SUPPLEMENT

# HOW WELL DO COUPLED MODELS SIMULATE TODAY'S CLIMATE?

## Model Identifiers and Characteristics

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This document is a supplement to "How Well Do Coupled Models Simulate Today's Climate?," by Thomas Reichler and Junsu Kim (*Bull. Amer. Meteor. Soc.*, **89,** 303–311) • ©2008 American Meteorological Society • Corresponding author: Thomas Reichler, Department of Meteorology, University of Utah, 135 S 1460 E, Rm 819 (WBB), Salt Lake City, UT 84112-0110 • E-mail: reichler@utah.edu • DOI: 10.1175/BAMS-89-3-Reichler.

Tables S1 to S3 list the names and identifiers of the different models investigated in this study along with some of their main characteristics.

**TABLE S1. Identifiers and characteristics of the CMIP-1 models included in this study. Grid resolution: longitude x latitude. *L* denotes number of vertical layers. The column for flux adjustment uses the following notation: H: heat; M: momentum; W: water; X: none.**

| ID | Short Name | Model | Atmosphere | Ocean | Reference | Flux Adj. |
|---|---|---|---|---|---|---|
| 01 | BMRC | BMRC1, Australia | R21 (5.6 x 3.2), L9 | 5.6 x 3.2, L12 | Power et al. 1993 | X |
| 02 | CCCMA | CCCma1, Canada | T32 (3.8 x 3.8), L10 | 1.8 x 1.8, L29 | Boer et al. 2000 | H, W |
| 03 | CCSR | CCSR, Japan | T21 (5.6 x 5.6), L20 | 2.8 x 2.8, L17 | Emori et al. 1999 | H, W |
| 04 | CERFACS | CERFACS1, France | T21 (5.6 x 5.6), L30 | 2.0 x 2.0, L31 | Guilyardi and Madec 1997 | X |
| 05 | COLA | COLA1, United States | R15 (7.5 x 4.5), L9 | 1.5 x 1.5, L20 | Schneider and Zhu 1998 | X |
| 06 | CSIRO | CSIRO, Australia | R21 (5.6 x 3.2), L9 | 5.6 x 3.3, L21 | Gordon and O'Farrell 1997 | H, W, M |
| 07 | GFDL | GFDL_R15_a, United States | R15 (7.5 x 4.5), L9 | 3.7 x 4.5, L12 | Manabe and Stouffer 1996 | H, W |
| 08 | GISSM | GISS (Miller), United States | 5.0 x 4.0, L9 | 5.0 x 4.0, L16 | Miller and Jiang 1996 | X |
| 09 | GISSR | GISS (Russell), United States | 5.0 x 4.0, L9 | 5.0 x 4.0, L13 | Russell et al. 1995 | X |
| 10 | IAP | IAP/LASG1, China | R15 (7.5 x 4.5), L9 | 5.0 x 4.0, L20 | Zhang et al. 2000 | H, W, M |
| 11 | LMD | LMD/IPSL1, France | 3.8 x 5.6, L15 | 2.0 x 2.0, L31 | Braconnot et al. 1997 | X |
| 12 | MPIE3 | ECHAM3+LSG, Germany | T21 (5.6 x 5.6), L19 | 4.0 x 4.0, L11 | Voss et al. 1998 | H, W, M |
| 13 | MPIE4 | ECHAM4+OPYC3 | T42 (2.8 x 2.8), L19 | 2.8 x 2.8, L11 | Roeckner et al. 1996 | H, W, M |
| 14 | MRI | MRI1, Japan | 5.0 x 4.0, L15 | 2.5 x 2.0, L21 | Tokioka et al. 1996 | H, W |
| 15 | NCARCSM | NCAR (CSM), United States | T42 (2.8 x 2.8), L18 | 2.4 x 2.0, L45 | Boville and Gent 1998 | X |
| 16 | NCARWM | NCAR (WM), United States | R15 (7.5 x 4.5), L9 | 1.0 x 1.0, L20 | Washington et al. 2000 | X |
| 17 | NRL | NRL1, United States | T47 (2.5 x 2.5), L18 | 2.0 x 1.0, L25 | Li and Hogan 1999 | H, W |
| 18 | UKMO | UKMO (HadCM2), United Kingdom | 3.75 x 2.5, L19 | 3.75 x 2.5, L20 | Johns et al. 1997 | H, W |

