Model Information of Potential Use to the IPCC Lead Authors and the AR4.
INGV-SXG Model
20 December 2006

I. Model identity:

A. Institution, sponsoring agency, country
Istituto Nazionale di Geofisica e Vulcanologia, Italy.

B. Model name (and names of component atmospheric, ocean, sea ice, etc. models)
INGV-SXG (SINTEX-G). ECHAM4.6, OPA8.2, LIM(Louvain-La-Neuve sea-ice model).

C. Vintage
2005.

D. General published references and web pages
- *https://www.cmcc.it/web/public/ANS/models/ingv-sxg*
- *Gualdi, S., E. Scoccimarro and A. Navarra (2006).*
- *Bellucci, A., S.Gualdi , E. Scoccimarro and A. Navarra (2006).*

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.
None.

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.)
Climate sensitivity parameter is 1.02, if estimated from slab ocean experiments: control and CO2 doubling: $\Delta T=2.44K$; adjusted forcing at the tropopause: 2.40 Wm-2.
Climate sensitivity parameter is 0.78, if estimated from transient expt: control and CO2 doubling: $\Delta T=1.86K$; adjusted forcing at the tropopause: 2.40 Wm-2.

G. Contacts (name and email addresses), as appropriate, for:
1. coupled model: *Silvio Gualdi. gualdi@bo.ingv.it*
2. atmosphere: *Eric Roeckner. roeckner@dkrz.de*
3. ocean: *Gurvan Madec. madec@lodyc.jussieu.fr*
4. sea ice: *Thierry Fichefet. fichefet@astr.ucl.ac.be*
5. land surface
6. vegetation
7. other?

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?
only direct effect of sulfate 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.

COPES (Coordinated Observation and Prediction of the Earth System).
No.

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

A. Atmosphere *(Roeckner et al., 1996)*

1. resolution:
   horizontal res: T106 (about 1.125^o x1.125^o).
   vertical res: L19
2. numerical scheme/grid : *spectral; hybrid sigma-pressure coordinate; top level at 10 hPa; 7 layers above 200 hPa, 5 layers below 850 hPa; semi-implicit leap-frog time stepping; transport of water vapor, cloud water, and (optionally) tracers by a semi-lagrangian scheme (Williamson and Rasch, 1994);*
3. list of prognostic variables : *vorticity, divergence, temperature, log surface pressure, water vapor, mixing ratio of total cloud water;*

4. major parametrizations:
   a. *clouds: Sundquist(1978) type prognostic scheme for stratiform fractional clouds; optical cloud properties and cloud water determined by Mie theory (Rockel et al., 1991; Roeckner, 1995);*
   b. *convection: shallow, mid-level, and deep cumulus convection with Tiedke (1989) mass flux scheme and adjustment closure for deep convection as described by Nordeng (1996);*
   c. *boundary layer: surface fluxes of momentum, heat, water vapor, and cloud water calculated with Monin-Obukhov theory (Luis, 1979), with eddy diffusivity coefficients depending on roughness length and Richardson No.; above the surface layer, the coefficients depend on wind shear, thermal stability, and mixing length;*
   d. *SW radiation: Fouquart and Bonnel(1980), LW radiation: Morcrette et al. (1986) includes methane, nitrous oxide, and 16 CFC species, ozone (14.6 µm), and various types of aerosols (optional) effects; revised water vapor continuum (Giorgetta and Wild, 1995);*

B. Ocean OPA8.2

1. resolution:
   quasi-isotrope tri-polar grid (2 poles in the northern hemisphere, one over Canada and the other over Siberia. 2° resolution Mercator grid (i.e. $\Delta x = \Delta y$) with enhanced meridional resolution in the vicinity of the equator and in Med and Red seas (1°)

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

time-stepping : *leap-frog except for lateral diffusion (forward) and vertical diffusion (backward)*
vertical coordinate *: z-coordinate*
free surface.

3. list of prognostic variables and tracers:
   U, V, T, S, TKE

4. name, terse descriptions, and references (journal articles, web pages) for all parameterizations. Include, as appropriate, descriptions of:
   All the description of the model physics can be found in the OPA reference manual (Madec at al 1999) available on the web (http://www.lodyc.jussieu.fr/opa/).

   a. *eddy parameterization*
      Isopycnal mixing on tracers (no horizontal background) with a constant coefficient of 2000 m2/s. Eddy induced velocity with a coefficient varying in function of the growth rate of baroclinic instability (ranges 15 m2/s to 2000 m2/s). Note that the coefficient is set to 0 in the vicinity of the equator.
   b. *bottom boundary layer treatment and/or sill overflow treatment*
      diffusive bottom boundary layer (Beckmann and Dorscher 1997)

   c. *mixed-layer treatment*
      TKE scheme (Blanke and Delecluse JPO, 1993 + modification Madec et al. 1999)

   d. *sunlight penetration*
      yes with 2 master lengths (Blanke and Delecluse 1993)
   e. *tidal mixing*
      None.
   f. *river mouth mixing*
      None.
   g. *mixing isolated seas with the ocean*
      no mixing (Red and Med seas are explicitly connected to the remaining ocean) . For closed "seas" (Black Sea, Great lakes, Caspian Seas) the mean sea level remain constant, excess (deficit) of water been either redistributed over the world ocean (Caspian Sea) or in St Laurent river mouth (Great lakes) or Dardanel strait area (Black Sea).

   h. *treatment of North Pole "singularity" (filtering, pole rotation, artificial island?)*
      semi analytical tri-polar grid, no singular point in the ocean domain. based on Madec and Imbar (Clim. Dyn. 1996) and Murray (JCP 1996).

