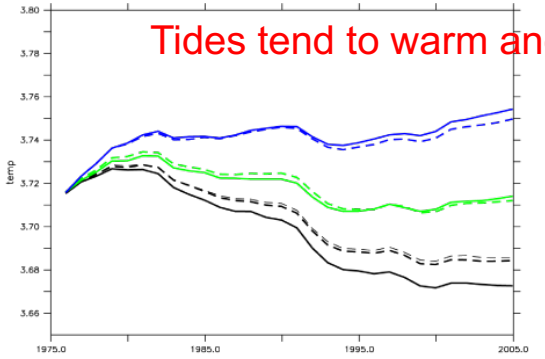
Preliminary diagnostics for GO8p1 tidal runs

This describes the experiments carried out under the CMEMS RENUMERATE project to test the sensitivity to z~ and tidal forcing.

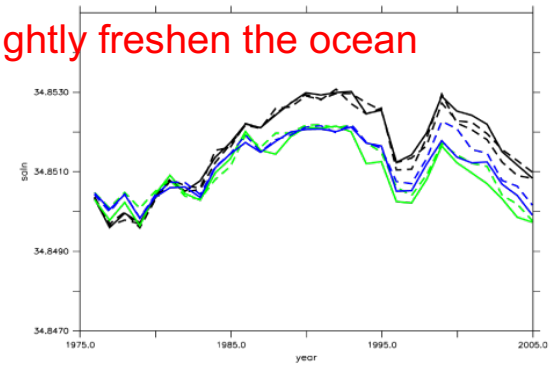
Suite Suite id	Vert coord	z~ domain	Min depth	Tides	Horiz tracer advection
u-ba208	z*	-	9 m	No	2
u-bm255	z~	Global	9 m	No	2
u-bf342	z*	-	23 m	Yes	2
u-bp703	z~	Off-Eq	23 m	Yes	2
u-bm759	z*	-	16 m	Yes	4
u-bm445	z~	Global	16 m	Yes	4

- All runs are forced with CORE2, and run from 1976 to 2005.
- Tidal forcing includes M2, S2, N2, K1 and O1 components
- I added 4th-order horizontal tracer advection ("FCT4H") to the final runs, as I had found that this also reduced numerical mixing.

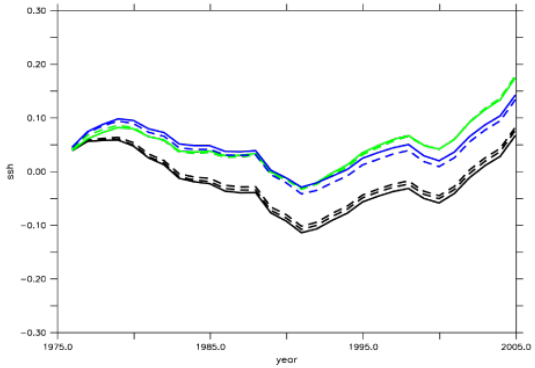
Tides tend to warm and slightly freshen the ocean



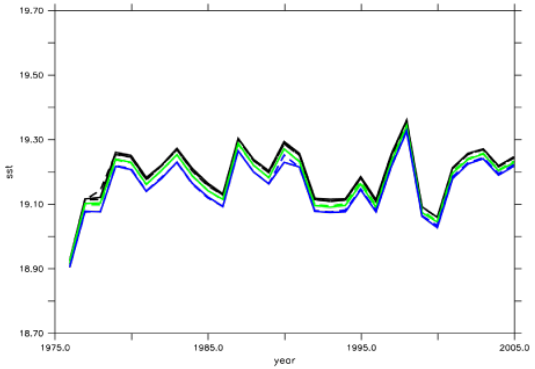
Temperature



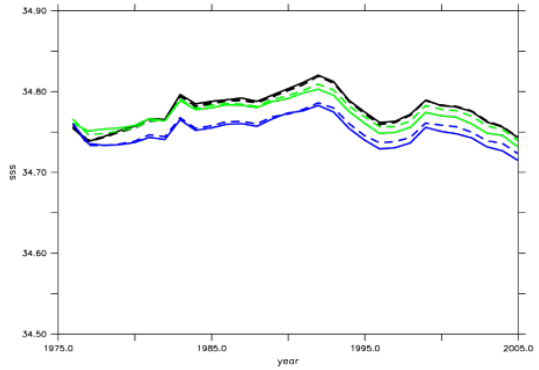
Salinity



SSH



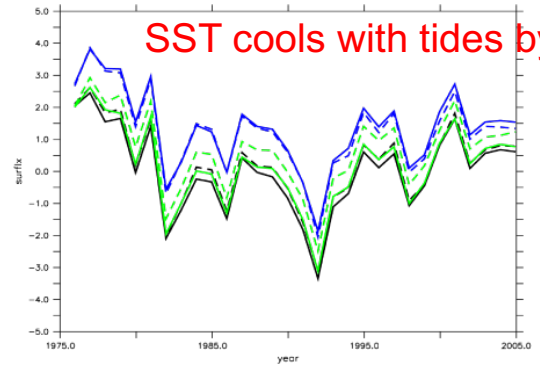
SST



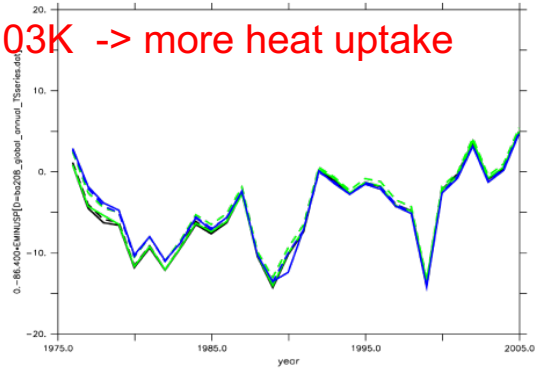
SSS

- No tides; z*
- No tides; z~ off Eq
- No tides; global z~
- Tides; z*; 23m min depth
- Tides; z~ off Eq; 23m min depth
- Tides; z*; 16m min depth; FCT4
- Tides; global z~; 16m min depth; FCT4

