ARM/ASR SGP HIGH-RESOLUTION MODELING WORKSHOP EXECUTIVE SUMMARY

In order to solicit community feedback, the U.S. Department of Energy (DOE) is hosting a series of workshops on how key scientific needs, gaps, and priorities in atmospheric process understanding and climate model prediction could be addressed through strategic deployment and operation of instruments and routine high-resolution modeling at the Atmospheric Radiation Measurement (ARM) Climate Research Facility Southern Great Plains (SGP) and North Slope of Alaska (NSA) sites. The first workshop was held in May 2014 and focused on the SGP site. In September 2014, a second workshop focused on the NSA site, and an additional workshop will focus on the ARM Aerial Facility.

The ARM Climate Research Facility is a scientific user facility within the U.S. DOE Climate and Environmental Sciences Division (CESD) of the Office of Biological and Environmental Research (BER). ARM is an observation facility whose purpose is to provide ground-based observations of the atmosphere to support climate research and the improvement of global climate models. ARM is closely affiliated with the Atmospheric System Research (ASR) program, which uses ARM data to address key atmospheric science issues and improve the parameterization of physical processes in climate models.

A common methodology for using ARM data to improve climate models has been to carry out multi-model evaluation projects, typically in conjunction with field campaigns in which intensive radiosonde launches support the development of model forcing data sets. These exercises have yielded important insights. However, in recent years, there has been a growing interest in supporting high-resolution model simulations on a more routine basis. An important aspect of ARM sites is the continuous collection of high-resolution data over long periods. More routine model simulations would take better advantage of these long-term data sets. Nevertheless, accomplishing this will require careful attention to the requirements for running and evaluating these models, together with a research program that maximizes the benefit of the model output.

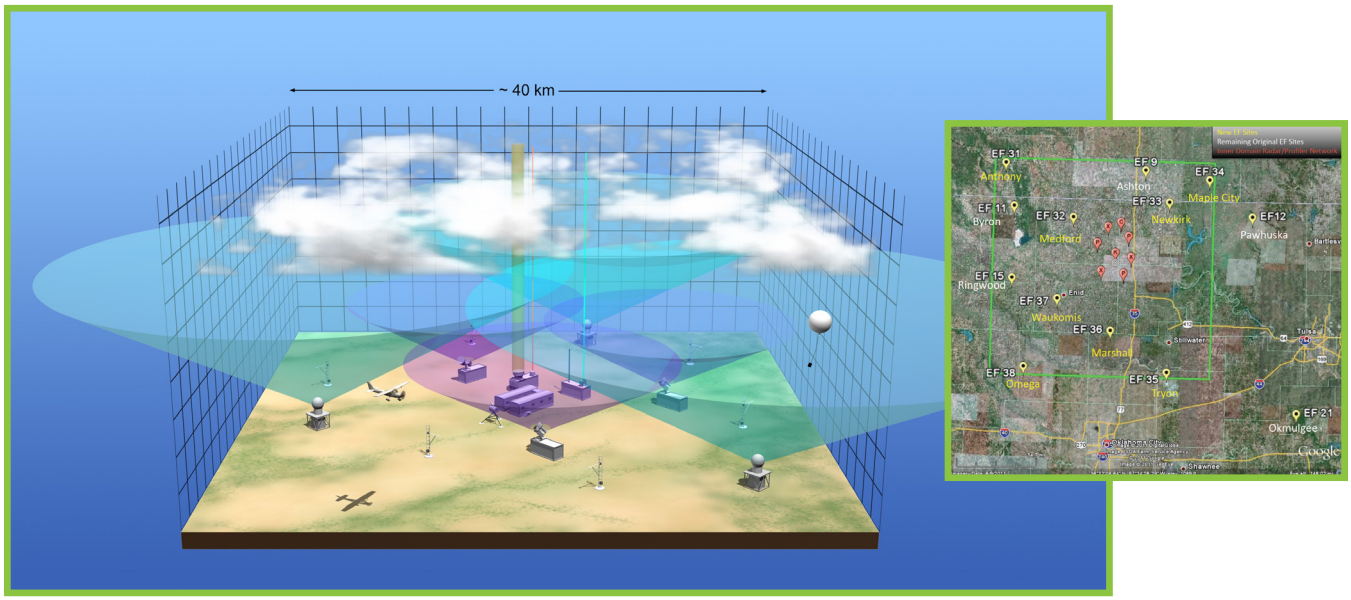
To support the routine operation of models, and at the same time, to improve the overall efficiency of operating ARM facilities, ARM is undergoing a reconfiguration through which instruments will be concentrated at fewer sites. Operations at the Tropical Western Pacific are being discontinued while the SGP and NSA sites will be augmented. Since ARM's inception, the SGP site has served as the testbed for ARM development activities as it experiences a wide range of meteorological conditions, while the NSA represents a region that is undergoing rapid change.

WORKSHOP CHALLENGE

Participants at the SGP workshop were selected to represent a broad range of interests including observations and modeling,

high- and low-resolution modeling, as well as clouds, aerosols, radiation, and land-atmosphere interactions. The workshop, and a pre-workshop survey, focused on ways the newly configured ARM sites could be used to address the following three questions:

1. What are key science questions or objectives relevant to the SGP region that are presently poorly constrained, but could be addressed with a more complete observation suite and associated modeling activities?



2. For the science questions identified, what are the key observable parameters required?

3. What modeling strategy would be effective to support these additional measurements toward addressing these science objectives?

With the majority of participants representing interest in cloud processes, the science themes that emerged from the white papers and workshop tended to organize around shallow and deep convection. Shallow convection systems over the SGP are amenable to large-eddy simulation (LES) with domains on the order of a few tens of kilometers. Their resolution is reasonably well matched with remote-sensing spatial scales. Priorities include improvement of process understanding in shallow clouds and the role of the land surface in driving convective processes. Deep convection represents a broader array of science issues. However, it also poses significant practical challenges in terms of developing a closed experiment system. Deep convection is inherently larger in scale, and deep convection systems over the SGP are often initiated by larger-scale systems developing along the front range of the Rocky Mountains.

SCIENTIFIC PRIORITIES FOR ENHANCING SCIENTIFIC OUTCOMES

The SGP workshop discussion identified several scientific priorities for enhancing the outcomes of running routine LES simulations at the SGP site:

- Carry out a pilot study in which the issues raised during the workshop can be examined in more detail and a viable modeling strategy can be developed;
- Focus initially on routine LES of shallow convection;
- Pursue single-column modeling (SCM) in parallel with LES, using methodologies developed to address parameterization deficiencies in climate models;
- Pursue LES of deep convection over large domains. Initially apply periodic boundary conditions but develop methodologies for nested domains;
- Establish protocols for initial and boundary conditions for both shallow and deep convection using LES, recognizing issues such as spatial variability in temperature, moisture, surface fluxes, advective tendencies, upstream conditions, etc.;
- Support LES through measurement enhancements of land-atmosphere interactions, cloud and aerosol properties, and radiative fluxes, as well as by continuing the routine measurements of carbon profiles and fluxes;
- Ensure that the modeling effort is supported by an active research program that maximizes the benefit of the enhanced measurement and regular modeling activities.

A copy of the full workshop report is available at: ***http://science.energy.gov/~/media/ber/pdf/workshop%20reports/doe-sc-0169-low-resolution.pdf***

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