

The effects of eddy parameterization in a coarse-resolution global ocean and sea-ice model

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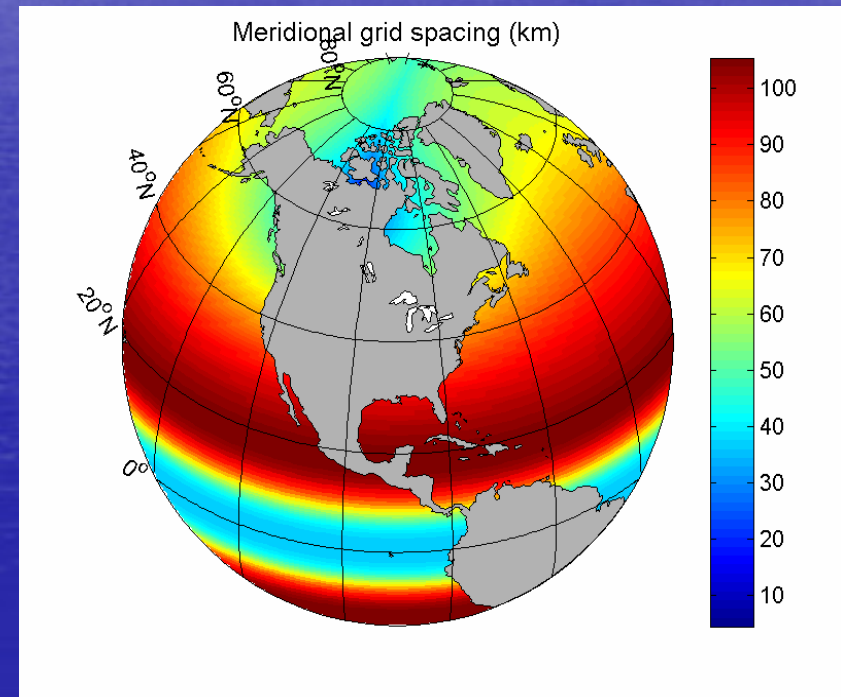
Canadian Foundation for Climate
and Atmospheric Sciences (CFCAS)

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du climat et de l'atmosphère (FCSCA)



Model Description

- Based on NEMO (Nucleus for European Modelling of the Ocean); ocean module OPA (z-level, C-grid); ice module LIM2 (2 layers ice, 1 layer snow)
- Nominal 1-deg lat/lon; tri-polar configuration, finest resolution in Arctic/CAA; enhanced resolution in tropics
- Forcing: A daily climatology derived from ECWMF reanalysis; monthly river runoff; SSS restoration
- Bulk formulae also take NCEP reanalysis and hybrid NCEP+ECMWF forcing



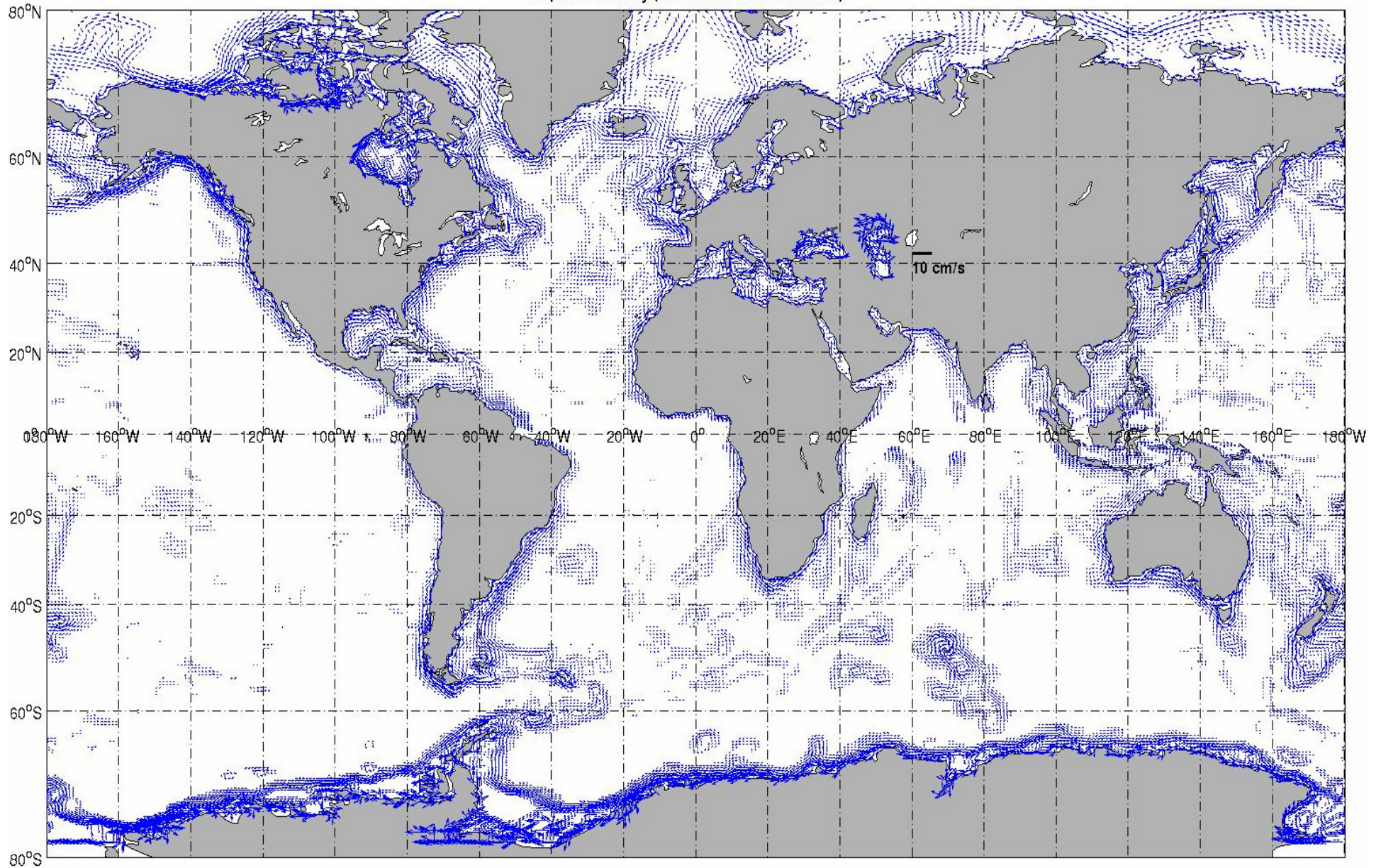
Parameterization of unresolved meso-scale eddies

- Neptune “topostress” (Holloway)
 - Representing eddy-topography interactions
 - Barotropic flow relaxed to a mean current along the direction of topographic Rossby wave propagation
- GM eddy mixing/advection (Gent and McWilliams)
 - Mixing along isopycnals (Laplacian)
 - Advection of tracers (T – S) by “bolus velocity”



Distribution of Neptune velocity

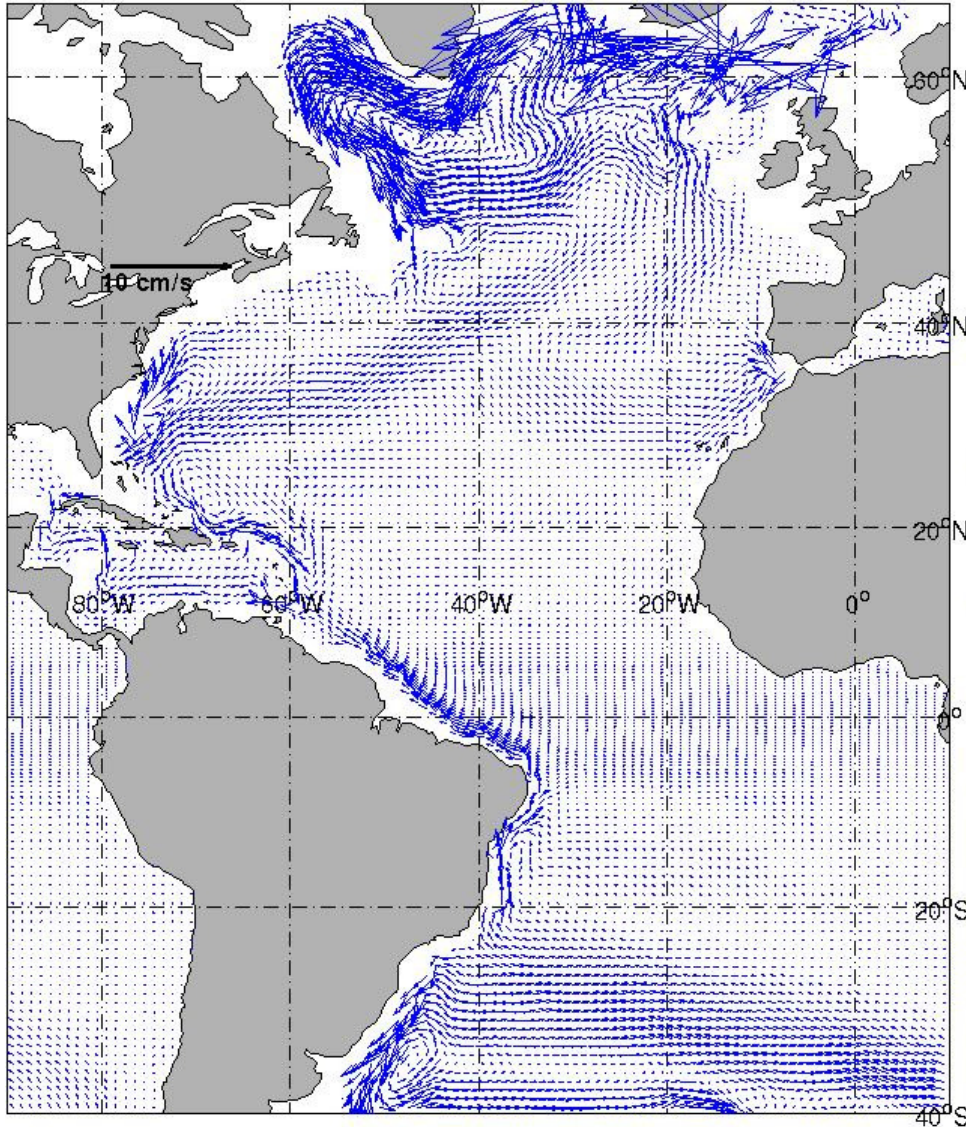
Neptune Velocity (not shown for $V < 0.006\text{m/s}$)



