AMIP II Standard Model Output

Contents

Introduction

The standard model output list for AMIP II is documented in six tables below. It has been prepared by the WGNE AMIP Panel and the PCMDI scientific staff, with the strong influence of many valuable recommendations made by diagnosticians and modelers during 1995-1997. The inclusion of many more diagnostics than in AMIP I results from the need for increasingly advanced analysis of AGCMs. Minor revisions made to this list since its first publication (AMIP Newsletter No. 8) are summarized at the end of this document. The list is ambitious, but not exhaustive. It represents a concerted effort to find a delicate balance between the needs of the diagnostic community and the practical limitations that modelers are faced with.

Additional information in the form of footnotes follows the upper air output (Tables 1a-c). Temporal sampling and variable-specific recommendations are summarized after the six tables. These recommendations are identified in the "Notes" of the rightmost Table columns (numbers for sampling and letters for variable-specific recommendations). The online version of this document also includes links to data volume estimates (as a function of resolution and data truncation), discussion of future AMIP diagnostics, and a description of the PCMDI variable names used in AMIP.

It is not expected that every modeling group participating in AMIP II will succeed in providing the entire AMIP II standard model output, especially from the "optional" listing of high frequency output (Table 6). Tables 1a, 2, 3, 4 and 5 are considered to represent minimum participation in AMIP II. As diagnostic subprojects are approved, their requests for Table 6 output will be posted so that modeling groups may determine on the basis of interest which fields to save.

Table 1a

Upper-air low frequency (monthly mean): Basic

 # * & 17 WMO standard pressure levels compatible with reanalysis products: 1000, 925, 850, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50,30, 20, 10 hPa
For those groups participating in GRIPS, the following levels are also encouraged: 15, 7, 5, 3, 2, 1.5, 1, 0.5 hPa
(Variable units are MKS)

PCMDI Name	Variable Title	Units	Notes
va	Northward wind	m/s	2
ua	Eastward wind	m/s	2
wap	Vertical motion	Pa/s	2
ta	Air temperature	K	2
zg	Geopotential height	m	2
hus	Specific humidity	kg/kg	2
hur	Relative humidity	%	2
psbg	Pressure surface below ground	%	1, a

Table 1b

Upper-air low frequency (monthly mean): Dynamical

 # * & 17 WMO standard pressure levels compatible with reanalysis products: 1000, 925, 850, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50,30, 20, 10 hPa
Calculation precision recommended: 64 bits
$ Covariances/variances acceptable
(Variable units are MKS)

PCMDI Name	Variable Title	Units	Notes
mpuva	Mean product of eastward and northward winds	m^2/s^2	3, b
mpvhusa	Mean product of northward wind and specific humidity	m/s (kg/kg)	3, b
mpvta	Mean product of northward wind and temperature	mK/s	3, b
mpwhusa	Mean product of vertical motion and specific humidity	(Pa/s)(kg/kg)	3, b
mpvzga	Mean product of northward wind and geopotential height	m^2/s	3, b
mpwapta	Mean product of vertical motion and temperature	Pa/s K	3, b
mpuua	Mean product of eastward wind and eastward wind	m^2/s^2	3, b
mpvva	Mean product of northward wind and northward wind	m^2/s^2	3, b
mptta	Mean product of temperature and temperature	K^2	3, b

Table 1c

Upper-air low frequency (monthly mean): Physical
On model levels
@or
 # * & 17 WMO standard pressure levels compatible with reanalysis products:
1000, 925, 850, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50,30, 20, 10 hPa
(Variable units are MKS)