**Table S2. As in Table S1 but for CMIP-2 models.**

| ID | Short Name | Model | Atmosphere | Ocean | Reference | Flux Adj. |
|---|---|---|---|---|---|---|
| a | BMRC | BMRC, Australia | R21 (5.6 x 3.2), L17 | 5.6 x 3.2, L12 | Colman 2001 | H, W, sfc SW rad. |
| b | CCCM | CCCma, CGCM1, Canada | T32 (3.8 x 3.8), L10 | 1.8 x 1.8, L29 | Kim et al. 2003 | H, W |
| c | CCSR | CCSR, Japan | T21 (5.6 x 5.6), L20 | 2.8 x 2.8, L17 | Emori et al. 1999 | H, W |
| d | CERF | CERFACS2 (ARPEGE/OPA2), France | T31 (3.9 x 3.9), L19 | 2.0 x 2.0, L31 | Barthelet et al. 1998 | X |
| e | CSIRO | CSIRO(Mk2), Australia | R21 (5.6 x 3.2), L9 | 5.6 x 3.2, L21 | Hirst et al. 2000 | H, W, M |
| f | MPIE3 | ECHAM3+LSG, Germany | T21 (5.6 x 5.6), L19 | 4.0 x 4.0, L11 | Voss et al. 1998 | H, W, M |
| g | GFDL | GFDL_R15_a, United States | R15 (7.5 x 4.5), L9 | 3.7 x 4.5, L12 | Dixon et al. 2003 | H, W |
| h | GISS | GISS (Russell), United States | 5.0 x 4.0, L9 | 5.0 x 4.0, L13 | Russell and Rind 1999 | X |
| i | IAP | IAP/LASG2, China | R15 (7.5 x 4.5), L9 | 5.0 x 4.0, L20 | Zhang et al. 2000 | H, W, M |
| j | LMD | LMD/IPSL2, France | 5.6 x 3.8, L15 | 2.0 x 2.0, L31 | Laurent et al. 1998 | X |
| k | MRI | MRI2 (Tokioka), Japan | 5.0 x 4.0, L15 | 2.5 x 2.0, L21 | Tokioka et al. 1996 | H, W |
| l | NCARC | NCAR(CSM), United States | T42 (2.8 x 2.8), L26 | 1.0 x (0.3–1.0), L40 | Buja and Craig 2002 | X |
| m | NCARW | NCAR-WM, United States | R15 (7.5 x 4.5), L9 | 1.0 x 1.0, L20 | Washington and Meehl 1996 | X |
| n | NRL | NRL2, Monterey | T47 (2.5 x 2.5), L18 | 1.0 x 1.0, L25 | Li and Hogan 1999 | H, W |
| o | PCM | DOE-PCM, United States | T42 (2.8 x 2.8), L18 | 0.67 x 0.67, L32 | Washington et al. 2000 | X |
| p | UKMO | UKMO (HadCM2), United Kingdom | 3.75 x 2.5, L19 | 3.75 x 2.5, L20 | Johns et al. 1997 | H, W |
| q | UKMO3 | UKMO (HadCM3), United Kingdom | 3.75 x 2.5, L19 | 1.25 x 1.25, L20 | Gordon et al. 2000 | X |

