

# AerChemMIP

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# AerChemMIP is part of CMIP6

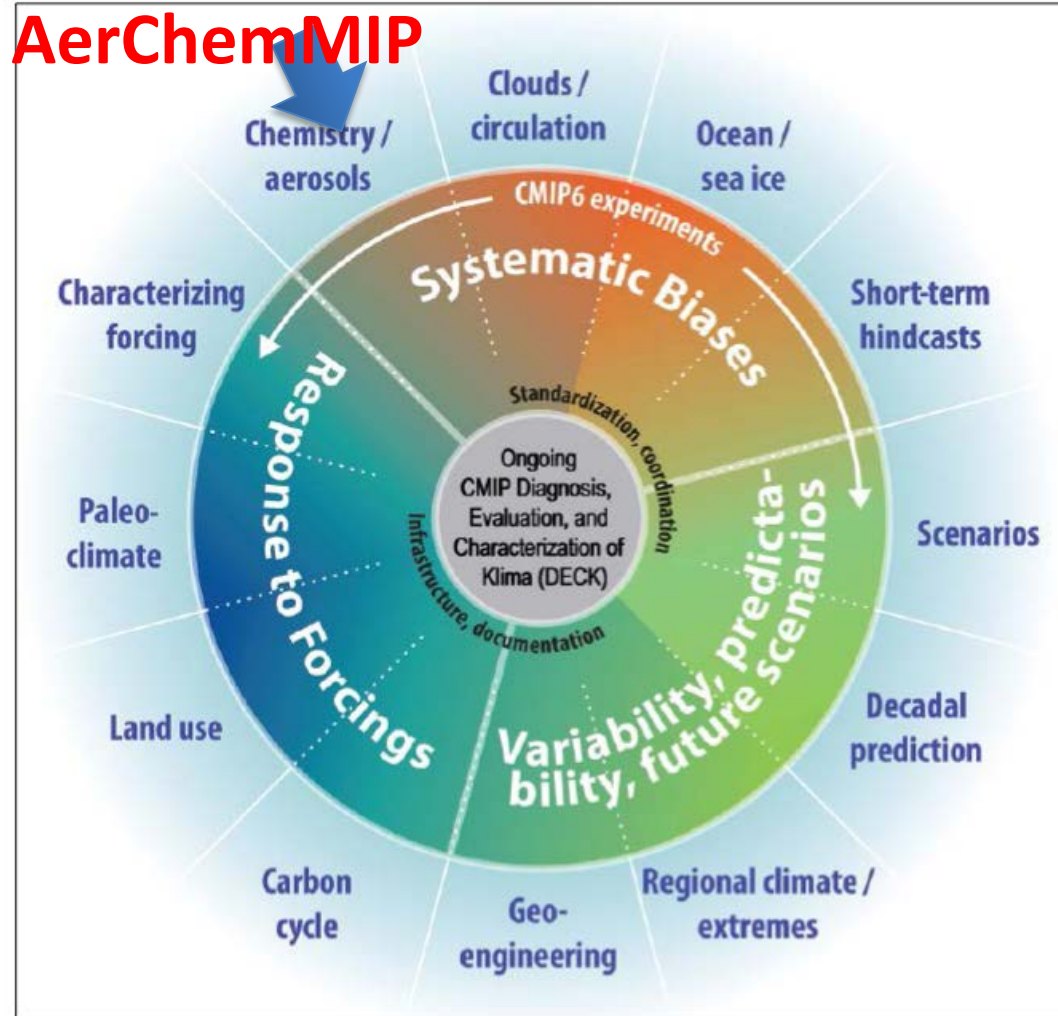
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## Climate Model Intercomparisons: Preparing for the Next Phase

