CMIP Panel Release of CMIP6 Forcing Datasets for DECK and Historical Simulations (v1.0)

20 December 2016

The forcing datasets needed for the CMIP6 DECK and historical simulations are being prepared by a number of different experts. The historical forcings are based on observations and cover the period 1850 to 2014. They include:

- Anthropogenic SLCF (Short Lived Climate Forcing) Emissions
- Open Biomass Burning Emissions
- Land Use
- GHG Historical Concentrations
- Gridded Historical Anthropogenic GHG Emissions
- Stratospheric Aerosols
- Ozone
- Nitrogen Deposition
- Solar
- Aerosol Optical Properties and Relative Change in Cloud Droplet Number Concentration
- AMIP Boundary Forcing

The forcing datasets are briefly described in a summary document at http://goo.gl/r8up31. That document also provides information on:

- Version numbers and doi's where they exist
- A link from where the forcings can be downloaded (local website or input4MIPs)
- A link to the documentation (note that all forcing datasets will be described also in a paper in the CMIP6 Special Issue at GMD but not all are yet submitted).

The intention, as part of an activity called "input4MIPs" (see https://pcmdi.llnl.gov/projects/input4mips/), is to archive and make available all the forcing data sets from one site via the Earth System Grid Federation (ESGF). The majority of the CMIP6 forcing datasets for the DECK and historical simulations is available via input4MIPs already. Currently, however, some forcing datasets must be obtained from sites maintained by the PI's preparing the forcing. The summary document provides up-to-date links on where each forcing dataset can be found. Please check this document shortly before starting your simulation.

The CMIP Panel herewith releases the **CMIP6 Forcing Datasets for the DECK and the historical simulations (v1.0)**. This set of forcings will be frozen and where not yet done, will be assigned doi's. Should any bug fixes be required after today, the changes compared to this officially released version will be reviewed by the CMIP Panel. The CMIP Panel will then decide whether a correction is needed or not and will inform the model groups if required. As much as possible, we hope this can be avoided since several groups are starting their runs end of 2016 or early 2017. Note that the release today only includes forcing dataset for the concentration-driven DECK and historical simulations. Datasets for CO_2 and CH_4 emissions that are required for emission driven simulations will only become available early next year.

For further details on the experiment specifications for the DECK and historical simulations, we refer to the CMIP6 overview paper (Eyring et al., doi:10.5194/gmd-9-1937-2016, 2016).

We would like to thank all experts who have prepared the forcing datasets and who are individually listed below. Thanks also to Paul Durack (PCMDI, USA) for making the forcing datasets available at input4MIPs.

If you have any questions, please do not hesitate to contact us.

Best wishes,

Veronika Eyring, Sandrine Bony, Jerry Meehl, Cath Senior, Bjorn Stevens, Ron Stouffer, and Karl Taylor

Snapshot of the summary document (http://goo.gl/r8up31)

What is copied below is the current snapshot of the summary document (http://goo.gl/r8up31). This forms the set of forcings included in the CMIP Panel Release of CMIP6 Forcing Datasets for DECK and Historical Simulations (v1.0). The summary document provides up-to-date links on where each forcing dataset can be found. Please check this document shortly before starting your simulation.

Modeling center contributors to CMIP6

Institutions and modeling centers that are contributing to CMIP6 are asked to update their details (institution_id, source_id/model acronym) in the CMIP6 Controlled Vocabulary (CV; https://github.com/WCRP-CMIP/CMIP6_CVs) by submitting a new issue here. Existing entries can be viewed at CMIP6_institution_id.html and CMIP6_source_id.html

CMIP6 FORCING DATASETS FOR THE DECK AND HISTORICAL SIMULATIONS

Status of dataset as identified below: <status uncertain, under preparation, under review, released for CMIP6 use>

Anthropogenic SLCF (Short Lived Climate Forcing) Emissions

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Available at: https://pcmdi.llnl.gov/search/input4mips/
Status: released for CMIP6 use
Latest version: 2016-06-18, 2016-06-18-sectorDimV2, 2016-07-26, 2016-07-26-sectorDim
Further information/documentation:
http://www.globalchange.umd.edu/ceds/ceds-cmip6-data/
http://www.wcrp-climate.org/images/modelling/WGCM/CMIP/Historical_Emissions_CMIP6%20v2.pdf

Only a brief outline of the data is given here, for further details including a README file and additional supplementary information see the CEDS project web site (and the CMIP6 page there) and paper to be submitted to GMD.

