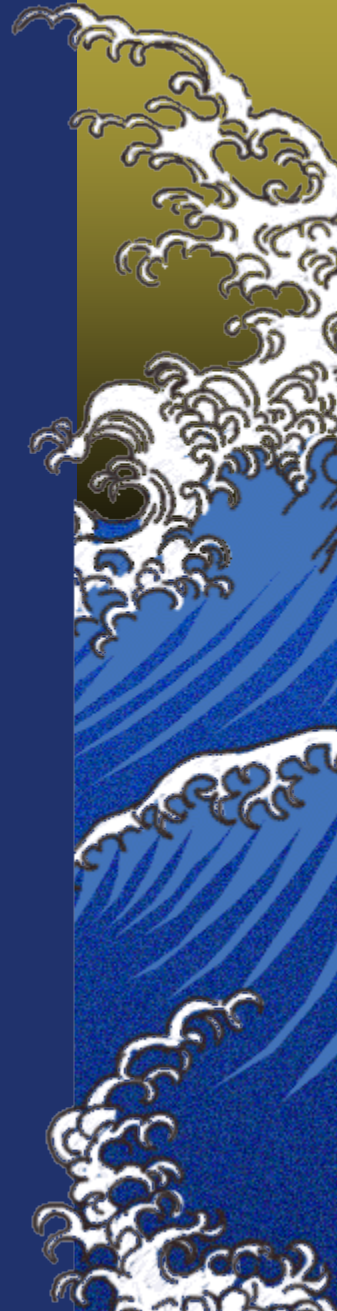


Ocean Perturbations Are Longwinded

*Forecast Ramifications of
Uncertainties in Idealised Transient
Scenarios*

OPAL
FRUIIS

Chris Brierley – 2u07

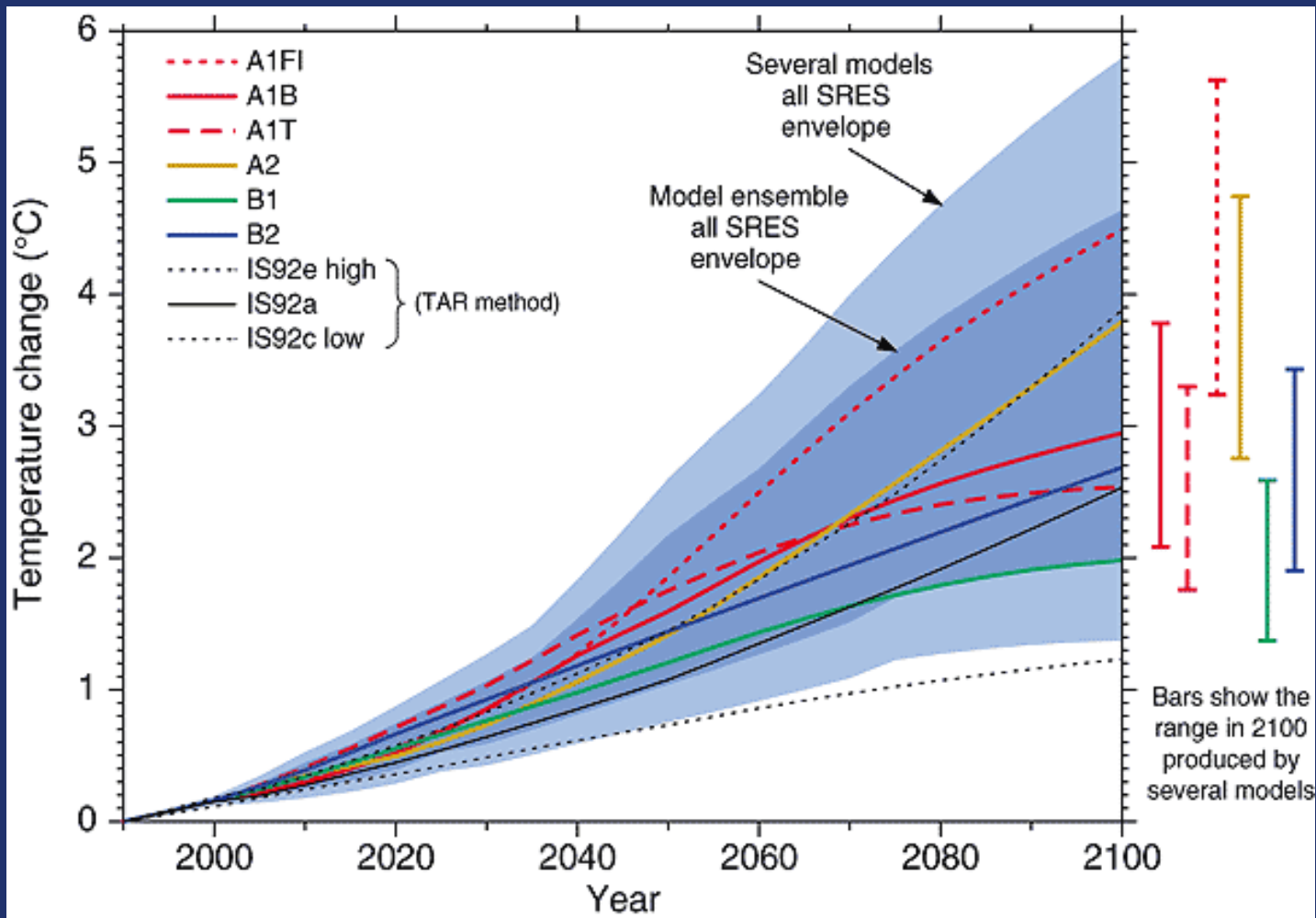


Tough on Uncertainty - Tough on the causes of Uncertainty

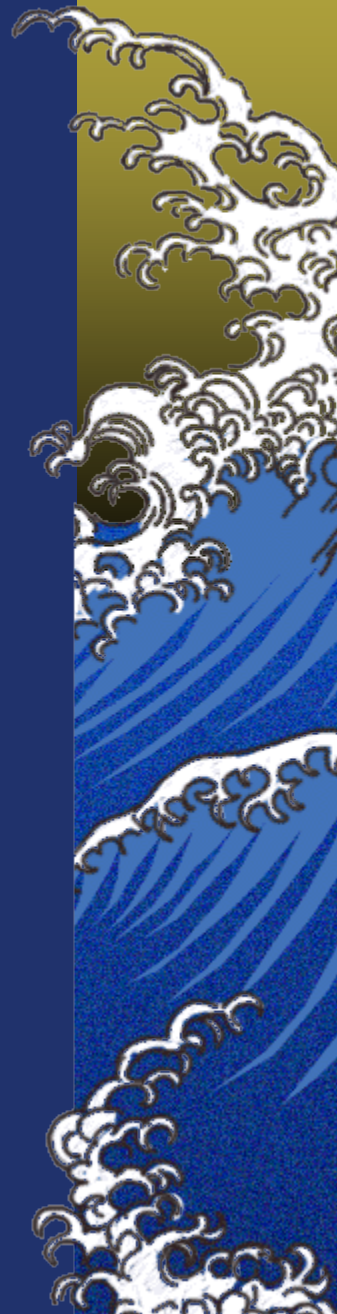
- ▶ *There are 2 approaches to deal with model errors/uncertainties.*
 - ▶ *Attempt to remove them with better models*
 - ▶ *Accept them, and work out how big they are.*

climateprediction.net and QUMP are doing the latter





