The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

CMIP5 datasets from the ACCESS1.0 and ACCESS1.3 coupled climate models

Mark Collier and Peter Uhe

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ABSTRACT

The task of generating Coupled Model Intercomparison Project Phase 5 (CMIP5) data from a climate model's raw output requires considerable human and computing resources beyond the modelling itself. The CMIP5 data generation, checking and publication generally continue for months after the climate model experimentation is complete. The information in this report is specifically aimed at climate data analysts who are seeking a summary of the Australian Community Climate and Earth-System Simulator (ACCESS) CMIP5 model features and their experimental outputs.

We summarise the major components that make up the ACCESS climate models, including the principal differences between the ACCESS1.0 and ACCESS1.3 models. We provide contact information for the principal modellers, and a list of recent research papers that describe the ACCESS models in more detail and focus on results from these models. We list the CMIP5 experiments that have been performed to date with the ACCESS models, as well as the branch year for experiments initialised from different time points of the pre-industrial control experiment. A summary of the forcings applied in each experiment is also given.

The basic steps of the data generation and publication are described, namely, 1) post-processing from raw to CMIP5 data, 2) quality control of CMIP5 data and 3) the CMIP5 data archive, available at the National Computing and Infrastructure (NCI) National Facility. Both the standard name and the "long name" of every published parameter are tabulated for easy identification. Crucial to reliable and up-to-date analysis are the ACCESS parameter versions, required when a parameter's definition is updated. This provides analysts with assurance that they are using the latest versions of the ACCESS CMIP5 parameters.

At the time of printing, the ACCESS CMIP5 submission includes data for 233 parameters from 7 experiments. The ACCESS submission includes data for most of the core CMIP5 experiments. Most experiments have a single ensemble member, however the number of members is expected to increase especially for the historical and historical "attribution" runs.

As an indicator of the success of the CMIP5 data submission described here, at the time of this report's completion, the ACCESS1.0 and 1.3 output fields have been used respectively in 50 and 31 publications that are based on the CMIP5 data sets.

1. INTRODUCTION

The Coupled Model Intercomparison Project Phase 5 (CMIP5) activity has provided years of continuous climate model development and experimentation to be scrutinized by climate scientists from around the world. It also provides a modelling centre with enhanced scientific recognition and opportunities for collaboration. The prospect of CMIP5 results contributing to the reporting component of Intergovernmental Panel on Climate Change Fifth Assessment Report (AR5), with its inherent deadlines, makes the modelling process more challenging. CMIP5 helps to focus the scope of the model development undertaken by a modelling centre, at least during the CMIP cycle itself.

This report describes information pertinent to the submission by CSIRO and the Bureau of Meteorology (CSIRO-BOM) of output fields from the Australian Community Climate and Earth-System Simulator (ACCESS) coupled model to the CMIP5 activity. A paper by Jeffrey et al. (2012) is available for the other Australian model submission, the CSIRO-Mk3.6.

This paper is designed to help potential users of ACCESS model data with technical descriptions of the CMIP5 data submission to answer potential questions that they might have. The contents include 1) a summary of model features 2) a summary of experimental design 3) details of the netCDF data including their structure and any caveats or recommendations of their use.

2. MODEL AND FORCING

For a complete description of the ACCESS models refer to several papers in a special edition of the Australian Meteorological and Oceanographic Journal (AMOJ), in particular, Bi et al. (2012a). Principal contacts and citable references for all aspects of the ACCESS modelling are provided in Table 1.

Table 1 Principal contacts for ACCESS coupled modelling.

Modelling Aspect	Contact	Reference
Leaders	Kamal Puri and Tony Hirst K.Puri@bom.gov.au Tony.Hirst@csiro.au	
Ocean	Simon Marsland Simon.Marsland@csiro.au	Bi et al. (2012a, b); Marsland et al., 2012
Atmosphere	Martin Dix Martin.Dix@csiro.au	Bi et al., 2012; Rashid et al., 2012
Land-Surface	Eva Kowalczyk Eva.Kowalcyzk@csiro.au	Kowalczyk et al., 2012
Sea-Ice	Petteri Uotila Petteri.Uotila@csiro.au	Uotila et al., 2012a, 2012b
Coupling	Dave Bi Dave.Bi@csiro.au	Bi et al., 2012a
Clouds	Zhian Sun Z.Sun@bom.gov.au Charmaine Franklin Charmaine.Franklin@csiro.au	Sun et al., 2012; Bi et al., 2012a
Aerosols	Peter Vohralik Peter.Vohralik@csiro.au	Dix et al., 2012
Forcing/Simulations	Martin Dix Martin.Dix@csiro.au	Dix et al., 2012
Computation and Data Infrastructure	Ben Evans Ben.Evans@anu.edu.au	

Post-Processing	Peter Uhe Peter.Uhe@csiro.au	Uhe et al., 2012

There are several important differences between the ACCESS models: the principal ones are the land surface scheme and cloud scheme in their atmospheric components shown in Table 2. There are other parameterisation differences, for example, sea-ice albedos, however readers are referred to the science papers provided in Table 1 where they are explained in detail. Both models generate published CMIP5 outputs on the same horizontal and vertical resolution, allowing for efficient comparison between them. Further details on ACCESS model grids are provided in Appendix 1.

Table 2 Summary of model components incorporated into the ACCESS1.0 and ACCESS1.3 coupled model [†]The atmospheric components of the ACCESS models are based on the Met Office Unified Model version 7.3 (UM7.3) code.

Coupled Model	Ocean	Sea-ice	Atmosphere[†]	Land-Biosphere
ACCESS1.0	MOM4p1	CICE4.1	HadGEM2 r1.1	MOSES
ACCESS1.3	MOM4p1	CICE4.1	Similar to GA 1.0	CABLE v1.8

3. EXPERIMENTS

The CMIP5 experimental design document (Taylor et al., 2012) defines a series of experiments that are driven by various combinations of anthropogenic and natural forcings. Natural forcings include solar irradiance and stratospheric aerosols from explosive volcanic eruptions; anthropogenic forcings include greenhouse gases (GHGs), anthropogenic aerosols and ozone. All forcings are time-varying unless specified otherwise. Readers are referred to Dix et al. (2012) for a thorough description of forcing used in the ACCESS CMIP5 experimentation.

CMIP5 defines a broad range of experiments encompassing control climate, paleoclimatic, sensitivity, hindcast and forecast experiments, as well as providing scope for modelling groups to define their own historical experiments for detection and attribution studies. The experiments are arranged in two focus groups (near-term and longer-term), with each group subdivided into "Core", "Tier 1" and "Tier 2", in order of priority. Modelling groups were encouraged to undertake the "Core" experiments (in either or both focus groups) first, followed by Tier 1 and Tier 2 experiments if resources were available.

The CSIRO-BOM submission consists of data for 7 experiments for each version of the ACCESS model. The experimental submission, along with other related information, is presented in Table 3. Most experiments have only a single member ensemble, where exceptions are listed.

CSIRO-BOM addressed mainly the Core experiments due to the need for resource intensive model development during the submission stage of CMIP5. The only exceptions to the Core experiments were additional historical ensemble members completed by the Centre of Excellence for Climate System Science (CoECSS), and an additional AMIP ensemble member.

Two diagnostic experiments have been performed for understanding the long-term simulations. These are the idealised 1-percent per year compounding to quadrupling CO_2 and an instantaneous quadrupling CO_2 experiment, the later referred to as the Gregory-style diagnosis of the "fast" climate system responses (Taylor et al., 2012).

