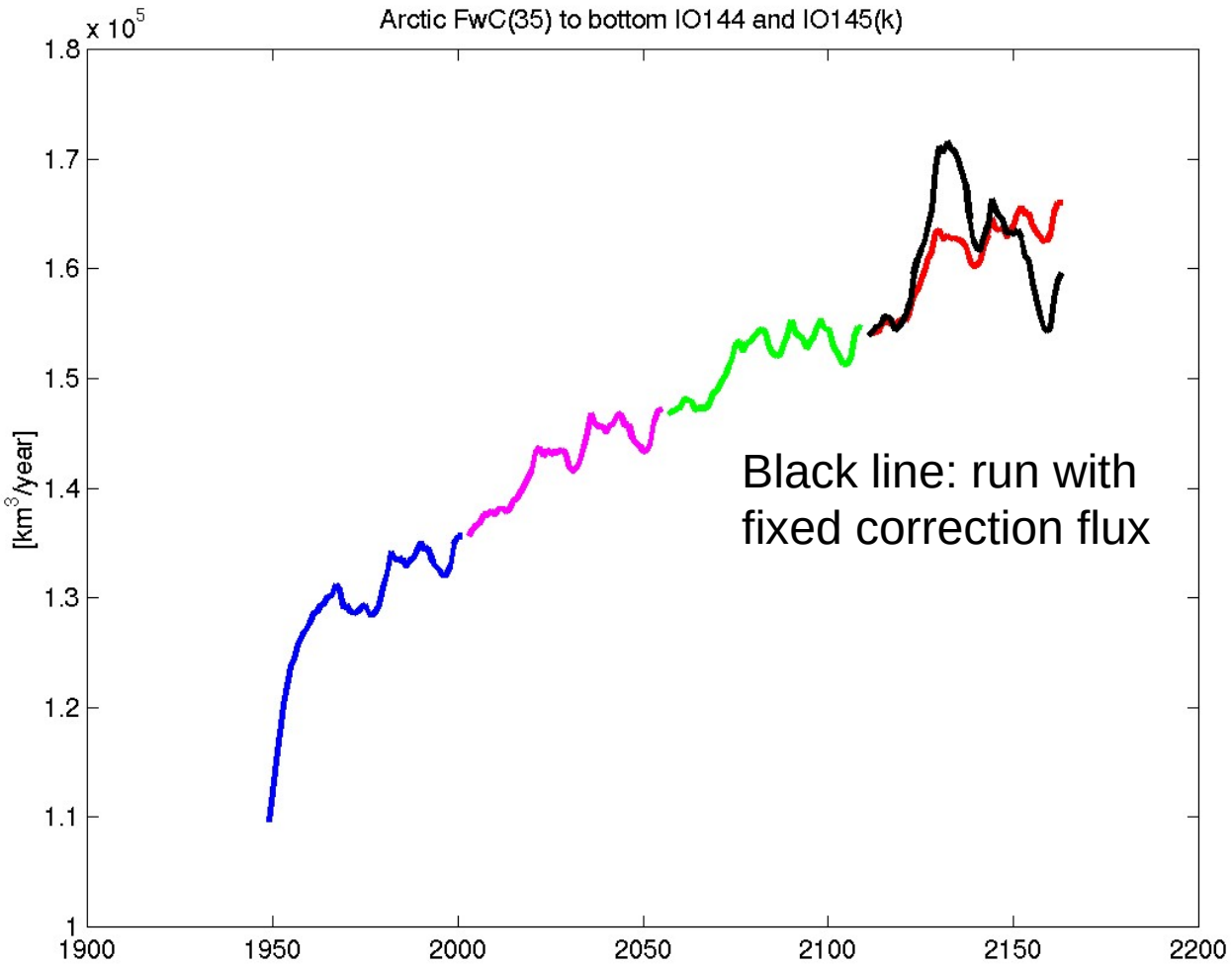
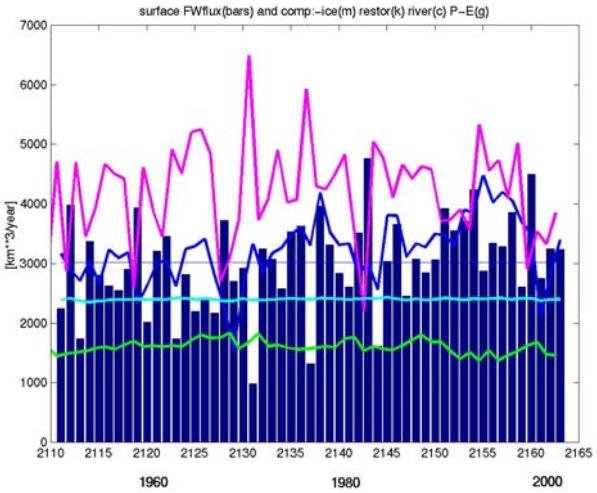
Components of surface liquid fresh water flux

