

Coupled Model Intercomparison Project Phase 6 (CMIP6) - an Overview of Activities

Veronika Eyring

¹Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institute of Atmospheric Physics, Oberpfaffenhofen, Germany

²University of Bremen, Institute of Environmental Physics, Bremen, Germany

WGCM-21 Meeting

9 October 2016

Exeter, UK



Knowledge for Tomorrow



Outline

1. Forcings for CMIP6 and Remaining Issues
2. CMIP6-Endorsed MIPs and new Applications
3. Participating Model Groups
4. CMIP Evaluation Tools
5. Key Messages CMIP6 Experiment Design
6. ES-DOC
7. Summary CMIP6 Achievements and Outlook
8. Recommendations for Future CMIP Phases
9. Action items WGCM-21



Official CMIP Panel Releases of Forcing Datasets for DECK/Historical CMIP6 experiments

20 December 2016: First official CMIP Panel Release (v1.0, now named 6.1.0)

- Forcing datasets for DECK and historical simulations



Official CMIP Panel Releases of Forcing Datasets for DECK/Historical CMIP6 experiments

22 May 2017: Second official CMIP Panel Release (v6.1.1)

- Only two of the forcing datasets have been revised.
 - 2017-05-18 of the CEDS Anthropogenic SLCF, CO₂ and CH₄ Emissions from PNNL-JGCRI (for details see <http://www.globalchange.umd.edu/ceds/ceds-cmip6-data>) and
 - AMIP boundary condition dataset from PCMDI.

These versions replace their predecessors and have been officially endorsed by the CMIP panel. The details for each have been updated in the google doc <http://goo.gl/r8up31>.

• For modeling groups that have already begun piControl simulations using the 1850-01 to 1850-12 anthropogenic emissions from the earlier versions 2016-06-* and 2016-07-* of the CEDS data, there is no **need to start these simulations** again. In 1850 anthropogenic emissions are relatively small and comprise ~20–30% of total global emissions for BC, OC, NMVOC, and CO (grassland and forest burning, estimated by Lamarque et al., 2010) and only 3% of global NO_x emissions (See Figures 2 and Figure 3, and supplemental material in Hoesly et al., 2017), with the open biomass burning emissions dominating during this period. The corrections made to the CEDS data are relatively small (e.g., February values were 8-9% higher than they should have been).

• The dataset changes have a larger impact over the **more recent period** where the anthropogenic emissions are a larger percentage of total forcing. Consequently, **we recommend using the 2017-05-18 (new) data for all simulations that are yet to begin**. The forcing data for future SSP scenario runs (under preparation) will be consistent with the 2017-05-18 data, but will be marked by a small discontinuity in 2015 if the earlier 2016-06-* and 2016-07-* data have been used for the historical period.



Official CMIP Panel Releases of Forcing Datasets for DECK/Historical CMIP6 experiments

20 September 2017: Third official CMIP Panel Release (v6.2.0)

•Compared to the previous CMIP Panel release (dataset collection v6.1.1; 22nd May 2017), the new dataset collection incorporates:

- **updates to the CEDS** (unrealistic small aircraft emissions before 1920 are set to zero)
- **New IACETH (stratospheric aerosols) forcing datasets** (unrealistic volcanic emissions in 1972 were removed and a time-varying background in SAOD introduced; further information for both changes are included below).

•Concerns were expressed that the dataset problems could impact the credibility of the forcing suite and simulations generated using these fields.

•Simulations forced with either of the two previously released versions (v6.0.0 and v6.1.1) of the forcing dataset collection are valid CMIP6 simulations and will be included in the data archive, but the new set of forcings (v6.2.0) should be used for all simulations not already underway.

•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 required and in this case, will inform the model groups. We are hoping at this late stage, no further changes will be required.



Official CMIP Panel Releases of Forcing Datasets for DECK/Historical CMIP6 experiments

20 September 2017: Third official CMIP Panel Release (v6.2.0) continued

Guidance for modeling groups who have already started piControl and historical simulations

- For those groups that have not yet started any CMIP6 simulations, **please use the latest forcing datasets (v6.2.0)**, as it addresses some small inconsistencies in earlier releases of the input forcing
- For those groups that have already started the **piControl and DECK idealized simulations** (1pctCO2, abrupt-4xCO2) with v6.1.1, **there is no need to rerun them**, as the 1850-2014 climatological mean AOD and SAD in the stratospheric aerosol data in v6.2.0 is nearly identical to that in the previous release (v6.1.1) and the difference in 1850 for aircraft emissions between these two versions is tiny
- For those groups that have already **started historical simulations**, you might want to consider restarting them to avoid some small inconsistencies in the CMIP6 ensemble. However, the climate impacts of the changes from v6.1.1. to v6.2.0 are likely to be very small, and that the most important thing is for groups to carefully document which input forcing they are using for their simulations.

Overview Preindustrial and Historical Forcing Datasets

Forcing Dataset	GMD Paper	Provided by	On input4 MIPs	Remaining Issues in v6.2.0?
SLCF Emissions	GMDD	Steve Smith	Yes	Possibly remaining issue
Biomass Burning	GMD	Margreet van Marle, Guido van der Werf	Yes	Yes
GHG Emissions	Not yet	Steve Smith, Bob Andres	Yes	Yes
Land-use	Not yet	George Hurtt	Yes	Yes
GHG concentrations	GMD	Malte Meinshausen	Yes	Yes
Ozone concentrations	Not yet	Michaela Hegglin	Yes	Yes
Nitrogen deposition	Not yet	Michaela Hegglin	Yes	Yes
Simple plume aerosol	GMD	Bjorn Stevens	Yes	Yes
Solar	GMD	Katja Matthes, Bernd Funke	Yes	Yes
Stratospheric aerosol	Not yet	Beiping Luo, Tom Peter, Larry Thomason	Yes	Possibly remaining issue
AMIP SST and SIC	Not yet	Paul Durack, Karl Taylor	Yes	Yes

KEY:

YES

NO

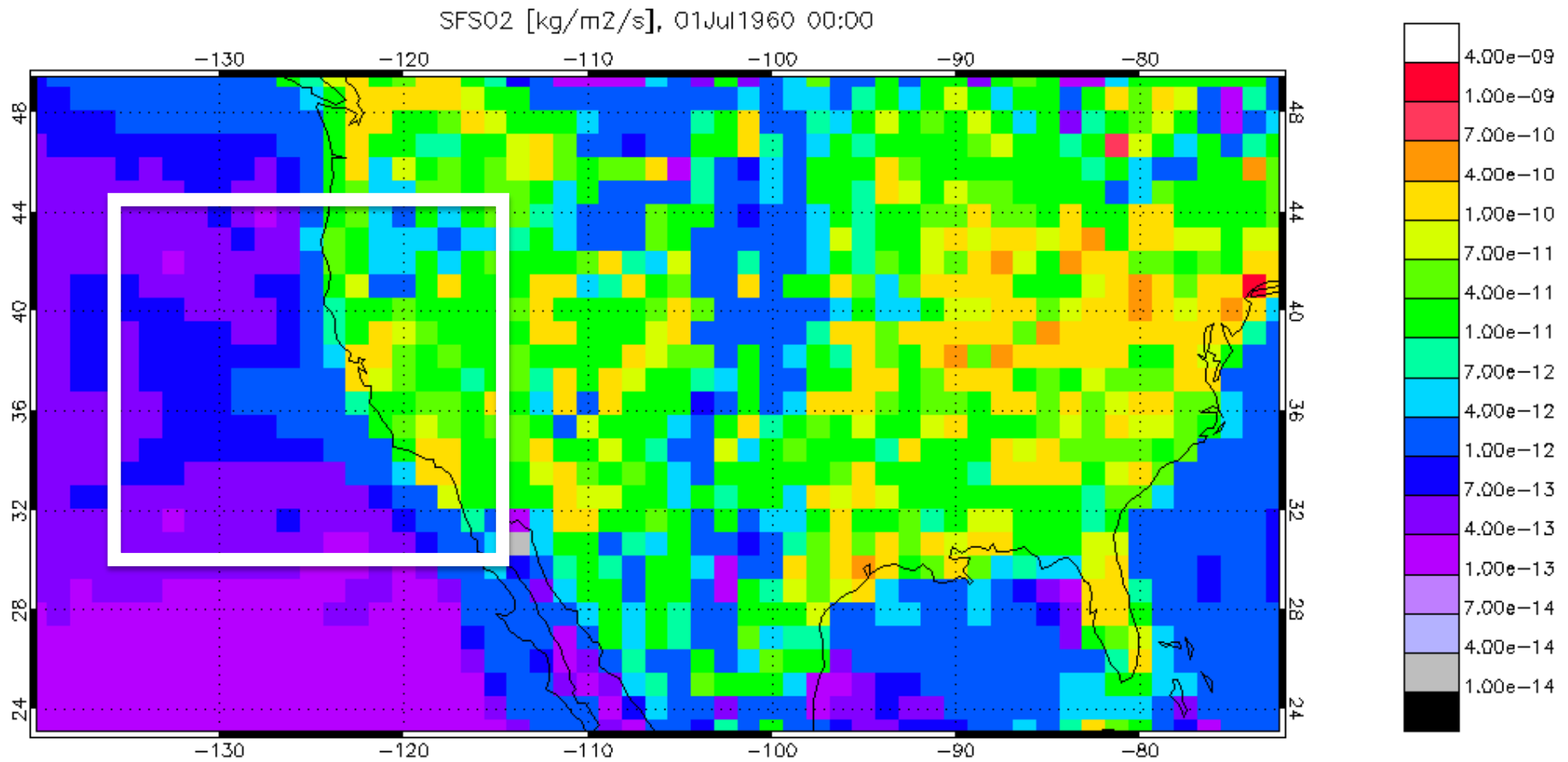
Possibly remaining issue

Download via input4MIPs <https://esgf-node.llnl.gov/search/input4MIPs>

Thanks to Paul Durack from PCMDI!