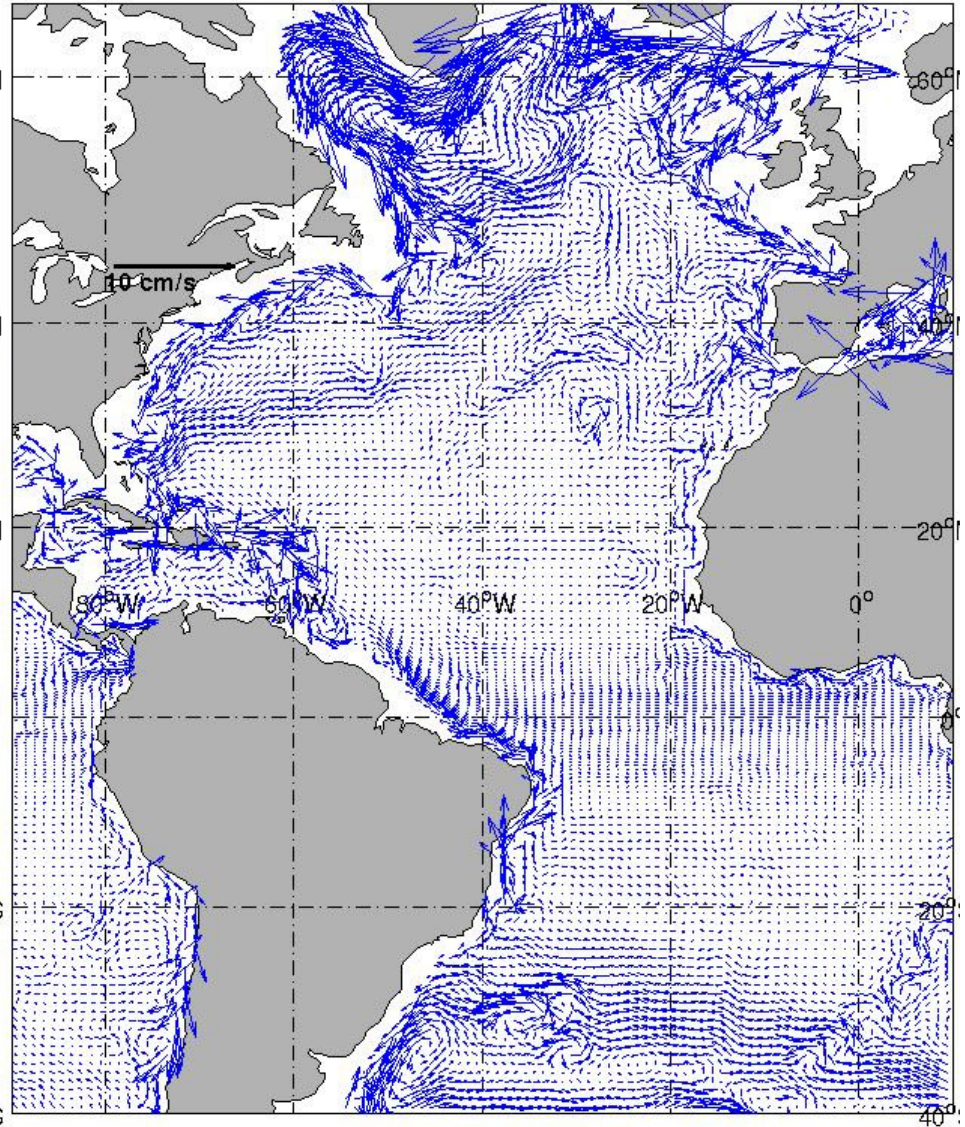
Impact of Neptune: Atlantic circulation

Atlantic 984m

No Neptune Depth: 984m



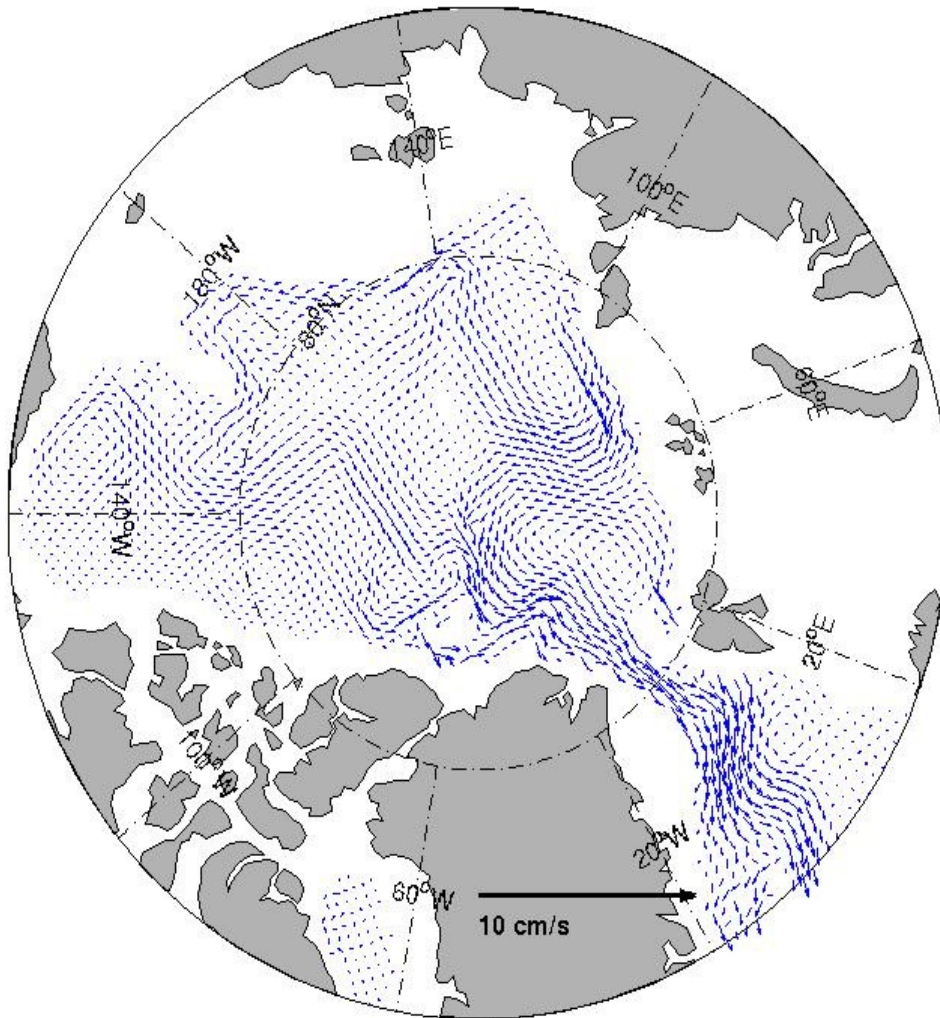
Neptune, Depth: 984m



