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

INM-CM3.0

31 January 2005

I. Model identity:

A. Institution, sponsoring agency, country:
Institute of Numerical Mathematics, Russian Academy of Science, Russia.

B. Model name (and names of component atmospheric, ocean, sea ice, etc. models):
INMCM3.0

C. Vintage (i.e., year that model version was first used in a published application):
2004.

D. General published references and web pages:
Alekseev et al. 1998.
Diansky et al. 2002.
Diansky, Volodin 2002.

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:
Volodin, Diansky 2004.
Galin et al. 2003.

F. IPCC model version's global climate sensitivity ($KW^{-1}m^2$) to increase in CO_2 and how it was determined (slab ocean expt., transient expt--Gregory method, ±2K Cess expt., etc.):
0.52 K W-1 m2, slab ocean experiment

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

1. coupled model
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2. atmosphere
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3. ocean
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4. sea ice
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5. land surface
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6. vegetation
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7. atmospheric radiation
   Vener Galin, galin@inm.ras.ru

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? NO
B. interactive biogeochemistry? NO
C. what aerosols and are indirect effects modeled?
   Sulfate and volcanic aerosols, no indirect effect.
D. dynamic vegetation? NO
E. ice-sheets? Prescribed ice-sheet distribution.

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.

AMIP II (model achronym DNM)
CMIP (INMCM)

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

A. Atmosphere
   1. resolution:
      5x4 in longitude and latitude, 21 levels in vertical. (Alekseev et al., 1998).

   2. numerical scheme/grid (advective and time-stepping schemes; model top; vertical coordinate and number of layers above 200 hPa and below 850 hPa):
      Finite difference (Arakawa 1977), semi-implicit in time (Robert 1972).
      Model top at 10 hPa.
      Vertical coordinate is sigma.
      8 layers above 200 hPa, 5 layers below 850 hPa.

   3. list of prognostic variables (be sure to include, as appropriate, liquid water, chemical species, ice, etc.). Model output variable names are not needed, just a generic descriptive name (e.g., temperature, northward and eastward wind components, etc.):
      Northward and eastward wind, temperature, specific humidity, surface pressure.

4. name, terse descriptions, and references (journal articles, web pages) for all major parameterizations. Include, as appropriate, descriptions of:
    a. clouds.
    Diagnostic calculation of cloud fraction. Stratiform cloud fraction is calculated as linear function of relative humidity. Parameterization of cloudiness under PBL inversion is included.

    Convective cloud fraction equals 0.5 for shallow convection and depends on precipitation for deep convection.

    b. convection.
    Deep and shallow convection after Betts (1986), but with changed referenced profile for deep convection.
    Large scale condensation in the case of relative humidity exceeds 1.
    Evaporation of stratiform precipitation.

    c. boundary layer.
    Bulk formulas for calculation of surface fluxes, with CU, CT dependent on wind shear and stratification. Vertical diffusion in PBL with coefficient dependent on Richardson number (Alekseev et al, 1998)

    d. SW, LW radiation
    18 spectral intervals in SW, and 10 spectral intervals in LW. (Galin 1998)

    e. any special handling of wind and temperature at top of model. NO

    f. Gravity wave drag parameterization.
    Orography GWD (Palmer et al, 1986) and non-orography GWD (Hines 1997)

B. Ocean
1. resolution:
    2.5x2 degrees in longitude and latitude, 33 sigma-levels in vertical

2. numerical scheme/grid, including advection scheme, time-stepping scheme, vertical coordinate, free surface or rigid lid, virtual salt flux or freshwater flux:
    C-grid of Arakawa, implicit scheme in time using the splitting method by physical processes and space coordinates, vertical coordinate is sigma, rigid lid, virtual salt flux (Diansky et al. 2002).

