

# Model Description and Trend Analysis for UBRIS-HadCM3M2

Rupert Gladstone, 18<sup>th</sup> May 2005

Version 1.0

This document aims to provide a brief description, along with references to more detailed descriptions, of the version of the Hadley centre model used at the University of Bristol for the PMIP2 experiments.

This document also provides a brief description of how the experiments were set up and run at Bristol, and a short trend analysis for a few key diagnostics.

## Contents

1	Model Description .....	2
1.1	Vertical Levels .....	2
1.2	Land Surface Scheme .....	2
2	PMIP2 Experiments .....	3
2.1	Spin up procedure .....	3
	The experiments were run for 100 years of ‘spin up’, prior to the mains runs. The spin up commenced from a standard HadCM3 dump file from a long pre-industrial Hadley Centre run. ....	3
3	Basic Trends Analysis.....	4

# 1 Model Description

The model used is the Hadley Centre Coupled Model version 3, with land surface scheme MOSES2 (HadCM3M2). See *Gordon et al.* [2000]. Pre-industrial and mid-Holocene experiments were performed both with and without the TRIFFID dynamic vegetation model.

Resolution is 1.25 \* 1.25 degrees for the ocean model and 2.5 (lat) \* 3.75 (lon) degrees for the atmosphere.

The Bering Strait and Torres Strait are open. The North West passage and Gibraltar Strait are closed.

Standard reference for HadCM3:

Gordon, C., C. Cooper, C. A. Senior, H. Banks, J. M. Gregory, T. C. Johns, J. F. B. Mitchell, R. A. Wood (2000), The simulation of SST, sea ice extents and ocean heat transport in a version of the Hadley Centre coupled model without flux adjustments, *Clim. Dyn.*, 16, 147--168.

## 1.1 Vertical Levels

The ocean uses fixed depth levels. The depths are given as the vertical axis values in the ocean PMIP2 netcdf files.

The atmosphere model uses a hybrid coordinate system, but all PMIP2 outputs have been interpolated onto standard WMO pressure levels to conform to PMIP2 requirements.

## 1.2 Land Surface Scheme

HadCM3M2 uses the MOSES 2 land surface scheme. The land surface scheme has a tile system consisting of 5 plant functional types (PFTs) and other tile types as follows (numbering corresponds to pseudo axis value in HadCM3M2 output files and in HadCM3M2 PMIP2-formatted netcdf files):

1. Broadleaf tree
2. Needleleaf tree
3. C3 grass
4. C4 grass
5. Shrub
6. Urban
7. Water
8. Bare Soil
9. Ice

For the oav experiments the vegetation model TRIFFID was used. TIFID has two modes: dynamic and equilibrium. The equilibrium mode is used to reduce spin-up times. The main PMIP2 oav runs were all carried out with TRIFFID in dynamic mode (equilibrium mode was used during spin-up, see below).

## 2 PMIP2 Experiments

The PMIP2 guidelines were strictly adhered to. Trace gases and insolation were exactly as defined on the PMIP2 website <http://www-lsce.cea.fr/pmip2/>

The following experiments were carried out:

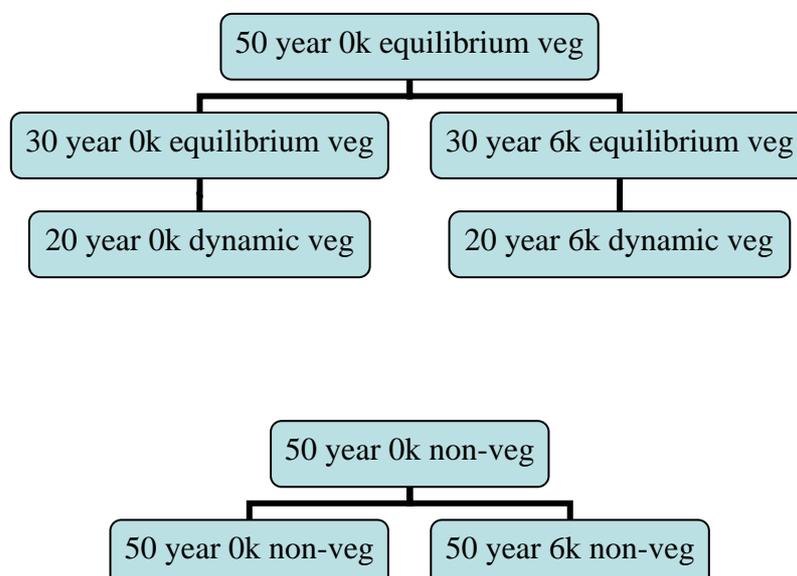
0k_oa	pre-industrial coupled ocean-atmosphere experiment
0k_oav	pre-industrial coupled ocean-atmosphere-vegetation experiment
6k_oa	mid-Holocene coupled ocean-atmosphere experiment
6k_oav	mid-Holocene coupled ocean-atmosphere-vegetation experiment

Trace Gases	0k	6k
CO2 (ppm)	280	280
CH4 (ppb)	760	650
N2O (ppb)	270	270

### 2.1 Spin up procedure

The experiments were run for 100 years of 'spin up', prior to the mains runs. The spin up commenced from a standard HadCM3 dump file from a long pre-industrial Hadley Centre run.

The 6k experiments were branched off after 50 years. TRIFFID (the vegetation model) was switched from equilibrium to dynamic mode after 80 years. See diagram below.



### 3 Basic Trends Analysis

See accompanying plots for the following trends:

Tas - Global 1.5M air-temperature as a function of time (annual means)

Tos - Global sea-surface temperature as a function of time (annual means)

Stfmnc - Atlantic THC index as a function of time

Sivol - Annual mean sea-ice volume in NH and SH as a function of time

Pftfrac (sum of forest pfts) - Evolution of forest area

Still to come:

- Global ocean temperature (= volume ocean temperature) as a function of time for the globe and for each ocean basin

- The same for global salinity

- Flow to southern ocean at 20°S as a function of time

#### Summary of Trends Plots

The North Atlantic overturning circulation shows high interannual variability between 15-223 Sv, with no clear trend. Similar for all experiments.

The fixed vegetation runs have a forest area of 12.36 million km<sup>2</sup> (mk<sup>2</sup>). The dynamic vegetation experiments show greater forest area, and a small continued trend of increase of forest area.

The 6k\_oav experiment has a mean forest area of 13.01 mk<sup>2</sup>, with a trend of 0.05 mk<sup>2</sup>/century.

The 0k\_oav experiment has a mean forest area of 13.87 mk<sup>2</sup>, with a trend of 0.04 mk<sup>2</sup>/century.

Surface air temperature is ~0.5K colder in the interactive vegetation experiments (285.9K compared to 286.4K). There are no clear trends (small negative trend?).

SST is similar to above (289.9K and 290.3K). I have not investigated the large downward spike in the 6k\_oav run.

The 6k oa experiment has less sea-ice in both hemispheres than the 0k oa experiment.

The 0k oav experiment has greater sea-ice vol in both hemispheres than the 0k\_oa experiment.

Problem with 6k\_oav seaice volume not yet investigated.