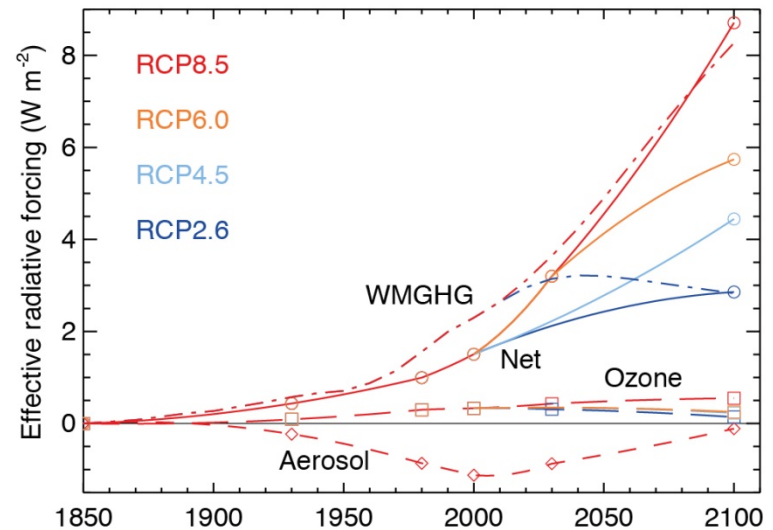
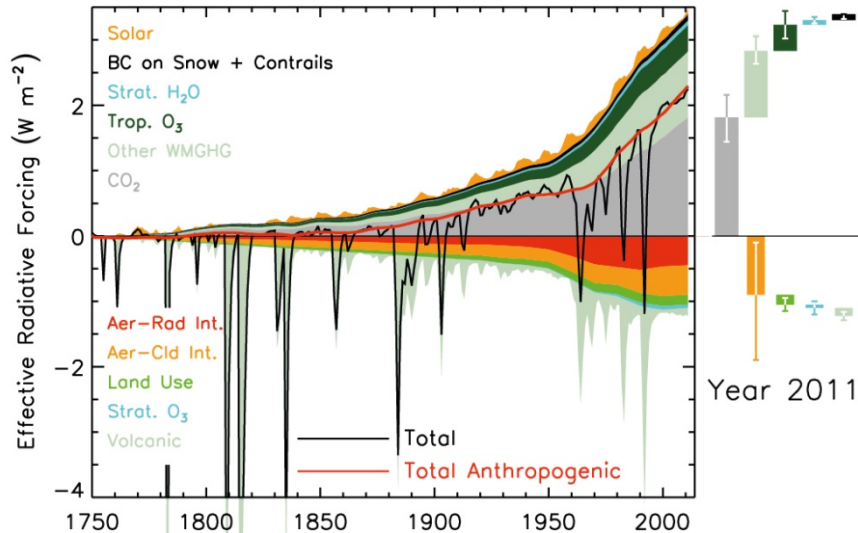
climate variability, climate predictability, and uncertainties in scenarios?  
Within this scientific framework, a more distributed organization for CMIP6 than in previous phases of CMIP is proposed. This would full address the commitment of the CMIP Decadal Plan.



- Aerosol and Chemistry contributions to CMIP6 simulations
- DECK control and Hist\_all with aerosols and/or chemistry

# What happened in AR5?

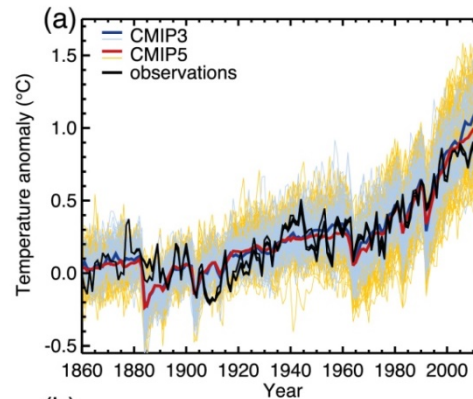
- RF from chapter 8 AR5 had mixture of
  - offline radiation codes (WMGHGs)
  - Chemistry-climate models, chemistry transport models ( $O_3$ , aerosols)
  - Expert judgement (aerosols)



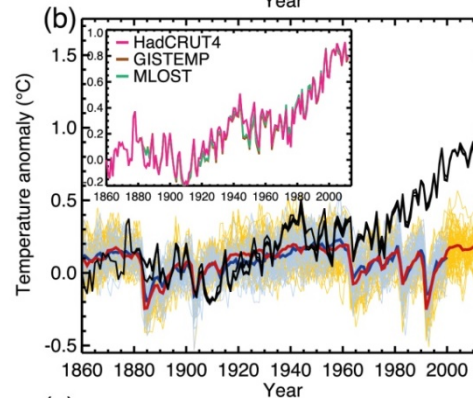
# CMIP5 Temperature Change

Relating forcing to climate change

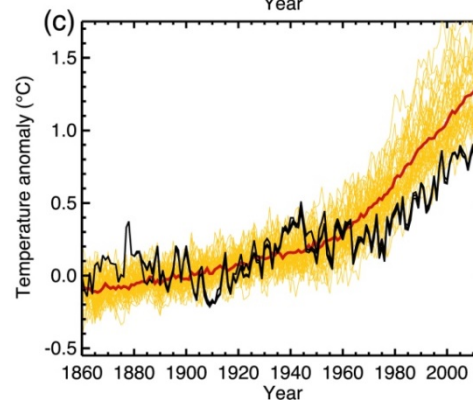
- Models have their own radiation schemes
  - Different assumptions for aerosols and ozone
- Can't use Ch. 8 forcing values
- Effective Forcing from Forster et al. 2014
- Not enough information to separate effects of O3 and aerosols



All



Aerosols



Greenhouse gases

# CMIP6 Big tent approach



# Science Questions

- CMIP6 Q1 “How does the Earth system respond to forcing?”.
- How have NTCF and ODS emissions contributed to global ERF and affected regional climate over the historical period?
- How have WMGHGs forced climate (including through their chemical impacts) over the historical period?
- How will future policies (on climate/AQ/land use) affect the NTCFs and their climate impacts?