PCMDI Name	Variable Title	Units	Notes
tnt	Temperature tendency due to total diabatic heating	K/s	1, c
tntsw	Temperature tendency due to SW radiation	K/s	1, c
tntlw	Temperature tendency due to LW radiation	K/s	1, c
tntmc	Temperature tendency due to moist convective processes	K/s	1, c
tntdc	Temperature tendency due to dry convective processes	K/s	1, c
tntlsp	Temperature tendency due to stratiform clouds	K/s	1, c
tnmrd	Moisture tendency due to diabatic processes (total)	(kg/kg)/s	1, d
tnmrc	Moisture tendency due to convective processes	(kg/kg)/s	1, d
tnmmugwd	Eastward momentum tendency due to gravity wave drag	m/s^2	1, e
tnmmvgwd	Northward momentum tendency due to gravity wave drag	m/s^2	1, e
tnmmuc	Eastward momentum tendency due to convection	m/s^2	1, e
tnmmvc	Northward momentum tendency due to convection	m/s^2	1, e
tnmmutot	Eastward total diabatic tendency of momentum	m/s^2	1, e
tnmmvtot	Northward total diabatic tendency of momentum	m/s^2	1, e
cl	Cloud fraction	%	5
clw	Cloud liquid water	kg/kg	1, f
cli	Cloud ice	kg/kg	1, f

Footnotes for Tables 1a-c

* Comparison of AMIP II model output with reanalyses will be an important part of the project. For consistency with reanalysis products, the AMIP II monthly mean upper air data must be on the 17 WMO standard pressure levels that are included in both the NCEP/NCAR and ECMWF reanalyses. Modeling groups are requested to provide data on these levels to insure that they are interpolated in a manner consistent with their model. Data from models with fewer than 17 levels should also be provided on the 17 standard levels to minimize the possibility of the data being misrepresented. Exceptions will be made for models with a top level that is at a lower pressure than the highest reanalysis level (10 hPa), as the transformation to pressure coordinates should not involve extrapolation. Models with a top level corresponding to a pressure that is more than 10 hPa should only provide data on the pressure levels that are greater than 10 hPa.

For all fields interpolated to standard pressure levels it is recommended that they be interpolated every sampled time step (e.g., every time step for temperature tendencies, every six hours for winds) rather than averaged on model surfaces and then interpolated. For some groups this may not be practical. Tests demonstrating the effects of the order of the interpolation (every sampled time step vs. end of month) are available at http://www-pcmdi.llnl.gov/amip/output/sampstudy/sampstudy.html

& If fields below ground are extrapolated, it is suggested that the method of Trenberth et al. (1993) be used.

@ It is recognized that many groups prefer to save these diagnostics on model levels. The rationale for this choice is that vertical interpolation can degredate vertical profiles in regions of sharp vertical gradients if the model level (equivalent pressure value) is not close to the target pressure level. Examples of this are posted on in the standard output section of the AMIP homepage. Determination of how best to save these fields (on model levels or standard pressure levels) may be model dependent and is best determined each group.

$ Either mean products (e.g., {uv}, with brackets representing time average) or covariances/variances (e.g., {u'v'}) are acceptable. The later (which can be computed with the former and the fields of Table 1a) will be archived by PCMDI. If covariances/variances are supplied, the corresponding name and title changes for Table 1b are: replace "mp" with "cv" in variable names, and "Mean product" with "Covariance" (or when applicable "Variance) in the variable title.

