White Paper on the formation of a Chemistry-Climate Working Group

We propose the formation of a Community Climate Systems Model (CCSM) chemistry-climate working group to focus on the coupling between the climate system, aerosols, atmospheric composition and chemistry. The recent successful efforts to incorporate chemistry into the Whole Atmosphere Community Climate Model (WACCM) and into the Community Atmosphere Model (CAM), and the successful outcomes of recent NCAR led chemistry-climate workshops makes this an opportune time to incorporate the CCSM community into this effort. A chemistry climate working group will draw new people into the CCSM and allow new problems to be approached.

The photochemistry of the Earth's atmosphere has been profoundly changed by anthropogenic activities through the emissions of aerosols and chemically active gases or their precursors. In addition atmospheric chemical species and aerosols regulate the nutrient cycling and the light and water availability to various ecosystems, and damage plant tissue in high concentrations. The atmospheric circulation and hydrological cycle are impacted by changes in atmospheric composition and aerosols through changes in the atmospheric radiative forcing, the modification of cloud processes, and the impact on the land surface. An Earth system model, such as the one envisioned by the CCSM effort, clearly must take the effect of atmospheric chemistry and aerosols into account.

The proposed chemistry-climate working group expects to initially focus on the following issues:

1) The role of the middle atmosphere in climate. Changes in anthropogenic emissions, changes in atmospheric water vapor and climate induced temperature changes in the stratosphere are all expected to influence stratospheric ozone chemistry with immediate feedbacks on atmospheric dynamics.
2) The role of tropospheric aerosols in climate. The formation of aerosols is strongly governed by the tropospheric oxidant balance. The radiative and chemical impact of aerosols also depends on their mixing state. These processes have not been fully investigated in the context of changing emissions and climate.
3) Air quality in the future climate. Changes in the tropospheric composition are not solely limited to climatic effects, but have profound impacts on human health, ecological systems, and agriculture. Here we investigate how changes in the physical climate, aerosol loading, biogenic emissions and atmospheric chemistry are expected to impact air quality.
4) The feedbacks between atmospheric chemistry and land-surface processes. The inclusion of atmospheric chemistry in the CCSM will allow an investigation of the feedbacks between chemistry, aerosols, the land surface and the physical climate system.
5) Paleochemical studies. The paleo-record is marked by large variations in temperature, atmospheric composition and the diversity of life. These variations provide challenges to our understanding of the chemical system under different climatic conditions and may serve as important indicators of the impact of future climate change.

A better treatment of chemical processes and aerosols will benefit from and enhance ongoing activities within the CCSM. Incorporation of chemistry and aerosols will increase our confidence in predictions of the physical climate in light of changing anthropogenic emissions, and will provide an additional and important constraint on atmospheric dynamics and transport (Atmosphere Model Working Group); a better representation of chemistry and aerosols is also necessary to understand future changes in land processes and particularly the impact of global change on carbon sequestration (Land Model Working Group and Biogeochemistry Working Group); finally, clues to past climate change are often marked by dramatic changes in atmospheric constituents (Paleoclimate Working Group).

The increased emphasis on atmospheric chemistry in the CCSM and a desire to increase community participation suggest an autonomous Chemistry-Climate Working Group is necessary. The complexity of the problems posed by adding atmospheric chemistry to the CCSM (e.g., the effect of internally mixed aerosols) does not fit well into any of the existing working groups. The biogeochemistry working group's primary focus is on nutrient cycling, while the atmospheric working group already contains six focus groups emphasizing the physical climate system and data assimilation. The creation of a separate working group would increase the visibility of the CCSM chemistry climate research to the greater community and entrain more atmospheric chemists into this effort. Cross-cutting issues clearly exist between a chemistry-climate working group and the other groups, as they should (e.g., the interaction between aerosols and clouds, or the effect of nitrogen fertilization), but the segregation of activities can be easily managed in consultation with the working group chairs. To continue to make substantial progress on the inclusion of atmospheric chemistry and aerosols within the CCSM, the user community needs to be expanded. This expansion will only be possible with a group dedicated to atmospheric chemistry, aerosols and their affect on climate.