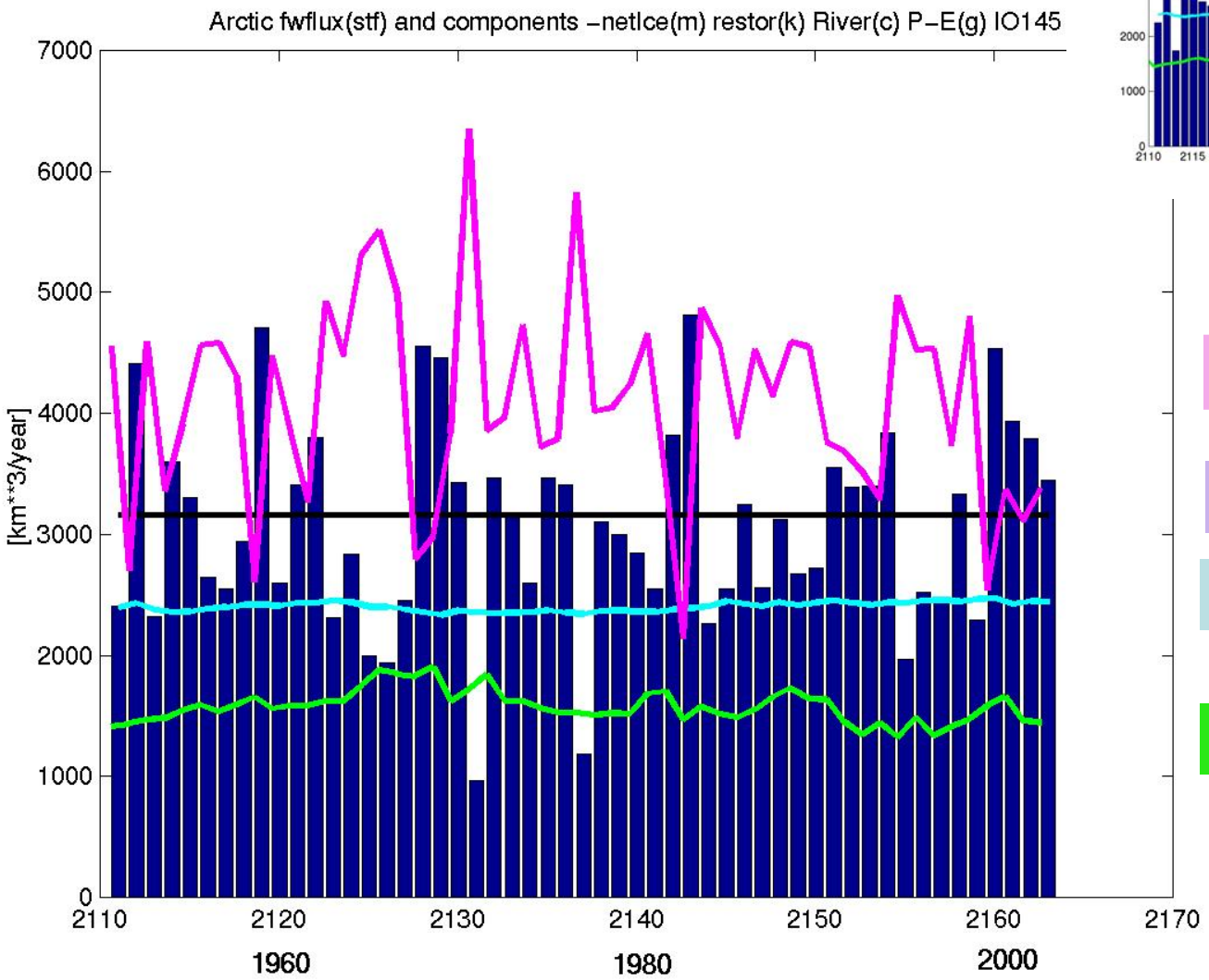


Arctic liquid fresh water(35.) content, to bottom



Arctic liquid surface fresh water flux





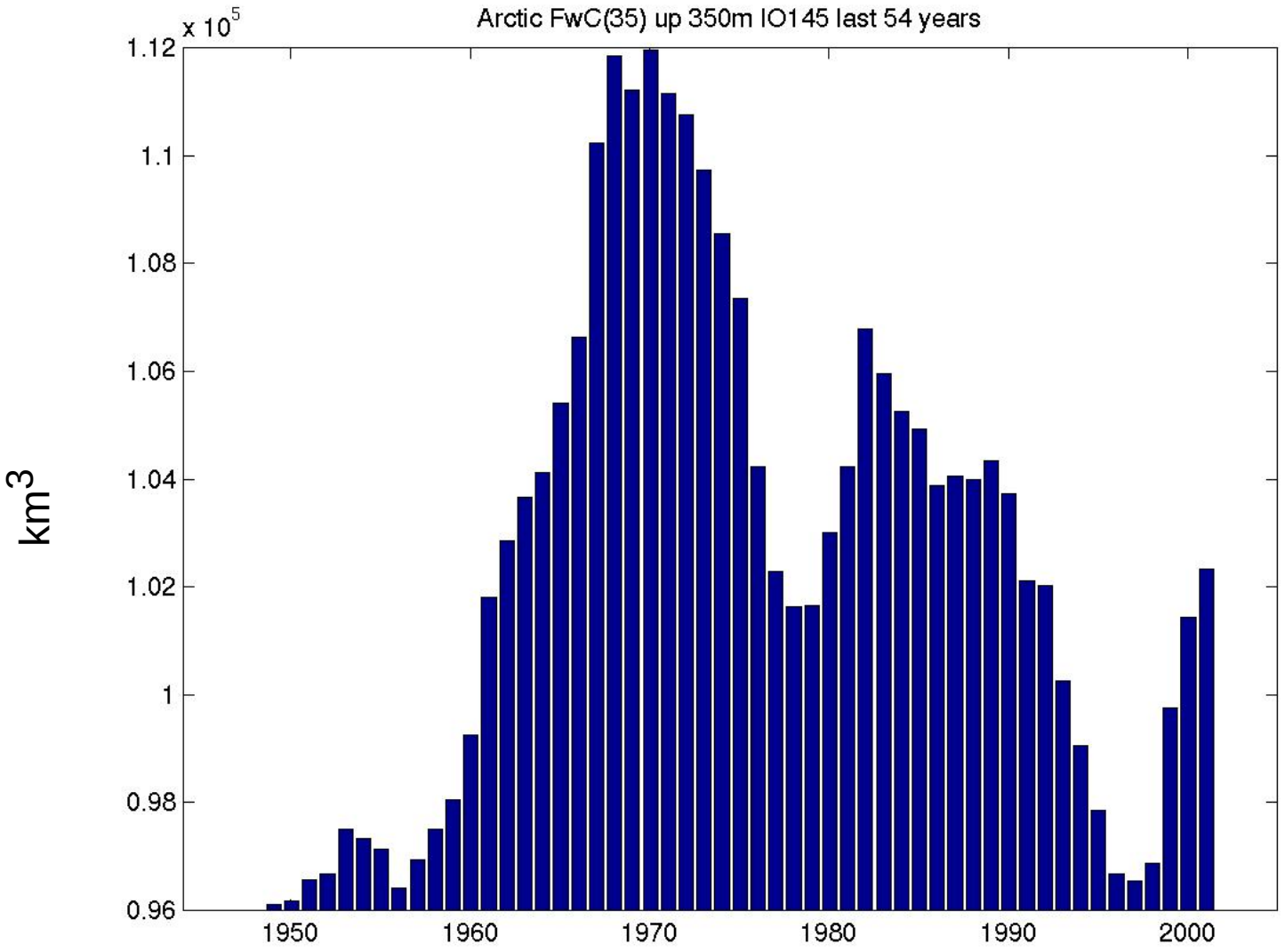
- net ice

restoring

river runoff

E -P

Arctic fresh water content(35.0) upper 350m

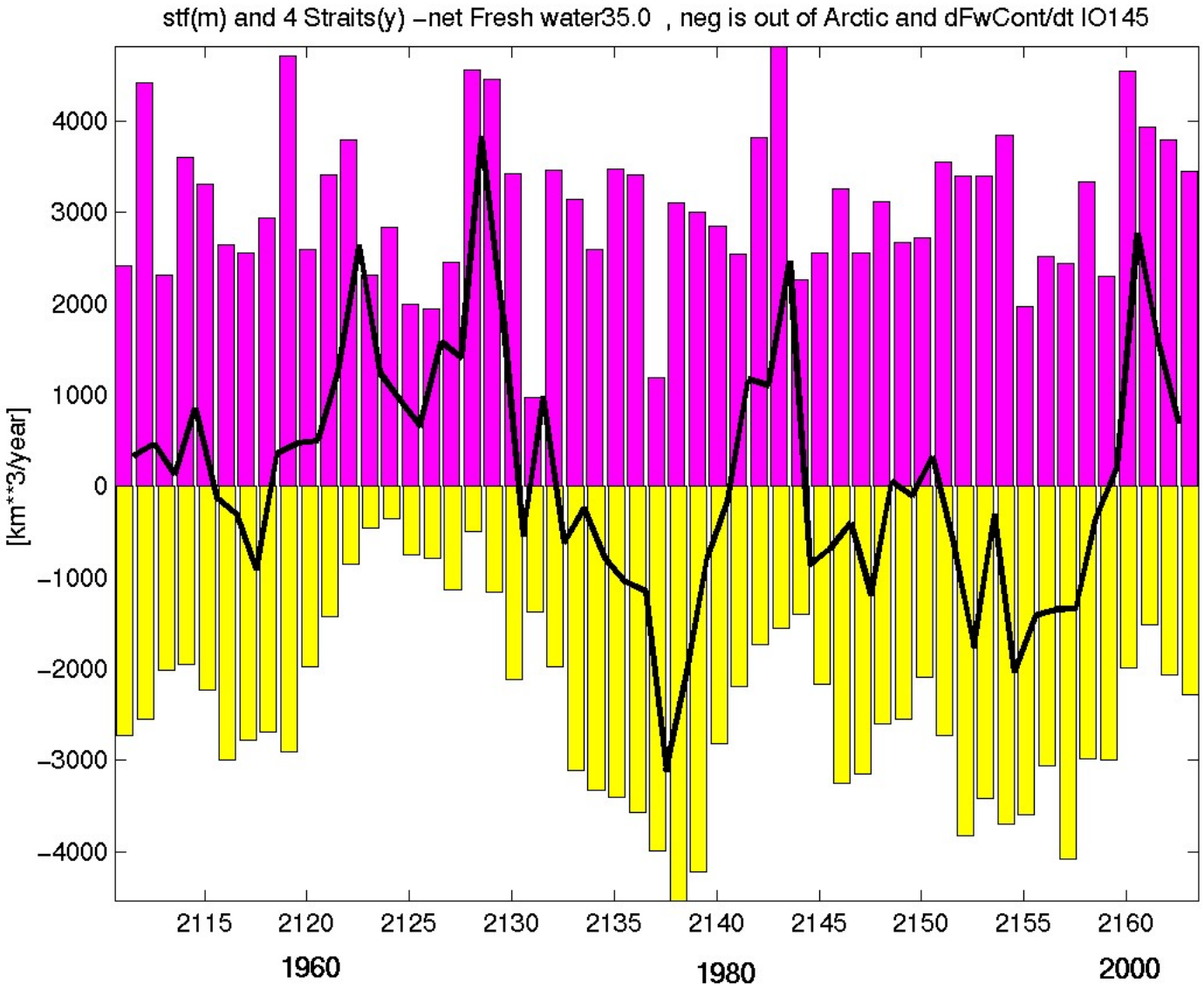


Arctic fresh water content(35.0) upper 350m and down to bottom

Arctic fresh water balance

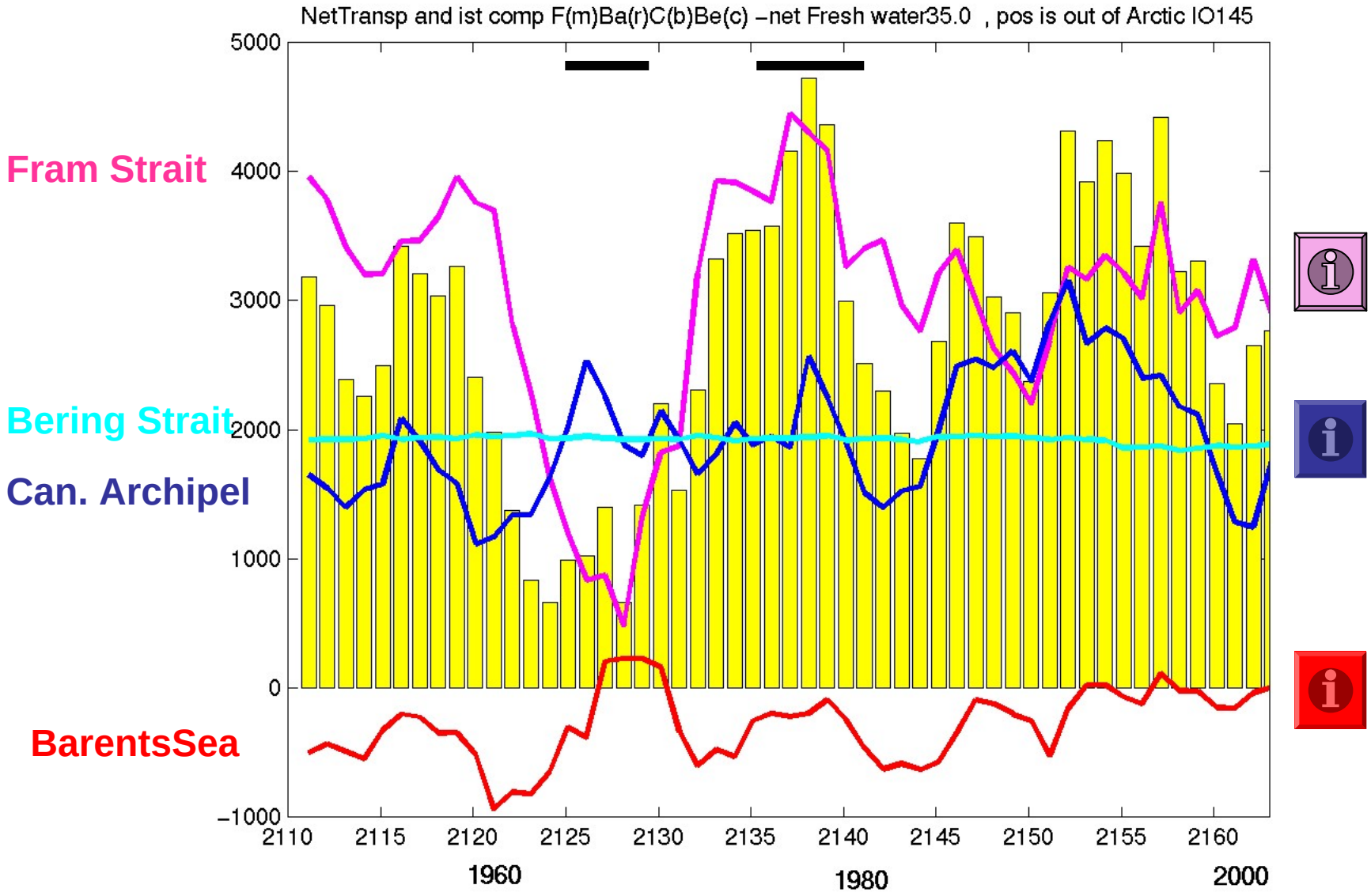
Surface fluxes

Fluxes through straits

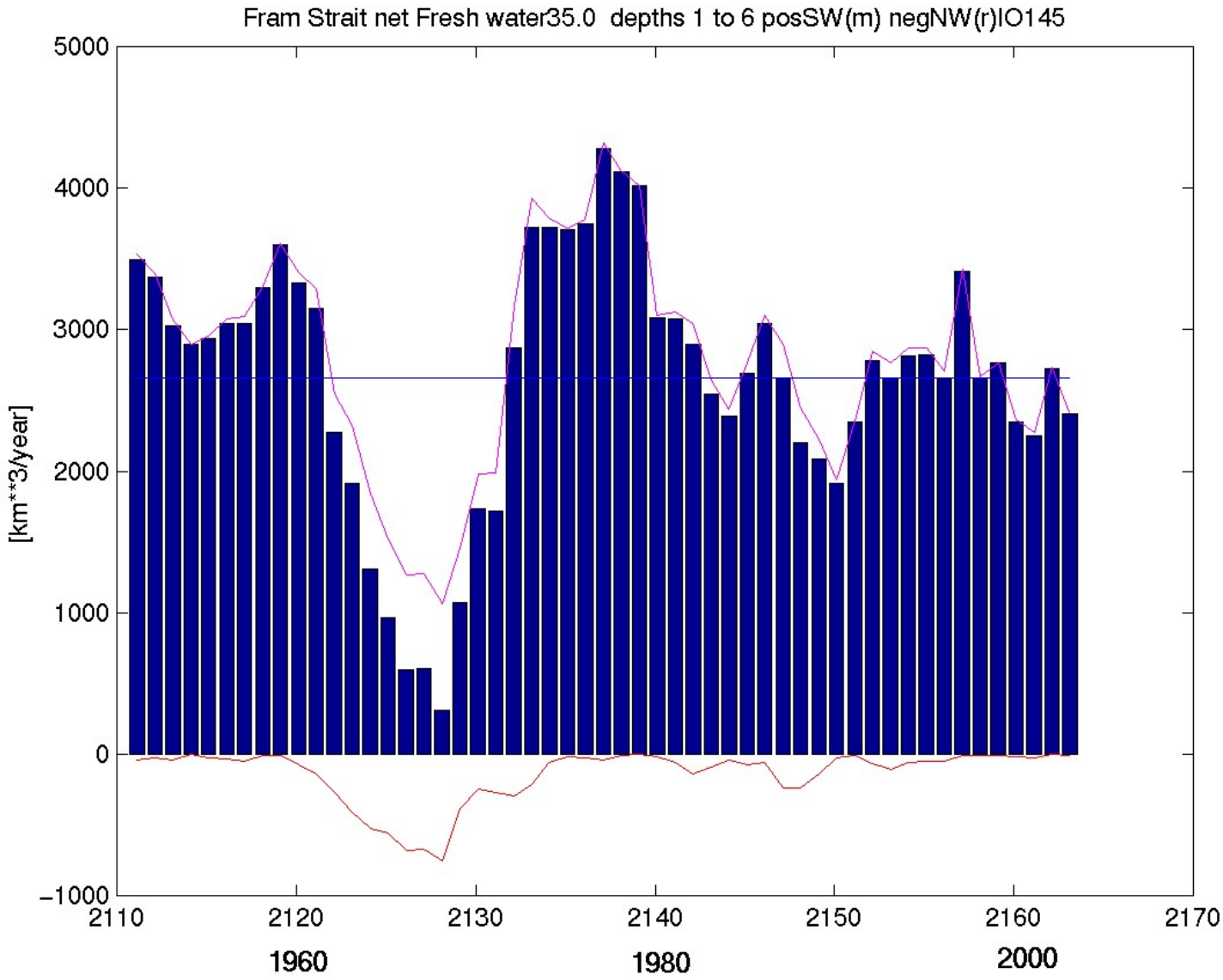


time rate of change of fresh water content

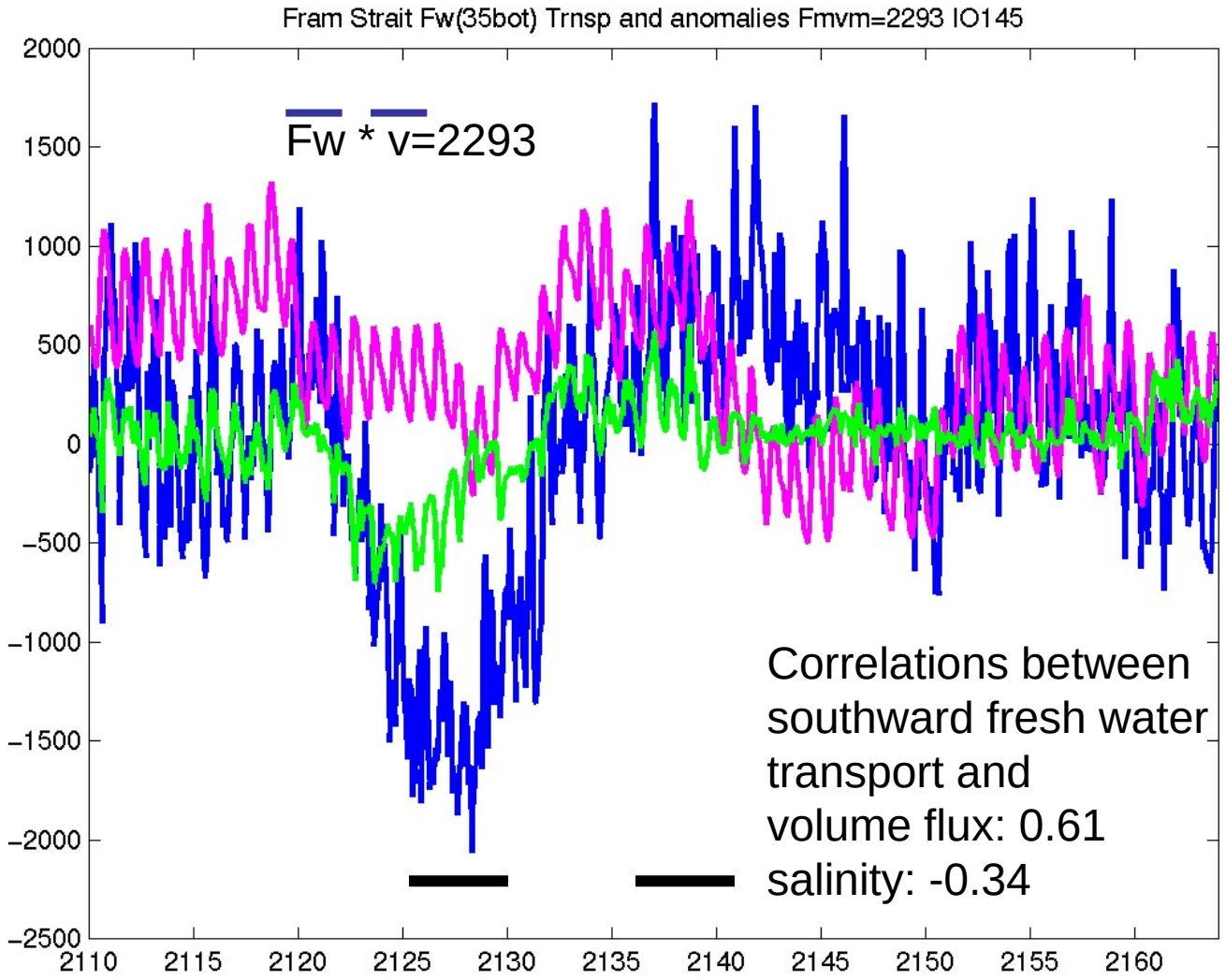
Arctic fresh water transports and ist components



Freshwater transports through Fram Strait

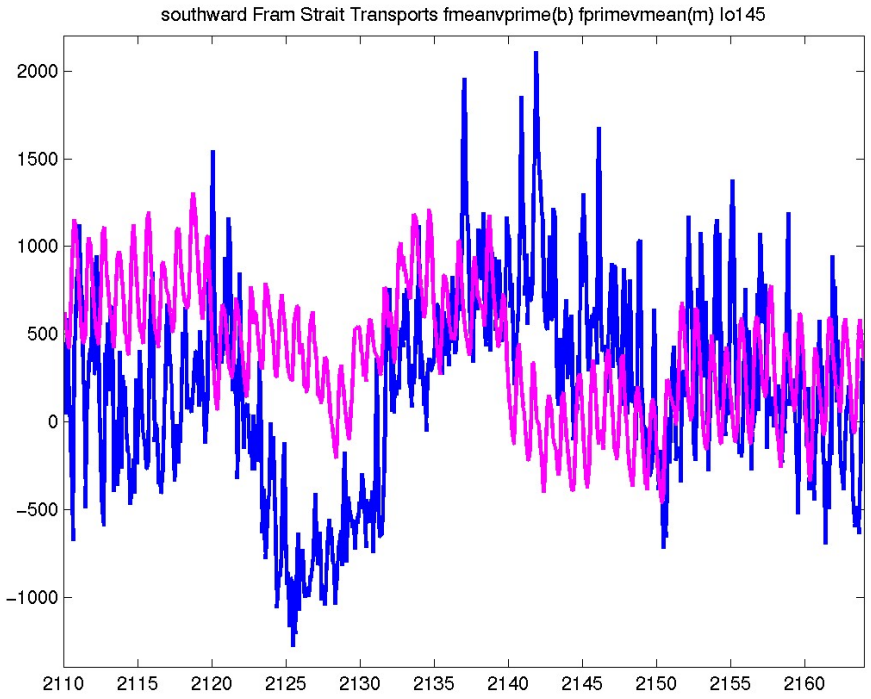


Southward fresh water transport through Fram Strait: $\overline{Fw}*v'$, $Fw'*\overline{v}$ $Fw'*v'$

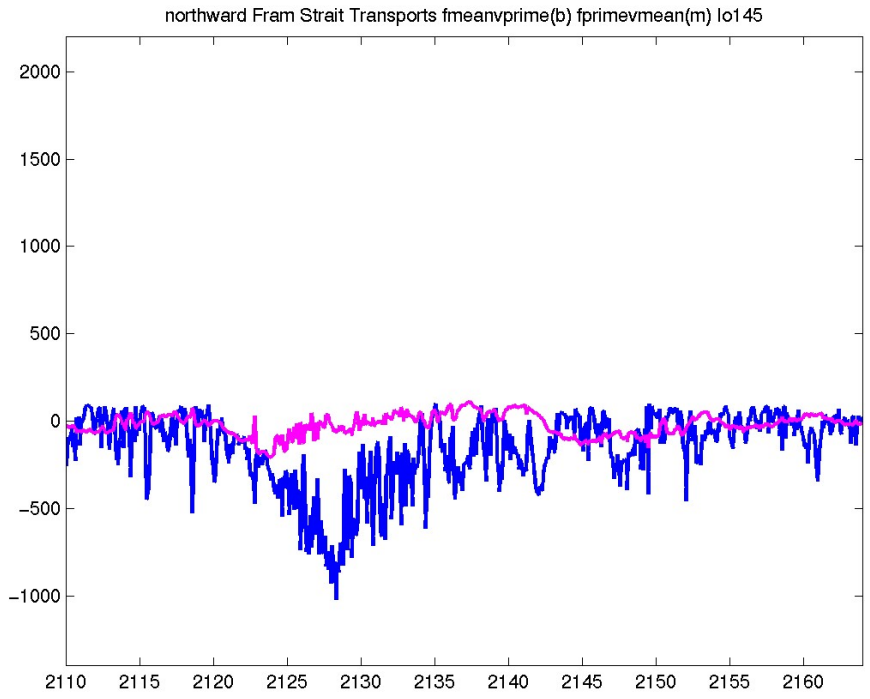


fresh water transports through Fram Strait:

Fw*v´, Fw´*v



southward

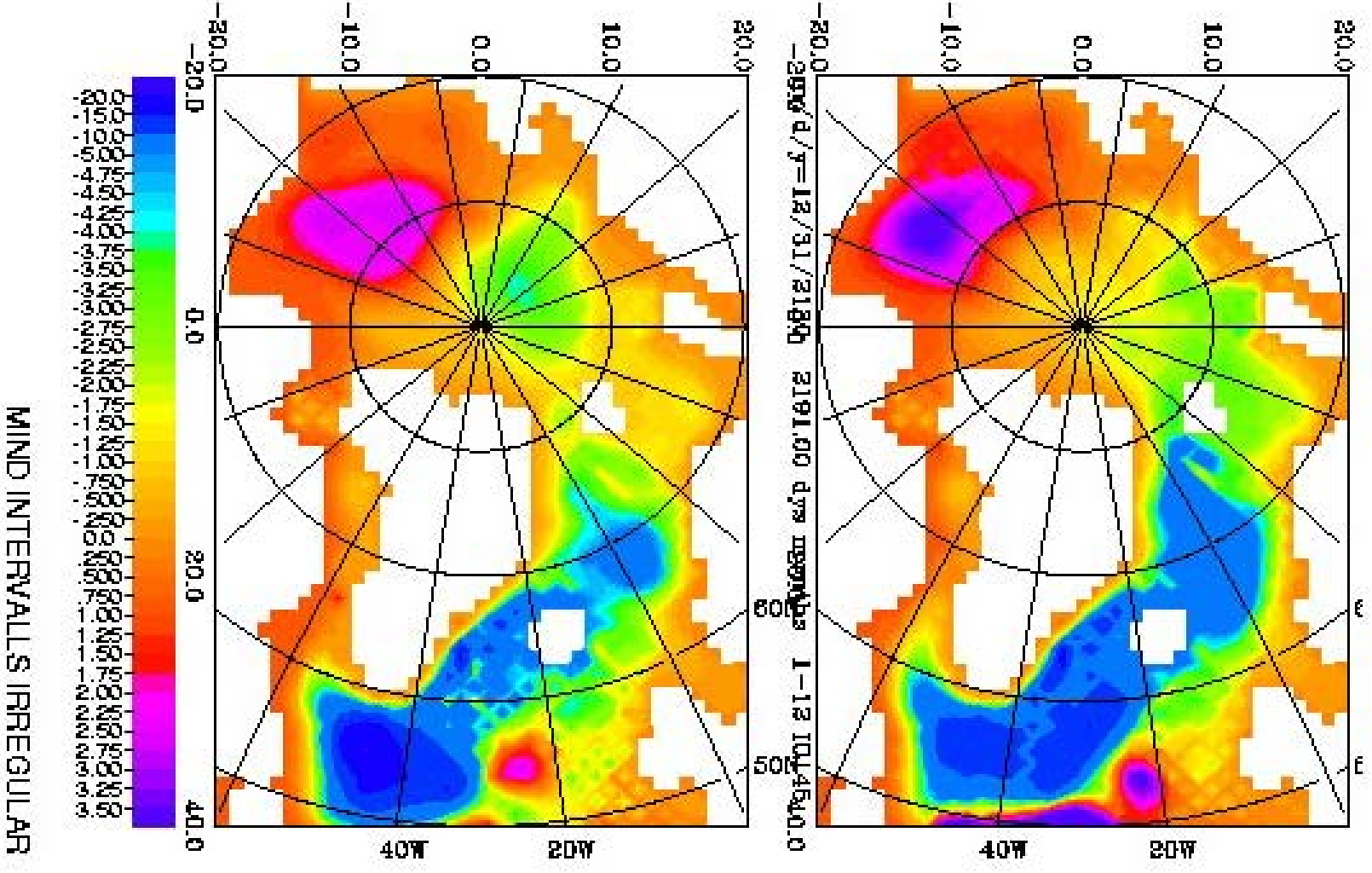


northward

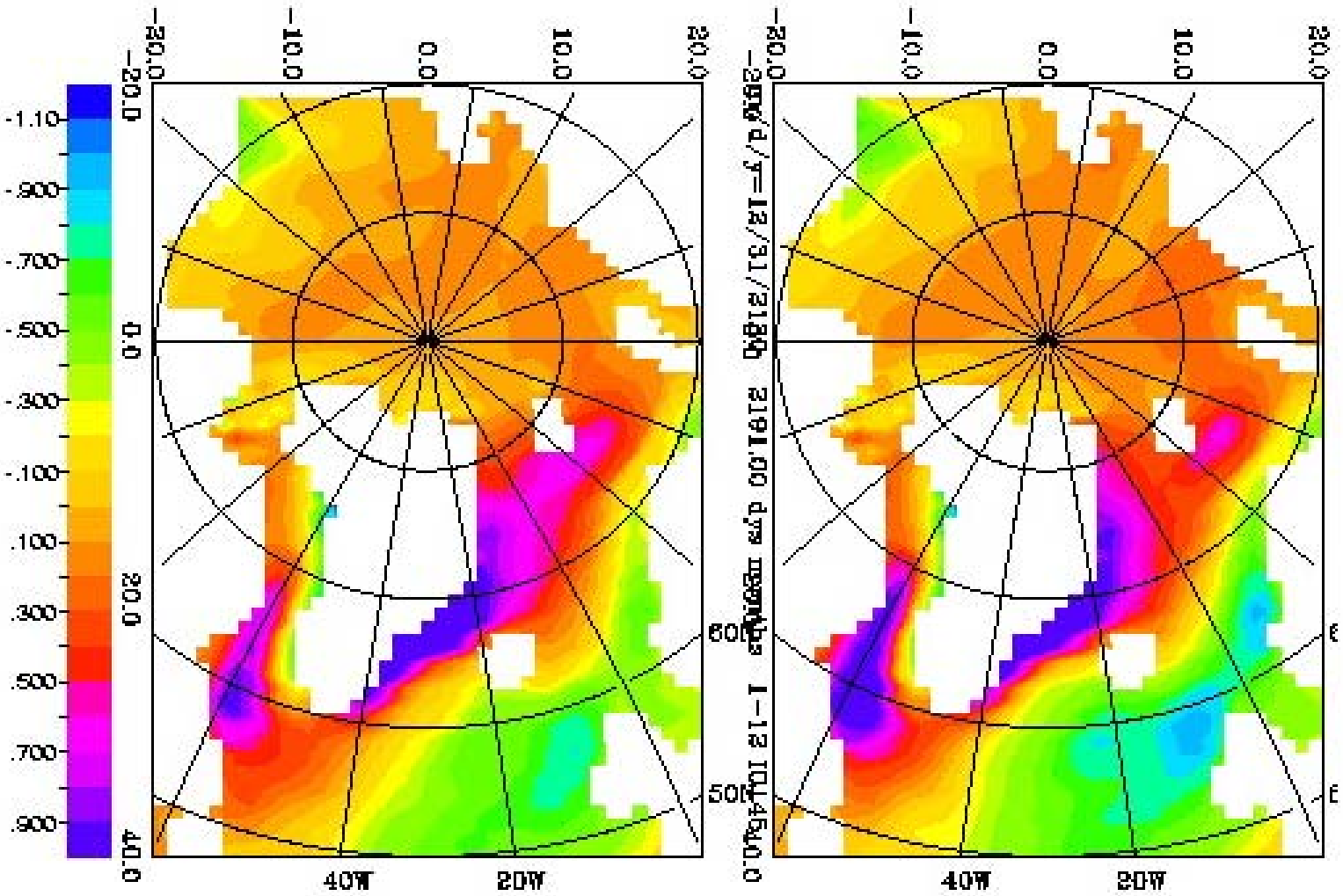
Barotropic streamfunction

Minimum transport

Maximum transport



taux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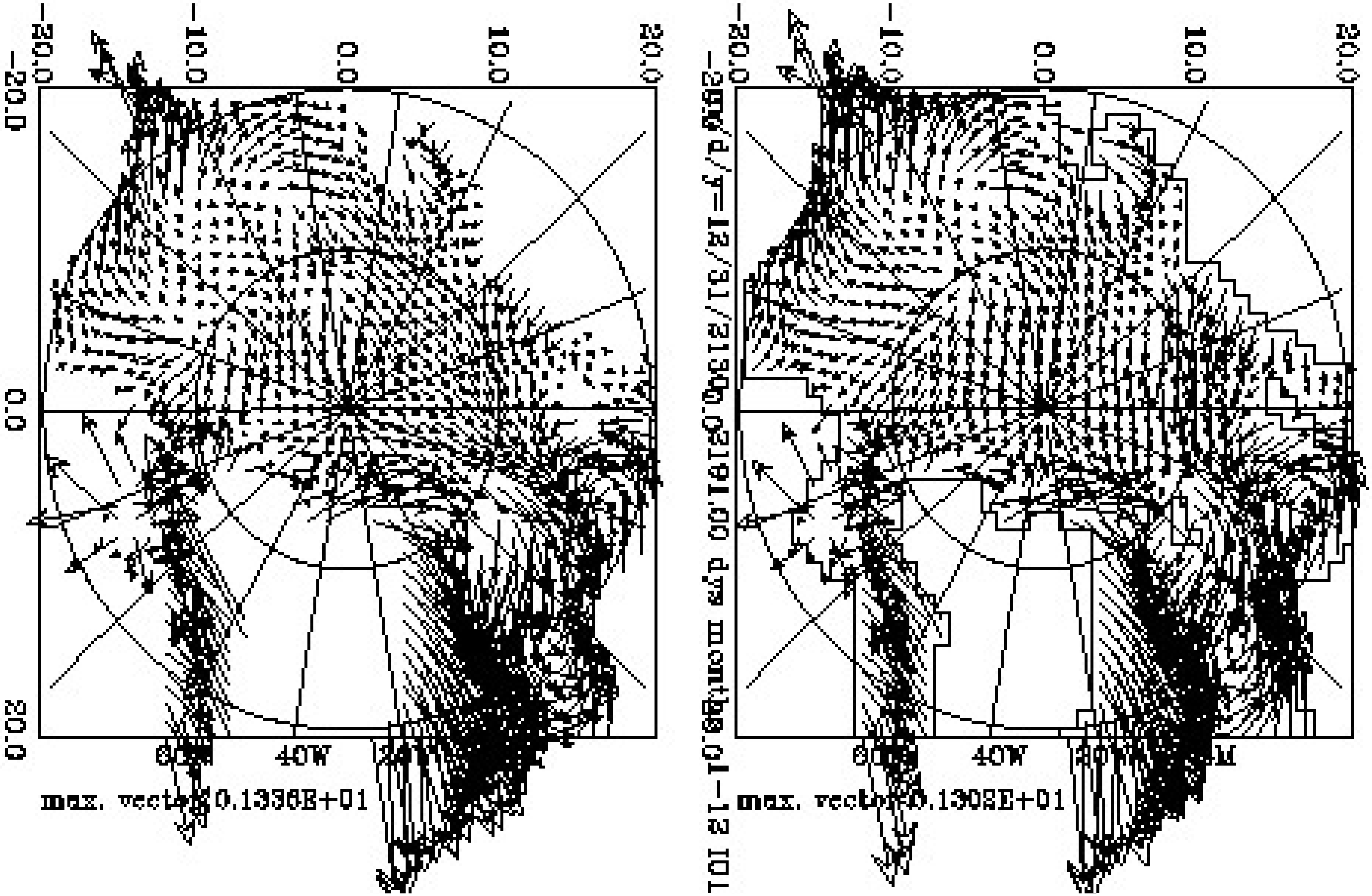
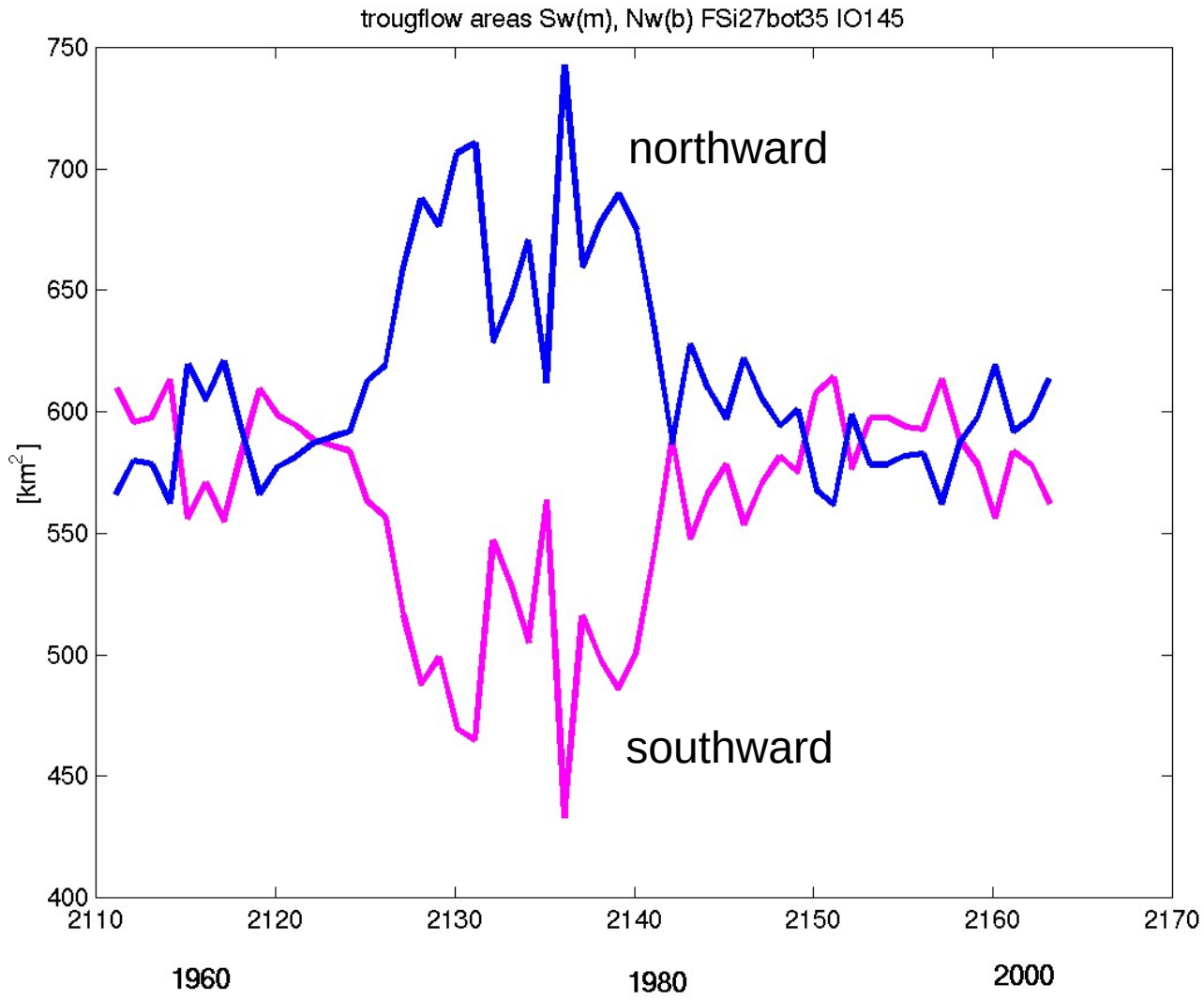
-.900
-.700
-.500
-.300
-.100
.100
.300
.500
.700
.900
-20.0
-10.0
0.0
10.0
20.0
40W
20W
60
50

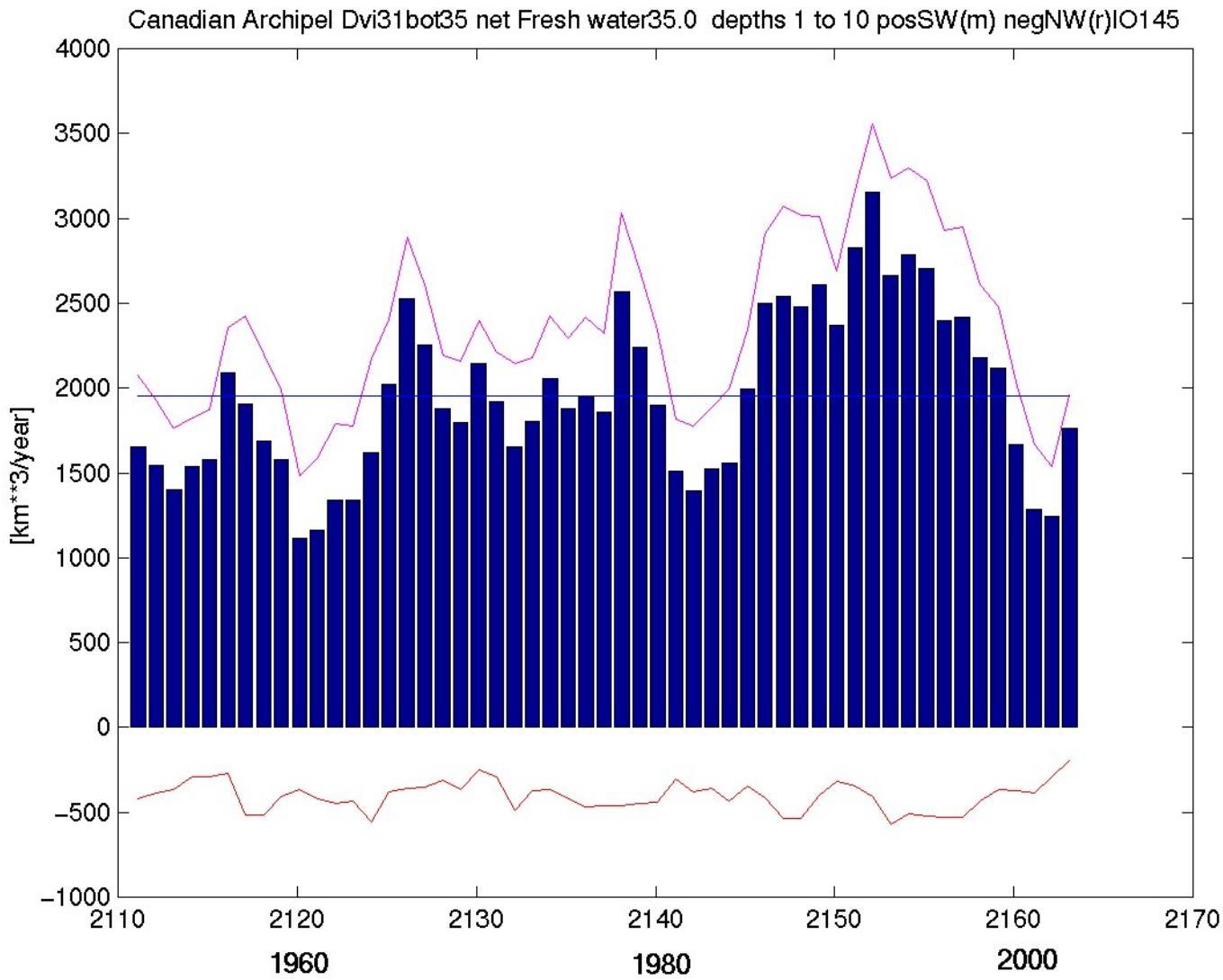
tau



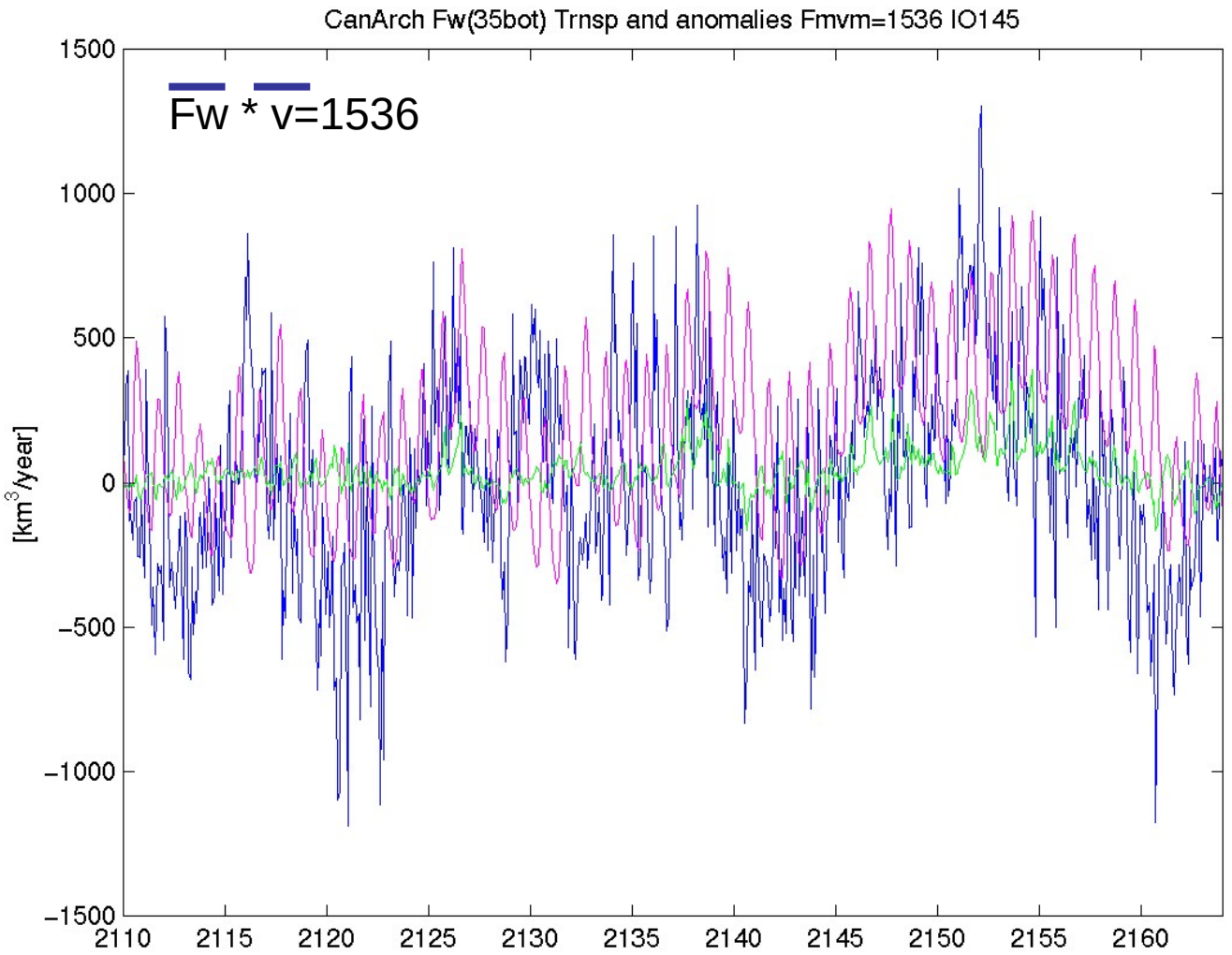
Fram Strait throughflow area



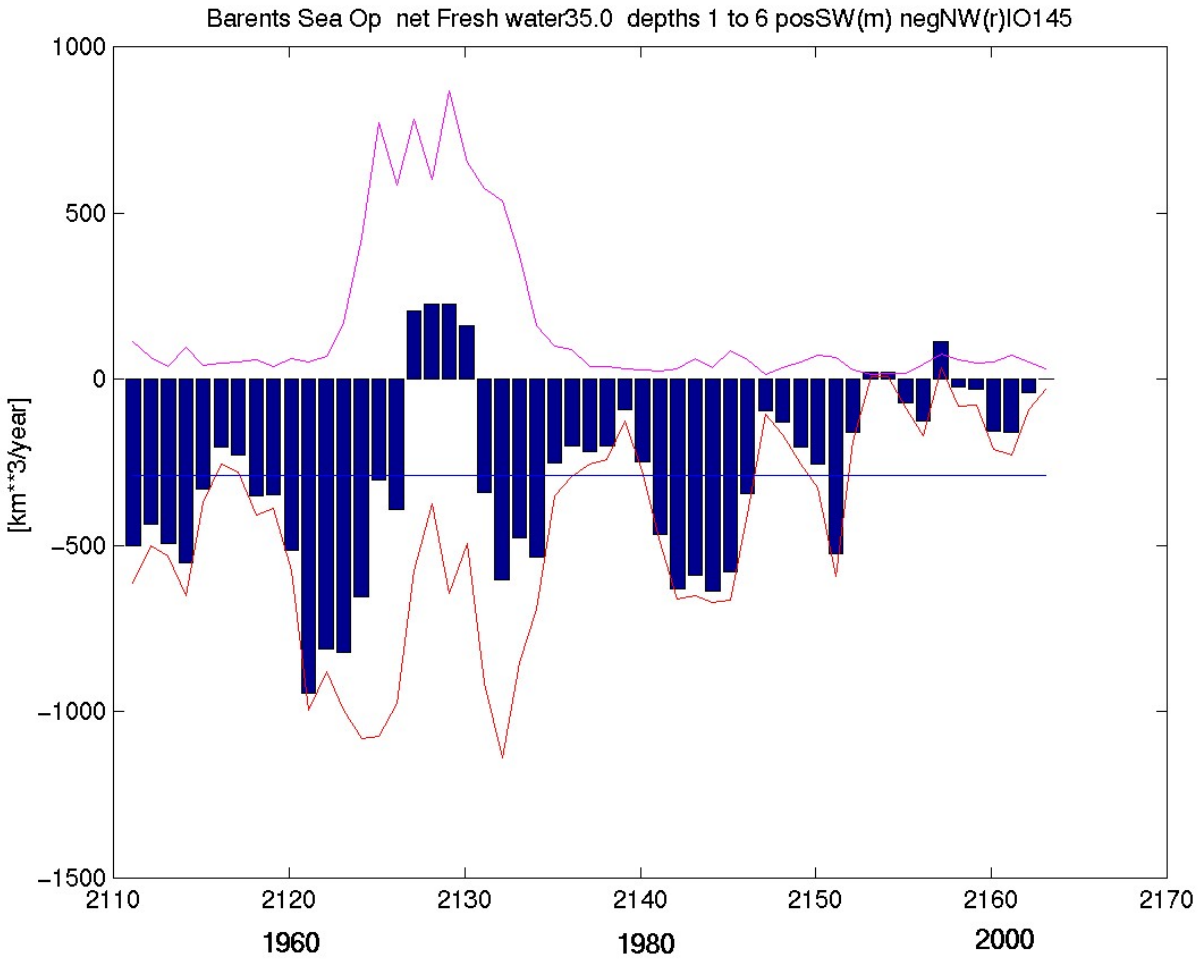
Fresh water transports through Canadian Archipelago