Table 2

Single-level low frequency (monthly mean) output

PCMDI Name	Variable	Units	Notes
ts	Ground temperature	K	1, g
tas	Surface (2m) air temperature	K	2, h
psl	Mean-sea-level pressure	N/m^2	2, i
ps	Surface pressure	N/m^2	2
pr	Total precipitation rate	$kg/(m^2s)$	1
prsn	Snowfall rate (water equivalent)	$kg/(m^2s)$	1
prc	Convective precipitation rate	$kg/(m^2s)$	1
prw	Precipitable water	kg/m^2	1
mrfso	Total soil frozen water content	kg/m^2	1
mrsos	Surface soil water content (upper 0.1m)	kg/m^2	1, j
mrso	Total soil water content	kg/m^2	1
mrros	Surface runoff	$kg/(m^2s)$	1, j
mrro	Total runoff (including drainage)	$kg/(m^2s)$	1
snw	Snow depth (water equivalent)	kg/m^2	1
snc	Snow cover	%	5
snm	Snow melt	$kg/(m^2s)$	1
sic	Sea-ice concentration	%	5, k
uas	Surface (10m) eastward wind	m/s	2, h
vas	Surface (10m) northward wind	m/s	2, j
huss	Surface specific humidity (2m)	kg/kg	2, h
hfss	Surface sensible heat flux (positive upward)	W/m^2	1
hfls	Surface latent heat flux (positive upward)	W/m^2	1
evspsbl	Surface evaporation plus sublimation rate	$kg/(m^2s)$	1
tauu	Eastward surface wind stress (positive for eastward wind)	N/m^2	1
tauv	Northward surface wind stress (positive for northward wind)	N/m^2	1
tauugwd	GWD induced eastward surface wind stress (positive for eastward wind)	N/m^2	1
tauvgwd	GWD induced northward surface wind stress (positive for northward wind)	N/m^2	1
rsds	Surface incident shortwave radiation (positive downward)	W/m^2	1
rsus	Surface reflected shortwave radiation (positive downward)	W/m^2	1
rlds	Surface downwelling longwave radiation (positive downward)	W/m^2	1
rlus	Surface upwelling longwave radiation (positive downward)	W/m^2	1
rsdt	TOA incident shortwave radiation (positive downward)	W/m^2	1, , l
rsut	TOA reflected shortwave radiation (positive downward)	W/m^2	1, l
rlut	Outgoing longwave radiation (positive downward)	W/m^2	1, l
rtmt	Net radiation at model top (positive downward)	W/m^2	1, m
rsdscs	Surface incident clear-sky shortwave radiation (method II)	W/m^2	1, n
rsuscs	Surface reflected clear-sky shortwave radiation (method II)	W/m^2	1, n
rldscs	Surface downwelling clear-sky longwave radiation (method II)	W/m^2	1, n
rlutcs	TOA clear-sky longwave radiation (method II)	W/m^2	1, n
rsutcs	TOA reflected clear-sky shortwave radiation (method II)	W/m^2	1, n
tasmax	Daily maximum surface (2m) air temperature	K	4, o
tasmin	Daily minimum surface (2m) air temperature	K	4, o
clt	Total cloud amount	%	5
clwvi	Vertically integrated cloud water (liquid and solid phase)	kg/m^2	1
clivi	Vertically integrated cloud ice	kg/m^2	1

Table 3
High-frequency (6-hourly and daily) output
(6-hourly data sample 4 times daily: 0, 6, 12, 18Z)

PCMDI Name	Variable	Units	Notes
va	Northward wind (850 and 200 hPa): 6-hourly	m/s	4
ua	Eastward wind (850 and 200 hPa): 6-hourly	m/s	4
rlut	Outgoing longwave radiation: 6-hourly	W/m^2	1
pr	Total precipitation rate: 6-hourly	$kg/(m^2s)$	1
psl	Mean-sea-level pressure: 6-hourly	Pa	4
tasmax	Daily maximum surface (2m) air temperature	K	8
tasmin	Daily minimum surface (2m) air temperature	K	8

Table 4
Time Series of daily global averages (area-weighted)

PCMDI Name	Variable	Units	Notes
rmt	Net radiation at model top (positive downward)	W/m^2	1, m
hfns	Net downward energy flux at surface	W/m^2	1
enek	Total kinetic energy (per unit area)	J/m^2	1
moa	Total relative angular momentum (per unit area)	kg/ s	1
torts	Total surface torque (including mountain torque)	N/m	1
ta	Temperature (mass-weighted vertically average)	K	1
ps	Surface pressure	Pa	1
evsps	Evaporation and sublimation (per unit area)	$kg/(m^2s)$	1
snc	Snow-covered area	%	5
snd	Snow depth (water equivalent)	kg/m^2	1
tso	SST over open (ice-free) ocean	K	1

Table 5
Fixed geographical fields

PCMDI Name	Variable	Units	Notes
orog	Model topography	m	6, p
sftlf	Land fraction (expressed as percent)	%	6, k
sftgif	Glacier fraction (expressed as percent)	%	6, k
mrsofc	Total soil moisture field capacity	kg/m^2	6
mrsofcs	Surface soil moisture field capacity (upper 0.1 m)	kg/m^2	6
tro3	Ozone climatology (zonal average -pressure cross section)	ppmv	7

Table 6 (optional)
Supplementary Output
High frequency (6-hourly)