**Table S3. As in Table S1 but for CMIP-3 models.**

| ID | Short name | Model | Atmosphere | Ocean | Reference | Flux Adj. |
|---|---|---|---|---|---|---|
| C | MIRCH | MIROC3.2 (hires), Japan | T106, L56 | 0.28 x 0.19, L47 | K-1-model-developers 2004 | X |
| D | MIRCM | MIROC3.2 (medres), Japan | T42, L20 | 1.4 x (0.5–1.4) L43 | K-1-model-developers 2004 | X |
| F | BCCRC | BCCR-BCM2.0, Norway | T63, L31 | 1.5 x 0.5, L35 | Furevik et al. 2003 | X |
| G | C3T47 | CGCM3.1 (T47), Canada | T47 (3.75 x 3.75), L31 | 1.85 x 1.85, L29 | Kim et al. 2002 | H,W |
| H | C3T63 | CGCM3.1 (T63), Canada | T63 (2.8 x 2.8), L 31 | 1.4 x 0.94, L29 | Flato and Boer 2001 | H,W |
| I | CNRMC | CNRM-CM3, France | T63 (2.8 x 2.8), L45 | 1.875 x (0.5–2), L31 | Salas-Melia et al. 2005, manuscript submitted to *Climate Dyn.* | X |
| J | CSIRO | CSIRO-Mk3.0, Australia | T63, L18 | 1.875 x 0.84, L31 | Gordon et al. 2002 | X |
| K | GFD20 | GFDL-CM2.0, United States | 2.5 x 2.0, L24 | 1.0 x (1/3–1), L50 | Delworth et al. 2006 | X |
| L | GFD21 | GFDL-CM2.1, United States | 2.5 x 2.0, L24 | 1.0 x (1/3–1), L50 | Delworth et al. 2006 | X |
| M | GISSA | GISS-AOM, United States | 4 x 3, L12 | 4 x 3, L16 | Lucarini and Russell 2002 | X |
| N | GISSH | GISS-EH, United States | 5 x 4, L20 | 5 x 4, L13 | Schmidt et al. 2006 | X |
| O | GISSR | GISS-ER, United States | 5 x 4, L20 | 5 x 4, L13 | Schmidt et al. 2006 | X |
| P | IAPFG | IAP-FGOALS1-0-G, China | 2.8 x 2.8, L26 | 1 x 1, L16 | Yu et al. 2004 | X |
| Q | INMCM | INM-CM3.0, Russia | 5 x 4, L21 | 2.5 x 2, L33 | Volodin and Diansky 2004 | W |
| R | IPSLC | IPSL-CM4, France | 2.5 x 3.75, L19 | 2 x (1–2), L30 | Marti et al. 2005 | X |
| S | MPICM | ECHAM5/MPI-OM | T63, L32 | 1 x 1, L41 | Min et al. 2005 | X |
| T | MRICM | MRI-CGCM2-3-2A, Japan | T42, L30 | 2.5 x (0.5-2.0) | Yukimoto and Noda 2002 | H,M,W |
| U | NCARC | NCAR-CCSM3, United States | T85L26, 1.4 x 1.4 | 1 x (0.27–1), L40 | Collins et al. 2005 | X |
| V | NCARP | NCAR-PCM, United States | T42 (2.8 x 2.8), L18 | 1 x (0.27–1), L40 | Kiehl and Gent 2004 | X |
| W | UKMOC | UKMO-HadCM3, United Kingdom | 3.75 x 2.5, L19 | 1.25 x 1.25, L20 | Gordon et al. 2000 | X |
| X | UKMOG | UKMO-HadGEM1, United Kingdom | 1.875 x 1.25, L38 | 1.25 x 1.25, L20 | Johns et al. 2004 | X |
| Y | INGVE | INGV-SXG, Italy | T42, L19 | 2 x (0.5-2), L31 | Gualdi et al. 2003 | X |

## REFERENCES


Barthelet, P., and Coauthors, 1998: Simulations couplees globales de changements climatiques associes a une augmentation de la teneur atmospherique en CO2. *C. R. Acad. Sci. Paris*, **326,** 677–684.

Boer, G. J., G. Flato, and D. Ramsden, 2000: A transient climate change simulation with greenhouse gas and aerosol forcing: Projected climate to the twenty-first century. *Climate Dyn.*, **16,** 427–450.

Boville, B. A., and P. R. Gent, 1998: The NCAR Climate System Model, version one. *J. Climate*, **11,** 1115–1130.

Braconnot, P., O. Marti, and S. Joussaume, 1997: Adjustment and feedbacks in a global coupled ocean-atmosphere model. *Climate Dyn.*, **13,** 507–519.

Buja, L., and T. Craig, 2002: CCSM2.0.1 User's Guide. Available online at www.ccsm.ucar.edu/models/ccsm2.0.1/ccsm.

Collins, N., and Coauthors, 2005: Design and implementation of components in the Earth System Modeling Famework. *Int. J. High Perform. Comput. Appl.*, **19,** 341–350.

Colman, R. A., 2001: On the vertical extent of atmospheric feedbacks. *Climate Dyn.*, **17,** 391–405.

Delworth, T. L., and Coauthors, 2006: GFDL's CM2 global coupled climate models. Part I: Formulation and simulation characteristics. *J. Climate*, **19,** 643–674.

