Flow Separation

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1 Initializing the MITgcm

1.1 Test files

A standard 2D grid of dimensions 100×1km was introduced in the x-z plane. Hyperbolic tangent topography was generated which had an extent of 50m in depth in the west to 1000m of depth in the east. A linear temperature profile was introduced; the surface was fixed at 14°C, and the lowest layer was fixed at 2°C. Boundary conditions were set on the west side for an inflow of $U(x = 0, z, t) = 1$m/s, $T(x = 0, z, t) = 14$°C. The flow of 1m/s would typically reach the shelf break after 1 day.

1.2 Adjusting the `data` parameters for numerical stability

The MITgcm was run serially on Snapper at varying resolutions on a 2D grid. The data file was initially stripped to the bare essentials and then modified to determine which lines were necessary. Initially, the file consisted simply of:

```
# Model parameters
# Continuous equation parameters
 &PARM01
 tRef=14.,
 sRef=30.,
 no_slip_sides=.TRUE.,
 no_slip_bottom=.TRUE.,
 viscAh=1E-2,
 viscAz=1E-2,
 f0=1E-4,
 beta=0.E-11,
 tAlpha=2.E-4,
 sBeta=7.4E-4,
 gravity=9.81,
 readBinaryPrec=64,
 nonHydrostatic=.FALSE.,
 &
# Elliptic solver parameters
 &PARM02
 &
# Time stepping parameters
 &PARM03
 nIter0=0,
 nTimeSteps=19440,
 deltaT=40,
 dumpFreq=86400.0,
# Gridding parameters
 &PARM04
 delXfile='delX_Nx_256.bin',
```

```
delY=100.,
delZ=64*15.625,
&
PARM05
bathyFile='Bathy_profile_Nx_256_Nz_64.bin',
hydrogThetaFile='T_profile_Nx_256_Nz_64.bin',
uVelInitFile=,
&
```

However on a 256×64 grid (in x and z respectively) the numerics were unstable and grid-scale oscillations developed in the u field, causing the final solutions to be `Inf` or `NaN`. The first attempt to remedy this was to change the lateral eddy viscosity line (denoted by `viscAh`), and use *Jamart wet points* [Jamart and Ozer, 1986]:

```
viscAh=1E0,
useJamartWetPoints=.TRUE.,
```

Jamart wet points force the code to calculate averages excluding boundary points. This change was insufficient; the output continued to show grid-scale oscillations in the u field. Subsequently, three lines were added:

```
viscAhGridMin=0.01,
viscAhGridMax=1.0,
viscAhReMax=10.0,
```

These lines were imported from Karina's MITgcm data initialization file. However, the grid-scale oscillations continued and the output eventually blew-up.

Smagorinsky eddy viscosity was added as the next attempt.

```
viscC2Smag=2.2,
```

The inclusion of this Smagorinsky eddy viscosity seemed to remedy the issues of grid-scale oscillations and unstable output. To determine which parameters could be disposed of, the previous set of `viscAh*` settings were reverted to the initial file settings, however the Jamart wet points flag was kept on. The code blew up again, and so the `viscAh` flag was reverted back to `viscAh=1E0`.

References

[Jamart and Ozer, 1986] Jamart, B. and Ozer, J. (1986). Numerical boundary layers and spurious residual flows. Journal of Geophys. Research.