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AMIP NEWSLETTER

No. 10 **WGNE Atmospheric Model Intercomparison Project** **August 2001**

An occasional information summary and activities description for the Atmospheric Model Intercomparison Project (AMIP) of the Working Group on Numerical Experimentation (WGNE) in support of the World Climate Research Programme (WCRP). Support for AMIP is provided by the Environmental Sciences Division of the U.S. Department of Energy through the Program for Climate Model Diagnosis and Intercomparison (PCMDI) at the Lawrence Livermore National Laboratory (LLNL), where this newsletter is edited by Peter Gleckler, Chairman, WGNE AMIP Panel. Questions or comments concerning the Atmospheric Model Intercomparison Project should be sent by email (preferred) to amip@pcmdi.llnl.gov or addressed to: The AMIP Project Office, PCMDI, L-264, LLNL, P.O. Box 808, Livermore, CA, 94550, USA.

Comprehensive project information is regularly updated on the AMIP homepage at the following Web sites:

http: //www-pcmdi.llnl.gov/amip (USA)
http://www.lmd.jussieu.fr/pcmdi-mirror/amip (Europe)
http://www.BoM.GOV.AU/bmrc/clch/pcmdi-mirror/amip (Australia)

1. OVERVIEW

AMIP continues to serve as a well defined experimental protocol for global Atmospheric General Circulation Models (AGCMs). Modeling groups provide standard (prescribed SST and sea-ice) runs to PCMDI where the data are quality assured and organized according to recognized metadata conventions to facilitate diagnosis. These simulations are made available to a diverse research community via "Diagnostic Subprojects" approved by the WGNE AMIP Panel. PCMDI provides 'quick-look' simulation summaries. While this remains the basic framework for AMIP, this Newsletter edition highlights how the project is evolving in an effort to become more useful and efficient for participating modeling groups as well as other communities involved in climate research.

Despite the project's success, it has always been a struggle for PCMDI to make the complex database of simulations available in a timely manner. Happily, during the past several years the PCMDI open source software system has helped solve many of the problems associated with managing AMIP efficiently. PCMDI can now provide modelers with a rapid response performance summary of submitted runs.

Nowadays, performing an AMIP simulation is something of a routine exercise for many modeling groups. While there are definite limitations to a prescribed SST and sea-ice experiment, it still serves as an invaluable configuration for model development and the evaluation of many simulation characteristics.

Efforts are underway to increase the coordination of AMIP with the WCRP's Coupled Model Intercomparison Project (CMIP). The WGNE has recommended that CMIP participants submit AMIP simulations (with the atmosphere unchanged) to PCMDI. With the AMIP data management system now fully operational, much of the AMIP infrastructure is being harnessed for CMIP. As these two WCRP projects become more closely aligned, we can expect some research activities to be more coordinated as well.

Early on in AMIP it became clear that model intercomparison by itself left many questions unanswered. Today, intercomparison remains a useful objective, but increasingly the '**I**' in AM'**I**'P could be better characterized to stand for *infrastructure*, some of which is summarized in Sections 2 and 3.

2. STATUS REPORT

Simulations archived at PCMDI[1]. Since the AMIP II protocol was described in Newsletter No. 8 (1996), 23 modeling groups have submitted simulations. Much of the monthly mean, daily and 6 hourly data from these standard runs is available to diagnostic subprojects. With PCMDI catching up on its holdings, it is expected that 95% of these data will be ready before the end of the year. The list of standard simulations added to the AMIP database since 1997 is shown on page 8. Many of these groups have expressed their intent to provide more recent runs and some have already done so. Several groups not included on page 8 intend to submit their first AMIP II simulations before the end of this year, a deadline recommended by the WGNE for this round of diagnostic subproject research. In addition to the standard runs, ensembles and runs at varying horizontal resolution are being archived for experimental subproject research.

AMIP simulation summaries[2]. Climatological comparisons are available for nearly every field archived in the AMIP standard model output. All models in the database are included with observations shown where available. These summaries are updated as new simulations arrive, and probably represent the most comprehensive resource of AGCM climatology results. All calculations and graphics are created using CDAT (see page 3).