Common characteristics of datasets in collection:
- Used in following expts.: <experiment_id 1>, <experiment_id 2>, …
- Spatial domain: Global
- Spatial resolution: 0.5° (up to 0.1° can be generated on request)
- Temporal domain: 1750 – 2014
- Temporal resolution: Monthly

Data was released in two phases:
- 1750 - 1850 released June 2016 (published on the ESGF 28th June 2016)
- 1851 - 2014 released July 2016 (published on the ESGF 2nd Sept 2016)

Data format
- Sectors include: Agriculture; Energy; Industrial; Transportation; Residential, Commercial, Other; Solvents production and application; Waste; International Shipping - for further information see the README file at the project web site

Primary Data
- Bulk emissions (BC, OC, SO2, NOx, NH3, CO, NMVOC)
  - Data volume: 4.32 GB; 42 files; 7 variables; 617 MB/variable; mean file size is 102 MB

Supplemental Data
- Supplemental Data: Speciated VOCs
  - Data volume: 7.63 GB; 69 files; 23 variables; 332 MB/variable; mean file size 111 MB
  - Same categories as used in HTAP and CMIP5 (Lamarque et al. 2010) data
  - Speciated NMVOCs add up to the bulk NMVOCs reported in the bulk emission files
  - See VOC README file at the project web site for additional details
- Supplemental Data: Solid Biofuel emissions
  - Data volume: 2.02 GB; 21 files; 7 variables; 289 MB/variable; mean file size is 96 MB
  - All species. Note that emissions from solid biofuels are already included the bulk emission files, these supplemental files provide the sub-set of emissions produced by solid biofuels.

Open Biomass Burning Emissions

- Monthly estimates of open biomass burning emissions (forests, grasslands, agricultural waste burning on fields, peatlands)
- Emission species: aerosol (BC,OC) and aerosol precursor and reactive compounds (SO2, N2O, NOx, NH3, CH4, CO, NMVOC, H2)
- NMVOC consists of the sum of: C2H6, CH3OH, C2H5OH, C3H8, C2H2, C2H4, C3H6, C5H8, C10H16, C7H8, C6H6, C8H10, Toluene_lump, Higher_Alkenes, Higher_Alkanes, CH2O, C2H4O, C3H6O, C2H6S, HCN, HCOOH, CH3COOH, MEK, CH3COCHO, HOCH2CHO. These NMVOCs are also provided separately

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Available at: https://pcmdi.llnl.gov/search/input4mips/
Status: released for CMIP6 use
Latest version: 1.2 (2016-12-13; replaced v1.1)
Modellers are advised to use v1.2. While global total emissions have only slightly changed from previous versions we now include specie-specific sectoral contributions (Deforestation, Agriculture, Boreal Forests, Temperate Forests, Peat and Savanna fires). Tables with estimates of emissions of the various species and sectors can be found on http://www.falw.vu/~gwerf/GFED/GFED4/tables/ for the1997 onwards period.

v1.1 to v1.2 differences:
·   v1.1 included only sectoral contributions of CO emissions, whereas v1.2 includes contributions for all species.
·   The interannual variability between 1960 and 1997 has changed for tropical regions.
· CO_2 emissions are excluded to avoid double counting (see usage notes). However these are available upon request.

v1.0 to v1.1 differences:

· Emissions from boreal regions have changed
· Globally, fire carbon emissions are ~5% lower (~100Tg C yr^{-1}, over 1750-2015).

Further information/documentation: www.globalfiredata.org

Common characteristics of datasets in collection:
- Used in following expts.: <experiment_id 1>, <experiment_id 2>, …
- Spatial domain: Global
- Spatial resolution: 0.25° x 0.25°
- Temporal domain: 1750-01 through 2015-12
- Temporal resolution: Monthly

Datasets:
- <specie_name>: 'CH4', 'SO2', 'NOx', 'N2O', 'CO', 'BC', 'OC', 'NH3', 'NMVOC_bulk', 'H2'
  o Per specie 2 files: 1 covering time period 175001-184912, 1 covering 185001-201512
  o Data volume: 12.8 GB total; 20 files; 1 variable per file; ~501 MB/variable (1750-1850), ~787MB/variable (1850-2016)
  o NMVOC_bulk is the sum of all NMVOC species listed below at NMVOC_<nmvoc_specie_name>
- NMVOC_<nmvoc_specie_name>: biomass burning emissions per nmvoc specie
  o Per <nmvoc_specie_name> 2 files: 1 covering time period 175001-184912, 1 covering 185001-201512
  o <nmvoc_specie_name>: 'C2H6' , 'CH3OH' , 'C2H5OH' , 'C3H8' , 'C2H2' , 'C2H4' , 'C3H6' , 'C5H8' , 'C10H16' , 'C7H8' , 'C6H6' , 'C8H10' , 'Toluene_lump' , 'Higher_Alkenes' , 'Higher_Alkanes' , 'CH2O' , 'C2H4O' , 'C3H6O' , 'C2H6S' , 'HCN' , 'HCOOH' , 'CH3COOH' , 'MEK' , 'CH3COCHO', 'HOCH2CHO'
  o Data volume: 32.2 GB; 50 files; 1 variable per file; ~501 MB/variable (1750-1850), ~787 MB/variable (1850-2016)
- <species_name>-percentageAGRI: Percentage of CO bulk emissions related to agricultural waste burning.
  o Data volume: 27.7 GB total; 35 file; 1 variable; ~790 MB/variable
  o Annual percentages from 1750-2016
  o <species_name>: 'CH4', 'SO2', 'NOx', 'N2O', 'CO', 'BC', 'OC', 'NH3', 'NMVOC_bulk', 'H2','C2H6' , 'CH3OH' , 'C2H5OH' , 'C3H8' , 'C2H2' , 'C2H4' , 'C3H6' , 'C5H8' , 'C10H16' , 'C7H8' , 'C6H6' , 'C8H10' , 'Toluene_lump' , 'Higher_Alkenes' , 'Higher_Alkanes' , 'CH2O' , 'C2H4O' , 'C3H6O' , 'C2H6S' , 'HCN' , 'HCOOH' , 'CH3COOH' , 'MEK' , 'CH3COCHO', 'HOCH2CHO'
- <species_name>-percentageBORF: Percentage of emissions related to boreal forest fires.
  o Data volume: 9.8 GB total; 35 file; 1 variable; ~279 MB/variable
  o Annual percentages from 1750-2016
  o <species_name>: 'CH4', 'SO2', 'NOx', 'N2O', 'CO', 'BC', 'OC', 'NH3', 'NMVOC_bulk', 'H2','C2H6' , 'CH3OH' , 'C2H5OH' , 'C3H8' , 'C2H2' , 'C2H4' , 'C3H6' , 'C5H8' , 'C10H16' , 'C7H8' , 'C6H6' , 'C8H10' , 'Toluene_lump' , 'Higher_Alkenes' , 'Higher_Alkanes' , 'CH2O' , 'C2H4O' , 'C3H6O' , 'C2H6S' , 'HCN' , 'HCOOH' , 'CH3COOH' , 'MEK' , 'CH3COCHO', 'HOCH2CHO'
- <species_name>-percentageDEFO: Percentage of emissions related to fires used in the deforestation.
  o Data volume: 9.9 GB total; 35 file; 1 variable; ~281 MB/variable

