AerChemMIP
Experiments

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ERF and regional climate over the historical period

• *Experiment 1.1: Transient historical coupled ocean × 3 members*
  – Control: 1850-2014 All emissions
  – 1.1.1: 1850 NTCF emissions.
  – 1.1.2: 1950 halocarbons.
  – 1.1.3: 1850 Aerosol (not NOx) emissions
ERF and regional climate over the historical period

• Experiment 1.2, 3.1: ERFs, 1850-2014 SST simulations $\times 1$
  – Control: 1850-2014 All emissions
  – 1.2.1: 1850 all NTCF emissions
  – 1.2.2: 1950 ODSs. 65 years (1950-2014)
  – 1.2.3: 1850 tropospheric ozone precursor emissions
  – 1.2.4: 1850 aerosol (not NOx) emissions
  – 3.1.1: 1850 CH4 concentrations (with chemistry)
  – 3.1.2: 1850 N2O concentrations (with chemistry)
ERFs

• Experiment 1.3. Time-slice, fixed SST, 30 years
  – 1.3.1: Control: 1850
  – 1.3.2: 2014 NTCF emissions
  – 1.3.3: 2014 aerosol (not NOx) emissions
  – 1.3.4: 2014 BC emissions
  – 1.3.5: 2014 Ozone precursor (not CH4) emissions
  – 1.3.6: 2014 CH4 concentrations
  – 1.3.7: 2014 N2O concentrations
  – 1.3.8: 2014 ODS concentrations
  – 1.3.9: 2014 NOx emissions
  – 1.3.10: 2014 CO/VOC emissions
ΔTsurf

ΔF_{TOA}

1850 1950 2014

1850 1950 2014

ΔF_{TOA}

1850 1950 2014

Full transient

Atmos-only

Evolving SSTs

Timeslice

Fixed SSTs
Current status of climate information (CMIP5)

Shared Socioeconomic Pathways

- SSP1: Sustainability
- SSP2: Middle of the Road
- SSP3: Regional Rivalry
- SSP4: Inequality
- SSP5: Fossil-fueled Development

CMIP5 RCP sims
- Infeasible
- SSP ref. scens.

Forcing level (W/m²)

- 2.6
- 4.5
- 6.0
- 8.5

SRES
• Short-lived species – much more spread in SSPs
• SSPs rule out some unrealistic projections
Future policies and their climate impact
Patterns of forcing, temperature and precipitation

• **Experiment 2.1: Transient coupled ocean climate impacts 2015-2055**
  – 2.1.1 SSP3-6 (ScenarioMIP)
  – 2.1.2 SSP3 with reduced NTCF (including methane)

• **Experiment 2.2: ERFs, prescribed SSTs 2015-2055**
  – 2.2.1: Control: as Experiment 2.1
  – 2.2.2: Reduced black carbon only
  – 2.2.3: Reduce aerosol emissions (but not NOx)
  – 2.2.4: Reduced ozone precursors except methane
  – 2.2.5: Reduced Methane
• Can apply tighter controls to high-polluting SSP (e.g. SSP3)

• Quantify climate impact of pollutant control
### Air pollution policy assumptions (Storylines, exposure, targets)

<table>
<thead>
<tr>
<th>Policy Strength</th>
<th>High Income Countries</th>
<th>Medium and Low Income</th>
<th>Technological Innovation</th>
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<tbody>
<tr>
<td><strong>Strong</strong></td>
<td>Much lower than current targets in order to minimize adverse effects on both general population, vulnerable groups, and ecosystems.</td>
<td>Comparatively quick catch-up with the developed world (relative to income)</td>
<td>Pollution control technology costs drop substantially with control performance increasing.</td>
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<tr>
<td><strong>Central</strong></td>
<td>Lower than current targets</td>
<td>Catch-up with the developed world at income levels lower than when OECD countries began controls (but not as quick as in the strong control case).</td>
<td>Continued modest technology advances.</td>
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<tr>
<td><strong>Weak</strong></td>
<td>Regionally varied policies.</td>
<td>High emissions levels and/or institutional limitations substantially slower progress in pollution control.</td>
<td>Lower levels of technological advance overall.</td>
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Within each SSP:

- Can impose different policy assumptions
- **Experiment 4.1:** Quantifying the ERFs of double natural emissions (based on 1850) control. 30 years
  - 4.1.1: 1850 doubled dust emissions
  - 4.1.2: 1850 doubled sea salt emissions.
  - 4.1.3: 1850 doubled emissions of oceanic DMS.
  - 4.1.4: 1850 doubled fire emissions.
  - 4.1.5: 1850 doubled biogenic VOCs.
  - 4.1.6: 1850 doubled lightning NOx.
  - 4.1.7: 1850 doubled wetland emissions of methane.
Idealised experiment?

• Do we need an AerChemMIP equivalent to 1% CO2?
  • Not obvious what this would be.
• Emissions → burden → forcing → response

• One possibility:
• Emission step 0% SO$_2$ → 100% SO$_2$, coupled-ocean
  • How to prescribe background (non-linearity)?
  • Direct – easier
  • Indirect – too much variation?

• Should this be CCMI/Aerocom rather than AerChemMIP?