Preliminary research. The research phase of AMIP II is well under way. A listing of active diagnostic subprojects is shown on page 7, and all research proposals are available online[3]. An example of how models have evolved since the archival of AMIP simulations began is described on page 4. Preliminary results from Subproject Nos. 1 and 3 are highlighted on pages 5 and 6.

SST and sea-ice boundary conditions.[4] At the request of the WGNE, the AMIP SST and sea-ice boundary conditions are now updated several times a year (K. Taylor) to 'near-present' and made publicly available[4]. This enables modelers to run simulations from 1979 to near-present as AMIP continues as an ongoing exercise (see Section 3). The recent observations were prepared (M. Fiorino) for use in the next ECMWF reanalysis (ERA-40), with the SST coming from the new NCEP 2DVAR data assimilation procedure. This scheme explicitly accounts for sea ice using a consensus SST Sea-ice relationship (between UKMO and NCEP) in the ice margins. The sea-ice data come from the NCEP daily operational high resolution analysis.

Metadata conventions. Another important infrastructure activity of the past several years has been the establishment of 'metadata' standards. The LATS[5] software was developed to facilitate data exchange while giving modelers a choice between netCDF (COARDS[6] convention) and GrADS/GRIB. LATS generated data insures consistency, but the associated metadata are limited. To address this, scientists from a variety of institutions have worked to identify information that would be of value for climate researchers to have directly accessible in data files. An important step was the establishment of the GDT[6] and NCAR/CSM[6] conventions, which introduced a variety of useful attributes and coordinate information (documentation of where the data came from, latitude weights, etc.). During the past year, these conventions have converged, leading to the development of the NetCDF Climate and Forecast (CF)[6] Metadata conventions. Data provided to the AMIP research community is GDT compliant and consistent with CF.

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1 http://www-pcmdi.llnl.gov/amip/status
2 http://www-pcmdi.llnl.gov/amip/quick-look
3 http://www-pcmdi.llnl.gov/amip/subprojects
4 http://www -pcmdi.llnl.gov/amip/bcs
5 http://www-pcmdi.llnl.gov/software/lats
6 http://www.unidata.ucar.edu/packages/netcdf/conventions.html

Why are these conventions so valuable? 1) A suite of useful information is directly available to users. 2) They provide a standard for software developers to design increasingly advanced tools. 3) The standards/tools increase the efficiency of research.

The PCMDI open source software system[7]. One by one, the many problems associated with the management of AMIP have been solved by the Climate Data Analysis Tool (CDAT), the foundation of the PCMDI software system. CDAT is built on and takes full advantage of the interpreted object-oriented language Python[8]. Data management, complex analysis, and visualization are all supported by CDAT. CDAT 3.0 is freely available and actively supported by the PCMDI software team[7]. CDAT is also the analysis tool of choice at PCMDI.

Monitoring the database[9]. A monitoring system (driven by CDAT) helps data users keep track of the AMIP database at PCMDI. Data questions or problems are documented (including plots) on a per model and variable basis. Users of the database are helping to ensure its integrity by contributing to this data documentation process.

AMIP homepage. The AMIP homepage has recently been upgraded, e.g., with a listing of publications based on standard AMIP simulations. Abstracts from approximately 100 peer-reviewed AMIP publications are archived. (Those who have publications based on the AMIP database should verify that they are included.) The model documentation effort is intensifying now that the data management infrastructure is complete.

3. LOOKING AHEAD

The continuing objective of AMIP is to support a standard experimental protocol that facilitates increasingly advanced diagnostic research. With the data management now under control at PCMDI, efforts are turning from infrastructure development towards design of an advanced diagnostic library that will be shared with the community via the PCMDI open source software system.

A WGNE diagnostics report series. PCMDI is preparing to begin a new report series that will highlight the performance of every AMIP simulation archived at PCMDI. Modeling groups will be provided with a comprehensive report of their simulation based on the WGNE Mean Climate Diagnostics[10], including a suite of model comparisons with observationally-based estimates. As an independent assessment, some interpretation of the model performance will be given by the PCMDI staff. The WGNE is preparing a list of variability diagnostics that will be incorporated into the report series along with selected diagnostics developed by PCMDI.