- o Annual percentages from 1750-2016
- o <species_name>: 'CH4', 'SO2', 'NOx', 'N2O', 'CO', 'BC', 'OC', 'NH3', 'NMVOC_bulk', 'H2','C2H6' , 'CH3OH' , 'C2H5OH' , 'C3H8' , 'C2H2' , 'C2H4' , 'C3H6' , 'C5H8' , 'C10H16' , 'C7H8' , 'C6H6' , 'C8H10' , 'Toluene_lump' , 'Higher_Alkenes' , 'Higher_Alkanes' , 'CH2O' , 'C2H4O' , 'C3H6O' , 'C2H6S' , 'HCN' , 'HCOOH' , 'CH3COOH' , 'MEK' , 'CH3COCHO', 'HOCH2CHO'
- <species_name>-percentagePEAT: Percentage of emissions related to peat fires.
  - o Data volume: 9.9 GB total; 35 file; 1 variable; ~281 MB/variable
  - o Annual percentages from 1750-2016
  - o <species_name>: 'CH4', 'SO2', 'NOx', 'N2O', 'CO', 'BC', 'OC', 'NH3', 'NMVOC_bulk', 'H2','C2H6' , 'CH3OH' , 'C2H5OH' , 'C3H8' , 'C2H2' , 'C2H4' , 'C3H6' , 'C5H8' , 'C10H16' , 'C7H8' , 'C6H6' , 'C8H10' , 'Toluene_lump' , 'Higher_Alkenes' , 'Higher_Alkanes' , 'CH2O' , 'C2H4O' , 'C3H6O' , 'C2H6S' , 'HCN' , 'HCOOH' , 'CH3COOH' , 'MEK' , 'CH3COCHO', 'HOCH2CHO'
- <species_name>-percentageSAVA: Percentage of emissions related to savanna fires.
  - o Data volume: 27.1 GB total; 35 file; 1 variable; ~774 MB/variable
  - o Annual percentages from 1750-2016
  - o <species_name>: 'CH4', 'SO2', 'NOx', 'N2O', 'CO', 'BC', 'OC', 'NH3', 'NMVOC_bulk', 'H2','C2H6' , 'CH3OH' , 'C2H5OH' , 'C3H8' , 'C2H2' , 'C2H4' , 'C3H6' , 'C5H8' , 'C10H16' , 'C7H8' , 'C6H6' , 'C8H10' , 'Toluene_lump' , 'Higher_Alkenes' , 'Higher_Alkanes' , 'CH2O' , 'C2H4O' , 'C3H6O' , 'C2H6S' , 'HCN' , 'HCOOH' , 'CH3COOH' , 'MEK' , 'CH3COCHO', 'HOCH2CHO'
- <species_name>-percentageTEMF: Percentage of emissions related to temperate forest fires.
  - o Data volume: 10.4 GB total; 35 file; 1 variable; ~299 MB/variable
  - o Annual percentages from 1750-2016
  - o <species_name>: 'CH4', 'SO2', 'NOx', 'N2O', 'CO', 'BC', 'OC', 'NH3', 'NMVOC_bulk', 'H2','C2H6' , 'CH3OH' , 'C2H5OH' , 'C3H8' , 'C2H2' , 'C2H4' , 'C3H6' , 'C5H8' , 'C10H16' , 'C7H8' , 'C6H6' , 'C8H10' , 'Toluene_lump' , 'Higher_Alkenes' , 'Higher_Alkanes' , 'CH2O' , 'C2H4O' , 'C3H6O' , 'C2H6S' , 'HCN' , 'HCOOH' , 'CH3COOH' , 'MEK' , 'CH3COCHO', 'HOCH2CHO'
- datasource: Specifies the datasource per year for the whole time period 1750-2015
  - o Data volume: 116 MB; 1 file; 1 variable; 116MB/variable
  - o "0: Ocean"
    "1: Based on FIRE-MIP model output constrained by charcoal records, scaled to Global Fire Emissions Database (GFED) version 4s";
    "2: Based on visibility records, scaled to Global Fire Emissions Database (GFED) version 4s";
    "3: Based on FIRE-MIP model output, scaled to Global Fire Emissions Database (GFED) version 4s";
    "4: Global Fire Emissions Database (GFED) version 4s";
- gridcellarea
  - o Data volume: 39KB total bytes; 1 file; 1 variable; 39KB/variable
  - o area of the 0.25° x 0.25° grid cells in m^2

