

WCRP-SPARC/IGBP-IGAC Atmospheric Chemistry & Climate Initiative (AC&C)
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High Scientific Value and Policy Relevance of Initiative

A large part of human-induced climate forcing occurs through chemically active species. Further, chemically active species are more amenable to short term manipulations through changes in emissions and therefore are of major policy relevance. Changes in climate can lead to changes in the chemical composition of the atmosphere both through alteration in emissions and changes in the chemical processes that occur in the atmosphere. Studies of climate-chemistry interactions represent one of the most important and, at the same time, most difficult foci of global change research. Changes in emissions themselves can also be brought on by climate trends or a change in climate variability. These factors also strongly couple the emerging issue of the coupling of climate and air quality, both from scientific and policy perspectives. Provision of high-quality, policy-relevant information on the current state of climate and its possible future states (e.g., for the next WMO/UNEP Scientific Assessment of Ozone Depletion and/or IPCC Report), as well as options for mitigation / control / change / adaptation are strongly dependent on the progress in studies in this area.

Governance by WCRP and IGBP

The "Atmospheric Chemistry and Climate Initiative" (AC&C) was endorsed in March 2006 as a joint effort of WCRP and IGBP, with the SPARC and IGAC projects tasked to take the lead in its definition and implementation. An initial scoping meeting for AC&C (Boulder, Colorado, USA; 7-9 August 2006) laid the groundwork for the basic structure and goals of the Initiative. An open workshop was then held (Geneva, Switzerland; 22-23 January 2007), where a broader set of the community was engaged and a first set of activities was decided upon.

Phased Approach Maximizing Policy Impact

AC&C will be implemented in phases, with the first phase planned to end in roughly 2009, in time for tangible inputs to the anticipated next IPCC assessment (AR5). Also, the initial phase will make contributions to elucidating and developing policy-relevant information on the connections between air-quality and climate. The plans discussed below pertain to AC&C Phase I. The primary focus of this phase will be specifically on improving process representation in chemistry-climate models that will be used for climate predictions as well as exploring the climate-air quality connections. Despite these models are essential tools for understanding and calculating the present, hindcasting the past (an essential element for confidence in our models), and forecasting future conditions and, therefore, for making policy decisions, many critical processes in them models have either never been tested or are known to be in error, though it is not always understood why.

Under AC&C we have set out to coordinate and add value to these existing activities by:

- identifying a set of science questions around atmospheric chemistry and climate that require integration and synthesis across the projects;
- identifying atmospheric processes that are both important to addressing key science questions and yet which remain poorly understood;
- identifying a set of common diagnostics that can be used to address these uncertainties;
- coordinating the modeling and measurement communities;
- facilitating the development of improved parameterizations; and
- possibly establishing a common database for archiving model outputs and observations.

At the first Initiative meeting in Boulder, three thematic areas were decided on for AC&C:

- the impacts of climate on atmospheric chemistry,
- the impact of atmospheric chemistry on climate, and
- the impact of climate on air quality.

The direction of AC&C will be guided by the current important science questions within each of these thematic areas, coupled with other considerations as described below.

Interaction and Coordination With Relevant Partners

Advances on aspects of this problem have already been made directly through several activities which will be linked to AC&C: the Chemistry-Climate Model Validation activity of WCRP-SPARC (CCM-Val), the global Aerosol model inter-Comparison (AeroCom), and the European ACCENT project Model Inter-comParison (ACCENT-MIP). CCM-Val is a model inter-comparison and validation effort for stratospheric chemistry-climate models. Under AeroCom, global tropospheric aerosol models were inter-compared and tested against some observational data sets. The ACCENT-MIP effort focused on IPCC scenarios, contrasting 2030 vs. 2000 runs across a suite of tropospheric chemistry-climate models, with an eye toward how climate change might affect air quality. This effort has now effectively been merged into the HTAP project (Hemispheric Transport of Atmospheric Pollutants). The HTAP activities comprise an aspect of the AC&C area of interest: understanding and quantifying northern hemispheric transport of gaseous and particulate air pollutants and their precursors from source to receptor region.

For all of these activities and for the AC&C objectives in general, characterization of emissions (amounts, nature of emissions, time-history, uncertainty, etc.) is of critical importance. Therefore, coordination with the IGBP-AIMES Global Emission Inventory Analysis (GEIA) will also be a component of the AC&C activity.