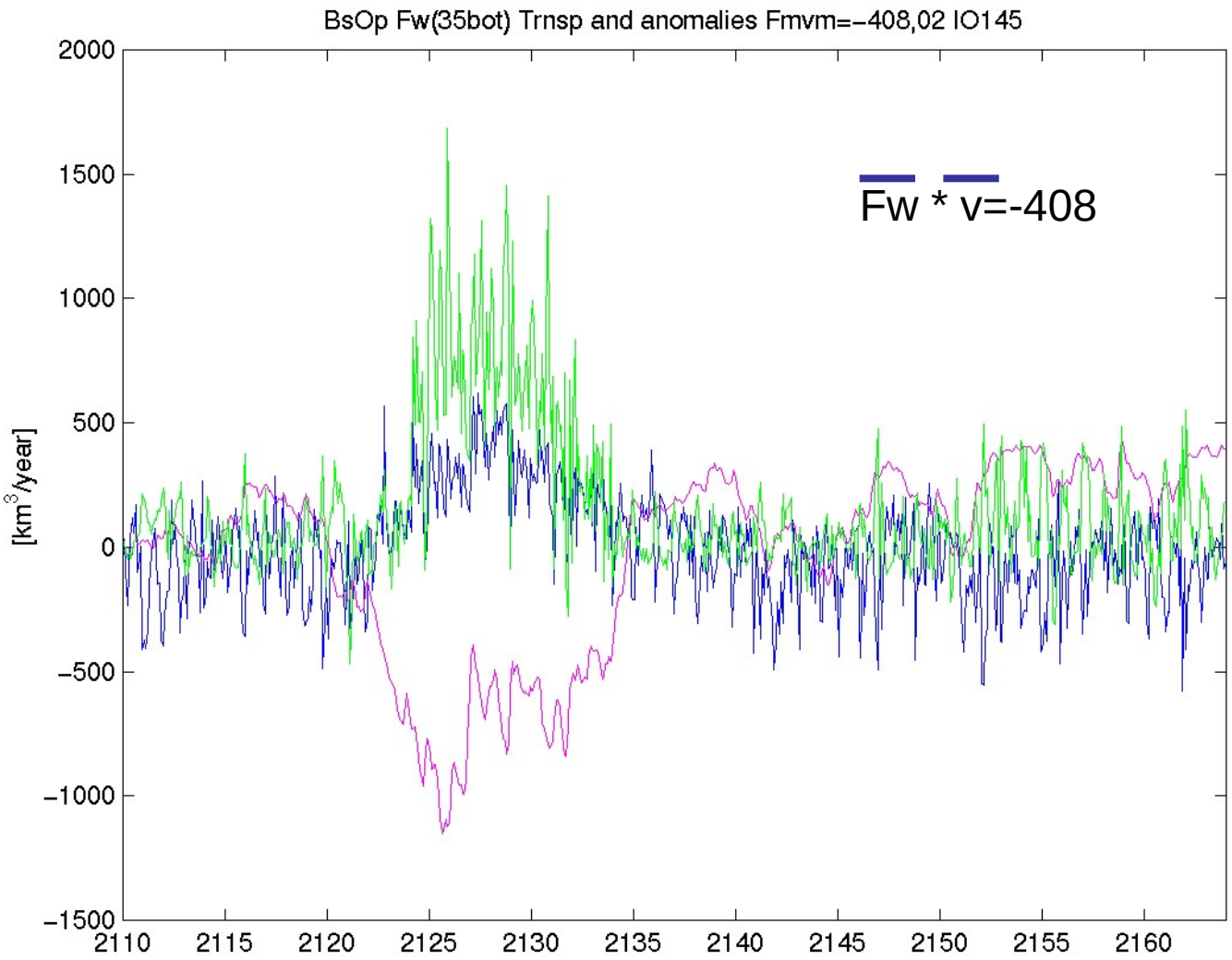
Fresh water transports trough Canadian Archipelago: $\overline{Fw}*v'$, $Fw'*\overline{v}$ $Fw'*v'$



Fresh water transports through Barents Sea opening



Fresh water flux through Barents Sea Opening: $\overline{Fw} * v'$, $Fw' * \overline{v}$, $Fw' * v'$



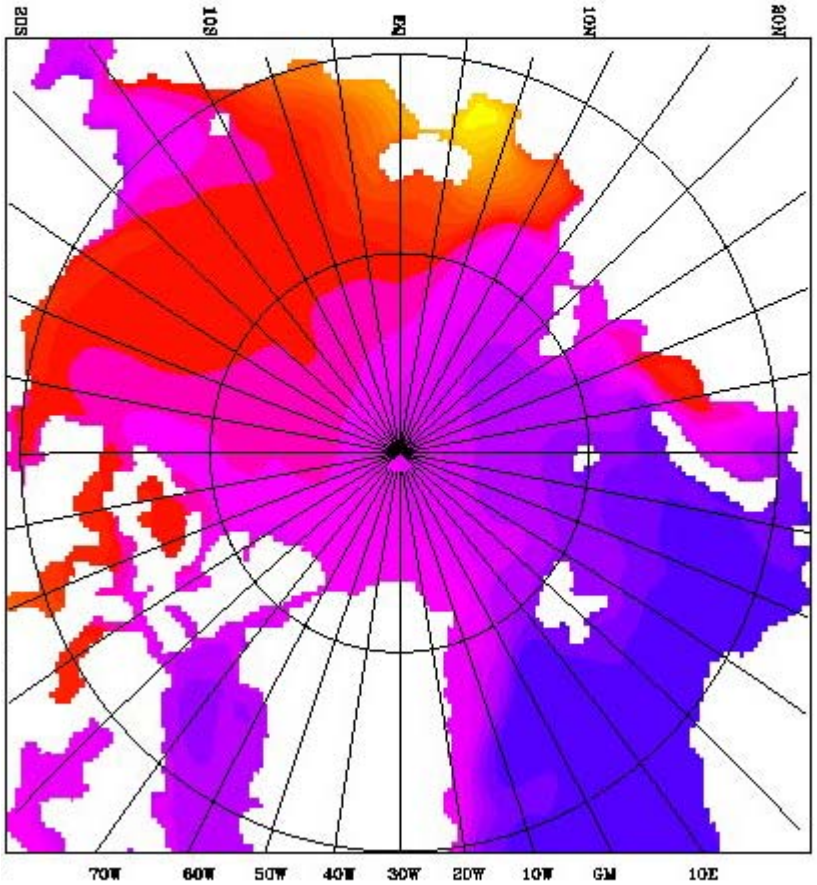
Model vs Observations

IO145

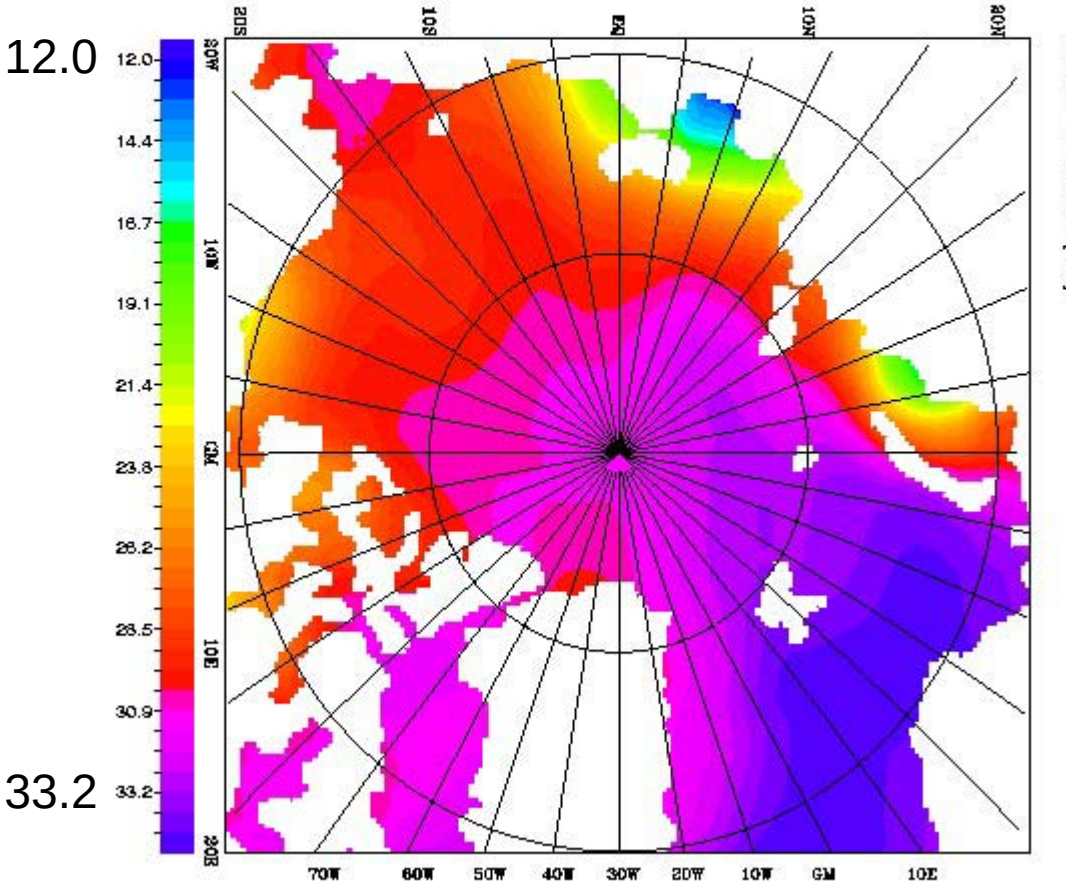
	Run-off	**Bering Strait**	**Canadian Archipelago**	**Fram Strait**	**BSO**	**P-E**	**Net-meltwater**	**Flux adjustment**	**Sum**
Observational estimates, Aargard &Carmack 2000 ***Prinsenberg and Hamilton 2004***	**3300**	**1800**	**-1220** *LanS* *1461* ***-2920--4175***	**-1330**	**270**	**900**	**-3020**	-	700
Model, Flux correction No restoring	**2404**	**1922**	**-2259**	**-3001**	**289**	**1576**	**-4087**	**3078**	**-78 dFwC/dt**
difference	896 technical	-122	1039 resolution?	1671	-19	-676	1067	-	
Standard deviation	38	29	572	905	276	135	845	0	

Salinity and how it “should be“

HRM
S mean over 50 years

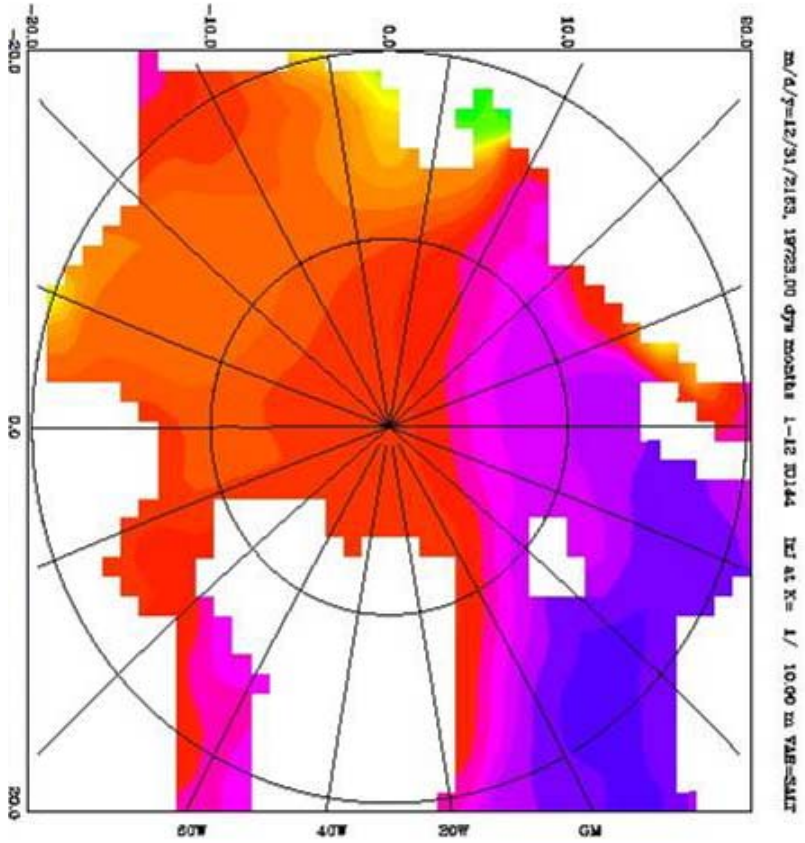


S climatology(Levitus mix)

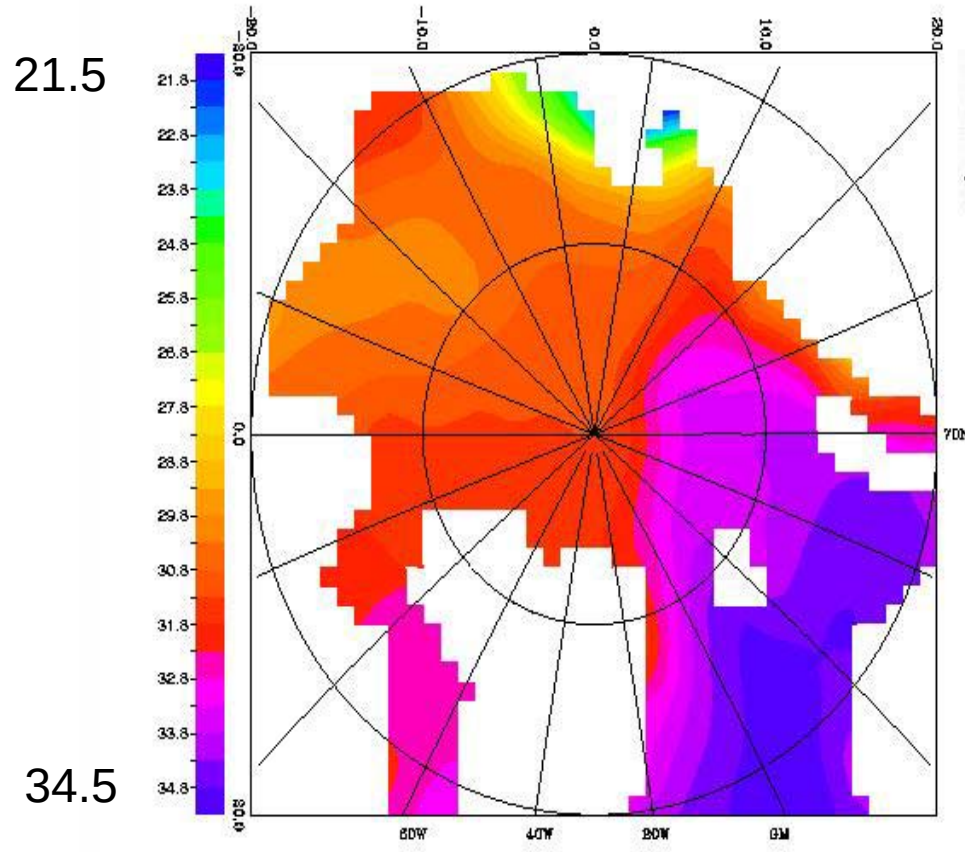


Salinity and how it “should be“

LRM
S mean over last 54 years

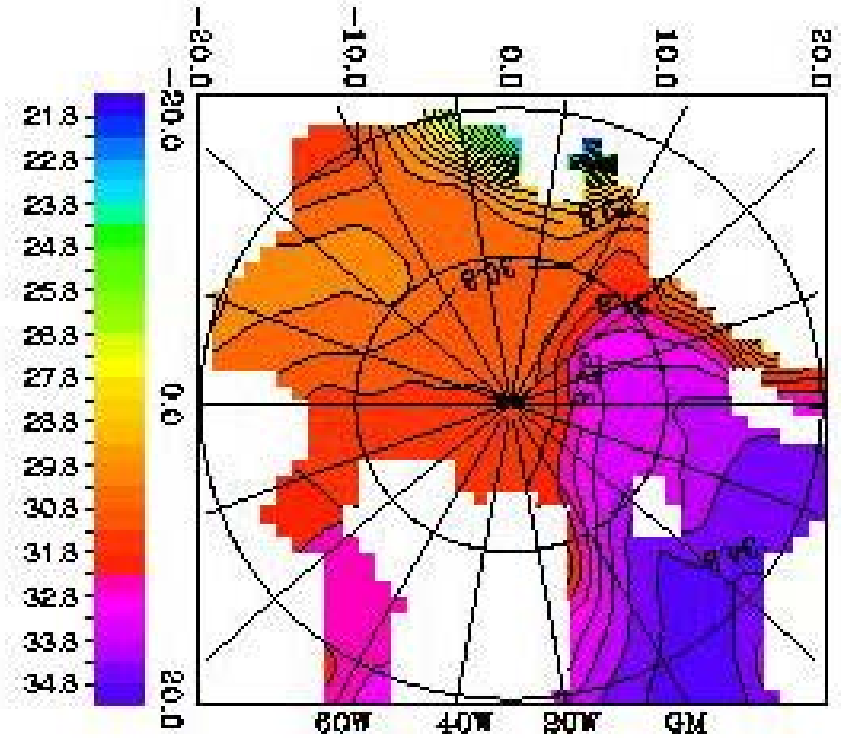


S climatology (PHC)