SST cools with tides by ~0.03K -> more heat uptake

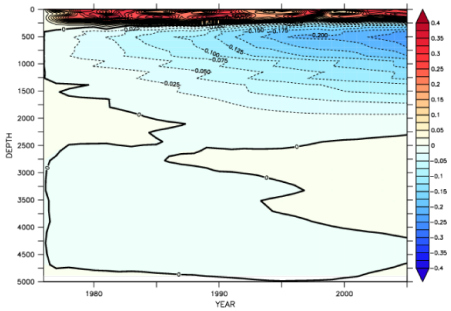


Downward heat flux

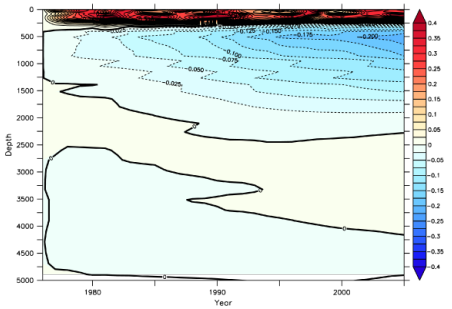


Downward FW flux

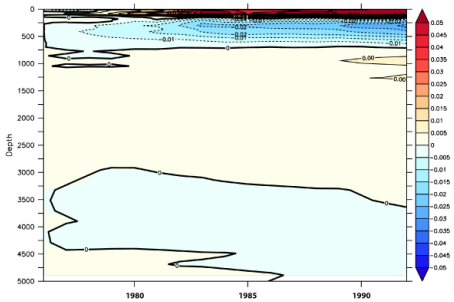
Global mean time series for RENUMERATE runs