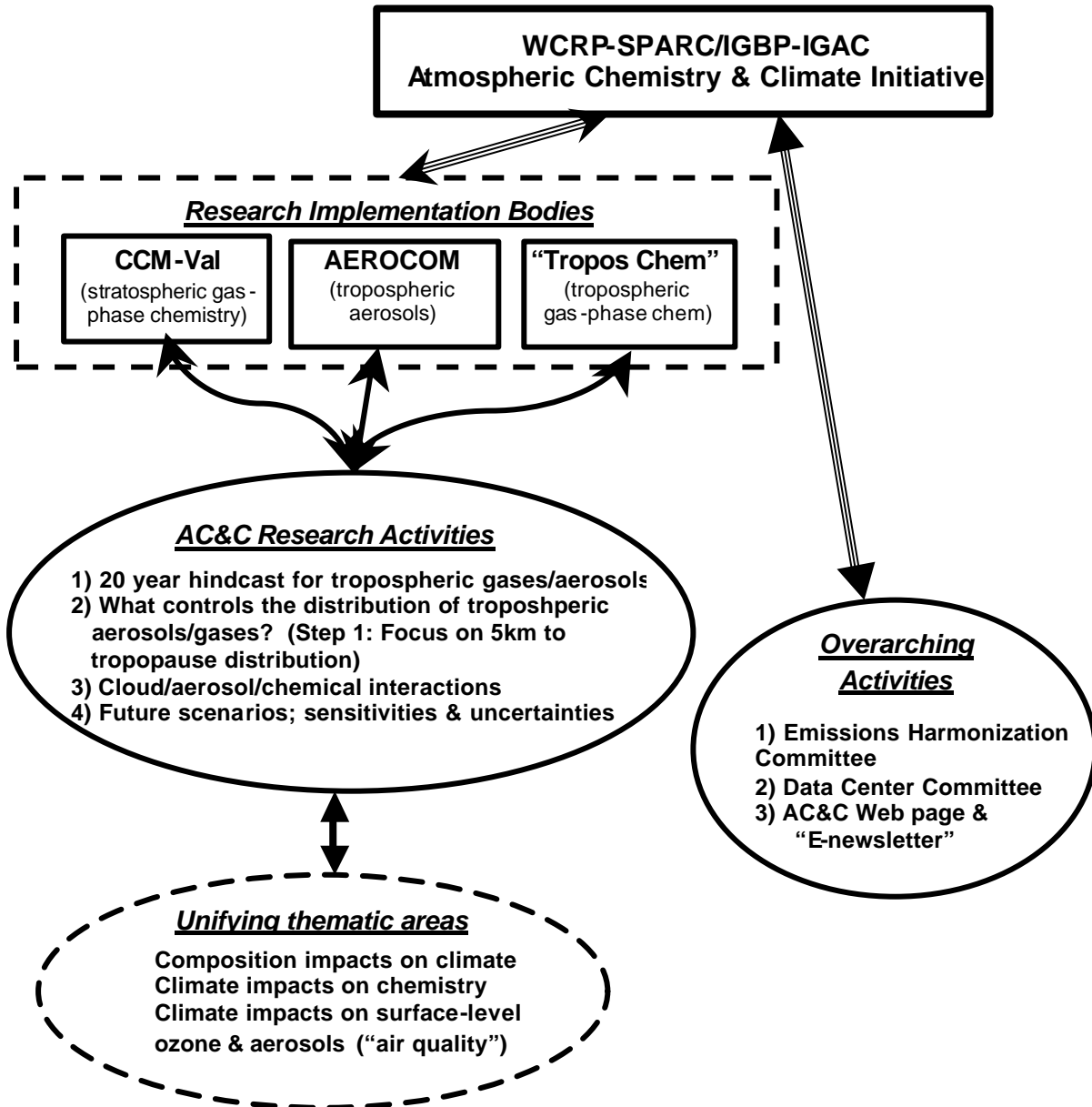
AC&C Structure and Mode of Operation

As AC&C is an unfunded activity, its success is contingent on *buy-in from the scientific community* and on being able to take *advantage of already-planned or existing activities/model runs*. Thus, the activities selected for pursuit under AC&C were selected in part on input from the community on how proposed projects rated for:

- scientific priority;
- likelihood of being tractable;
- whether research groups are likely to address this problem in the next few years;
- value of return for investment.

The activities of AC&C will be pursued under the organizational framework given in the figure below. Two existing activities – CCM-Val and AeroCom – cover two of the areas of interest under AC&C: stratospheric gas phase chemistry and tropospheric aerosols. A third area of interest, tropospheric gas phase chemistry, is covered only in part by other activities (e.g. ACCENT-MIP/HTAP). Thus the implementation body “Tropos-Chem” in the figure below will comprise a new

committee formed under AC&C. This steering committee will act as an information clearinghouse, facilitate various activities, define some of the foci, and coordinate tropospheric chemical modelers working on AC&C activities.



Activities Selected for AC&C Phase 1

The selection of activities is based on the following guidelines:

- Some components of AC&C should contribute to the next WMO Ozone Assessment and the next IPCC Assessment (assuming there will be one).
- AC&C activities must require the engagement of two or more of the three implementation groups. (If only one was needed, the group could pursue it on its own and AC&C would not be needed).
- AC&C modeling exercises should involve three or more models. (Again, otherwise the integrative role of AC&C is not necessary).

- Observations are to be used wherever available to validate and test models. The observational community will be engaged in each of the AC&C activities for this purpose.

