The Challenge of Mesoscale Probabilistic Weather Prediction and Communication

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Major Points

- During the next decade, the U.S. atmospheric sciences community must transition from deterministic single-value forecasting to probabilistic weather prediction.
- Why? Because there is great value in probabilistic weather information for a wide variety of users.
- U.S. progress in high-resolution probabilistic prediction has been lacking and this country has now lost leadership to others. U.S. capabilities have stagnated.

Major Points

- This loss of leadership has many causes: lack of resources, lack of coordination and cooperative efforts, not-invented-here attitudes, disconnection between the operational and research communities, and insufficient targeted R&D.
- The U.S. does have substantial resources available for the probabilistic transition, including a number of regional and institutional efforts.
- With more active cooperation and increased leadership of the NWS and others, rapid progress is possible.
- The transition to probabilistic prediction will be difficult and requires the efforts of the entire weather enterprise.

Major Points

- The time for **concrete** action has come. Just like the national health plan.

This meeting was designed to review U.S. and international capabilities, promote frank discussion---leading to a plan of action that accelerates U.S. development and operational capabilities.

The importance of the transition to probabilistic prediction has been made clear in a number of national studies, including the recent National Academy report "Completing the Forecast"

Some findings of that report

“ All prediction is inherently uncertain and effective communication of uncertainty benefits users’ decisions.”

“ … many products from the Enterprise lack uncertainty information or include it ineffectively.”

“ Effective incorporation of uncertainty information will require a fundamental and coordinated shift by all sectors of the Enterprise. “

Meteorology is only part of the challenge

- Developing the science and technology for producing sharp and reliable probabilistic information is only half the battle…and perhaps the easiest part.
- **Probably more difficult is learning how to communicate and display uncertainty information and to make it useful to society**.
- Both physical AND social scientists will be needed.

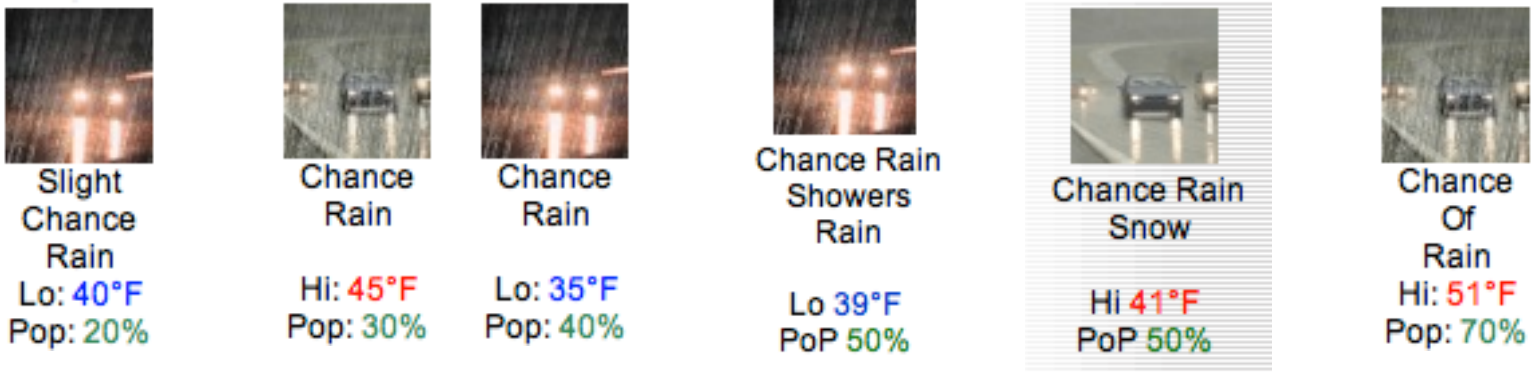
Our Current Probabilistic Report Card

Some subjects we receive poor grades

Deterministic Forecasting Dominates

The overwhelming majority of products disseminated by the government, the private sector, and others is deterministic in form.

Poor Communication



National Weather Service Icons

- Even when we try to provide probabilistic information we are not doing a good job.
- Lack of active participation of social scientists.