Does not show relative probabilities!



Trinity of Uncertainty

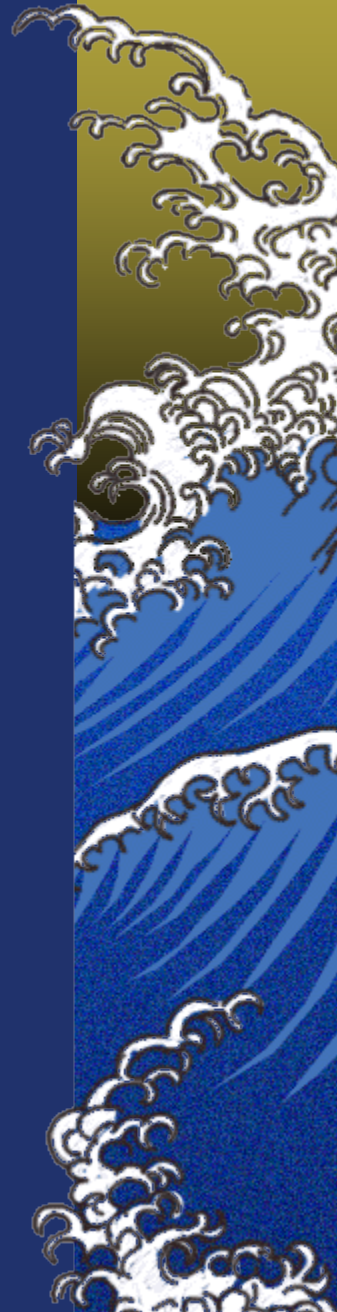
- ▶ *Initial Condition :*
 - ▶ *Atmosphere => Weather errors*
 - ▶ *Ocean => Seasonal and Annual errors*
- ▶ *Scenario – Humanities/Economics*
- ▶ *Model:*
 - ▶ *Multi-model ensembles*
 - ▶ *Parameter perturbations*



Step 1: Get the Recipe

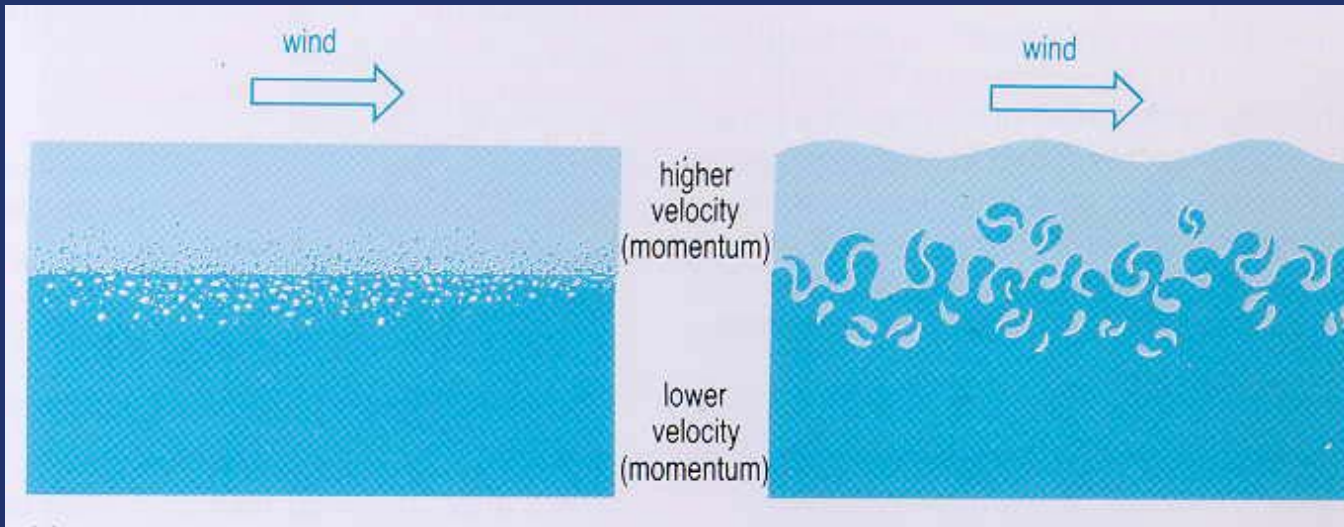
- ★ *Isopycnal Diffusion, 200-2000 g.*
- ★ *Mixed Layer Model, 0.3-0.7 fl. oz.*
- ★ *Vertical Diffusion, 5-20 tsp.*
- ★ *Add 5-8 tsp. of Vertical Viscosity to taste.*

