Aerosols and Climate: Overview of ESRL's Research Program

John Ogren NOAA Earth System Research Laboratory Boulder, CO



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



Climate: Aerosols

• Aerosols scatter and absorb incoming radiation (a daytime process)- there is a large uncertainty in the quantification of this process.

Key Questions: What are the concentrations, trends, and properties of aerosols? What is the relation between emissions and aerosol's abundance/properties?

• Aerosols also *modify* clouds: amounts, properties and distribution (&vice-versa). The Indirect Effects

Highly uncertain, but key for predictions and impacts **Key Question:** Can we quantify a few important effects?

Aerosols come in multiple flavors:

Composition, size, physical state, surface properties, etc.

Key Question: Can we develop the capability to predict these parameters?

Goal: Characterize influence of aerosol and aerosol - cloud interactions (radiation and precipitation) on climate to a "usable" level now and enable future predictions.

- 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

- <u>Mission</u>: 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

Tool	Process	Long-term	Modelling
Topic	Studies	Studies	Studies
Aerosol	Formation of secondary organics	Arctic aerosol	Organics in
Chemistry		trends	cloud water
Direct Radiative Forcing	Hygroscopic growth	Climatology of radiative properties	Using field data to assess model uncert.
Indirect Effects on Clouds	Combine remote- sensing and in-situ msmts	CCN climatology	Cloud-scale modeling

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 highestvisibility 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