Usage notes:
- This dataset is made available as forcing dataset for the Coupled Model Intercomparison Project Phase 6 (CMIP6) analyses at the PCDMI repository (https://pcmdi.llnl.gov/search/input4mips) and is obviously only needed for models that do not simulate fire emissions. Emissions are bulk values for all biomes, ancillary datasets with

contribution of emissions related to agricultural waste burning, fires used in deforestation, boreal forest fires, peat fires, savanna fires and temperate forest fires are provided per specie. The calculated sectoral emissions for the 1997-2015 period can be validated per specie with the tables found on: http://www.falw.vu/~gwerf/GFED/GFED4/tables/

- Models that have their own fire model but do not simulate anthropogenic fires are advised to use only the emissions related to deforestation and agricultural waste burning. We provide the fraction of emissions associated with this
- While the large interannual variability is a key feature of global fire emissions, modelers may consider averaging out this fire signal to avoid having interannual variability in climate and in fires being out of sync
- While using: Please check if the global annual emissions for the first and last year of the file are correct. These are provided in the attributes [annual_total_first_year_Tg_yr] and [annual_total_last_year_Tg_yr]
- Molecular weights for all species are listed in the following table:

Species (bulk)	Molecular weight (g)	Species (NMVOC)	Molecular weight (g)
CO2	44.01	C2H6 (ethane)	30.07
CO	28.01	CH3OH (methanol)	32.04
CH4	16.04	C2H5OH (ethanol)	46.07
NMHC	15	C3H8 (propane)	44.1
H2	2.02	C2H2 (acetylene)	26.04
NOx (as NO)	30.01	C2H4 (ethylene)	28.05
N2O	44.01	C3H6 (propylene)	42.08
PM2.5	x	C5H8 (isoprene)	68.12
TPM	x	C10H16 (terpenes)	136.24
TPC (OC+BC)	12	C7H8 (toluene)	92.14
OC	12	C6H6 (benzene)	78.11
BC	12	C8H10 (xylene)	106.17
SO2	64.02	Toluene_lump	12
		Higher_Alkenes	12
		Higher_Alkanes	12
		CH2O (formaldehyde)	30.03
		C2H4O (acetaldehyde)	44.05
		C3H6O (acetone)	58.08
		NH3 (ammonia)	17.03
		C2H6S (dms)	62.07
		HCN (hydrogen cyanide)	27.02
		HCOOH (formic acid)	47.02

CH3COOH (acetic acid)	60.05
MEK (methyl Ethyl Ketone / 2-butanone)	72.11
CH3COCHO (methylglyoxal)	72.06
HOCH2CHO (hydroxyacetaldehyde)	60.05

Land Use

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Available at: http://luh.umd.edu (externally hosted)
Status: released for CMIP6 use
Latest version: v2h (2016-10-14; replaced v1.0h)
Further information/documentation:
https://cmip.ucar.edu/lumip
https://cmip.ucar.edu/sites/default/files/lumip/LUH2_v1.0h_README.pdf
http://luh.umd.edu

Common characteristics of datasets in collection:
- Used in following expts.: historical, piControl, amip
- Domain: global (land only)
- Spatial resolution: 0.25 x 0.25 degree
- Temporal domain: 850 - 2015
- Temporal resolution: annual

Datasets:
- States.nc: 12 land use states recorded as fractions of grid cell area (e.g. "forested primary land", "managed pasture", "C4 annual crops"), and 2 land-use variables given in biomass density unit and age units
  - Data volume: 5.4 GB; 1 file; 14 variables; 400MB/variable
  - Years: 850-2015
- transitions.nc: transitions from each of 12 land-use states to 9 target land-use states (12x9 = 108 variables) plus harvest information from 5 forest/non-forest types, recorded both as an area fraction and a carbon mass harvested (5x2 = 10 variables):
  - Data volume: 13 GB; 1 file; 118 variables; 100MB/variable
  - Years: 850-2014
- management.nc: 22 variables (e.g. fertilizer, and irrigation information for each of 5 crop types, flooded fraction of C3 annuals (for paddy rice), fraction of each crop type grown for use as bioenergy, fraction of C3 perennial and C4 perennial biomass harvested each year (e.g. for fruit trees etc), fraction of wood harvest biomass used for industrial roundwood, traditional fuelwood, or commercial biofuels)
  - Data volume: 1.4 GB; 1 file; 22 variables; 64 MB/variable
  - Years: 850-2015

- staticData.nc: grid-cell area, forest/non-forest mask, potential biomass carbon content, and country codes
  - Data volume: 40 MB; 1 file; 4 variables; 10MB/variable