*Delia's handy tips: grams can be substituted for m^2s^{-1}
teaspoons are very small – only $10^6 m^2s^{-1}$
fluid ounces don't mean anything to anybody*

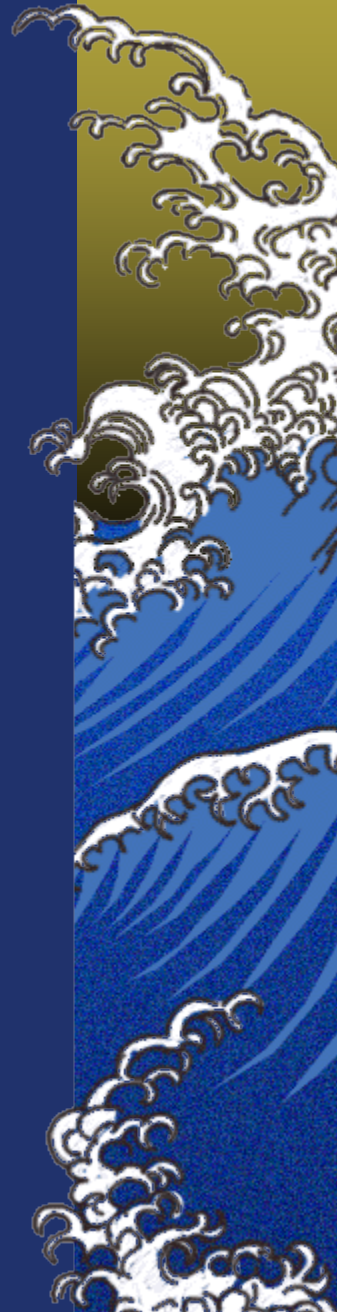


I'm going to the market and I'm going to buy...

Vertical Diffusion

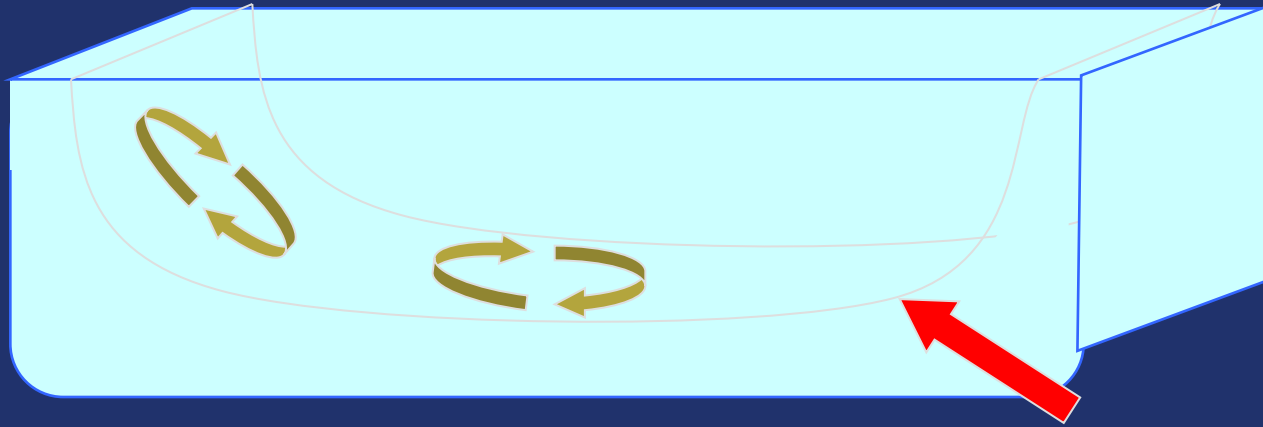


- ▶ *Small over most of the ocean. Majority of water properties are set at surface and brought down with convection.*
- ▶ *However all mixing is small vertically, due to stratification.*



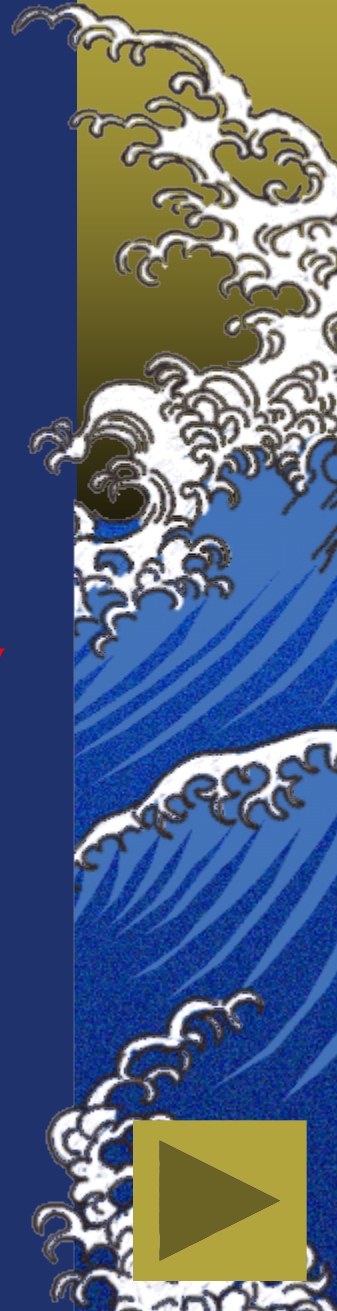
I went to the market and I bought V. Diff and ...

