Progress since September 2007 NEWS meeting in Huntsville, Alabama

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1) Project Status and Progress

Since the September 2007 NEWS meeting, we performed more analysis and comparison of sensitivity of squall line simulations to aerosol concentrations using a spectral bin microphysics scheme (Hebrew University of Jerusalem) and a bulk microphysics scheme (Thompson scheme) with prognostic droplet number concentrations. We found large differences between simulations performed using the two different microphysics schemes, which provided insights to improve the prognostic droplet number concentrations. As a result, we implemented a secondary nucleation mechanism of cloud droplets in the Thompson scheme. This has resulted in some improvements and brought the sensitivity to aerosol concentrations closer to that simulated by the spectral bin microphysics. We are summarizing the results in a journal paper.

We initiated new simulations of orographic clouds using a case study designed based on the IMPROVE2 field experiment that took place in southern Oregon. We have completed a series of simulations with different prescribed aerosol concentrations. Unlike the squall line case, which is an idealized case, results from these IMPROVE2 simulations can be compared against field measurements. Currently, we are still in the process of obtaining the field data to evaluate our simulations.

Based on the IMPROVE2 results and other published results of orographic cases, it is apparent that environment conditions have large influence on how orographic clouds and precipitation respond to aerosol concentrations. In the IMPROVE2 case where the atmosphere is relatively wet (i.e., with relatively high relative humidity), our results show an increase in precipitation with increasing aerosol concentrations. This is in contrast to other published results where precipitation decreases with increasing aerosol concentration, which would support our hypothesis that air pollution reduces orographic precipitation downwind. Therefore, we plan to systematically examine a suite of environmental conditions to assess the impacts of aerosols on orographic precipitation. This will provide the basis for examining aerosol effects on the climatic time scale where a wide range of environmental conditions will be experienced during the cold season.

2) Collaboration

We have followed the research of Wei-kuo Tao closely and have some discussions with him regarding his approach to represent aerosol effects in the WRF model. Some comparison of his approach with ours would be beneficial and provide insights on key elements that are needed to realistically capture aerosol effects on clouds and precipitation.

We have also discussed with Christa Peters-Liddard on their development efforts with the WRF model. As the chair of the WRF regional climate modeling working group, I hope

to coordinate across various community efforts to advance the use of WRF for climate research and applications.

I intend to design some case studies where we can use some Cloudsat and CALIPSO data to evaluate model simulations as well as provide analysis of aerosol effects. I will contact Bruce Wielicki on the use and interpretation of the Cloudsat and CALIPSO data.

3) Issues

The main issue has been in transitioning from 2D and 3D case studies to long-term simulations. Our efforts have so far been driven by the need to improve bulk microphysics scheme based on spectral bin microphysics scheme (which is too computationally intensive for climate applications), so that long-term simulations can be performed using bulk microphysics scheme to assess aerosol climate impacts. However, our results suggest that bulk microphysics and spectral bin microphysics are very different. Our hope is to be able to quantify some uncertainties/errors associated with the bulk microphysics scheme, and with these in mind, perform long-term simulations to assess aerosol impacts.

4) Product

This is not a product-driven research project.

5) Integration

Although my project does not contribute directly to the NEWS integration projects being discussed, I intend to contribute to integration project #2 on "Two Golden Years" to use my experience with the WRF model and leverage with other projects to study the influence of the land surface on extreme conditions. I will attend the AGU Spring meeting in Fort Lauderdale and participate in the NEWS meeting and discussion. This will allow me to interact more with other NEWS investigators and make contributions to the broader NEWS objectives.

6) Alignment with NEWS Integration Plan

A main gap is in the use of the newly available Cloudsat and CALIPSO data to evaluate model and assess aerosol effects. This will be mitigated by actively consulting with Bruce Wielicki on the design of our numerical experiments and use and interpretation of the satellite data.

Our project can provide important information on the effects of aerosols on precipitation and snowpack in the western US. Such knowledge can be used to assess the need to assimilate aerosol effects in global and regional reanalysis projects to more accurately assess variations and changes in the global and regional energy and water cycle.