At the AC&C workshop in Geneva, four specific research activities were decided upon, based on the above set of criteria/guidelines. In addition, there was a resounding message from the community that AC&C could benefit scientific advancement in the area of chemistry and climate through several other over-arching activities, which are necessary and where AC&C can help.

Following are the four research projects that have been planned for AC&C in Phase I of the project (nominally to end in 2009). Steering committees for each were identified in Geneva, including some members who were not present but will be contacted and asked to join the effort.

Observations and laboratory data will be utilized within each of the four AC&C activities as appropriate for validating and understanding model processes and output and as a way of increasing our ability to represent processes in models.

Activity 1: 20 Year Hindcast Simulation

This activity will provide important input to the next round of assessments and will also set the "baseline" for comparison of future composition.

A series of ~5 or more models will generate a 20-25 year "hindcast" to address the questions:

- Can we understand what has happened with tropospheric chemistry, and in particular ozone and aerosols?
- Can we replicate the observed changes in composition over the past 20 years?

Models will be compared to each other and to observations as available to assess them for where uncertainties lie. Within the 20 year run there can be special "focus" or "snapshot" periods, e.g. El Nino vs. La Nina years; periods when field campaign data are available for ground-truthing; etc. To the best degree possible, everyone would run models with the same emissions (anthropogenic). Diagnostics would be designed to reveal information on model processes.

Activity 2: What controls the distribution of aerosols/gases in the troposphere?

Step 1: Investigate what controls the distribution of climate/air quality relevant chemicals between 5km and the tropopause.

> This activity would contribute to the next WMO Ozone Assessment.

The upper troposphere was chosen as an area of interest because a) it is known that models do a poor job of representing the distribution of species in this region, but it is not understood why; b) species in this altitude range (e.g. ozone, dust, black carbon) can have a significant radiative impact; c) the processes that control the distribution of species in this altitude range (e.g. vertical lofting; wet deposition; cloud processing) also control the long-range transport of these species; and d) the distribution of species in this region depends on and influences processes in the upper troposphere/lower stratosphere.

Activity 3: Cloud, Aerosol, Chemical Interactions

The main question here is how well we can characterize warm cloud / aerosol interactions in global models, with a specific focus on the interactions with gas phase photochemistry. This activity is aimed at exploring the impact of aerosols on atmospheric chemistry through their modification on clouds. The idea would be to employ a paradigm of controlling sets of parameters (cloud droplet number, etc.) and then let chemistry run. After that more and more links to aerosols will be included and their impacts on in-cloud chemistry investigated.

Activity 4: Future Scenarios: Sensitivities & Uncertainties

> This activity would contribute to the next IPCC Assessment.

The goal would be specifically to have a better representation of aerosol and chemistry in the anticipated AR5 as well as other national and international assessments. This group could define the pre-industrial to present and future scenarios, based on emissions that are consistent with other

AR5 runs (to the best degree possible). By running multiple models with constrained emissions, it would be possible to define a “best guess” and uncertainties. The model runs would further be designed to explore sensitivities to model processes.

AC&C Overarching Activities, Capacity Building and Networking

A “**Tropos-Chem**” **Committee** is to be formed to act as the third implementation body for AC&C. As a starting point, the group will:

- form a list of groups that should be aware of AC&C activities;
- act as a liaison to these groups so that activities are coordinated wherever possible.

A **Data Center Committee** was formed to explore issues/options for having a centralized data center/tools under AC&C. Many committee members have been defined and others being notified or are in negotiation.

An **Emissions Harmonization Committee** was formed to work with GEIA and HTAP and improve the utility of emissions databases for use by models. It includes Claire Granier (co-chair of GEIA), Terry Keating (Co-Chair of HTAP), Martin Schultz (RETRO), as well as representative of EDGAR, observational scientists and others.

Visibility and Communication

An **AC&C Web page** and **E-newsletter** (or similar) will be established to link to related activities (CCMVal, AeroCom, HTAP, GEIA, ACCENT-MIP, “Tropos-Chem”) and facilitate AC&C work.

Throughout, the AC&C steering committee will be sure to communicate and coordinate with related activities as relevant (i.e. HTAP; GEIA; other WCRP/IGBP initiatives such as the nascent “Aerosols, Clouds, Precipitation and Climate” initiative, etc.).

The Immediate Path Forward

At the meeting in Geneva, it was agreed that the committees for each of the projects above would generate a brief proposal for the activity, including: motivation, proposed simulations, implementation plan, and what observations would be needed for validation. This is to be accomplished by late March 2007. These write-ups will then be circulated to the whole group for iteration and identifying areas of overlap, etc. Each activity’s plans will be sufficiently refined for publication of an article in EOS, BAMS, or similar in approximately June 2007, which will present to the larger community the AC&C Initiative background, plans and timeline.

Between June 2007 and January 2008, participants of each activity will reiterate their implementation strategies with the goal of starting model runs in January 2008.

To Attention of JSC

The JSC is invited to comment on the Initiative progress, particularly taking into account the role of AC&C as a truly jointly developing activity by WCRP and IGBP.