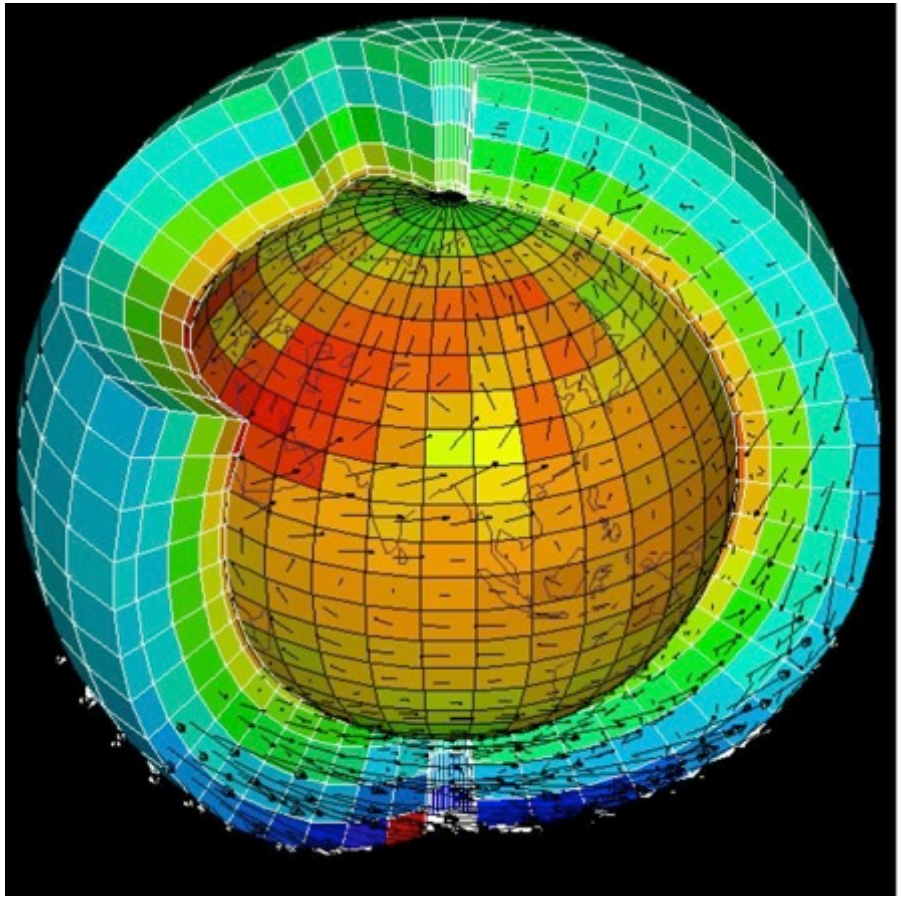
WCRP Working Group on Coupled Models (WGCM)



Co-Chairs

Cath Senior (Met Office, UK)

Greg Flato (CCCma, Canada)

C Senior, pan-WCRP modelling meeting, Exeter, October 9th 2017

CMIP The World Climate Research Programme's Coupled Model Intercomparison Project

WCRP World Climate Research Programme

WGCM Aims

• Review and foster the development of coupled ocean-atmosphere and Earth system models

• Co-ordinate model intercomparisons to;

- *better understand natural climate variability*
- *predict the climate response to natural and anthropogenic perturbations*
- *assess the climate predictability at the decadal timescale*

e.g. CMIP (Coupled Model Intercomparison Project), CFMIP (Cloud Feedbacks Intercomparison Project), PMIP (Palaeoclimate Model Intercomparison Project), Transpose-AMIP (climate model used in NWP mode)

• Promote and facilitate the models evaluation and diagnosis of shortcomings, and understanding of processes and feedbacks in the climate system

Done in collaboration with many partners; WGNE (atmospheric process community), WGSIP (decadal forecasting community) , many MIPs

WGCM promotes a balance between

simulation – evaluation - understanding

WCRP
World Climate Research Programme

Recent WGCM Activities

CMIP (coordinated through the CMIP panel)

• coordinated climate model experiments involving international modeling teams since 1995. Now in 6th phase (**CMIP6**)

• delivered better understanding of past, present and future climate change and variability in a **multi-model framework.**

• defined **common experiment protocols, forcings and output.**

• model simulations have also been regularly assessed as part of the **IPCC** Climate Assessments Reports and various national assessments.

WGCM Infrastructure Panel (WIP)

•manages and coordinates infrastructure development, and oversees implementation, and operations.

•maintains a website where "Position papers" and specifications for CMIP6 should be examined.

- https://www.earthsystemcog.org/projects/wip/

•BADC (Martin Juckes) is responsible for developing the list of variables that should be archived for each experiment in CMIP6 (the "data request").

•PCMDI provides guidance documents for CMIP6 participants, maintains the "controlled vocabularies", and leads the input4MIPs initiative to provide forcing datasets for CMIP6.

Grand Challenges

•WGCM provides leadership and support for 2 of the 7 WCRP grand challenges on '**Clouds, Circulation and Climate Sensitivity**' and '**Carbon Feedbacks in the Climate System**'

•Promoted **workshops** engaging a wide group of scientists in the core questions.

