Climate, Ocean and Sea Ice Modeling Program

AOMIP: 2 Runs, a Lesson and 2 Questions

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POP:

Bryan-Cox z-coordinate ocean model

hydrostatic, Boussinesq primitive equations for ocean temperature, salinity, momentum

implicit free surface

implicit barotropic fast gravity wave mode; else explicit 3D

KPP vertical mixing parameterization

GM or biharmonic horizontal mixing (on tracers)

biharmonic horizontal friction (on momentum)

CICE:

energy conserving thermodynamics

energy-based ridging and ice strength

elastic-viscous-plastic dynamics

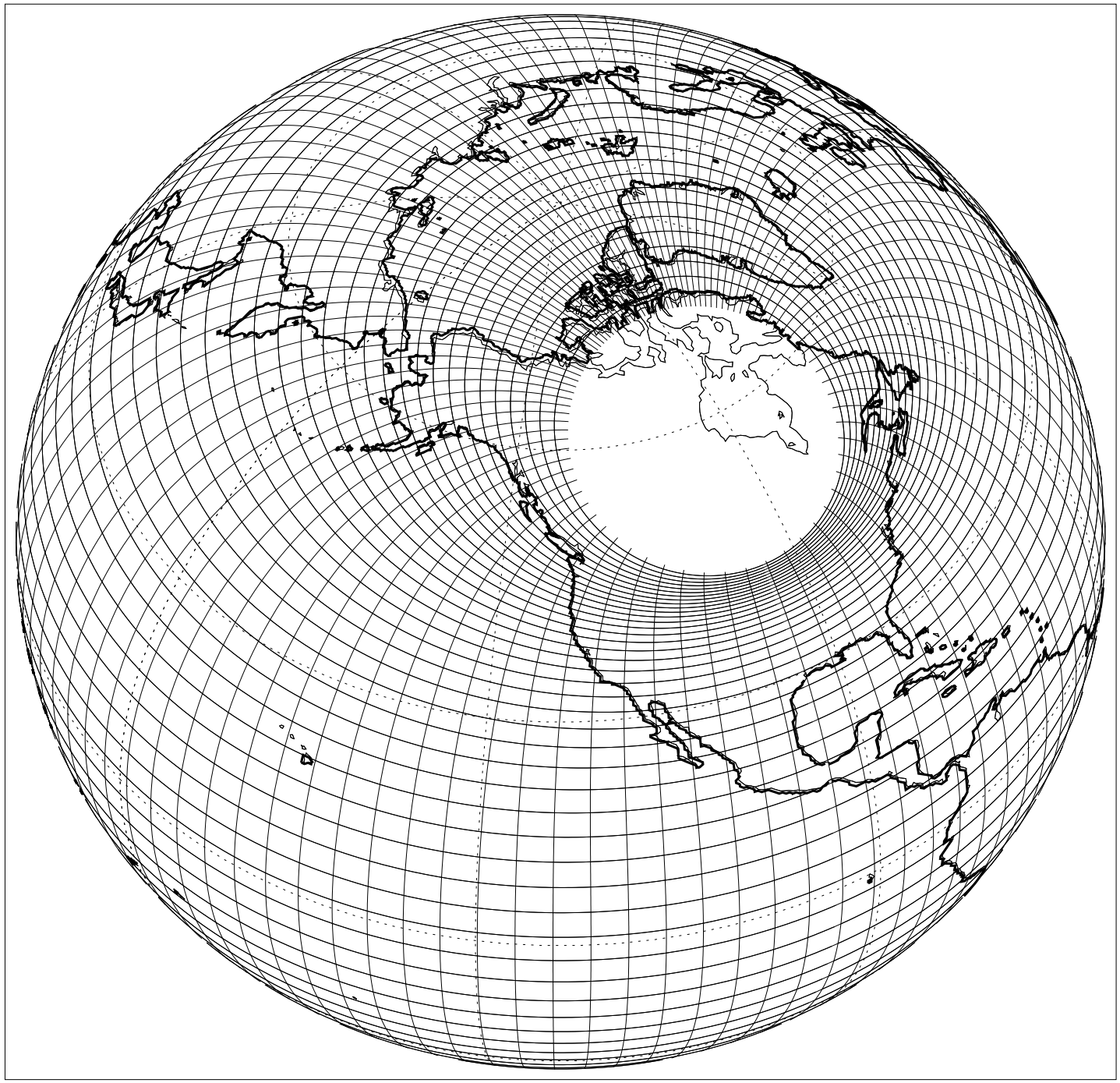
incremental remapping advection

5 thickness categories, 4 layers of ice + 1 layer of snow

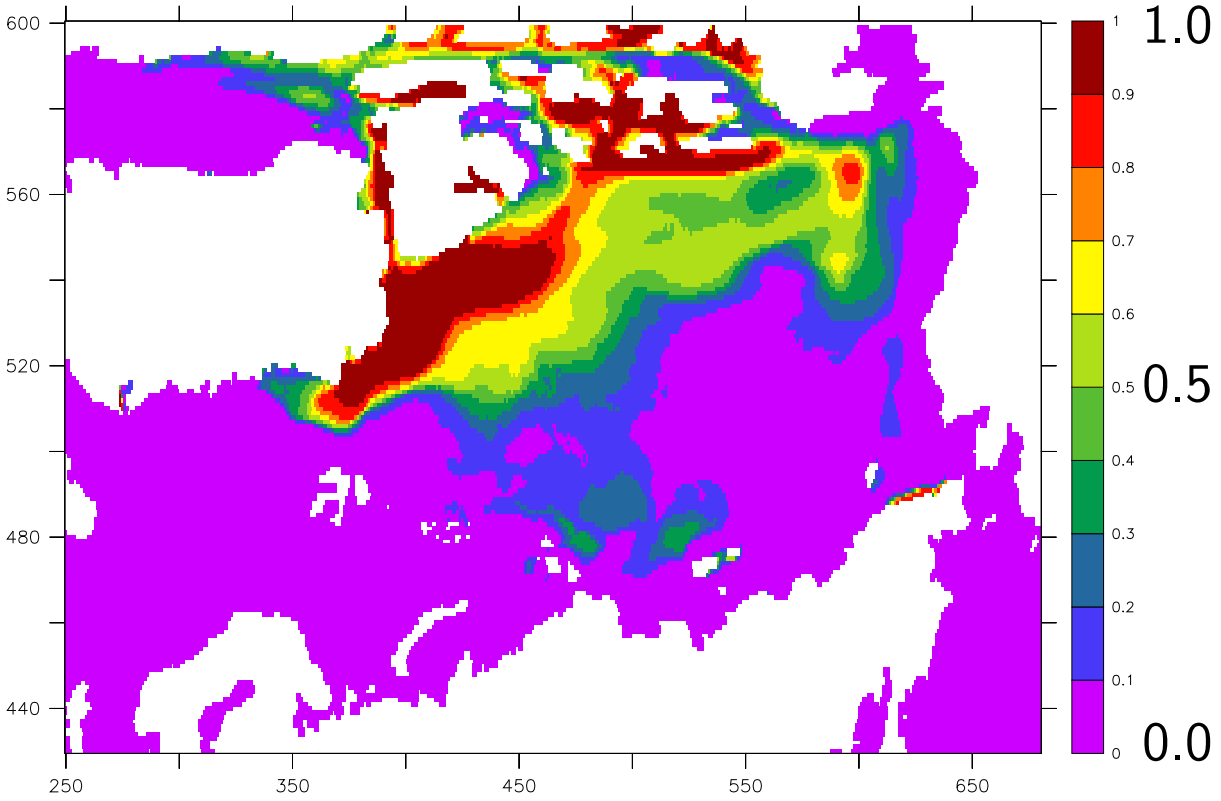
variables/tracers (for each thickness category):