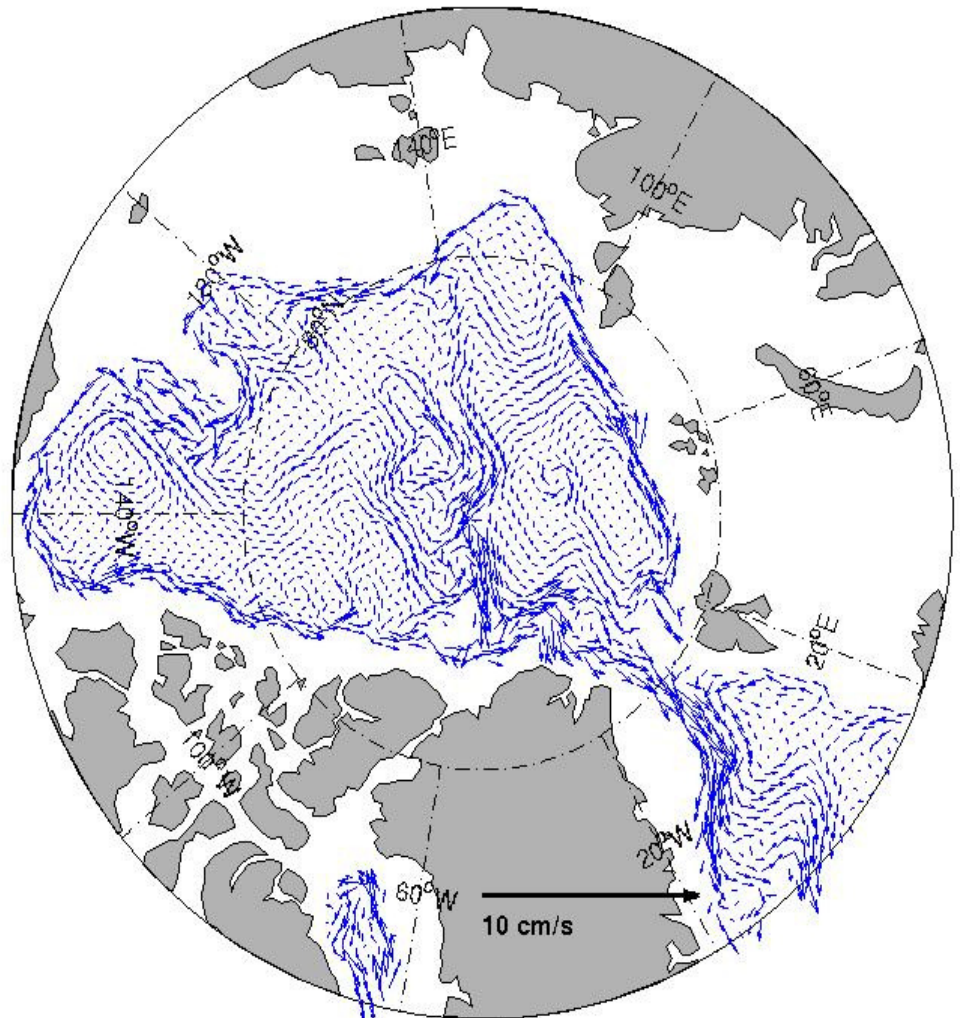
Impact of Neptune: Arctic circulation

Arctic 984m

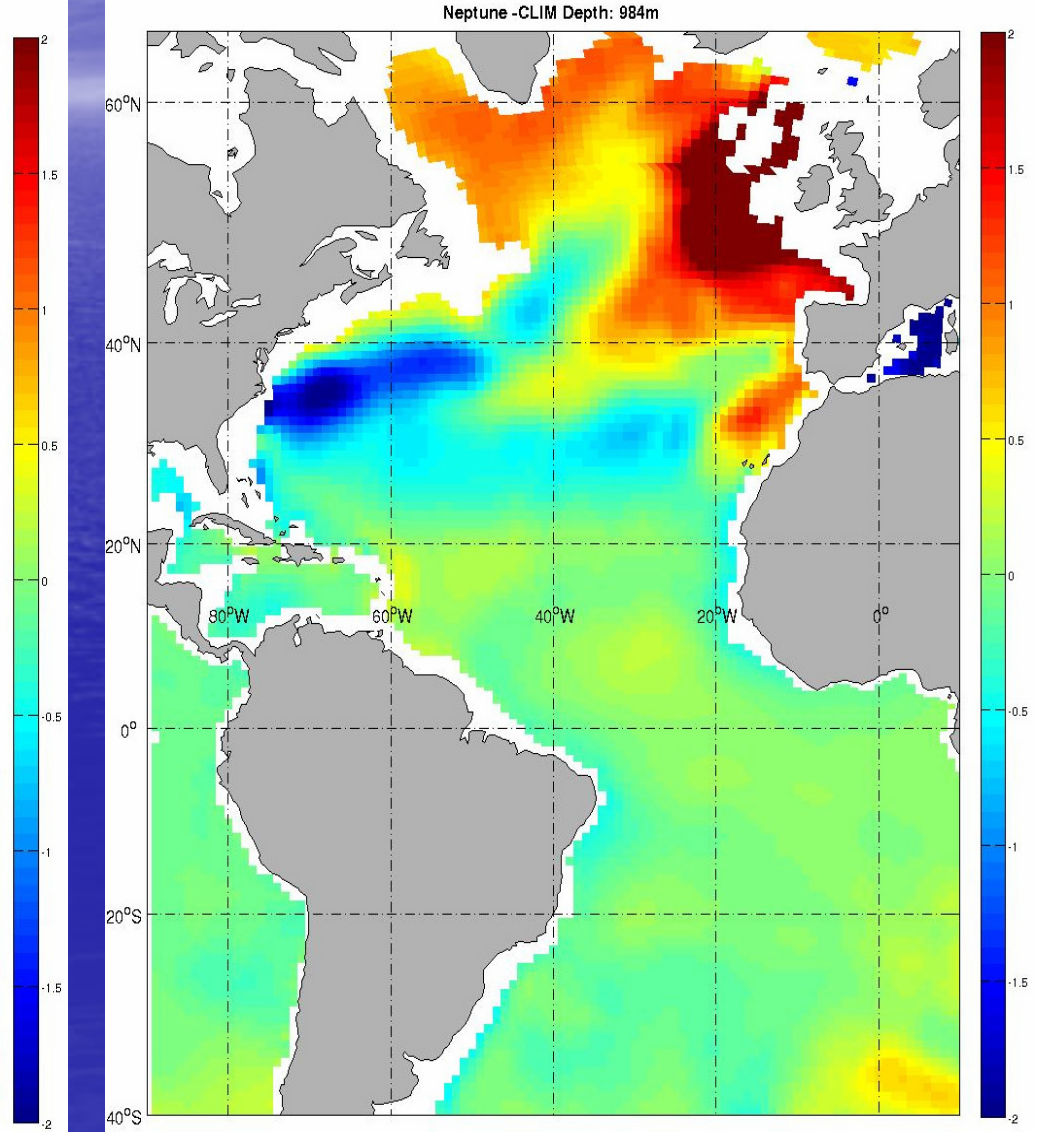
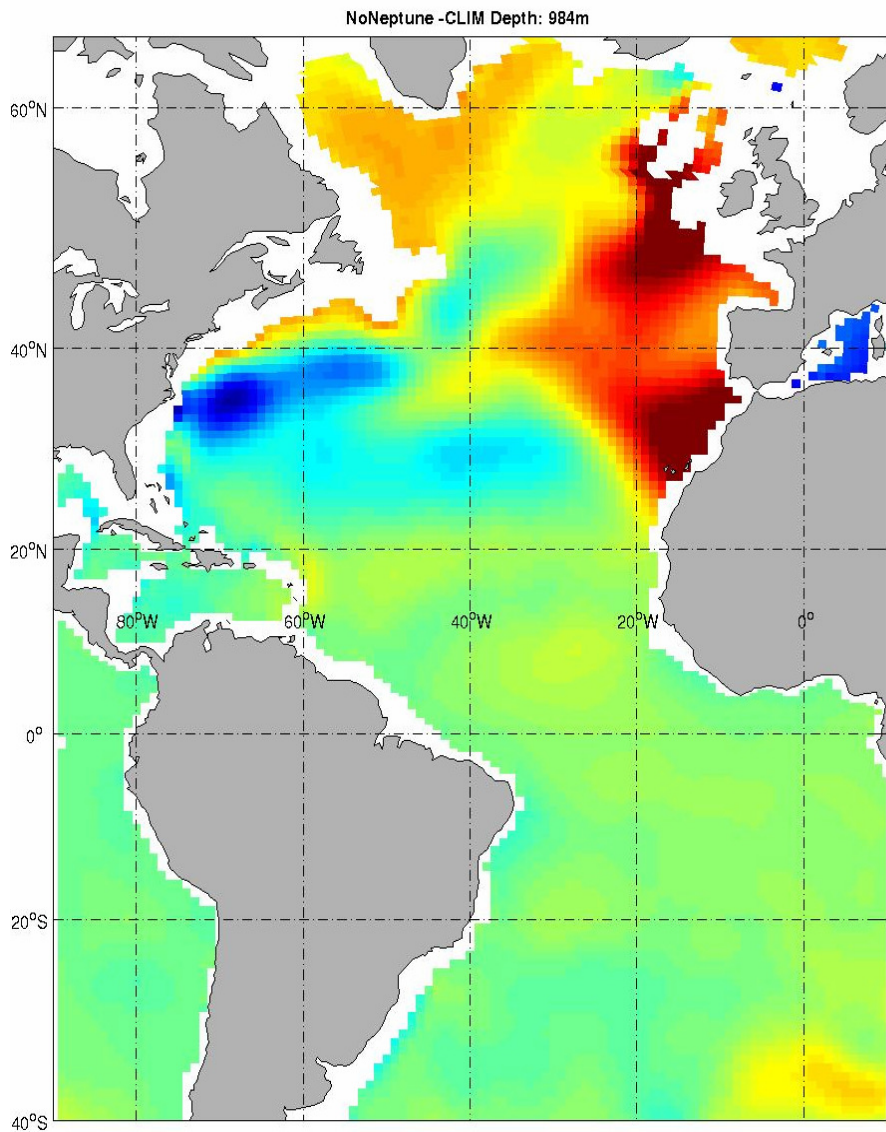
No Neptune, Depth: 984m



