Air Pollution and Climate:
Short and longer-term research for the IAMC

IAMC Meeting

September 23, 2008

Baden, Austria

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With substantial contributions and discussion with numerous colleagues.

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Air Pollution and Climate

Emissions of pollutant gases impact climate:

- Ozone precursors (CH_4, NO_x, CO, NMVOCs) change tropospheric ozone levels.

  Tropospheric ozone is a significant GHG (~ 0.35 W/m^2 in 2005)

- Aerosols (sulfate and carbonaceous) together are not only a substantial forcing but also are the largest present-day forcing uncertainty.

Climate change impacts pollutant levels:

- Changes in climate (temperature, precipitation, clouds) change surface pollutant levels.

Climate mitigation impacts pollutant emissions:

- Climate mitigation generally reduces, sometimes quite substantially, emissions of pollutant gases.

Air Pollution and Climate: Research Needs

General results from research to date:

- Forcing from air pollutant emissions is most important over the first half of the 21st century.
- In scenarios with continued economic development, or substantial climate policy, air pollutant emissions are a relatively small contributor to climate forcing by 2100.

More systematic scenario analysis is needed.

The atmospheric chemistry community desires a set of consistent scenarios that can be used to examine air pollution and climate issues.

- Consistent pollution assumptions for different climate mitigation levels.
- Requested multiple (high, med, low) pollution control levels for each RCP.
- TF HTAP -- needs scenarios for assessment of intercontinental transport to be completed by June 2010.

Air Pollution and Climate: A Potential Near-Term Research Path

The RCP scenario process was designed to produce scenarios for ESM experiments.

Although all RCPs include emissions controls on air pollutants, **the RCPs were not designed to examine the connection between air pollution and climate.**

What can be done to further the needs of air pollution and climate research building on the RCP process?

1) RCP Scenarios

- The RCP scenarios can be used (and mixed) for bounding studies.
- The chemistry community can assist in evaluating RCP scenarios.

2) RCP Variant Scenarios (very) early in 2009

- Scenarios that are variants of the RCPs could be made available.

3) Further work

- Further work, although not necessarily in time for AR5.

A Potential Near-Term Research Path: 1) Work With the RCP scenarios

To produce bounding scenarios, air pollutant emissions from different RCPs would need to be "mixed" to identify a plausible range of pollutant emission impacts on forcing and climate. ✓ **Works for TF HTAP**

- The 2.6 scenario will generally have the lowest emissions. Or the lowest of the other scenarios could be used.
- A mid-range regional (or global) emissions path for each gas could be picked from the RCP set to produce a “medium” pollution scenario. While this is not a consistent scenario, such a scenario can be used for sensitivity studies.
- The four RCP scenarios may not provide a high pollutant emissions scenario. Adding reference case runs from the four models would help. May need one or more models to run with lower levels of emissions controls.
- A low, mid, and high pollutant scenario can be run with multiple RCP GHG pathways in order to conduct an examination of interactions between climate and pollutant emissions.

Comparison with available near-term pollutant emissions projections will be useful for general validation.

- This may also help determine if the RCP scenarios constitute a reasonable bounding range. Likely to be true on the low end, less likely for high end.

A Potential Near-Term Research Path: 2) Potential RCP variants in early 2009

A number of variants of the RCP scenarios could be produced in early 2009 that would be useful for air pollution research.

A) Could produce several sets of scenarios with consistent pollution control assumptions for the RCP range of stabilization targets.

- Achievable if each RCP group produces emissions for the full range of reference through low (2.9/2.6) RCP scenarios.
- The four RCP models will already be set up to do this (but 8.5 could not).
- Enable analysis of the impact of climate policy on pollutant emissions/levels.

B) Scenarios produced with different pollution control assumptions.

- Will take additional work to develop new pollution control assumption sets.
- May be necessary to obtain a good "high" pollution scenario.

1 or 2 models complete by Jan 2009?

C) Consistent assumptions across models is more challenging.

- May need a reference case harmonization exercise for pollutant emissions.
- Difficult to define one "best" set of pollution control assumptions.
- May be difficult to implement in some IA models.

Preliminary Proposal

Fall 2008

- Input into RCP scenario process from relevant communities.
- Identify needs for post-RCP scenarios and RCP variant scenarios.
- 3 RCP IAMs generate reference case emissions in addition to RCP path.

January 2009

- Virtual or physical meeting to discuss short-term work and data selection for scenarios to address chemistry needs. Include impacts researchers.
- 1-2 RCP IAMs generate reference case scenarios with lower emission controls. (Possible in Fall 2008?)
- Some or all RCP models produce full range of RCP scenarios for analysis aimed at AR5. (Early 2009?)

2009 - early 2010

- Longer-term research plans. **Include impacts researchers.**
- Chemistry models perform experiments using RCP and variant scenarios.
- IAMs perform individual or perhaps coordinated experiments examining climate-chemistry connection.

Perhaps using new parameterizations developed from chemistry models

Could potentially include IAM groups beyond the 4 RCP models

3) Further Work

There are a number of potential research questions to be examined.

Examination of impact of current-day emissions uncertainty.

- Uncertainty in current emissions translates into both past and future emissions (and potentially climate attribution and climate sensitivity!).
- Uncertainty can be quite large for emissions that depend sensitivity on combustion characteristics (BC, OC, CO, NO_x, MNVCO).
- Differences between inventories is not necessarily equal to uncertainty!

  Sometimes more detailed regional information is available but resources have not been sufficient to incorporate this (uncertainty overestimate).

  Use of common emissions factors underestimates uncertainty.

Further work as motivated by results of previous research.

- Incorporate impacts. Combined climate/pollution impacts. Improved scenario consistency.
- Pollution control “down-grade” due to climate mitigation?
- Improved parametrizations of emission controls/levels in IAMs.
- Economics of pollution controls.
- Residual emissions for very low emissions targets.