# Overview

AerChemMIP will quantify **composition, forcings, feedbacks** and global-to-regional climate **response** ( $\Delta T, \Delta P$ ) from changes to:

- NTCF emissions (aerosols,  $O_3$  precursors)
- Reactive GHGs concentrations ( $N_2O$ ,  $CH_4$ , ODSs)

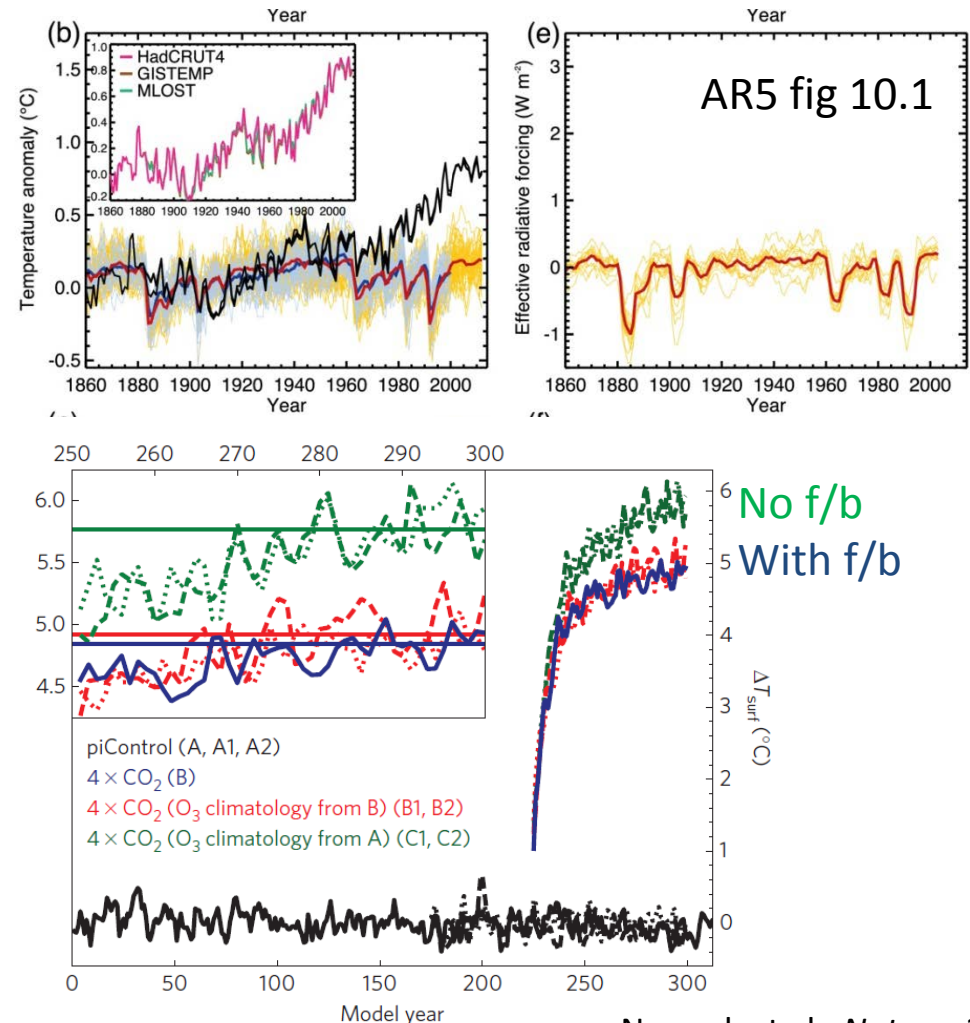
Experiments, coupled chemistry-climate models:

Fixed SST -> ERF

Full ocean ->  $\Delta T, \Delta P$

# Motivation 1: Quantification of the transient Effective Radiative Forcing of Near-Term Climate Forcers

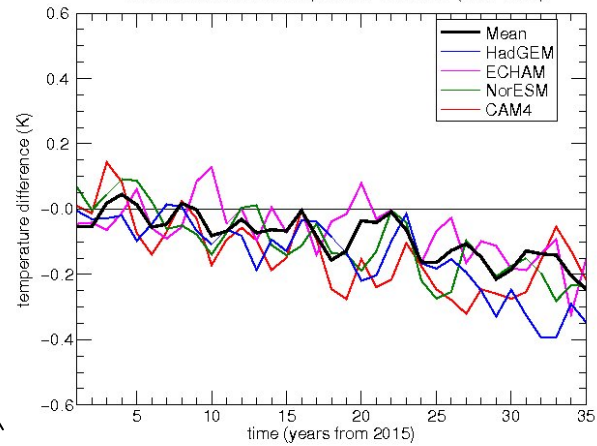
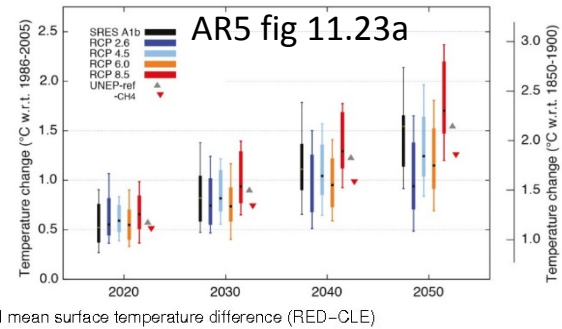
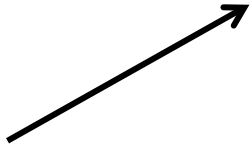
- Quantification of Effective Radiative Forcing of NTCFs for historical runs with interactive aerosol (+chemistry)
  - Needed for D&A
  - Improves on AR5 and Forster 2013
  - Includes tropospheric  $O_3$
- Quantification of biogeochemical feedbacks
  - E.g., chemistry-climate feedback under a  $4 \times CO_2$  with (AerChemMIP) vs without (RFMIP) interactive aerosols and chemistry changes the climate sensitivity



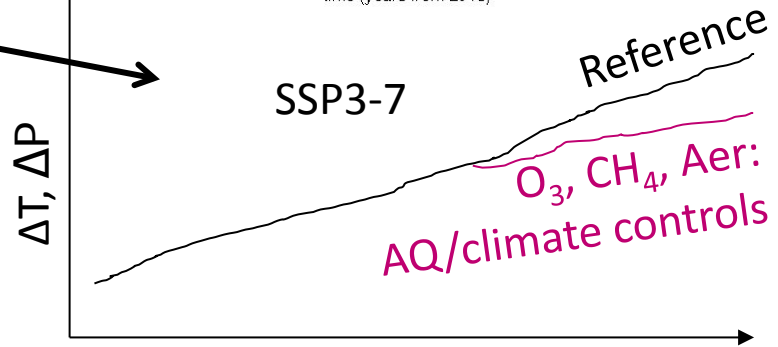


# Motivation 2: Quantifying the climate impacts of Near-Term Climate Forcers

- Importance of NTCFs in climate prediction scenarios
  - AR5: near term  $\Delta T$  spread was due to Near-Term Climate Forcers
  - ECLIPSE (FP7): Mitigation of  $\text{CH}_4$ , BC compared to business as usual
- AerChemMIP will quantify the climate effects of NTCF mitigation based on a variant to ScenarioMIP Tier 1 SSP3-7



Stohl et al. 2015



# Experiments

1. Historical contribution of NTCFs and ODSs to ERF and regional climate
  - 1.1: *Transient historical coupled ocean climate impacts of NTCFs and ODSs*
  - 1.2: *ERFs, as 1.1 but specified transient historical SST simulations*
  - 1.3: *Time-slice simulation, present day ERFs*
2. Future policy effects on NTCFs and their climate impacts
  - 2.1: *Transient coupled ocean climate impacts*
  - 2.2: *ERFs, as 2.1 but specified transient SST simulations*
3. Historical forcing from reactive WMGHGs
  - 3.1: *Transient historical ERFs*
4. Quantifying the climate feedbacks through changes in natural emissions
  - 4.1 *Timeslice ERFs*

Within each experiment runs are prioritised into 3 tiers.

Finalize Scenario choice, March 2015  
(B. O'Neill, C. Tebaldi, D. van Vuuren)

# CMIP6 Forcing Timeline

WGCM  
CMIP6  
Design

Jan 1  
2015

April  
2015

July  
2015

Oct  
2015

CMIP6  
Design  
Special  
Issue

Jan 1  
2016

April  
2016

July  
2016

Oct  
2016

Jan 1  
2017

PI/Historical SLCF emissions (S. Smith)

Historical SLCF emissions with  
uncertainties, seasonality, + (S. Smith)

- = prototype ready
- = Pre-industrial ready

Historical ozone concentrations (M. Hegglin, J.-F. Lamarque)

Historical aerosol concentrations (M. Schulz, G. Myhre)

Future emissions (IAMs)

Gridding & Harmonization past to future (IAMs)

Future GHG concentrations (IAMs)

Future ozone and aerosol concentrations (M. Hegglin, J.-F. Lamarque, M. Schulz, G. Myhre)

PI control and idealized model experiments: DECK

Global model historical runs: DECK+

ScenarioMIP global model runs

nominal Period of CMIP6 (2015-2020)