A set of historical experiments designed for detection and attribution studies will be performed beyond the AR5 activity, as well as a range of other experiments of interest to the ACCESS modelling centre and its collaborators likely using ACCESS1.3. These experiments are likely to include several Tier 1 and 2 experiments designed to explore the Core experiments in more detail (Taylor et al., 2012).

Table 3 The CSIRO-BOM CMIP5 Experiments. †The second ensemble member has been completed by the CoECSS. ††The second and third ensemble member have been completed by the CoECSS. *Data was not submitted to CMIP5 for spin-up periods.

Experiment	Model	Ens. size	Branch point	Model	Ens. size	Branch point	Summary
	ACCESS1.0			**ACCESS1.3**			
piControl*	300-799	1	300	250-749	1	250	All forcings fixed at 1850 levels
historical	1850-2005	1†	300	1850-2005	1	250	All forcings are time varying
		2	349		2††	340	
					3††	550	
amip	1978-2008	1	N/A		2	N/A	AGCM experiment using observed SSTs and sea-ice
rcp45	2006-2100	1	300	2006-2100	1	250	RCP 4.5
rcp85	2006-2100	1	300	2006-2100	1	250	RCP 8.5
1pctCO2	300-439	1	300	250-389	1	250	Cumulative increase in CO_2 of 1% per year up to 4×1850 concentration; all other forcings fixed at 1850 levels
abrupt4xCO2	300-449	1	300	250-401	1	250	CO_2 fixed at 4×1850 concentration; all other forcings fixed at 1850 levels

The pre-industrial control experiment was initialised from starting conditions taken from an unrelated (i.e. non-CMIP5) control experiment that was known to be relatively stable. A 300 (250)-year "spin-up" (or adjustment) period allowed for ACCESS1.0 (ACCESS1.3) to adjust to the new CMIP5 pre-industrial forcings, before data collection commenced. Data throughout this spin-up period were not submitted to CMIP5. Other experiments were initialised from the end of the spin-up period. Those experiments with a multi-member ensemble (conducted by the CoECSS) were initialised from starting conditions taken from different positions of the pre-industrial control. Table 3 columns labelled "branch point" provide the simulation year (all beginning at first of January) at which each experiment and ensemble member branched from the parent experiment. No spin-up periods were conducted with the ACCESS (atmosphere only) AMIP experiments prior to the collection of data.

4. SIMULATED TEMPERATURE CHANGES

The pre-industrial control experiment can be used to provide a baseline for the other experiments and also to determine if there is any residual climate drift in the model. A time-series of globally averaged near surface temperature is a parameter of interest in climate model evaluation as it describes the evolution of the net thermal energy (and hence if the model has a net drift which could indicate a modelling problem) at the air-surface interface, and there is a long (>century) and accurate observational record of it. Figures 1 and 2 show the globally averaged (2m) surface air temperature for the pre-industrial, historical, two projection (rcp45 and rcp85) and two idealised (abrupt4xCO2 and 1pctCO2) experiments. The results for the piControl simulations in the top panels indicate both of the ACCESS models are stable; this conclusions is based solely on the small temperature drift they show. Further analysis, beyond the scope of this report, is required to understand the model's mean state and variability in detail. The bottom panels compare the modelled result (for the historic period) with observations (Morice et al., 2012); these are modified from Dix et al. (2012). The drift in the pre-industrial experiment, averaged over all modelled years, for ACCESS1.0 is 0.07°C per Century and for ACCESS1.3 is a very small 0.007°C per Century.

The second half of the twentieth century for the ACCESS1.3 model tends to display somewhat reduced warming compared to both ACCESS1.0 and observations, however, by 2005, the warming in both model versions and the observations are quite similar. Dix et al. (2012) showed that the climate sensitivity in the idealised simulations is 10-15% larger in ACCESS1.0 than ACCESS1.3. As shown by Figures 1 and 2, the surface air temperature is about 0.7°C (0.3°C) warmer in the ACCESS1.0 compared to ACCESS1.3 by the end of the 1pctCO2 (abrupt4xCO2) experiment, compared to their initial values. Unlike Dix et al. (2012) we have not removed the control drift from the model results in Figures 1b and 2b. From Figures 1a and 2b it can be seen that the drift is small, especially in the ACCESS1.3 model. The demonstrated stability of the model and agreement with observational records indicates that there is unlikely to be a serious flaw in the ACCESS modelling or conversion of the raw model output to CMIP5 netCDF format, the later process a focus of the work described in this report. For further analysis of the ACCESS datasets, the reader is referred to other papers in the forthcoming Special Issue in AMOJ (Table 1).

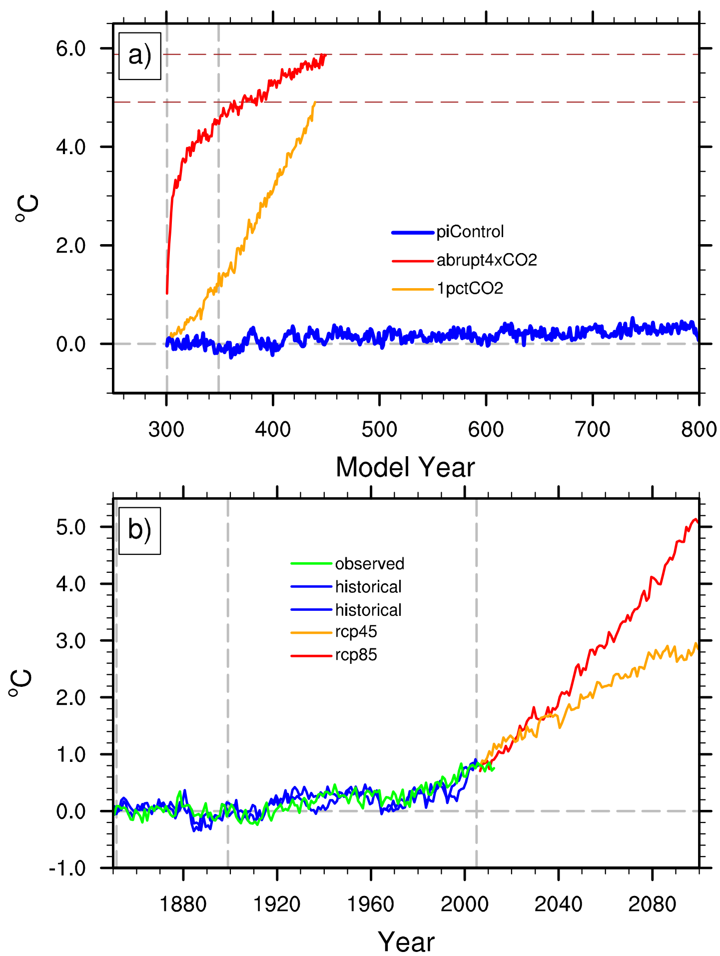

Fig. 1 ACCESS1.0 annual global-mean surface air temperature anomalies (°C) for a) pre-industrial control, abrupt4xCO2 and 1pctCO2 experiments; and b) HadCRUT4 observations and historical, rcp45 and rcp85 experiments. Results in panel a) are presented as anomalies relative to piControl years 300-

349 and panel b) years 1850-1899, these periods are shown by the grey vertical dashed lines. An additional vertical dashed line is shown in panel b) at the end of year 2005 where the RCP extensions begin. Note that each historical member (2 in total following information in Table 3) time-series is shown to give an indication of variability. The brown horizontal lines indicate the maximum value attained at the end of each idealised experiment.

