Proposed Request to the Standard Variables List for the Next Coordinated Climate Model Experiments

IPCC Task Group on Data and Scenario Support for Impact and Climate Analysis (IPCC TGICA)
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Responding to a request by Ronald J. Stouffer, the Chair of the Coupled Model Intercomparison Project Panel of the World Climate Research Programme group on Coupled Models and Anthropogenic Climate Change (WCRP CMACC), IPCC TGICA has taken charge of collecting and compiling requests to the standard variables list for the next coordinated climate model experiments from the perspective of the users of climate model outputs, especially the Impact, Adaptation and Vulnerability (IAV) research community. Based on a survey of selected IAV experts and discussion by TGICA members, TGICA proposes the following set of variables lists.

1. Extension of Daily 2-D Variables List

Based on Table A2a: Daily-mean 2-d atmosphere data (longitude, latitude, time:day).
(http://www-pcmdi.llnl.gov/ipcc/standard_output.html#Table_A2a)

	output variable name	units	Notes
1	psl	Pa	air pressure at sea level
2	pr	Kg m-2 s-1	precipitation flux (includes both liquid and solid phases)
3	tasmin	K	daily-minimum near-surface air temperature
4	tasmax	K	daily-maximum near-surface air temperature
5	tas	K	daily-mean near-surface air temperature
6	hfls	W m-2	surface upward latent heat flux
7	hfss	W m-2	surface upward sensible heat flux
8	rlds	W m-2	surface downwelling longwave flux in air
9	rlus	W m-2	surface upwelling longwave flux in air
10	rsds	W m-2	surface downwelling shortwave flux in air
11	rsus	W m-2	surface upwelling shortwave flux in air
12	uas	m s-1	eastward wind
13	vas	m s-1	northward wind
14	rlut	W m-2	TOA outgoing longwave flux
15		1	specific humidity
16		1	relative humidity
17		K	daily-minimum near-surface dew point temperature
18		K	daily-maximum near-surface dew point temperature
19		K	daily-mean near-surface dew point temperature

20		Pa	air pressure at the ground level
21		kg m-2	snow amount
22		1	snow area fraction
23		1	near surface soil moisture
24		K	near surface soil temperature
25		K	water skin temperature
26		kg m-2 s-1	convective precipitation flux
27		kg m-2 s-1	solid precipitation flux
28		kg m-2 s-1	runoff
29		m s-1	daily-mean wind speed
30		m s-1	eastward component of daily-maximum wind speed
31		m s-1	northward component of daily-maximum wind speed
32		1	cloud fraction

Provided for the entire simulation period until 2100 (+selected intervals for 2101-2300) and for as many ensemble members as possible.

Rationale:

1. Surface conditions and fluxes at daily temporal resolution are indispensable for driving process-based impact models, such as hydrological and agricultural models, and for detailed heat-health assessment. Since Table A2a already includes many of those, an extension of the table is proposed. Since some variables in an impact model have a long memory (e.g., soil condition in an agricultural model), it is highly desired that the forcing data (i.e., daily surface variables) be provided continuously for the entire simulation period, at least until the year 2100, rather than for selected intervals as in the case of Table A2a. We are aware that it implies a substantial demand for data storage and transfer. We are not able to assess the feasibility of this request because both computer technology and model resolution is expected to be substantially changed for the next round experiments. The assessment of feasibility is left to experts of climate modeling and data management.

2. (For extremes indices) The extension of variables and the period of Table A2a is justified also from the viewpoint of producing extremes indices. It is difficult to predefine a well-agreed set of extremes indices, since there are different preferences in the base period (e.g., 1971-2000 rather than 1961-1990) and threshold values (e.g., 10 deg C rather than 5 deg C threshold for the growing season of low-latitude plants) for different applications of the indices. Including daily variables archived for the entire simulation period would allow users the flexibility to define extremes indices themselves.

2. Daily Upper-Air Variables for Selected Levels

(longitude, latitude, time:day)

	output variable name	units	Notes
1	ua	m s-1	eastward wind

2	va	m s-1	northward wind
3	ta	K	Temperature
4	hus	1	specific humidity
5	zg	m	geopotential height
6	wap	Pa s-1	vertical velocity

Provided on the following pressure levels: 1000, 850, 700, 500, 200 hPa.
Provided for the entire simulation period until 2100 (+selected intervals for 2101-2300) and for as many ensemble members as possible.

