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Introduction RAPIT

• RAPIT project is part of RAPID-WATCH, the continuation of RAPID

- Main aim of RAPID is 26N Atlantic MOC monitoring array
- Bill Johns and Lisa Beal (RSMAS) involved with RAPID
- http://www.noc.soton.ac.uk/rapid/rapid.php
- RAPIT includes climate scientists, climate modellers, and statisticians
- Overall aim is to produce our best current estimate of the probability of the collapse of the Atlantic MOC



Introduction Method

- Run large ensembles of models (of order 10,000 members)
- Vary ocean & atmos parameters using Latin Hypercube designs
- Build emulators to assist in exploring parameter space
- Use emulators to steer subsequent ensembles towards "interesting" areas of parameter space
- Emulators originate from engineering modelling applications (e.g. fluid mechanics, jet engines)
- Recently used to explore parameter space in a galaxy formation model (see Bower et. al. 2010, MNRAS)





- Run climate models on desktop computers
- Members of the public volunteer spare PC time
- Currently 54,705 active "hosts"

CPDN

- Compute power equivalent to a top 10 system
- Over 115 million model years completed in project's lifetime



http://www.climateprediction.net/



Introduction

Model details

HadCM3 (currently running on CPDN)

- UK Met Office Hadley Centre Climate Model
- 1.25°x 1.25° ocean with 20 Z- levels
- 2.5°x 3.75° atmosphere with 19 sigma- levels

FAMOUS (currently running on CPDN)

- 2.5°x 3.75° ocean with 20 Z- levels
- 5°x 7.5° atmosphere with 19 sigma- levels
- Near-identical code to HadCM3

CHIME (not currently running on CPDN)

• 1.25°x 1.25° ocean with 25 hybrid- levels (HYCOM)





Experimental design & Emulators

Latin Hypercube experiment design

- Use Latin Hypercube designs
- Efficiently fills parameter space
- Can be extended
- Use emulators to guide model ensembles



Experimental design & Emulators

Complex function



 Red dots are points where we have run the model



Experimental design & Emulators

Overlay mean of 100 member ensemble



- Build an emulator of the complex function
- Blue line is the mean of an emulator ensemble

Experimental design & Emulators

Ensemble members & confidence intervals

- Grey lines are individual emulator ensemble members
- Dashed lines are 95% confidence intervals
- Emulators are fast can do hundreds of emulations in a second



Complex function

Experimental design & Emulators

Additional point in parameter space

- Adding 2 additional data points constrains emulator uncertainty
- Note that the additional data is not near the region where uncertainty was largest



Results so far

FAMOUS 700 member ensemble AMOC



- FAMOUS 700 member ensemble run Summer 2010
- Demostrated "proof of concept" to RAPID and MO partners



Results so far

FAMOUS 700 member ensemble AMOC



Splines for each scenario



Results so far

FAMOUS 700 member ensemble AMOC



years

years

years

Results so far

HadCM3 beta test



Experiment AMOC 48.75N

Experiment AMOC 25N



- Initial results from 100 member HadCM3 beta test
- Released on 23rd December
- Runs ~2 model years per day
- Testing 3 groups of parameters:-
 - Yellow: As yet untested
 - MO Ranges: Standard parameter set and ranges
 - Extended: MO parameters tested over much larger ranges

Expectations

Why might a layer model be more stable?

Why might AMOC in a layer model be more stable than one with Z-coordinates?

- AR3 and AR4 results indicate layer models may be more stable under CO2 forcing
- Sun & Bleck 2001 found no reduction in AMOC strength to a 1% CO₂ forcing





Expectations

Why might a layer model be more stable?

- CHIME responds similarly to HadCM3 under CO₂ forcing...
- but appears more stable to 0.1 Sv hosing



Summary	
Summary	

- Overall aim is to produce our best current estimate of the probability of AMOC collapse
- We will be able to compare stability of CHIME (hybrid-) and HadCM3 (z-) coordinate models
- We will be able to see how resolution affects MOC stability
- All RAPIT data will be available for immediate access at BADC and CPDN



Summary

- Launch first full HadCM3 ensemble with 10,000 members
- Launch equivalent experiment with FAMOUS
- Work towards getting CHIME into the CPDN framework
- Analyse output from all the model runs!
- For a full overview of the experiment design and concept see Michael Goldstein's seminar at the Newton Institute:http://www.newton.ac.uk/programmes/CLP/seminars/ 120711401.html