•Many **papers** published

WCRP
World Climate Research Programme

CMIP6 Organization

- **CMIP Panel** (V. Eyring (chair), S. Bony, J. Meehl, C. Senior, B. Stevens, R. Stouffer, K. Taylor) which is responsible for direct coordination of CMIP and overseeing the whole CMIP process.

- **WGCM Infrastructure Panel** (WIP, co-chairs V. Balaji & K. Taylor): Establishes standards and policies for sharing climate model output; puts the data request together technically (M. Juckes).

CMIP6 Experimental Design

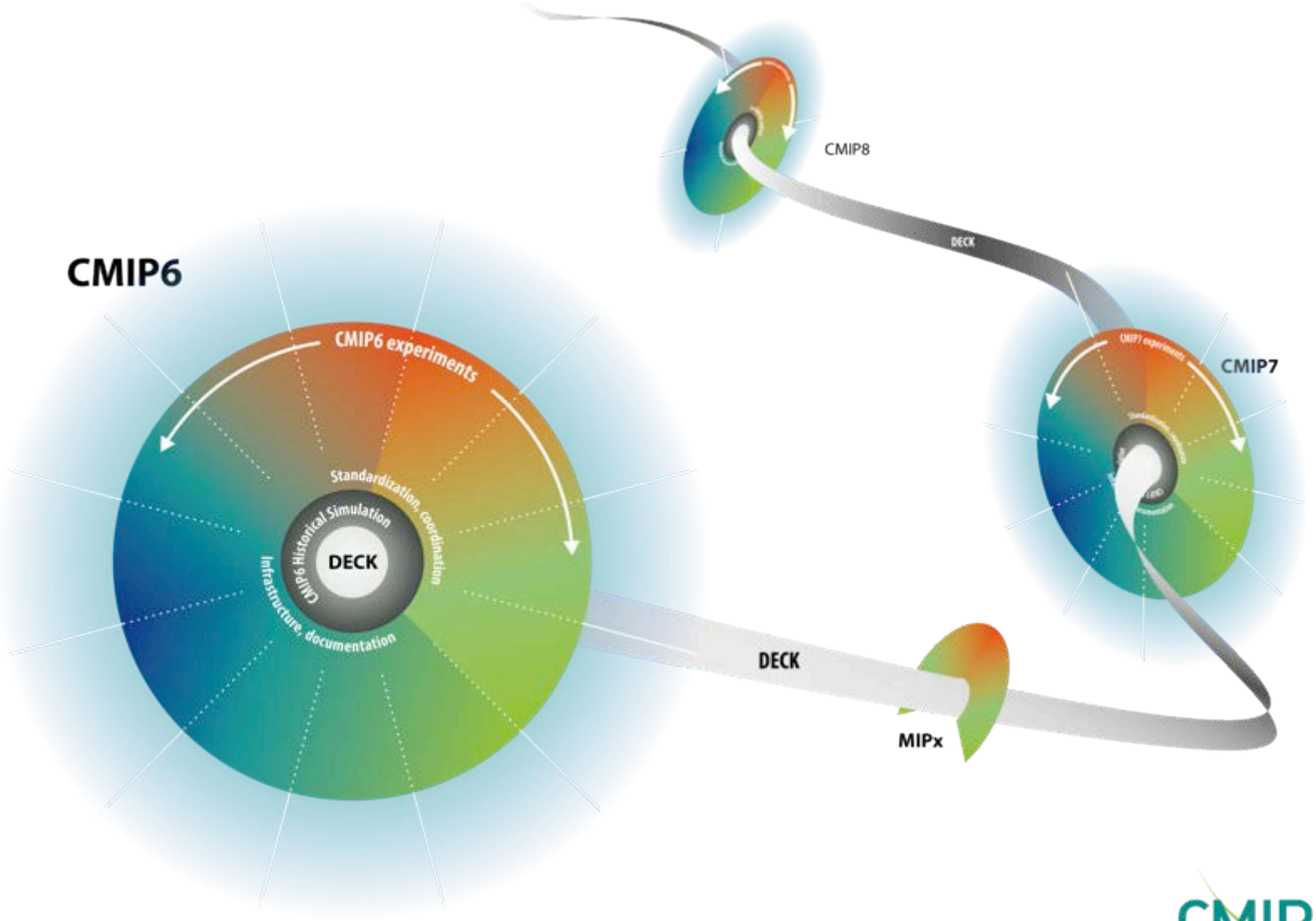
Based on an extensive period (three years) of community consultation

- Meehl et al., EOS, 2014
- Finalized at WGCM-18 session (October 2014, Grainau)
- Eyring et al., CMIP6 Experimental Design and Organization, GMD, 2016
- Science Backdrop of WCRP GCs
- Experimental design based on 3 broad questions
  - How does the Earth System respond to forcing?
  - What are the origins and consequences of systematic model biases?
  - How can we assess future climate changes given climate variability, predictability and uncertainties in scenarios?