Isopycnal diffusion



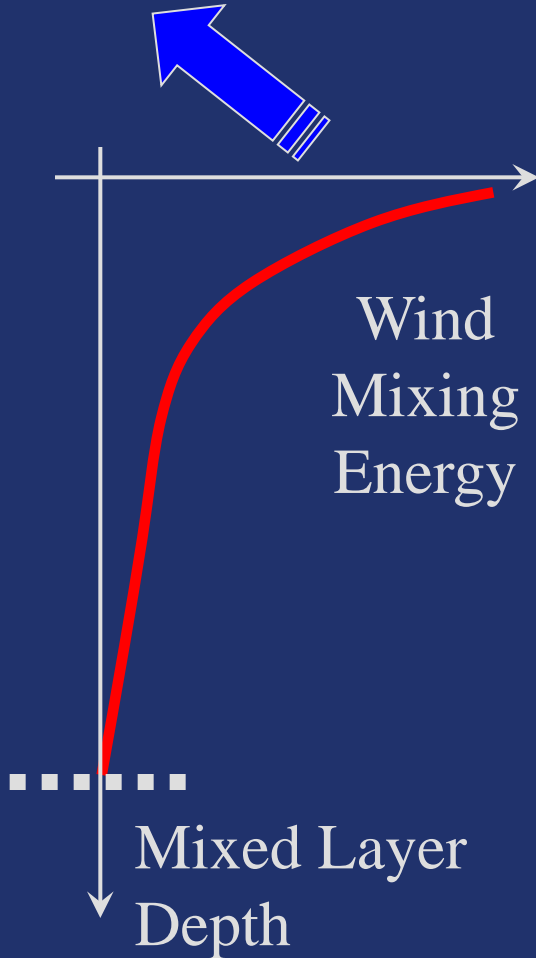
line of constant density

- ★ *Mainly horizontal*
- ★ *Vertical transfers possible at high latitudes*
- ★ *Largest in Southern Ocean, due to large quantity of eddies in ACC*

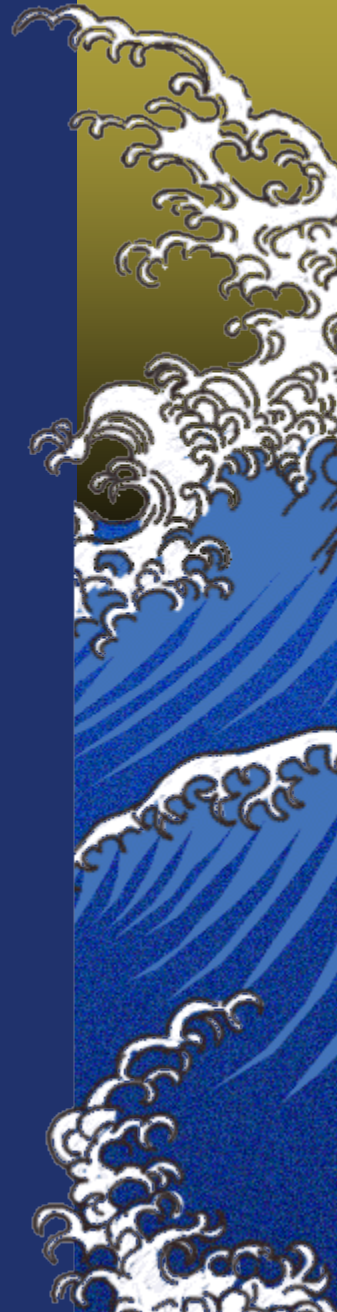


I went to the market and I bought V. Diff, Iso. Diff and ...

A Mixed Up Mixed Layer

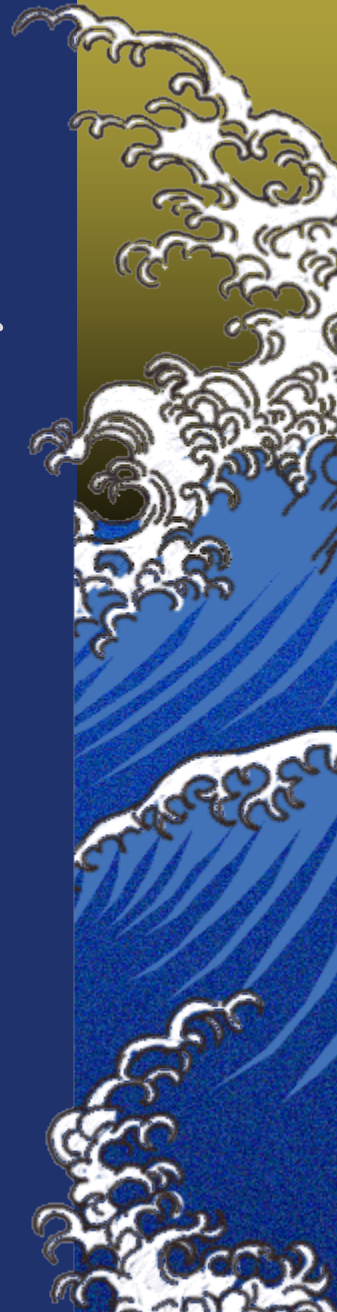


- ▶ *Parameterise the mixed layer by working out MLD and then mixing.*
- ▶ *MLD is when wind energy runs out.*
- ▶ *Scheme has 2 parameters - fraction and a decay length*



Step 2. Stir them up.