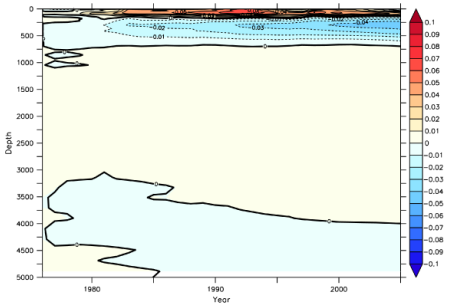
No tides; z*



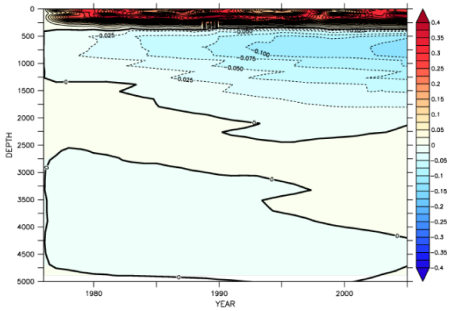
No tides; global z~



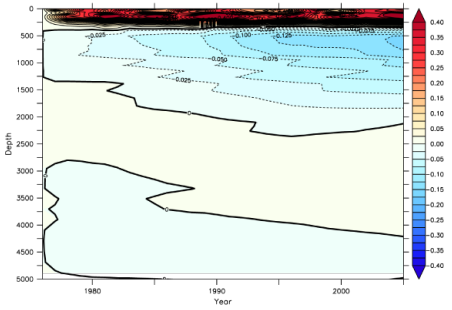
No tides; z*



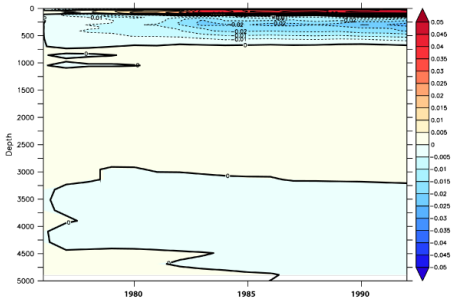
No tides; global z~



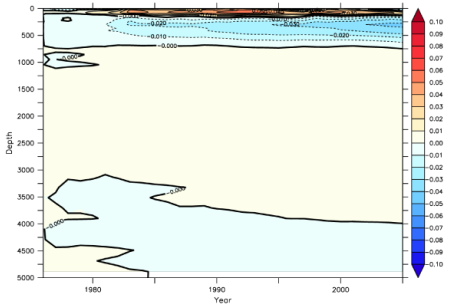
Tides; z*; min depth 23m



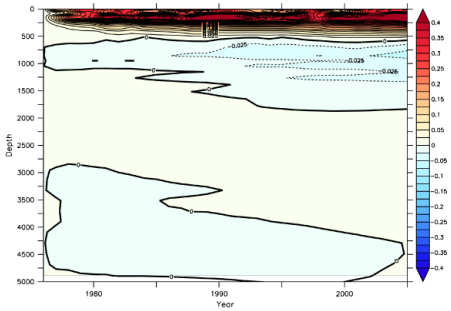
Tides; z~ off-Eq; min depth 23m



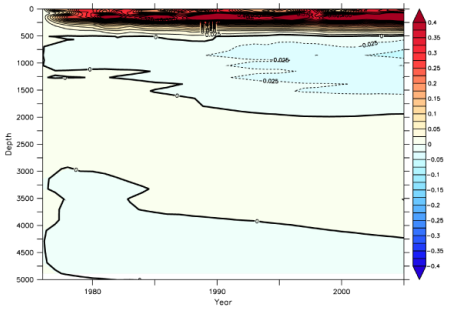
Tides; z*; min depth 23m



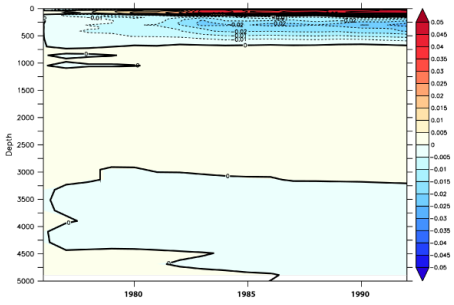
Tides; z~ off-Eq; min depth 23m



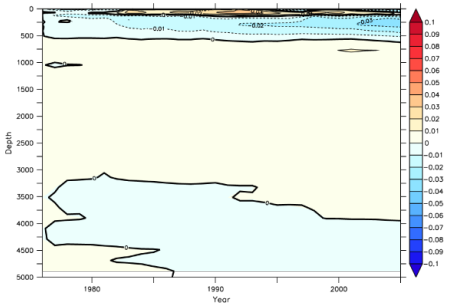
Tides; z*; min depth 16m



Tides; global z~; min depth 16m



Tides; z*; min depth 16m

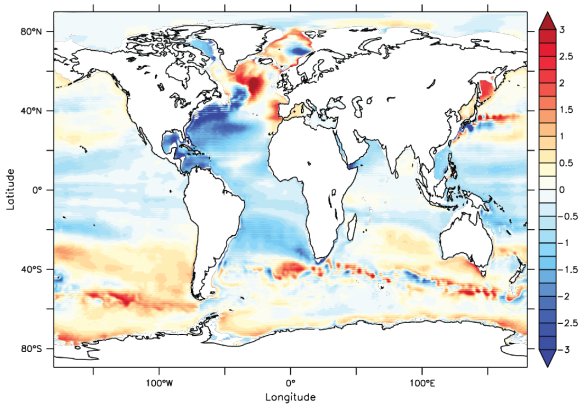


Tides; global z~; min depth 16m

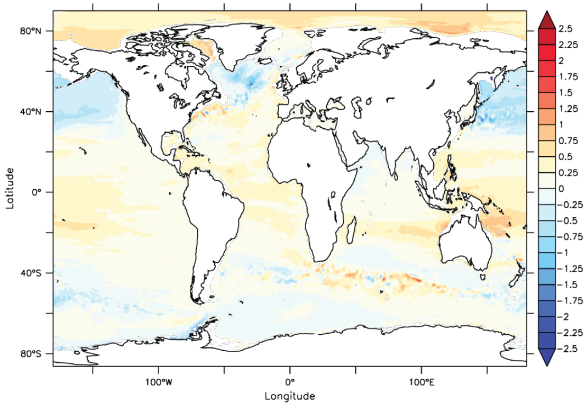
Temperature Tides tend to reduce T drifts

Salinity z~ tends to reduce S drifts

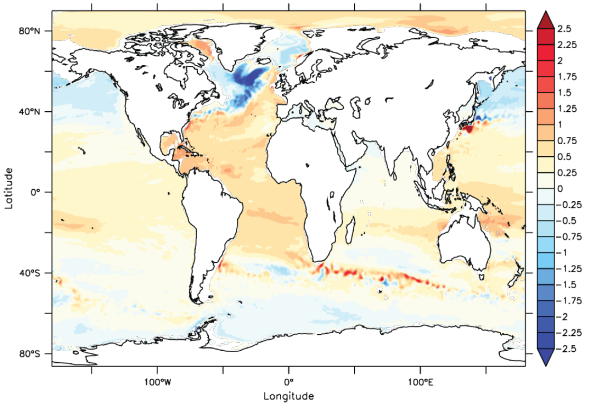
Global temperature and salinity drifts of GO8 tidal runs from first year