CMIP
The World Climate Research Programme's Coupled Model Intercomparison Project

CMIP Continuity

A common suite of experiments for each phase of CMIP provides an opportunity to construct a multi-model ensemble using model output from various phases of CMIP

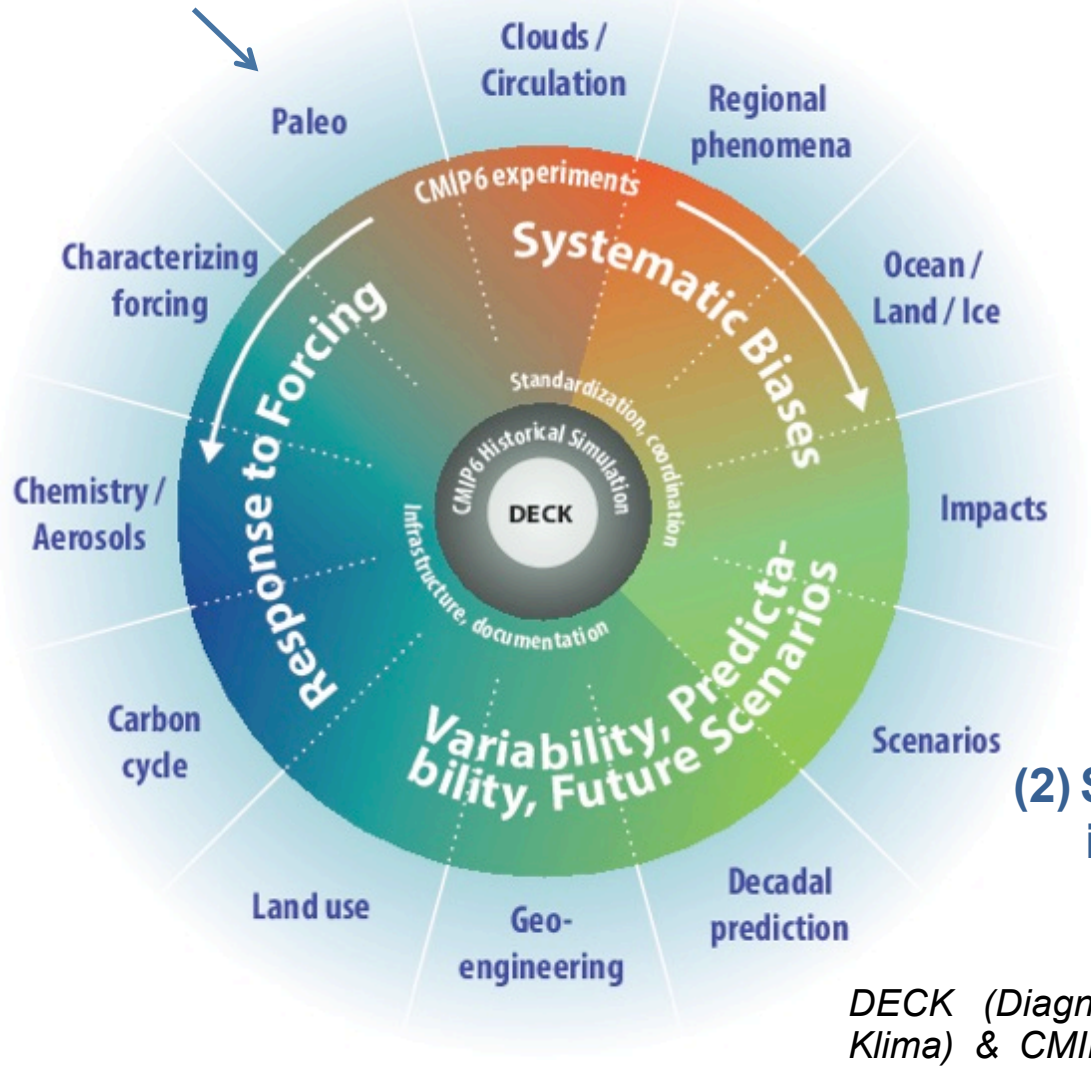


Eyring et al., CMIP6 Experimental Design and Organization, GMD, 2016

CMIP
The World Climate Research Programme's Coupled Model Intercomparison Project

CMIP: a More Continuous and Distributed Organization

(3) CMIP-Endorsed Model Intercomparison Projects (MIPs)



Eyring et al., GMD, 2016

(1) A handful of common experiments

DECK (entry card for CMIP)

i. AMIP simulation (~1979-2014)
ii. Pre-industrial control simulation
iii. 1%/yr CO_2 increase
iv. Abrupt 4xCO_2 run