Usage notes:
- See Frequently Asked Questions section on Land-Use Harmonization website: http://luh.umd.edu/faq.shtml

GHG Historical Concentrations

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Available at: https://pcmdi.llnl.gov/search/input4mips/
Status: released for CMIP6 use
Latest version: 1.2.0 (2016-07-01)
Further information/documentation: 10.5194/gmd-2016-169 and http://www.climate-energy-college.net/cmip6
- Malte Meinshausen[1,2,3] Elisabeth Vogel[1,2], Alexander Nauels[1,2], Katja Lorbacher[1,2], Nicolai Meinshausen[4], David Etheridge[5], Paul Fraser[5], Stephen A. Montzka[6], Peter Rayner[2], Cathy Trudinger[5], Paul Krummel[5], Urs Beyerle[7], Josep G. Canadell[8], John S. Daniel[9], Ian Enting[10], Rachel M. Law[5], Simon O'Doherty[11], Ron G. Prinn[12], Stefan Reimann[13], Mauro Rubino[5,14], Guus J.M. Velders[15], Martin K. Vollmer[13], Ray Weiss[16] "Historical greenhouse gas surface concentrations"
- Manuscript available here: http://www.geosci-model-dev-discuss.net/gmd-2016-169/
Common characteristics of datasets in collection:
- Used in following expts.: historical, piControl, amip, ...
- Spatial domain: global
- Spatial resolution: 0.5 degree latitudinal resolution and 15 degree latitudinal as also NH, SH, and global
- Temporal domain: Year Jan 0 to Dec 2014
- Temporal resolution: monthly (and annual for NH, SH, and global spatial means)

Datasets:
- mole_fraction_of_XXX_in_air_input4MIPs_GHGConcentrations_CMIP_UoM-CMIP-1-2-0_gr3-GMNHSH_0000-2014.nc: Hemispheric mean and global-mean annual-mean surface mole fraction of greenhouse gas XXX
  - Data volume: 3MB; 46 files; 46 variables; 75KB/variable
  - Per file, one greenhouse gas is provided. Annual-mean, global-mean resolution. Note that 3 equivalence species are provided, too, providing a radiative efficiency-weighted sum of greenhouses gases other than CO_2, CH_4, and N_2O. see below.
- mole_fraction_of_XXX_in_air_input4MIPs_GHGConcentrations_CMIP_UoM-CMIP-1-2-0_gr3-GMNHSH_000001-201412.nc: Hemispheric mean and global-mean monthly-mean surface mole fraction of greenhouse gas XXX
  - Data volume: 42MB; 46 files; 46 variables; 873kB/variable
- mole_fraction_of_XXXX_in_air_input4MIPs_GHGConcentrations_CMIP_UoM-CMIP-1-2-0_gr-15x360deg_000001-201412.nc: Zonal mean, monthly-mean surface mole fraction of greenhouse gas XXX in 15-degree latitudinal bands
  - Data volume: 85MB; 46 files; 46 variables; 1.7MB/variable

- mole_fraction_of_XXXX_in_air_input4MIPs_GHGConcentrations_CMIP_UoM-CMIP-1-2-0_gr2-0p5x360deg_000001-201412.nc: Zonal mean, monthly-mean surface mole fraction of greenhouse gas XXX in 0.5-degree latitudinal bands
  - Data volume: 1.5GB; 46 files; 46 variables; 35MB/variable
  - Note that this is finely-interpolated dataset is a mean-preserving interpolation of the 15-degree data. Provided for convenience to interpolate to the respective model grid. The underlying observational data assimilation procedure cannot provide information on GHG surface concentrations on such a fine latitude resolution.