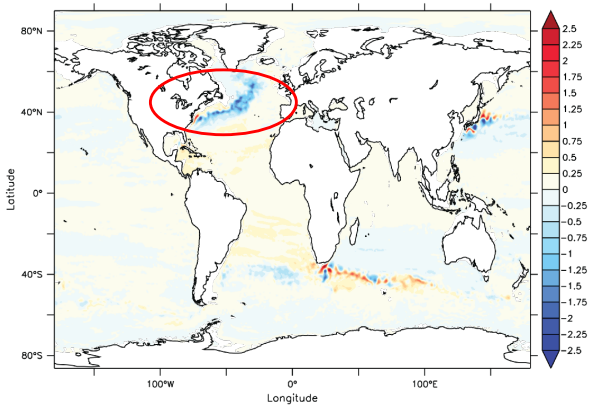
z*; no tides: bias wrt EN4



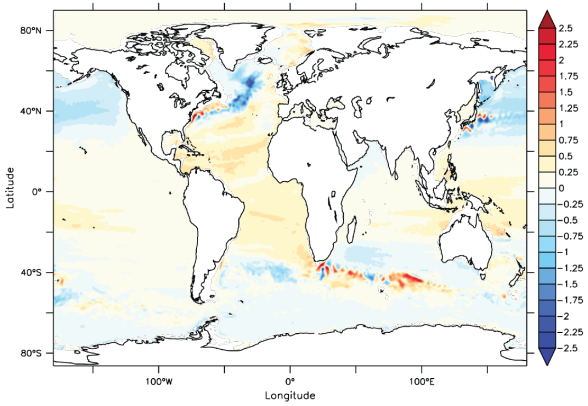
z*; tides



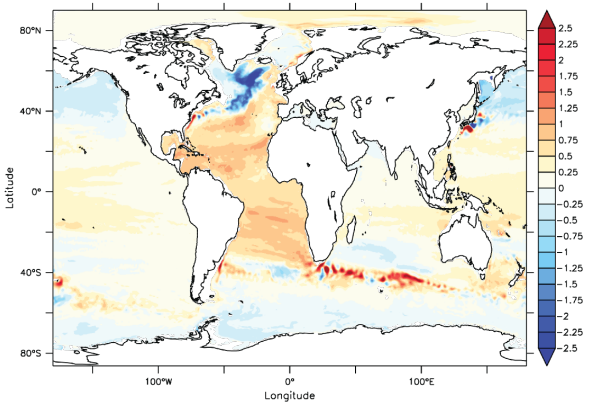
z*; tides and FCT4H



z~; no tides



z~ tides

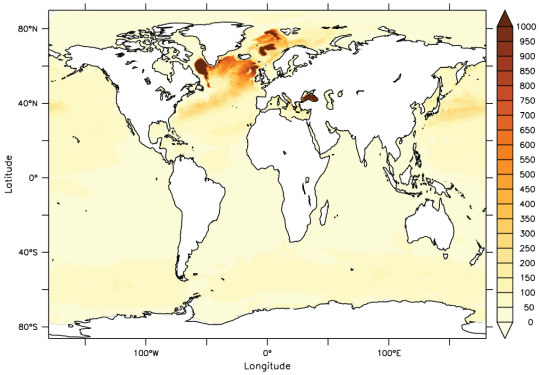


z~; tides and FCT4H

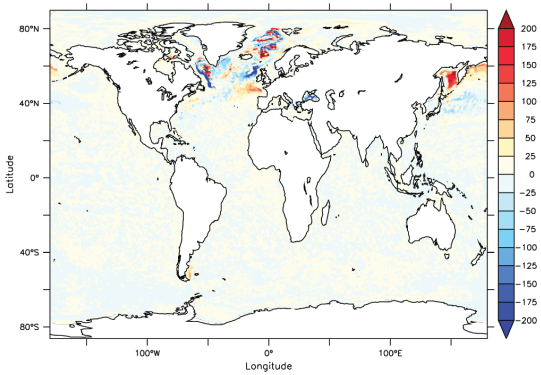
z~ tends to oppose biases (though note cold bias over NAC)

Tides plus z~ and FCT4H oppose biases even more

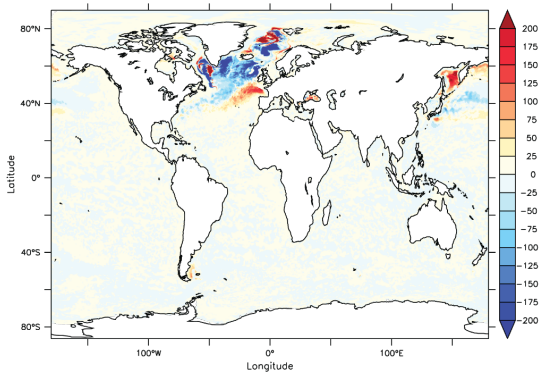
Mean temperature changes at 500 metres from the z* control (with the temperature bias with respect to EN4 at top left)



z*; no tides: MLD

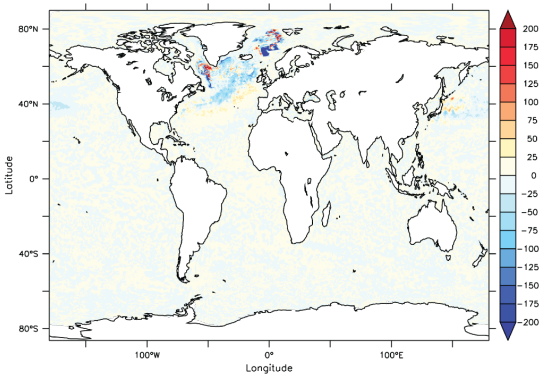


z*; tides

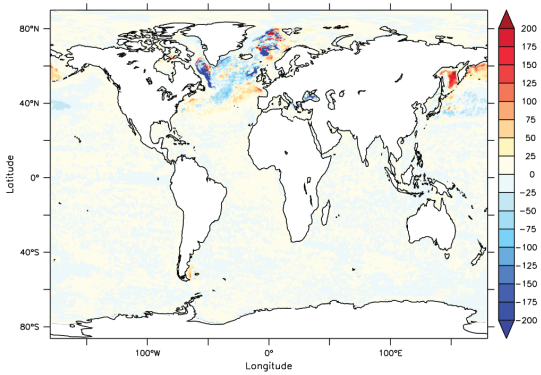


z*; tides and FCT4H

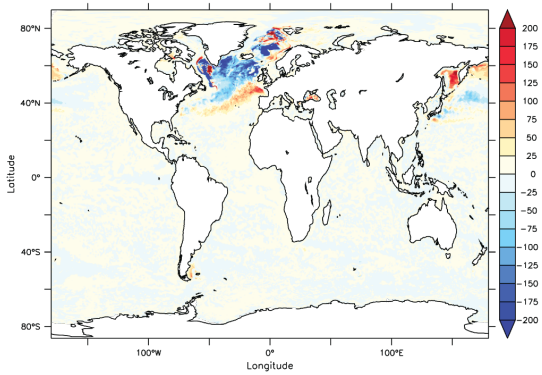
Tidal forcing tends to reduce MLD in North Atlantic



