EARTH SYSTEM RESEARCH LABORATORY

Serving Society through Science

Atmospheric Chemistry at the Earth System Research Laboratory

Wrap Up and Thoughts on Our Future

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- **Highlights**
- **What we could not cover here**
- **Our path of progress**
- **Our future science**

James H. Butler

- **A few words on Integration**
- **Society in transition**
- **Mapping future research to evolving needs**
- **Focus areas and approaches**
- **Goals, approaches, and Themes**

What You Heard

Highlights from Regional Air Quality, Stratospheric Ozone, and Climate

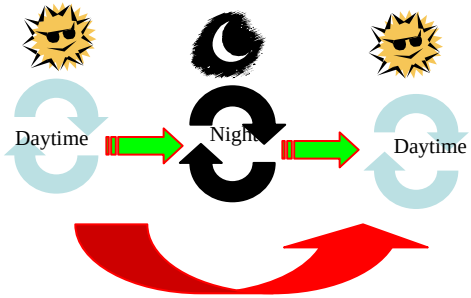
A few highlights to remind you of what you heard!

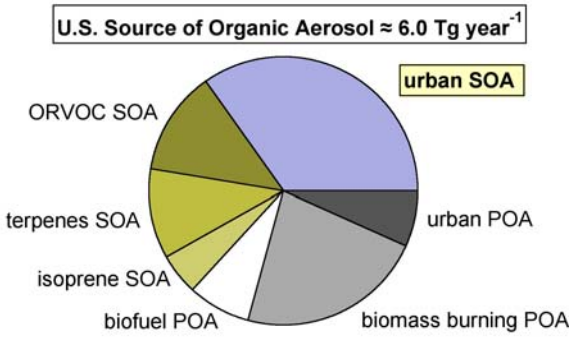
What You Heard: Regional Air Quality

End-to-end stakeholder involvement to address AQ issues

Role of nighttime chemistry for nitrogen oxides and then ozone:

– What happens at night matters for the next day's ozone and for its precursors!





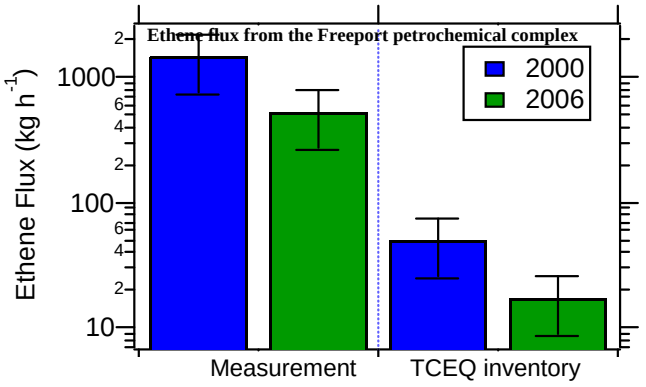
Identification of the mismatch in calculated and observed Secondary Organic Aerosol (SOA): Linkages to biogenic and anthropogenic precursors:

– A major emerging issue for health and climate,

– Chemistry matters in controlling aerosols.

Top-down evaluations point to several weakness in current emission inventories:

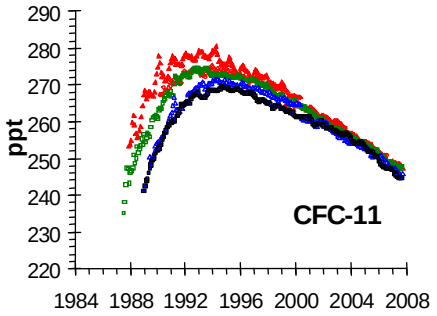
– Emission inventory critical for regions and states to manage Air Quality.



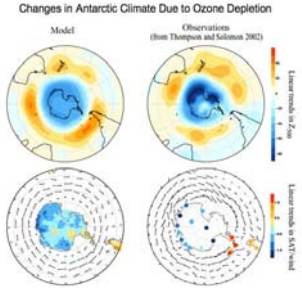
What You Heard: Stratospheric Ozone

Leadership in the O_3 layer assessment and shepherding through the "accountability phase"

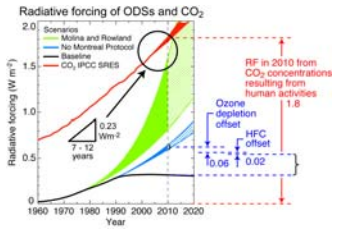
- Long-term accurate monitoring of ODSs and their substitutes have enabled:
  1. Showing that ODSs are decreasing (MP works!);
  2. Advances in process-level understanding have enabled better prediction of when the ozone layer will recover.