Possible Remaining Issues in v6.2.0

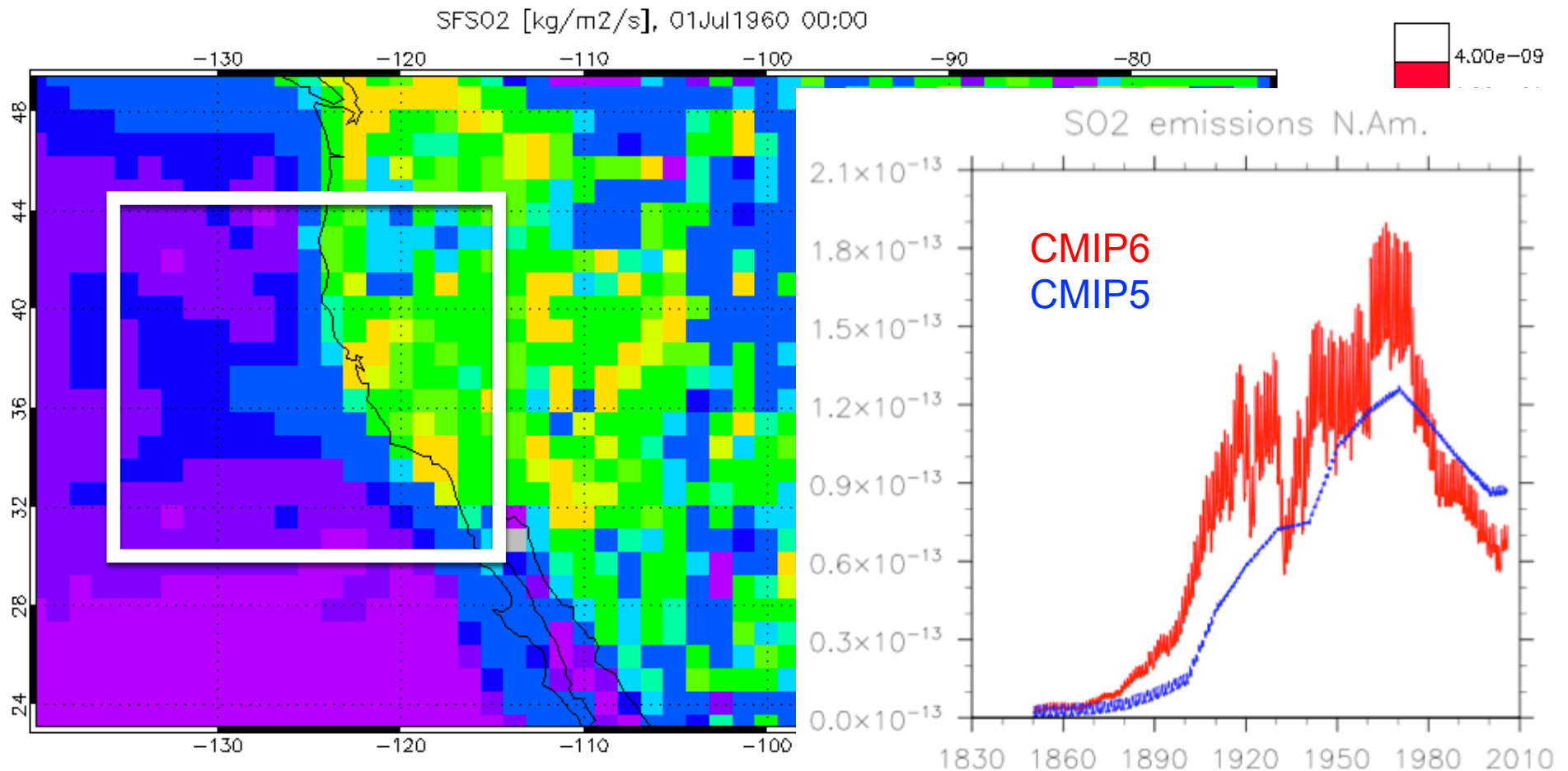
(1) Potential issues with the short-lived emission datasets



Courtesy of Jean-Francois Lamarque (NCAR)

Possible Remaining Issues in v6.2.0

(1) Potential issues with the short-lived emission datasets

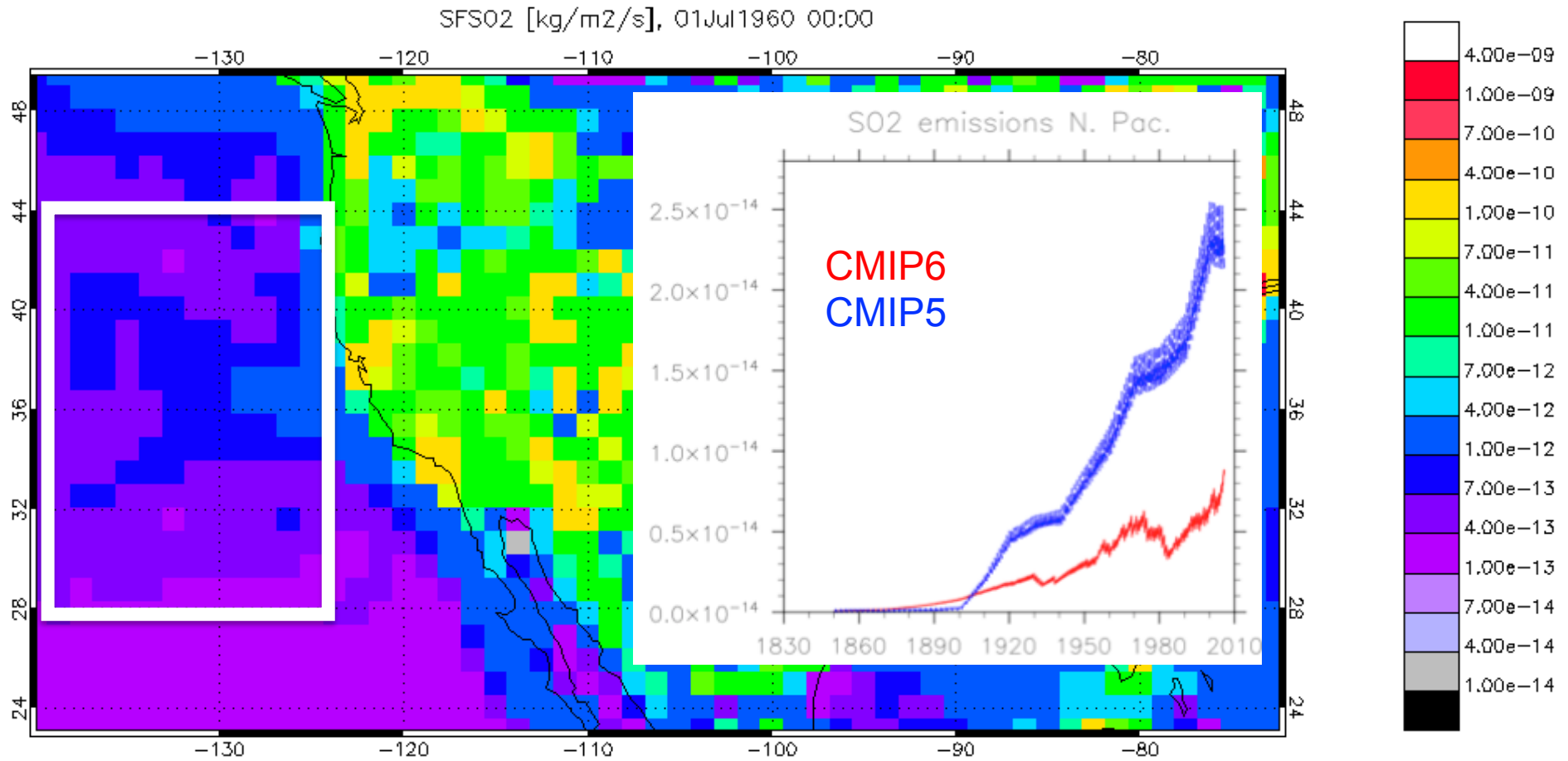


Courtesy of Jean-Francois Lamarque (NCAR)



Possible Remaining Issues in v6.2.0

(1) Potential issues with the short-lived emission datasets



Courtesy of Jean-Francois Lamarque (NCAR)



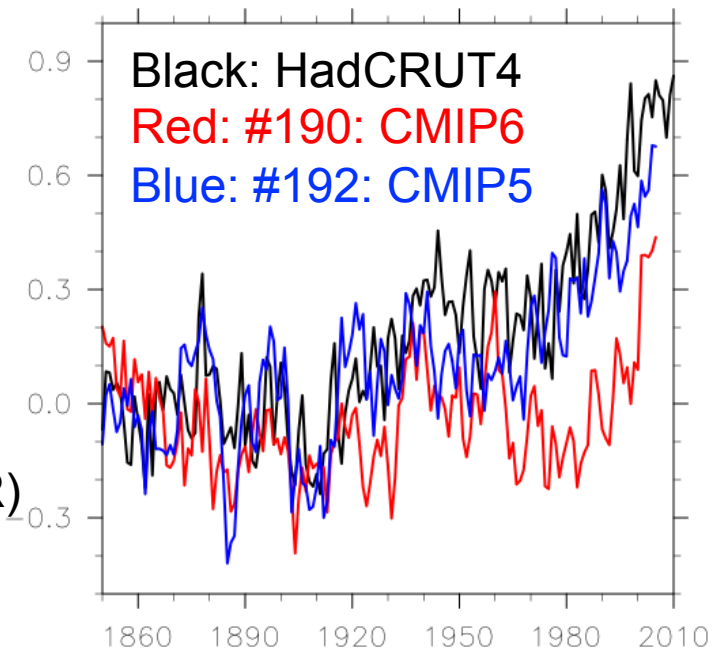
Possible Remaining Issues in v6.2.0

(1) Potential issues with the short-lived emission datasets

- CESM2, driven by CMIP5, simulates a credible 20th century surface temperature simulation
- CESM2, driven by CMIP6, still simulates a larger-than-observed cooling trend in the 1950-1980 period
- CMIP6 simulations generally a lot more variability possibly due to annual instead of decadal (CMIP5) emissions provided

Similar CMIP5 versus CMIP6 simulations available from other groups?

