Model Information of Potential Use to the IPCC Lead Authors and the AR4.

Parallel Climate Model (PCM)

20 April 2005

I. Model identity:

A. Institution, sponsoring agency, country

Parallel Climate Model (PCM)
National Center for Atmospheric Research (NCAR),
NSF (a primary sponsor), DOE (a primary sponsor), NASA, and NOAA
USA

B. Model name (and names of component atmospheric, ocean, sea ice, etc. models)

Coupled model Parallel Climate Model (PCM)
Atmosphere Community Climate Model
Ocean Parallel Ocean Program,
Sea ice Community Sea Ice Model
Land Land Surface Model (LSM)

C. Vintage (i.e., year that model version was first used in a published application)

First control run: Aug 1998

D. General published references and web pages

Main website : http://www.cgd.ucar.edu/pcm

general model description and initial 1% CO2 increase results:
Washington, W.M., J.W. Weatherly, G.A. Meehl, A.J. Semtner Jr., T.W. Bettge, A.P. Craig, W.G. Strand Jr., J.M. Arblaster, V.B. Wayland, R. James, Y. Zhang, 2000: Parallel climate model (PCM) control and transient simulations. Clim. Dyn., 16, 755--774.

documentation of El Nino well-simulated in PCM:
Meehl, G.A., P. Gent, J.M. Arblaster, B. Otto-Bliesner, E. Brady, and A. Craig, 2001: Factors that affect amplitude of El Nino in global coupled climate models. Clim. Dyn., 17, 515--526.

documentation of the recent IPCC climate change results from PCM (and CCSM3):
Meehl, G.A., W.M. Washington, W.D. Collins, J.M. Arblaster, A. Hu, L.E. Buja, W.G. Strand, and H. Teng, 2005a: How much more global warming and sea level rise? Science, 307, 1769--1772.

Regarding CCSM3 documentation of the IPCC runs, there is a paper under review in J. Climate with that information. I attach a pre-print. The reference:

Meehl, G.A., W.M. Washington, B.D. Santer, W.D. Collins, J.M. Arblaster, A. Hu, D. Lawrence, H. Teng, L.E. Buja, and W.G.Strand, 2005: Climate change in the 20th and 21st centuries and climate change commitment in the CCSM3. J. Climate, submitted.

E. References that document changes over the last ~5 years (i.e., since the IPCC TAR) in the coupled model or its components. We are specifically looking for references that document changes in some aspect(s) of model performance.

documentation of the 20th century forcing experiments with PCM (forcings include volcanoes, solar, GHGs, sulfate aerosols, ozone):
Meehl, G.A., W.M. Washington, C. Ammann, J.M. Arblaster, T.M.L. Wigley, and C. Tebaldi, 2004: Combinations of natural and anthropogenic forcings and 20th century climate. J. Climate, 17, 3721--3727.

F. IPCC model version's global climate sensitivity (KW-1m2) to increase in CO2 and how it was determined (slab ocean expt., transient expt--Gregory method, =B12K Cess expt., etc.)

G. Contacts (name and email addresses), as appropriate, for:

1. coupled model: Lawrence Buja, southern@ucar.edu
2. atmosphere: Lawrence Buja, southern@ucar.edu
3. ocean: Lawrence Buja, southern@ucar.edu
4. sea ice: Lawrence Buja, southern@ucar.edu
5. land surface: Lawrence Buja, southern@ucar.edu
6. vegetation: Lawrence Buja, southern@ucar.edu
7. other: Lawrence Buja, southern@ucar.edu

IPCC runs: Lawrence Buja, southern@ucar.edu

II. Besides atmosphere, ocean, sea ice, and prescription of land/vegetated surface, what can be included (interactively) and was it active in the model version that produced output stored in the PCMDI database?

A. atmospheric chemistry?

B. interactive biogeochemistry?

No

C. what aerosols and are indirect effects modeled?

No indirect forcing effects are included.

D. dynamic vegetation?

No

E. ice-sheets?

No

III. List the community based projects (e.g., AMIP, C4MIP, PMIP, PILPS, etc.) that your modeling group has participated in and indicate if your model results from each project should carry over to the current (IPCC) version of your model in the PCMDI database.

IV. Component model characteristics (of current IPCC model version):

A. Atmosphere

1. resolution

Lateral resolution from 42-wavenumber triangular spectral truncation of the dynamics. At the equator, the spatial resolution is approximately 2.8 degrees.