- "Testing" of substitutes has continued to enable a smooth transition from ODSs and to better alternatives.



- The connection between stratospheric ozone changes and the tropospheric temperature (climate) has been identified and solved a key problem in climate change attribution.



- Quantification of the contribution of banned ozone depletion substances to climate in comparison to Kyoto Protocol.

What You Heard: Climate

Leadership roles in IPCC assessment and a role in the dawn of a new era

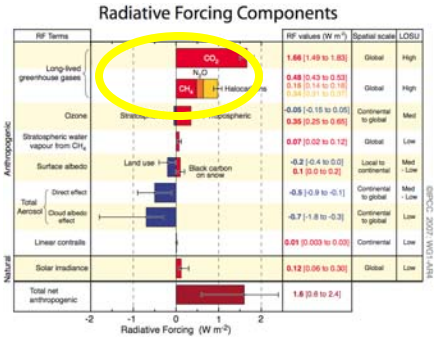
Long-term accurate measurements of CO_2 and non-CO_2 long-lived greenhouse gases enabled:

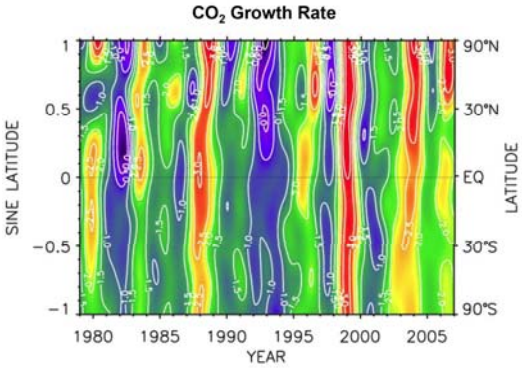
1. Accurate calculation of climate forcing in IPCC AR4, with all its implications;

2. Better quantified regions of CO_2 uptake, with major implications for carbon cycle understanding;

3. Carbon tracker helps data assimilation and development of predictive capabilities;

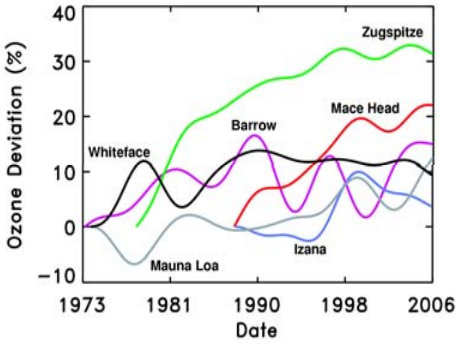
4. The “forensics” of ozone depletion substances – what comes from where.



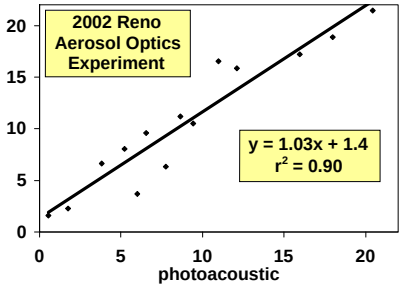


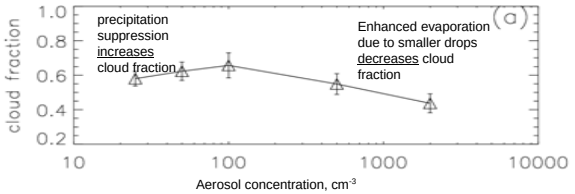
What You Heard: Climate, contd.

- Role of tropospheric ozone, an important GHG, in forcing and feedbacks:
  1. Development of process understanding to enable better quantification of abundance and distribution;
  2. Better understanding of the long range transport in ozone distribution (including contribution to AQ issues).