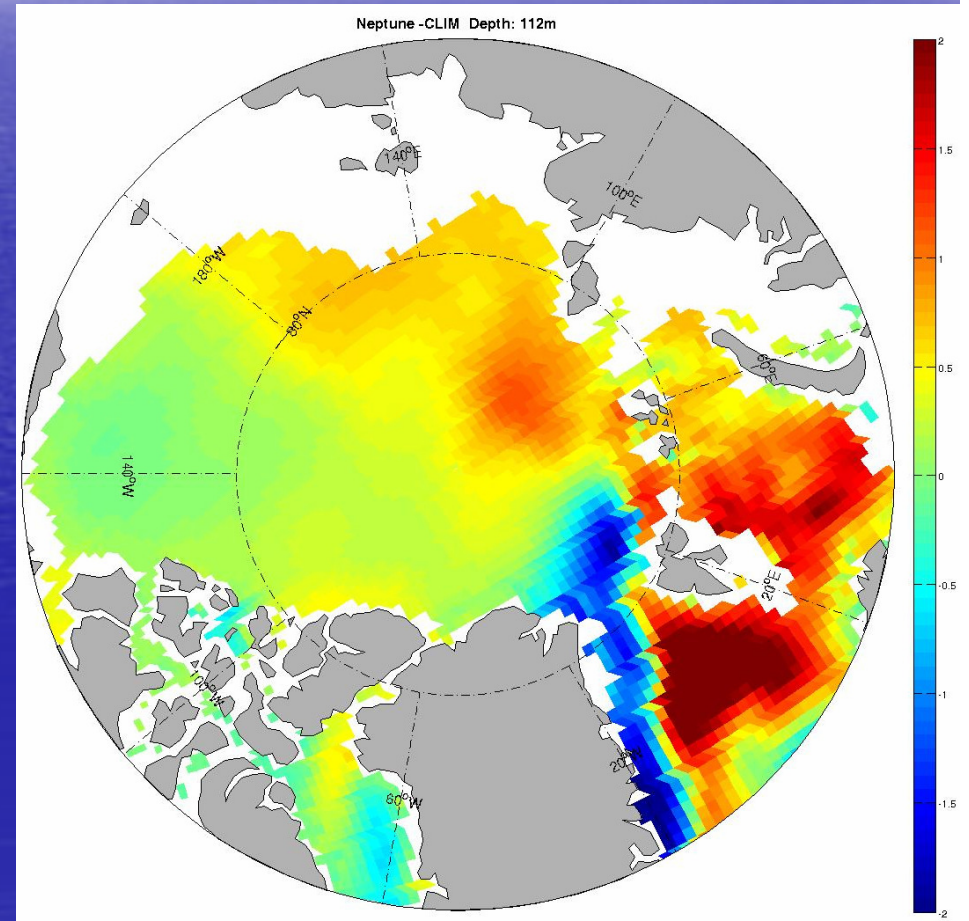
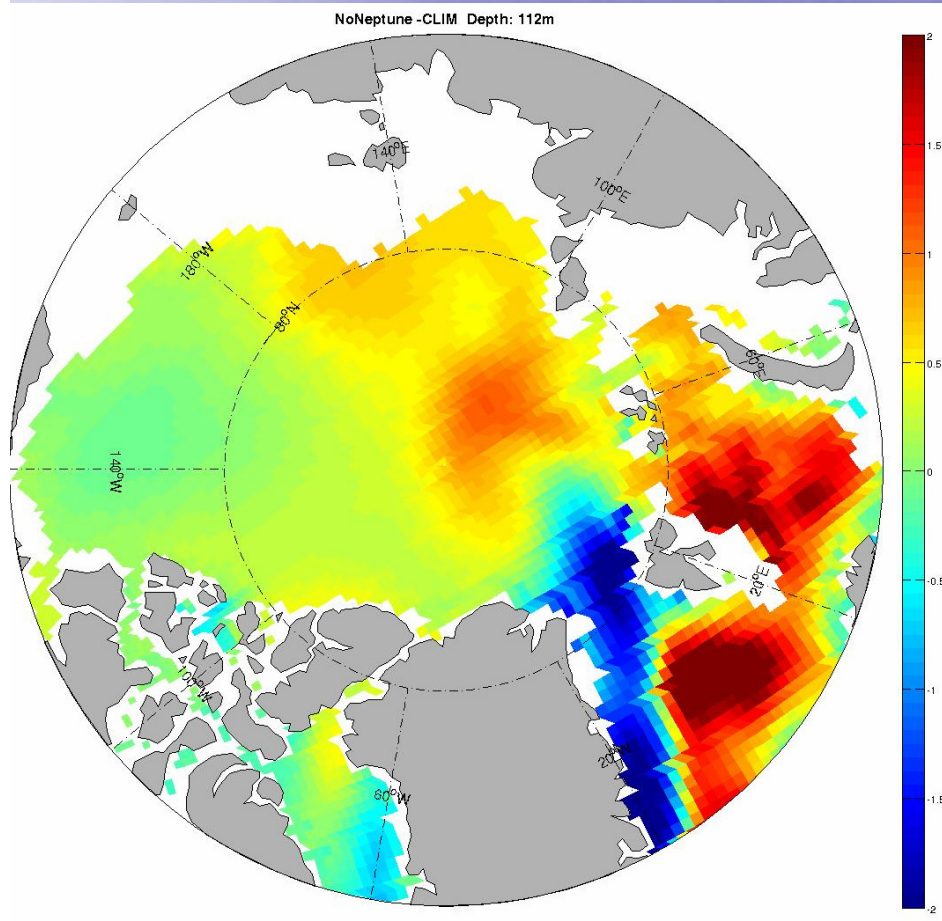
Neptune Depth: 984m