- ★ *Combine the perturbations in manner of your pleasing.*
 1. *All together – allow for non-linearities.*
 2. *Latin Hypercube (posh and complicated)*
 3. *Do each one singularly to really understand the physical processes.*

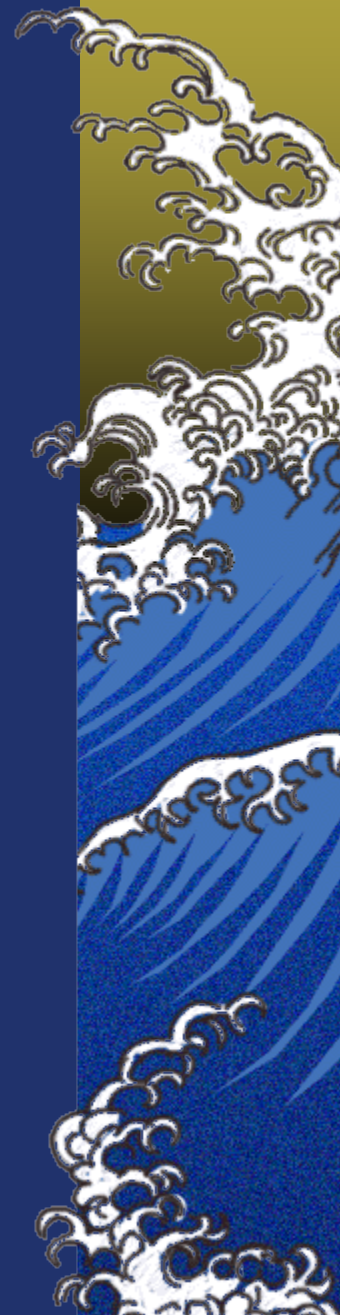


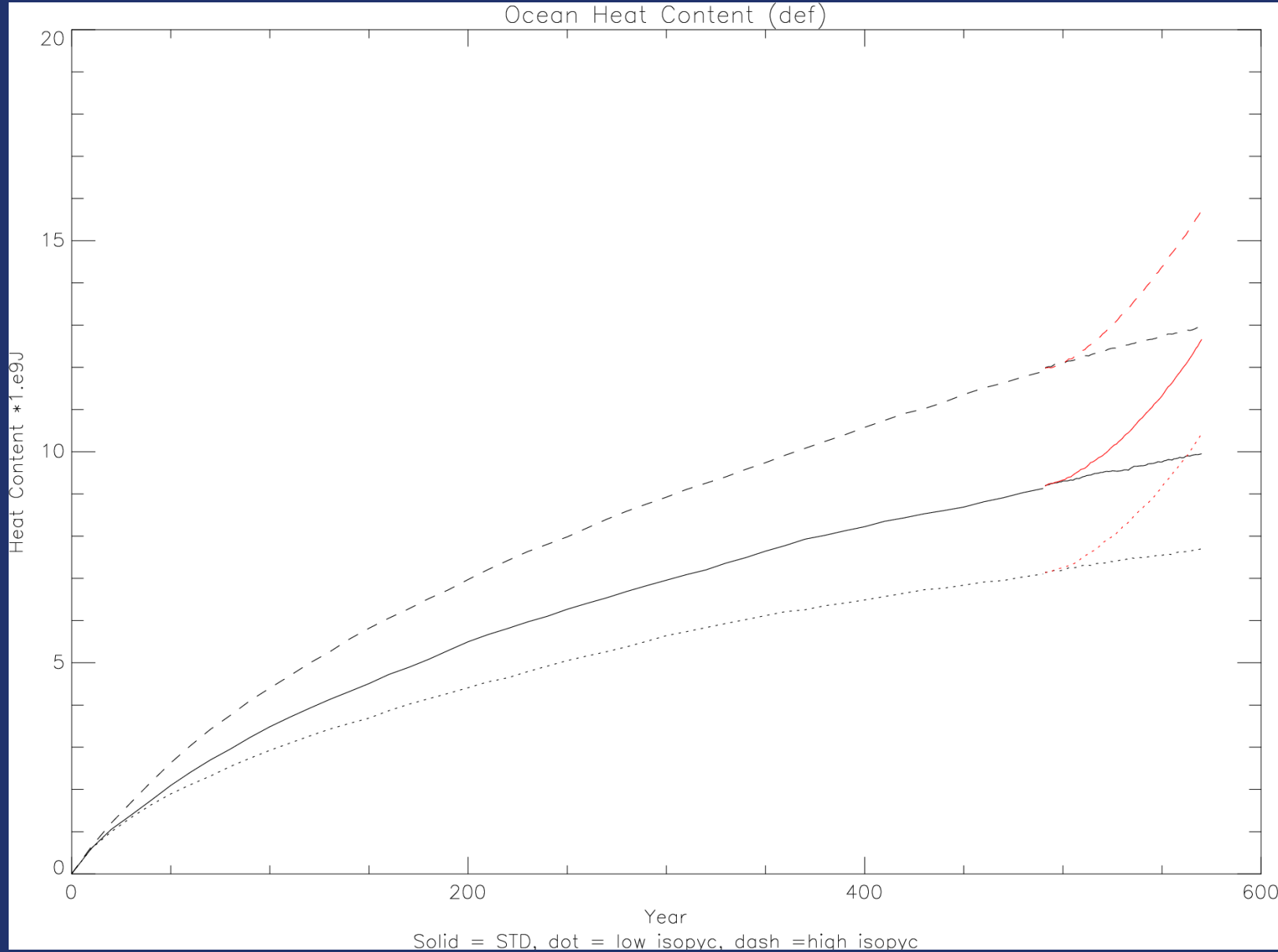
Step 3. Bake for ages.