Reviewing the project framework. The WGNE has recommended that AMIP evolve from a "snapshot" exercise (e.g., AMIP I and II) into an ongoing activity, with modeling groups submitting new runs to PCMDI every few years. The WGNE and its AMIP Panel are currently working to refine the project to meet this objective. Modeling groups will be given the opportunity to review the PCMDI diagnostic report on their simulation before giving the clearance for it to be distributed for subproject research. The role of diagnostic subprojects may change with a continual stream of simulations being added to the database. The WGNE has also recommended that the standard output list be reviewed annually, as it is clear that improvements are needed, e.g., to cloud related and land surface fields. Another item to consider: Is the presentation of research at various meetings sufficient, or should there be another AMIP International Conference?

Comments are encouraged and should be sent to amip@pcmdi.llnl.gov. We've received many requests for more frequent Newsletter editions, so you can expect them!

[7] http://www-pcmdi.llnl.gov/software/cdat
[8] http://www.python.org
[9] http: //www-pcmdi.llnl.gov/amip/status
[10] http: //www-pcmdi.llnl.gov/amip/output/wgnediags.html

Tracking AMIP Model Performance and Improvement

A Taylor diagram (Fig. 1) may be used to summarize how model performance has changed over the last decade. Composite "median" model results were computed based on the AMIP output of a subset of 14 AMIP simulations performed between 1992 and 1996. A more recent "median" model result was obtained from newer versions of the same subset of AMIP models (1997-2001). Statistical comparisons between several simulated and observed fields were made, and the results are displayed in the diagram as fully described in Taylor (2001, J. Geophys. Res., 106, 7183-7192). The tail of each arrow indicates the statistics for the older median model, and the head the newer median model. The fields analyzed were: 500 hPa geopotential height (Z_{500}), precipitable water (PRW), 200 hPa zonal and meridional wind (U_{200} and V_{200}), zonal and meridional components of surface wind stress over the oceans (TAUU and TAUV), mean sea level pressure (PSL), precipitation (P), cloud fraction (CLT), 200 hPa temperature (T_{200}), and surface sensible heat flux (SH).

The statistics shown are the correlation coefficient between the observed and simulated field (related to the azimuthal angle), the root-mean-square (RMS) difference between the two fields (proportional to the distance to the point on the x-axis marked observed), and the ratio of the standard deviation (SD) of the simulated field to that observed (proportional to the radial distance). The dimensional statistics (RMS error and SD) have been normalized by the observed SD.

A model may be judged to have improved if the correlation increases, the arrow points toward the observed point (indicating a reduction in RMS error), and the arrow moves toward the dotted arc (i.e., the simulated SD moves toward the observed).

The composite "median" model result was calculated from the subset of model results available from both ca. 1993 and ca. 2000. For each model, monthly mean output was considered. For each of the 120 mean months (1979-1988) and each grid cell, the median result from the 14 models was selected. This set of values comprises the composite "median" model. A similar result would be obtained by taking the mean over the monthly mean fields simulated by the 14 models, but in this case outliers would have more influence. The statistics shown in the figure are the so-called space-time statistics for seasonal data, weighted by the area of each grid cell. In the case of the RMS error, for example, the sum of the squared difference runs over all grid cells (weighted by the grid-cell area) and also over all 40 seasons.

Simulated fields were compared to reanalysis (ERA), with the following exceptions: Precipitation was compared to the Xie-Arkin data set, cloud fraction was compared to the ISCCP data, and sensible heat was compared to the UWM/COADS climatology. Efforts are underway to incorporate observational uncertainties into these and other PCMDI performance summaries.

The impression given by the diagram is that general improvement has occurred over the past decade. This conclusion applies to the median model, but further analysis demonstrates that many individual models have also improved. This summary is limited in that only a dozen fields were considered and only global seasonal statistics are computed. Interannual variability simulated by the models or the performance in individual geographical regions might not show analogous improvement, but the global-scale climatological statistics are encouraging.