Impact of Neptune: Atlantic temperature distribution

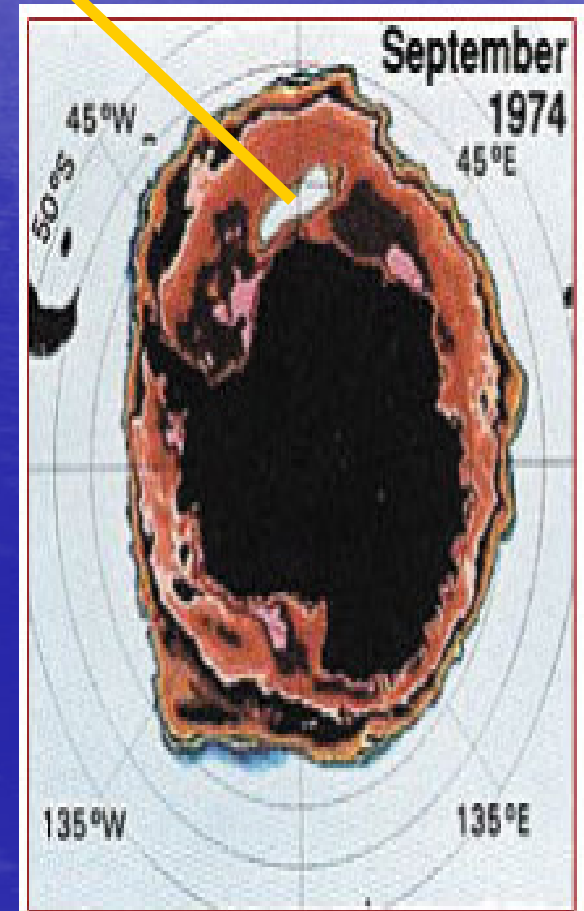
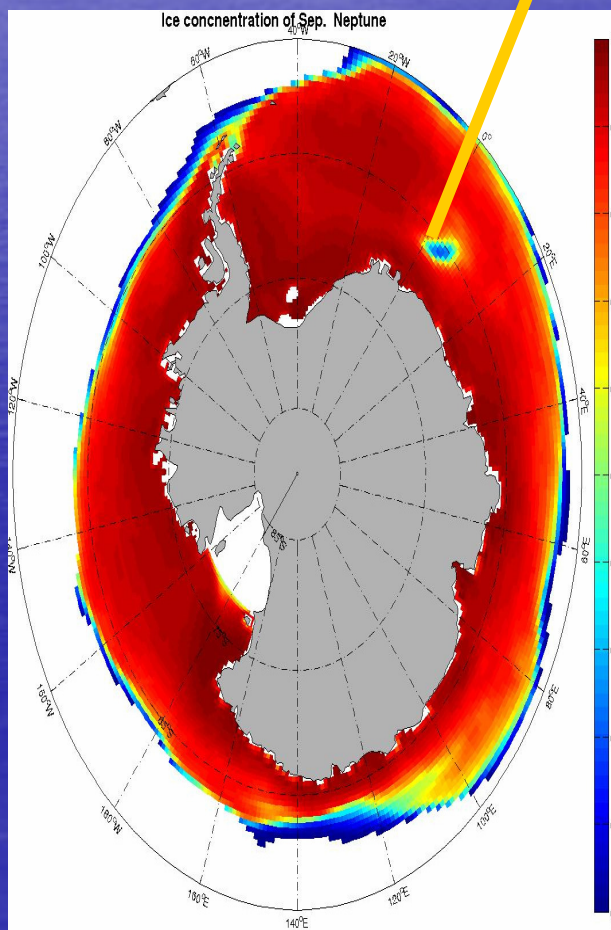
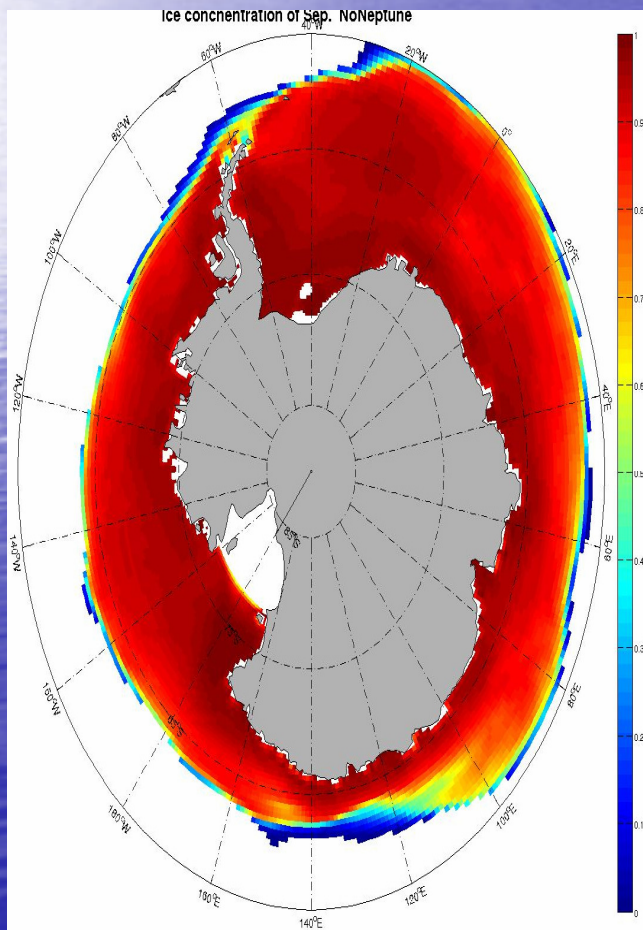


Impact of Neptune: Arctic temperature distribution



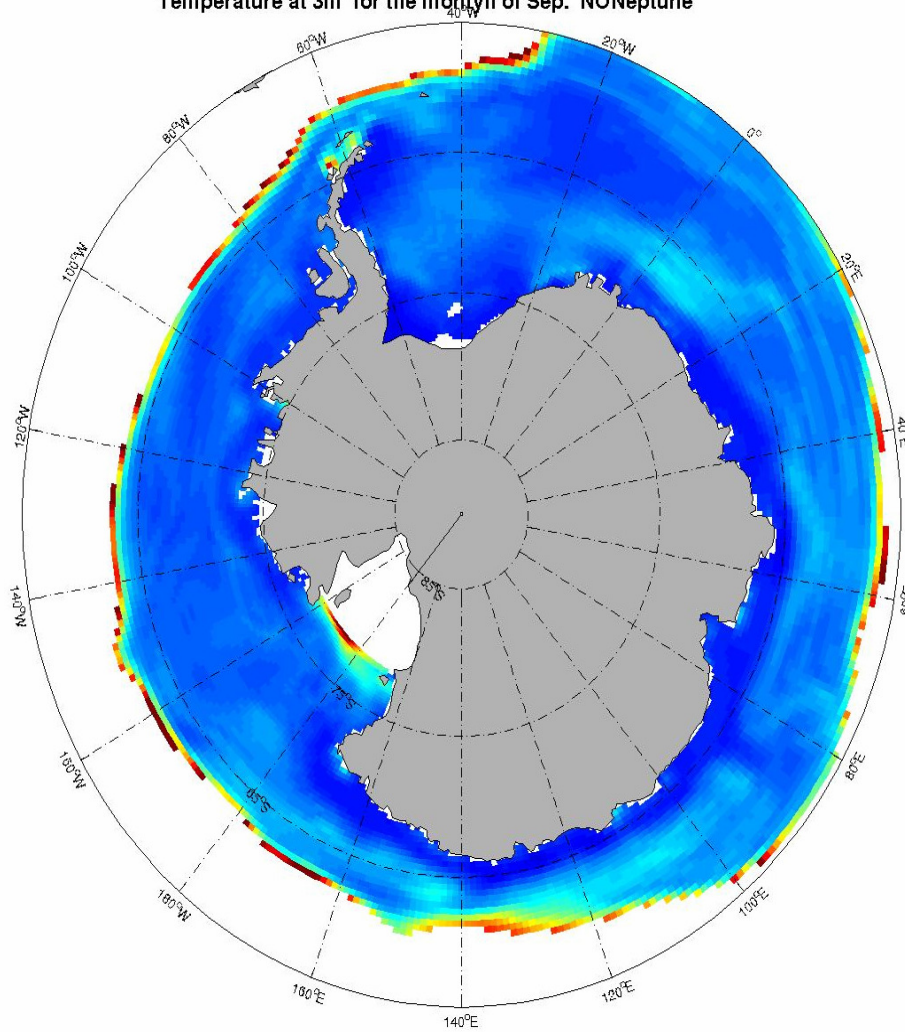
Impact of Neptune: Antarctic sea-ice concentration