z~; no tides

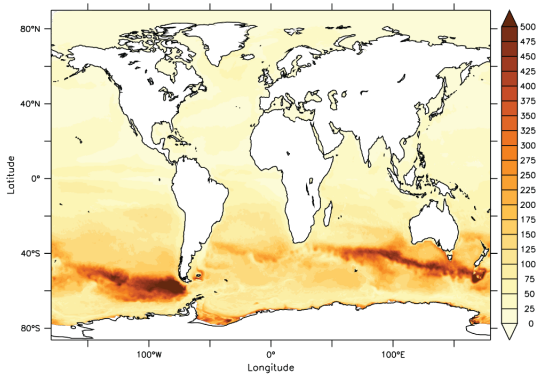


z~; tides

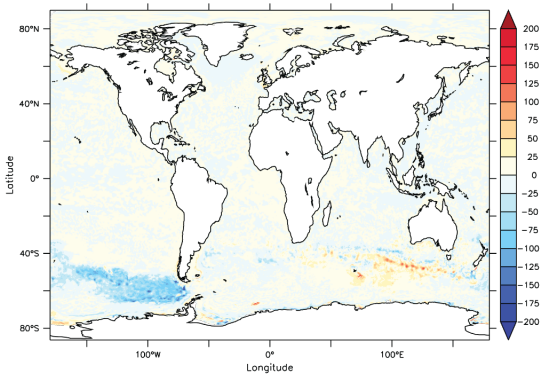


z~; tides and FCT4H

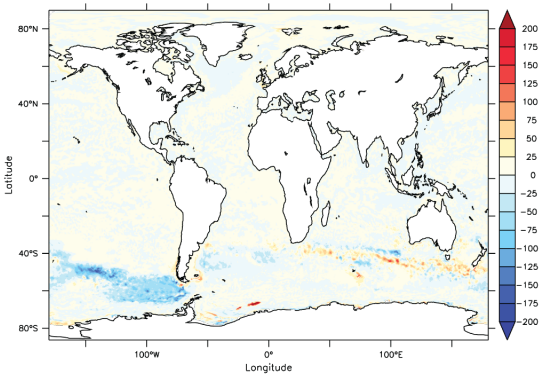
Difference of March mixed-layer depth from that in z* control



z*; no tides: MLD

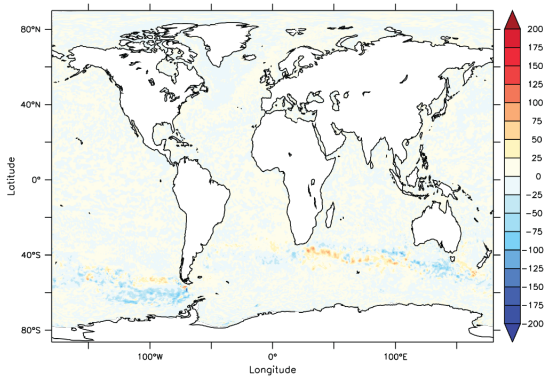


z*; tides

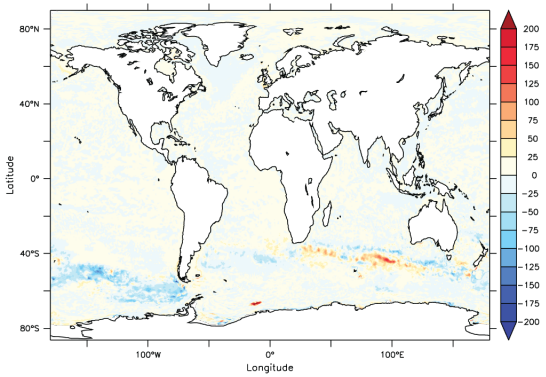


z*; tides and FCT4H

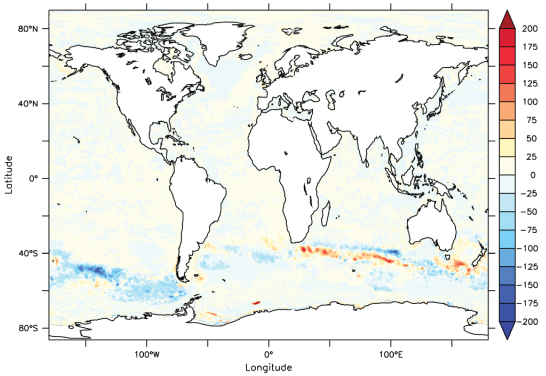
Tidal forcing tends to reduce MLD in Southern Ocean; z~ increases it again