Courtesy of Jean-Francois Lamarque (NCAR)



Possible Remaining Issues in v6.2.0

(1) Potential issues with the short-lived emission datasets

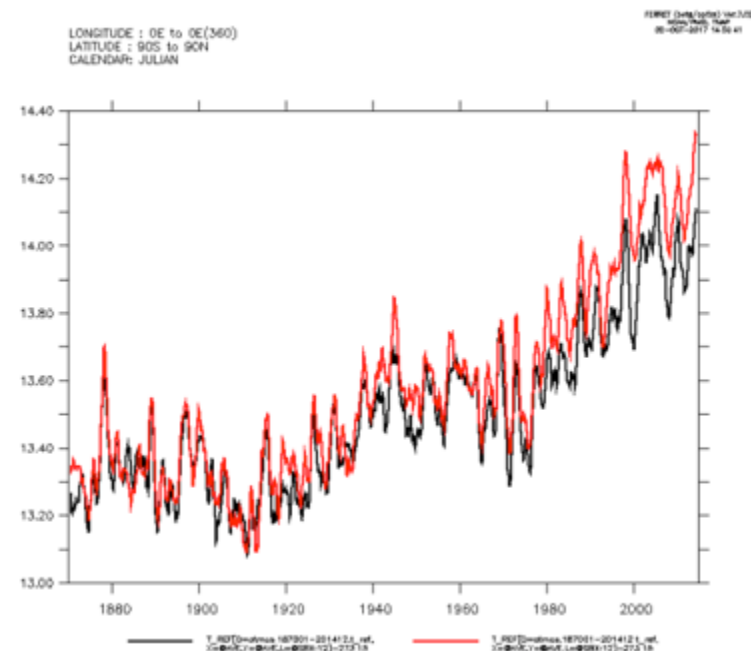
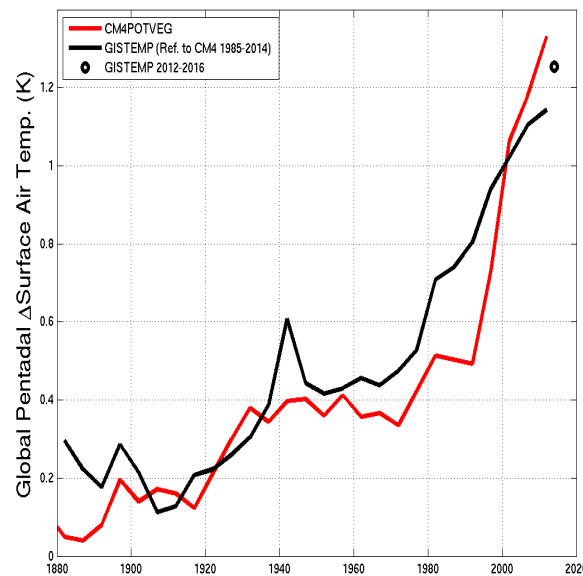
Similar CMIP5 versus CMIP6 simulations available from other groups?

Courtesy of John Dunne (GFDL)

Obs versus coupled prototype

AMIP CMIP5 and CMIP6

Prototype Simulations



Possible Remaining Issues in v6.2.0

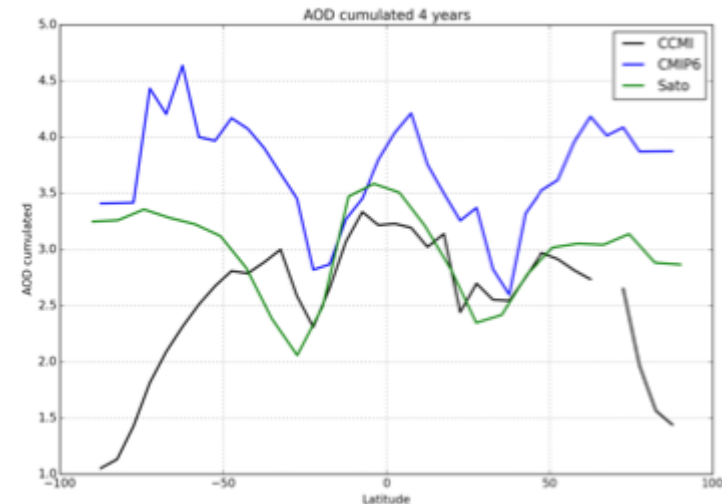
(2) Potential issues with the Pinatubo Period

Issues raised by Myriam Khodri

- What matters most for the climatic impact is the AOD in the visible band
- Generally larger AOD than other volcanic forcing datasets
- Large disagreement exist for the peak AOD time and persistence
- Large patchiness patterns, strong minimum values around 20°S and 30°N in 1991 and 1992

Response Tom Peter

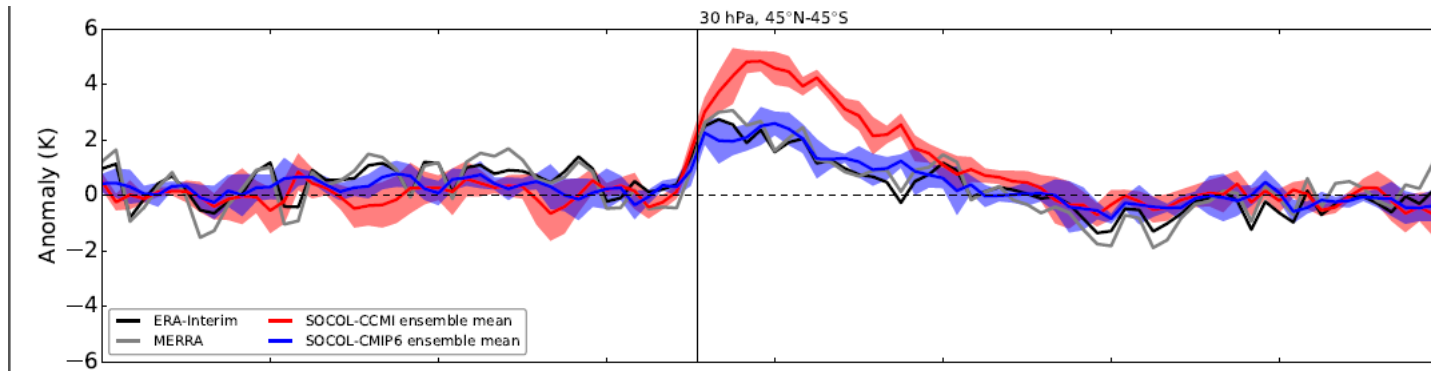
- It is correct that SAOD is larger, and we expected this and understand the reasons.
- In CCMI, when in a zonal ring the atmosphere became partly opaque and stayed partly still penetrable for SAGE-II, we took only the still penetrable measurements and used these for the entire zonal ring. While back then this was a reasonable approach, it must be clear that this makes SAOD being low biased. With a (partial) correction of this artifact in CMIP6, it is unavoidable that SAOD generally increases in the months after Pinatubo.
- However, what is more important than SAOD, is that the CMIP6 dataset describes the spatiotemporal distribution in a better manner. Main reason is the significantly improved gap-filling procedure by means of CLAES.