The location of Maud Rise seamount

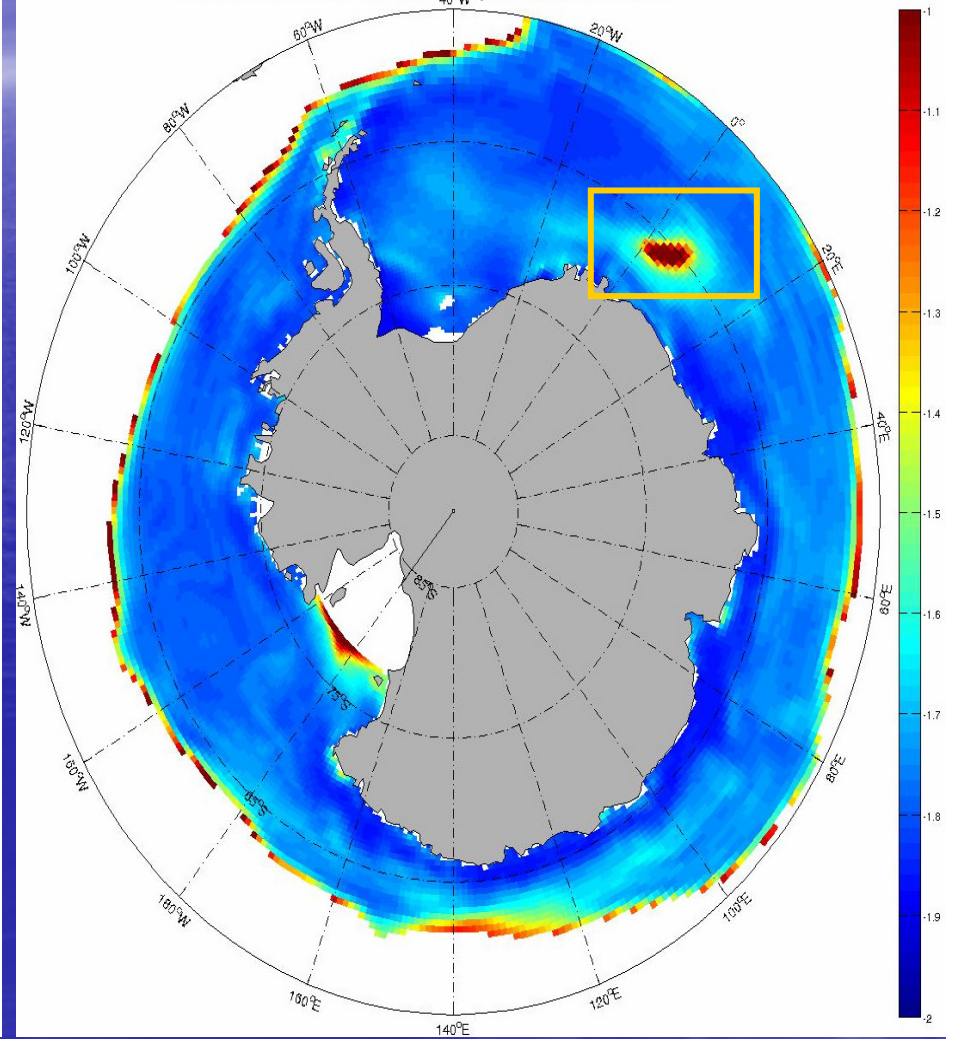


Impact of Neptune: Antarctic SST

Temperature at 3m for the month of Sep. NONeptune

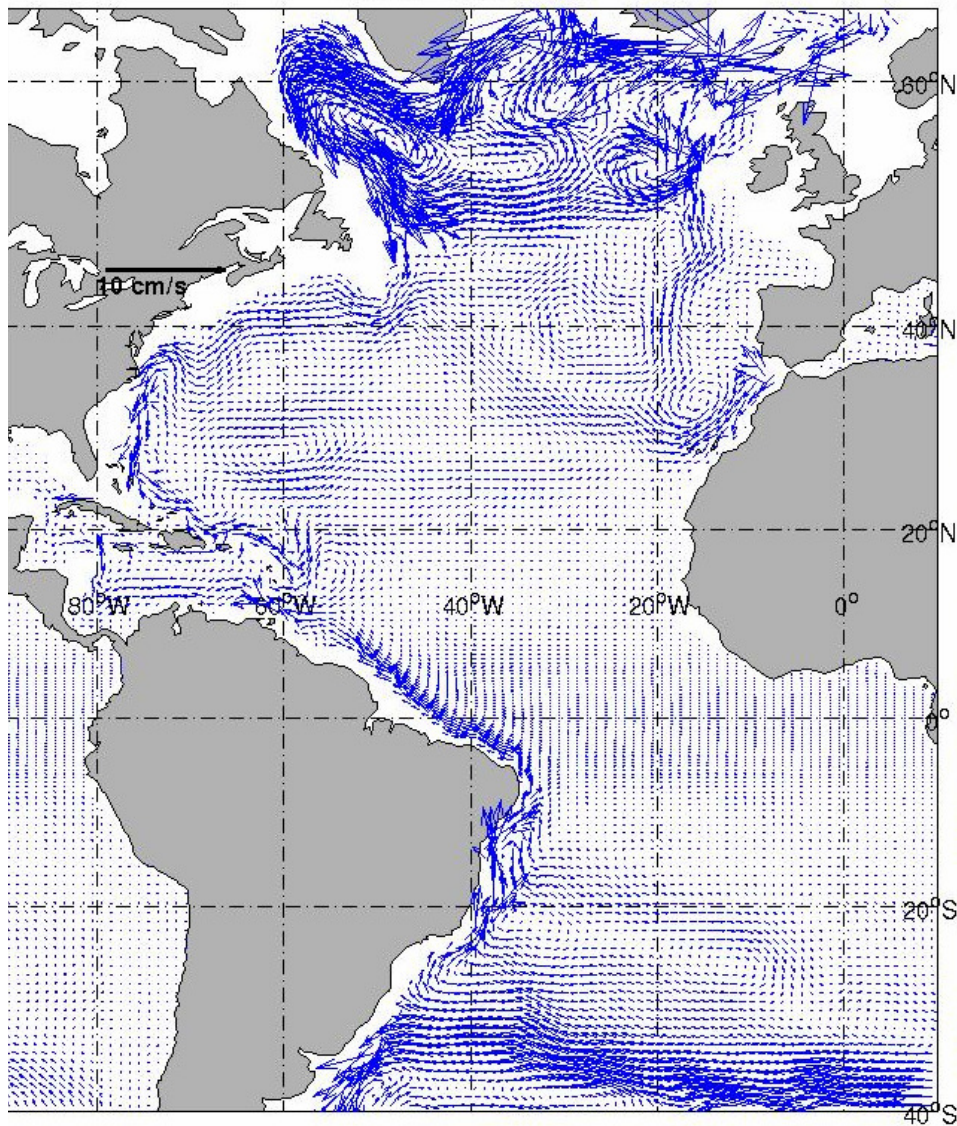


Temperature at 3m for the month of Sep. Neptune