Usage notes:
- **The greenhouse gases XXX**, for which data is provided are the 43 gases: 'CO2', 'CH4', 'N2O', 'CFC-11', 'CFC-12', 'CFC-113', 'CFC-114', 'CFC-115', 'HCFC-22', 'HCFC-141b', 'HCFC-142b', 'HFC-23', 'HFC-32', 'HFC-125', 'HFC-134a', 'HFC-143a', 'HFC-152a', 'HFC-227ea', 'HFC-236fa', 'HFC-245fa', 'HFC-365mfc', 'HFC-43-10mee', 'CH3CCl3', 'CCl4', 'CH3Cl', 'CH2Cl2', 'CHCl3', 'CH3Br', 'Halon-1211', 'Halon-1301', 'Halon-2402', 'NF3', 'SF6', 'SO2F2', 'CF4', 'C2F6', 'C3F8', 'C4F10' 'C5F12' 'C6F14' 'C7F16' 'C8F18' and 'c-C4F8'. The XXX gas names used in the files are CF-compliant for those gases that have a CF-compliant name. Namely, the XXX names are: 'carbon_dioxide', 'methane', 'nitrous_oxide', 'cfc11', 'cfc12', 'cfc113', 'cfc114', 'cfc115', 'hcfc22', 'hcfc141b', 'hcfc142b', 'hfc23', 'hfc32', 'hfc125', 'hfc134a', 'hfc143a', 'hfc152a', 'hfc227ea', 'hfc236fa', 'hfc245fa', 'hfc365mfc', 'hfc4310mee','ch3ccl3', 'carbon_tetrachloride', 'methyl_chloride','ch2cl2','chcl3'), 'methyl_bromide', 'halon1211', 'halon1301', 'halon2402', 'nf3', 'sf6', 'so2f2', 'cf4', 'c2f6', 'c3f8' 'c4f10' 'c5f12' 'c6f14' 'c7f16' 'c8f18' 'c_c4f8'
- **Equivalence concentrations:** In addition, three equivalent concentration timeseries are provided, that provide radiative efficiency weighted sums of above greenhouse gases, namely:
  - 'HFC-134a-eq'. This equivalent concentration summarizes the gases: 'HFC-134a', 'HFC-23', 'HFC-32', 'HFC-125', 'HFC-143a', 'HFC-152a', 'HFC-227ea', 'HFC-236fa', 'HFC-245fa', 'HFC-365mfc', 'HFC-43-10mee', 'NF3', 'SF6', 'SO2F2', 'CF4', 'C2F6', 'C3F8' 'C4F10' 'C5F12' 'C6F14' 'C7F16' 'C8F18' 'c-C4F8'
  - 'CFC-12-eq'. This equivalent concentration summarizes the gases: 'CFC-12', 'CFC-11', 'CFC-113', 'CFC-114', 'CFC-115', 'HCFC-22', 'HCFC-141b', 'HCFC-142b', 'CH3CCl3', 'CCl4', 'CH3Cl', 'CH2Cl2', 'CHCl3', 'CH3Br', 'Halon-1211', 'Halon-1301', 'Halon-2402'
  - 'CFC-11-eq'. This equivalent concentration summarizes the gases: 'HFC-134a', 'HFC-23', 'HFC-32', 'HFC-125', 'HFC-143a', 'HFC-152a', 'HFC-227ea', 'HFC-236fa', 'HFC-245fa', 'HFC-365mfc', 'HFC-43-10mee', 'NF3', 'SF6', 'SO2F2', 'CF4', 'C2F6', 'C3F8', 'C4F10' 'C5F12' 'C6F14' 'C7F16' 'C8F18' 'c-C4F8' 'CFC-11', 'CFC-113', 'CFC-114', 'CFC-115', 'HCFC-22', 'HCFC-141b', 'HCFC-142b', 'CH3CCl3', 'CCl4', 'CH3Cl', 'CH2Cl2', 'CHCl3', 'CH3Br', 'Halon-1211', 'Halon-1301', 'Halon-2402'
  - The equivalent species can be used as surrogate to approximate the radiative forcing effect of the summarized gases. Specifically, three options to include the radiative forcing effect of the full set of 43 gases are available:
    - ■ **Option 1**: Climate models implement a subset of 43 greenhouse gases.
    - ■ **Option 2**: Climate models implement the four most important GHGs with their actual concentrations explicitly, namely CO_2, CH_4, N_2O and CFC-12 and summarize the effect of all other 39 gases in an equivalence concentration of CFC-11. For this purpose, we provide CFC-11-eq concentrations ('full equivalence').

■ **Option 3**: Like option 2, but with a different split up of gases other than CO_2, CH_4 and N_2O. Climate models implement the three most important GHGs with their actual concentrations explicitly, namely CO_2, CH_4, and N_2O and summarize the radiative effect of the ozone depleting substances in a CFC-12-eq concentration and the radiative effect of all other fluorinated gases in a HFC-134a-eq concentration. For this purpose, we provide CFC-12-eq and HFC-134a-eq concentrations ('full equivalence')

Additional notes:
- Approximations for vertical extensions of the surface concentration are provided for models without internal schemes. Please see the manuscript: Meinshausen et al. (submitted) "Historical greenhouse gas surface concentrations", available here: http://www.geosci-model-dev-discuss.net/gmd-2016-169/

Known issues:
- No major issues known.
- Minor issues that could be addressed in future versions. See limitations section in manuscript: 10.5194/gmd-2016-169

Gridded Historical Anthropogenic GHG Emissions

Gridded anthropogenic CO2 (fossil fuels + cement + other processes) and CH4 historical emissions

Contacts:
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Available at: NA
Status: under preparation
CO2 to be released by 2nd week of January 2017, CH4 by February 2017
Latest version <#> <2016-MM-DD>
Further information/documentation:

Emissions will be provided in the same format as described in Anthropogenic SLCF (Short Lived Climate Forcing) Emissions above.

Common characteristics of datasets in collection:
- Used in following expts.: <experiment_id 1>, <experiment_id 2>, ...
- Spatial domain: Global
- Spatial resolution: 0.5° (up to 0.1° can be generated on request)
- Temporal domain: 1750 - 2014 (CO2), 1960 - 2014 (CH4)
- Temporal resolution: Monthly

Datasets:
- <dataset 1>
  - Data volume: <total bytes>; <# of> files; <# of> variables; <bytes>/variable
  - <additional dataset-specific characteristic 1>

Usage notes:
- <note 1>

Additional notes:
- <note 1>

Stratospheric Aerosols

Surface area density (sad) of aerosols; 1850 - 2014 (temporal extent)
The forcing data (extinction coefficients, single scattering factors, asymmetric factor g for all band widths for the radiation module are also provided. The extinction coefficients, single scattering albedo and asymmetrical factors of the stratospheric aerosol, including not only volcanic but also **natural and anthropogenic** contributions