Possible Remaining Issues in v6.2.0

(2) Potential issues with the Pinatubo Period

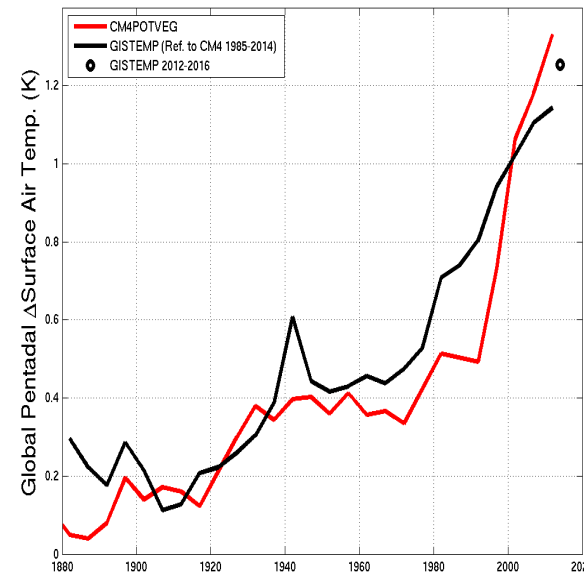
- Better agreement in SOCOL in terms of temperature response to Pinatubo eruption



Obs versus coupled prototype

Prototype Simulations

Courtesy of John Dunne (GFDL)



VolMIP: status, early October 2017

MODELLING AND ANALYSIS:

- **Status of VolMIP experiments:** MPI-M and IPSL are currently testing the different experiments.
- **MPI-M successfully conducted VolMIP-type experiments using the eVolv2k data forcing.** An ensemble of volc-cluster simulations with different parameters for the evol2k/EVA forcing is currently being analysed (see Figure)
We foresee no major issue in the setup of the volc-cluster and volc-long experiments using eVolv2k/EVA forcing.
- **Testing with IPSL revealed a possible issue about the volcanic forcing for the volc-pinatubo experiments**
 - In brief, the issue concerns the strong forcing generated by tropospheric aerosols and ambiguity in how to remove them. This will probably add unnecessary noise and large differences in the radiative forcing among CMIP6 models.
 - A possible solution is to provide to modelling groups the tropopause levels to allow separate consistently the stratospheric forcing from the

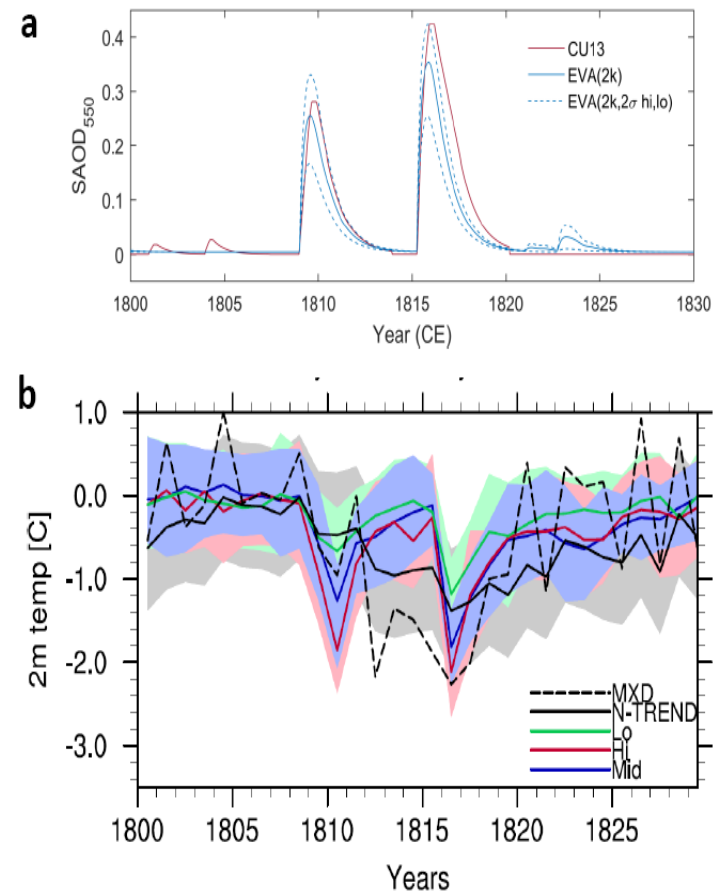


Figure: – Testing forcing uncertainty for the volc-cluster experiments. (a) Stratospheric Aerosol Optical Depth in the early 19th Century from Crowley and Untermann (2013, CU13) and from EVA (eVolv2k, Toohey and Sigl, 2017), with $\pm 2\sigma$ uncertainty (b) NH land temperature anomalies simulated with MPI-ESM using the three forcing reconstructions, compared to reconstructed NH summer temperature (N-TREND, Wilson et al., 2016).

Possible Remaining Issues in v6.2.0

(3) Potential issues with land use forcing datasets

- TRENDY models start from a steady state spin up for 1860 conditions (climate, CO₂ and land cover, then run in transient model with time-dependent forcing, very similar to CMIP6 historical runs.
- Models using the LUH land cover forcing simulate an anomalous large carbon source in 1861 (about 1GtC/yr), first year of the transient simulation. This is not realistic and is due to the spin-up assuming "static vegetation cover", i.e. no shifting cultivations (gross transitions) and/or no wood harvest for secondary forests.
- For GCP we decided not to use these models for their LUC estimate (cumulative budget was way too high). Solution for next year would be to start in 1700, to get rid of this initial "shock"...
- That's a potential issue for CMIP6 both for E-driven runs (Atm CO₂ will be too high), or for C-driven runs (compatible will be too low).

Possible Remaining Issues in v6.2.0

(3) Potential issues with land use forcing datasets

- **Land use should not change in the control run and should be fixed according to reconstructed agricultural maps from 1850.** Due to the diversity of model approaches in ESMs for land carbon, some groups might deviate from this specification, and again this must be clearly documented.
- There are some special considerations that apply to control simulations performed by “emission-driven” ESMs.
- the esm-piControl simulation, emissions of CO₂ from both fossil fuel combustion and land use change are prescribed to be zero. In this run any residual drift in atmospheric CO₂ concentration that arises from an imbalance in the exchanges of CO₂ between the atmosphere and the ocean and land (i.e. by the natural carbon cycle in the absence of anthropogenic CO₂ emissions) will need to be subtracted from perturbation runs to correct for a control state not in equilibrium. It should be emphasized that the esm-piControl is an idealized experiment and is not meant to mimic the true 1850 conditions, which would have to **include a source of carbon of around 0.6 PgC/yr** from the already perturbed state that existed in 1850.
- A general recommendation is that the land carbon fluxes in the emission and concentration driven control simulations should be stable in time and in approximate balance so that the **net carbon flux into the atmosphere is small (less than 0.1 PgC/yr)**.

Possible Remaining Issues in v6.2.0

(3) Potential issues with land use forcing datasets

- **Conditions in the control should generally be consistent with the forcing imposed near the beginning of the CMIP historical simulation.** This should minimize artificial transient effects in the first portion of the CMIP historical simulation.
- An exception is that for the CO₂-emission driven experiments, **the zero CO₂ emissions from fossil fuel and the land use specifications for 1850 in the esm-piControl could cause a discontinuity in land carbon at the branch point.**
- The 1850 esm-piControl should be developed for an idealized case that is stable in time and balance so that the net carbon flux into the atmosphere is small. Meanwhile, the start of the esm-hist in 1850 should be as realistic as possible and attempt to account for the fact the land-surface was not in equilibrium in 1850 **due to prior land-use effects** (Houghton, 2010; Hurtt et al., 2011).
- **Some modelling groups have developed methods to achieve these twin goals** in a computationally efficient manner, for example by performing pre-1850 off-line land model simulations to account for the land carbon cycle disequilibrium before 1850 and to adequately simulate carbon stores at the start of the historical simulation (Sentman et al., 2011). Due to the wide diversity of modelling approaches for land carbon in the ESMs, the actual method applied by each group to account for these effects will differ and needs to be well documented.

ScenarioMIP

Provision of future forcings harmonized to historical forcings at 2016 (base year)

IAM scenarios: finished January, 2017 (Published in Special Issue GEC)

IAM scenarios emissions downscaled and harmonised: Finished May, 2017 (harmonisation, let by IIASA); downscaling: Finished very soon

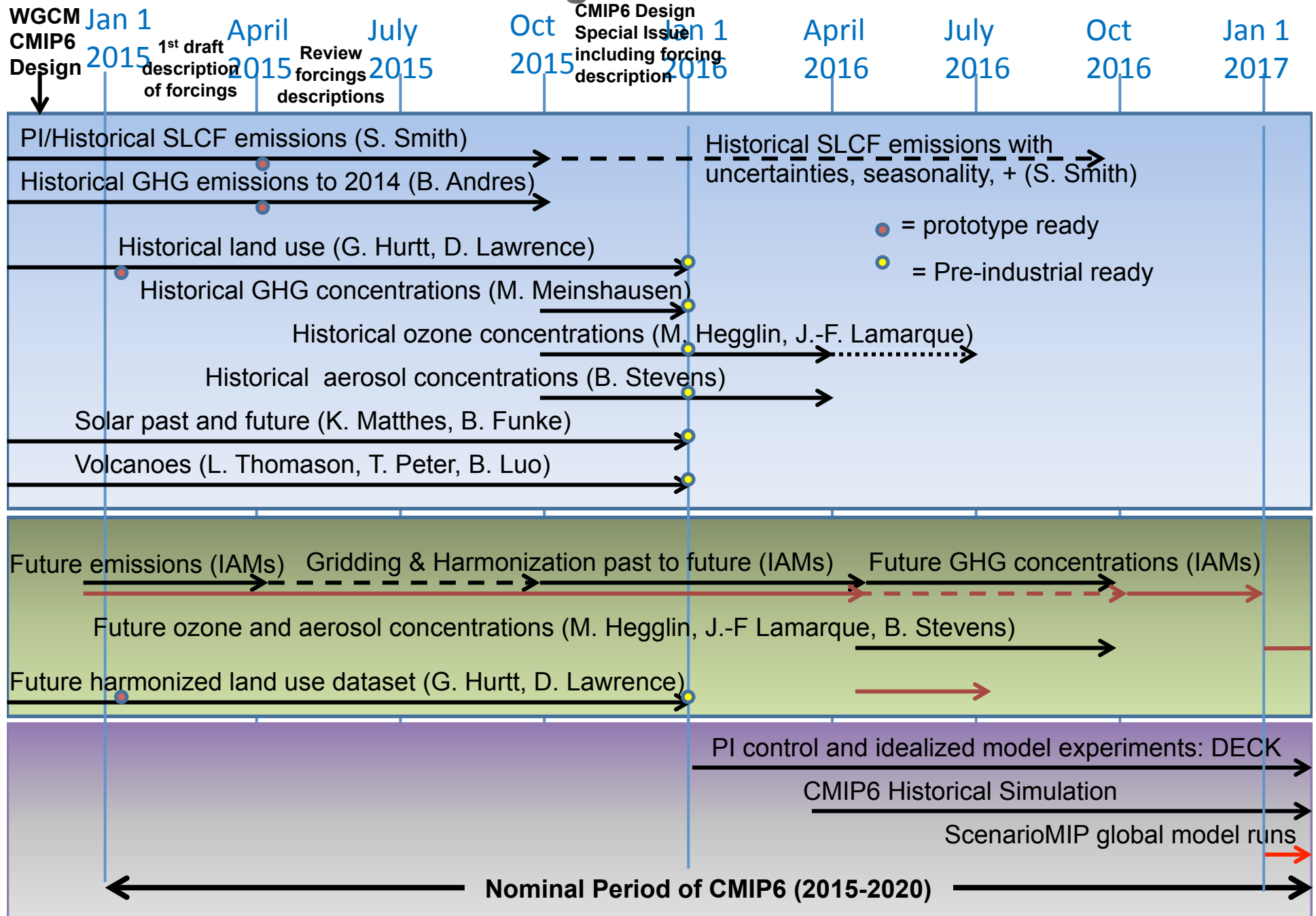
IAM based land use product (George Hurtt): Finished for 3 of 4 tier one scenarios (yesterday); 5 out of 8 if we include tier 2. Other tier 1 expected in 2-3 weeks time.

