AerChemMIP

Co-chairs:
Bill Collins (UK)
Jean-François Lamarque (USA)
Michael Schulz (Norway)
AerChemMIP is part of CMIP6

- 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)
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
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 O₃

- Quantification of biogeochemical feedbacks
  - E.g., chemistry-climate feedback under a 4xCO₂ with (AerChemMIP) vs without (RFMIP) interactive aerosols and chemistry changes the climate sensitivity

AR5 fig 10.1

Nowack et al., Nature, 2015
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 $CH_4$, 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

AR5 fig 11.23a

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.
CMIP6 Forcing Timeline

- **Jan 1, 2015**
  - PI/Historical SLCF emissions (S. Smith)
  - Historical ozone concentrations (M. Hegglin, J.-F. Lamarque)
  - Historical aerosol concentrations (M. Schulz, G. Myhre)

- **Jan 1, 2016**
  - Finalize Scenario choice, March 2015 (B. O’Neill, C. Tebaldi, D. van Vuuren)

- **Jan 1, 2017**
  - ScenarioMIP global model runs

- **July 2015**
  - CMIP6 Design Special Issue

- **Oct 2015**
  - WGCM CMIP6 Design

- **Jan 1, 2016**
  - ScenarioMIP global model runs

- **Oct 2016**
  - Historical SLCF emissions with uncertainties, seasonality, + (S. Smith)

- **Jan 1, 2017**
  - Global model historical runs: DECK+
  - Future ozone and aerosol concentrations (M. Hegglin, J.-F Lamarque, M. Schulz, G. Myhre)

- **Apr 2016**
  - Future emissions (IAMs)
  - Gridding & Harmonization past to future (IAMs)
  - Future GHG concentrations (IAMs)

- **July 2016**
  - WGCM CMIP6 Design Special Issue

- **Oct 2016**
  - ScenarioMIP global model runs

- **Jan 1, 2017**
  - Global model historical runs: DECK+
  - ScenarioMIP global model runs

- **nominal Period of CMIP6 (2015-2020)**
  - = prototype ready
  - = Pre-industrial ready