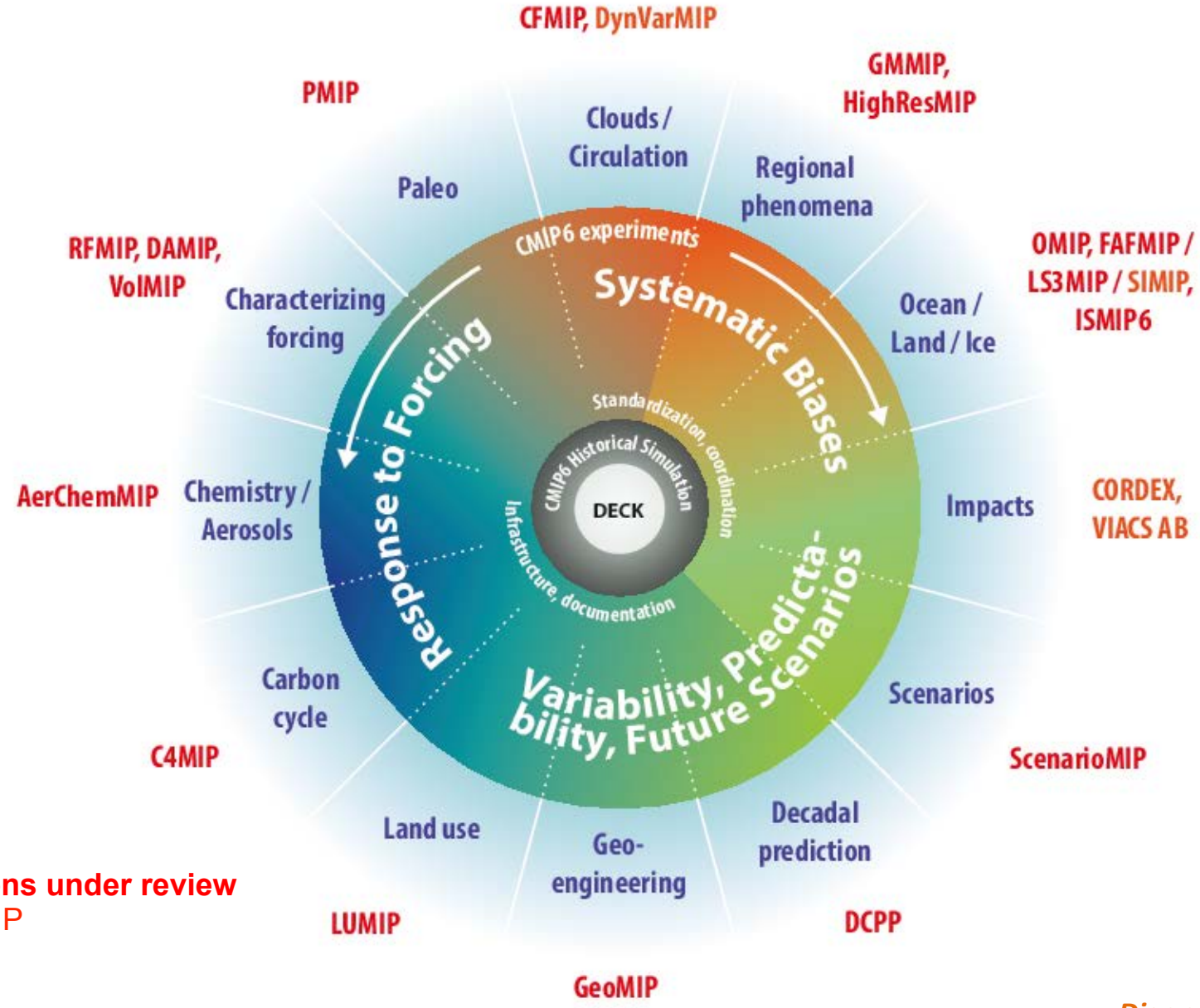
CMIP6 Historical Simulation (entry card for CMIP6)

v. Historical simulation using CMIP6 forcings (1850-2014)

(2) Standardization, coordination, infrastructure, documentation

DECK (Diagnosis, Evaluation, and Characterization of Klima) & CMIP6 Historical Simulation to be run for each model configuration used in CMIP6-Endorsed MIPs