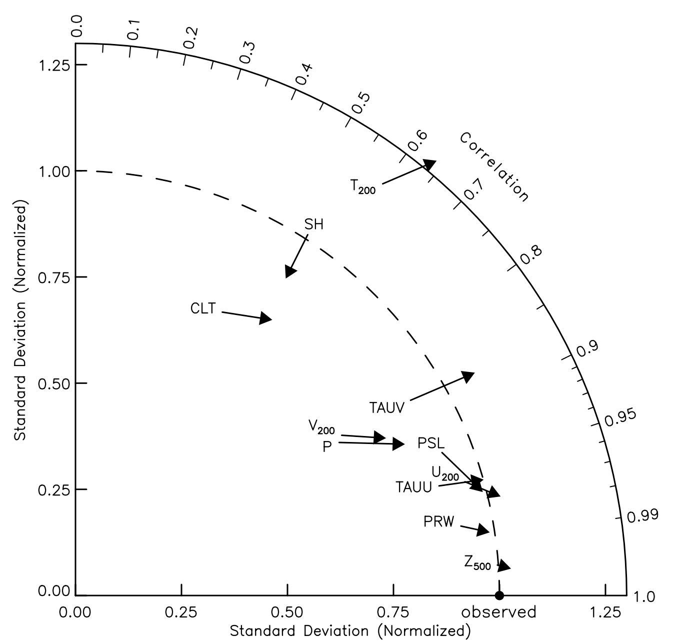

Fig. 1: Change in Median Model Performance

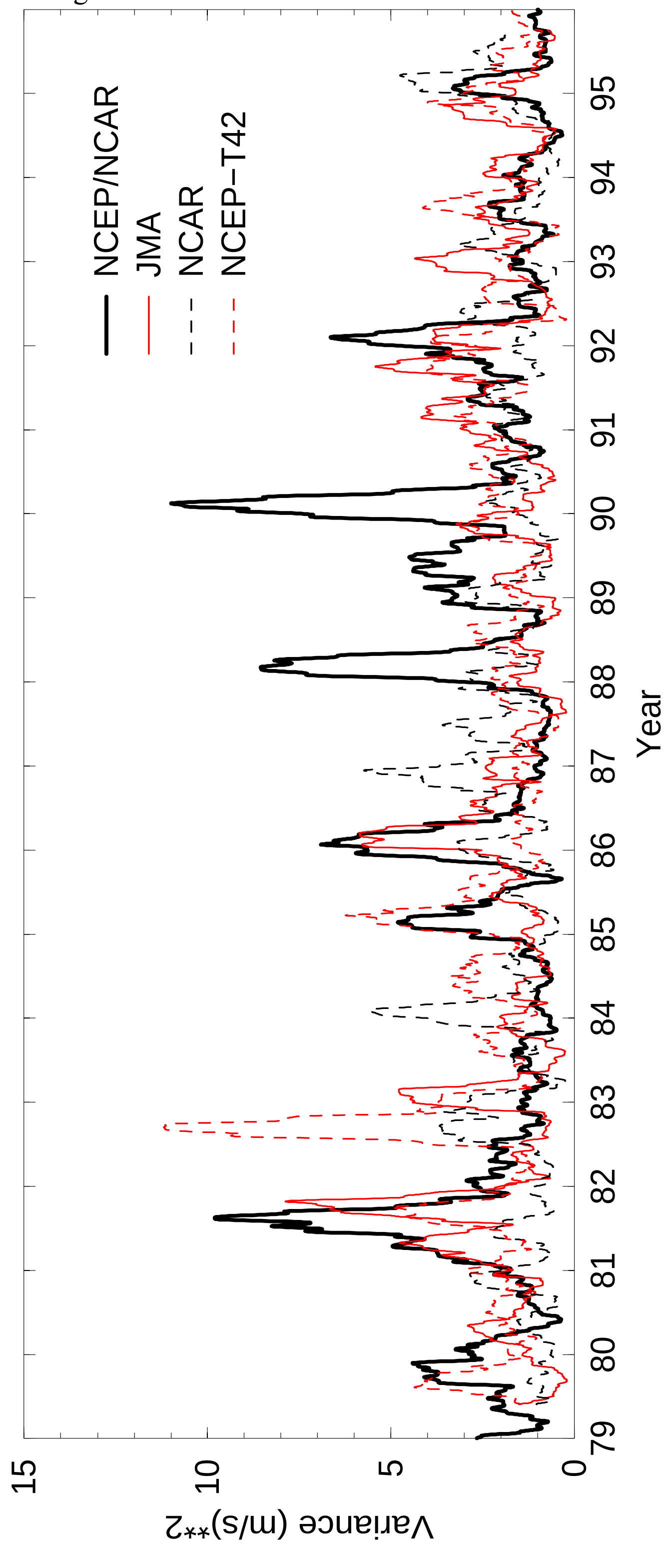

Fig. 2: Variance in a 101-day moving window of the 20-100 day bandpass filtered 200hPa 10N-10S averaged zonal mean zonal wind.