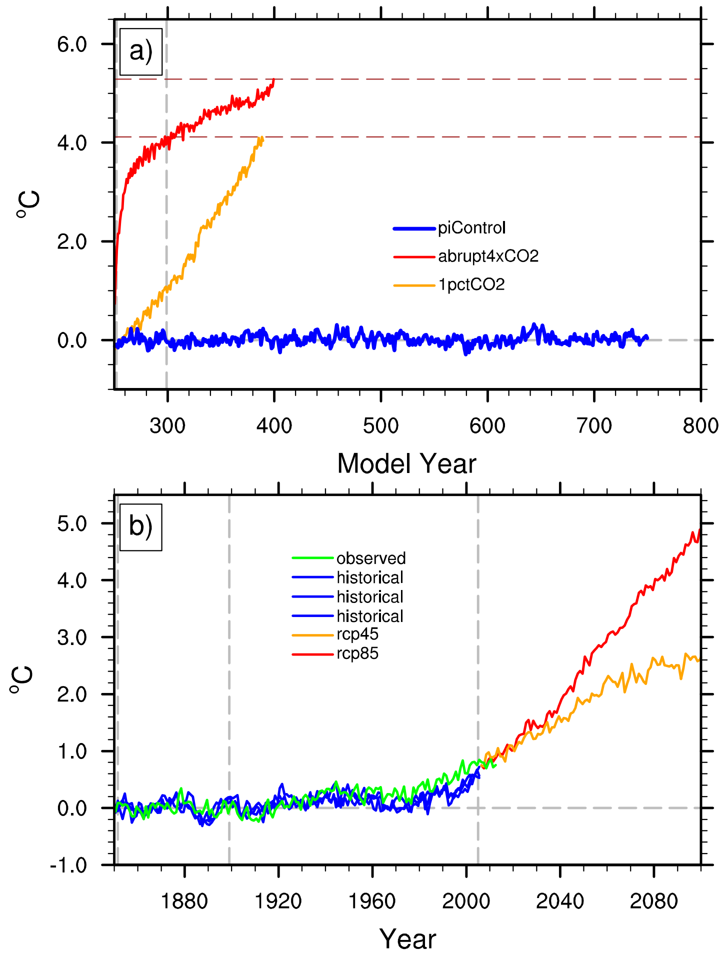

Fig. 2 ACCESS1.0 annual global-mean surface air temperature anomalies (°C) for a) pre-industrial control, abrupt4xCO2 and 1pctCO2 experiments; and b) HadCRUT4 observations and historical, rcp45 and rcp85 experiments. Results in panel a) are presented as anomalies relative to piControl years 250-299 and panel b) years 1850-1899, these periods are shown by the grey vertical dashed lines. An additional vertical dashed line is shown in panel b) at then end of year 2005 where the RCP extensions begin. Note that each historical member (3 in total following information in Table 3) time-series is shown to give an indication of variability. The brown horizontal lines indicate the maximum value attained at the end of each idealised experiment.

5. PARAMETERS

The CMIP5 output specification (Taylor and Doutriaux, 2010; Taylor, 2012) defines the output datasets requested for each experiment. In many cases, climate parameters are requested for a subset of experiments, ensemble members and simulation years. The CSIRO-BOM submission includes data for 276 climate parameters of which 8 are time invariant parameters (such as grid cell volumes) and the remainder vary in frequency of output from monthly to three-hourly output. Data were submitted for those parameters that were output directly from the ACCESS model, and those that could be readily derived from model outputs. The CSIRO-BOM submission also includes a number of experiment extensions and some experiment ensembles. The datasets available are summarised in Table 6 (Appendix 2).

Three-dimensional atmospheric datasets have been provided using the vertical coordinate defined by CMIP5 for each parameter, which in most cases is either the model's native vertical coordinate or prescribed pressure levels. See Uhe et al. (2012) for a description of how the atmospheric model component output was converted to a CMIP5 compliant netCDF format.

In general, data were not extrapolated beyond the vertical levels supported by model. The ACCESS models use hybrid height vertical levels (Bi et al., 2012). CMIP5 requested a number of daily and monthly atmospheric parameters on pressure levels up to and including 1000hPa. Where these pressure levels were greater than the surface pressure (i.e. below ground level), the values were reported as missing.

All parameters were written on their native horizontal model grid described in Appendix 1; therefore when new parameters in the APP were defined from multiple inputs (described in next section), no horizontal interpolation or extrapolation was required.

6. THE POST-PROCESSOR

Software written in the Python scripting language was developed to enable post-processing of ACCESS model outputs and is described by Uhe et al. (2012); it is referred to as the ACCESS Post-Processor (APP). The APP was linked with the Climate Model Output Rewriter (CMOR2) library Version 2 supplied to the community by PCMDI to ensure 1) strict formatting of files, 2) a minimum level of quality control, and 3) outputs are adequately compliant with the CMIP5 data standard which uses a NetCDF format with additional metadata requirements, see Taylor and Doutriaux (2010).

The APP takes the raw ACCESS model output and produces files with one CMIP5 parameter per file, also containing all the metadata required to meet CMIP5 standards. In addition, the UM output which uses a local binary file format is first converted to netCDF format before processing, unlike the other model components which natively output data in netCDF format.

Many of the CMIP5 parameters definable for the ACCESS models were calculated from more than one input parameter, often by simple arithmetic manipulation. Other parameters required a more complex processing. In addition to this, the processing of many parameters required further data manipulation including averaging over time domains, units conversion, and filling missing values to match the CMIP5 requirements. A number of unsolicited parameters were defined and written out by the APP, however, only standard CMIP5 parameters are discussed in this report. Please contact the authors if you would like to discuss the existing range of unsolicited parameters or how to define your own.

7. QUALITY CONTROL

CMIP5 datasets must pass a series of quality control (QC) checks before they can be published and formally cited. Some overview information is given in the web page https://redmine.dkrz.de/collaboration/projects/cmip5-qc/wiki. The stages of quality control are: QC1 (data and metadata compliance checks automatically imposed by CMOR2 and the Earth System Grid data publishing software); QC2 (data consistency checks); and QC3 (extended checking of data and metadata). In addition to official QC checks, the ACCESS modelling team has done extensive analysis and manual checking of the data before publishing.

Datasets prepared using CMOR2 and published using the Earth System Grid software (Williams et al., 2009) are guaranteed to achieve compliance with QC level 1. Datasets must be manually checked using the QC L2 tools to achieve the QC2 compliance. A description of these is given in the web page https://redmine.dkrz.de/collaboration/projects/cmip5-qc/wiki/Qc_level_2. Individual modelling groups are responsible for ensuring their datasets pass the QC1 and QC2 checks. Datasets passing both QC1 and QC2 are then subject to QC3 checking by the World Data Centre for Climate; their role is described in the web page http://www.dkrz.de/daten-en/wdcc?set_language=en. Datasets meeting QC3 requirements are assigned a Digital Object Identifier (DOI) and can then be formally cited in the scientific literature. Further information on the DOI project can be found from the web address http://www.doi.org/

The ACCESS CMIP5 datasets have passed the level 1 and 2 quality control checks. At publication time of this report the datasets were ready to undergo QC3 checks.