21 CMIP6-Endorsed MIPs



Applications under review

- CDRMIP
- PAMIP

Diagnostic MIPs

Eyring et al., GMD, 2016

CMIP infrastructure coordination

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)
==========

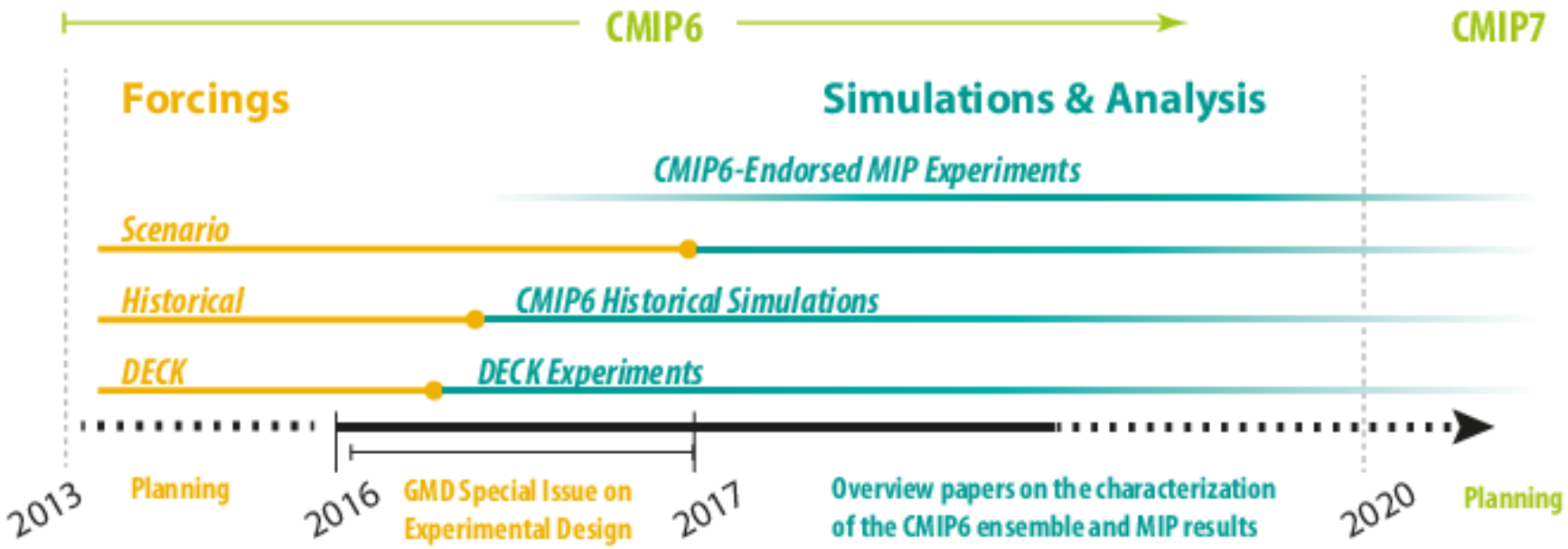
⇒ **13 new model groups so far**

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

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

CMIP
The World Climate Research Programme's Coupled Model Intercomparison Project

CMIP6 Timeline



Eyring et al., CMIP6 Experimental Design and Organization, GMD, 2016

The Grand Challenge on Clouds Circulation and Climate Sensitivity (2012-2022)

S. Bony and B. Stevens

1. Cloud Feedbacks & Climate Sensitivity

- A strategy to narrow uncertainty in ECS (Stevens et al. 2016)
- NARVAL2 and EUREC^{4}A field studies (Bony & Stevens)
- ISSI team on organization of Shallow Clouds (Pincus, Bony, Stevens Winker)
- ECS assessment (Webb & Sherwood)
- Aerosol forcing assessment, (Ringberg, Feb 2018, Bellouin, Quaas, Stevens & others)

2. Storm Tracks

- 4ICESM (Hamburg, Aug 2016)
- Targeted small workshop to develop select Grindelwald themes (2018, Caballero & Kaspi)

3. Rainbelts

- ICTP, TRAC-MIP summer school (Jul 2018, Biasutti et al)
- ENS-MIP?
- A tropical response to forcing synthesis workshop/ discussion in the frame of CFMIP?

4. Convective Aggregation

- ISSI team on organization of Shallow Clouds (Pincus, Bony, Stevens Winker)
- RCE-MIP (Wing, Reed, Satoh & Others)
- Future of Convective Parameterization (Jakob, Siebesma)

Related Activities

- Model hierarchies workshop: Nov 2016 in Princeton, to become a regular WGCM/GC event?
- GASS conference (Feb 2018): discussion about the articulation GC / Core projects (GEWEX) / CFMIP ?
- Workshop on the Challenges in modeling weather and climate in the trades (date and location TBD)
- Contribution to a H2020 Proposal

GC: Carbon Feedbacks in the Climate System

to understand how biogeochemical cycles and feedbacks control CO_2 concentrations and impact on the climate system

chaired by Tatiana Ilyina & Pierre Friedlingstein

Guiding questions:

1. What are the drivers of land and ocean carbon sinks?
2. What is the potential for amplification of climate change over the 21st century via climate-carbon cycle feedbacks?
3. How do greenhouse gases fluxes from highly vulnerable carbon reservoirs respond to changing climate (including climate extremes and abrupt changes)?

Activities:

1. GC Carbon approved by JSC, May 2016
2. Kick-off meeting Nov 2016 (Hamburg). Report on WCRP website
3. Workshop on carbon feedbacks framework and Emergent constraints, to be held in Bern, March-April 2018.
4. GC-carbon − GC-decadal discussions on decadal predictability of the carbon cycle

UNIVERSITY OF EXETER

Future Priorities

CMIP

- Facilitating CMIP6 experiments and data exchange from modeling groups to research community and through to influencing IPCC AR6
- Routine model evaluation
- Considering design of CMIP7

Grand Challenges

•Continue to support the grand challenges on '**Clouds, Circulation and Climate Sensitivity**' and '**Carbon Feedbacks in the Climate System**' through to their maturity and continue to seek emerging science questions from within these communities going forward

Links to Wider modelling community

•Maintain existing strong links to process community (WGNE)

•Idealised modelling community where traceability to higher order models can be established (e.g. Princeton workshop 2016)

•Regional climate modelling and downscaling

Links to Impacts and Climate Services

•Promoting VIACS diagnostics with modelling groups

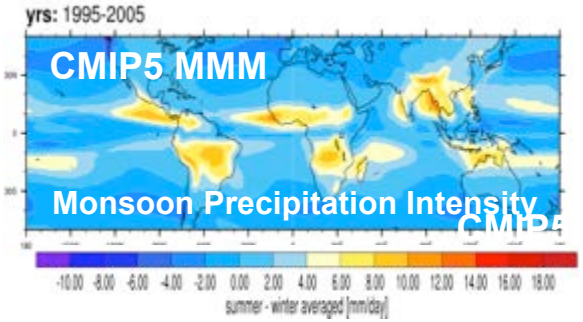
WCRP
World Climate Research Programme

How to characterize the wide variety of models in CMIP6?