The Madden-Julian Oscillation (MJO) dominates tropical variability during the boreal winter/spring (Madden and Julian 1994, MWR, 122) when the west Pacific warm pool tends to be symmetrical about the equator (Salby et al. 1994, JAS 51). The MJO modulates convection over the eastern hemisphere on time scales of 30-70 days, and it displays substantial interannual (IA) variability. Numerous authors have suggested that the MJO may be important for initiating and/or influencing the amplitude of El Nino (e.g., McPhaden 1999, Science, 283). As such, this is an important mode of variability that GCMs should simulate. However the AMIP I simulations of the MJO were problematic (Slingo et al. 1996, Clim.Dyn.,12, and Sperber et al. 1997, Clim.Dyn.,13). Here, we present preliminary results from a subset of the AMIP II models compared to the NCEP/NCAR reanalysis (Kalnay et al. 1996, BAMS, 77). The MJO projects strongly on to the zonal wind (Slingo et al. 1999). Figure 2 is an MJO index based on the zonal wind that shows the envelope of intraseasonal (IS) variability, indicating the preferred seasonality of the MJO as well as its IA variability. While it is not expected that the models represent the observed year-to-year IS variations (since the MJO is not controlled by the boundary forcing on IA time scales [Slingo et al. 1999, QJRMS, 125]) it is apparent that the models typically underestimate the amplitude of the IS variability. The models also fail to capture the 30-70 day spectral peak in the eastward propagating wave number-1 component of the 10N-10S averaged zonal wind seen in the reanalysis. These are shortcomings that were common to the AMIP I simulations. In subsequent work the IS variability of all of the AMIP models will be investigated. A more comprehensive analysis of the simulated IS variability will be performed. This will include the evaluation of the 3-dimensional structure of the oscillation, and the link of the convection to the wind stress forcing and the surface evaporation that are important for maintaining the MJO (Sperber at al. 1997, Clim.Dyn, 13 and Woolnough et al. 2000, J.Clim,13).

Subproject No 3.: Transient Circulation Systems using Feature Based Analysis Methods

(courtesy J. Boyle and K. Hodges)

