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

FGOALS-g1.0

31 January 2005

I. Model identity:

A. Institution, sponsoring agency, country

LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences, P.O. Box 9804, Beijing 100029, P. R. China

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

Name of the coupled GCM: FGOALS1.0_g (TAR=GOALS)
Name of AGCM: GAMIL1.0 (TAR=R15L9)
Name of OGCM: LICOM1.0 (TAR=ML20)
Name of sea ice model: NCAR CSIM4
Name of land model: NCAR CLM2

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

2004

D. General published references and web pages

Yu Yongqiang, Zhang Xuehong, Guo Yufu, 2004: Global coupled ocean- atmosphere general circulation models in LASG/IAP. *Adv. Atmos. Sci.*, 21, 444-455.

Yu Yongqiang, Yu Rucong, Zhang Xuehong, and Liu Hailong, 2002: A flexible global coupled climate model. *Adv. Atmos. Sci.*, Vol. 19, 169-190.

http://web.lasg.ac.cn/FGCM/index.htm

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.

Liu Hailong, Zhang Xuehong, Li Wei, Yu Yongqiang, and Yu Rucong, 2004: An eddy-permitting oceanic general circulation model and its preliminary evaluations, *Adv. Atmos. Sci.*, Vol. 21, 675-690.

Wang Bin, Wan Hui, Ji Zongzhen, Zhang Xin, Yu Rucong, Yu Yongqiang, and Liu Hongtao, 2004: Design of a new dynamical core for global atmospheric models based on some efficient numerical methods. *Science in China*, *Series A*, Vol.47 Suppl., 4-21.

Zhang Xuehong, Yu Yongqiang, Yu Rucong, Liu Hailong, Zhou Tianjun, and Li Wei, 2003: Assessments of an OGCM and the relevant CGCM Part I: Annual mean simulations in the tropical ocean. *Chinese J. Atmos. Sci.*, 27, 649-970. (In Chinese)

Zhang Xuehong, Yu Yongqiang, and Liu Hailong, 2003: The development and application of the oceanic circulation models, Part I. The global oceanic general circulation models. *Chinese J. Atmos. Sci.*, 27, 607-617. (In Chinese)

Liu Hailong, Yu Yongqiang, Zhang Xuehong, and Li Wei, 2004: Manual for LASG/IAP Climate system ocean model. *Science Press*, Beijing, 1 - 128pp. (In Chinese)

Liu Xiying, Zhang Xuehong, Yu Yongqiang, and Yu Rucong, 2004: Mean climatic characteristics in high northern latitudes in an ocean-sea ice-atmosphere coupled model. *Adv. Atmos. Sci.*, 21, 236-244.

Ma Xiaoyan， Guo Yufu， Shi Guangyu, and Yu Yongqiang, 2004: Numerical simulation of global temperature change over the 20th century with IAP/LASG GOALS model. *Adv. Atmos. Sci.*, 21, 234-242.

Jin X. Z., X. H. Zhang, and T. J. Zhou, 1999, Fundamental framework and experiments of the third generation of IAP/LASG world ocean general circulation model, *Adv. Atmos. Sci.*, 16, 197-215

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.)

G. Contacts (name and email addresses), as appropriate, for:
1. coupled model (Dr. Yongqiang Yu, yyq@lasg.iap.ac.cn)
2. atmosphere (Dr. Bin Wang, wab@lasg.iap.ac.cn)
3. ocean (Dr. Yongqiang Yu, yyq@lasg.iap.ac.cn and Dr. Hailong Liu, lhl@lasg.iap.ac.cn)
4. sea ice (Dr. Yongqiang Yu, yyq@lasg.iap.ac.cn)
5. land surface (Dr. Yongqiang Yu, yyq@lasg.iap.ac.cn)
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? ***Sulfate aerosols***.

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.

Coupled GCM: CMIP1, CMIP2, 20C3M
AGCM: SMIP

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

A. Atmosphere

1. resolution:

   2.8lon x about 2.8lat, L26

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 method, a semi-implicit time-stepping scheme with exact quadratic conservations; two-step shape-preserving advection scheme.

   The T42 gaussian grid is used between 65.58ºN and 65.58ºS, while a weighted even-area grid is used elsewhere (Wang et al 2004, Sci. China. Ser. A, 47,4-21). Vertically, there are 26 layers in a σ-coordinate, with the model top situated on a isobaric surface of 2.194 hPa. There are 13 layers above 200hPa and 4 layers below 850hPa.

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.)