- Routine Benchmarking and Evaluation Central Part of CMIP6 -

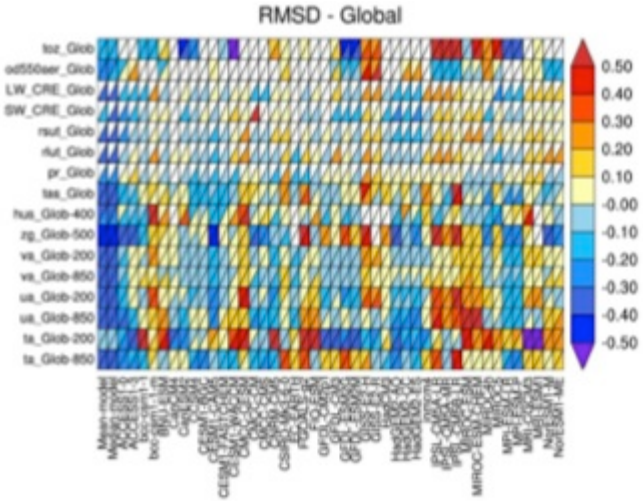
Tools such as the community-developed **Earth System Model Evaluation Tool** (**ESMValTool**, *Eyring et al., ESMValTool, GMD (2016b)*) that includes other software packages such as the **NCAR CVDP** *(Phillips et al., 2014)*), and the **PCMDI Metrics Package** (**PMP**, *Gleckler et al., EOS (2016)*)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

*Similar to **Figure 9.7** of AR5*



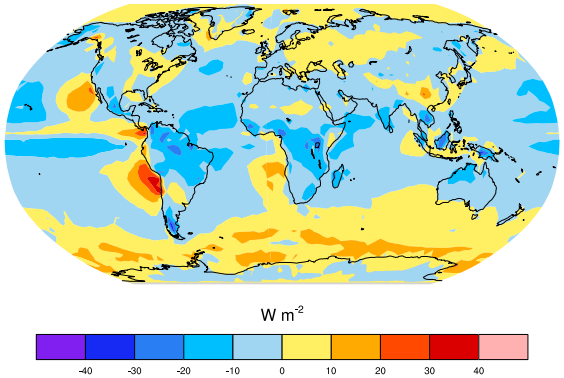
Broad Characterization of Model Behavior
(incl. IPCC AR5 Chap 9 & 12 diagnostics in ESMValTool)

Running alongside the ESGF

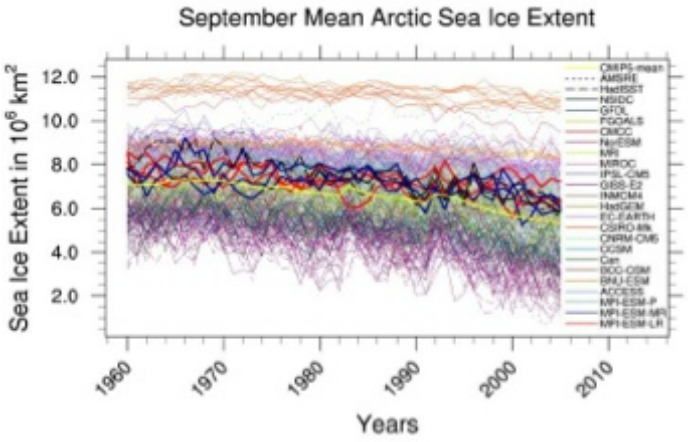


*Similar to **Figure 9.5** of AR5*

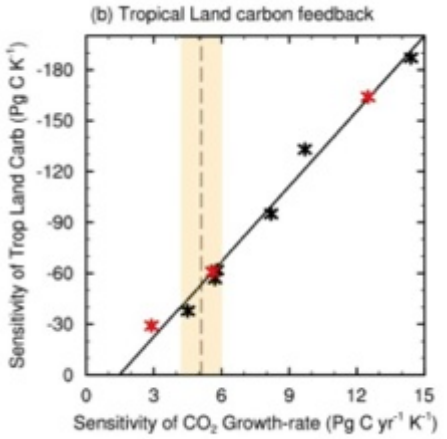
Net Cloud radiative effect against CERES EBAF