- ice area fraction
- ice/snow volume
- ice/snow energy in each vertical layer
- surface temperature

$0.4°$: 900x600x40

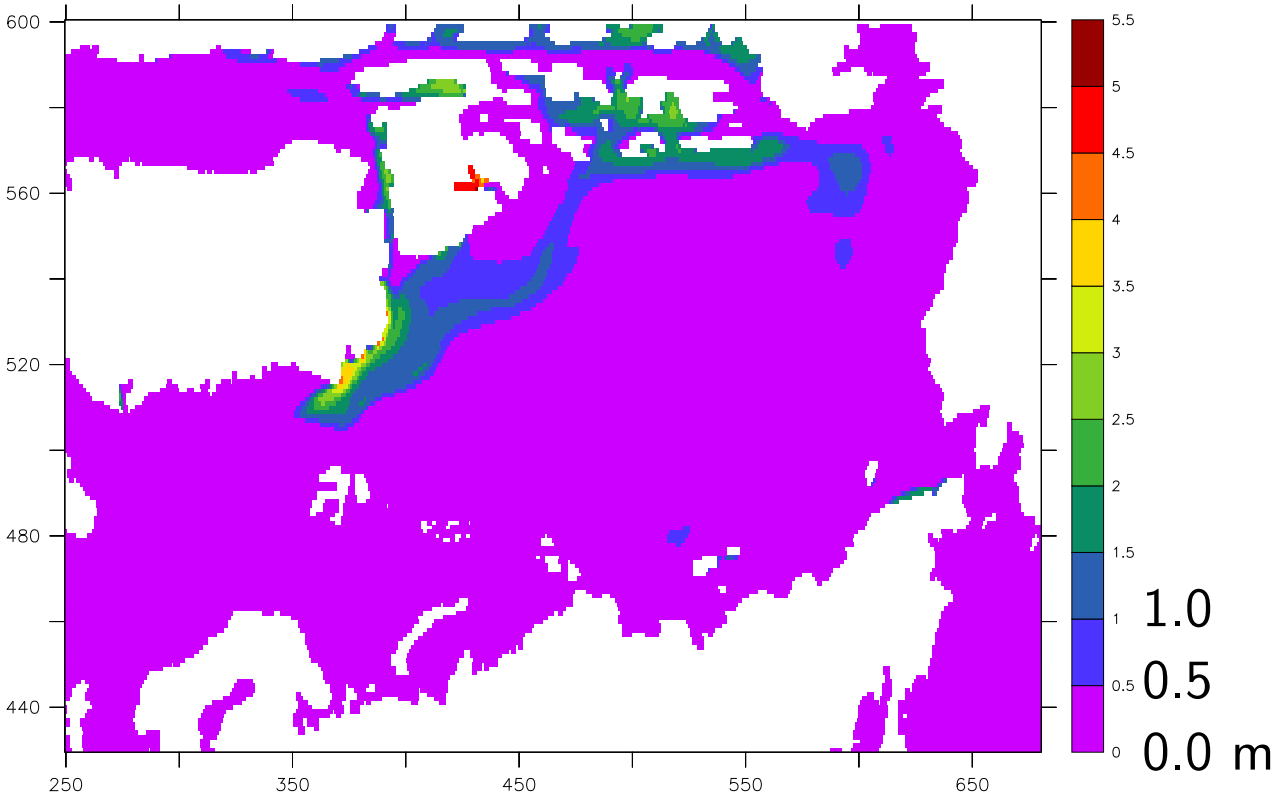


1 of every 25 mesh nodes shown

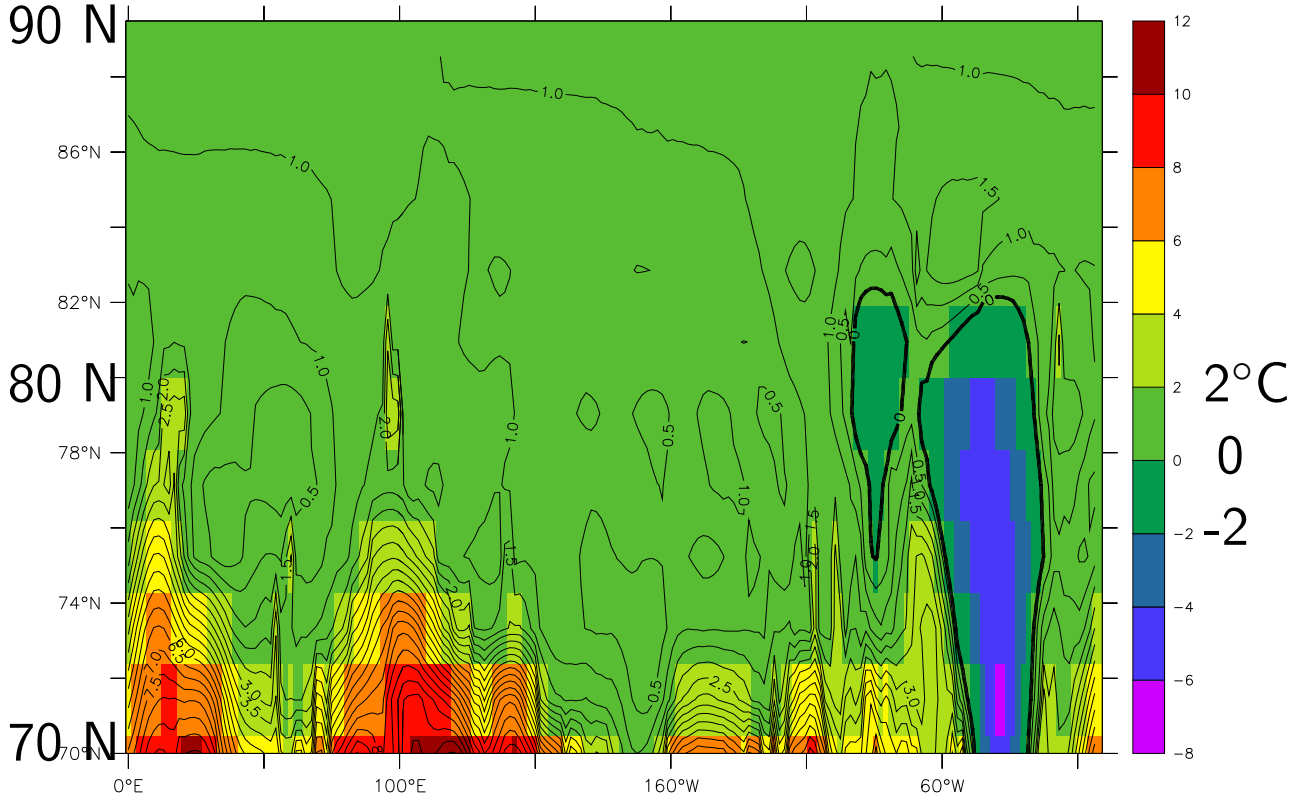


September, Year 5
of ice spinup (1952)
using original T_{air}

Ice Area Fraction