Dixon, K. W., T. L. Delworth, T. R. Knutson, M. J. Spelman, and R. J. Stouffer, 2003: A comparison of climate change simulations produced by two GFDL coupled climate models. *Global Planet. Change*, **37,** 81–102.

Emori, S., T. Nozawa, A. Abe-Ouchi, A. Numaguti, M. Kimoto, and T. Nakajima, 1999: Coupled ocean–atmosphere model experiments of future climate change with an explicit representation of sulfate aerosol scattering. *J. Meteor. Soc. Japan*, **77,** 1299–1307.

Flato, G. M., and G. J. Boer, 2001: Warming asymmetry in climate change simulations. *Geophys. Res. Lett.*, **28,** 195–198.

Furevik, T., M. Bentsen, H. Drange, I. K. T. Kindem, N. G. Kvamstø, and A. Sorteberg, 2003: Description and validation of the Bergen Climate Model: ARPEGE coupled with MICOM. *Climate Dyn.*, **21,** 27–51.

Gordon, C., C. Cooper, C. A. Senior, H. Banks, J. M. Gregory, T. C. Johns, J. F. B. Mitchell, and 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. *Climate Dyn.*, **16,** 147–168.

Gordon, H. B., and S. P. O'Farrell, 1997: Transient climate change in the CSIRO coupled model with dynamic sea ice. *Mon. Wea. Rev.*, **125,** 875–908.

——, and Coauthors, 2002: The CSIRO Mk3 climate system model. CSIRO Atmospheric Research Tech. Rep. 60, 134 pp.

Gualdi, S., A. Navarra, E. Guilyardi, and P. Delecluse, 2003: Assessment of the tropical Indo-Pacific climate in the SINTEX CGCM. *Ann. Geophys.*, **46,** 1–26.

Guilyardi, E., and G. Madec, 1997: Performance of the OPA/ARPEGE-T21 global ocean–atmosphere coupled model. *Climate Dyn.*, **13,** 149–165.

Hirst, A. C., S. P. O'Farrell, and H. B. Gordon, 2000: Comparison of a coupled ocean–atmosphere model with and without oceanic eddy-induced advection. Part 1: Ocean spin-up and control integrations. *J. Climate*, **13,** 139–163.

Johns, T. C., R. E. Carnell, J. F. Crossley, J. M. Gregory, J. F. B. Mitchell, C. A. Senior, S. F. B. Tett, and R. A. Wood, 1997: The second Hadley Centre coupled ocean–atmosphere GCM: Model description, spinup and validation. *Climate Dyn.*, **13,** 103–134.

——, and Coauthors, 2004: HadGEM1—Model description and analysis of preliminary experiments for the IPCC Fourth Assessment Report. Tech. Rep. 55, Met Office, Exeter, United Kingdom.

K-1-model-developers, 2004: K-1 coupled model (MIROC) description. Center for Climate System Research, University of Tokyo.

Kiehl, J. T., and P. R. Gent, 2004: The Community Climate System Model, Version 2. *J. Climate*, **17,** 3666–3682.

Kim, S.-J., G. M. Flato, G. J. Boer, and N. A. McFarlane, 2002: A coupled climate model simulation of the Last Glacial Maximum, Part 1: Transient multi-decadal response. *Climate Dyn.*, **19,** 515–537.

——, G. M. Flato, and G. J. Boer, 2003: A coupled climate model simulation of the Last Glacial Maximum, Part 2: Approach to equilibrium. *Climate Dyn.*, **20,** 635–661.

Laurent, C., H. LeTreut, Z. X. Li, L. Fairhead, and J. L. Dufresne, 1998: The influence of resolution in simulating inter-annual and inter-decadal variability in a coupled ocean–atmosphere GCM with emphasis over the North Atlantic. IPSL Rep. N8.

Li, T., and T. F. Hogan, 1999: The role of the annual mean climate on seasonal and interannual variability of the tropical Pacific in a coupled GCM. *J. Climate*, **12,** 780–792.

Lucarini, V., and G. L. Russell, 2002: Comparison of mean climate trends in the Northern Hemisphere between National Centers for Environmental Prediction and two atmosphere–ocean model forced runs. *J. Geophys. Res.*, **107,** 4269, doi:10.1029/2001JD001247.