C. sea ice LIM
   1. horizontal resolution, number of layers, number of thickness categories:

- *Horizontal resolution: same as ocean model (2° in longitude and roughly 2° cos(phi) in latitude; equations for ice motion and transport written in curvilinear, orthogonal coordinates; staggered spatial grid of type B).*
- *Number of layers: 3 (1 in snow and 2 in ice).*
- *Number of thickness categories: 2 (level ice and leads).*

2. numerical scheme/grid, including advection scheme, time-stepping scheme:
   - *Heat-diffusion equation: fully implicit scheme.*
   - *Momentum equation: semi-implicit scheme (combination of a modified Euler time step scheme and a point successive relaxation procedure).*
   - *Advection equations: forward time marching scheme which conserves the second-order moments of the spatial distribution of the advected quantities.*

3. list of prognostic variables
   - *snow thickness;*
   - *ice thickness;*
   - *ice concentration;*
   - *ice velocity;*
   - *internal temperatures of snow and ice;*
   - *heat content of brine reservoir.*

4. completeness (dynamics? rheology? leads? snow treatment on sea ice)
   - *Effective thermal conductivity to account for the effect of the subgrid-scale snow- and ice-thickness distributions on sea-ice thermodynamics.*
   - *Surface albedo dependent on the state of the surface (frozen or melting), the thickness of the snow and ice covers, and the cloudiness.*
   - *Parameterisation of leads.*
   - *Snow-ice formation scheme.*
   - *Viscous-plastic rheology.*

5. treatment of salinity in ice
   - *Constant ice salinity.*
   - *Heat reservoir to account for the storage of latent heat inside the ice resulting from trapping of shortwave radiation by brine pockets*

6. brine rejection treatment
   - *Salt rejected during ice accretion and snow-ice formation is put in the first oceanic layer.*

7. treatment of the North Pole "singularity" (filtering, pole rotation, artificial island?)
   - *Same as ocean model (pole rotation).*

D. **land / ice sheets** (some of the following may be omitted if information is clearly included in cited references.
None.

E. coupling details
1. frequency of coupling

atm - ocean: 1.5 hours.
ocean - sea-ice: 1.5 hours.

2. Are heat and water conserved by coupling scheme?
   Water: No.
   Heat: Yes.
3. list of variables passed between components:
   a. atmosphere – ocean
      1. *Net short wave over open ocean.*
      2. *Non solar flux over open ocean.*
      3. *Water budget over open ocean.*
      4. *Wind stresses over open ocean.*
      5. *Ocean surface temperature over open ocean.*

   b. atmosphere – land

   c. land – ocean

   d. sea ice – ocean
      1. *Stress under sea ice.*
      2. *Fresh water flux (concentration/dilution) .*
      3. *Fresh water flux (volume flux for free surface) .*
      4. *Sea ice fraction.*
      5. *Ocean surface temperature .*
      6. *Ocean surface salinity .*
      7. *Surface current.*

   e. sea ice – atmosphere
      1. *Net short wave on sea ice .*
      2. *Non solar heat flux on sea ice .*
      3. *Solid precipitation .*
      4. *Wind stress over sea ice.*
      5. *Sea ice fraction .*

4. Flux adjustment? (heat?, water?, momentum?, annual?, monthly?).
   None.

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

picntrl

This preindustrial control simulation was initialized as follows: Ocean starting from temperature and salinity profiles specified from Levitus (1982) climatology; Atmosphere starting from a restart provided by a previous INGV coupled run . 50 years of speen-up have been performed. Preindustrial 1870 greenhouse gases concentrations have been used during the 100 years of picntrl run.

20C3M

This simulation was initialized from the last year of the picntrl simulation. The greenhouse gases annual global concentrations were specified based on observations as specified in the ENSEMBLES project webpage:(http://www.cnrm.meteo.fr/ensembles/public/results/results.html). Sulfate aerosols are specified according to Boucher and Pham (2002) data (http://www-loa.univ-lille1.fr/~boucher/sres/). Results are given for the years 1870 to 2000.

SRESA1B

This simulation was initialized from January/2000 of the 20C3M simulation. The greenhouse gases annual global concentrations were specified based on scenario SRES A1B as specified in the ENSEMBLES project webpage (http://www.cnrm.meteo.fr/ensembles/public/results/results.html). Sulfate aerosols are specified according to Boucher and Pham (2002) data (http://www-loa.univ-lille1.fr/~boucher/sres/) Results are given for years 2000 to 2100.

1pctto2x

This simulation was initialized from the last year of picntrl simulation. This initial state corresponds to nominal year 1870. The concentrations of greenhouse gases are held constant at preindustrial levels, except for CO2, which increases from its preindustrial level at the rate of 1% per year, until the initial concentration is doubled. From the time of doubling the concentrations of all radiative forcing are held constant. Results are given for nominal years 1870 to 2030.

1pctto4x

This simulation was initialized from the last year of picntrl simulation. This initial state corresponds to nominal year 1870. The concentrations of greenhouse gases are held constant at preindustrial levels, except for CO2, which increases from its preindustrial level at the rate of 1% per year, until the initial concentration is quadrupled. From the time of doubling the concentrations of all radiative forcing are held constant. Results are given for nominal years 1870 to 2099.

VI. References

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