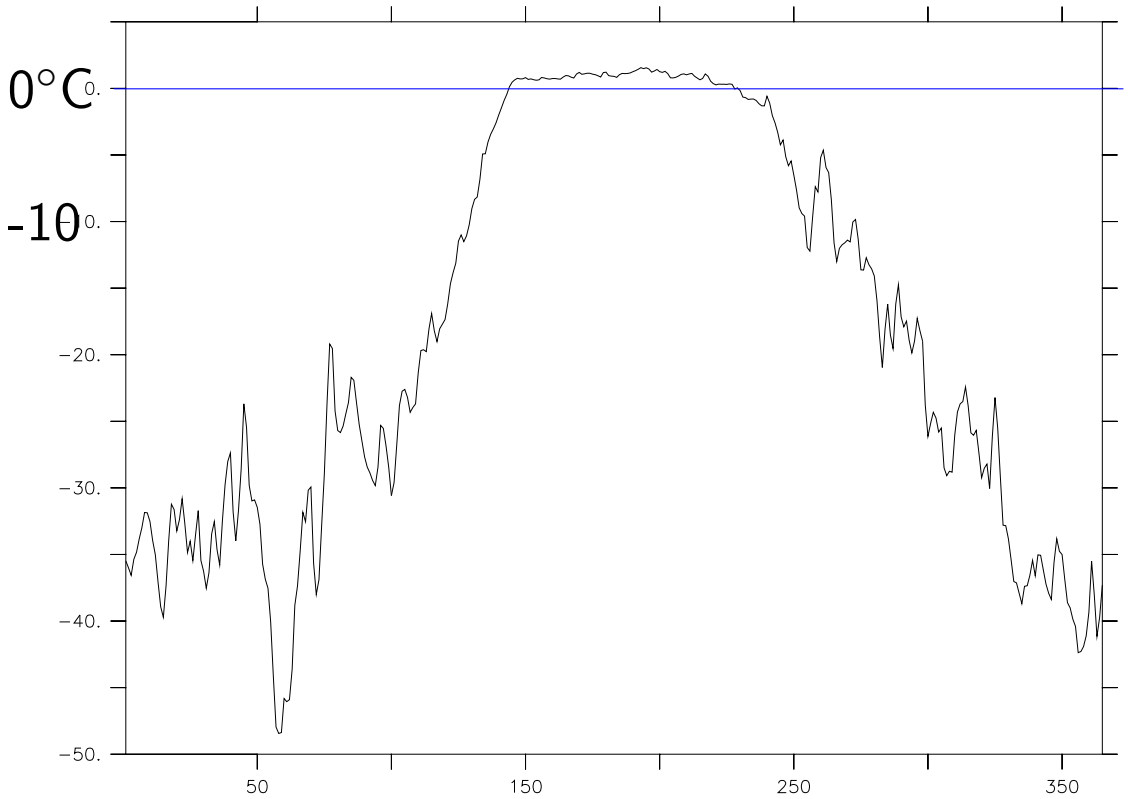


Ice Thickness



10-m T_{air}, 1949–1952

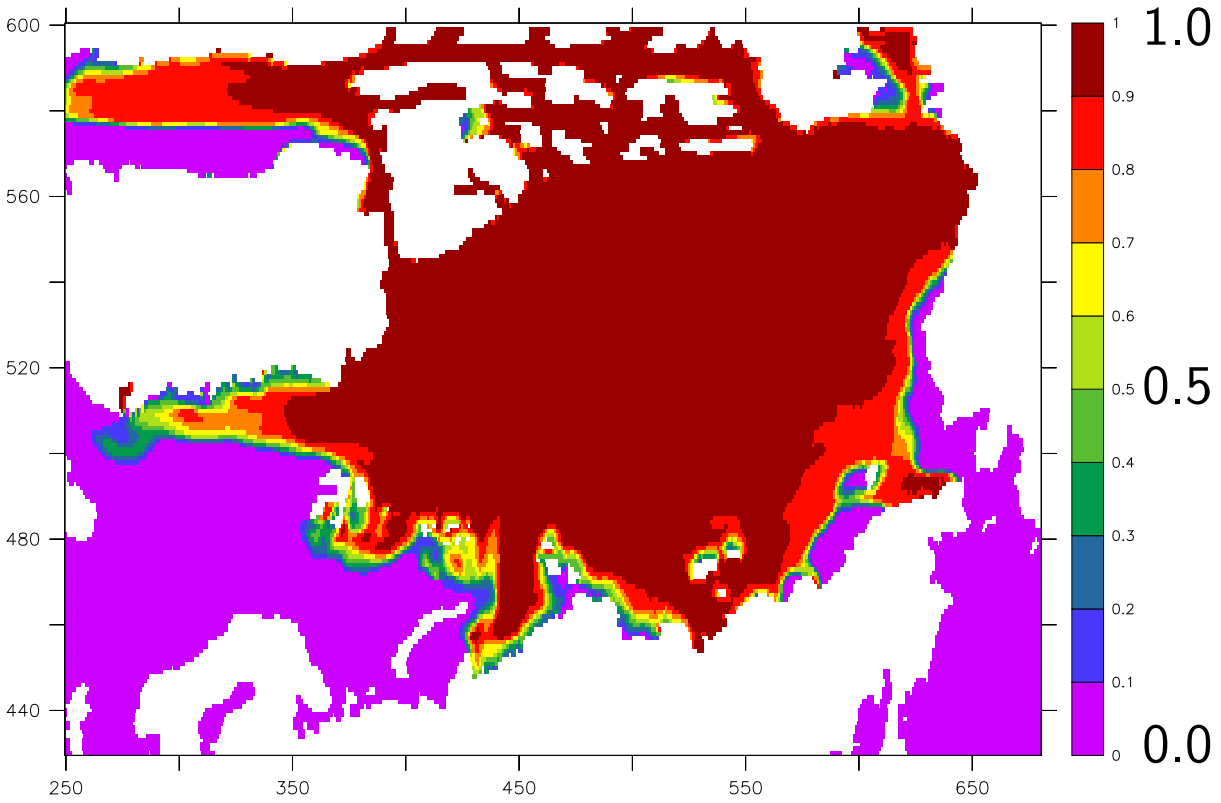
averaged June-July



averaged 80–90 N

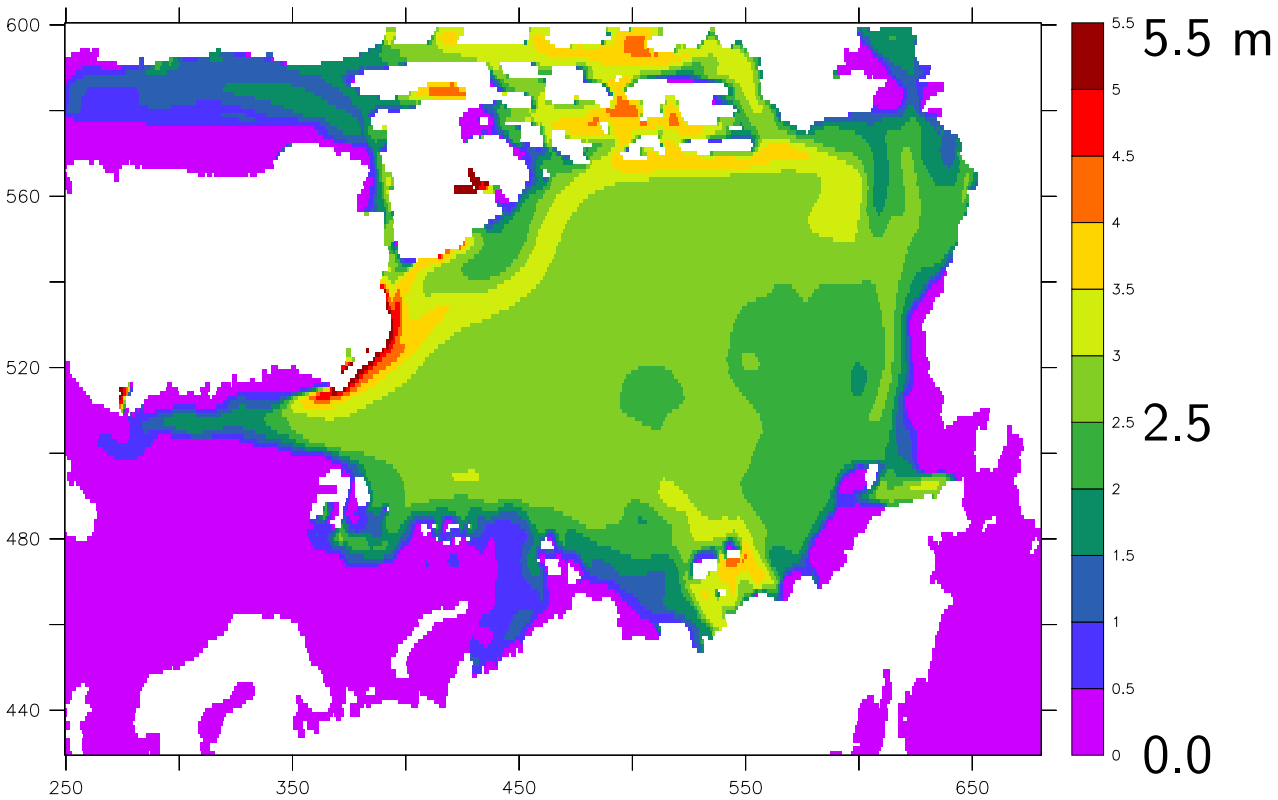
Rigor, I., R. L. Colony and S. Martin, 2000. *Variations in Surface Air Temperature Observations in the Arctic, 1979-97*, J. Clim., **13**, 896-914:

"Note that an isothermal melt period can be observed in the time series for each dataset when the SAT reaches the ice melt point. During this period the SAT is maintained at about 0 C until all the snow and ice in an area have melted... Over the sea ice, the SAT remains close to the melt point all summer."



September, Year 5
of ice spinup (1952)
using max $T_{air} = 0.1°C$
if ice area fraction > 0.1
and all precip = snow

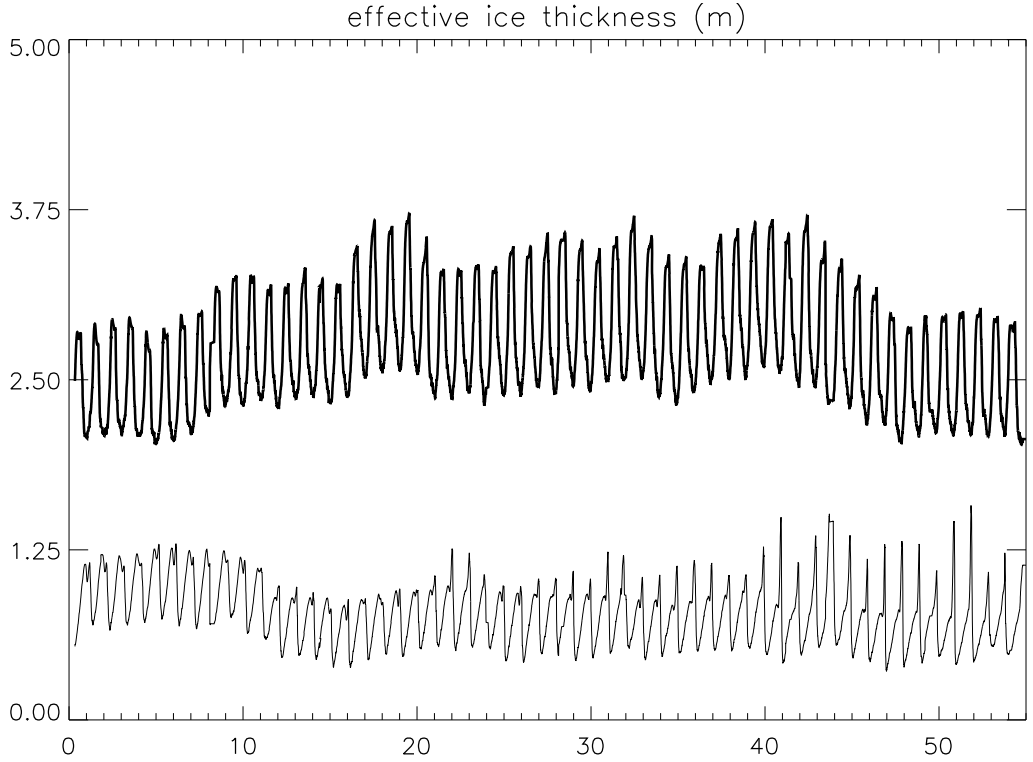
Ice Area Fraction



Ice Thickness

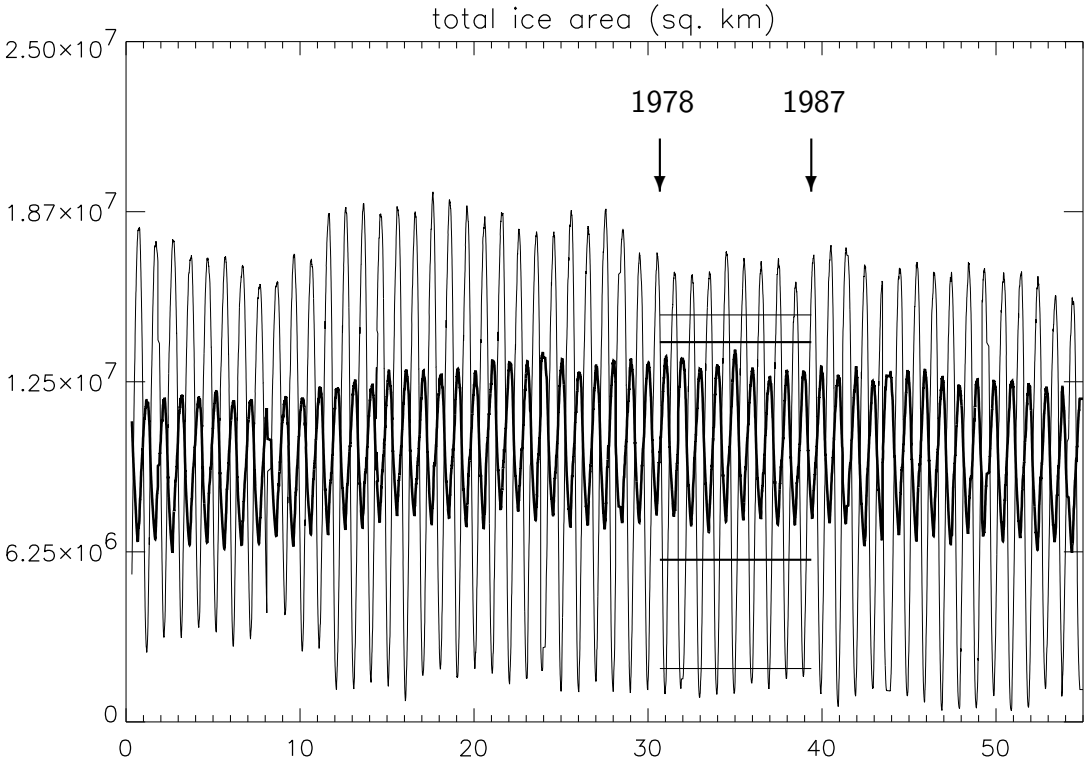
Lesson

Allowing some feedback on the atmospheric data where there's ice, by limiting the air temperature to be near 0°C, has quite a large effect in this model.