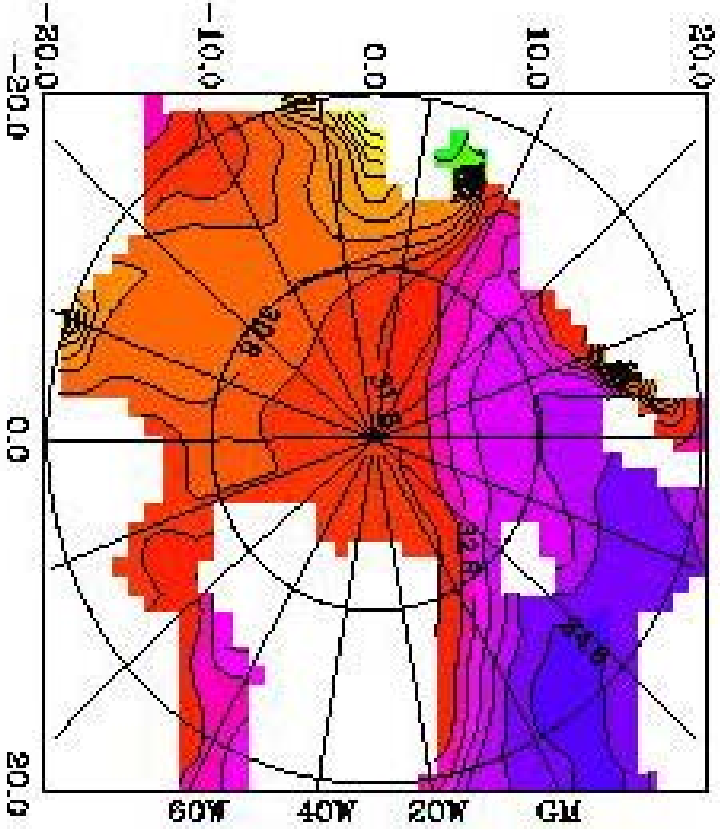


Surface salinity

Climatology(PHC)



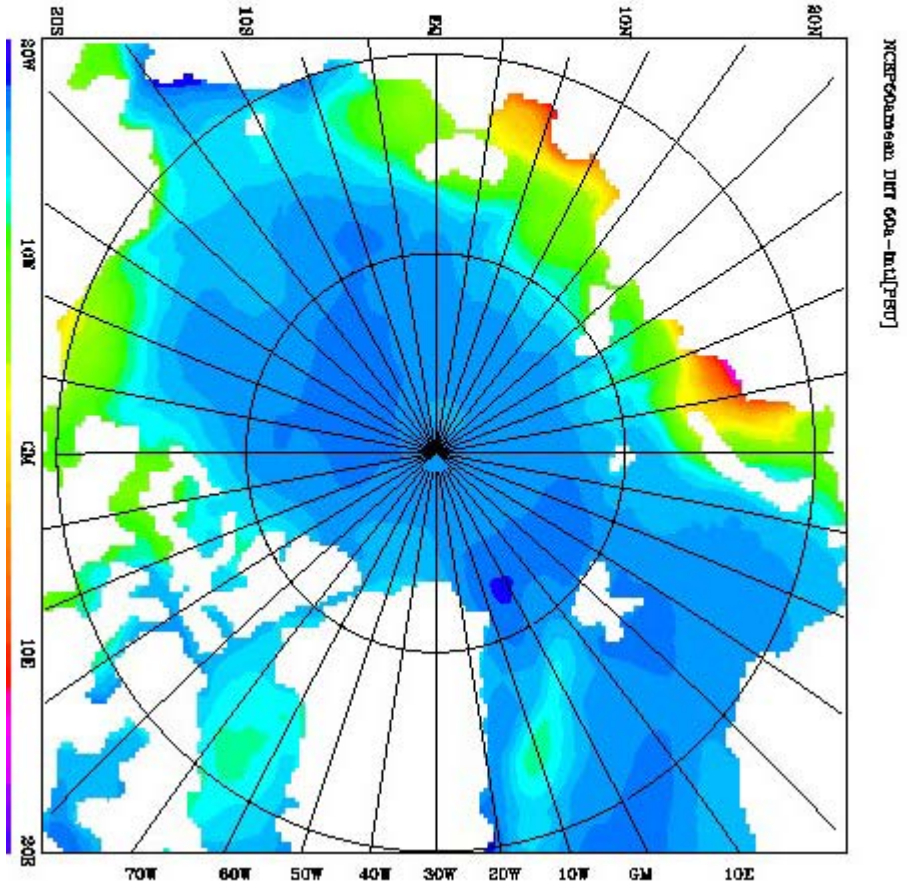
Modell, mean of last 54 years



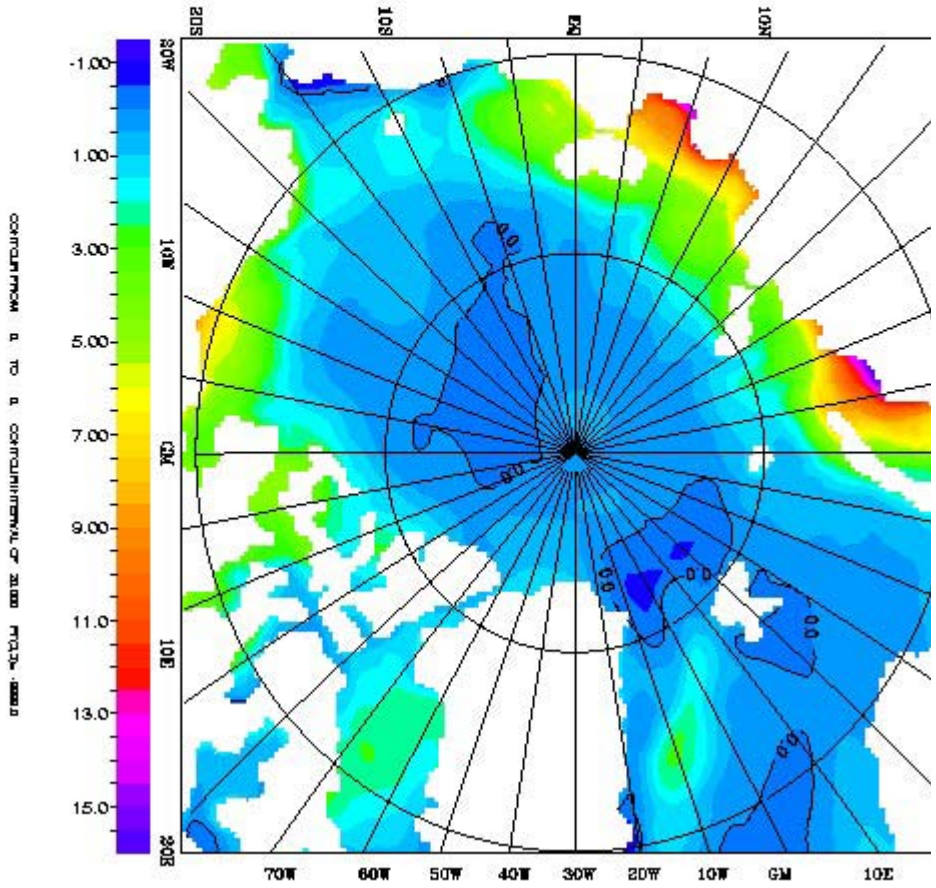
SSS 2110-2163 mean

Salinity deviation and resulting correction

Smean - Sclim



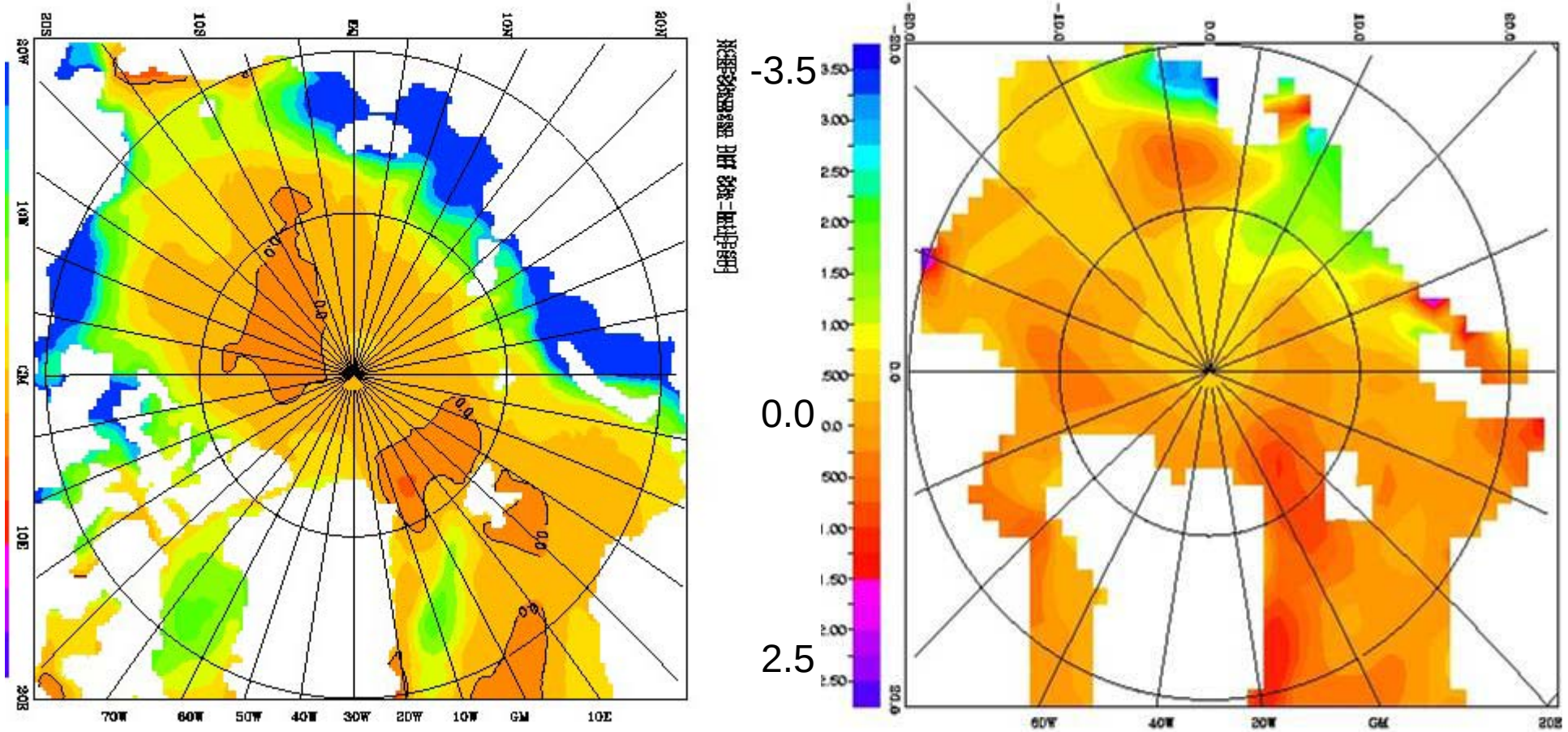
Resulting mean restoring flux



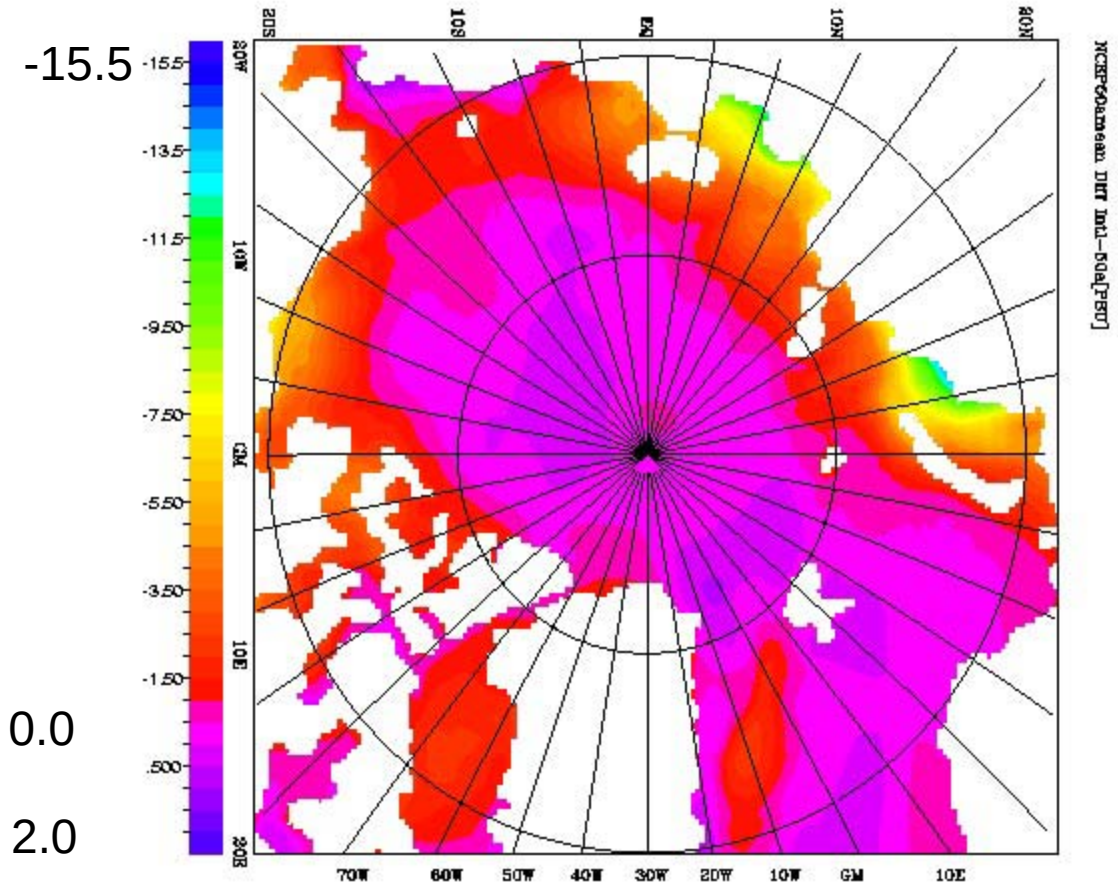
Salinity deviation as a proxy for restoring flux