MAGICC output (concentration): before end of November.

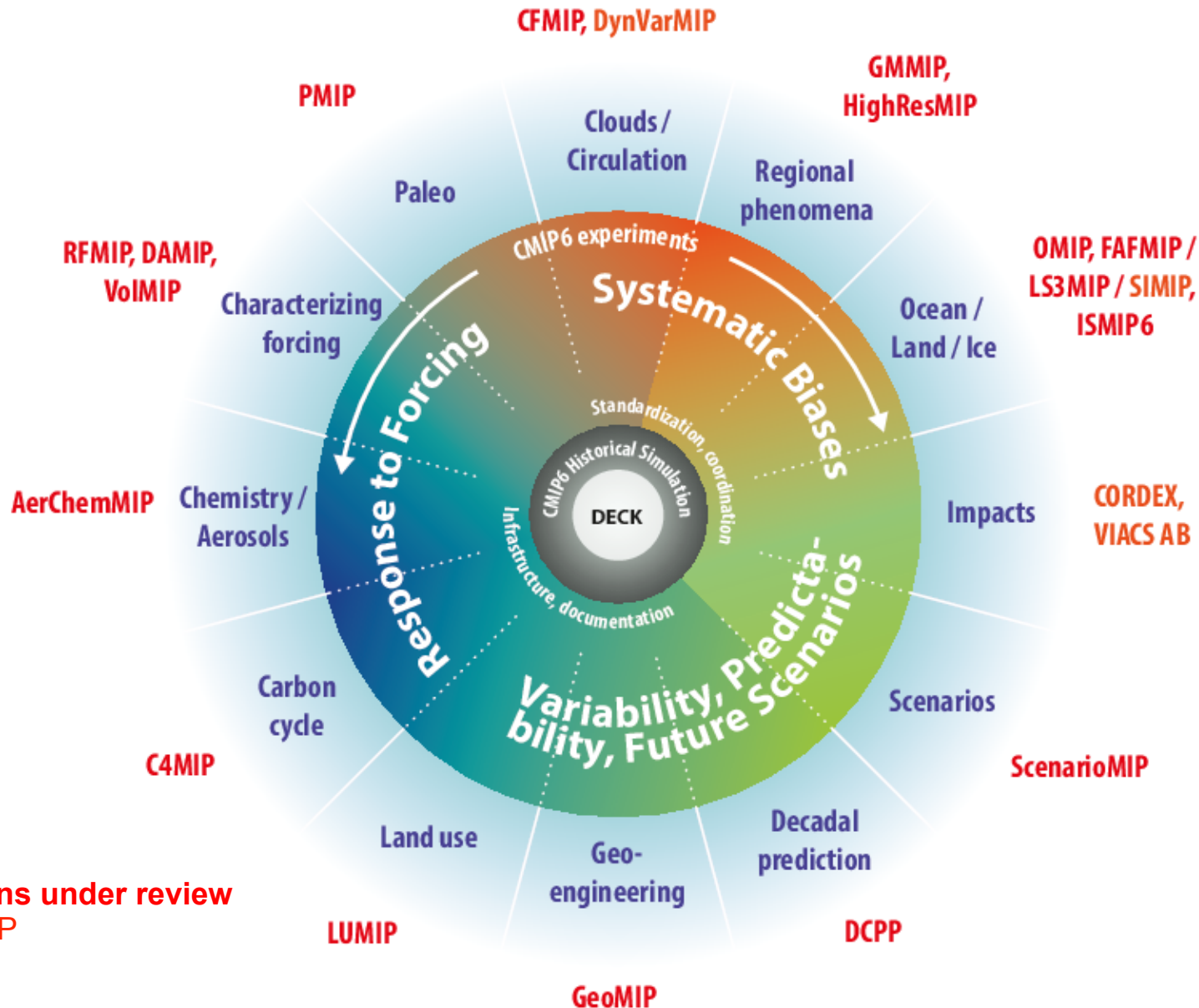
Aerosols/ozone: Intended to be on the same time schedule (Detlef contacting relevant people).

[Mid-December / Early January: Test run Hadley [TBC]].

CMIP6 Timeline agreed at WGCM-19 in 2015



21 CMIP6-Endorsed MIPs



CMIP6-Endorsed MIPs



Main Criteria for Endorsement

1. The MIP and its experiments address at least one of the key science questions of CMIP6.
2. The MIP demonstrates connectivity to the DECK experiments and the CMIP6 Historical Simulation.
3. The MIP adopts the CMIP modeling infrastructure standards and conventions.
4. All experiments are tiered, well-defined, and useful in a multi-model context and don't overlap with other CMIP6 experiments.
5. Unless a Tier 1 experiment differs only slightly from another well-established experiment, it must already have been performed by more than one modeling group.
6. A sufficient number of modelling centers (~8) are committed to performing all of the MIP's Tier 1 experiments and providing all the requested diagnostics needed to answer at least one of its science questions.
7. The MIP presents an analysis plan describing how it will use all proposed experiments, any relevant observations, and specially requested model output to evaluate the models and address its science questions.
8. The MIP has completed the MIP template questionnaire.
9. The MIP contributes a paper on its experimental design to the CMIP6 Special Issue.
10. The MIP considers reporting on the results by co-authoring a paper with the modelling groups.

* For "Diagnostic-MIPs" only non-experimental criteria apply

Application Carbon Dioxide Removal Model Intercomparison Project (CDRMIP)

Co-Chairs: Andrew Lenton, David P. Keller, Vivian Scott, and Naomi E. Vaughan

- The majority of future emission scenarios that stay well below 2°C, and nearly all emission scenarios that do not exceed 1.5°C warming by the year 2100, require some form of CDR. At present, there is little consensus on the impacts and efficacy of the different types of proposed CDR.
- CDRMIP explores the potential, impacts, and challenges of CDR.
- CDR-MIP experiments designed to address questions concerning CDR-induced climate "reversibility", the response of the Earth system to direct atmospheric CO₂ removal (direct air capture and storage), and the CDR potential and impacts of afforestation/reforestation, as well as ocean alkalization.
- GMDD paper submitted, endorsement criteria seem to be met

Model	Institute	Country
BNU-ESM	Beijing Normal University	China
Mk3L-COAL	Commonwealth Scientific & Industrial Research Organization	Australia
ACCESS	Commonwealth Scientific & Industrial Research Organization	Australia
MPI-ESM	Max Planck Institute for Meteorology	Germany
NorESM1-M	Norwegian Climate Centre (NCC)	Norway
HadGEM2-ES	UK Met Office Hadley Centre	UK
CNRM-ESM1	CNRS	France
NCAR CSM1-4.carbon	ETH Zurich	Switzerland

Application Polar Amplification MIP (PAMIP)

Co-Chairs: Doug Smith, James Screen, Clara Deser

- The overall aim of PA-MIP is to investigate the causes and global consequences of polar amplification, through creation and analysis of an unprecedented set of coordinated multi-model experiments and strengthened international collaboration.
- The broad science objectives are:
 - Provide new multi-model estimates of the global climate response to Arctic and Antarctic sea ice changes.
 - Determine the robustness of the responses between different models and the physical reasons for differences.
 - Improve physical understanding of the mechanisms causing polar amplification and its global effects.
 - Harness increased process understanding and new multi-model ensembles to constrain projections of future climate change in the polar regions and associated global climate impacts.
- Application not yet ready
- Supported by APPLICATE project