- ▶ *The perturbation will probably change the model's climatology.*
- ▶ *Leading to climate drift - of unknown size.*
- ▶ *Oceans are slow, it takes centuries for changes to work their way through.*

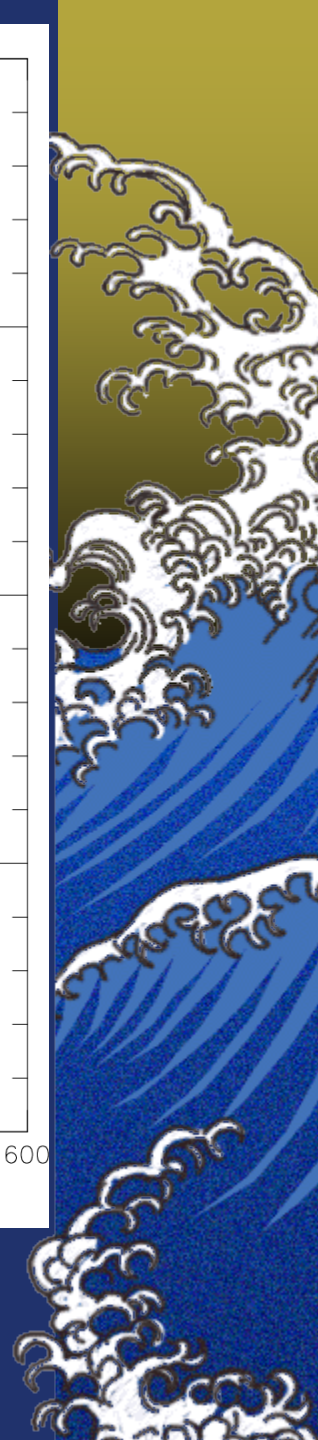
Delia's Tip: Get access to an über fast computer. My "small" ensemble requires model

4620 years of HadCM3

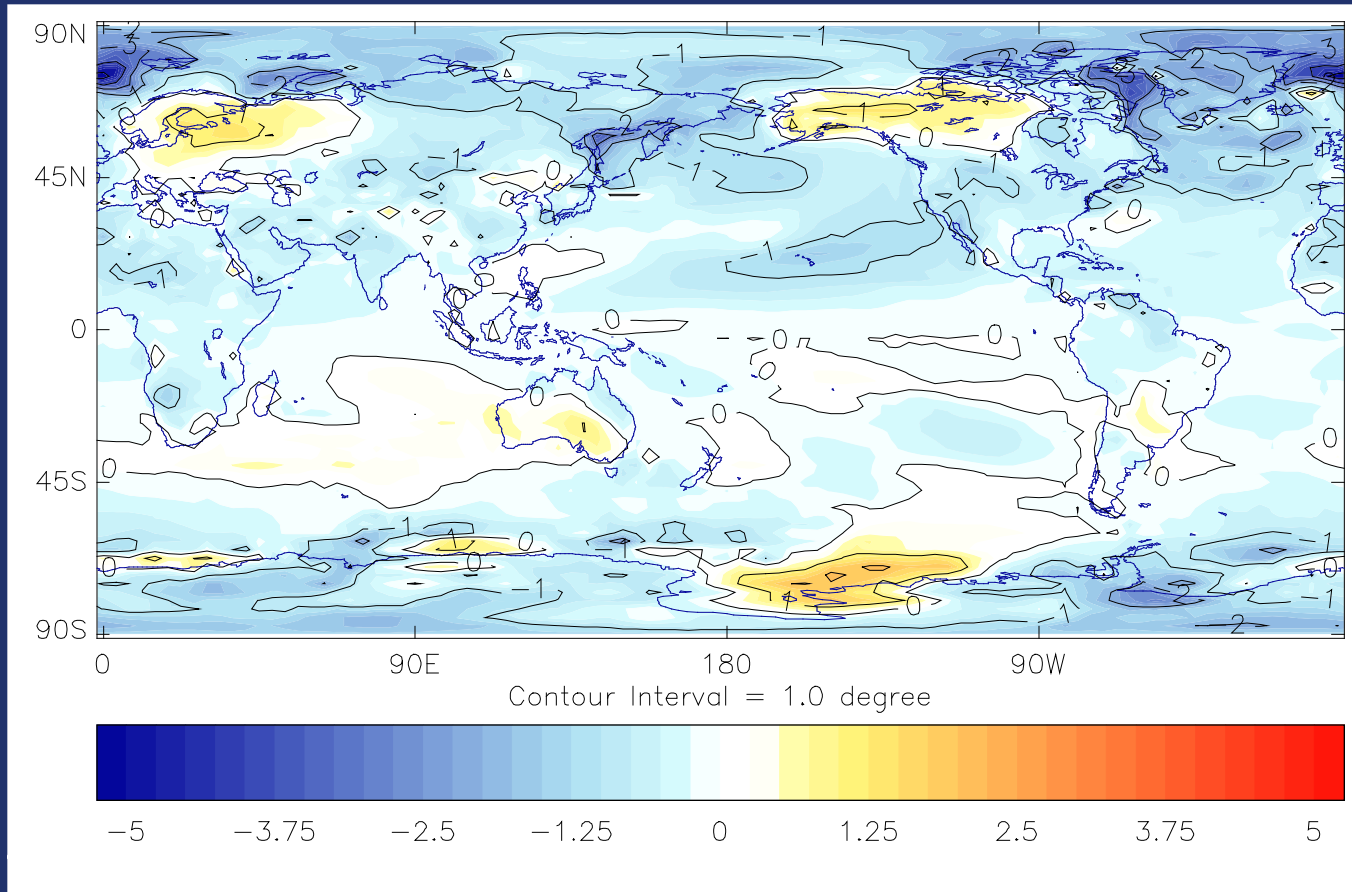




Initial drift is of similar magnitude to global warming !!