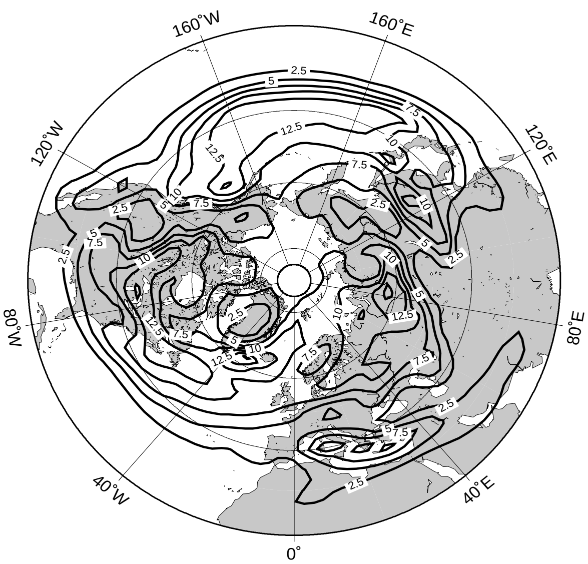

Fig. 3: ERA DJF 850 hPa storm track density

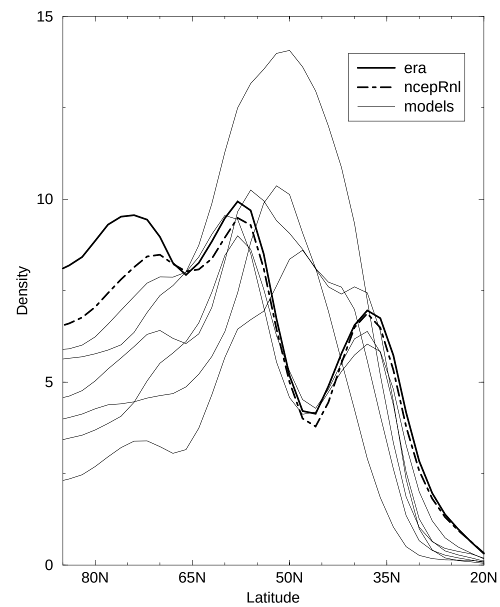

Fig. 4: 0-40E averaged storm track density

A feature tracking method (Hodges, K.I., 1999: Adaptive Constraints for Feature Tracking, *Mon.Wea. Rev*.,**127**, 1362-1373.) is applied to identify, track and derive statistical synoptic scale features in the reanalyses and GCM integrations. The data fields used are the relative vorticity and meridional wind at 850 and 200 hPa and the mean sea level pressure. The data were available at time intervals of 6 hours. The tracking was performed directly on the sphere with constraints for displacement and track smoothness which are applied adaptively. The statistics are computed using spherical kernel estimators with adaptive smoothing which obviate problems with map projection distortions. The statistics computed were track, feature, genesis and lysis densities; mean intensity, speed/velocity, lifetime and growth/decay rates. The two reanalyses agree rather closely, with the ERA being a bit more active. The largest differences occur for the upper level vorticity related to the assimilation methods used.

The models exhibit a wide variation of skill in depicting the various aspects of the synoptic systems. The correspondence to the reanalyses is especially poor in the Tropics. The models having low horizontal resolution tend to have systematically weaker midlatitude storm track features. Most of the models tend to have too zonal a pattern of storm tracks extending into Europe. Figure 3 above shows the track density for the wintertime 850 hPa positive vorticity features for the ERA reanalyses. The familiar storm tracks are in evidence. Figure 4 shows the track density averaged over longitudes from 0 to 40E and extending from 20N to 90N for the ERA, NCEP reanalysis, and 6 models. The thick lines are reanalyses and the thin lines are the models, which can be seen to underestimate the values north of 50N with 4 of the six missing the minimum near 45N. These same models fail to capture the secondary maximum over the Mediterranean near 35N.

Active AMIP Diagnostic Subprojects

Subproject proposals are available on the AMIP homepage. Nos. 1-26 are a continuation from AMIP I, some of which are not listed below because they are currently inactive.

- No. 1: **Synoptic to Intraseasonal Variability** (J. Slingo and K. Sperber)
- No. 3: **Statistics of Transient Circulation Systems** (J. Boyle, K. Hodges, I. Simmonds, D. Jones)
- No. 5: **Ocean surface fluxes of heat, momentum, and implied transports** (P. Gleckler and K. Taylor)
- No. 6: **Intraseasonal to Interannual Variability of the Asian Summer Monsoon** (H. Annamalai, J. Slingo and K. Sperber)
- No. 7: **Hydrologic processes** (W. Lau and Y. Sud)
- No. 9: **Polar Processes and Sea Ice** (J. Walsh, D. Bromwich, H. Cattle, V. Kattsov, V. Meleshko, J. Maslanik)
- No. 11: **Evaluation of soil moisture and continental water budget** (A. Robock, K. Y. Vinnikov, G. Srinivasan)
- No. 12: **Land-surface processes and parameterizations** (T. Phillips, A. Henderson-Sellers, A. Hahmann, A. Pitman)
- No. 13: **Evaluation of global cloudiness** (B. Weare)
- No. 15: **Angular Momentum and the Planetary Momentum Balance** (D. Salstein, R. Rosen, J. Dickey and S. Marcus)
- No. 16: **Simulations of the stratospheric circulation** (coordinated with GRIPS) (W. Lahoz, R. Swinbank, S. Pawson and G. Roff)
- No. 18: **Surface climate extremes** (F. Zwiers and V. Kharin)
- No. 20: **West African Monsoon** (Serge Janicot, Jan Polcher, Chris Thorncroft, Henri Laurent, Thierry Lebel)
- No. 21: **Surface Climatologies** (P. D.Jones, M. Hulme and T. Osborn)
- No. 23: **Variations of the centers of action** (S. Hameed)
- No. 25: **East Asian climate** (W-C. Wang, G.-X. Wu, H.-H. Hsu, X-Z. Liang)
- No. 26: **Monsoon precipitation** (S. Gadgil, J. Srinivasan)
- No. 27: **Tropospheric Humidity and Meridional Moisture Fluxes** (D. Gaffen, R. Rosen D. Salstein, J. Boyle, B. Soden)
- No. 28: **Evaluation of Snow Cover** (D. Robinson, A. Frei, R. Brown and A. Walker)
- No. 29: **Nonlinear Circulation Regimes** (A. Hannachi, F. Molteni and T.N.Palmer)
- No. 30: **Maintenance Mechanisms of Stationary Waves** (M. Ting and R. Joseph)
- No. 31: **Climatology of Maximum Potential Intensity (MPI) of Tropical Cyclones** (G. Holloway and W.Qu)
- No. 32: **Surface and Atmospheric Radiative Fluxes** (M, Wild, A. Ohmural, G. Potter, J. Hnilo)
- No. 33: **Atmospheric Transports and Energetics** (G.J. Boer and S.J. Lambert)
- No. 34: **Evaluation of convection, upper level moisture and links using Meteosat** (R. Roca and L. Picon)
- No. 35**: Seasonal-to-decadal variability in the tropical Atlantic Ocean** (J. Carton, S. Nigam and J. Wang)
- No. 36: **Water Vapor and Cloud Feedback Processes** (M.-D. Chou, C. Covey, A. Hou, R. Lindzen, D.-Z. Sun)
- No. 37: **Super-Ensemle Modeling of Seasonal Climate** (Krishnamurti, T.N., and C.M. Kishtawal, T. LaRow, D. Bachiochi, Z. Zhang, et al.)
- No. 38: **North American Monsoon** (R. Arritt)