Rationale: Statistical downscaling studies use these variables as predictors to be related with predictands (surface air temperature, precipitation etc.). For producing a complete down-scaled climate change scenario, the provision of predictors for the entire simulation period, at least until the year 2100, is highly desired. Moreover, those upper air variables are useful not only for statistical downscaling but also for various climate analyses. Again, the assessment of the technical feasibility to store and transfer the data for the entire simulation period is left for experts of climate modeling and data management.

3. Extension of 3-Hourly 2-D Variables List

Based on Table A3: 3-hourly 2-d atmosphere data (longitude, latitude, time:3hour at 0, 3, 6, 9, 12, 15, 18, 21 Z). (http://www-pcmdi.llnl.gov/ipcc/standard_output.html#Table_A3)

	output variable name	units	Notes
1	psl	Pa	air pressure at sea level
2	pr	Kg m-2 s-1	precipitation flux (includes both liquid and solid phases)
3	tas	K	near-surface air temperature
4	hfls	W m-2	surface upward latent heat flux
5	hfss	W m-2	surface upward sensible heat flux
6	rlds	W m-2	surface downwelling longwave flux in air
7	rlus	W m-2	surface upwelling longwave flux in air
8	rsds	W m-2	surface downwelling shortwave flux in air
9	rsus	W m-2	surface upwelling shortwave flux in air
10		m s-1	eastward wind
11		m s-1	northward wind
12		1	specific humidity
13		1	near surface soil moisture
14		K	near surface soil temperature
15		K	water skin temperature
16		kg m-2 s-1	convective precipitation flux
17		kg m-2 s-1	solid precipitation flux
18		kg m-2 s-1	runoff

19		W m-2	clear-sky surface downwelling longwave flux in air
19		W m-2	clear-sky surface upwelling longwave flux in air
20		W m-2	clear-sky surface downwelling shortwave flux in air
21		W m-2	clear-sky surface upwelling shortwave flux in air

Provided for some selected intervals (e.g., 1961–2000, 2046–2065, 2081–2100, 2181–2200, 2281–2300)

Rationale: The 3-hourly data can be used for investigating diurnal cycles. Some variables whose diurnal cycle would be worth investigating have been added to Table A3. In particular, clear-sky radiative fluxes were added to investigate the diurnal cycles of cloud effects.

4. Hourly 2-D Variables

(longitude, latitude, time:hour)

	output variable name	Units	notes
1	psl	Pa	air pressure at sea level
2	pr	kg m-2 s-1	precipitation flux
3	tas	K	near-surface air temperature
4	uas	m s-1	eastward wind
5	vas	m s-1	northward wind

Provided for some selected intervals (e.g., 1961–2000, 2046–2065, 2081–2100, 2181–2200, 2281–2300)

Rationale: The hourly data can be used for extreme impact analyses. For example, a flood analysis needs hourly precipitation and a high tide analysis needs hourly sea level pressure and surface winds. We are aware that hourly output from climate models has not been extensively validated for the current generation models, but we presume it is worth investigating for the next round experiments.

5. Extremes Indices

Although extremes indices are useful for some IAV studies, we are not proposing any particular set of extremes indices to modify or extend the existing list, Table A4 (http://www-pcmdi.llnl.gov/ipcc/standard_output.html#Table_A4). We found it extremely difficult to predefine a well-agreed set of extremes indices, as stated in Rationale 2 of Item 1 above. Instead, we have proposed the provision of daily data for entire simulation periods, at least until the year 2100, which would allow users the flexibility to define extremes indices themselves.

6. Land Bio-Geochemical Variables

We support the concept of the provisional land bio-geochemical variables list provided by Elena Shevliakova and Ronald J. Stouffer (Appendix A). These variables should be useful not only for IAV studies on ecosystems but also for the assessment of potential bio-fuel productivity for mitigation studies. We would request to add diagnostic bio-physical state variables, such as Leaf Area Index (LAI) to the list.

7. Ocean Bio-Geochemical Variables

We support the concept of the provisional ocean bio-geochemical variables list provided by John Dunne (Appendix B). From the perspective of marine-ecosystem IAV studies, we would request to add 3-D fields of pH and dissolved O_2 to the list, if they can be obtained from the models.

