AeroCom historical aerosols

Components of radiative forcing for principal emissions

- CO₂
- CH₄
- Halocarbons
- N₂O
- HFCs

CO₂ → CH₄ → O₃(T) → H₂O(S) → CO₂

Well-Mixed GHGs
- CO₂
- CH₄
- HaloCarbons
- N₂O
- HFCs-PFCs

Aerosols and Precursors
- Black carbon
- Sulphate
- Organic carbon
- SO₂
- Mineral dust
- Biomass burning
- Aerosol–Cloud

Effective Radiative Forcing (W m⁻²)

 IPCC, AR4, 2007

IPCC, AR5, 2013

Year 2011

Climate and Environmental Research - Oslo
**Motivation**

- Understand regional trends in aerosol from 1850 to 2015
- Establish a reference aerosol distribution dataset (1850-2015)
- Quantify evolution of aerosol impact on TOA and surface forcing
- Estimate relative contributions of anthropogenic and natural aerosols
- Assess the effects of aerosol-cloud-radiation interactions

**Which models?**

- AeroCom core suite of models
- AerChemMIP models or other CMIP6 models running historical fixed SST and AMIP simulations

**Timeline**

- Control 2010 before 1\textsuperscript{st} of August
- Submission of model results End of 2017 (tbd in Helsinki)
- Analysis 2018-2019

**Analysis**

- Forcing and historical distribution (model mean, best guess) - Gunnar
- Sulfate trends evaluation - Augustin/Wenche
- AOD trends evaluation - Michael
- UTLS trends - Mian
- In situ aerosol trends - Betsy
- Brightening and Dimming from historical simulations - Martin
- Comparison to ice cores and sediments (BC, SO4, NO3) – Mark Flanner
- Dust trends - Yves
- BB trends - Nick
- Aerosol-cloud interaction trends - Johannes/Philip
- Uncertainty in preindustrial aerosol - Ken
- Attribution of aerosol-radiation interactions (ARI) and aerosol-cloud interactions (ACI) on the brightening/dimming trends – Mian/Huisheng/Martin
Global emissions

CEDS - Hoesly et al. GMDD, 2017
ECLIPSE – Stohl et al., ACP, 2015
CMIP5 – Lamarque et al., ACP, 2010
Radiative forcing of direct aerosol effect

Multi-model simulations of aerosol and ozone radiative forcing due to anthropogenic emission changes during the period 1990–2015

Gunnar Myhre1, Wenche Aas2, Ritu Cherian3, William Collins4, Greg Faluvegi5, Mark Flanner6, Piers Forster1, Oivind Hodnebrøg1, Zbigniew Klimont5, Marianne T. Lund3, Johannes Mühlenstiefel5, Cathrine Lund Myhre1, Dirk Olivié3, Michael Prather10, Johannes Quaas5, Bjorn H. Samset1, Jordan L. Schnell10, Michael Schulz7, Drew Shindell11, Ragnhild B. Skeie1, Toshihiko Takegna3, and Svetlana Tyro3

Atmos. Chem. Phys., 17, 2709–2720, 2017
www.atmos-chem-phys.net/17/2709/2017/
doi:10.5194/acp-17-2709-2017
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Direct aerosol effect by component

(a) Sulphate

(b) Black carbon

(c) Organic aerosols

(d) Nitrate
Changes in PM2.5 and AOD 1990 - 2015

PM2.5 (%/yr)

Changes in surface PM2.5

<table>
<thead>
<tr>
<th>Region</th>
<th>Observations (% / yr)</th>
<th>Mean-models (% / yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe (2000-2010)</td>
<td>-2.9</td>
<td>-2.4</td>
</tr>
<tr>
<td>US (1989-2009)</td>
<td>-1.5</td>
<td>-1.3</td>
</tr>
</tbody>
</table>
Lund et al., in preparations
“AeroCom historical aerosols”
Coordination Gunnar and Michael

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Direct aerosol effect of sulphate and black carbon

Changes 1990-2015

Sulphate

Black carbon
Indirect aerosol effect and total aerosol effect
Simulations

- Requirement: Use CMIP6 CEDS emissions
- Output: Every 10\textsuperscript{th} year until 1980 / Every 5\textsuperscript{th} year 1980-2015 (preference yearly)
- Historic& AMIP SST (GCMs) or reanalysis for specified years (CTMs)
- Diagnostics $\rightarrow$ Aerocom control
- (needs to be checked, AerChemMIP overlap, possibly less output 1980-2015
  Split of FF,BF,BB, 3D extinction fields, cloud properties, mostly monthly mean output)