8. CMIP5 DATA ARCHIVE

CMIP5 datasets are hosted on the Earth System Grid (ESG; Williams et al. (2009) Federation. Currently there are about 45 models from 25 centres making their data available to the CMIP5 activity. The ESG is an international network of data nodes that enables users to transparently access data irrespective of where the data are physically stored. The ACCESS datasets are publicly available for non-commercial use and are physically stored at the data node hosted by the National Computational Infrastructure National Facility (NCI, Australian National University, Canberra, Australia); further information about NCI is available at the web address http://nf.nci.org.au/. The web end for the NCI ESGF node is accessed from http://esg2.nci.org.au/

The datasets are being replicated at the World Data Centre for Climate for QC3 data checking and to enable users to access the data when the primary host is inaccessible. At the time of publication, the ACCESS archive consisted of approximately 75,000 files and occupying about 20TB of disk space. In comparison, the total data contributed so far from modelling centres amounts to 1.7PB, about forty times larger than the previous coupled model intercomparison.

Once the user has logged in to the ESGF and selected the dataset(s) of interest, the relevant file(s) can be downloaded. This can be either done directly through the web browser or using a wget download script (a UNIX shell script). The wget script method is recommended for downloading moderately sized volumes of data, but users require access to access to the wget application and java to run the scripts. A guide to using the ESGF systems is available at
http://www.esgf.org/wiki/ESGF_User_Guide.

The most efficient method of analysing the data for many Australian researchers will be through direct access to the NCI where the data is hosted, along with maintained copies of other model data from the ESGF of interest to the local community. To access the datasets using this method, you will need to have an account on the National Facility machine called "dcc.nci.org.au", and join the user group "ua6" (which requires you to be registered with the NCI ESG gateway). The directory and file names follow CMIP5 Data Reference Syntax (DRS) (Taylor et al., 2011) and for each model are located under the directory /projects/ua6/authoritative/IPCC/CMIP5/CSIRO-BOM/(ACCESS1-0, ACCESS1-3).

9. PARAMETER CORRECTION

CMIP5 datasets include a version number to enable users to track modifications to the data. The version number is included in the HTTP path to each file and (depending on the modelling group), may also be specified in the metadata in each file. The path is visible in wget download scripts and is also accessible via the ESG web interface (see the "File Details" section once a dataset has been selected). The version number that is displayed when browsing the CMIP5 catalogue is derived from the date when the dataset was added to the catalogue; it may have no relation to the data version.

Some parameters were found to have incorrect calculations or missing components. When these were fixed they then were republished. To distinguish the old and new files, they were given a new version number. Each netCDF file has an attribute "version_number" which is used to distinguish between versions the default value is "v20120115" ("v20120413") for ACCESS1.0 (ACCESS1.3). Updates of these are posted at the web page
https://wiki.csiro.au/display/ACCESS/Known+Issues+with+ACCESS+CMIP5+data

Updates up to 1/12/2012:

- zosga and zossga to make calculations consistent between ACCESS1.0 and ACCESS1.3. The latest files have the version_number="v20121203"
- emiso2 (total emission rate of SO2). The new files were been modified to include the 3D background emissions of SO2 from degassing volcanoes. The latest files have version_number="v20121030"
- clivi and clwvi for ACCESS1.0 were found to be missing some contributions from convection. The latest files have version_number="v20120727"

10. SUMMARY

The Centre for Australian Weather and Climate Research has prepared a substantial CMIP5 data submission using the ACCESS1.0 and ACCESS1.3 coupled climate models. The comprehensive and timely submission was achieved by the development of a specialised post-processing tool and a data management approach described in this report.

In total there are 233 parameters from 7 unique CMIP5 experiments. Although presently there is much current interest and value in the ACCESS submissions, they will equally provide interest into the future as benchmark results for continued model improvement.

11. ACKNOWLEDGMENTS

We would like to acknowledge the contribution of the ACCESS modelling team in assisting with the development of the ACCESS post-processor especially in helping to ensure that the CMIP5 parameters were defined accurately.

This work is supported by the NCI based at the Australian National University. In particular, NCI provided computing resources for the post-processing and data hosting infrastructure, and the serving of ACCESS CMIP5 data to the international community via the Earth System Grid.

Drs. Sophie Lewis and Paola Petrelli from the Centre of Excellence for Climate System Science were responsible for performing the second historical ensemble member for ACCESS1.0 and the second and third historical ensemble members for ACCESS1.3, and for post-processing their raw model outputs into CMIP5 format.

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Other References

For Reader's convenience these useful web sites have been reproduced here from Jeffrey et al. (2012):

Climate Model Output Rewriter web site: http://www2-pcmdi.llnl.gov/cmor

Coupled Model Intercomparison Project web site: http://cmip-pcmdi.llnl.gov

CMIP5 - Modeling Info - Producing Model Output web site:
http://cmip-pcmdi.llnl.gov/cmip5/output_req.html

CMIP5 Quality Control web site: https://redmine.dkrz.de/collaboration/projects/cmip5-qc/wiki

Digital Object Identifier web site: http://www.doi.org/

Earth System Grid web site: http://www.earthsystemgrid.org/home.htm

Forcings in GISS Climate Model web site: http://data.giss.nasa.gov/modelforce/strataer

World Data Centre for Climate web site: http://www.dkrz.de/daten-en/wdcc?set_language=en

13. APPENDIX 1. MODEL GRIDS

Resolution and grids of model components

The following gives a brief summary, followed by tables with values of the grid specifications. The values are typically defined at the mid-points of a cell. The tables can help, for example, analysts prepare subsets of the full domain (by selecting out the appropriate array indices via the simple expression (row#+1)x10+column#+1 for a single index) for a specific study. Please note that all the necessary information/metadata to analyse the CMIP5 files is in the netCDF files, or available via a parameter in the fx CMIP5 table (e.g. land mask, grid area weights, time and space bounds etc.)

Atmosphere:
Horizontal grid: 1.25° latitude by 1.875° longitude, using a staggered Arakawa C grid.
Vertical Levels: 38 levels hybrid height levels,
Height obeys: z(k,j,i)= a(k)+ b(k)*orog(j,i), a and b are the hybrid height co-efficients and orog is the model orography.

Atmosphere pressure levels:
Output for some parameters is interpolated from model vertical levels to pressure levels for easier model inter-comparison. These differ for different frequency output with 17 levels for monthly output, 9 for daily output and 3 for 6-hourly output.

Ocean:
Horizontal grid: 300x360 tripolar grid. Nominally 1° in north-south and east-west direction with modifications: Mercator grid spacing south of 30°S, has 1/3 latitudinal degree spacing between 10°S and 10°N. Approximate latitude and longitude given in later in this Appendix. Actual latitude and longitude are lat(j,i) and lon(j,i) given in netCDF files (note i,j indices start at 0). T, U and V grids are staggered.
Vertical Levels: Z* grid with 50 depth levels.

Sea-Ice:
Horizontal grid as for the ocean.

Land Surface Tiles:
ACCESS1.0 (MOSES) 9 tiles (5 vegetated and 4 non-vegetated)
ACCESS1.3 (CABLE) 17 surface tile types (11 vegetated, 4 non-vegetated and 2 unused)

Land Surface soil levels:
ACCESS1.0 (MOSES) 4 soil levels
ACCESS1.3 (CABLE) 6 soil levels

Table 4.1 Atmosphere/Sea-ice/Land-surface latitudes.