Northern Hemisphere

Southern Hemisphere

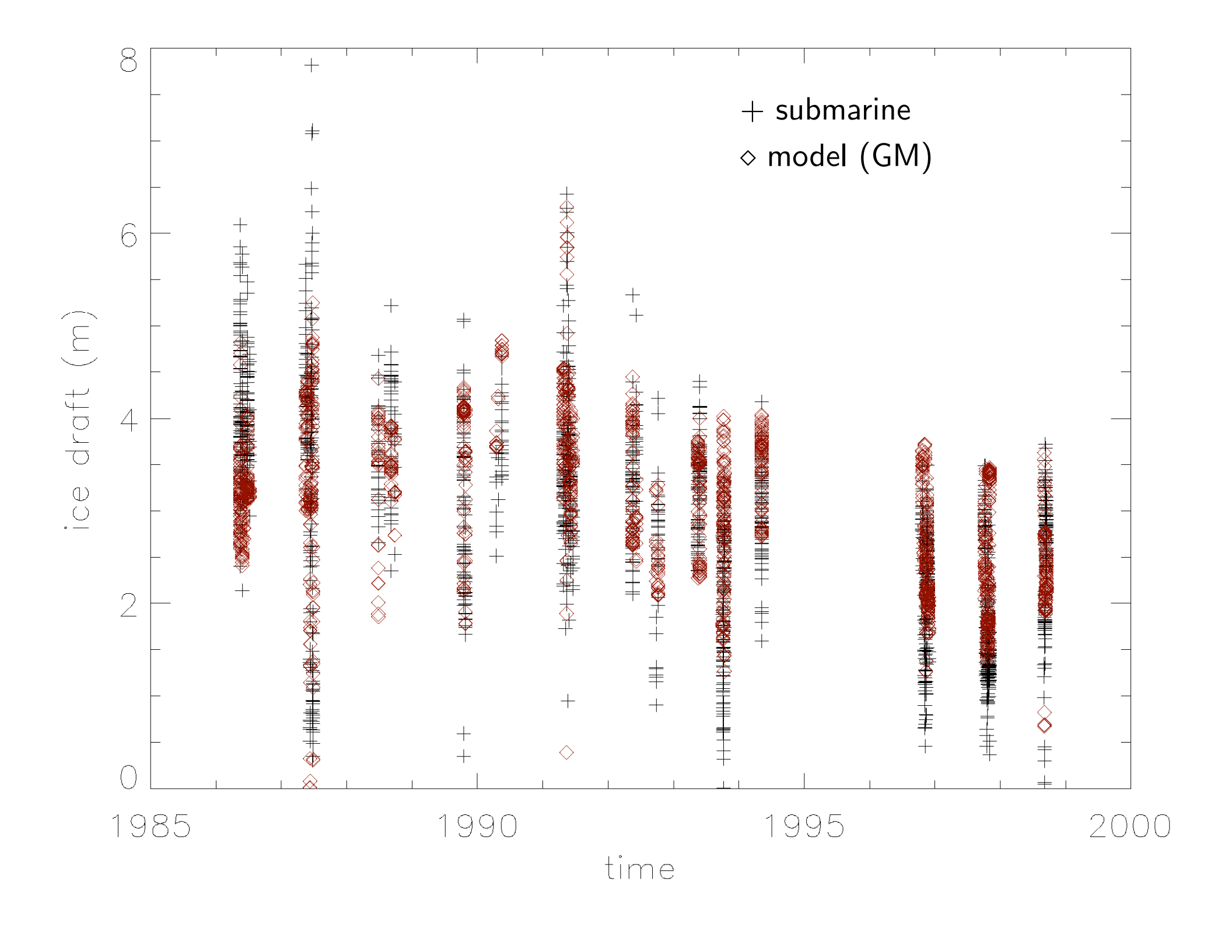


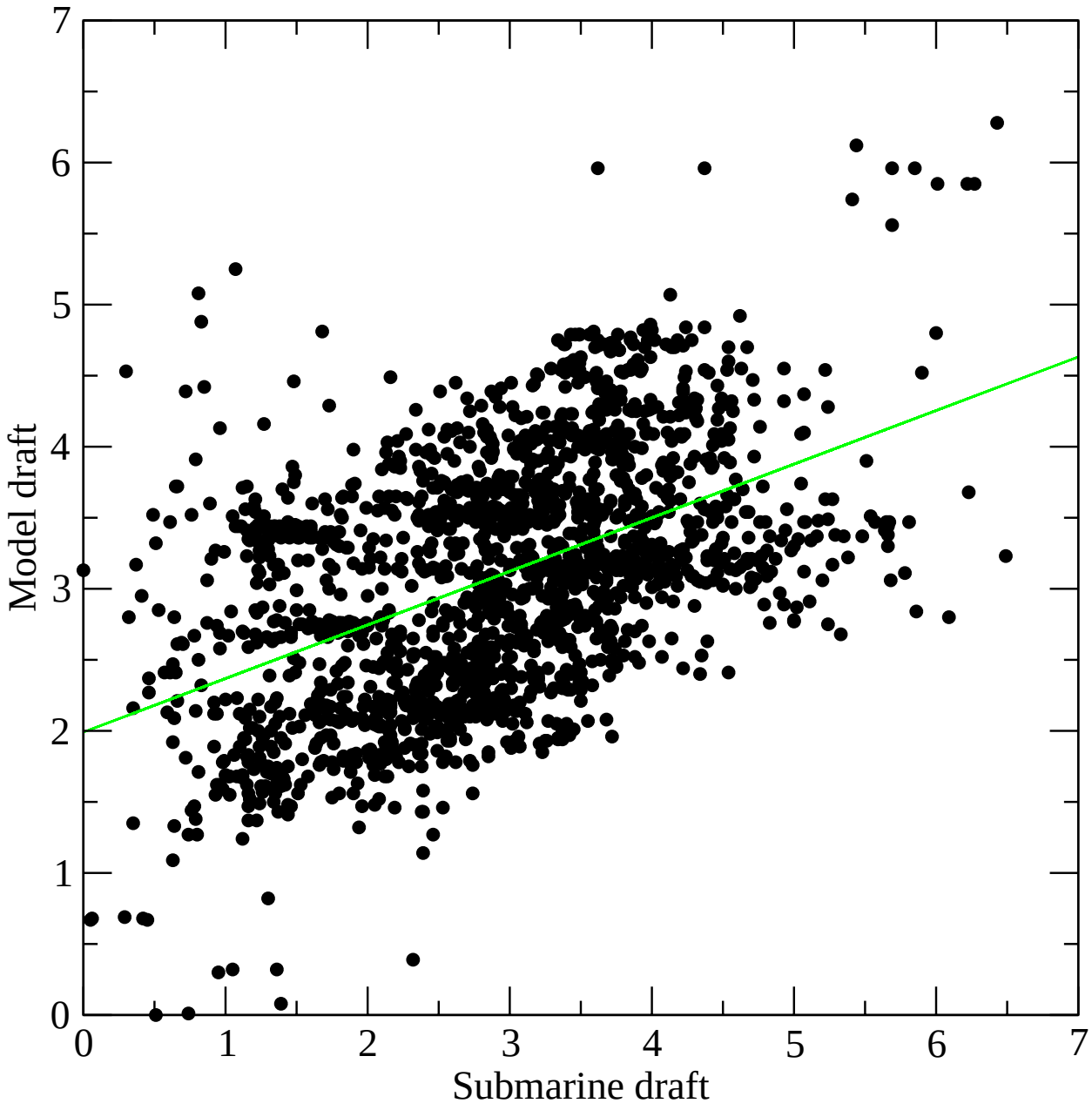
SMMR ice area, 1978–1987:

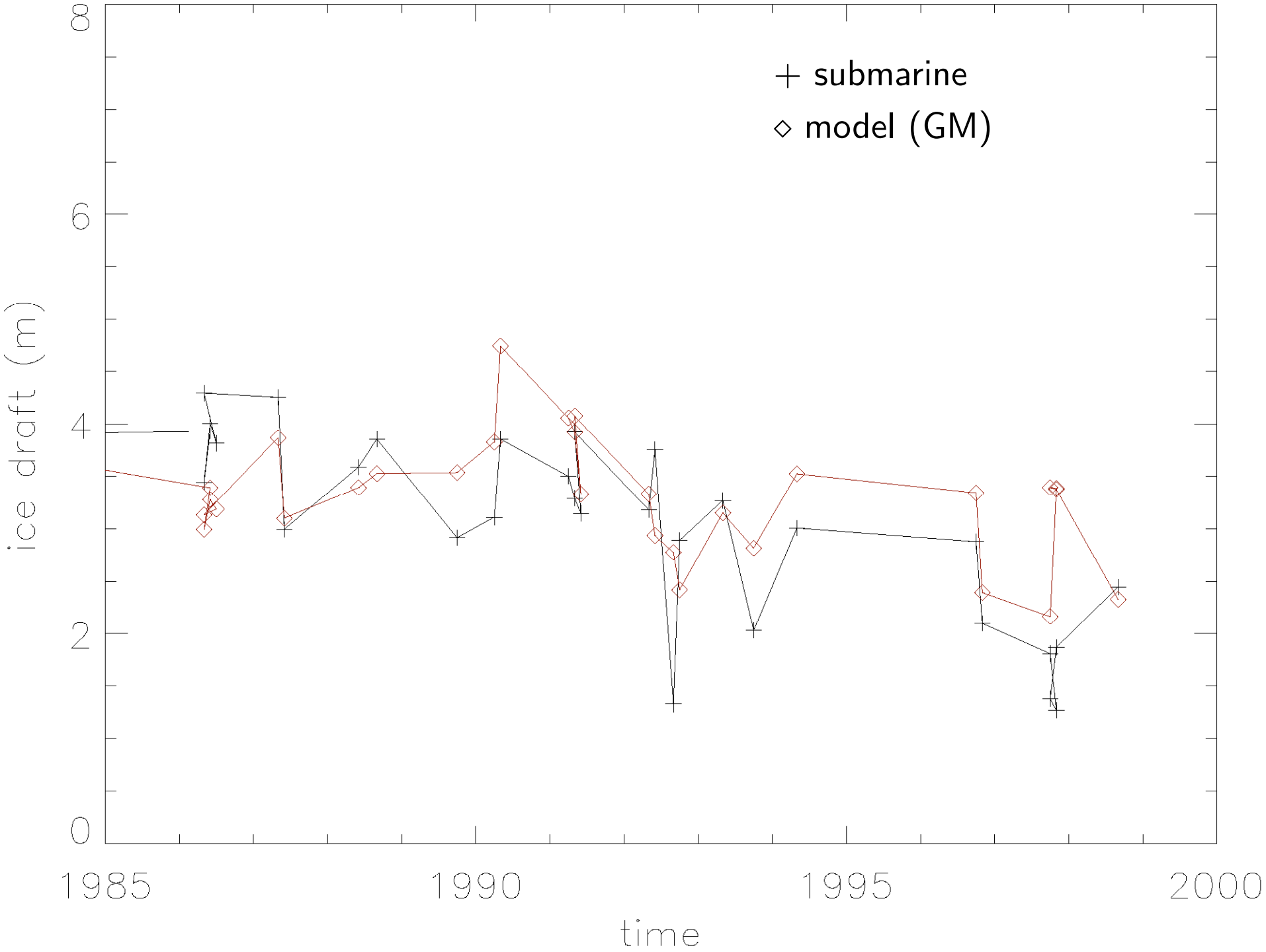
NH $\sim$ 6–14 x 10^6 sq km

SH $\sim$ 2–15 x 10^6 sq km

(from the Big Blue NASA Book)


+ submarine
◇ model (GM)
ice draft (m)
0
2
4
6
8
1985
1990
1995
2000
time


Model draft
Submarine draft
0
1
2
3
4
5
6
7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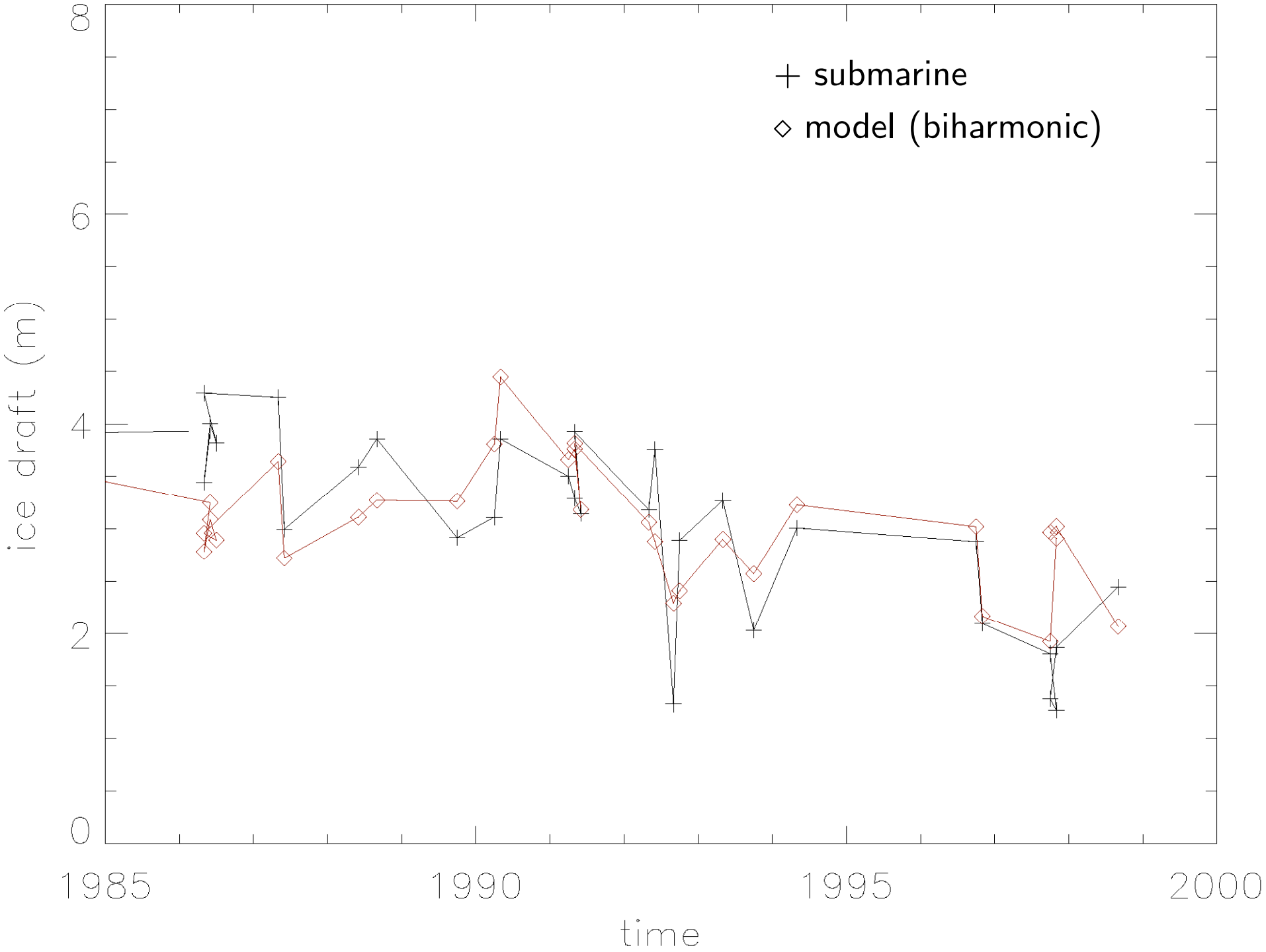