HighResolutionModel

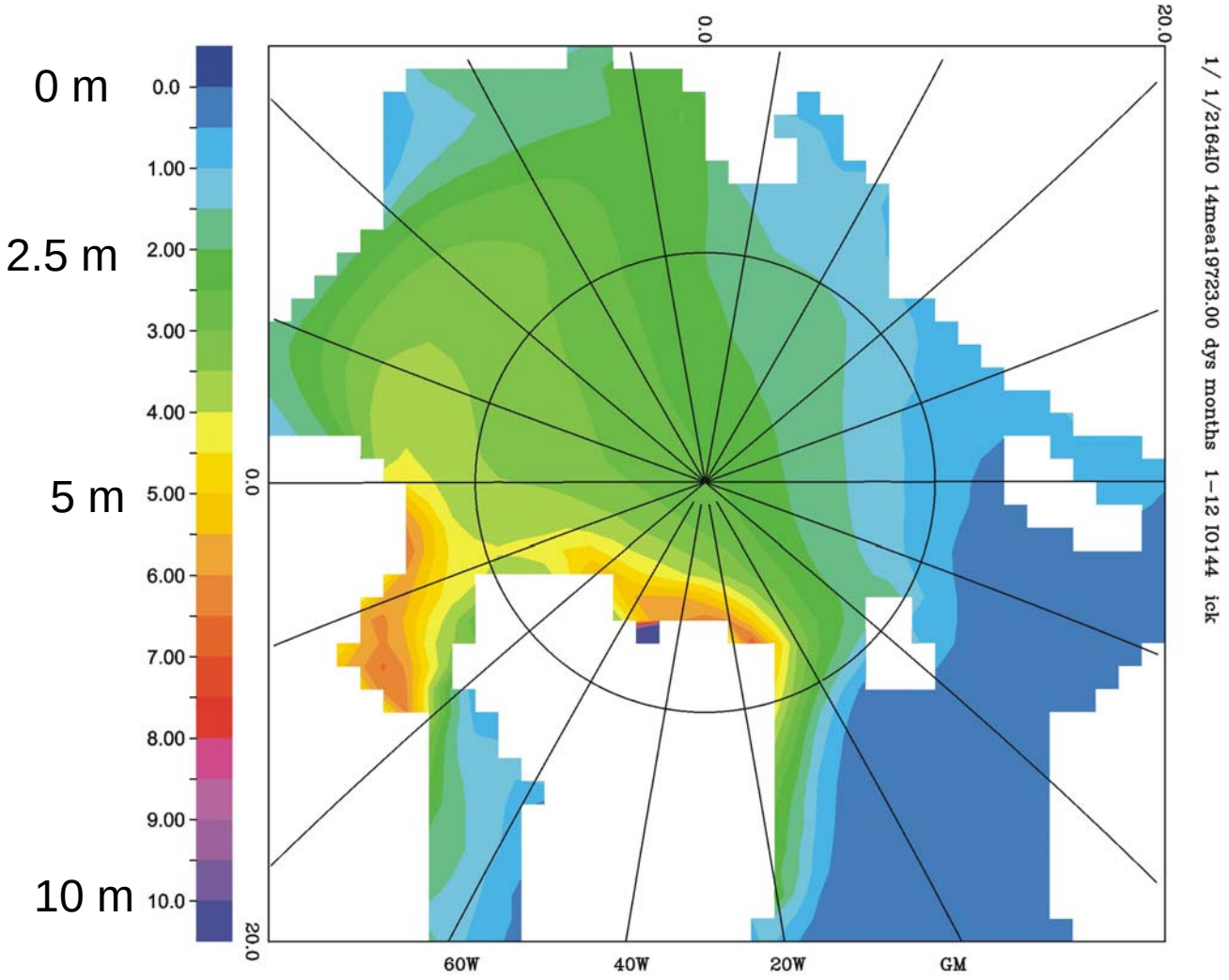
LowResolutionModel



Salinity deviation in high resolution model

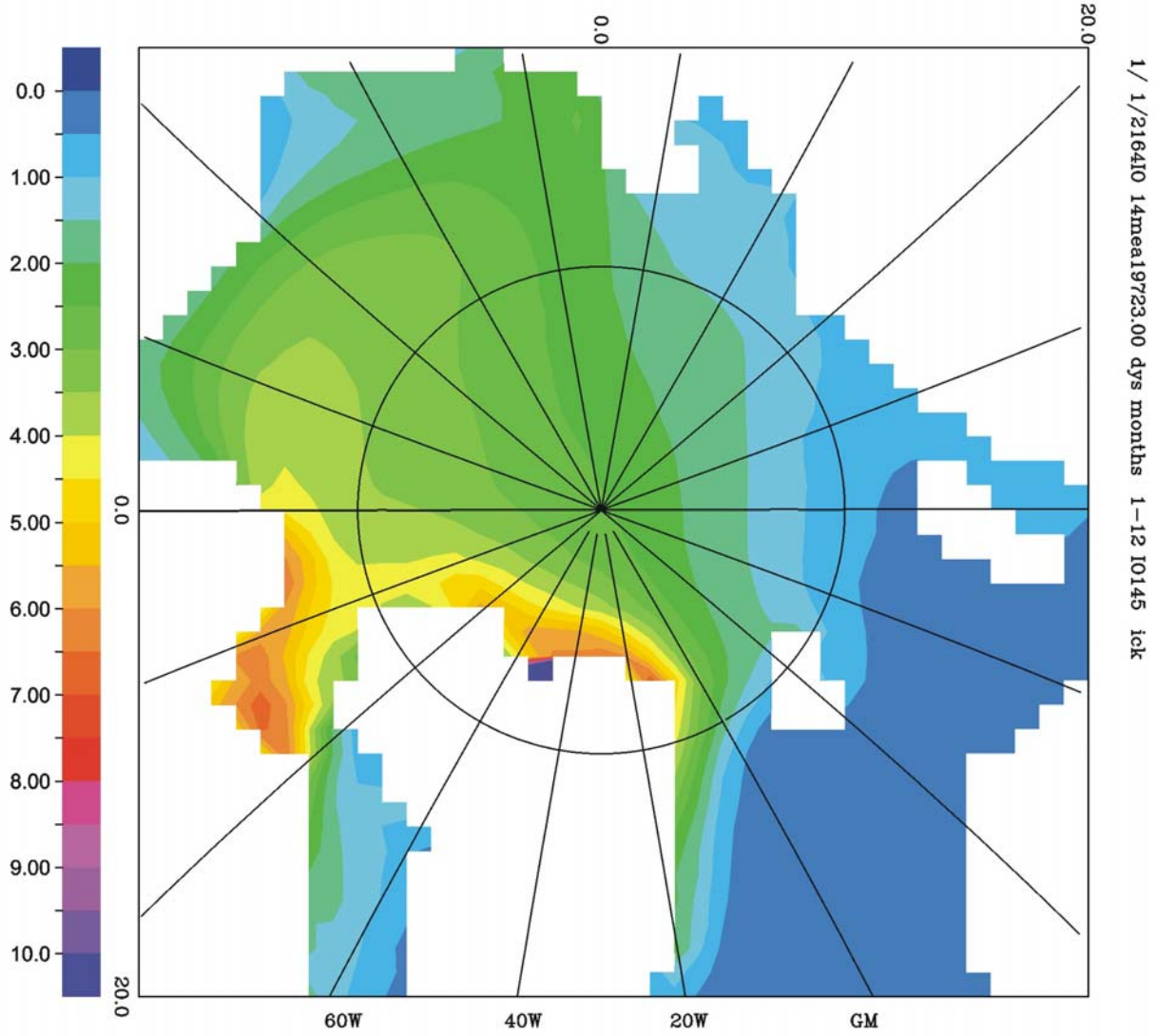


Mean ice thickness over last 54 years IO144



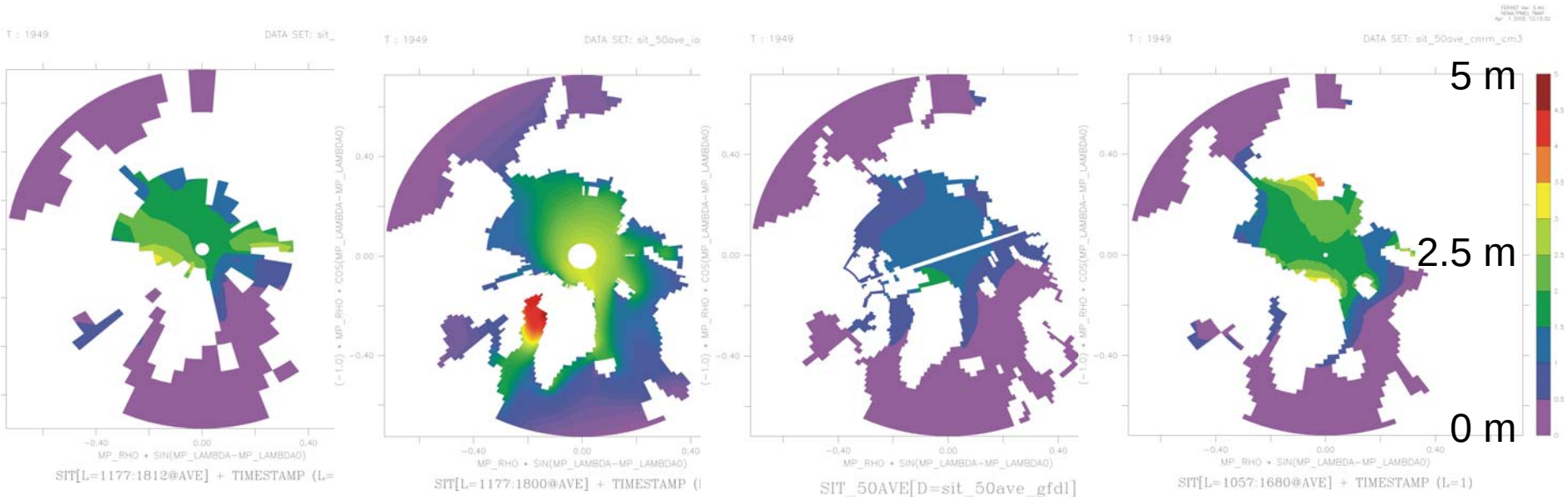
area mean ice volume 21144 km^3

Mean ice thickness over last 54 years IO145



area mean ice volume 21296 km^3

ice thickness: mean over model period 20th century(20c3m) 4th IPPC little and/or thin ice in the Arctic



giss_aom1
Arctic volume
17240 km^3

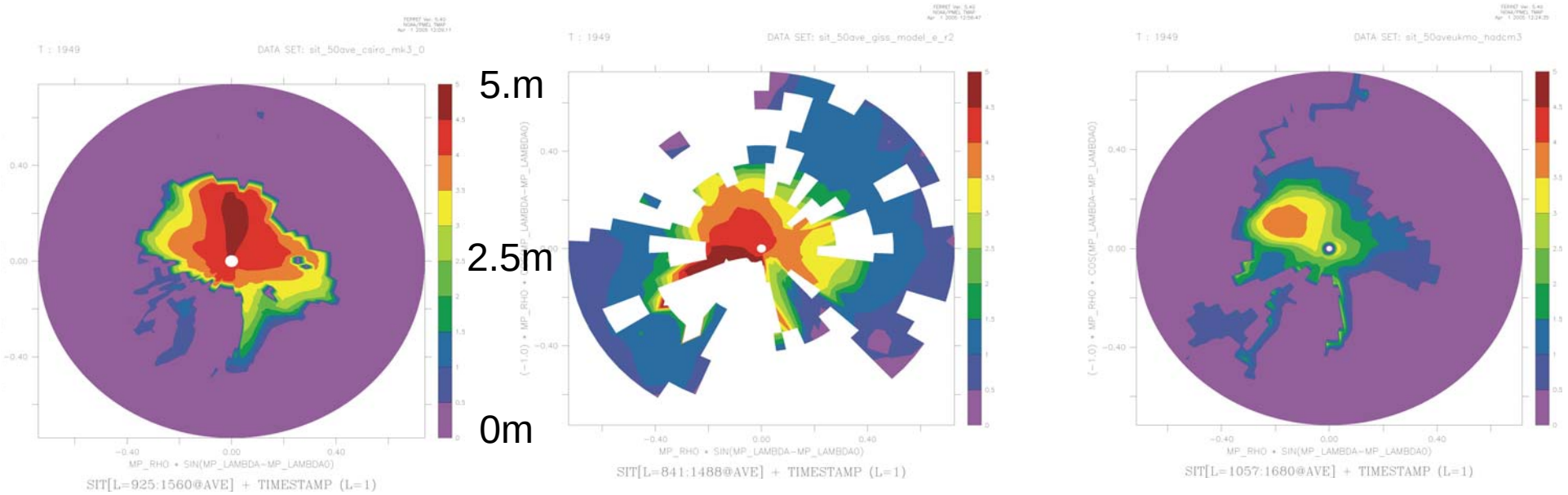
iap_fgoals1
Arctic volume
97490?? km^3

GFDL
Arctic volume
5720 km^3

cnrm_cm3
Arctic volume
14840 km3

Note: area of Arctic about 10^7 km^3, so 1m thick ice yields a volume of 10^4 km^3

Ice thickness: mean over model period 20th century(20c3m) 4th IPPC much and/or thick ice



csiro_mk
Arctic volume
36810 km^3

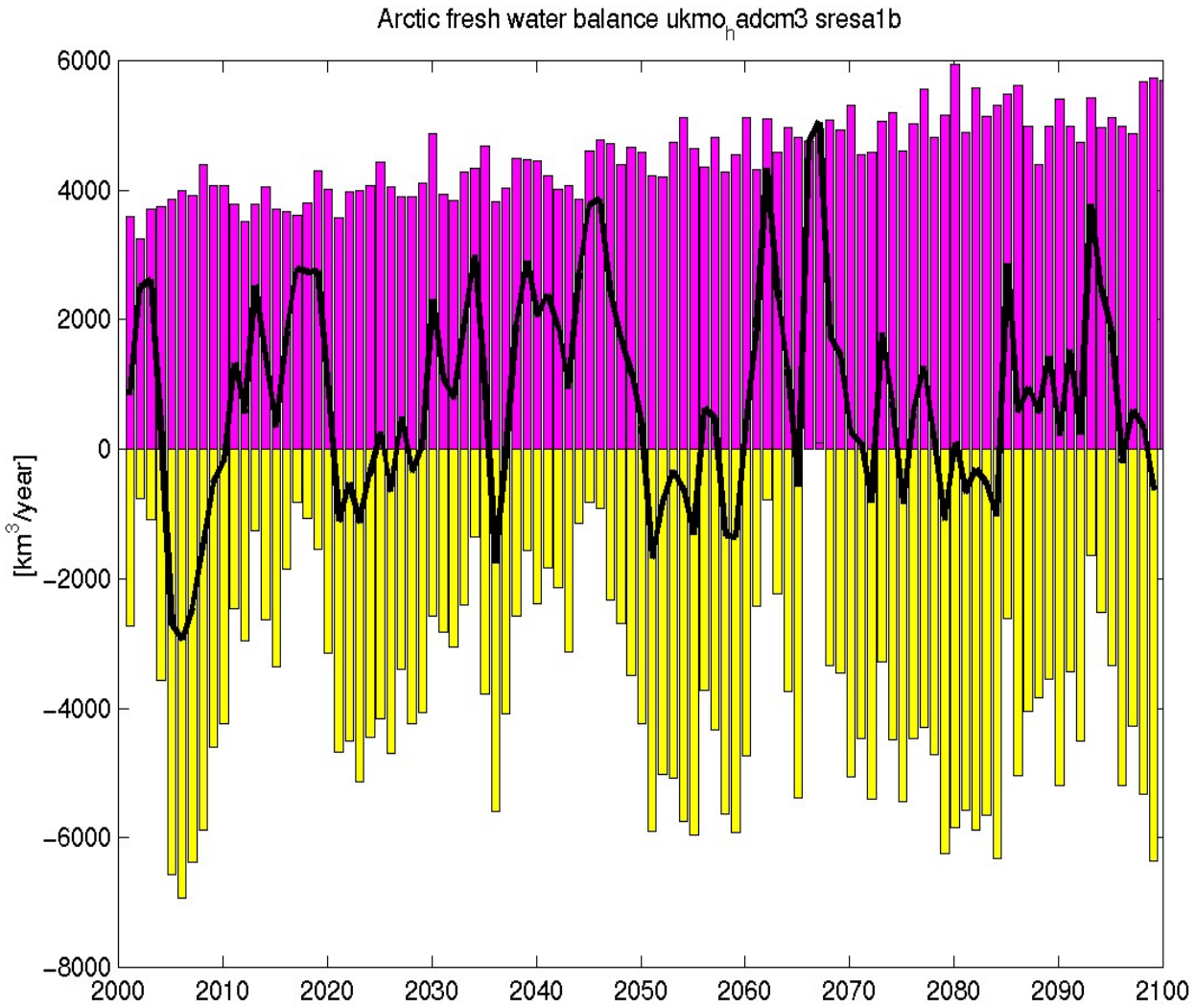
giss_model_e
Arctic volume
48870 km^3

ukmo_hadcm3
Arctic volume
19180 km^3

Note: area of Arctic about 10^7 km^3, so 1m thick ice yields a volume of 10^4 km^3