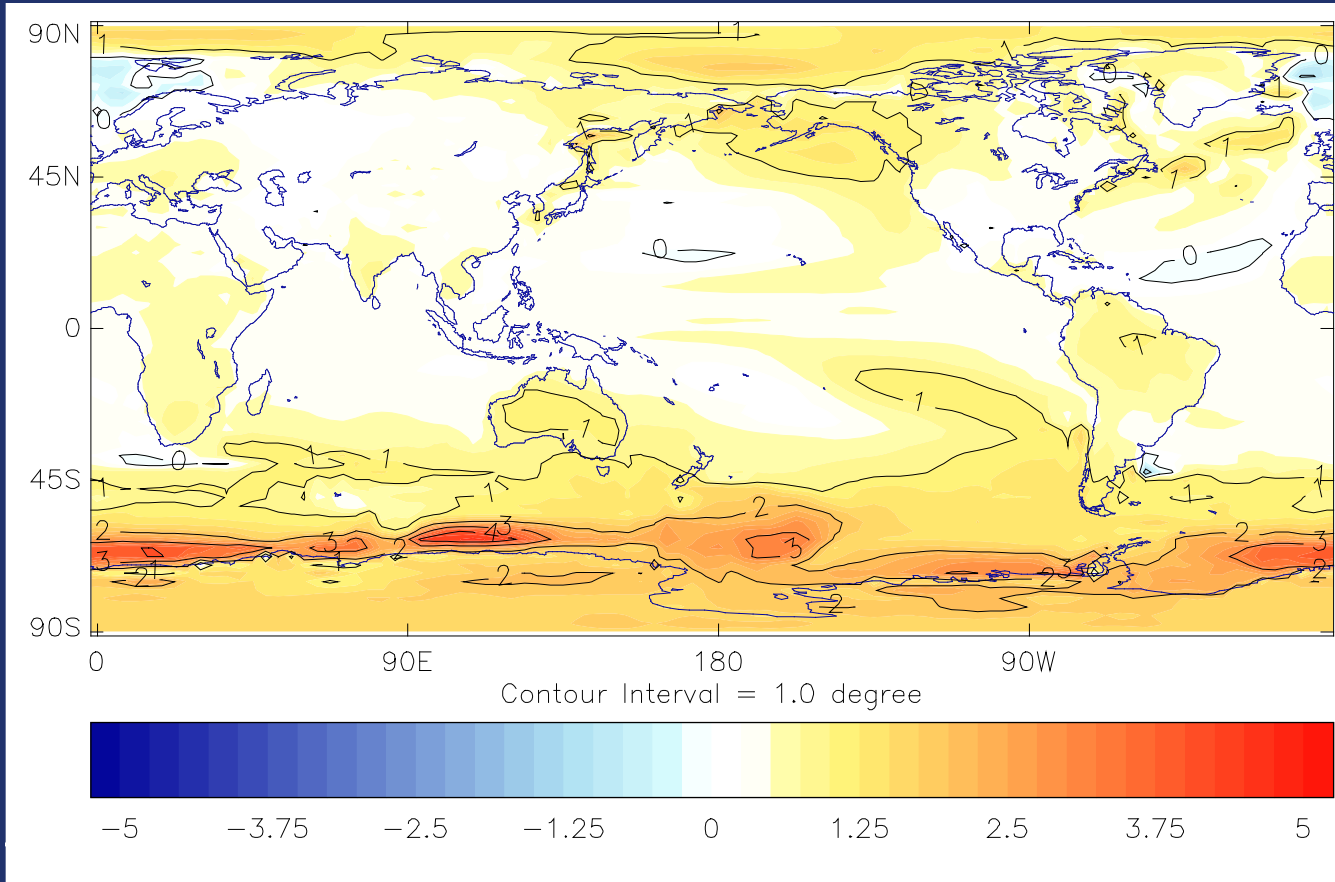
Isopycnal Diffusivity Effects (1)



Effect on Global Warming Signal – 20yrs around CO₂ doubling minus same 20yrs of control run (Max-Min)



Isopycnal Diffusivity Effects (2)



Effect on Model Climatology (Max-Min)