CMIP6: Participating Model Groups

	Institution	Country		Institution	Country		Institution	Country
1	AWI	Germany	12	DOE	USA	23	MRI	Japan
2	BCC	China	13	EC-Earth-Cons	Europe	24	NASA-GISS	USA
3	BNU	China	14	FGOALS	China	25	NCAR	USA
4	CAMS	China	15	FIO-RONM	China	26	NCC	Norway
5	CasESM	China	16	INM	Russia	27	NERC	UK
6	CCCma	Canada	17	INPE	Brazil	28	NIMS-KMA	Republic of Korea
7	CCCR-IITM	India	18	IPSL	France	29	NOAA-GFDL	USA
8	CMCC	Italy	19	MESSY-Cons	Germany	30	NUIST	China
9	CNRM	France	20	MIROC	Japan	31	TaiESM	Taiwan, China
10	CSIR-CSIRO	South Africa	21	MOHC	UK	32	THU	China
11	CSIRO-BOM	Australia	22	MPI-M	Germany	33	Seoul Nat.Uni	Republic of Korea

New in CMIP:

- 2 new model groups from Germany (AWI, MESSY-Consortium)
- 4 new model groups from China (CAMS, CasESM, NUIST, THU)
- 1 new model group from Brazil (INPE)
- 1 new model group from India (CCCR-IITM)
- 1 new model group from Taiwan, China (TaiESM)
- 1 new model group from USA (DOE)
- 2 new model group from Republic of Korea (NIMS-KMA, SAM0-UNICON)
- 1 new model group from South Africa / Australia (CSIR-CSIRO)

=====

⇒ **13 new model groups so far**

* Other models can join providing DECK and historical simulations are submitted

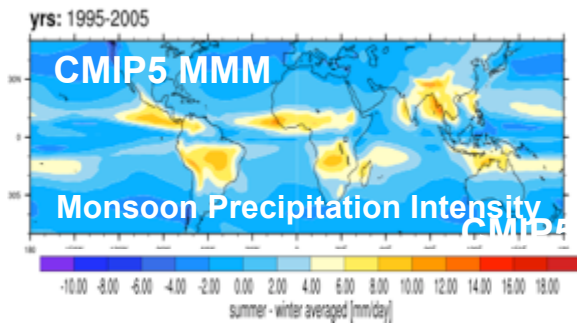
More models (>70)
 New models
 More complex models
 Higher resolution models

How to characterize the wide variety of models in CMIP6?

- Routine Benchmarking and Evaluation Central Part of CMIP6 -

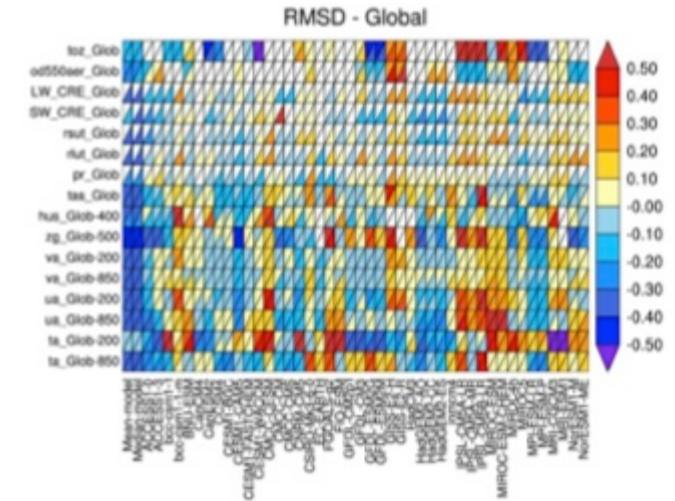
Tools such as the community-developed **Earth System Model Evaluation Tool (ESMValTool, Eyring et al., ESMValTool, GMD (2016b))** that includes other software packages such as the **NCAR CVDP (Phillips et al., 2014)**, and the **PCMDI Metrics Package (PMP, Gleckler et al., EOS (2016))** to produce well-established analyses as soon as CMIP model output is submitted.

Similar to **Figure 9.7 of AR5**



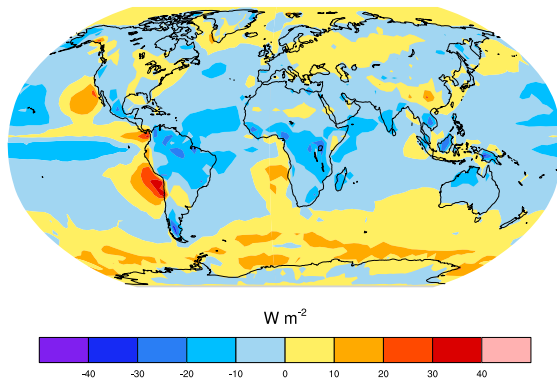
Broad Characterization of Model Behavior
(incl. IPCC AR5 Chap 9 & 12 diagnostics in ESMValTool)

Running alongside the ESGF

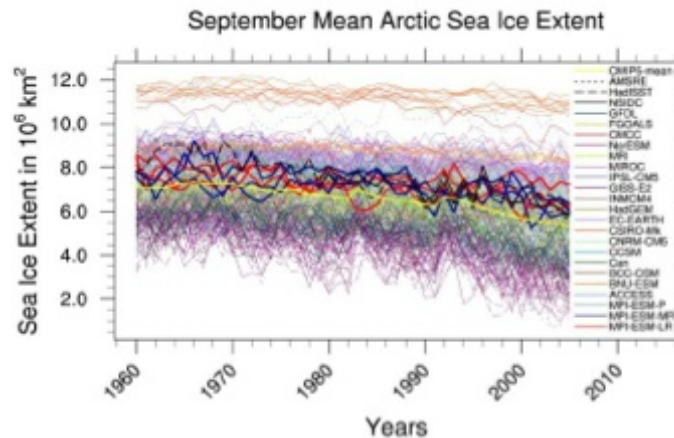


Similar to **Figure 9.5 of AR5**

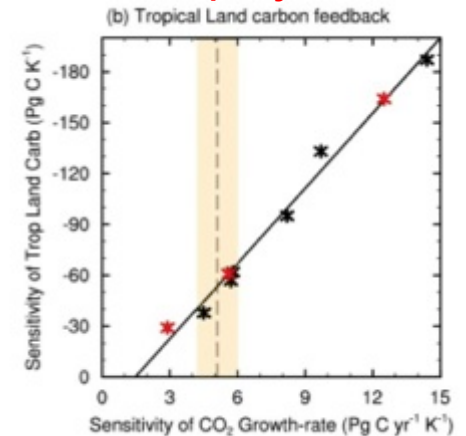
Net Cloud radiative effect against CERES EBAF



Similar to **Figure 9.24 of AR5**



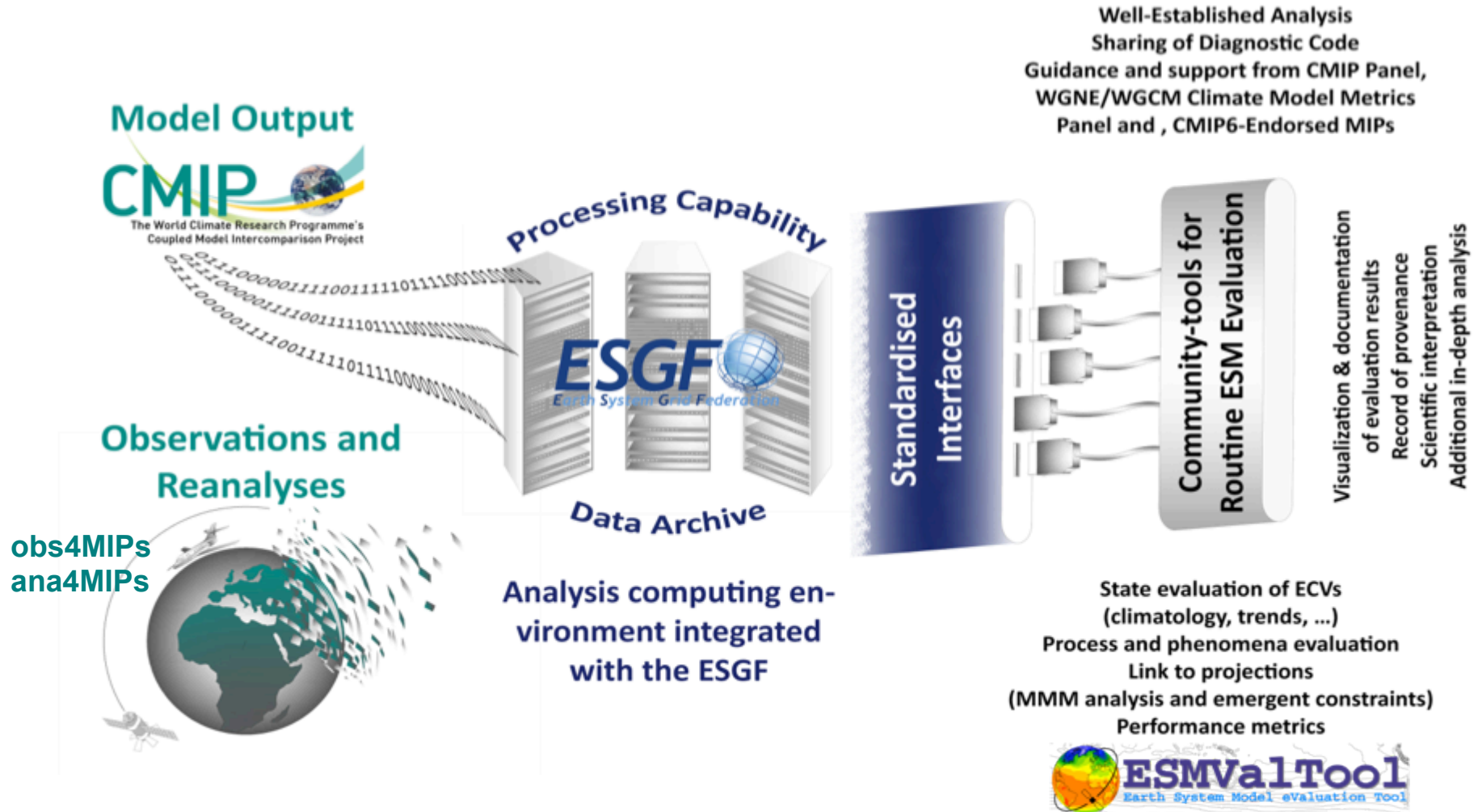
Link to projections



Similar to **Figure 9.24 of AR5**

Envisaged Workflow for Routine Evaluation in CMIP

- Ensuring traceability and provenance of the results -



Eyring et al., ESD (2016)

Results at <http://cmip-esmvaltool.dkrz.de/>



Key Messages: CMIP6 Design and Organization (1)

1. DECK and CMIP6 Historical Simulations

- Provide opportunity for sophisticated characterization of the CMIP6 ensemble and continuity across CMIP6 phases.
- Newly developed evaluation tools coupled to ESGF (ESMValTool, PMP) will provide a more systematic, open and comprehensive performance assessment on timescales not possible for AR5 (incl. AR5 Chs. 9 & 12 figures).