*Similar to **Figure 9.24** of AR5*

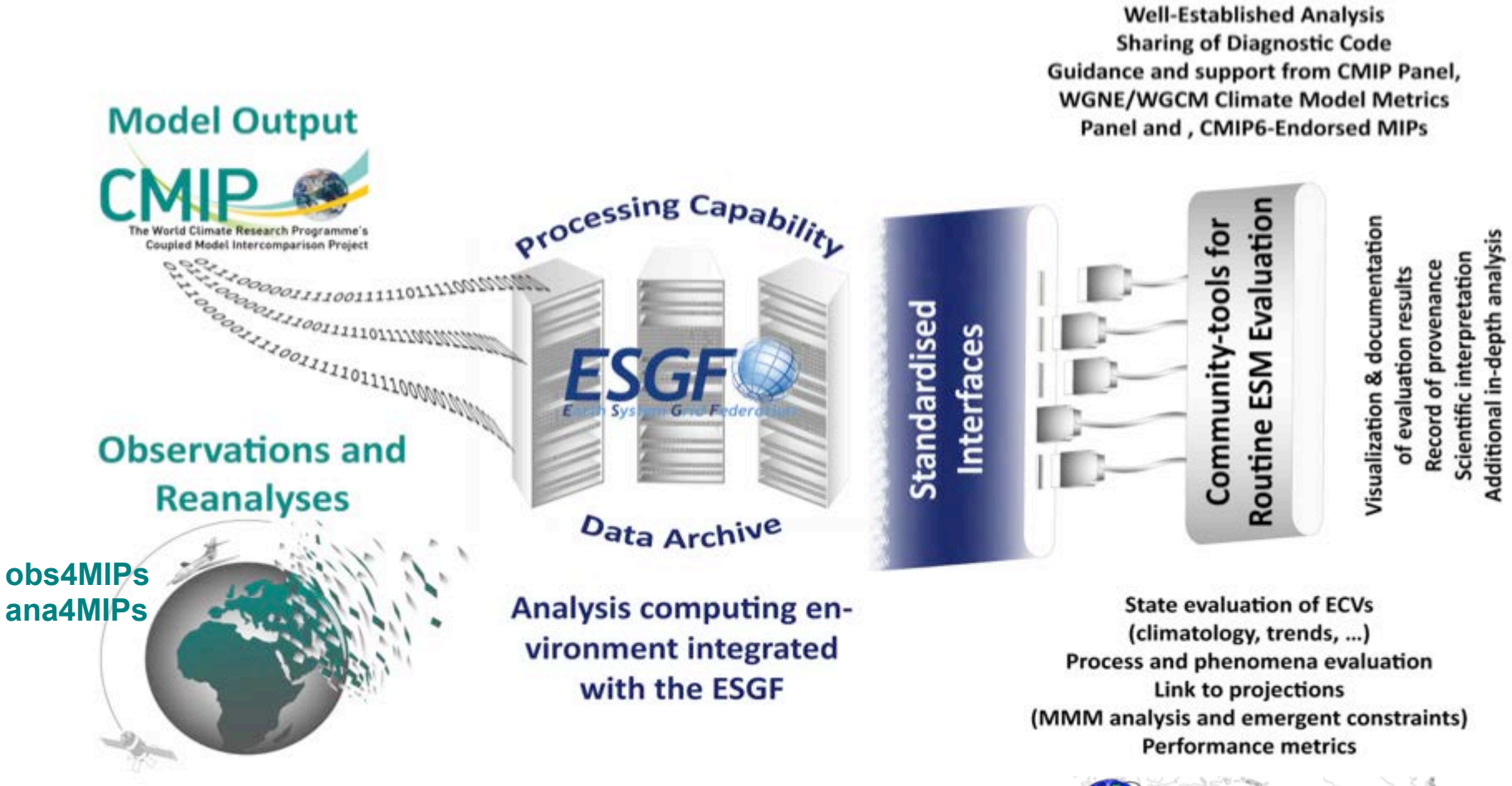


Link to projections



*Similar to **Figure 9.24** of AR5*

Envisaged Workflow for Routine Evaluation in CMIP

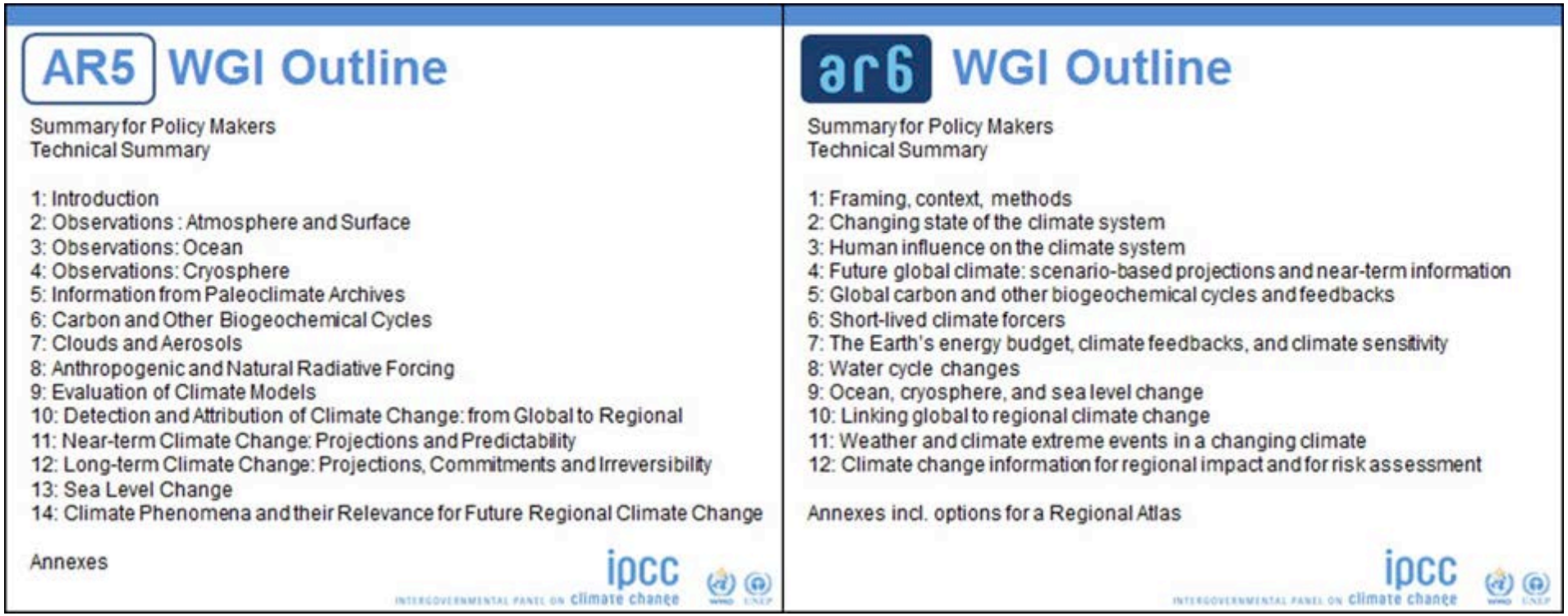


Eyring et al., ESD (2016)

PCMDI Metrics Package (PMP)

DLR

IPCC 6th Assessment (ar6)



AR5 WGI Outline

Summary for Policy Makers
Technical Summary

1: Introduction
2: Observations : Atmosphere and Surface
3: Observations: Ocean
4: Observations: Cryosphere
5: Information from Paleoclimate Archives
6: Carbon and Other Biogeochemical Cycles
7: Clouds and Aerosols
8: Anthropogenic and Natural Radiative Forcing
9: Evaluation of Climate Models
10: Detection and Attribution of Climate Change: from Global to Regional
11: Near-term Climate Change: Projections and Predictability
12: Long-term Climate Change: Projections, Commitments and Irreversibility
13: Sea Level Change
14: Climate Phenomena and their Relevance for Future Regional Climate Change

Annexes

ipcc INTERGOVERNMENTAL PANEL ON climate change

ar6 WGI Outline

Summary for Policy Makers
Technical Summary

1: Framing, context, methods
2: Changing state of the climate system
3: Human influence on the climate system
4: Future global climate: scenario-based projections and near-term information
5: Global carbon and other biogeochemical cycles and feedbacks
6: Short-lived climate forcers
7: The Earth's energy budget, climate feedbacks, and climate sensitivity
8: Water cycle changes
9: Ocean, cryosphere, and sea level change
10: Linking global to regional climate change
11: Weather and climate extreme events in a changing climate
12: Climate change information for regional impact and for risk assessment

Annexes incl. options for a Regional Atlas

ipcc INTERGOVERNMENTAL PANEL ON climate change

See Sarah Connors' nice overview at:
http://blogs.egu.eu/geolog/2017/09/27/geopolicy-ipcc-decides-on-fresh-approach-for-next-major-report/

Outline: https://www.ipcc.ch/meetings/session46/AR6_WGI_outlines_P46.pdf

ipcc INTERGOVERNMENTAL PANEL ON climate change WMO UNEP

ar6 Working Group I Report

Summary for Policy Makers
Technical Summary

Chapter 1: Framing, context, methods