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Available at: ftp://iacftp.ethz.ch/pub_read/luo/CMIP6/<YOUR MODEL> (externally hosted; modeling centers should contact Beiping to get data generated for the correct model spectral bands)
Status: released for CMIP6 use
Latest version: v2 (2016-06-02)
Further information/documentation:
    ftp://iacftp.ethz.ch/pub_read/luo/CMIP6/Readme_Data_Description.pdf

Common characteristics of datasets in collection:
- Used in following expts.: <experiment_id 1>, <experiment_id 2>, ...
- Spatial domain: global YZ (latitude x height)
- Spatial resolution: global YZ (latitude, height; 90S and 90N and from 5 to 39.5km in 0.5km resolution)
- Temporal domain: 1850 - 2014
- Temporal resolution: monthly

Datasets:
- CMIP_1850_2014_sad_V2.nc
    - Data volume: 136MB;
- CMIP_1850_2014_sad_annual_average_V2.nc: the mean value for the **control run,** averaged over 1850 - 2014
    - Data volume: 62KB
Usage notes:
- The SAD (version V2, 2016-06-02) is corrected using the long term OPC data over Laramie by Terry Deshler below 20 km. The present data set is strictly reliable at and above tropopause. The values below the tropopause are less reliable. Below the instantaneous local model tropopause, the tropospheric data set should be used. For more detail and the procedure for dealing with the strat-trop interface, see the Readme_Data_Description.pdf

Ozone

Ozone volume mixing ratios [mol mol^{-1}]
1850 (control); 1850-2014; 2015-2100

Contacts:
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Available at: https://pcmdi.llnl.gov/search/input4mips/
Further information can be found at:
https://blogs.reading.ac.uk/ccmi/forcing-databases-in-support-of-cmip6/

Status:
released for CMIP6 use:
- 1850 (control) latest version: 1.0 (2016-07-11)
- 1850-2014 (historical) latest version: 1.0 (2016-07-11)

Common characteristics of datasets in collection:
- Used in following expts.: CMIP6 DECK, endorsed MIPs, …
- Spatial domain: global (3D)
- Spatial resolution: 96x144 (latxlon); 66 (pressure levels between 1000 and 0.0001 hPa)
- Temporal domain: Jan-Dec 1850; Jan 1850-Dec 2014; Jan 2015-Dec 2100
- Temporal resolution: monthly

Datasets:
- 1850 (control; Please use first year of 1850-1899 file)
  - Filename: vmro3_input4MIPs_ozone_CMIP_UReading-CCMI-1-0_gr_185001-189912.nc
  - Data volume: 1.7 GB; 1 file; 1 variable; 1.7 GB/variable
  - Comment: The monthly mean ozone fields represent multi-annual averages of multi-year pre-industrial control simulations
- 1850-2014 (historical)
  - Filename: vmro3_input4MIPs_ozone_CMIP_UReading-CCMI-1-0_gr_[185001-201412].nc
  - Data volume: 7.23 GB; 4 files; 1 variable; 7.23 GB/variable
- 2015-2100 (future)

Additional notes:
- Please subscribe to the ozone-database user list by emailing m.i.hegglin@reading.ac.uk if you wish to use the data and receive updates on the status and other information of the different parts of the database.
- A description of the database will be published in GMD: *Hegglin, M. I., D. Kinnison, D. Plummer, et al., CCMI ozone database (1850-2100) in support of CMIP6, GMD, in preparation.*

Nitrogen Deposition

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Douglas Kinnison dkin@ucar.edu

Available at: https://pcmdi.llnl.gov/search/input4mips/
Further information can be found at: http://blogs.reading.ac.uk/ccmi/forcing-databases-in-support-of-cmip6/

Status:
released for CMIP6 use
- 1850 (control) latest version: 2.0 (2016-12-07; replaced v1.0)
- 1850-2014 latest version: 2.0 (2016-12-07; replaced v1.0)

Common characteristics of datasets in collection:

- Used in following expts.: CMIP6 DECK, endorsed MIPs, …
- Spatial domain: global (2D)
- Spatial resolution: 96x144 (latxlon)
- Temporal domain: Jan-Dec 1850; Jan 1850-Dec 2014; Jan 2015-Dec 2100
- Temporal resolution: monthly

Variables included:

- DRYNHX, WETNHX, DRYNOY, WETNOY
- N1850 (control); 1850-2014; 2015-2100

Datasets:

- 1850 (control; Please use first year of 1850-1899 file)
  - Filenames:
    - drynhx_input4MIPs_surfaceFluxes_CMIP_NCAR-CCMI-2-0_gn_185001-185012-clim.nc
    - drynoy_input4MIPs_surfaceFluxes_CMIP_NCAR-CCMI-2-0_gn_185001-185012-clim.nc
    - wetnhx_input4MIPs_surfaceFluxes_CMIP_NCAR-CCMI-2-0_gn_185001-185012-clim.nc
    - wetnoy_input4MIPs_surfaceFluxes_CMIP_NCAR-CCMI-2-0_gn_185001-185012-clim.nc
  - Data volume: 2.7 MB; 4 files; 4 variables; 668 KB/variable
  - Comment: The monthly mean nitrogen deposition fields represent multi-annual averages of multi-year pre-industrial control simulations
- 1850-2014 (historical)
  - Filenames:
    - drynhx_input4MIPs_surfaceFluxes_CMIP_NCAR-CCMI-2-0_gn_185001-201412.nc
    - drynoy_input4MIPs_surfaceFluxes_CMIP_NCAR-CCMI-2-0_gn_185001-201412.nc
    - wetnhx_input4MIPs_surfaceFluxes_CMIP_NCAR-CCMI-2-0_gn_185001-201412.nc
    - wetnoy_input4MIPs_surfaceFluxes_CMIP_NCAR-CCMI-2-0_gn_185001-201412.nc
  - Data volume: 438 MB; 4 files; 4 variables; 109.5 GB/variable
- 2015-2100 (future)
  - TBD

Usage notes:

- <note 1>

Additional notes:

- Please subscribe to the ozone-database user list by emailing m.i.hegglin@reading.ac.uk if you wish to use the N-deposition data and receive updates on the status and other information of the different parts of the database.

Solar

Contacts:
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Bernd Funke bernd@iaa.es

Available at: http://solarisheppa.geomar.de/cmip6 (externally hosted)
Status: released for CMIP6 use
Latest version: 3.2 (2016-10-24; replaced v3.1)
Further information/documentation: http://solarisheppa.geomar.de/cmip6

Common characteristics of datasets in collection:
- Used in following expts.: CMIP6 DECK and endorsed MIPs
- Spatial domain: (only variables describing particle-induced ion-pair production rate) global, zonal mean (in geomagnetic coordinates)
- Spatial resolution: variable
- Temporal domain: 1850-01-01 – 2299-12-31

Datasets:
- Solarforcing_ref_day_3.1.nc
  - Data volume: 3.1 GB; 1 files; 22 variables
  - Temporal resolution: day
- Solarforcing_ref_mon_3.1.nc
  - Data volume: 77 MB; 1 file; 16 variables
  - Temporal resolution: mon
- Solarforcing_picontrol_fx_3.1.nc
  - Data volume: 44 kB; 1 file; 20 variables
  - Temporal resolution: fx

Usage notes:
- The solar forcing is provided for radiative properties, i.e., total solar irradiance (TSI) and solar spectral irradiance (SSI), and F10.7cm radio flux, as well as particle forcing, i.e., geomagnetic indices Ap and Kp, and ionisation rates to account for effects of solar protons, electrons and galactic cosmic rays.
- piControl solar forcing is constructed of time-averaged historical data corresponding to 1850-1873 (solar cycle 9+10) mean conditions.

Additional notes:
- Particle forcing is provided only in the daily-resolved dataset.

Aerosol Optical Properties and Relative Change in Cloud Droplet Number Concentration

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Available at: http://www.geosci-model-dev-discuss.net/gmd-2016-189/ (externally hosted)
Status: released for CMIP6 use
Latest version: MACv2-SP_V1 (2016-07-09)
Further information/documentation: http://www.geosci-model-dev-discuss.net/gmd-2016-189/

Common characteristics of datasets in collection:
- Used in following expts.: <experiment_id 1>, <experiment_id 2>, …
- Spatial domain:
- Spatial resolution:
- Temporal domain:
- Temporal resolution:

Datasets:
- <dataset 1>
  - Data volume: <total bytes>; <# of> files; <# of> variables; <bytes>/variable
  - <additional dataset-specific characteristic 1>

Usage notes:
- <note 1>

Additional notes:
- <note 1>

AMIP Boundary Forcing

Sea surface temperature and sea-ice concentration datasets for driving atmospheric-only simulations

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Available at: https://pcmdi.llnl.gov/search/input4mips/
Status: released for CMIP6 use
Latest version: 1.1.1 (2016-10-20) [New versions will be released every 6 months; each update will extend the observations by 6 months to near present.]
Further information/documentation: http://www-pcmdi.llnl.gov/projects/amip/AMIP2EXPDSN/BCS

Common characteristics of datasets in collection:
- Used in following expts.: AMIP
- Spatial domain: global
- Spatial resolution: 1x1 degree
- Temporal domain: 1870-01 through 2016-06
- Temporal resolution: monthly

Datasets:
- Ocean Grid-Cell Area data (areacello)
  - Data volume: 42KB; 1 file; 1 variable
- Sea area fraction (sftof; will be included in v1.1.2/April 2017 release)
- Sea ice monthly-mean data (siconc)
  - Data volume: 45MB; 1 file; 1 variable
- Sea ice fraction mid-month boundary condition dataset (siconcbcs)
  - Data volume: 74MB; 1 file; 1 variable
- SST monthly-mean data (tos)
  - Data volume: 178MB; 1 file; 1 variable
- SST mid-month boundary condition dataset (tosbcs)
  - Data volume: 186MB; 1 file; 1 variable

Usage notes:
- Be sure to understand the difference between tosbcs and tos (and similarly, siconcbcs and siconc) before using the data for AMIP simulations. (see http://www-pcmdi.llnl.gov/projects/amip/AMIP2EXPDSN/BCS

Additional notes:
- These data sets will be updated approximately every 6 months as additional observational data become available (next update due April 2017)