2. 21 CMIP6-Endorsed MIPs that build on the DECK and historical simulations

- Will address a large range of specific science questions
- Will fill scientific gaps of the previous CMIP phases and support the WCRP GCs
- Will lead to increased process understanding in many areas including clouds, aerosols, internal variability, impact of volcanic eruptions on climate, and geoengineering.
- For the first time in CMIP, an avenue for a formal communication with the vulnerability, impacts and adaptation and climate services community is established (VIACS AB)

3. Enhanced Infrastructure (ESGF) & documentation (ES-DOC) coordinated by the WGCM Infrastructure Panel (WIP)

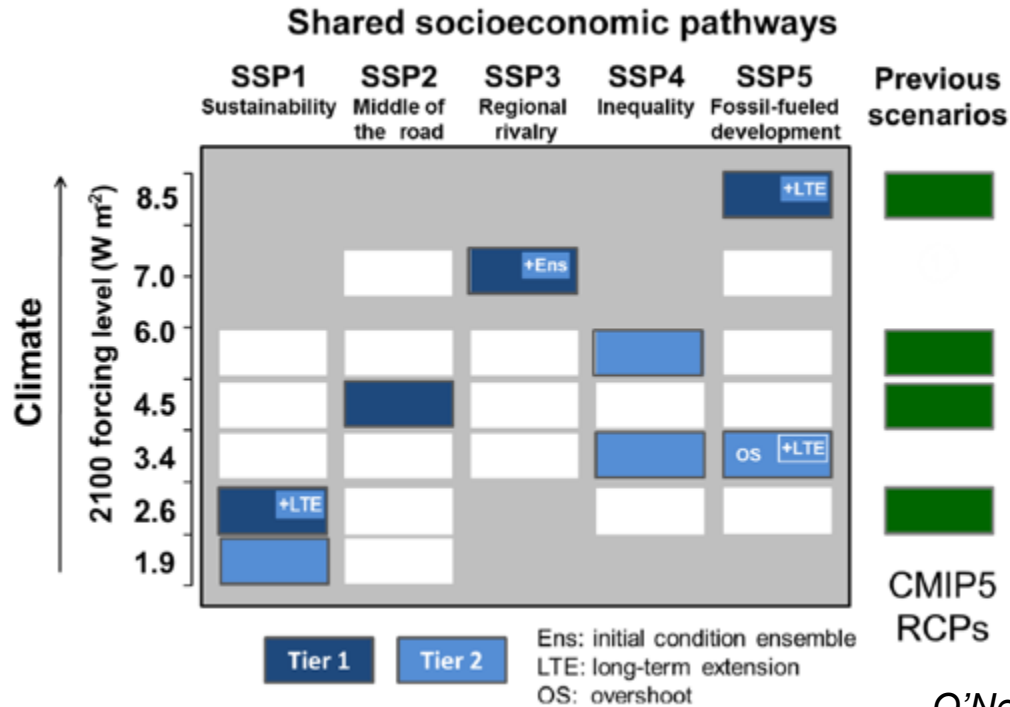
=> More robust statistical testing of model results through a larger ensemble (more models and ensemble members; using CMIP3, CMIP5 & CMIP6 together)

=> Increased information of the role of internal climate variability and observational uncertainty

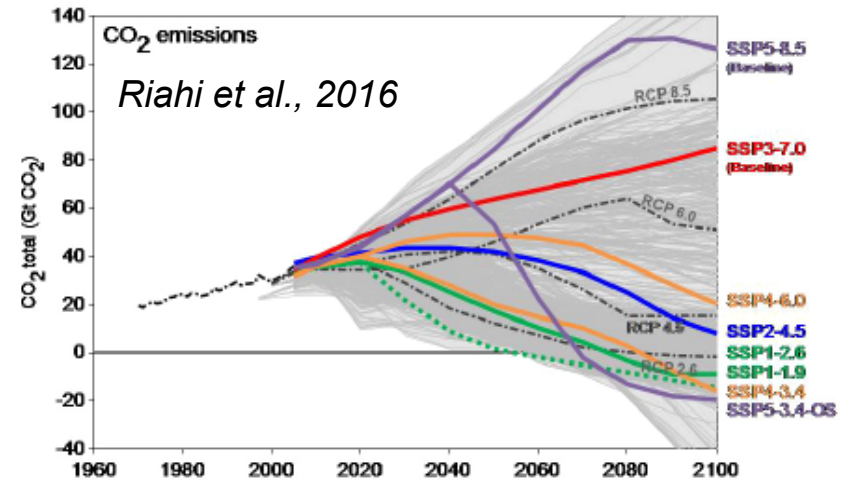
=> Increased evidence for several messages of AR5

Key Messages: Model Projections / Predictions (2)

SSPs: set of baselines, with future developments in absence of new climate policies beyond those in place today



Future in CMIP6: 2015-2100 plus Extensions to 2300



O'Neill et al., ScenarioMIP for CMIP6, GMD, 2016

ScenarioMIP: New scenarios span a similar range as the RCPs, but fill critical gaps, including

- Role of specific forcings such as land use and short-lived species (air quality)
- The effect of a peak and decline in forcing,
- The consequences of scenarios that limit warming to below 2 °C,

DCPP: Improvements in models, reanalysis, methods of initialization and ensemble generation, and data analysis will provide extended comprehensive decadal predictions

Key Messages: New Scientific Methods and Approaches (3)

1. Fitness-for-purpose evaluation

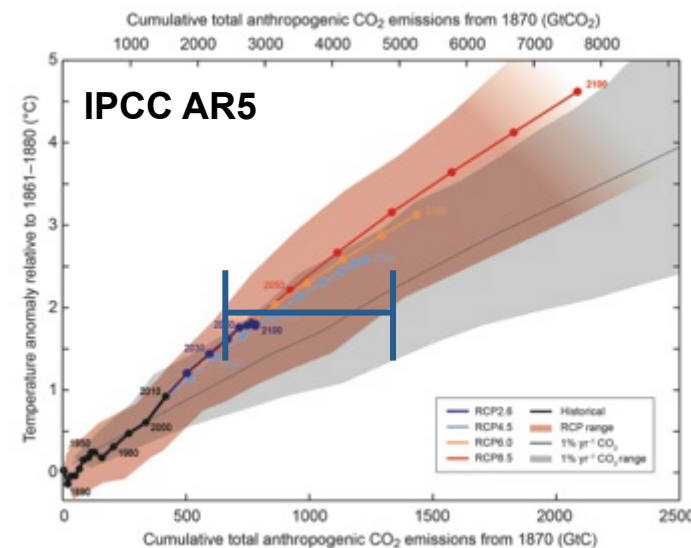
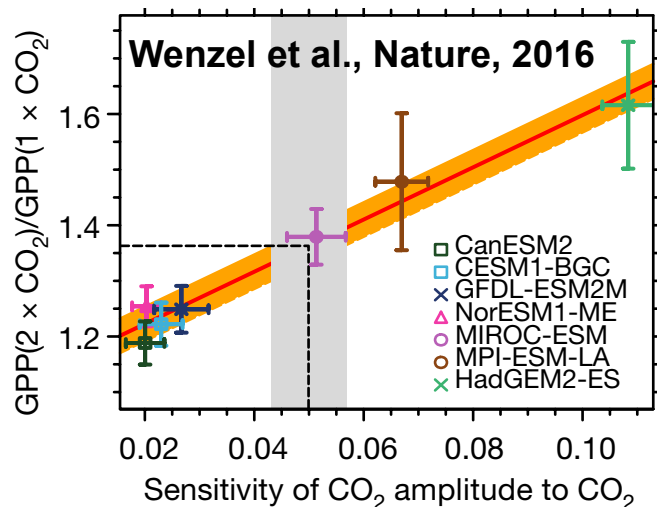
- General model evaluation **supported by new CMIP evaluation tools remains** important
- Additionally identify **“purpose”** (e.g. purposes might be projections, regional information, impact studies, mitigation pathways, physical understanding)
- Process-oriented, process-based, regime-based evaluation can be done better given expanded suite of MIPs in CMIP6 => Needs to be fully exploited
- Large number of metrics, process-based, and ensuring that new ones arriving all the time.

2. Emergent constraints and exploration of model weighting: **can be used to distill robust information from multi-model output** for science and as evidence for policy-making

=> Help quantifying & reducing uncertainties in key feedbacks and projections

=> Can be used to draw conclusions for critical questions such as climate sensitivity and cumulative CO₂ emissions for a specific temperature target (TCRE, TCR, ECS).