Standard AMIP Simulations
Archived at PCMDI During 1997-2001

X indicates current availability for diagnostic subprojects

Model Designation	Model ID	Monthly	Daily	6h	Doc
CCC GCM3 (T47L32) 1999	cccma-99a	X	X	X	
CCSR/NIES AGCM (T42L18) 1998	ccsr-98a	X	X	X	
CNRM ARPEGE Cy18 (T63L45) 2000	cnrm-00a	X	X	X	
COLA V2.2 (R40L18) 2000	cola-00a	X	X		
DNM A5421 (4x5 L21) 1998	dnm-98a	X	X	X	X
ECMWF CY18R5 (T63L50) 1998	ecmwf-98a	X	X	X	
DERF GFDLSM392.2 (T42 L18)1998	derf-98a	X			
GISS B295DM12 (4x5L12) 1998	giss-98a	X	X	X	
GLA GEOS-2 (4x5, L20) 1988	gla-98a	X			
JMA GSM9603 (T63 L30) 1998	jma-98a	X	X	X	X
MGO AMIP2.01 (T42L14) 2001	mgo-01a	X			
MPI ECHAM4 (T42 L19) 1998	mpi-98a	X		X	
MRI JMA98 (T42L30) 1998	mri-98a	X	X	X	X
NTU (4X5 L18) 2001	ntu-01a				
NCAR CCM3.5 (T42L18) 1998	ncar-98a	X	X	X	X
NCEP REANL2 (T42L18) 1998	ncep-99a	X	X	X	X
PNNL CCM2 (T42L18) 1997	pnnl-97a	X			X
RPN UGEM NWP (G1.875 L40) 2001	rpn-01a				
SUNYA CCM3 (T42L18) 1999	sunya-99a	X			
UKMO HADAM3 (3.75x2.5x19L) 1998	ukmo-98a	X			X
UIUC 24-L ST-GCM (4x5 L24) 1998	uiuc-98a	X	X		
UGAMP HADAM3 (3.75x2.5 58L)1998	ugamp-98a	X		X	X
YONU ST15 (4x5 L15) 1998	yonu-98a	X	X		

Experimental subproject simulations

Ensembles (number of realizations): cola-00 (6), mpi-98 (6), ncar-98 (10), ukmo-98 (6)
Variations in resolution**:** ecmwf-98b (T159L50), ncar-98b (T239 L18 – *in progress*), ncep-99b (T62L28), ukmo-98b (3.75x2.5x19L), ukmo-98c (1.875x1.25L30), ukmo-98d (2.5x1.66L30), ukmo-98e (1.25x0.833L30), yonu-98b(4x5 L30)

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