PCMDI Name	Variable	Units	Notes
ta	Air temperature (850, 500, 50 hPa)	K	4
zg	Geopotential height (500 hPa)	m	4
hus	Specific humidity (850, 500 hPa)	kg/kg	4
uas	Surface (10m) eastward wind	m/s	4, h
vas	Surface (10m) northward wind	m/s	4, h
tas	Surface (2m) temperature	K	4, h
huss	Surface specific humidity (2m)	kg/kg	4, h
wap	Vertical motion (500 hPa)	Pa/s	4
va	Northward wind (50 hPa)	m/s	4
ua	Eastward wind (50 hPa)	m/s	4
ps	Surface pressure	Pa	4
clt	Total cloud cover	%	5
tauu	Eastward surface wind stress (positive for eastward wind)	N/m^2	1
tauv	Northward surface wind stress (positive for northward wind)	N/m^2	1
prw	Precipitable water	kg/m^2	1
hfss	Surface sensible heat flux (positive upward)	W/m^2	1
hfls	Surface latent heat flux (positive upward)	W/m^2	1
mrro	Total runoff (including drainage)	$kg/(m^2s)$	1
mrso	Total soil water content	kg/m^2	1
snw	Snow depth (water equivalent)	kg/m^2	1
rsds	Surface incident shortwave radiation	W/m^2	1
rsus	Surface reflected shortwave radiation	W/m^2	1
rlds	Surface downwelling longwave radiation	W/m^2	1
rlus	Surface upwelling longwave radiation	W/m^2	1
rsdt	TOA incident shortwave radiation	W/m^2	1
rsut	TOA reflected shortwave radiation	W/m^2	1
vorpot	Potential vorticity 350, 380, 405K	1/(Pas)	4, q
zblh	Planetary boundary layer height	m	2, r

Notes_for_Tables 1-6

Recommended sampling

1 Averages computed to most accurately represent true simulation average (i.e., based on every time step)

2 Averages based on instantaneous samples at 0, 6, 12 and 18Z.

3 Mean products are the monthly means **{xy} = {x} * {y} + {x'y'}** where**{xy}** is the monthly mean of the product of 6-hour (0,6,12,18Z) insta samples. If calculations are done in pressure coordinates they will be more consistent with reanalysis products.

4 Instantaneous values.

5 Accumulated time average of the fraction of the grid cell covered, expressed as percent.

6 Time independent, but two-dimensional in space (longitude x latitude).

7 Monthly mean latitude-height (pressure) climatology.

8 Daily quantity, based on all model time steps

Recommended calculations

a Fraction of time that a pressure surface is below ground: recommended method of calculation is outlined in Boer (1985).

b Mean products -

c Temperature tendencies - Total diabatic temperature tendency: temperature tendency due to radiation, shallow and deep convection, large scale precipitation, dry convective adjustment and vertical diffusion. Temperature tendency due to moist convection: for deep and shallow convection and including latent heat release, sub-gridscale vertical heat transport, and the tendencies due to the evaporation and phase change of falling precipitation. Temperature tendency due to dry convection: This should include the tendencies from dry convective adjustment only. Some models may not treat this explicitly. Temperature tendency due to large scale/stratiform precipitation: This should include the tendency associated with evaporation and phase change of falling precipitation.

d Moisture tendencies - Total moisture tendency: Include the total change in moisture due to diabatic processes. It should include shallow and deep convection, large scale precipitation, vertical diffusion, and the tendency due the evaporation of falling precipitation.

e Momentum tendencies - Both momentum tendency due to gravity wave drag and that due to convective processes should be scaler quantities representing the magnitude of both eastward and westward componenents [e.g., (tnmmcu**2 + tnmmcv**2)**0.5].

f Cloud liquid water and ice: grid-cell average mixing ratios.

g Ground temperature: this is the prescribed SST over ocean. Over land, the surface effective radiating temperature (as "seen" by the atmosphere) should be reported.

h Surface-air variables: calculations should be consistent with Hess et al. (1995).

i Mean-sea-level pressure: use corrected ECMWF algorithm (Trenberth et al., 1993).

j Land surface variables: for surface water content, integrate from surface down to 0.1 m of the soil. Surface runoff should include that portion of rainfall and snowmelt that does not infiltrate the soil.