- The role of aerosols in climate through scattering and absorption and via their influence on clouds:
  1. Long-term accurate monitoring of aerosols provided key data to reduce uncertainties in aerosol forcing;
  2. Development and utilization of new state-of-the-art instruments has enabled better characterization of aerosols and enhanced ability to predict: (a) optical properties and (b) composition;
  3. Key field studies and modeling have enabled better definition of the influence of aerosols on clouds, and hence climate.





What You Did Not Hear

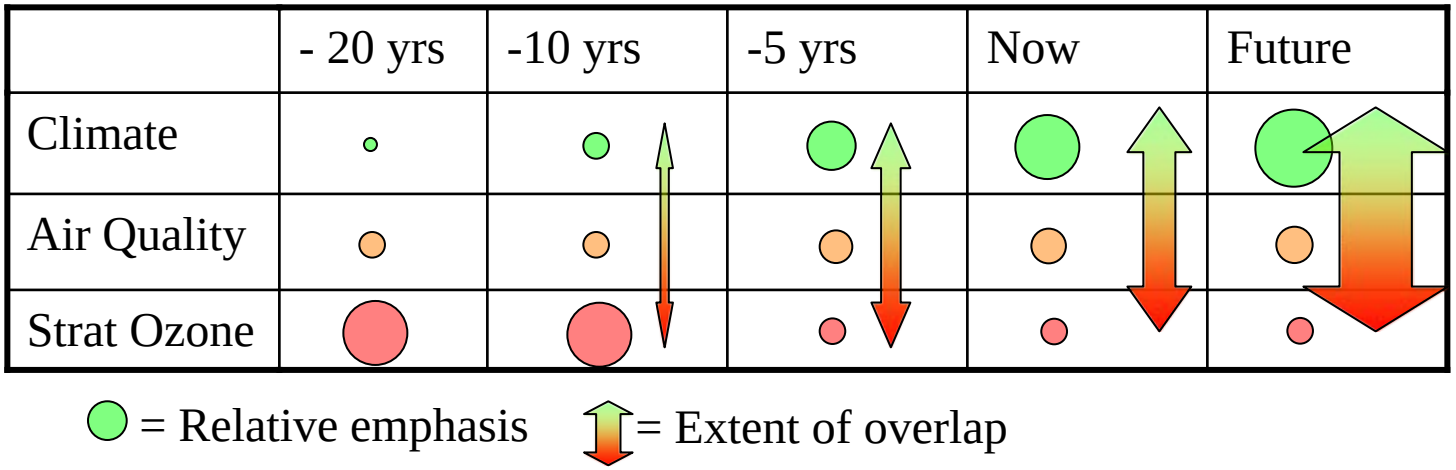
Approximately 80% of the work over the last four years (550 papers worth)!

You did not hear about some important areas that were not the main emphases of this review:

- Details of Boundary Layer meteorology relevant to Air Quality and climate;
- Details of Surface Radiation measurements and interpretations;
- Some key fundamental studies in dynamics, chemistry, and meteorology of the atmosphere.

The material on the website has the "rest of the story!"

Our Progress and Changes In The Past



- Significant changes in emphases
  - Dictated by societal needs
  - Dictated by scientific progress
- Significant increase in “synergy”
- Major advances in technology, data quality & acquisition, analyses, and interpretation

We have evolved and will continue to evolve to address major environmental questions.

Where We Are Headed

- Addressing the needs of the post-IPCC AR4 era

  Climate change and attribution is still a key

  - Regional attributions
  - Attributions of parameters other than just T (e.g., precipitation)

  More information for adaptation/mitigation issues

  - Need brand new science
  - Need improvements in current science

(Living with a problem, requires more knowledge than "amputating" a problem!)

- Continued expansion of Air Quality research and development of decision support information

- Continue to shepherd the ozone layer through the accountability phase

Where We Are Headed

More emphasis on “one atmosphere approach:”

- Needed for decision making (e.g., climate-Air Quality);
- Significant opportunities for scientific breakthroughs;
- Enhanced synergy and gain in efficient/effective policy.