Arctic fresh water balance

ukmo_hadcm3 sresa1b

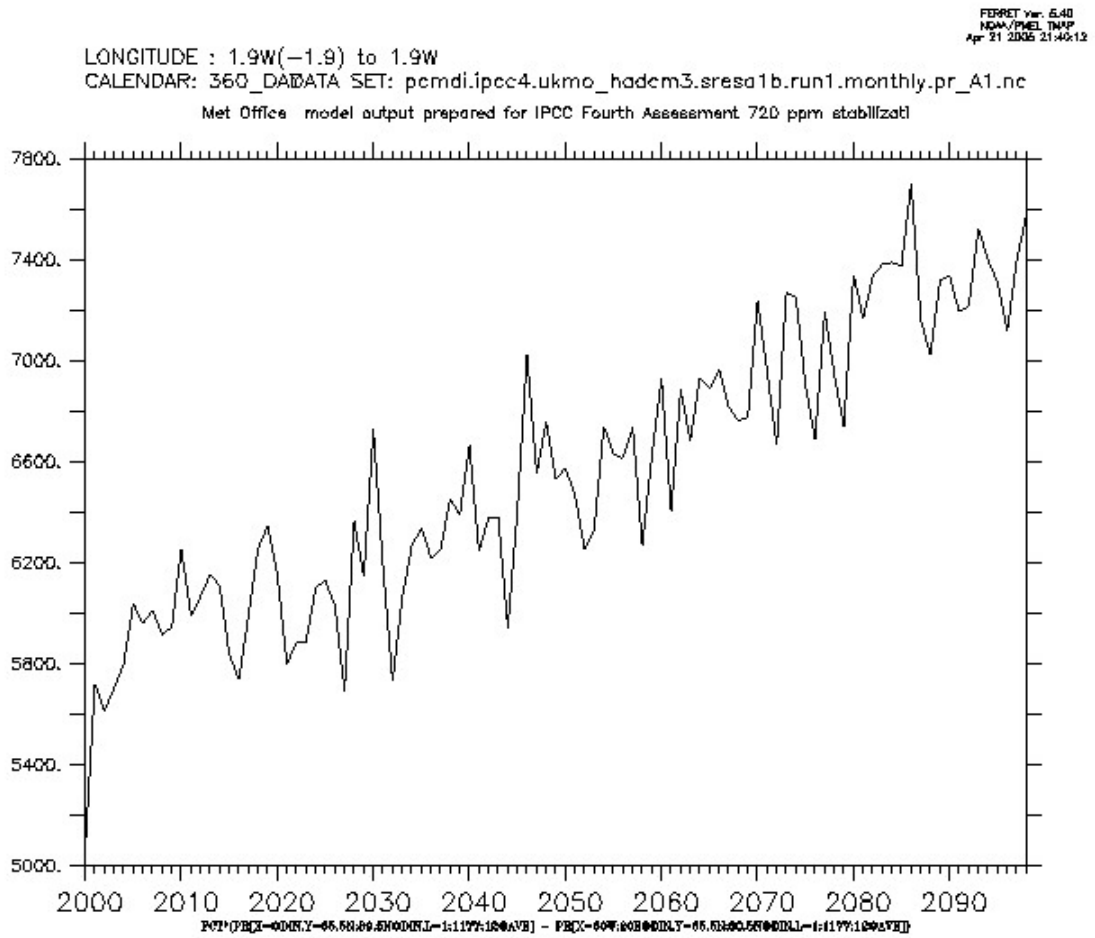


Surface fluxes

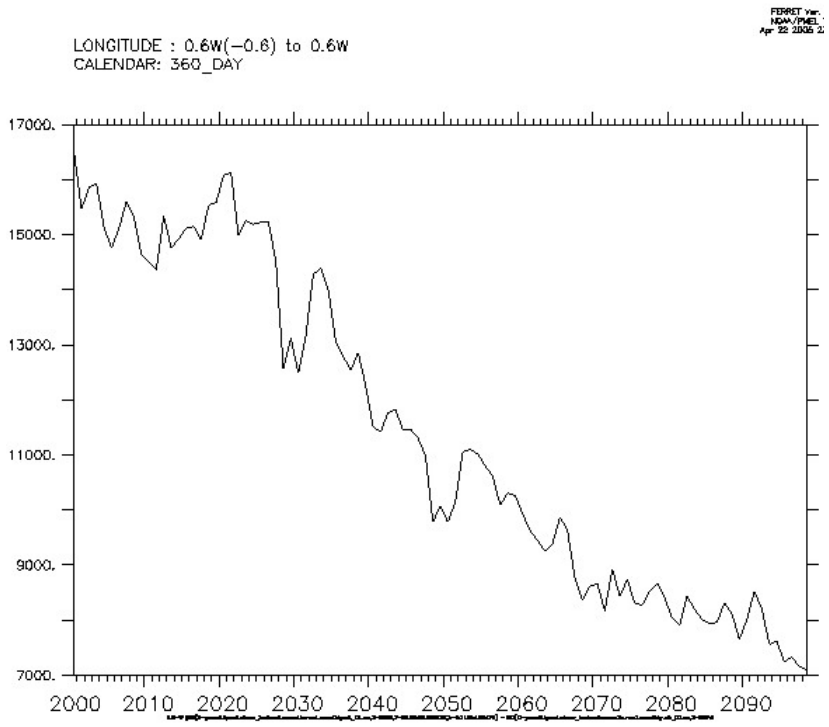
Fluxes through straits: residuum

time rate of change of fresh water content

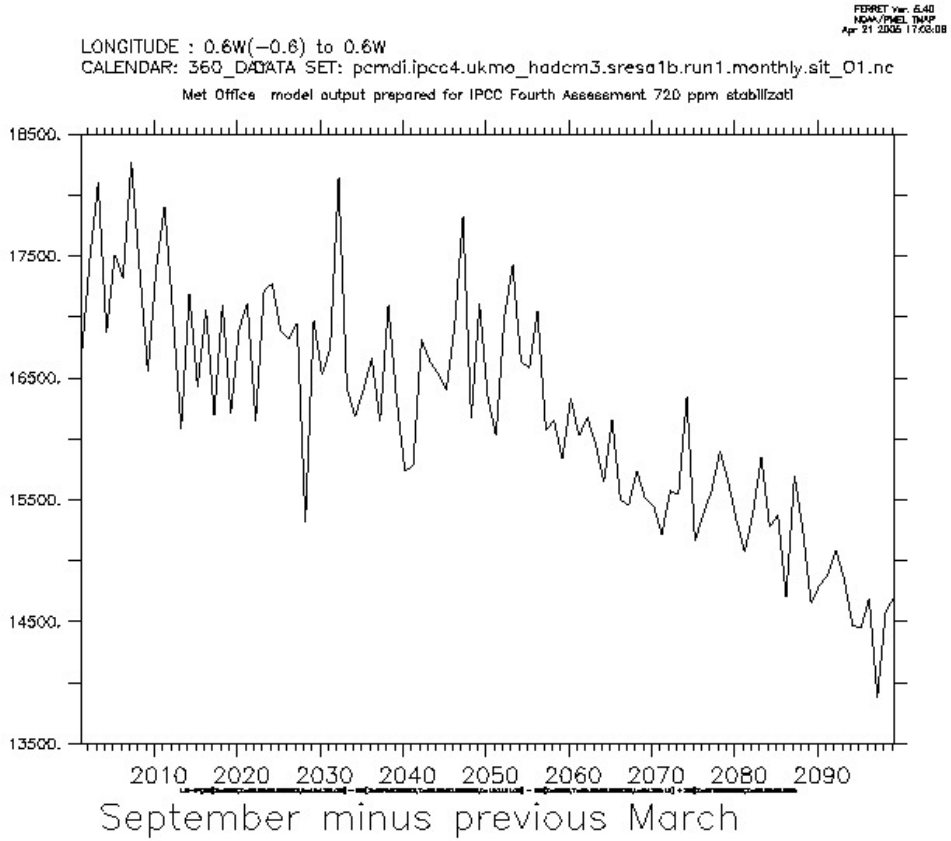
Arctic precipitation



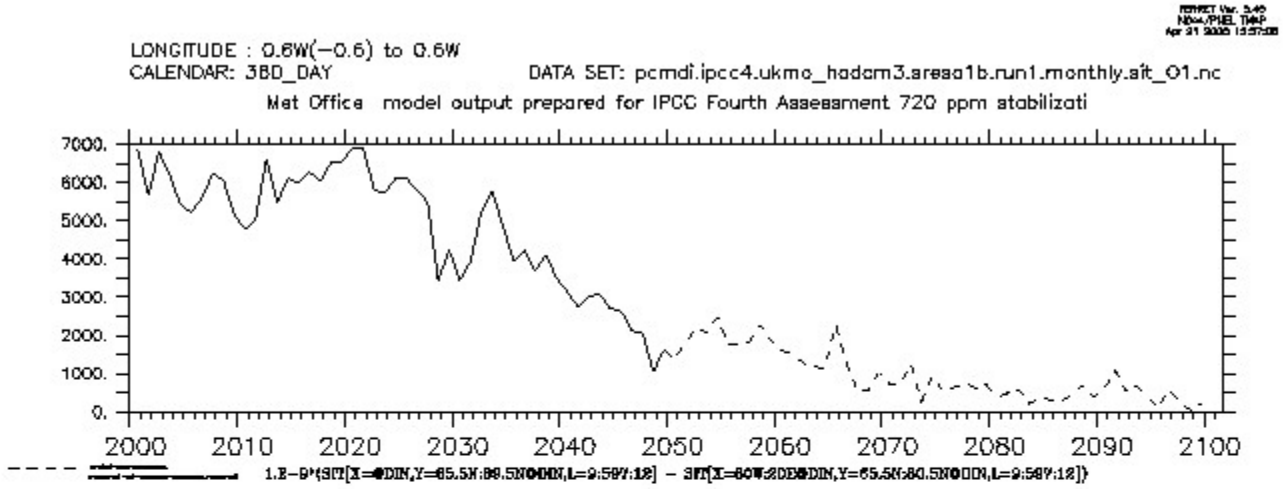
Arctic ice volume

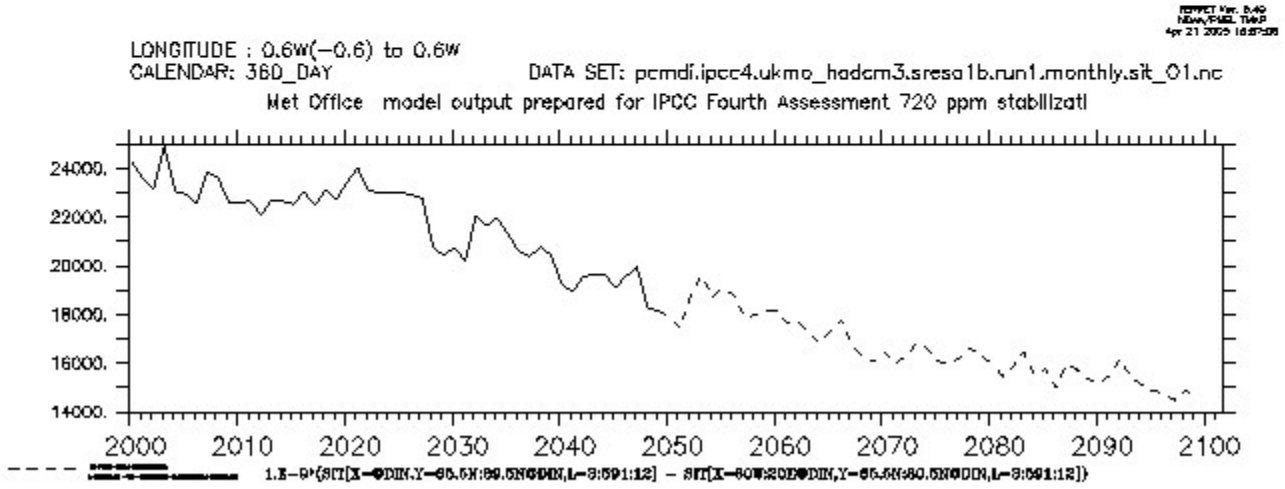


Arctic ice volume change: winter minus previous summer

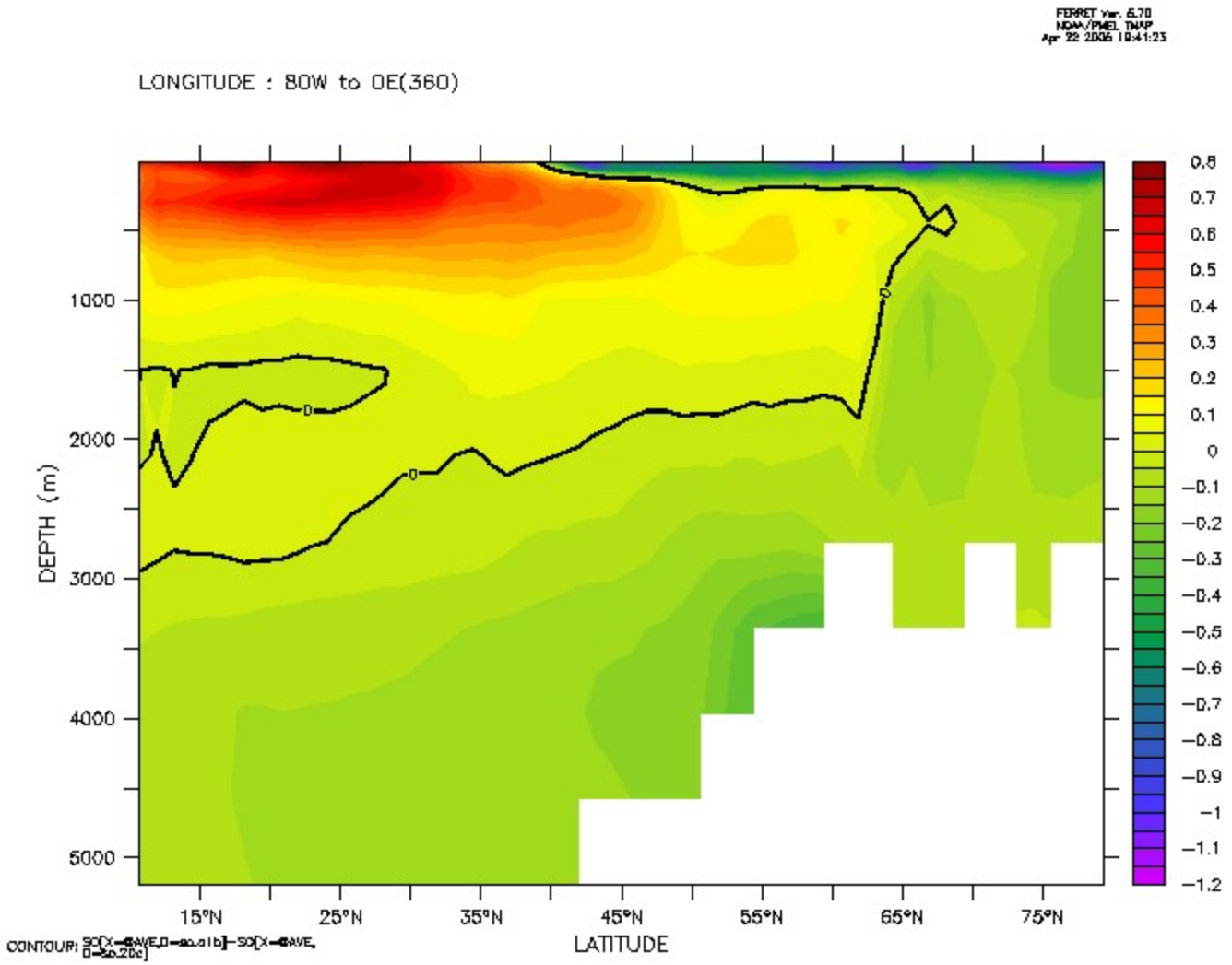


Arctic ice volume summer(above) and winter



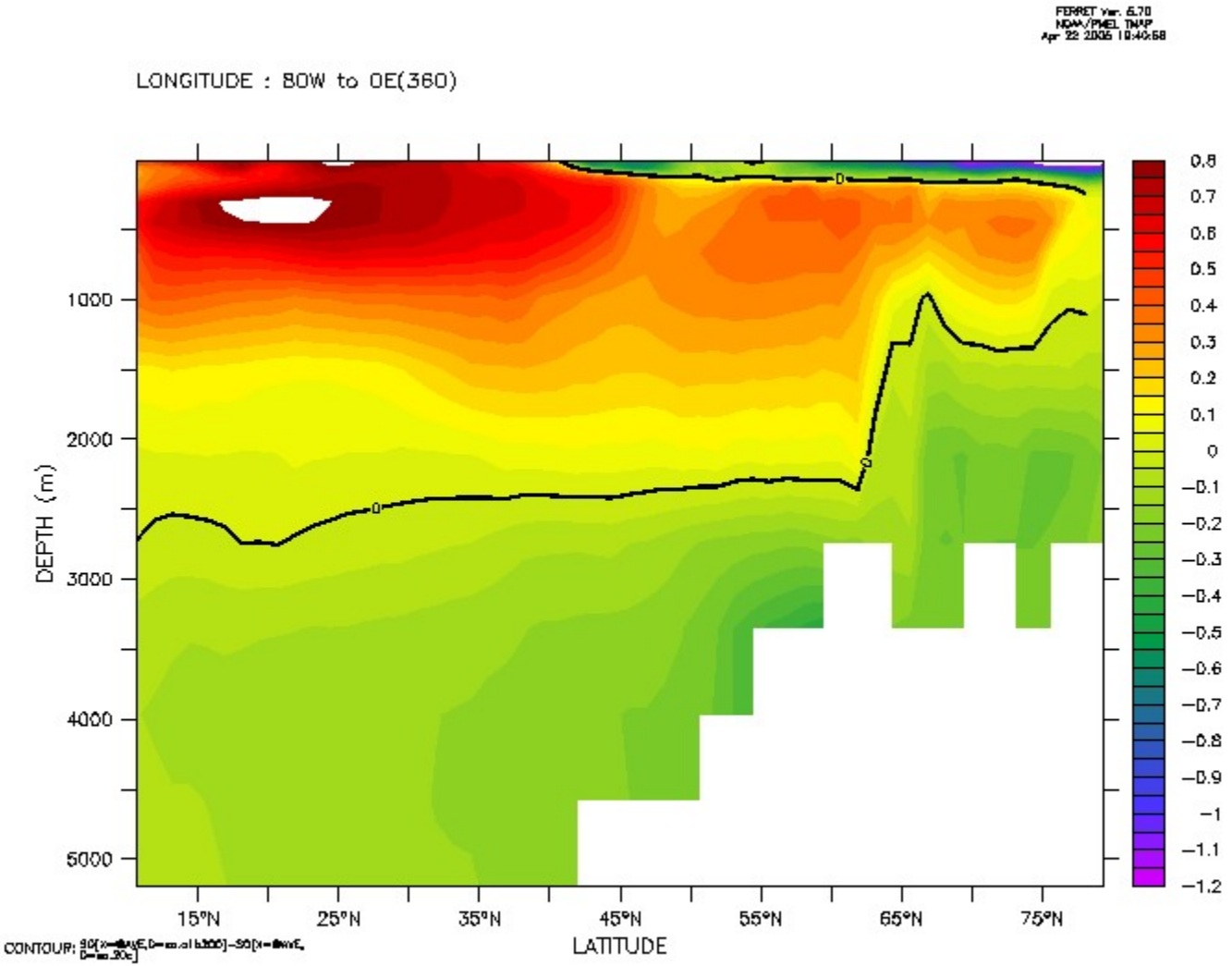


Salinity change to end 21th century



SO[X=@AVE,D=so.a1b]−SO[X=@AVE,D=so.20c]

