Executive Summary

A Community Meeting on Real-Time and Retrospective Mesoscale Objective Analysis: An Analysis of Record Summit

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Introduction

Over seventy individuals representing government agencies, research institutions, and commercial firms participated in a two-day workshop on mesoscale objective analysis and its potential value. This meeting was motivated by the ongoing effort of the National Weather Service (NWS) to provide forecasts out to 7 days, at up to hourly temporal resolution, on a fine-resolution grid; the National Digital Forecast Database (NDFD) has a nominal grid spacing of 5 km across the United States and represents a blend of objective forecast guidance and forecaster edits. Early evaluation efforts of the new gridded forecasts have been hampered by the lack of gridded analyses of the various forecast parameters, which include, among others, temperature, dew-point temperature, wind, precipitation, clouds, and weather. In addition, such analyses are expected to play an important role in the forecast process and in generating forecast guidance. Thus, the NWS has an immediate and critical need to produce real-time and retrospective analyses at high spatial and temporal resolution in order to facilitate the creation of the NDFD forecasts as well as verify their accuracy. The term "Analysis of Record (AOR)" has been used provisionally to describe such analyses.

The AOR is, however, not solely a need of the NWS. Demands for high-resolution objective analyses are growing rapidly across the environmental community to support such activities as: mesoscale modeling for both operational weather forecasting and fundamental scientific investigation; dispersion modeling for real-time prediction of hazardous materials and air pollution; homeland defense; and environmental issues from the coastal zone to national forests, including fire management. Additionally, accurate high-resolutions analyses would help to form the basic building blocks of a climate database to help assess the impacts of climate change on a regional scale.

Meeting Specifics

During the first day eighteen invited presentations summarized the needs for fine-scale mesoscale analyses, linkages to other USWRP programs, current and future methodologies, and possible operational strategies. Breakout sessions followed in the afternoon of the first day and extended into the morning of the second day. The sessions emphasized: (1) translating the variety of needs for an AOR into specific requirements; (2) identifying the observational resources required to develop reliable AORs and verify their

accuracy; and (3) evaluating the current capabilities to develop AORs and recommend ways that current deficiencies may be overcome. A number of constructively competing pressures for AORs emerged during the breakout sessions. For example:

- How can the needs for real-time analyses (with as little time latency as 30 minutes), which require stringent data cutoffs, be balanced against the needs to provide retrospective analyses of the highest quality possible?
- Given the existing observational limitations, how can the AOR resolve both detailed microclimates as well as define synoptic and mesoscale weather features?
- What elements and quality are required to verify NDFD forecasts compared to other needs for AORs?
- What role is appropriate for 2-dimensional surface analysis approaches in contrast to more complete 3-dimensional data assimilation strategies?
- How can analysis errors due to the biases of the underlying modeling system be minimized?
- How can the uncertainty implicit in any analysis approach be quantified and expressed to the end user?
- What is possible now using existing resources and technologies, compared to what might be possible in a few years?

Recommendations

A plenary session prior to the conclusion of the Workshop led to consensus recommendations regarding the AOR. The consensus recommendations consist of the following:

1. **Every effort should be made to proceed rapidly to foster an AOR program that will meet the diverse needs of the environmental community for high spatial and temporal resolution mesoscale analyses.** The term "Analysis of Record (AOR)" implies that the mesoscale analyses should strive for the highest quality possible subject to the limitations of the available observational resources and technologies, current scientific understanding, and the uncertainty implicit in any gridded analysis. The AOR program is expected to require basic and applied research, transfer of resulting technologies to operations, and ongoing operational implementation.
2. **The AOR program should be viewed as leading to a suite of consistent products that meet the ongoing diverse needs of the community.** For example, provisional mesoscale analyses available within roughly 30 minutes of the valid time are required by NWS forecasters to monitor current conditions and to initialize NDFD forecasts. Mesoscale analyses completed a day or so after the valid time would take advantage of more complete and diverse observational resources than would be available for the provisional analyses in near real time and would be of great value to many applications, including the verification of NDFD forecasts. The "gold standard" AOR would be an archive-quality analysis of base-state and sensible weather elements at mesoscale resolution, similar to previous global and regional reanalysis efforts.
3. **Community support for an AOR project must be broadened.** The need to provide

input to, and verify, NDFD forecasts is a catalyst for mesoscale analyses, but is not an end in itself. A compelling business case must be developed for the AOR program that both broadens the awareness of the potential applications for AORs as well as broadens the funding base. Outreach to the regional and global climate change impact communities is a priority as well as to agencies that depend upon accurate environmental information (e.g., transportation, fire, air quality, homeland defense).

4. The Workshop participants noted that **ongoing research and development efforts supported by other programs are critical to the future success of the AOR program**. For example, continued support is critical for research and development of variational and ensemble Kalman filter techniques for the Weather Research and Forecasting (WRF) model. Further, the COOP modernization program will greatly enhance the observational resources required for the AOR. However, current Modernization plans envision most stations to be equipped with temperature and precipitation sensors only. It is recommended that, at a minimum, the infrastructure be in place to allow for additional sensors and that additional pressure, wind, and relative humidity sensors be installed at as many locations as possible.

5. In order to meet the immediate needs of the NWS for an AOR, as well as expand community support for an AOR project, **a Mesoscale Analysis Committee (MAC) should be formed that reports to the Director of the NWS Office of Science and Technology**. Lead sponsorship by the NWS for an AOR effort will help to maintain focus on the core goals required to foster the AOR program. A **preliminary charge to the Committee** discussed by the Workshop participants was: foster planning, development, testing, and implementation of high spatial and temporal resolution analyses of the atmosphere with particular attention placed on weather and climate conditions near the surface.

   Efforts should emphasize both real-time operational requirements and state of the science strategies to define the best possible "analysis of record." Coordination with existing working groups, both within and external to NOAA/NWS, is a high priority, and, as efforts get underway, broader community support must be pursued. A high priority task of the Committee is to consider the feasibility of a very early (within 6 months) phase 0 AOR process, which takes advantage of existing capabilities.

   Workshop participants recommended that the committee consist of order ten members who represent the operational, research, and end user communities for an AOR program. Participants indicated by acclimation that Brad Colman and John Horel should be candidates to be co-chairs of the MAC. Recommendations for additional committee members have been solicited from meeting attendees and other individuals interested in the AOR program.

Final Comments

The Workshop participants agreed that an AOR program should proceed rapidly. The formation of the Mesoscale Analysis Committee and appointment of its members was suggested to be followed by a meeting of that body during September 2004. One of the reasons for moving quickly is that the NDFD forecasts are scheduled to become operational during December 2004. Hence, the NWS has an immediate and critical need to have analyses available at high spatial and temporal resolution in order to facilitate the

creation of those forecasts as well as verify their accuracy.

Responding to this immediate need, several groups have tentatively volunteered to develop experimental analyses at 5 km resolution within the next 6 months. One approach relies upon a 2-dimensional variational analysis under development in the Environmental Modeling Center of the National Centers for Environmental Prediction. Other promising approaches were suggested by research groups within the Forecast Systems Laboratory and the private sector. These experimental efforts need to be explored and encouraged by the MAC as quickly as possible. In addition, every effort should be made to insure that procedures are in place within the next several months to collect and archive the data sets required to verify the NDFD forecasts.