+ submarine
◇ model (biharmonic)
ice draft (m)
0
2
4
6
8
1985
1990
1995
2000
time

	Submarine	Model (GM)	Model (bih.)
Mean ice draft (m)	2.90	3.08	2.84
Standard deviation	1.13	0.86	0.88
Correlation coefficient		0.49	0.53

Thanks to Bill Lipscomb for these numbers and Sam Mills for the inspiration

Question

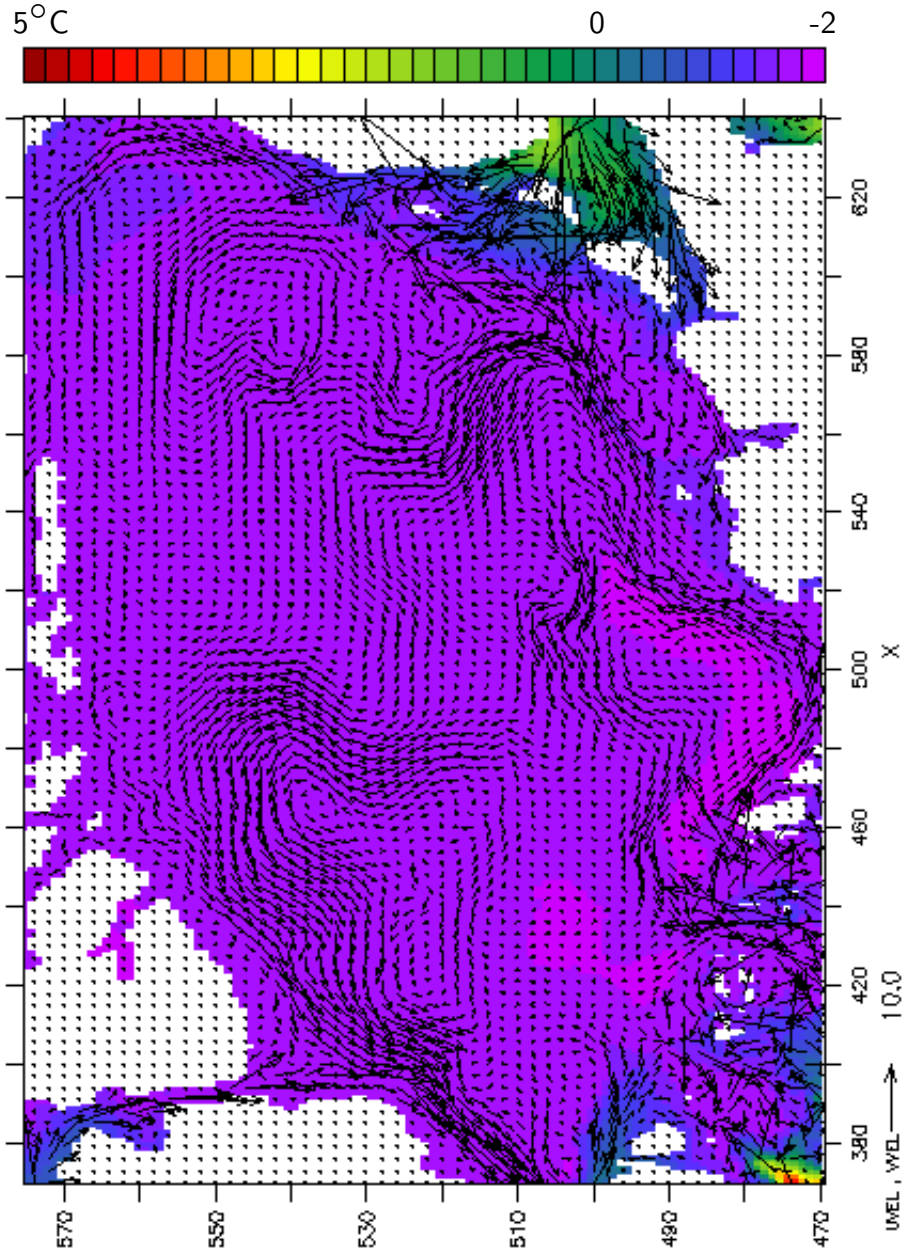
A LANL summer student is making a statistical comparison of our AOMIP model output with the submarine data. Would anyone else like to contribute?