z~; no tides

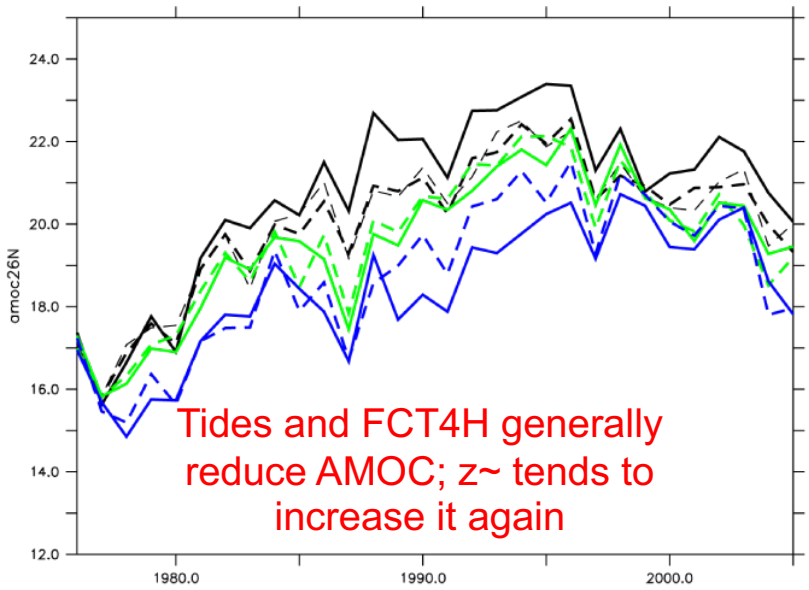


z~; tides



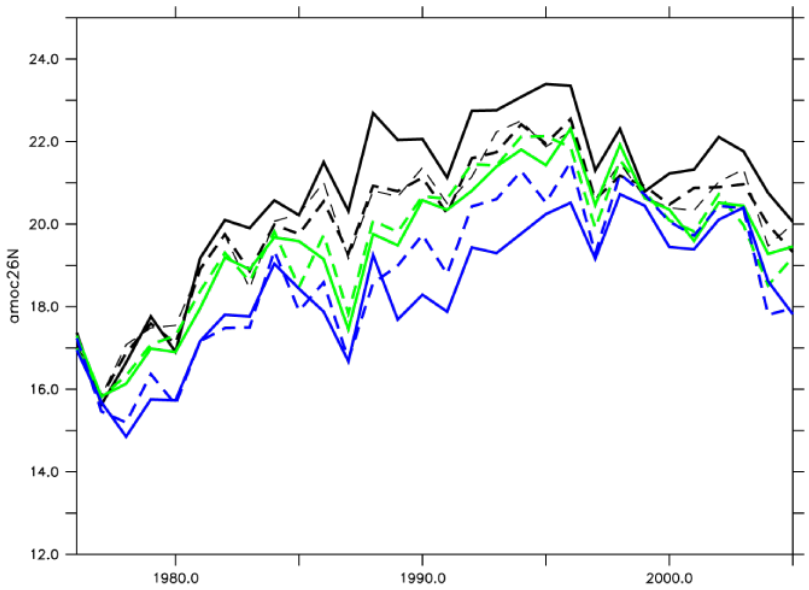
z~; tides and FCT4H

Difference of September mixed-layer depth from that in z* control

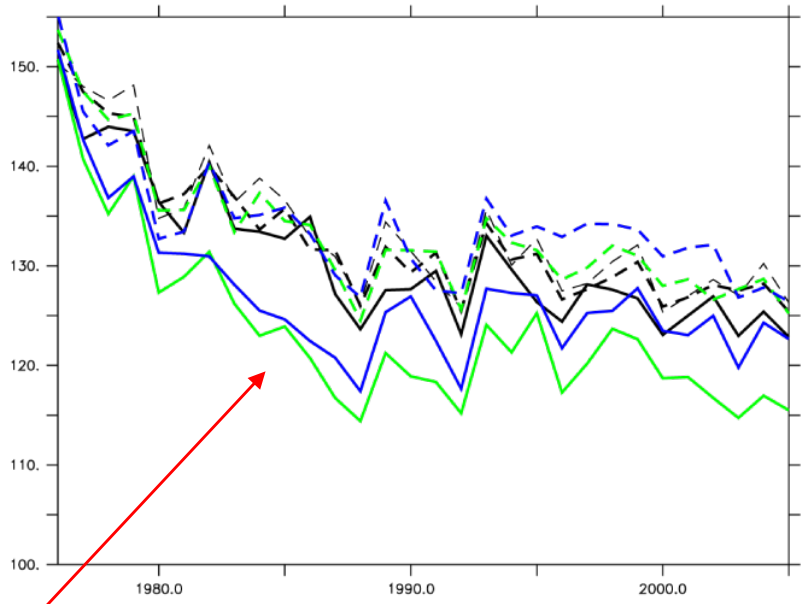


Tides and FCT4H generally reduce AMOC; z~ tends to increase it again

AMOC at 26°N



AMOC at 45°N



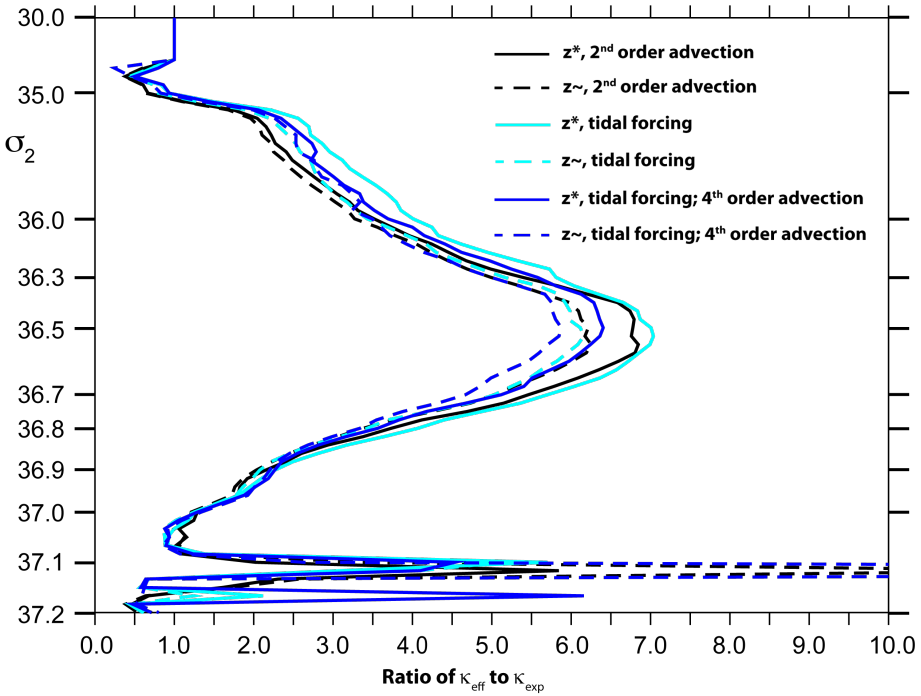
Drake Passage

Tides with z* have largest ACC spindown

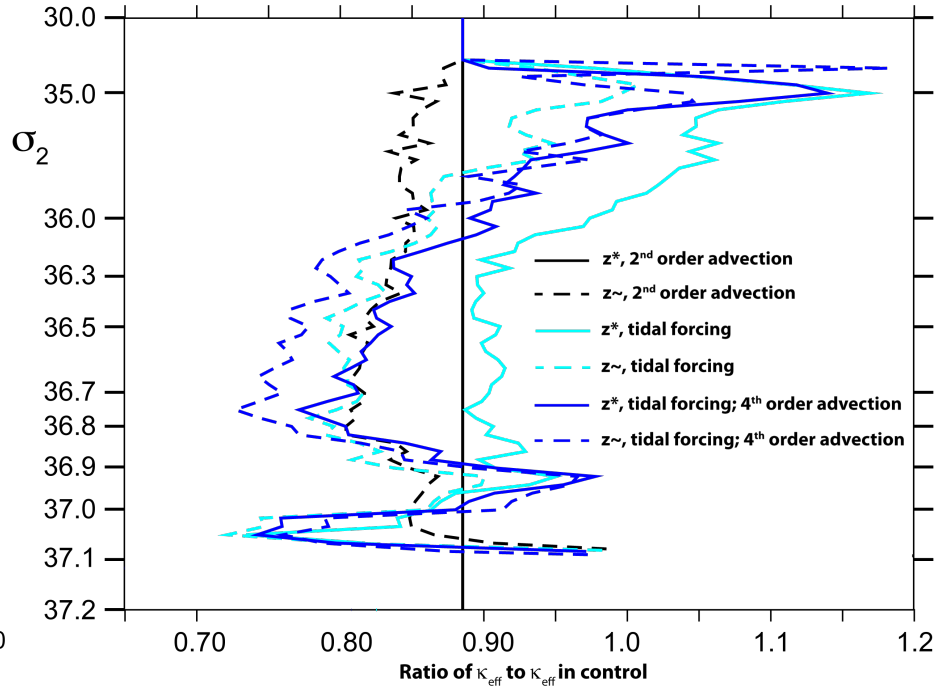
- **No tides; z***