	0	1	2	3	4	5	6	7	8	9
0	-89.38	-88.13	-86.88	-85.63	-84.38	-83.13	-81.88	-80.63	-79.38	-78.13
1	-76.88	-75.63	-74.38	-73.13	-71.88	-70.63	-69.38	-68.13	-66.88	-65.63
2	-64.38	-63.13	-61.88	-60.63	-59.38	-58.13	-56.88	-55.63	-54.38	-53.13
3	-51.88	-50.63	-49.38	-48.13	-46.88	-45.63	-44.38	-43.13	-41.88	-40.63
4	-39.38	-38.13	-36.88	-35.63	-34.38	-33.13	-31.88	-30.63	-29.38	-28.13
5	-26.88	-25.63	-24.38	-23.13	-21.88	-20.63	-19.38	-18.13	-16.88	-15.63
6	-14.38	-13.13	-11.88	-10.63	-9.38	-8.13	-6.88	-5.63	-4.38	-3.13
7	-1.88	-0.63	0.63	1.88	3.13	4.38	5.63	6.88	8.13	9.38
8	10.63	11.88	13.13	14.38	15.63	16.88	18.13	19.38	20.63	21.88
9	23.13	24.38	25.63	26.88	28.13	29.38	30.63	31.88	33.13	34.38
10	35.63	36.88	38.13	39.38	40.63	41.88	43.13	44.38	45.63	46.88
11	48.13	49.38	50.63	51.88	53.13	54.38	55.63	56.88	58.13	59.38
12	60.63	61.88	63.13	64.38	65.63	66.88	68.13	69.38	70.63	71.88
13	73.13	74.38	75.63	76.88	78.13	79.38	80.63	81.88	83.13	84.38
14	85.63	86.88	88.13	89.38						

Table 4.2 Atmosphere/Sea-ice/Land-surface longitudes.

	0	1	2	3	4	5	6	7	8	9
0	0.94	2.81	4.69	6.56	8.44	10.31	12.19	14.06	15.94	17.81
1	19.69	21.56	23.44	25.31	27.19	29.06	30.94	32.81	34.69	36.56
2	38.44	40.31	42.19	44.06	45.94	47.81	49.69	51.56	53.44	55.31
3	57.19	59.06	60.94	62.81	64.69	66.56	68.44	70.31	72.19	74.06
4	75.94	77.81	79.69	81.56	83.44	85.31	87.19	89.06	90.94	92.81
5	94.69	96.56	98.44	100.31	102.19	104.06	105.94	107.81	109.69	111.56
6	113.44	115.31	117.19	119.06	120.94	122.81	124.69	126.56	128.44	130.31
7	132.19	134.06	135.94	137.81	139.69	141.56	143.44	145.31	147.19	149.06
8	150.94	152.81	154.69	156.56	158.44	160.31	162.19	164.06	165.94	167.81
9	169.69	171.56	173.44	175.31	177.19	179.06	180.94	182.81	184.69	186.56
10	188.44	190.31	192.19	194.06	195.94	197.81	199.69	201.56	203.44	205.31
11	207.19	209.06	210.94	212.81	214.69	216.56	218.44	220.31	222.19	224.06
12	225.94	227.81	229.69	231.56	233.44	235.31	237.19	239.06	240.94	242.81
13	244.69	246.56	248.44	250.31	252.19	254.06	255.94	257.81	259.69	261.56
14	263.44	265.31	267.19	269.06	270.94	272.81	274.69	276.56	278.44	280.31
15	282.19	284.06	285.94	287.81	289.69	291.56	293.44	295.31	297.19	299.06
16	300.94	302.81	304.69	306.56	308.44	310.31	312.19	314.06	315.94	317.81
17	319.69	321.56	323.44	325.31	327.19	329.06	330.94	332.81	334.69	336.56
18	338.44	340.31	342.19	344.06	345.94	347.81	349.69	351.56	353.44	355.31
19	357.19	359.06								

Table 4.3 Atmosphere Vertical levels (Pa).

	0	1	2	3	4	5	6	7	8	9
0	100000	925000	85000	70000	60000	50000	40000	30000	25000	20000
1	15000	10000	7000	5000	3000	2000	1000			

Table 4.4 Atmospheric Vertical Hybrid Levels (m) (*a* coefficients)[1].

	0	1	2	3	4	5	6	7	8	9
0	20	80.001	179.999	320.001	500.001	720.000	980.001	1279.998	1620.000	1999.998
1	2420.002	2880.001	3379.998	3920.000	4500.001	5120.000	5780.000	6480.000	7220.000	8000.001
2	8820.000	9679.999	10579.998	11519.998	12499.999	13520.001	14580.800	15694.64	16875.311	18138.627
3	19503.01	20990.188	22626.082	24458.285	26583.641	29219.080	32908.691	39254.832		

Table 4.5 Atmospheric Vertical Hybrid (m) (*b* coefficients).

	0	1	2	3	4	5	6	7	8	9
0	0.99771649	0.9908815	0.97954255	0.96377707	0.94369549	0.91943836	0.89117801	0.85911834	0.82349348	0.78457052
1	0.74264622	0.6980502	0.65114272	0.60231441	0.55198872	0.50061995	0.44869339	0.39672577	0.34526527	0.29489139
2	0.24621508	0.19987822	0.15655422	0.11694787	0.08179524	0.05186372	0.02793682	0.01071648	0.00130179	

Table 4.6 Ocean/Ice latitudes[2].

	0	1	2	3	4	5	6	7	8	9
0	-77.877	-77.63	-77.382	-77.132	-76.881	-76.626	-76.368	-76.106	-75.84	-75.568
1	-75.29	-75.006	-74.715	-74.417	-74.11	-73.795	-73.471	-73.138	-72.794	-72.44
2	-72.074	-71.698	-71.309	-70.908	-70.495	-70.069	-69.629	-69.176	-68.709	-68.228
3	-67.733	-67.223	-66.698	-66.159	-65.604	-65.035	-64.45	-63.849	-63.234	-62.603
4	-61.956	-61.294	-60.617	-59.925	-59.218	-58.496	-57.759	-57.008	-56.242	-55.462
5	-54.668	-53.861	-53.04	-52.207	-51.361	-50.503	-49.633	-48.751	-47.859	-46.956
6	-46.043	-45.12	-44.188	-43.248	-42.3	-41.344	-40.381	-39.412	-38.437	-37.457
7	-36.472	-35.483	-34.491	-33.496	-32.499	-31.5	-30.5	-29.5	-28.501	-27.508
8	-26.524	-25.552	-24.596	-23.66	-22.745	-21.855	-20.992	-20.159	-19.356	-18.587
9	-17.85	-17.149	-16.482	-15.851	-15.253	-14.69	-14.158	-13.659	-13.188	-12.745
10	-12.326	-11.93	-11.552	-11.191	-10.841	-10.501	-10.166	-9.834	-9.5	-9.167
11	-8.833	-8.5	-8.166	-7.834	-7.5	-7.167	-6.833	-6.5	-6.166	-5.834
12	-5.5	-5.167	-4.833	-4.5	-4.166	-3.834	-3.5	-3.167	-2.833	-2.5
13	-2.166	-1.834	-1.5	-1.167	-0.833	-0.5	-0.166	0.166	0.5	0.833
14	1.167	1.5	1.834	2.166	2.5	2.833	3.167	3.5	3.834	4.166
15	4.5	4.833	5.167	5.5	5.834	6.166	6.5	6.833	7.167	7.5
16	7.834	8.166	8.5	8.833	9.167	9.5	9.834	10.166	10.501	10.841
17	11.191	11.552	11.93	12.326	12.745	13.188	13.659	14.158	14.69	15.253
18	15.851	16.482	17.149	17.85	18.587	19.356	20.159	20.992	21.855	22.745
19	23.66	24.596	25.552	26.524	27.508	28.501	29.5	30.5	31.5	32.497
20	33.492	34.483	35.469	36.449	37.421	38.385	39.339	40.283	41.216	42.137
21	43.045	43.939	44.819	45.683	46.532	47.365	48.181	48.981	49.763	50.527
22	51.274	52.003	52.715	53.409	54.085	54.744	55.386	56.011	56.621	57.214
22	57.793	58.357	58.908	59.445	59.971	60.485	60.989	61.483	61.97	62.448
23	62.921	63.388	63.852	64.312	64.771					

[1] z=a+b*orog; z refers to height and orog is a 2D array (lat.,lon.) referred to as the present day height above "the geoid".
[2] North of 65°N the model utilizes the horizontal tripolar grid of Murray (1996) and requires a 2D array to define both the latitudes and longitudes, and are therefore not provided here. Note that 0-180 degrees corresponds to 0-180°E and 180-360 corresponds to 180°W-0°E/W.