2. numerical scheme/grid (advective and time-stepping schemes; model top; vertical coordinate and number of layers above 200 hPa and below 850 hPa)

Numerical scheme Eulerian spectral transform,

Grid: T42
Time stepping: semi-implicit leapfrog
Model top: 2.2 hPa
Vertical coordinate: generalized terrain-following hybrid coordinate,
26 levels
Number of layers above 200 hPa: 13
Number of layers below 850 hPa: 4

3. list of prognostic variables (be sure to include, as appropriate, liquid water, chemical species, ice, etc.)

a. Vorticity
b. Divergence
c. Temperature
d. Specific humidity
e. Surface pressure
f. Grid box averaged liquid condensate amount
g. Grid box averaged ice condensate amount

4. name, terse descriptions, and references (journal articles, web pages) for all major parameterizations. Include, as appropriate, descriptions of:

a. clouds

b. convection

Shallow convection:
Hack, J. J., Parameterization of moist convection in the National Center for Atmospheric Research Community Climate Model (CCM2), J. Geophys. Res., 99, 5551-5568, 1994.

c. boundary layer

Non-local atmospheric boundary layer scheme

Holtslag, A. A. M., and B. A. Boville, Local versus nonlocal boundary-layer diffusion in a global climate model, J. Climate, 6, 1825-1842, 1993.

d. SW, LW radiation

LW: absorptivity-emissivity method for clear-skies, plus Truncated Independent Column Approximation (TICA) for all-sky

SW: delta-Eddington with exponential-sum fit representation of near-IR, truncated ICA (TICA) for all-sky

Kiehl, J. T., J. J. Hack, G. B. Bonan, B. B. Boville, D. L. Williamson, and P. J. Rasch, The National Center for Atmospheric Research Community Climate Model: CCM3, J. Climate, 11, 1131-1149, 1998.

e. any special handling of wind and temperature at top of model

Horizontal diffusion of temperature and wind with a del-squared diffusion operator is introduced in the top three layers of the model.

B. Ocean

1. resolution

nominal 1 degree displaced pole horizontal grid
320x384 horizontal grid points
40 vertical levels
1.125degx0.27deg resolution on the equator
northern pole in Greenland

2. numerical scheme/grid, including advection scheme, time-stepping scheme, vertical coordinate, free surface or rigid lid, virtual salt flux or freshwater flux

third-order upwinding advection
3-time-level second-order modified leapfrog time stepping
40-level geopotential grid extending to 5500m,
with resolution increasing from 10m at the surface to 250m in the deep ocean.
implicit free surface
virtual salt flux

3. list of prognostic variables and tracers

grid-oriented zonal and meridional velocity components
vertical velocity
pressure
density
potential temperature
salinity

ideal age

4. name, terse descriptions, and references (journal articles, web pages) for all parameterizations. Include, as appropriate, descriptions of:

a. eddy parameterization
b. bottom boundary layer treatment and/or sill overflow treatment
None
c. mixed-layer treatment
KPP boundary layer mixing

Large, W.G., J.C. McWilliams and S.C. Doney, 1994: Oceanic vertical mixing: A review and a model with a nonlocal boundary layer parameterization, Reviews of Geophysics, 32, 363-403.
e. tidal mixing
None

f. river mouth mixing

g. mixing isolated seas with the ocean

h. treatment of North Pole "singularity" (filtering, pole rotation, artificial island?)

C. sea ice
1. horizontal resolution, number of layers, number of thickness categories
gx1v3 grid (nominally 1 degree, displaced pole grid. see ocean resolution)

2. numerical scheme/grid, including advection scheme, time-stepping scheme,
3. list of prognostic variables

4. completeness (dynamics? rheology? leads? snow treatment on sea ice)
dynamics: elastic-viscous-plastic (Hunke and Dukowicz, 1997) with updates (Hunke, 2001; Hunke and Dukowicz, 2002; Hunke and Dukowicz, 2003)

5. treatment of salinity in ice

6. brine rejection treatment

7. treatment of the North Pole "singularity" (filtering, pole rotation, artificial island?)

D. land / ice sheets (some of the following may be omitted if information is clearly included in cited references.

1. resolution (tiling?), number of layers for heat and water

2. treatment of frozen soil and permafrost

3. treatment of surface runoff and river routing scheme

4. treatment of snow cover on land

5. description of water storage model and drainage

6. surface albedo scheme

7. vegetation treatment (canopy?)

8. list of prognostic variables

9. ice sheet characteristics (How are snow cover, ice melting, ice accumulation, ice dynamics handled? How are the heat and water fluxes handled when the ice sheet is melting?)

E. coupling details

1. frequency of coupling

ocean coupled once per day, atm/lnd/ice coupled once per hour

2. Are heat and water conserved by coupling scheme?

yes

3. list of variables passed between components:

a. atmosphere - ocean
b. atmosphere - land
c. land - ocean
d. sea ice - ocean
e. sea ice - atmosphere

4. Flux adjustment? (heat?, water?, momentum?, annual?, monthly?).

none

V. Simulation Details (report separately for each IPCC simulation contributed to database at PCMDI):

A. IPCC "experiment" name

B. Describe method used to obtain initial conditions for each component model

1. If initialized from a control run, which month/year.
2. For control runs, describe spin-up procedure.

C. For pre-industrial and present-day control runs, describe radiative forcing agents (e.g., non-anthropogenic aerosols, solar variability) present Provide references or web pages containing further information as to the distribution and temporal changes in these agents.

D. For perturbation runs, describe radiative forcing agents (e.g., which greenhouse gases, which aerosols, ozone, land surface changes, etc.) present. Provide references or web pages containing further information as to the distribution and temporal changes in these agents.