- **No tides; z~ off Eq**
- **No tides; global z~**
- **Tides; z*; 23m min depth**
- **Tides; z~ off Eq; 23m min depth**
- **Tides; z*; 16m min depth; FCT4**
- **Tides; global z~; 16m min depth; FCT4**

Large-scale transports in RENUMERATE integrations

Effective diffusivity



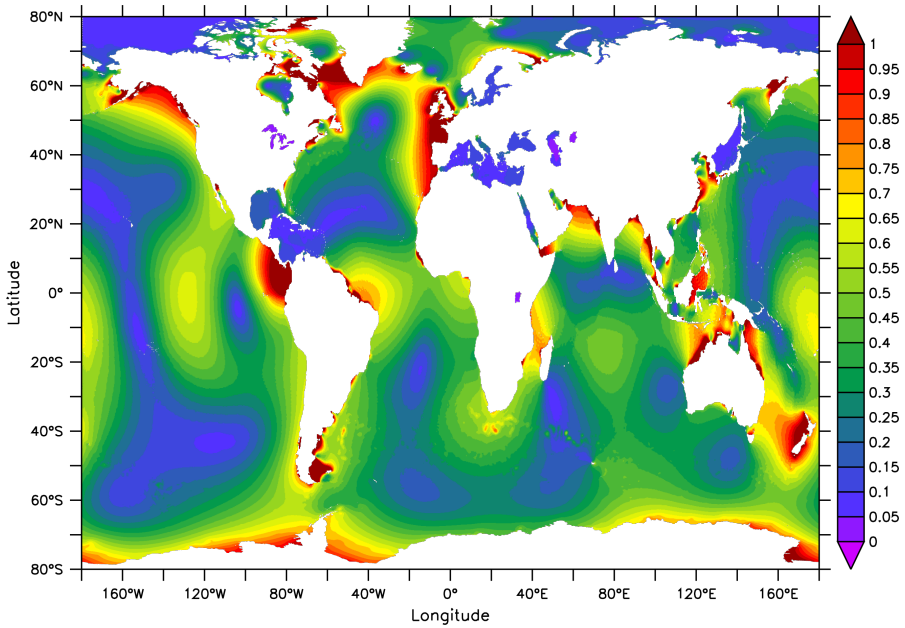
Ratio of effective diffusivity κ_{eff} to explicit diffusivity κ_{exp}



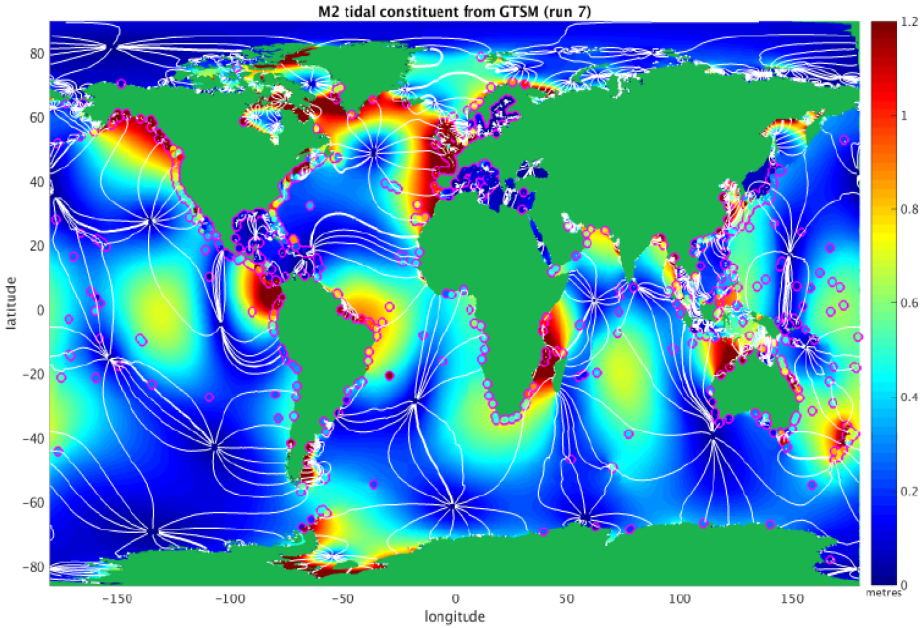
Ratio of effective diffusivity κ_{eff} to κ_{eff} in z* control