3. list of prognostic variables and tracers:
    Eastward and northward velocity, potential temperature, salinity, barotropic stream function.
4. name, terse descriptions, and references (journal articles, web pages) for all parameterizations. Include, as appropriate, descriptions of:
    a. eddy parameterization:
    Horizontal diffusion of the 2d order (Laplas) for temperature and salinity at z-surfaces. Horizontal diffusion of 4d order (Laplas**2) for eastward, northward velocity at sigma-surfaces.

b. bottom boundary layer treatment and/or sill overflow treatment: linear friction at the bottom.
c. mixed-layer treatment:
   Vertical diffusion parameterization by Pacanovsky, Philander (1981).
d. sunlight penetration:
   58% are absorbed by the surface, 42% penetrate with decreasing by e times at 20m.
e. tidal mixing: NO
f. river mouth mixing: NO
g. mixing isolated seas with the ocean:
   salinity flux from Red sea, Black Sea, Baltic sea, Persian gulf. No heat flux.
h. treatment of North Pole "singularity" (filtering, pole rotation, artificial island?): filtering and artificial island.

C. sea ice
1. horizontal resolution, number of layers, number of thickness categories:
   2.5x2 degrees in longitude and latitude, 1 layer in vertical, 1 thickness category.
2. numerical scheme/grid, including advection scheme, time-stepping scheme:
   No advection, explicit time scheme.
3. list of prognostic variables:
   Ice volume, compactness, snow volume.
4. completeness (dynamics? rheology? leads? snow treatment on sea ice):
   No dynamics, melting/freezing only. Accumulation/melting of snow on sea ice.
5. treatment of salinity in ice: 4 permil.
6. brine rejection treatment: No
7. treatment of the North Pole "singularity" (filtering, pole rotation, artificial island?): artificial island.

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

Soil and vegetation block description can be found in Alekseev et al (1998), Volodin and Lykossov (1998)

1. resolution (tiling?), number of layers for heat and water:
   5x4 degrees in longitude and latitude, 23 layers for heat and water.
2. treatment of frozen soil and permafrost:
   Freezing/melting of soil moisture is taken into account
3. treatment of surface runoff and river routing scheme
   Surface runoff is calculated using precipitation and snow melting
   Runoff water calculated over the river basin moves
   to river mouth instantaneously and includes to ocean model input.
4. treatment of snow cover on land
   4 layers in snow, equation of heat transfer.
5. description of water storage model and drainage
   23 layers for soil water up to 10 m, equations include water conductivity, thermo-water conductivity, hydraulic flux, freezing/melting. Drainage depends on water content.
6. surface albedo scheme:
   Ocean albedo depends on zenith angle of Sun.

For land snow-free albedo is prescribed for 4 seasons (Dorman, Sellers 1989), real albedo is calculated using snow covered part of surface. Snow albedo depends on temperature.

7. vegetation treatment (canopy?):
   Distribution of 13 types of vegetation is prescribed with different parameters for leaf resistance, LAI, wilting point and root depth. No dynamical vegetation.
8. list of prognostic variables:
   Soil temperature, water, frozen water.
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?):
   no ice sheet snow cover, no ice melting/accumulation, no ice dynamics. Runoff from melted ice sheet is not taken into account.

E. coupling details
1. frequency of coupling:
   1 hour between atmosphere and sea ice, 6 hours between atmosphere and open sea.
2. Are heat and water conserved by coupling scheme? Yes.
3. list of variables passed between components:
   a. atmosphere – ocean:
      total heat flux,
      SW flux penetrating into water,
      fresh water flux,
      momentum flux.

   b. atmosphere – land:
      surface temperature, water flux to the surface
   c. land – ocean: river runoff
   d. sea ice – ocean: fresh water flux
   e. sea ice – atmosphere: sea ice temperature, sea ice square
4. Flux adjustment? (heat?, water?, momentum?, annual?, monthly?):

Annual mean flux adjustment of water in GIN, Barentz and Kara seas only (1.75 mm/day adjustment water flux from ocean to the atmosphere in this region). No heat and momentum flux adjustment.