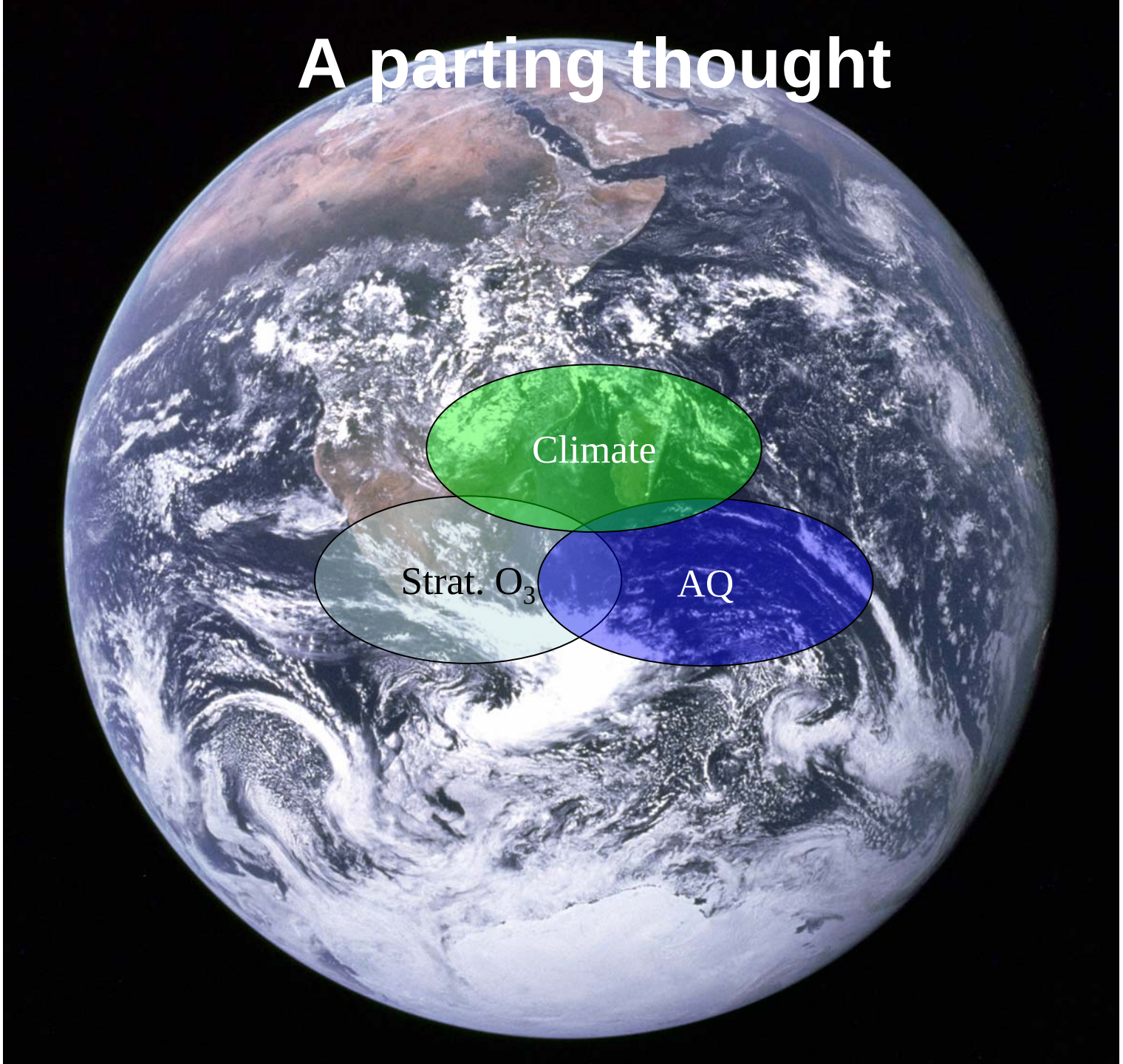
Science at the interfaces:

- Science interfaces (e.g., UT/LS, emissions, deposition processes, ...);
- Climate-Air Quality connections;
- Water vapor… the “orphan” in the climate game;
- Policy interfaces.

Emerging emphasis on one Earth System approach:

- Connections with other components (e.g., chemistry module for an Earth System model);
- Needed by Society.

A parting thought



Some Details of Planned Near-Term Activities

Take it away Jim