- Tidal forcing tends to increase κ_{eff}, especially at lighter densities
- z~ tends to reduce κ_{eff} in all density classes relative to z*…
- … but does not completely remedy the numerical mixing by tides at lower densities.
- 4th-order horizontal advection further reduces numerical mixing

Barotropic tide

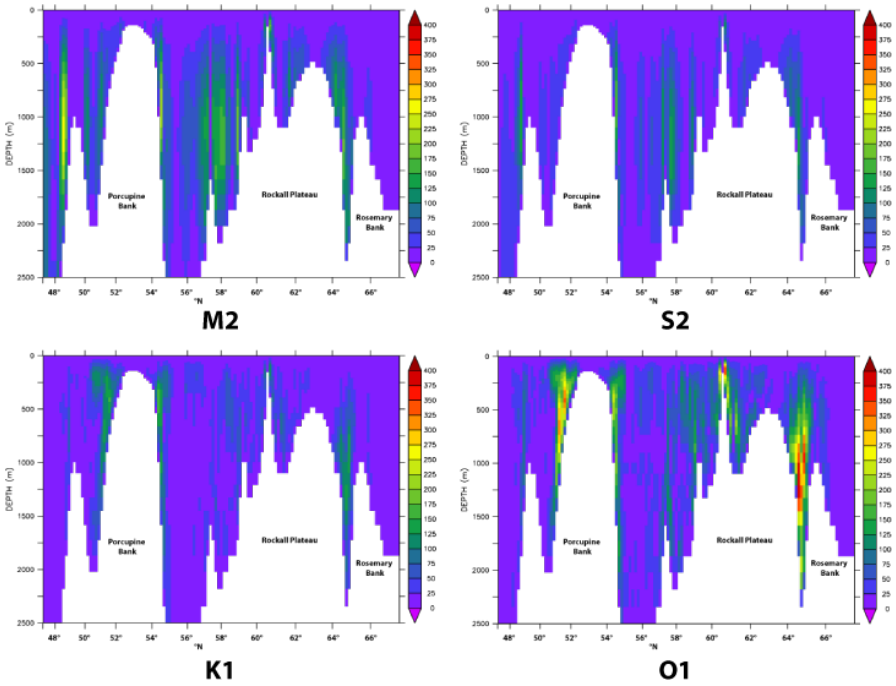


RMS hourly surface elevation excursion from the mean (metres) over three months in tidally-forced z* simulation

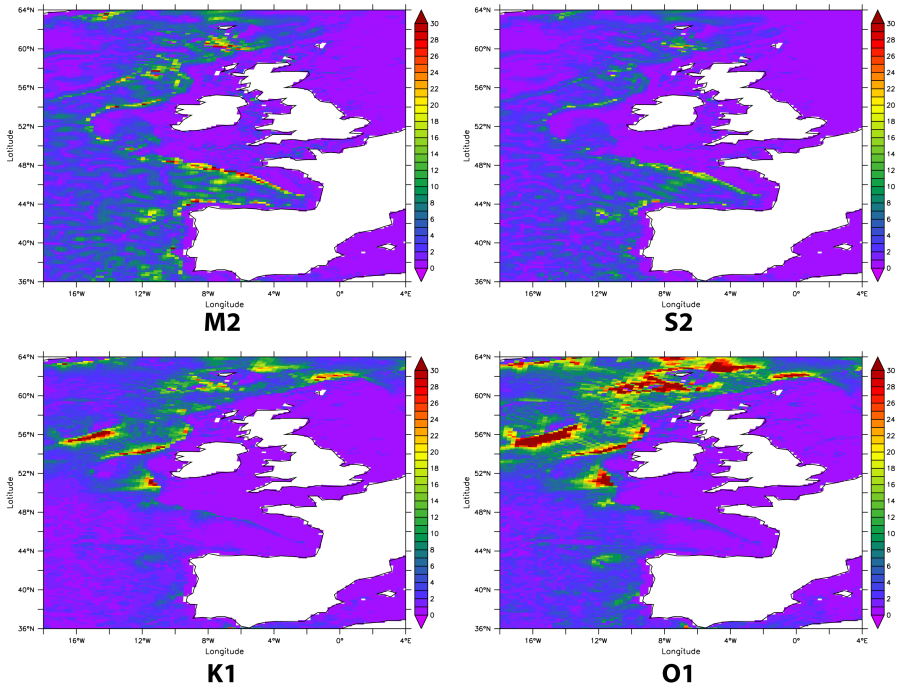


M2 amplitude in GESLA analysis

Internal tides



Tidal velocities (in m/day) on a north-south section in the North Atlantic at ~12°W



Vertical amplitude (in metres) of tidal harmonics in the north-east Atlantic

Clear that wavelength of internal tide in eORCA025 is close to grid size