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

1. Climate of the 20th Century experiment (20C3M).

At the beginning, Levitus climatology for temperature and salinity, zero sea ice and atmospheric and soil conditions from AGCM were specified. 200-year run with constant forcing for the end of XX century was performed. After this, 80-year run with conditions for 1871, taken from ftp://sprite.llnl.gov/pub/covey/IPCC_4AR_Forcing (4ARForcing further), was made. The end of this 80-year run (1st January) was taken as start point for 20C3M run.

Temporal changes of CO2, CH4, N2O, Solar constant were taken from 4ARForcing (file PCM1_A1.nc). Volcanic aerosols were taken from pcm_volcanic_1890-2000_T42.nc, Sulfate aerosol changes were used from 2-dimensional data in 4ARForcing (burden…). Linear interpolation in time was used to obtain instantaneous values of these values. CFC11, CFC-12 are not taken into account. Ozone changes were not taken into account, Ozone monthly climatology was prescribed as for AMIP II (Wang et al, 1995).

2. 720 ppm stabilization experiment (SRES A1B).

Initial condition was the end of run for XX century (20C3M), 01 Jan 2001.

Temporal changes of CO2, CH4, N2O were taken from 4ARForcing (file PCM1_A1.nc). Sulfate aerosol changes were used from 2-dimensional data in 4ARForcing (burden…). Linear interpolation in time was used to obtain instantaneous values of these values. CFC11, CFC-12 were not taken into account. Ozone changes were not taken into account, Ozone monthly climatology was prescribed as for AMIP II (Wang et al, 1995). Solar constant and volcanic aerosols were specified as in year 2000 of run 20C3M.

3. 550 ppm stabilization experiment (SRES B1).

Initial condition was the end of run for XX century (20C3M), 01 Jan 2001.

Temporal changes of CO2, CH4, N2O were taken from 4ARForcing (file PCM1_B1.nc). Sulfate aerosol changes were used from 2-dimensional data in 4ARForcing (burden…). Linear interpolation in time was used to obtain instantaneous values of these values. CFC11, CFC-12 were not taken into account. Ozone changes were not taken into account, Ozone monthly climatology was prescribed as for AMIP II (Wang et al, 1995). Solar constant and volcanic aerosols were specified as in year 2000 of run 20C3M.

4. SRES A2 experiment.

Initial condition was the end of run for XX century (20C3M), 01 Jan 2001.

Temporal changes of CO2, CH4, N2O were taken from 4ARForcing (file PCM1_A2.nc). Sulfate aerosol changes were used from 2-dimensional data in 4ARForcing (burden…). Linear interpolation in time was used to obtain instantaneous values of these values. CFC11, CFC-12 were not taken into account. Ozone changes were not taken into account, Ozone monthly climatology was prescribed as for AMIP II (Wang et al, 1995). Solar constant and volcanic aerosols were specified as in year 2000 of run 20C3M.

5. Committed climate change experiment.

Initial condition was the end of run for XX century (20C3M).
All forcings were prescribed as for year 2000 of 20C3M.

6. Pre-industrial control experiment.

Initial condition was taken the same as for 20C3M.

During the run, all forcings were prescribed as in year 1871 of 20C3M.

7. 1%/year CO2 increase experiment (to doubling).

Initial condition was taken the same as for 20C3M.

During the run, all forcings except CO2 were prescribed as in year 1871 of 20C3M.

8. 1%/year CO2 increase experiment (to quadrupling).

Initial condition was taken the same as for 20C3M.

During the run, all forcings except CO2 were prescribed as in year 1871 of 20C3M.
The first 70 years of this experiment are the same as the first 70 years of experiment to doubling.

9. SLAB ocean control experiment.

At the beginning, observed SST and zero sea ice were specified. 30-year run was performed from this state. The end of 20-year run was the start point of considered experiment.

10. 2xCO2 equilibrium experiment.

From start point for SLAB ocean control experiment, 20-year run with doubling of CO2 was performed. The end of 20-year run was the start point of considered experiment.

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