k Sea-ice concentration, land and glacier masks: those models that do not include fraction grid-cell coverage should report values as 0 (e.g., 0% sea-ice) or 100 (e.g., 100% sea-ice).

l Top-of-atmosphere radiation fields: true "top-of-the-atmosphere" fluxes appropriate for comparison with satellite measurements (cf. model top calculations).

m Model top calculations: should be based on the radiation calculations at the top of the dynamically active model (cf. top-of-atmosphere calculations).

n Cloud-radiative forcing calculations: calculations consistent with Potter et al. (1992).

o Maximum/minimum temperatures: monthly means of daily extremes, based on all timesteps.

p Model topography: this should be the same as that which is used in the model. In AMIP I, some groups provided cosmetically altered topography.

q Potential vorticity: recommended method of calculation is outlined in Hoskins et al. (1985).

r Planetary boundary layer height: some suggestions are provided in Holtslag and Boville (1993), Beljaars et al. (1993), and Vogelezang and Holtslag (1996).

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Listing of corrections and minor revision

Because of the complexities and controversies associated with the AMIP II standard output list, there have been several minor revisions and corrections since its original publication in AMIP Newsletter No. 8. However, it is understood that not all modeling groups will be able to account for the revisions made in their first AMIP II simulations.

Units corrections:

Table 1: Mean Product of vertical motion and specific humidity - (Pa/s)(kg/kg)
Table 4: Total relative angular momentum (per unit area) - kg/s
Table 6: Total soil water content - kg/m^2

Organizational changes:

Table 1 has been split up into three categories: a) "basic", b) "physical" and c) "dynamical" fields in an attempt to partition the complexities of computing the various quantities. It is expected that all participants will save every basic field. Several "physical" fields will not apply to all models, and for some calculating the "dynamical" fields may be prohibitively difficult.

Additional Pressure levels:

Table 1a on additional levels in coordination with the stratospheric intercomparison activities of GRIPS.

Clarifications

Table 4: "Total relative angular momentum" and "Global average temperature" should both be column integrated quantities.

Removed fields

Satellite/surface views of 3-d cloud amounts, cloud optical depth and LW emissivity (Table 1):

These fields initiated a great deal of interest and confusion. Many modelers continue to feel that they deserve further consideration. However, to date no one has clearly defined the satellite and surface views of cloud cover for the general case of different cloud cover treatments used in AGCMs. For this reason, the satellite and surface views of 3-d cloud amounts have been removed from Table 1. Cloud optical depth (extinction coefficient) and LW emissivity have also been removed because of a lacking consensus on how to define them. It is clear that there remains a strong interest in these fields, and they are certain to gain increasing attention. For now they will be archived (and analyzed) for those modeling groups that believe they deserves further attention. In this case, documentation of how the calculations are made will be necessary. (6/15/97)

New fields:

Table 1: Gravity wave drag momentum tendency - $m/(s^2)$
Table 1: Convective momentum transport tendency- $m/(s^2)$
Talbe 1: Momentem tendencies changed from scalar to compenents
Table 1 Mean product of vertical velocity and temperature
Table 1 Mean product of temperature and total heating
Table 1 Mean product of eastward wind and eastward wind
Table 1 Mean product of northward wind and northward wind
Table 1 Mean product of temperature and temperature
Table 2: Snowmelt - $kg/(m^2\ s)$
Table 3: Surface air temperature (2m) daily min and max fields - K
Table 4: Global average total surface torque - N/m
Table 6: Air temperature at 50hPa - K

3-d fields interpolated to standardized pressure levels:

Some modelers have expressed reservations about interpolating cloud-related fields (e.g., cloud amount, temperature and moisture tendencies) to standard pressure levels. For this reason, cloud-related fields will be accepted on either model coordinates or the 17 standard pressure levels.

Order of vertical interpolation:

Tests have demonstrated that in some cases (especially with fields on Tables 1b-c), interpolating every time step vs. at the end of the month can yield important differences. For this reason, a recommendation has now been made for the order of interpolation. (6/15/97).

For further information contact the AMIP Project Office (amip@pcmdi.llnl.gov).

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