   Temperature, northward and eastward wind components, surface pressure, specific humidity, ice water, liquid water

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

   a. clouds

      Cloud amount is evaluated via a diagnostic method which is a generalization of the scheme introduced by Slingo (1987, Q. J. R. Meteorol. Soc., 113, 899-927), with variations described in Hack et al. (1993, Technical Report NCAR/TN-382+STR,122pp), Kiehl et al. (1998, J. Climate, 11,1131-1149) and Rasch and Kristjansson (1998, J. Climate, 11,1587-1614).

   b. Convection

      Mass-flux scheme designed by Zhang and McFarlane(1995, Atmos.-Ocean, 33, 407) for deep convection, and the scheme by Hack (1994, J. Geophys. Res., 99, 5551) for middle/shallow convection.

   c. boundary layer

      An explicit and non-local scheme, as discussed by Holtslag and Boville (1993,J. Climate, 6,1825-1842)

   d. SW, LW radiation

      The longwave scheme is based on Ramanathan and Downey (1986, J. Geophys. Res., 90,5547-5566), and the shortwave scheme is described in Collins (2003)

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

      The vertical velocity is set to be zero at top of model.

B. Ocean

1. resolution

$1^o X 1^o$

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

Uniform longitude-latitude grid without shift poles.
Leap-frog time integration scheme.
Free surface.
Eta vertical coordinate.
Freshwater flux.

3. list of prognostic variables and tracers

Sea surface height, temperature, salinity, horizontal velocity

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

   a. eddy parameterization

   GM90 scheme from MOM2 (Gent, P.R., McWilliams, J.C., 1990. Isopycnal mixing in ocean circulation models. Journal of Physical Oceanography, 20, 150-155.)

   b. bottom boundary layer treatment and/or sill overflow treatment

   No

   c. mixed-layer treatment

   PP scheme within 30S-30N (Pacanowski, R.C., Philander, G., 1981. Parametrization of vertical mixing in numerical models of the tropical ocean. Journal of Physical Oceanography 11, 1442-1451.)

   vertical mixing is treated as a constant outside the tropic area.

   d. sunlight penetration

   MOM2's method described by Rosati, A and K., Miyakoda(1988, J. Phys. Oceanogr., 18, 1601-1626.)

   e. tidal mixing

   No

   f. river mouth mixing

   No

   g. mixing isolated seas with the ocean

   No

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

   Filtering with a artificial island at the polar.

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

horizontal resolution, , *$1^o X 1^o$*
number of layers: 16
number of thickness categories: 5

   2. numerical scheme/grid, including advection scheme, time-stepping scheme,

advection scheme: Up-wind

   3. list of prognostic variables

Sea ice fraction, zonal and meridional sea ice velocity, sea ice thickness, snow thickness

   4. completeness

dynamics, rheology, leads, snow treatment on sea ice)

   5. treatment of salinity in ice

No

   6. brine rejection treatment

Yes

   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.
   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

One day for oceanic model and one hour for atmospheric, land and sea ice models.

   2. Are heat and water conserved by coupling scheme?

No.

   3. list of variables passed between components:
      a. atmosphere – ocean
      b. atmosphere – land
      c. land – ocean
      d. sea ice – ocean
      e. sea ice – atmosphere

a,b,c,d,e

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

No.

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.

A. Picntrl
B. Firstly, the each component model is integrated with the observed climatologically forcing, e.g. 10 model years for land and atmospheric model, and 500 model years for OGCM. Secondly, the coupled model was integrated 100 years from the last year of uncoupled model integration, which can be defined as CGCM spin-up. Finially, the initial condition of the experiment "Picntr " is from the last year of the CGCM spin-up integration in the second step.
C. No non-antropogenic aerosols included. Solar constant is 1367 W/M*M.
D. /

A. 20C3M
B. The initial conditions of 20C3M ensemble simulations are from the 1st January of year 1850,1855 and 1860 of the experiment Picntr, respectively.
C./
D. CO2, N2O, CH4, CFC11, CFC12; climatologic mean ozone ; sulfate aerosol data from ftp://sprite.llnl.gov/pub/covey/IPCC_4AR_Forcing/

A. Commit
B. The initial conditions of Commit ensemble simulations are from the 1st January of year 2000 of the corresponding experiment 20C3M, respectively.
C./

D. CO2, N2O, CH4, CFC11, CFC12; climatologic mean ozone; sulfate aerosol data from ftp://sprite.llnl.gov/pub/covey/IPCC_4AR_Forcing/

A. SRESA1B
B. The initial conditions of SRESA1B ensemble simulations are from the 1st January of year 2000 of the corresponding experiment 20C3M, respectively.
C./
D. CO2, N2O, CH4, CFC11, CFC12; climatologic mean ozone; sulfate aerosol data from ftp://sprite.llnl.gov/pub/covey/IPCC_4AR_Forcing/

A. SRESB1
B. The initial conditions of SRESB1 ensemble simulations are from the 1st January of year 2000 of the corresponding experiment 20C3M, respectively.
C./
D. CO2, N2O, CH4, CFC11, CFC12; climatologic mean ozone ; sulfate aerosol data from ftp://sprite.llnl.gov/pub/covey/IPCC_4AR_Forcing/

A. 1%to2x
B. The initial conditions of 1%to2x ensemble simulations are from the 1st January of year 1850,1855 and 1860 of the experiment Picntr, respectively.
C./
D. CO2 increases by 1% per year from 280ppm. The other forcing is same as Picntr.