Salinity change to end 22th century



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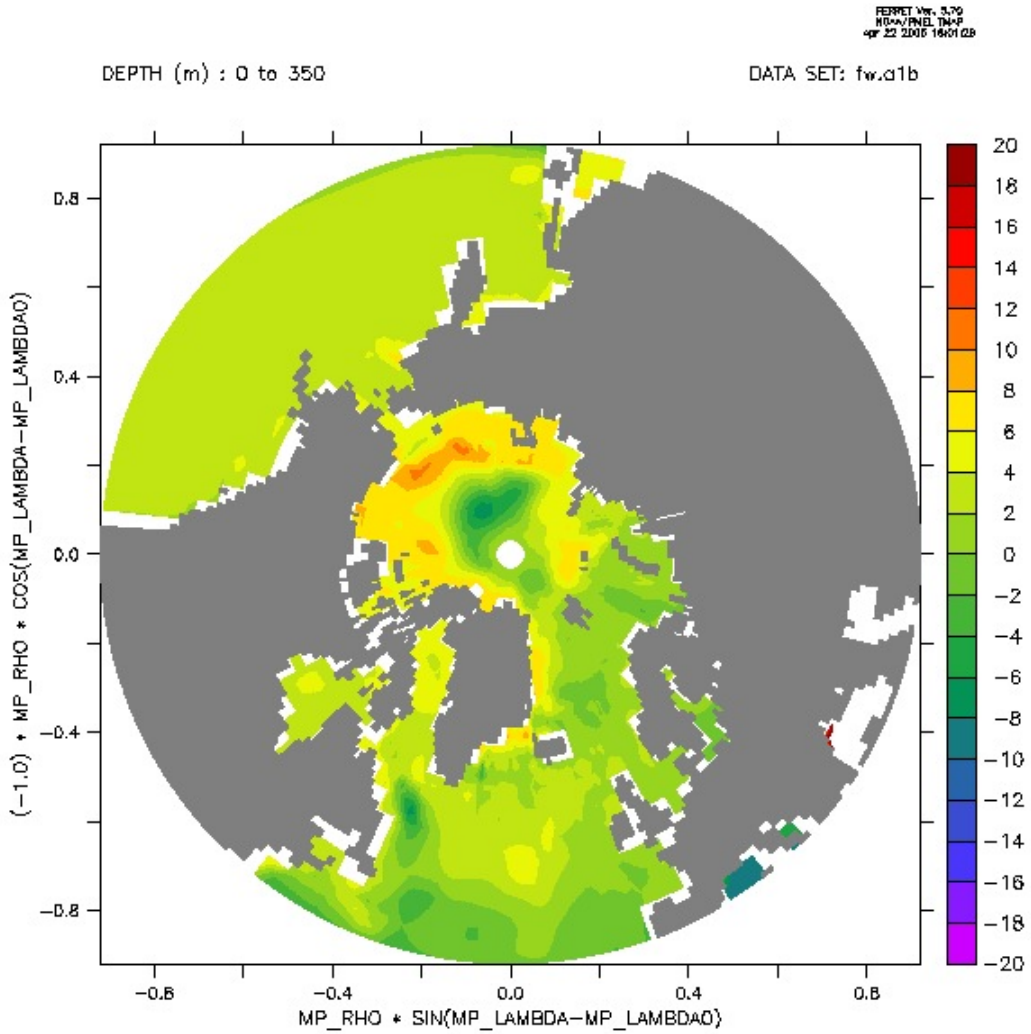
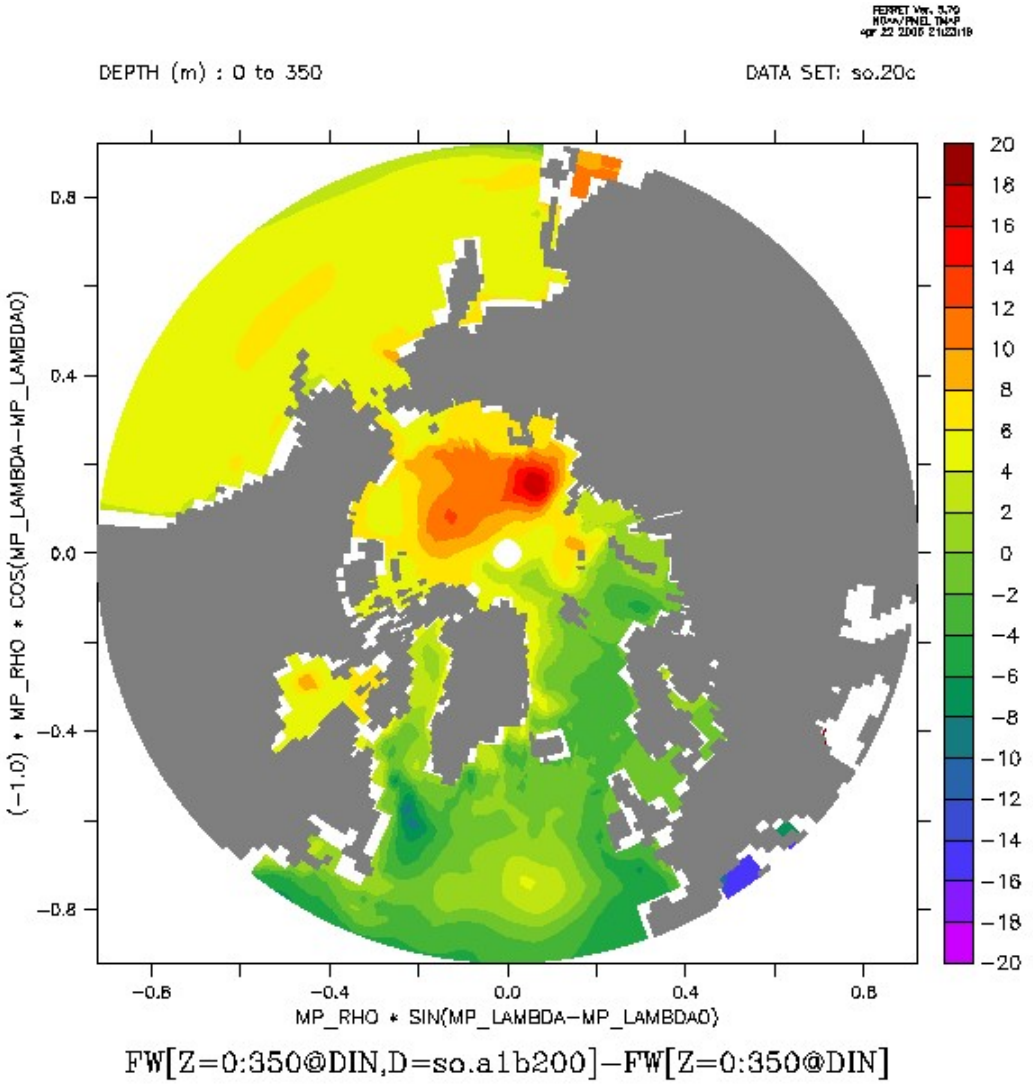
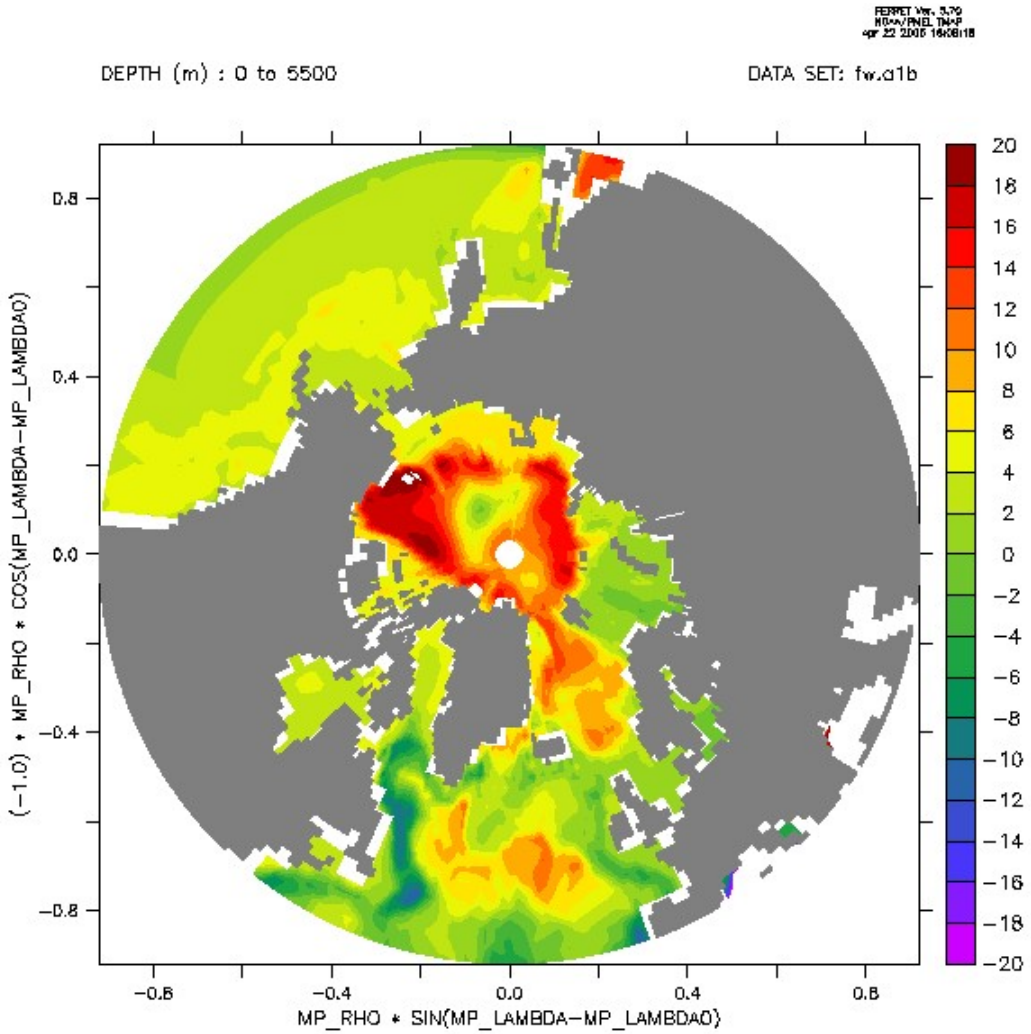
Fresh water content(35) up350m change to end of 21th century



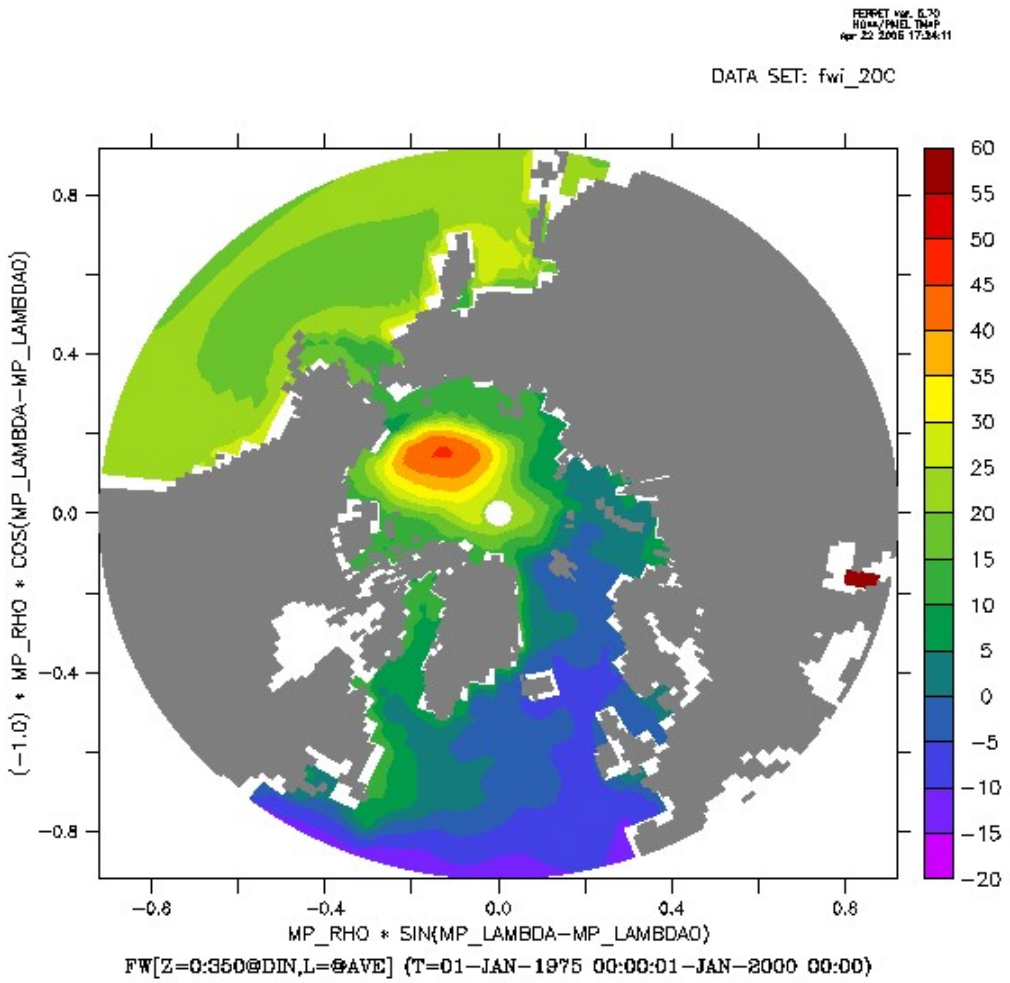
Fresh water content(35) up350m change to end 22th century



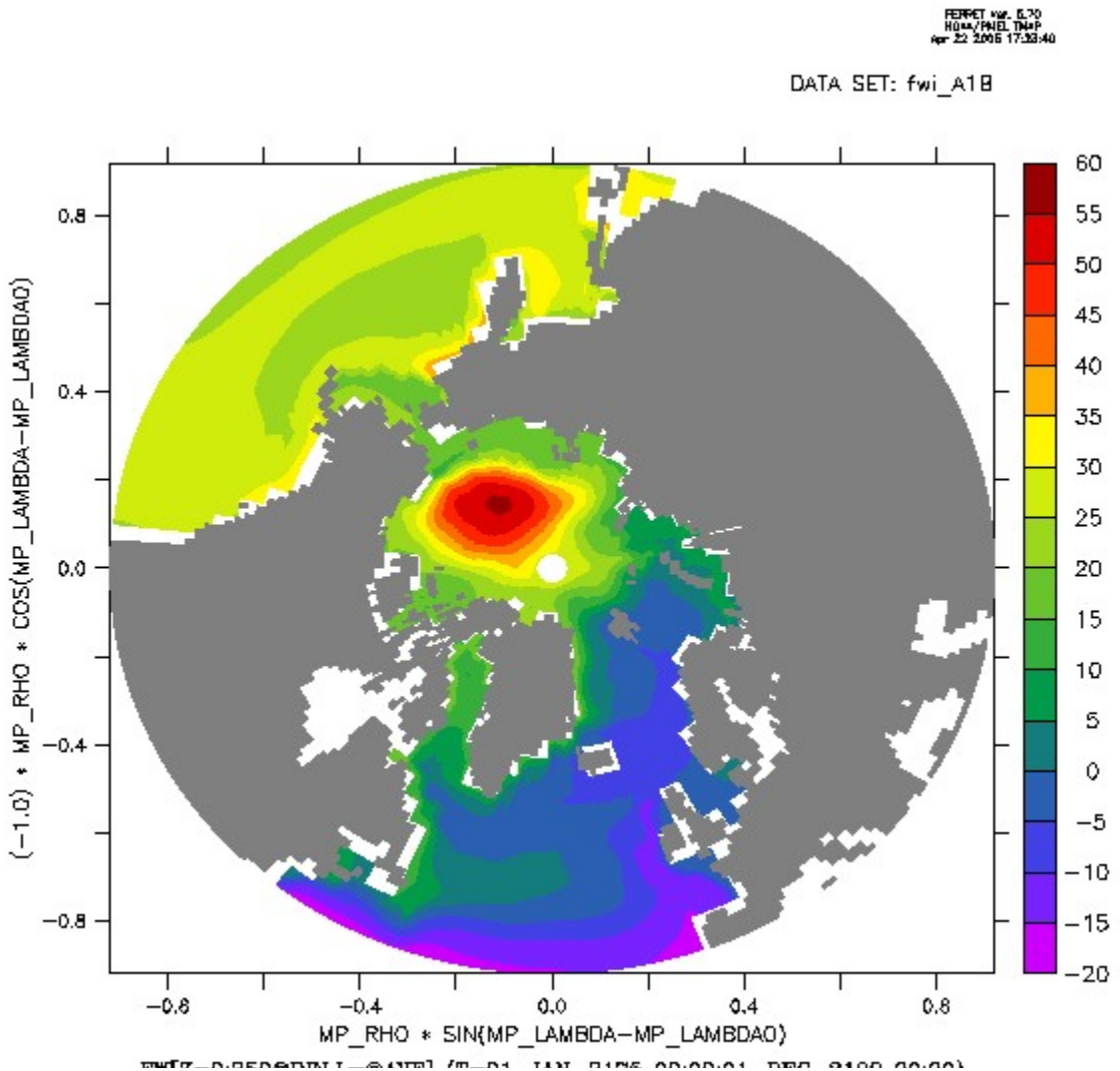
Fresh water content(35) to bottom change to end of 21th century



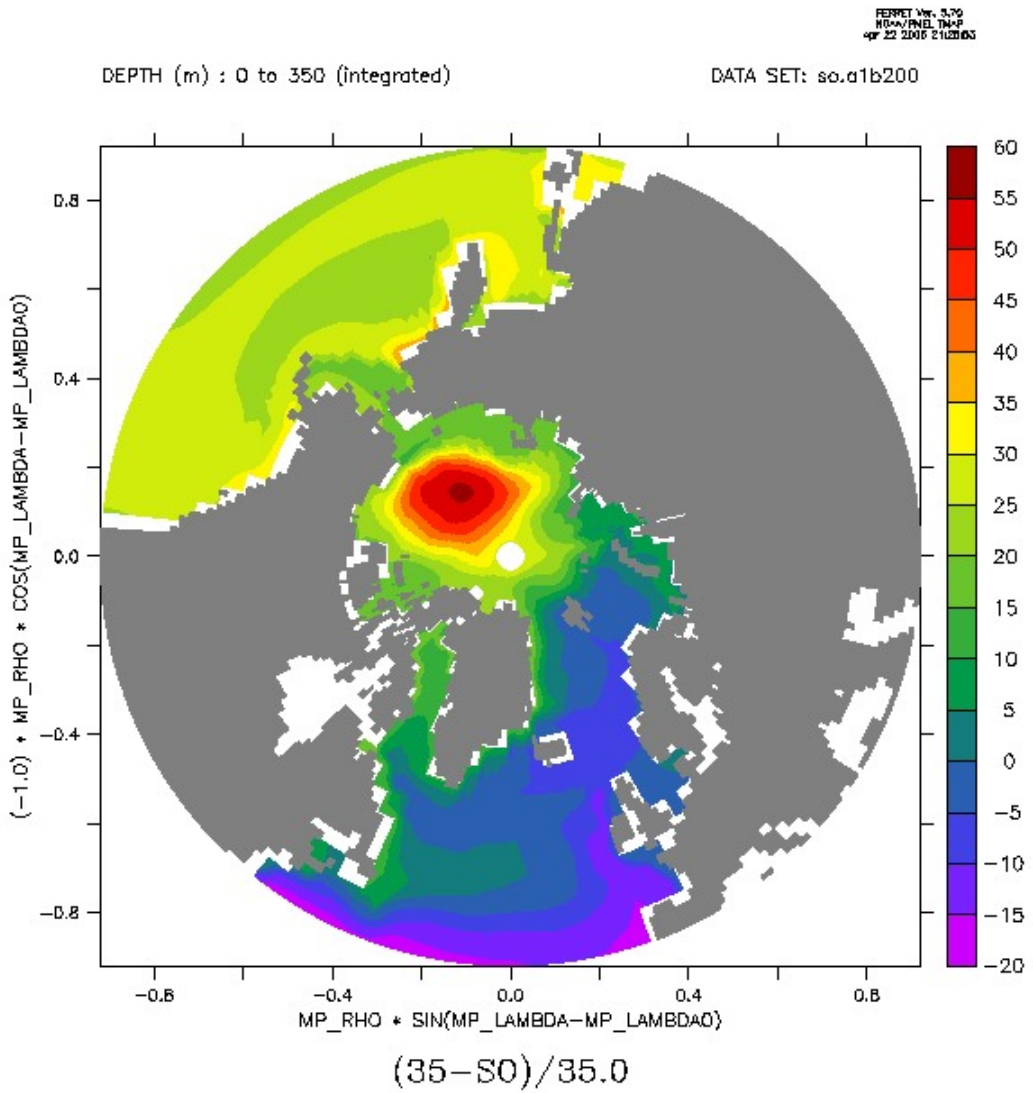
Fresh water content(35) up350m end 20th century



Fresh water content(35) up350m end 21th century



Fresh water content(35) up350m end 22th century



Conclusion

- **Restoring** can at the moment not be neglected as a liquid surface fresh water flux. Fortunately, our model is stable with a time constant flux correction, thus allowing to analyze variability of fresh water flux.
- One still underrepresented source of liquid fresh water is river runoff; this will be improved with an open boundary condition.
- The “quality“ of the climatological data has to be assessed critically. On could try to construct a “better“ data set.

- Liquid fresh water **budget** is balanced in the model and its components fall in the range of published numbers- allthough there are uncertanties in those, too. Nevertheless, one needs a flux correction that is larger than the known deficiencies. The ice provides most variability in the surface flux, Fram Strait dominates the transports through the Straits.

- ice from **IPCC scenario** 20c3m shows the enormous range of ice modelled by state-of-the-art GCMs….
- scenario sresa1b (HadCM3) shows - in contrast to the hindcast - an increase in fresh water content and a decrease in ice volume.
- The fresh water content increase is mostly due to precipitation and run-off.