8. User-Friendliness of the Data

We have received several requests to improve the 'user-friendliness' of climate model outputs for impact researchers. This would include putting the data in a format that is easier to read, providing better descriptions of the data definitions, and providing standard tools for processing and visualizing the data. This should not to be taken as a one-sided request to the climate modeling community, but as an opportunity for the impact research and climate modeling communities to work together to solve the problem. The IPCC TGICA and the Data Distribution Centre (DDC) should take this on.

Appendix A. Provisional list of land bio-geochemical variables

A Framework for Archiving Variables from Terrestrial Models

Elena Shevliakova and Ronald J. Stouffer

February 9, 2007

Prognostic variables

Variable	Name	Units
C_l	carbon in leaves	Kg C/ m^2
C_r	carbon in fine roots	Kg C/ m^2
C_{sw}	carbon in sapwood	Kg C/ m^2
C_w	carbon in woody compartments (coarse roots, stems, branches)	Kg C/ m^2
C_{vl}	carbon in labile plant stores	Kg C/ m^2
C_{fs}	carbon in fast decomposing soil pool	Kg C/ m^2
C_{ss}	carbon in slow decomposing soil pool	Kg C/ m^2
C_p	carbon from grazing on pastures	Kg C/ m^2
C_c	carbon from harvests on crops	Kg C/ m^2
C_{wp1}	carbon in fast decomposing wood products	Kg C/ m^2
C_{wp2}	carbon in medium decomposing wood products	Kg C/ m^2
C_{wp3}	carbon in slow decomposing wood products	Kg C/ m^2

Diagnostic variables documenting transfers of carbon among atmosphere, vegetation and soil due to natural processes

Variable	Name	Units
A_n	net photosynthesis	Kg C/ m^2 y
R_p	respiration from veg. pools	Kg C/ m^2 y
R_g	growth respiration	Kg C/ m^2 y
A_f	burned area fraction	-
NEP	net ecosystem production	Kg C/ m^2 y

Diagnostic variables documenting transfers of carbon among atmosphere, vegetation and soil due to land use

Variable	Name	Units
f_{ntrl}	fraction of natural vegetation	
f_{crop}	fraction of cropland	
f_{past}	fraction of pasture	
f_{scnd}	fraction of secondary vegetation	
H_w	wood harvesting rate	Kg C/ m2 y
H_c	crops harvesting rate	Kg C/ m2 y
H_p	grazing rate	Kg C/ m2 y
L_{lu}	litter flux (debris) from land-use	Kg C/ m2 y
F_c	flux from crops consumption	Kg C/ m2 y
F_p	flux from grazing on pastures	Kg C/ m2 y
F_{wp1}	flux from fast decaying wood pool	Kg C/ m2 y
F_{wp2}	flux from medium decaying wood pool	Kg C/ m2 y
F_{wp3}	flux from slow decaying wood pool	Kg C/ m2 y

Appendix B. Provisional list of ocean bio-geochemical variables

A Minimal List for Archiving Variables from Ocean Bio-geochemical Models

Suggestion by John Dunne forwarded by Ron Stouffer

November 7, 2006

Scalars

xy-integrated sfc_co2_flux

xy-integrated runoff_DIC_flux

xy-integrated runoff_OC_flux

xy-integrated runoff_N_flux

xyz-integrated carbon

xyz-integrated no3

xyz-integrated new_production (no3-based)

xyz-integrated total_production

xyz-integrated nitrogen fixation

xyz-integrated sediment_denitrification

xyz-integrated water_column_denitrification

2-D fields, all in carbon units

sfc_co2_flux

z-integrated new_production (no3-based)

z-integrated total_production

particle sinking flux at 100 m

z-integrated total DIC

z-integrated total DOC

z-integrated total POC

runoff_dic_flux

sediment_CaCO3_flux

Other 2-D fields

sfc_chl

sfc_O2_flux

sfc_N_flux

runoff_N_flux

runoff_alk_flux

sediment_denitrification

3-D fields in carbon units

new_production

total_production

sinking flux

DIC

DOC

phytoplankton

zooplankton

detritus

Other 3-D fields

NO3

chl

nitrogen fixation

water column denitrification

For more complex models (e.g., including PO4, SiO4, Fe, multiple phyto, zoo, det, diss org groups), I would presume that they would also follow these same guidelines and include their equivalent variables and fluxes.