Table 4.7 Ocean/Ice longitudes[2].

	0	1	2	3	4	5	6	7	8	
0	80.5	81.5	82.5	83.5	84.5	85.5	86.5	87.5	88.5	89.5
1	90.5	91.5	92.5	93.5	94.5	95.5	96.5	97.5	98.5	99.5
2	100.5	101.5	102.5	103.5	104.5	105.5	106.5	107.5	108.5	109.5
3	110.5	111.5	112.5	113.5	114.5	115.5	116.5	117.5	118.5	119.5
4	120.5	121.5	122.5	123.5	124.5	125.5	126.5	127.5	128.5	129.5
5	130.5	131.5	132.5	133.5	134.5	135.5	136.5	137.5	138.5	139.5
6	140.5	141.5	142.5	143.5	144.5	145.5	146.5	147.5	148.5	149.5
7	150.5	151.5	152.5	153.5	154.5	155.5	156.5	157.5	158.5	159.5
8	160.5	161.5	162.5	163.5	164.5	165.5	166.5	167.5	168.5	169.5
9	170.5	171.5	172.5	173.5	174.5	175.5	176.5	177.5	178.5	179.5
10	180.5	181.5	182.5	183.5	184.5	185.5	186.5	187.5	188.5	189.5
11	190.5	191.5	192.5	193.5	194.5	195.5	196.5	197.5	198.5	199.5
12	200.5	201.5	202.5	203.5	204.5	205.5	206.5	207.5	208.5	209.5
13	210.5	211.5	212.5	213.5	214.5	215.5	216.5	217.5	218.5	219.5
14	220.5	221.5	222.5	223.5	224.5	225.5	226.5	227.5	228.5	229.5
15	230.5	231.5	232.5	233.5	234.5	235.5	236.5	237.5	238.5	239.5
16	240.5	241.5	242.5	243.5	244.5	245.5	246.5	247.5	248.5	249.5
17	250.5	251.5	252.5	253.5	254.5	255.5	256.5	257.5	258.5	259.5
18	260.5	261.5	262.5	263.5	264.5	265.5	266.5	267.5	268.5	269.5
19	270.5	271.5	272.5	273.5	274.5	275.5	276.5	277.5	278.5	279.5
20	280.5	281.5	282.5	283.5	284.5	285.5	286.5	287.5	288.5	289.5
21	290.5	291.5	292.5	293.5	294.5	295.5	296.5	297.5	298.5	299.5
22	300.5	301.5	302.5	303.5	304.5	305.5	306.5	307.5	308.5	309.5
23	310.5	311.5	312.5	313.5	314.5	315.5	316.5	317.5	318.5	319.5
24	320.5	321.5	322.5	323.5	324.5	325.5	326.5	327.5	328.5	329.5
25	330.5	331.5	332.5	333.5	334.5	335.5	336.5	337.5	338.5	339.5
26	340.5	341.5	342.5	343.5	344.5	345.5	346.5	347.5	348.5	349.5
27	350.5	351.5	352.5	353.5	354.5	355.5	356.5	357.5	358.5	359.5
28	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5
29	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5
30	20.5	21.5	22.5	23.5	24.5	25.5	26.5	27.5	28.5	29.5
31	30.5	31.5	32.5	33.5	34.5	35.5	36.5	37.5	38.5	39.5
32	40.5	41.5	42.5	43.5	44.5	45.5	46.5	47.5	48.5	49.5
33	50.5	51.5	52.5	53.5	54.5	55.5	56.5	57.5	58.5	59.5
34	60.5	61.5	62.5	63.5	64.5	65.5	66.5	67.5	68.5	69.5
35	70.5	71.5	72.5	73.5	74.5	75.5	76.5	77.5	78.5	79.5

Table 4.8 Ocean depths[3].

	0	1	2	3	4	5	6	7	8	9
0	5	15	25	35	45	55	65	75	85	95
1	105	115	125	135	145	155	165	175	185	195
2	205	216.84	241.349	280.78	343.25	427.31	536.71	665.41	812.78	969.06
3	1130.93	1289.60	1455.77	1622.92	1801.55	1984.85	2182.90	2388.41	2610.93	2842.56
4	3092.20	3351.29	3628.05	3913.26	4214.49	4521.91	4842.56	5166.13	5499.24	5831.29

[3] These depths are a close approximation only; the implementation of z* vertical coordinate requires thickness to be a function of time, i.e. depth(time,lat,lon) due to the contributions from the surface pressure field. Currently in the ACCESS models a globally uniform air pressure is applied and so this has no effect. However, sea-ice does contribute especially over shelf regions where the depth is small.

Table 4.9 Soil levels.

Shown is the bottom extent of each soil level in metres.

Level	ACCESS1.0	ACCESS1.3
1	0.1	0.022
2	0.35	0.08
3	1.0	0.234
4	3.0	0.643
5		1.728
6		4.6

Table 4.10 Vegetation types.[4]

Level	ACCESS1.0	ACCESS1.3
1	Broadleaf	Evergreen Needleleaf
2	Needleleaf	Evergreen Broadleaf
3	C3 grass	Deciduous Needleleaf
4	C4 grass	Deciduous Broadleaf
5	Shrubs	Shrub
6	Urban	C3 grass
7	Water	C4 grass
8	Bare ground	Tundra
9	Ice	C3 crop
10	-	C4 crop
11	-	Wetland
12	-	-
13	-	-
14	-	Barren
15	-	Urban
16	-	Lakes
17	-	Ice

[4] See Table 2 in Kowalczyk et al. (2012) for a detailed list of surface types and parameter values used in ACCESS1.3 (CABLE).

14. APPENDIX 2. DATASETS AVAILABLE

CMIP5 datasets have been prepared and published on the Earth System Grid for the parameters listed in Table 3. Three-dimensional atmospheric datasets use the vertical coordinate specified by CMIP5, which in most cases is either the model's native vertical coordinate or prescribed pressure levels.

Table 5 ACCESS datasets. Notes: † model levels; †† pressure levels; ††† data provided at 2m (CMIP5 requested data at 10m); ^ corresponds to the last 30 years of the abrupt4xCO2 run, however years 429-458 (300-449) were created instead for ACCESS1.0(1.3); ^^ last 30 years; ^^^ corresponds to years 1979-2005 in the historical experiments; * corresponds to years 1986-2005 in the historical experiments; ** 1-year timeslice taken every decade; *** timeslices correspond to years 1850, 1870, 1890, 1910, 1930, 1950, 1960, 1970, 1980, 1990, 2000, 2010, 2020, 2040, 2060, 2080 and 2100 in the historical experiments. *E1, E2* denotes the ensemble member in a multi-member ensemble; AGCM denotes atmosphere-only experiment; and CAOGCM denotes couple atmosphere-ocean experiment. ˜ provided for all experiments, including AGCM experiments; ˜˜ in reality first 5 years are missing (i.e. 200-204). + All ensembles except where noted.