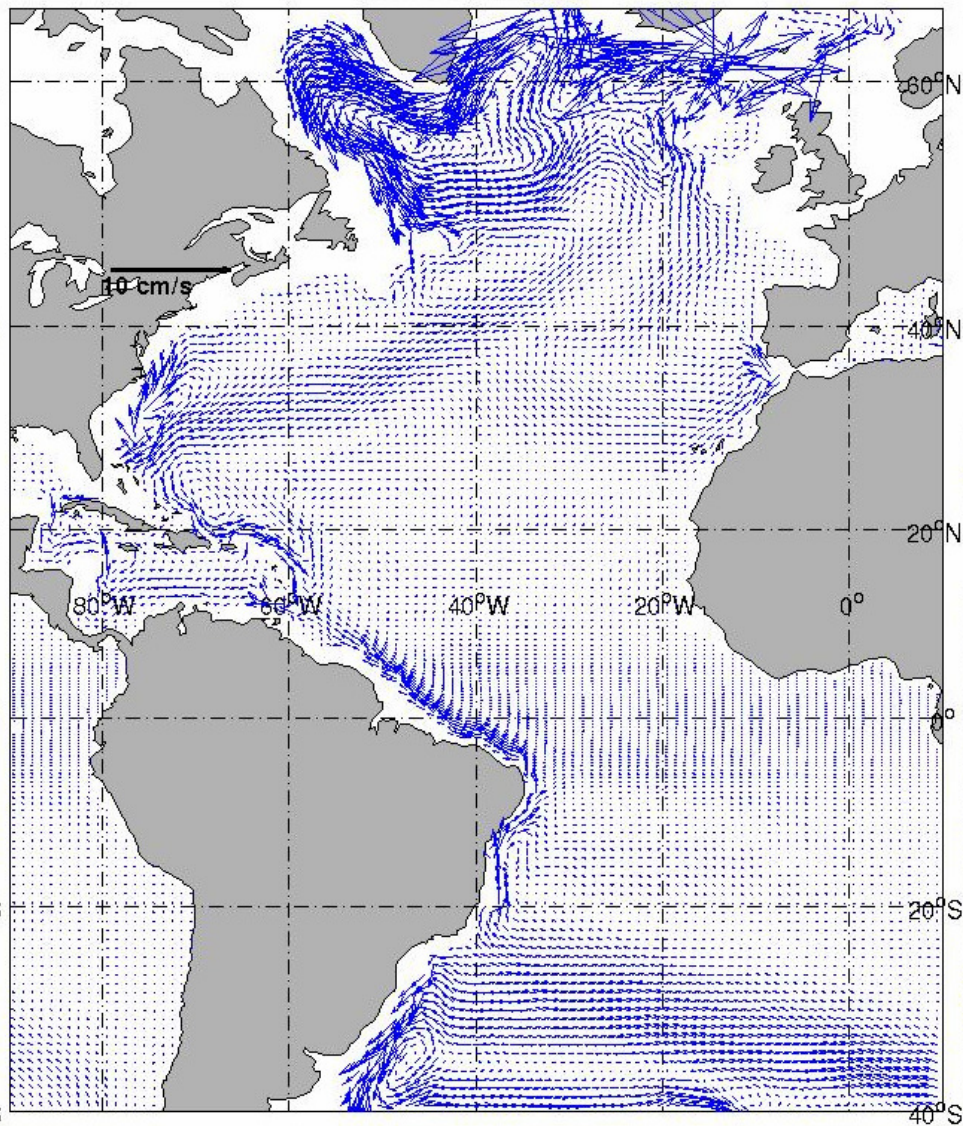


Impact of GM: Atlantic circulation

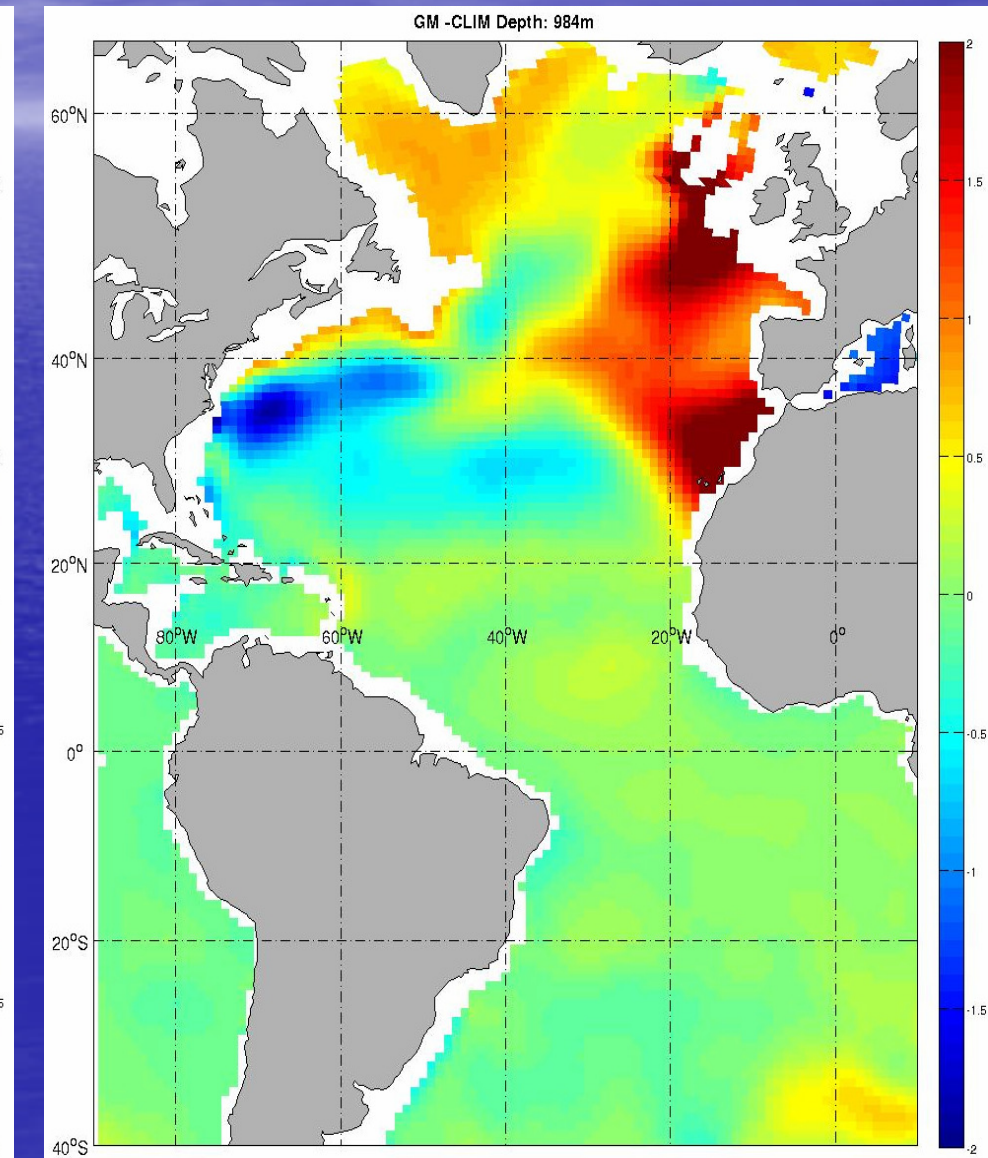
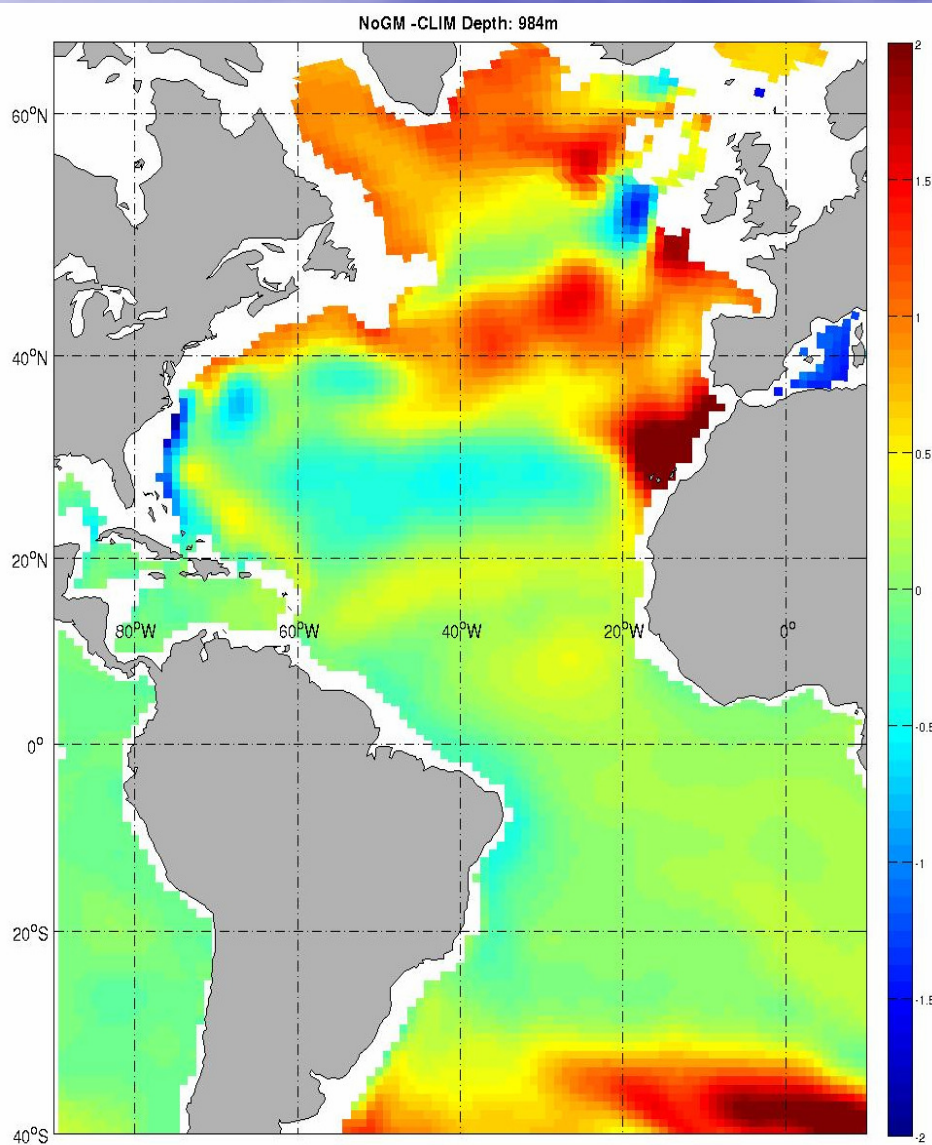
No GM Depth: 984m



GM, Depth: 984m



Impact of GM: Atlantic temperature



Assessment of global model

define (Holloway)