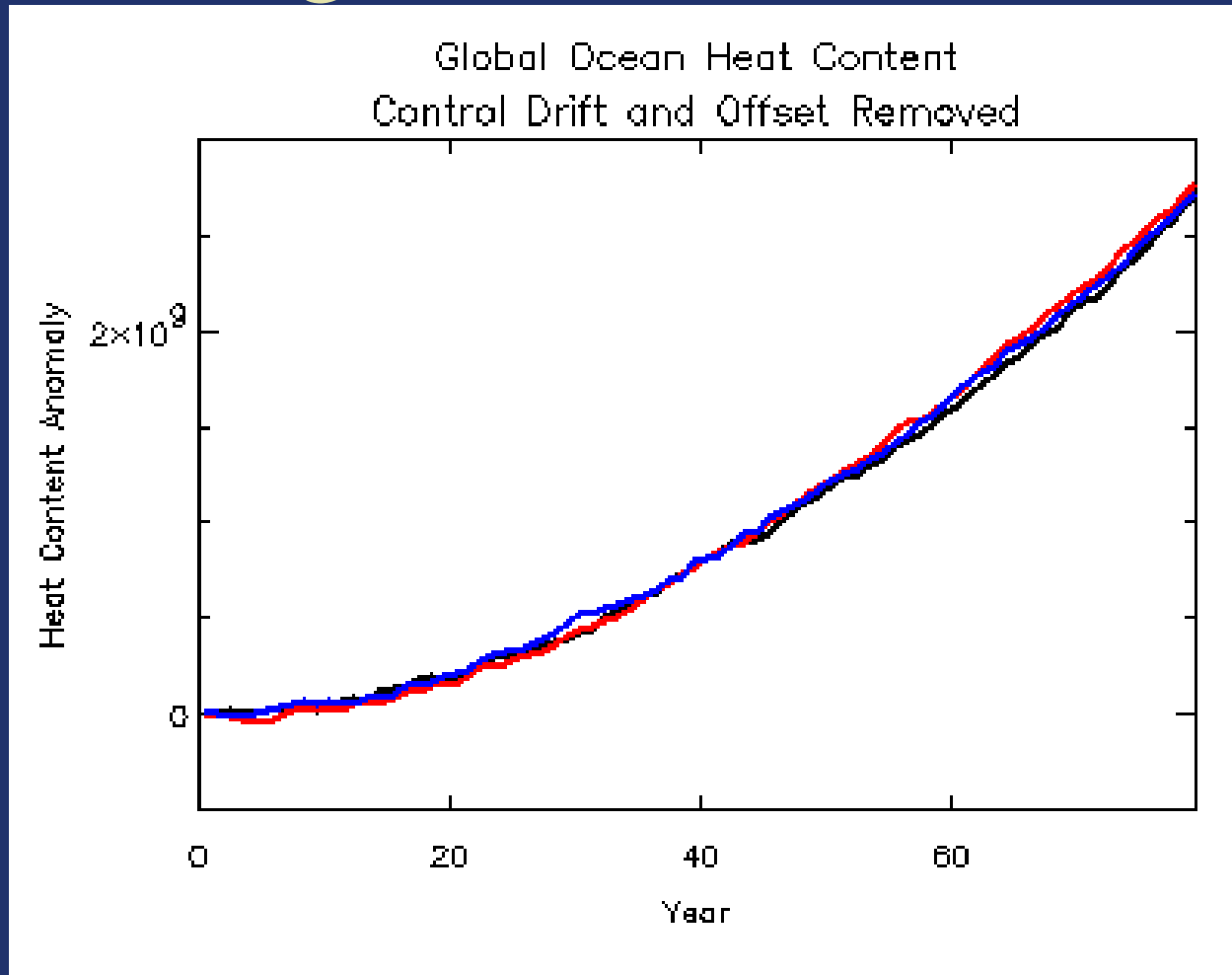


How do Signal differences arise?

- ▶ *Are they due to differences in climatology or different model responses to climate change?*
- ▶ *Need to look at other measures...*



Change in Heat Content

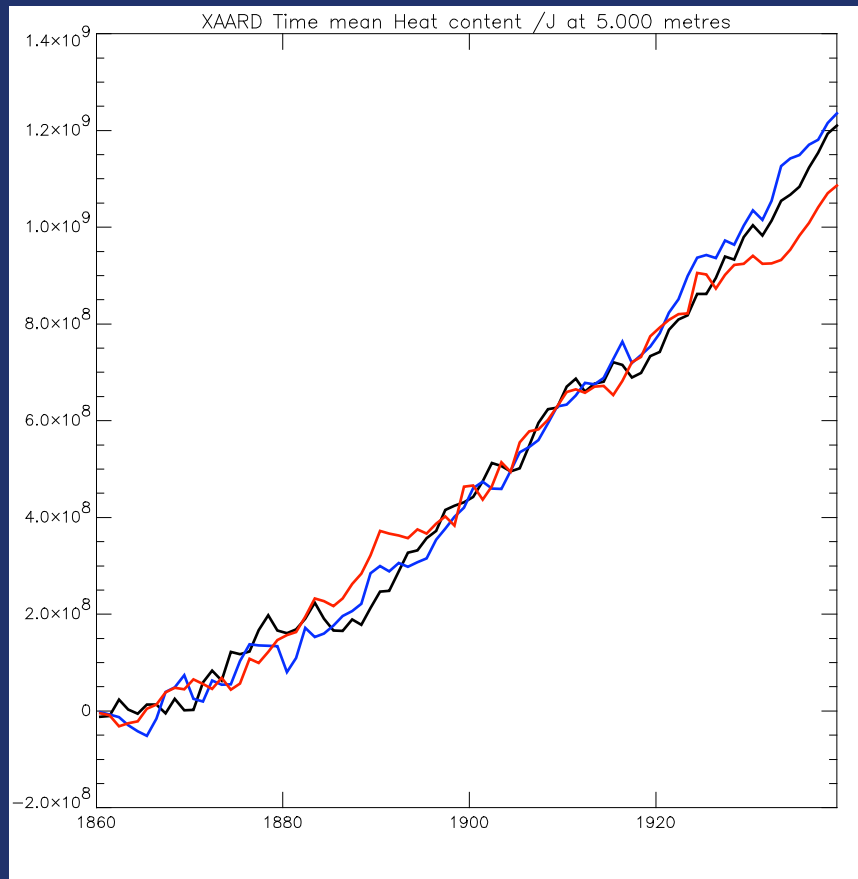


Red = High, Black = Medium, Blue = Low

- This considers whole ocean and could be hiding important depth structure



Top 250m



- Differences only seem to emerge after 70yrs.
- So probably natural variability.
- No depth structure difference affecting the surface.

Is ocean heat uptake unaffected by ocean parameters?



Possible Hypotheses

1. *It's just this one parameter.*
 - ▲ *Isopycnal Diffusion was top of my experts' suggestions. The mixed layer parameters seem to be giving a similar preliminary results.*
2. *The global warming signal differences are due to the different climatologies – ocean perturbations have little effect.*
 - ▲ *Brilliant – no more long spin-ups*
3. *Although irrelevant on a global scale, ocean uncertainties are essential regional climate change.*
 - ▲ *I best keep working then. Shame.*