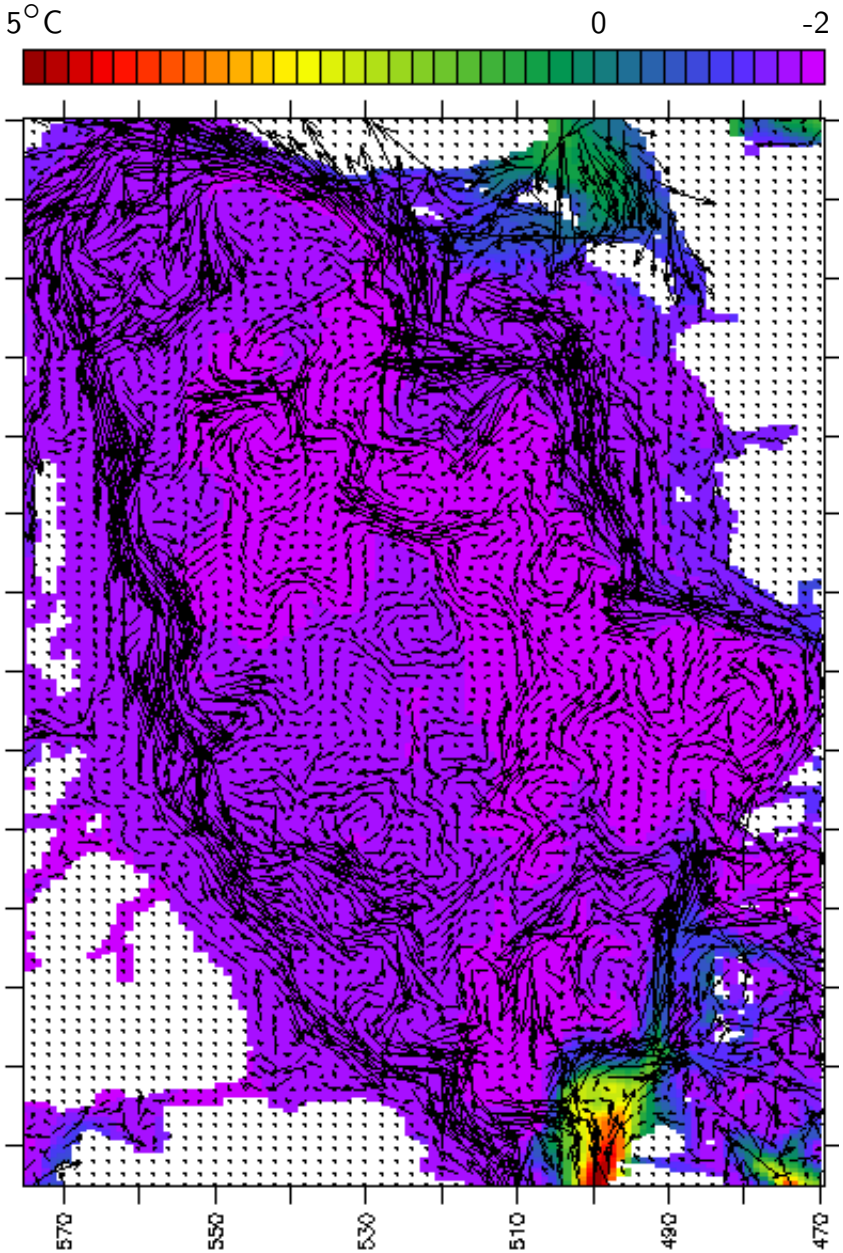
1978

GM

36 m

Biharmonic



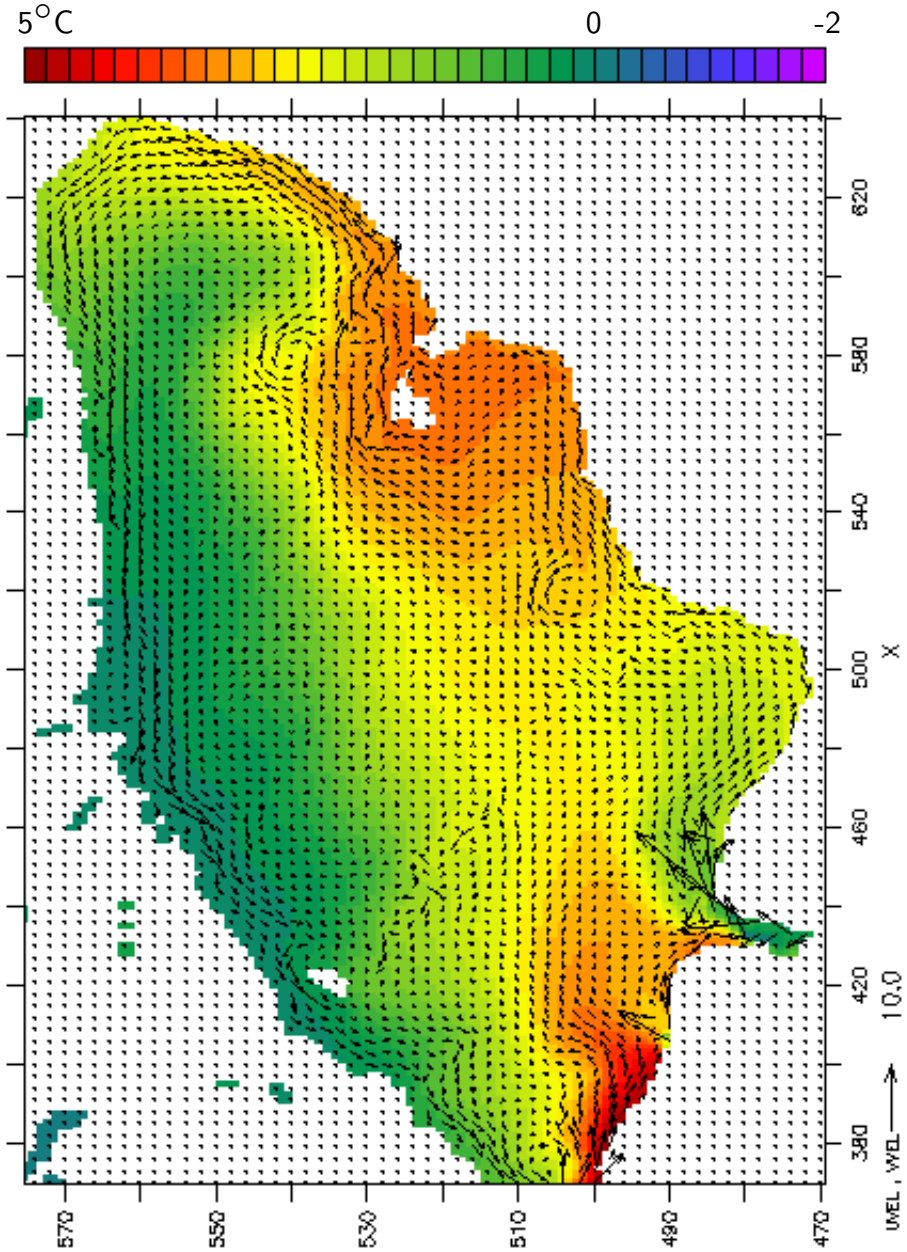


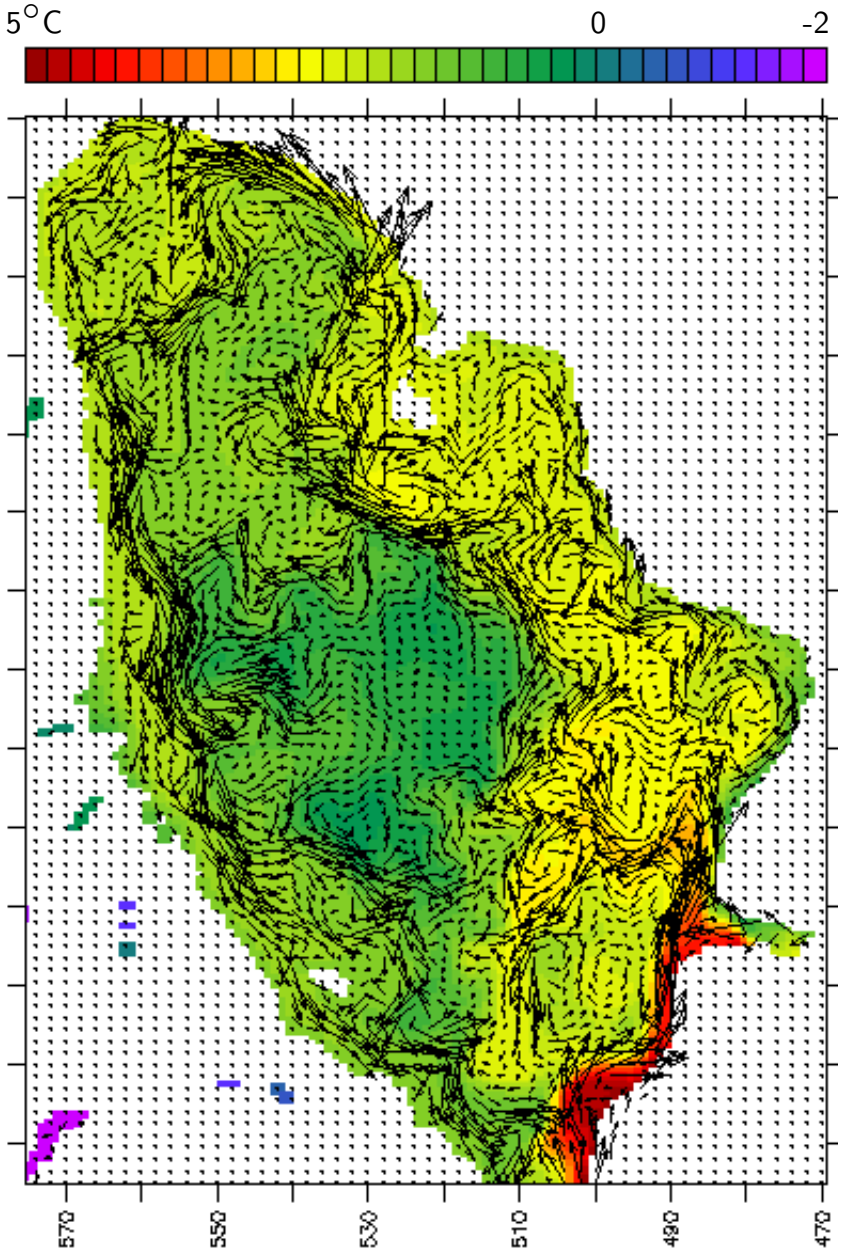
1978

GM

466 m

Biharmonic





Question

Why are the GM and biharmonic simulations so different?

LANL's two AOMIP runs promise rich analysis results!

Many thanks
to David Holland for suggesting we join the effort,
to Andrey for being supportive of us,
to Mat and Marika and Bill for their insight and help at LANL and NCAR, and
to Oak Ridge National Laboratory for > 1200 hours on each of 60 nodes of their Cray X1!