FORUM ON MODELING THE ATMOSPHERIC BOUNDARY LAYER

BY ROGER A. PIELKE SR. AND TOMISLAVA VUKICEVIC

FORUM ON MODELING THE ATMOSPHERIC BOUNDARY LAYER

What: Seven mesoscale modeling groups met to discuss techniques and Department of Defense requirements, with focus on boundary layer issues
When: 19–23 May 2003
Where: Fort Collins, Colorado

The Army Research Laboratory and the Department of Defense Center for Geoscience/Atmospheric Research (CG/AR) at Colorado State University convened a meeting of seven major mesoscale modeling groups in Fort Collins, Colorado. Representatives from each modeling group [Coupled Ocean–Atmosphere Response Experiment (COAMPS), Weather Research and Forecasting (WRF) Model, fifth-generation Pennsylvania State University–National Center for Atmospheric Research (PSU–NCAR) Mesoscale Model, Operational Multiscale Environmental Model with Grid Adaptivity (OMEGA), Regional Atmospheric Modeling System (RAMS), Advanced Regional Prediction System (ARPS), Purdue Mesoscale Model, Eta Model, and the University of Wisconsin Nonhydrostatic Modeling System (UW NMS)] presented technical descriptions of specific components of their model, with particular emphasis on the atmospheric boundary layer. The outline of the topics followed the categories presented in Pielke (2002). These components included the coordinate system, the dynamic core, parameterizations of the subgrid-scale fluxes, radiative fluxes, stratiform clouds and precipitation, convective clouds and precipitation, initial conditions (including the assimilation of atmospheric and land surface data), and lateral and top boundary conditions. The procedures that each group utilized to evaluate the skill of their model were also presented. The value of ensemble, low spatial-resolution modeling, as contrasted with a single realization with high spatial-resolution simulation, was discussed. The use of these models for prognostic, diagnostic, and process studies was reviewed. The presentations given at the forum are available on the CG/AR Web site (online at www.cira.colostate.edu/GeoSci/overview.htm).

There were several major conclusions that resulted from this meeting.

First, it was generally concluded that it is scientifically healthy to have multiple modeling groups constructively compete with each other. This synergism promotes effective advancement of the modeling capabilities of each group. No one model should be adopted as the only mesoscale modeling tool for prognostic, diagnostic, and process studies.

Second, the combination of predictive and process modeling within the same code presents both an opportunity and a challenge. The codes will necessarily

AFFILIATIONS: PIELKE—Department of Defense Center for Geosciences/Atmospheric Research, Fort Collins, Colorado; VUKICEVIC—Cooperative Institute for Research in the Atmosphere, Fort Collins, Colorado
CORRESPONDING AUTHOR: Roger A. Pielke Sr., Colorado State University, Fort Collins, CO 80523
E-mail: pielke@atmos.colostate.edu
DOI:10.1175/BAMS-86-1-95

In final form 4 August 2004

be more complex, but it is easier to transfer new model developments from process study applications to the predictive version of the code. However, the predictive model may run slower and have unnecessarily complex parameterizations.

The third conclusion proposed at the forum is that parameterizations, which themselves are models, can be replaced with lookup tables or analytic formulations. This would significantly improve the computational requirements of mesoscale models (and other atmospheric models, as well). The tables or analytic formulations would produce the same response to the prescribed input variables, as would the more complex form of the parameterization. With this approach, the existing parameterizations of the subgrid-scale fluxes, radiative fluxes, stratiform clouds and precipitation, and convective clouds and precipitation would be replaced with lookup tables or analytic formulations.

The fourth conclusion of the forum is that continued improvements of initial and lateral boundary data by means of data assimilation on all spatial scales are necessary to improve nowcasting and forecast skill. Data assimilation research at the mesoscale level should be prioritized by the level of uncertainty in key forecast requirements on these scales, such as turbulence, severe local winds, precipitation, visibility, and pollution transport and dispersion. The forum recognized that there are difficulties in assessing forecast skill at the mesoscale due to the limited volume of traditional observations and/or the difficulty in explicit verification against less traditional remote sensing measurements. Systematic assessment on the mesoscale of both the forecast skill and the value added of data assimilation associated with the variety of observations is needed.

The forum concluded with a discussion of the applicability of the various models and their components to the mission of the U.S. Army and Department of Defense (DoD), and what significant research requirements are needed to improve the modeling of the atmospheric boundary layer. Existing U.S. Army and DoD requirements for atmospheric boundary layer information and prediction were presented. One example presented was the value of accurate weather information at a target location—during the 2004 Iraq War, aircraft from U.S. Navy carriers that were loaded with expensive smart bombs had to jettison them at sea upon their return if their target was obscured, even though the forecast had been for acceptable weather at the target.

Finally, the forum participants recognized the value of periodic joint meetings of the modeling groups. Such meetings foster the constructive research and operational interactions that were viewed as valuable by the attendees.

REFERENCES

Pielke, R.A., Sr., 2002: *Mesoscale Meteorological Modeling*. 2d ed, Academic Press, 676 pp.