Frequency	**Type**	**Parameter(s)**	**Data available**		
			Experiments	ACCESS1.0 Years	ACCESS1.3 Years
Fixed	2D	Land/ocean parameters areacella (ocean grid-cell area), areacello (ocean grid-cell area), basin (region selection index), deptho (sea floor depth), orog (surface altitude), sftgif (fraction of grid cell covered with glacier), sftlf (land area fraction), sftof (sea area fraction)	All CAOGCM		
	3D	*None*	N/A	N/A	N/A
Three-hourly		*Atmosphere parameters* clt (total cloud fraction), hfls (surface upward latent heat flux), hfss (surface upward sensible heat flux), huss (near-surface specific humidity), mrsos (moisture in upper portion of soil column)?, pr (precipitation), prc (convective precipitation), prsn (solid precipitation), ps (surface air pressure), rlds (surface downwelling longwave radiation), rlus (surface upwelling longwave radiation), rsdsdiff (surface diffuse downwelling shortwave radiation), rsds (surface downwelling shortwave radiation), rsus (surface upwelling shortwave radiation), rldscs (surface	 piControl historical amip rcp 4.5/8.5 1pctCO2 abrupt4xCO2	All ensembles 420-449^ 1950-2005 1978-2008 2006-2100 410-439^^ 250-254,420-	All ensembles 370-399^ 1950-2005 1978-2008 2006-2100 410-439^^ 200-

Six-hourly		downwelling clear-sky longwave radiation), rsdscs (surface downwelling clear-sky shortwave radiation), rsuscs (surface upwelling clear-sky shortwave radiation), tas (near-surface air temperature), uas (eastward near-surface wind), vas (northward near-surface wind), *Atmosphere parameters* psl (sea level pressure) ps (surface air pressure)	piControl historical amip rcp 4.5/8.5 piControl historical amip rcp 4.5/8.5	449^^ All ensembles$^+$ 429-255^^^ 1950-2005 E1 1978-2008 2006-2100 429-255^^^ 1950-2005 E1,E2 1978-2008 2006-2100	204$^{\sim\sim}$,370- 399^^ All ensembles$^+$ 379-205^^^ 1950-2005 E1 1978-2008 2006-2100 379-205^^^ 1950-2005 E1,E2,E3 1978-2008 2006-2100
	3D m-levels†	*Atmosphere parameters* hus (specific humidity), ta (air temperature), ua (eastward wind), va (northward wind)	historical amip rcp 4.5/8.5	All ensembles$^+$ 1950-2005 E1 1978-2008 2006-2100	All ensembles$^+$ 1950-2005 E1 1978-2008 2006-2100
	3D p-levels††	*Atmosphere parameters* ta (air temperature), ua (eastward wind), va (northward wind)	piControl historical amip rcp 4.5/8.5	All ensembles$^+$ 429-455^^^ 1950-2005 E1,E2 1978-2008 2006-2100	All ensembles$^+$ 379-405^^^ 1950-2005 E1,E2,E3 1978-2008 2006-2100
Daily	2D	*Atmosphere parameters* huss (near-surface specific humidity)*, pr* (precipitation), sfcWind* (daily-mean near-surface wind speed), psl* (sea level pressure), tas* (near-surface air temperature), tasmax* (daily maximum near-surface air temperature), tasmin*	All	All periods/ensembl es	All periods/ensem bles

		(daily minimum near-surface air temperature) *Atmosphere parameters* clt (total cloud fraction), hfls (surface upward latent heat flux), hfss (surface upward sensible heat flux), prc (convective precipitation), prsn (solid precipitation), rhs (near-surface relative humidity), rhsmax (surface daily maximum relative humidity), rhsmin (surface daily minimum relative humidity), rlds (surface downwelling longwave radiation), rlus (surface upwelling longwave radiation), rlut (top-of-atmosphere outgoing longwave radiation), rsds (surface downwelling shortwave radiation), rsus (surface upwelling shortwave radiation), sfcWindmax (daily maximum near-surface wind speed), uas (eastward near-surface wind), vas (northward near-surface wind) *Land parameters* mrsos (moisture in upper portion of soil column), tslsi (surface temperature where land or sea ice) *Land ice parameters* snw (surface snow amount) *Ocean parameters* omldamax* (daily maximum ocean mixed layer thickness defined by mixing scheme), tos* (sea surface temperature), tossq* (square of sea surface temperature) *Sea ice parameters* sic (sea ice area fraction), sit (sea ice thickness), usi (x-component of sea ice velocity), vsi (y-component of sea ice velocity)	piControl historical amip rcp 4.5/8.5 piControl historical amip rcp 4.5/8.5 piControl historical amip rcp 4.5/8.5 All CAOGCM piControl historical	All periods/ensembl es 436-455* 1950-2005 E1,E2 1978-2008 2006-2100 All periods/ensembl es$^+$ 436-455* 1950-2005 E1,E2 1978-2008 2006-2100 All periods/ensembl es$^+$ 436-455* 1950-2005 E1,E2	All periods/ensem bles 386-405* 1950-2005 1978-2008 2006-2100 All periods/ensem bles$^+$ 386-405* 1950-2005 1978-2008 2006-2100 All periods/ensem bles$^+$ 386-405* 1950-2005 E1,E2,E3 1978-2008 2006-2100

			amip rcp 4.5/8.5	1978-2008 2006-2100 All periods/ensembles[+] All periods/ensembles[+] 436-455* 1950-2005 E1,E2 1978-2008 2006-2100	 All periods/ensembles[+] All periods/ensembles[+] 386-405* 1950-2005 E1,E2,E3 1978-2008 2006-2100
	3D p-levels	*Atmosphere parameters* hur (relative humidity), hus (specific humidity), ta (air temperature), ua (eastward wind), va (northward wind), wap (omega), zg (geopotential height)	 piControl historical amip rcp 4.5/8.5	All ensembles[+] 436-455* 1950-2005 E1,E2 1978-2008 2006-2100	All ensembles[+] 386-405* 1950-2005 E1,E2,E3 1978-2008 2006-2100
Monthly	2D	*Aerosol parameters* dryso2 (dry deposition rate of SO2), dryso4 (dry deposition rate of SO4), emidust (total emission rate of dust), drydust (dry deposition rate of dust), od550aer (ambient aerosol optical thickness at 550 nm), drypoa (dry deposition rate of dry aerosol primary organic matter), drybc (dry deposition rate of black carbon aerosol mass), emibb (total emission of primary aerosol from biomass burning), emipoa (emission rate of dry aerosol primary organic matter), emibc (emission rate of black carbon aerosol mass), emiso2 (total emission rate of SO2), emidms (total emission rate of DMS), loadpoa (load of dry aerosol primary organic matter), loadsoa (load of dry aerosol secondary organic matter), loadbc (load of black carbon aerosol), loadso4 (load of SO4), loaddust (load of dust), loadss (load of	 All	 All periods/ensembles	 All periods/ensembles