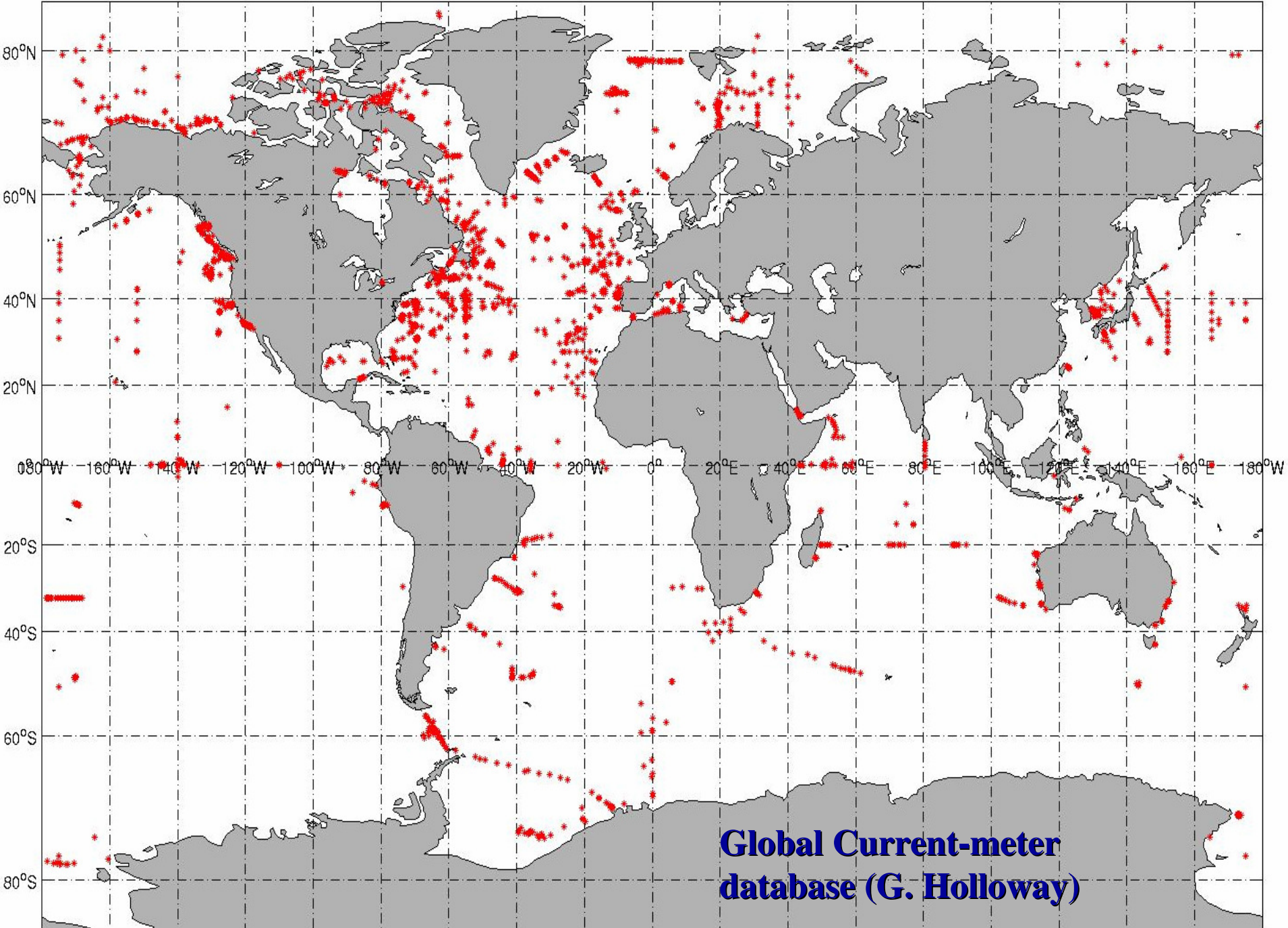
$$\tau = \frac{f \times V \cdot \nabla H}{\sqrt{|f \times V|^2 |\nabla H|^2}}, \tau \text{ is topostrophy}$$

$$\text{skill}_{\text{current}} = 1 - \frac{|\tau_{\text{obs}} - \tau_{\text{mod}}|}{|\tau_{\text{obs}}|}$$

$$\text{skill}_{\text{temperature}} = 1 - \sqrt{\frac{(T'_{\text{obs}} - T'_{\text{mod}})^2}{(T'_{\text{obs}})^2}} \quad T' = T - \bar{T} \quad \text{The skill is a function of depth}$$

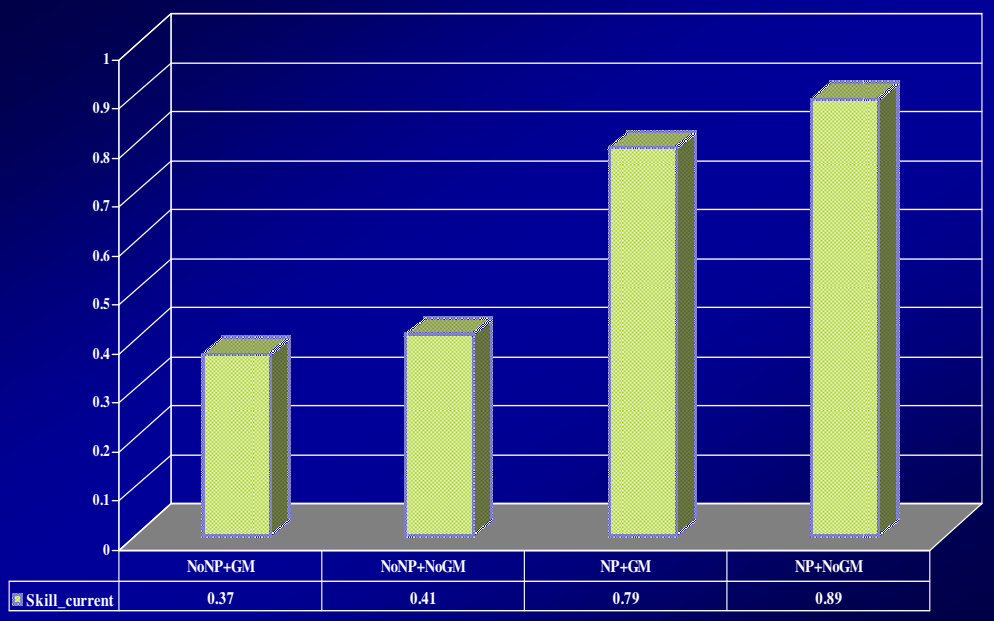
Skill=+1 good ; Skill=0 bad ; Skill <0 worse

Currentmeter Stations

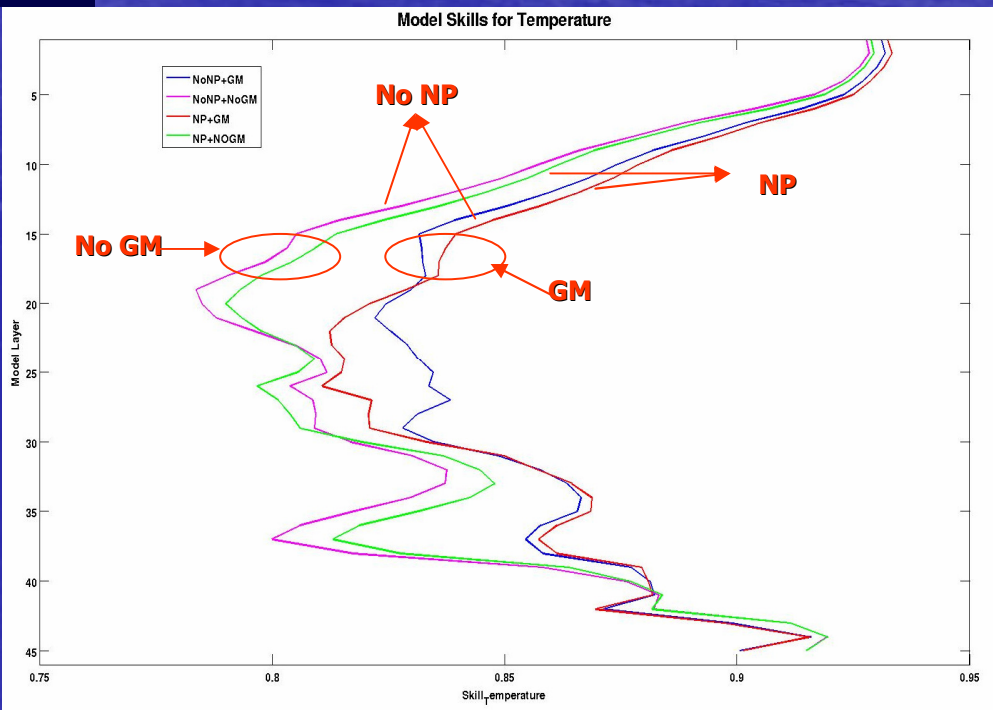


**Global Current-meter
database (G. Holloway)**

Model Skills for Current



Model Skills for Temperature



- NP = Neptune
- NoNP = Neptune is not used in this case
- NoGM = GM is not used in this case

Conclusion and discussion

- Neptune brings global ocean circulation closer to observations.
- Overall, GM reduces temperature biases. Neptune can also help reduce temperature bias.
- GM flattens isopycnals. This leads to a weaker and more diffusive Gulf Stream.
- Spatially non-uniform GM parameters (Visbeck, 1997) will be implemented.

The background is a blue gradient with a horizon line. The top half shows a lighter blue sky with wispy white clouds, and the bottom half shows a darker blue sea with gentle ripples. The text "Thank you!" is centered in the middle of the image.

Thank you!