Aerosols and Climate: Overview of ESRL’s Research Program

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Why study aerosols and climate?

- Forcings are large, especially on regional scale
  - patchy distribution
- Uncertainties are largest of all terms in IPCC assessment
- Additional effects, e.g. on precipitation, are also important
- Forcings and effects are controlled by aerosol amount and type (size, composition)
  - In contrast to greenhouse gases where only amount is needed to calculate forcing
- Characterization of aerosols and their contribution in today’s atmosphere lags behind those of other constituents.
  - The large error bars are a reflection of this issue
What we do

• **Mission:** To observe and understand aerosol effects on climate in support of decision makers through:
  – Long-term monitoring
  – Field studies
  – Laboratory studies
  – Modeling

• **Payoffs:**
  – Improved understanding of aerosol processes and properties, leading to...
  – Predictive capability of aerosol climate forcing ...
  – With known uncertainties.
# Aerosol/Climate Research Matrix

<table>
<thead>
<tr>
<th>Topic</th>
<th>Tool</th>
<th>Process Studies</th>
<th>Long-term Studies</th>
<th>Modelling Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aerosol Chemistry</strong></td>
<td></td>
<td>Formation of secondary organics</td>
<td>Arctic aerosol trends</td>
<td>Organics in cloud water</td>
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<tr>
<td><strong>Direct Radiative Forcing</strong></td>
<td></td>
<td>Hygroscopic growth</td>
<td>Climatology of radiative properties</td>
<td>Using field data to assess model uncert.</td>
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<tr>
<td><strong>Indirect Effects on Clouds</strong></td>
<td></td>
<td>Combine remote-sensing and in-situ msmts</td>
<td>CCN climatology</td>
<td>Cloud-scale modeling</td>
</tr>
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Reviewers’ Charge: Relevance

• Does the research address existing (or future) societally relevant needs (national and international)? Are customers engaged to ensure relevance of the research?
  – IPCC bar chart shows that aerosols are the source of the biggest uncertainties in radiative forcing
  – Active involvement in all phases of IPCC process (research, authors, reviewers) keep us in close touch with our highest-visibility customer

• How well does it address issues identified in the NOAA research plans or other policy or guiding documents?
  – CCSP: Develop reliable representations of the climatic forcing resulting from atmospheric aerosols
  – NOAA: Improve the quantification and understanding of the forces bringing about climate change by examining relevant human-induced increases in atmospheric constituents
  – OAR: Reduce the uncertainty in model simulations of the influence of aerosols on climate
Reviewers’ Charge: Transition

• How well has the laboratory delivered products?
  – Publications, CCSP and IPCC contributions
  – Long-term data in WMO/GAW data archive
  – Export of long-term monitoring stations

• Are there appropriate interactions with stakeholders and customers?
  – Evaluate chemical transport models with field data
    • key partners at GFDL and PMEL
    • good example of results in Bates et al. (2006)
  – Provide essential information to assessments (IPCC, CCSP Synthesis and Assessment Products)
  – Key partner in CCSP
  – Contribute to formulation and execution of international research programs (IGAC, AEROCOM, AC&C, WMO/GAW, GCOS)
Today’s Talks

• Overview
  – Ogren: *Aerosol Direct Radiative Forcing*
  – Murphy: *Aerosol Composition*
  – Feingold: *Aerosol-Cloud Interactions*

• Focused Science
  – Andrews: *Influence of clouds on aerosol properties*
  – Lack: *Soot emissions from ships*

• Discussion