		seasalt), od870aer (ambient aerosol optical thickness at 870 nm), sconcpoa (surface concentration of dry aerosol primary organic matter), sconcsoa (surface concentration of dry aerosol secondary organic matter), sconcbc (mass concentration of black carbon dry aerosol in air in model lowest layer), sconcso4 (surface concentration of SO4), sconcdust (surface concentration of dust), sconcss (surface concentration of seasalt), wetpoa (wet deposition rate of dry aerosol primary organic matter), wetbc (wet deposition rate of black carbon aerosol mass), wetdust (wet deposition rate of dust), wetso4 (wet deposition rate of SO4), wetso2 (wet deposition rate of SO2),			
		Atmosphere parameters (other than aerosol parameters) clt (total cloud fraction), clwvi (condensed water path), clivi (ice water path), evspsbl (evaporation), hurs (near-surface relative humidity), huss (near-surface specific humidity), hfls (surface upward latent heat flux), hfss (surface upward sensible heat flux), pr (precipitation), prsn (snowfall flux), prc (convective precipitation), prw (water vapor path), psl (sea level pressure), ps (surface sir pressure), rsdscs (surface downwelling clear-sky, vas (northward near-surface wind), shortwave radiation), rsuscs (surface upwelling clear-sky shortwave radiation), rldscs (surface downwelling clear-sky shortwave radiation), rsdt (TOA incident shortwave radiation), rtmt (net downward flux at top of model), rsut (TOA outgoing shortwave radiation), rlut (TOA outgoing longwave radiation), rlutcs (TOA outgoing clear-sky longwave radiation), rsutcs (TOA outgoing clear-sky shortwave radiation), rlds (surface downwelling longwave radiation), rlus (surface upwelling longwave radiation), rsds (surface downwelling shortwave radiation), rsus (surface upwelling shortwave radiation), sbl (surface snow and ice sublimation flux), sci (fraction of time shallow convection occurs), sfcWind (near-surface wind speed), uas (eastward near-surface wind), tas (near-surface air temperature), ts (surface temperature), tasmin (daily minimum near-surface air temperature), tasmax (daily maximum near-surface air temperature), tauu (surface downward eastward wind stress), tauv (surface downward northward wind stress)	All	All periods/ensembles	All periods/ensembles
		Land parameters baresoilFrac (bare soil fraction), evspsblveg (evaporation from canopy), evspsblsoi (water evaporation from soil), grassFrac (natural grass fraction), lai (leaf area index), landCoverFrac (plant functional type grid fraction), mrso (total soil moisture content), mrros (surface runoff), mrro (total runoff), mrsos (moisture in upper portion of soil column), mrfso (soil frozen water content), mrlsl (water content of soil Layer), prveg (precipitation onto canopy), residualFrac (fraction of	All	All	All

		grid cell that is land but neither vegetation-covered nor bare soil), shrubFrac (shrub fraction), tsl (temperature of soil), treeFrac (tree cover fraction)		periods/ensembles	periods/ensembles
		Ocean parameters agessc (sea water age since surface contact), evs (water evaporation flux where ice free ocean over sea), friver (water flux into sea water from rivers), fsitherm (water flux into sea water due to sea ice thermodynamics), hfds (downward heat flux at sea water surface), hfls (surface downward latent heat flux), hfss (surface downward sensible heat flux), hfrunoffds (temperature flux due to runoff expressed as heat flux into sea water), hfx (ocean heat x transport), hfy (ocean heat y transport), hfyba (ocean heat y transport due to bolus advection), hfydiff (ocean heat y transport due to diffussion), hfxba (ocean heat x transport due to bolus advection), hfxdiff (ocean heat x transport due to diffusion), mfo (sea water transport), msftbarot (ocean barotropic mass streamfunction), mlotst (ocean mixed layer thickness defined by sigma t), mlotstsq (square of ocean mixed layer thickness defined by sigma t), masso (sea water mass), omldamax (mean daily maximum ocean mixed layer thickness defined by mixing scheme), omlmax (monthly maximum ocean mixed layer thickness defined by mixing scheme), pbo (sea water pressure at sea floor), pr (rainfall flux where ice free ocean over sea), prsn (snowfall flux where ice free ocean over sea), pso (sea water pressure at sea water surface), rlds (surface net downward longwave radiation), rsntds (net downward shortwave radiation at sea water surface), rsds (downwelling shortwave radiation in sea water), sos (sea surface salinity), tos (sea surface temperature), tossq (square of sea surface temperature), tauuo (surface downward x stress), tauvo (surface downward y stress), wfo (water flux into sea water), wmosq (square of upward ocean mass transport), zos (sea surface height above geoid), zossq (square of sea surface height above geoid), zossga (global average steric sea level change)	All CAOGCM	All periods/ensembles	All periods/ensembles
		Sea ice parameters divice (strain rate divergence of sea ice), grFrazil (frazil sea ice growth rate), hflssi (surface upward latent heat flux over sea ice), pr (surface rainfall rate into the sea ice portion of the grid cell), prsn (surface snowfall rate into the sea ice portion of the grid cell), ridgice (sea ice ridging rate), sim (sea ice plus surface snow amount), sit (sea ice thickness), snc (surface snow area fraction), snd (snow depth), strairx (x-component of atmospheric stress on sea ice), strairy (y-component of atmospheric stress on sea ice), streng (compressive sea ice strength), strocnx (x-component of ocean stress on sea ice), strocny (y-component of ocean stress on sea ice), transifs (sea ice mass transport through Fram Strait), transix (x-	All CAOGCM		

	1D Other	component of sea ice mass transport), transiy (y-component of sea ice mass transport) *Ocean parameters* thetaoga (global average sea water potential temperature), soga (global mean sea water salinity), volo (sea water volume), zosga (global average sea level change), masscello (sea water mass per unit area) *Ocean parameters* msftyrhoz (ocean y overturning mass streamfunction), msftyrhozba (ocean meridional overturning mass streamfunction due to bolus advection), msftyyz (ocean y overturning mass streamfunction), msftyyzba (ocean y overturning mass streamfunction due to bolus advection)	All CAOGCM All CAOGCM	All periods/ensembles All periods/ensembles All periods/ensembles	All periods/ensembles All periods/ensembles All periods/ensembles
	3D m-levels†	*Aerosol parameters* concbb (concentration of biomass burning aerosol), concbc (concentration of black carbon aerosol), concdms (mole fraction of DMS), concpoa (concentration of dry aerosol primary organic matter), concsoa (concentration of dry aerosol secondary organic matter), concso4 (concentration of SO4), concdust (concentration of dust), concso2 (mole fraction of SO2), concss (concentration of seasalt) *Atmosphere parameters (other than aerosol parameters)* cl (cloud area fraction, convective mass flux), cli (mass fraction of cloud ice), clw (mass fraction of cloud liquid water)	piControl historical amip rcp 4.5/8.5	All ensembles 300,320,340,360,380,400,410,420,430,440,450,460,470,490,510,530,550*** 1950-2005** 1978-2008** 2010,2020,2040,	All ensembles 250,270,290,310,330,350,360,370,380,390,400,410,420,440,460,480,500*** 1950-2005** 1978-2008** 2010,2020,204

		Ocean parameters rhopoto (sea water potential density), so (sea water salinity), thetao (sea water potential temperature), thkcello (ocean model cell thickness), umo (ocean mass x transport), uo (sea water x velocity), vmo (ocean mass y transport), vo (sea water y velocity), wmo (upward ocean mass transport),	All All	2060,2080,2100 All periods/ensembles All periods/ensembles	0, 2060,2080,2100 All periods/ensembles All periods/ensembles
	3D p-levels[††]	*Atmosphere parameters* hur (relative humidity), hus (specific humidity), ta (air temperature), ua (eastward wind), va (northward wind), wap (omega), zg (geopotential height)	All	All periods/ensembles	All periods/ensembles
	Area average	*Ocean parameters* soga (global mean sea water salinity), thetaoga (global average sea water potential temperature), zosga (global average thermosteric sea level change)	All CAOGCM	All periods/ensembles	All periods/ensembles

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