Relative GPP increase at CO₂ doubling

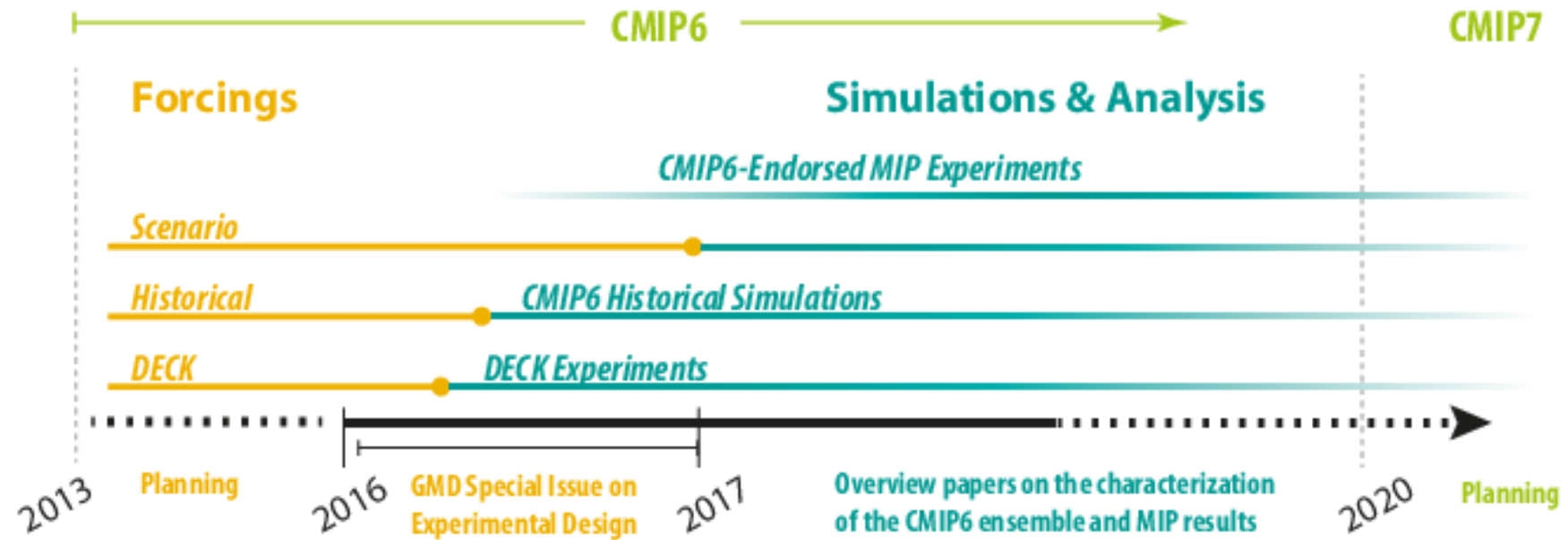


ES-DOC (see also Karl's talk)

- Initial call for review last May
- White paper is published and the list of ES-DOC liaison people is almost complete.
- A NEW ACTION is now required on the science review of model realms documentation.
 - We've now added additional realms, short tables and another way of reviewing the science content of this model documentation using html pages (which can also be printed, if needed).
 - As per WGCM request, short tables are to be used in publications describing CMIP6 models - these short table are a subset of the full model documentation.
 - We would like to request a science review of these short tables and the wider model documentation before they are released for community use.
 - The realm descriptions and short table are easily viewed as html, but also available in their canonical text form as Python files (json for the short tables).
 - These realms and the associated feedback forms can also be found at <http://es-doc.org/cmip6-specialisations>.

Please provide any feedback on these realms and short tables by Oct 10th and via the on-line feedback forms.

CMIP6 Timeline



Dissemination of CMIP6 (selection)

- CMIP6 Special Issue in GMD at https://www.geosci-model-dev.net/special_issue590.html
- WMO bulletin
- A Short Introduction to Climate Models - CMIP & CMIP6 Video produced by WCRP
 - Short version on Youtube at <https://www.youtube.com/watch?v=wTBkq9nWNEE>
 - Long version on Youtube at <https://www.youtube.com/watch?v=WdRiYPJLt4o>
- GMD Highlight Article by David Carlson, Veronika Eyring, Narelle van der Wel, and Gaby Langendijk
- Nature Climate Change Interview on CMIP6 at <http://www.nature.com/nclimate/journal/v7/n10/full/nclimate3398.html>
- Model output will be published at the Earth System Grid Federation (ESGF)
- Monitor results of CMIP5/CMIP6 model evaluation with the ESMValTool at <http://cmip-esmvaltool.dkrz.de/>

Status and Outlook



CMIP6 Status

- CMIP6 Experimental Design finalized on time
- Forcing datasets for DECK and CMIP6 historical simulations finalized
- CMIP6 Data Request released but new versions still published
- CMIP6 Simulation Period (2017-2020)
- Infrastructure in preparation by WGCM Infrastructure Panel (WIP)

CMIP6 Participating Model Groups: > 30 using a wide variety of different model versions

21 CMIP6-Endorsed MIPs that build on the DECK and CMIP historical simulations to address a large range of specific questions with WCRP Grand Challenges as scientific backdrop.

CMIP6 Climate Projections part of a CMIP6-Endorsed MIP (ScenarioMIP)

- New scenarios span the same range as the RCPs, but fill critical gaps for intermediate forcing levels and questions for example on short-lived species and land-use.
- Forcings for future scenarios available by end of 2017, climate model projections expected to be available within the 2018-2020 time frame.

A Central Goal of CMIP6 is Routine Evaluation of the Models with Observations

- Community evaluation tools (ESMValTool, PMP): development & coupling to ESGF; Concept towards improved and routine evaluation of ESMs in CMIP developed (Eyring et al., ESD, 2016)

Geosci. Model Dev. Special Issue on CMIP6 Design

- Overview of the CMIP6 Experiment Design and Organization (Eyring et al., GMD, 2016)
- Experimental design from all 21 CMIP6-Endorsed MIPs, 2 new applications
- Description of the CMIP6 forcing datasets
- CMIP6 infrastructure (WIP, Balaji et al., in prep.) and data request (Juckes et al., in prep.)

=> We expect CMIP6 to continue CMIP's tradition of major scientific advances

First Recommendations for CMIP7



CMIP Organization

- **Seeking community input** in each phase of the definition of the CMIP design is essential and should be kept (e.g. CMIP5 survey, iteration of CMIP design, Special Issue, forcings etc.)
- The more distributed organization with the **CMIP Panel** overseeing CMIP DECK and historical simulations and entire CMIP process and the **CMIP-Endorsed MIPs** works well so far and should be kept.
- Too many essential deliveries rely on **single people** (e.g. data request, forcings)
- Too many essential deliveries are **unfunded**

Forcings:

- **Writing of early initial descriptions of the forcings and review by the model groups and MIPs** was a good initiative, but hasn't worked since we hardly received any feedback / key questions remained open => **Create more formal link by asking each model group to assign one person for each forcing dataset early on in the process.**
- Build into the timeline that before the CMIP Panel releases an official version of the forcings, the **model groups sign off on them**. This will avoid that the data are taken for granted.
- **Ideally have an organization** in charge for each forcing dataset.
- **Forcing papers should be submitted well before forcings are due** so that review comments can be considered in the final data product.
- **Data standards and formats** need to be finalized well before forcings are due.
- **The publication to the ESGF** takes long and was not built into the CMIP timeline; this should be included as formal step in the CMIP7 timeline
- **Official CMIP Panel releases** should be kept rather than an oversight by input4MIPs and floating versions.
- **input4MIPs** should be continued

First Recommendations for CMIP7



CMIP6 Data Request:

- Many issues; Requires more than one person in charge,
- Should be a group of people that oversees the technical and scientific part of the data request => Form a **CMIP Data Request Panel NOW?**
- Overall size needs to be limited
- Additionally provide regridded fields (in particular for the ocean), zonal and global means etc.?

Meetings:

- Can some of the WGCM meetings be held remotely?
- Combine/organize WGCM with other interesting meetings (e.g. CMIP analysis, tuning)

Models and Science

- How many models do we really need? How to stay innovative?

Funding:

- CMIP is a largely unfunded activity with huge demands; Most of CMIP coordination/collaboration occurs through volunteered time of climate scientists
- The growing dependency on CMIP products by a broad research community and by national and international climate assessments means that basic CMIP activities, such as the creation of forcing datasets, the provision and archiving of CMIP products, and model development, require substantial efforts. Start thinking about this NOW.

Action Items for WGCM-21



CMIP Analysis Workshop

- When is a good time? 2019?
- Have MIPs and model groups present would be ideal
- Combine with WGCM meeting?
- Possibly combine also with other meetings (as we had last time with EMBRACE)?
- Possibly have a remote WGCM meeting in 2018, then a larger analysis workshop in 2019?

CMIP6-Endorsed MIP Applications (CMIP Panel)

- CDRMIP, PAMIP

Forcings

- What about the remaining issues with historical forcings (Pinatubo, short-lived emissions)?

Announce CMIP model evaluation capability to the modelling groups and CMIP6-Endorsed MIPs (Veronika and Peter)

ES-DOC

- Encourage the review of the scientific content of the questions; ensure that tables that are produced can be used in peer-reviewed publications

CMIP6 Data Request

- Status and feedback from model groups

Status Ocean Grids?