Chapter 2: Changing state of the climate system
Chapter 3: Human influence on the climate system
Chapter 4: Future global climate: scenario-based projections and near-term information
Chapter 5: Global carbon and other biogeochemical cycles and feedbacks
Chapter 6: Short-lived climate forcers
Chapter 7: The Earth's energy budget, climate feedbacks, and climate sensitivity
Chapter 8: Water cycle changes
Chapter 9: Ocean, cryosphere, and sea level change
Chapter 10: Linking global to regional climate change
Chapter 11: Weather and climate extreme events in a changing climate
Chapter 12: Climate change information for regional impact and for risk assessment

Annexes incl. options for a Regional Atlas and Technical Annexes

ipcc
INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

The Sixth Assessment cycle

Special Reports

October 2018
Global warming of 1.5° C
An IPCC special report on the impacts of global warming of 1.5° C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty

September 2019
Special Report on the Ocean and Cryosphere in a Changing Climate

September 2019
Climate Change and Land:
An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems

Methodology Report

May 2019
2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Sixth Assessment Report

April 2021
Working Group I contribution
The physical science basis

July 2021
Working Group III contribution
Mitigation of climate change

October 2021
Working Group II contribution
Impacts, adaptation and vulnerability

April 2022
Synthesis Report

https://www.ipcc.ch/pdf/ar6_material/AC6_brochure_en.pdf

INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

ar6 milestones

IPCC call for author nominations for the Sixth Assessment Report
Deadline is Friday 27th October 2017

https://wg1.ipcc.ch/index.html#AR6Nominations

Literature cutoff dates:

SR on Global Warming of 1.5°C

submission: 1 November, 2017
acceptance: 15 May, 2018

SR on Oceans, Cryosphere and Climate (Sept., 2019)

submission: July (?), 2018
acceptance: February(?) 2019

SR on Land use, Desertification

as above

WG-I (tentative)

submission: 31 January, 2020
acceptance: 15 October, 2020