Manabe, S., and R. J. Stouffer, 1996: Low-frequency variability of surface air temperature in a 1000-year integration of a coupled atmosphere–ocean–land surface model. *J. Climate*, **9,** 376–393.

Marti, O., and Coauthors, 2005: The new IPSL climate system model: IPSL-CM4. Note du Pole de Model 26, Institut Pierre Simon Laplace des Sciences de l'Environment Global, Paris, France, 86 pp.

Miller, R. L., and X. Jiang, 1996: Surface energy fluxes and coupled variability in the tropics of a coupled general circulation model. *J. Climate*, **9,** 1599–1620.

Min, S.-K., S. Legutke, A. Hense, and W.-T. Kwon, 2005: Internal variability in a 1000-year control simulation with the coupled climate model ECHO-G. Part I: Near surface temperature, precipitation, and mean sea level pressure. *Tellus*, **57A,** 605–621.

Power, S. B., R. A. Colman, B. J. McAvaney, R. R. Dahni, A. M. Moore, and N. R. Smith, 1993: The BMRC coupled atmosphere/ocean/sea-ice model. Bureau of Meteorology Research Centre Rep. 37, Melbourne, 55 pp.

Roeckner, E., J. M. Oberhuber, A. Bacher, M. Christoph, and I. Kirchner, 1996: ENSO variability and atmospheric response in a global coupled atmosphere–ocean GCM. *Climate Dyn.*, **12,** 737–754.

Russell, G. L., and D. Rind, 1999: Response to $CO_2$ transient increase in the GISS coupled model: Regional coolings in a warming climate. *J. Climate*, **12,** 531–539.

——, J. R. Miller, and D. Rind, 1995: A coupled atmosphere–ocean model for transient climate change studies. *Atmos.–Ocean*, **33,** 683–730.

Salas-Melia, D., and Coauthors, 2005: Description and validation of the CNRM-CM3 global coupled model. CNRM Working Note 103, 36 pp.

Schmidt, G. A., and Coauthors, 2006: Present-day atmospheric simulations using GISS ModelE: Comparison to in situ, satellite, and reanalysis data. *J. Climate*, **19,** 153–192.

Schneider, E. K., and Z. Zhu, 1998: Sensitivity of the simulated annual cycle of sea surface temperature in the equatorial Pacific to sunlight penetration. *J. Climate*, **11,** 1932–1950.

Tokioka, T., A. Noda, A. Kitoh, Y. Nikaidou, S. Nakagawa, T. Motoi, S. Yukimoto, and K. Takata, 1996: A transient $CO_2$ experiment with the MRI CGCM: Annual mean response. Center for Global Environmntal Research, National Institute for Environmental Studies, Environment Agency of Japan, Ibaraki, Japan, CGER-IO22-96, 86 pp.

Volodin, E. M., and N. A. Diansky, 2004: El Niño reproduction in coupled general circulation model of atmosphere and ocean. *Russ. Meteor. Hydrol.*, **12,** 5–14.

Voss, R., R. Sausen, and U. Cubasch, 1998: Periodically synchronously coupled integrations with the atmosphere–ocean general circulation model ECHAM3/LSG. *Climate Dyn.*, **14,** 249–266.

Washington, W. M., and G. A. Meehl, 1996: High-latitude climate change in a global coupled ocean–atmosphere–sea ice model with increased atmospheric $CO_2$. *J. Geophys. Res.*, **101,** 12 795–12 801.

——, and Coauthors, 2000: Parallel climate model (PCM) control and transient simulations. *Climate Dyn.*, **16,** 755–774.

Yu, Y., X. Zhang, and Y. Guo, 2004: Global coupled ocean–atmosphere general circulation models in LASG/IAP. *Adv. Atmos. Sci.*, **21,** 444–455.

Yukimoto, S., and A. Noda, 2002: Improvements of the Meteorological Research Institute Global Ocean–Atmosphere Coupled GCM(MRI-CGCM2) and its climate sensitivity. Tech.Rep. 10, NIES, Japan, 8 pp.

Zhang, X.-H., G.-Y. Shi, H. Liu, and Y.-Q. Yu, Eds., 2000: *IAP Global Atmosphere–Land System Model*. Science Press, 259 pp.