Inadequate National Mesoscale Ensemble System (SREF)

- Too coarse (32 and 40 km grid spacing)
- Questionable approach to diversity (breeding)
- Poor performance (NWS SREF ensemble mean is inferior to GFS deterministic forecasts)
- Lack of post-processing.
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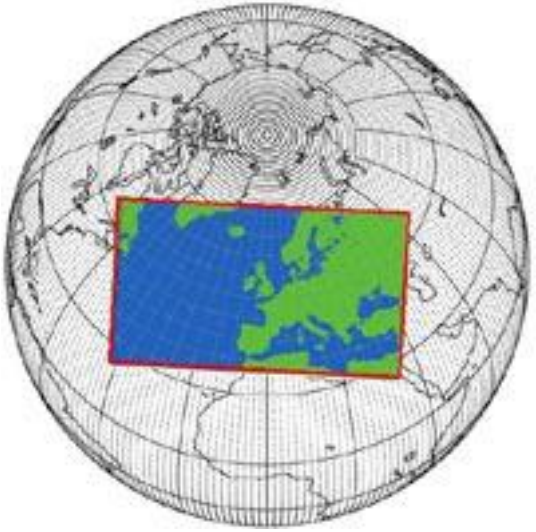
  Lack of resources and personnel

The U.S. has lost leadership in mesoscale probabilistic prediction

- Example of a superior non-U.S. system: MOGREPS
  - 24 km resolution (U.S. SREF 32 and 40 km)
  - Uses ETKF for diversity (U.S. uses breeding)
  - Stochastic physics
- Canadian Meteorological Center is using sophisticated post-processing: BMA

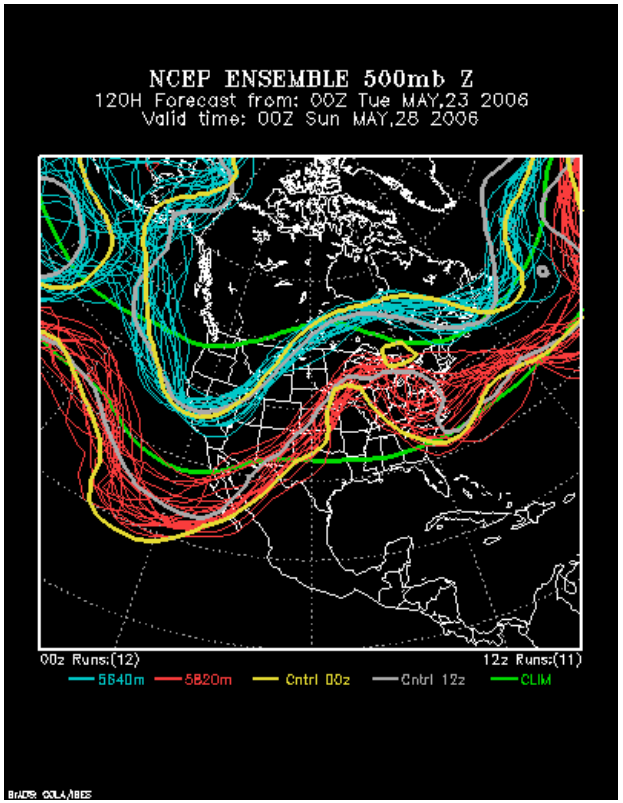


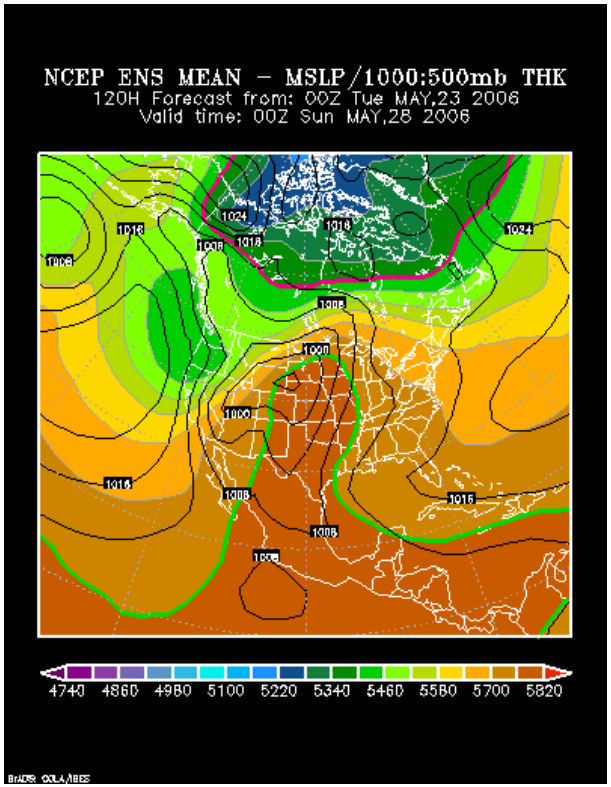
Report Card

- The Navy and Air Force have not worked together effectively or with sufficient resources to make their Joint Ensemble Forecasting System (JEFS) a success.
- Probabilistic prediction technology using MOS has been relatively stagnant over the past decades
- Lack of effective probabilistic verification statistics for a range of parameters.
- Lack of enterprise-wide prioritization and cooperation for an essentially enterprise issue.

Better Grades

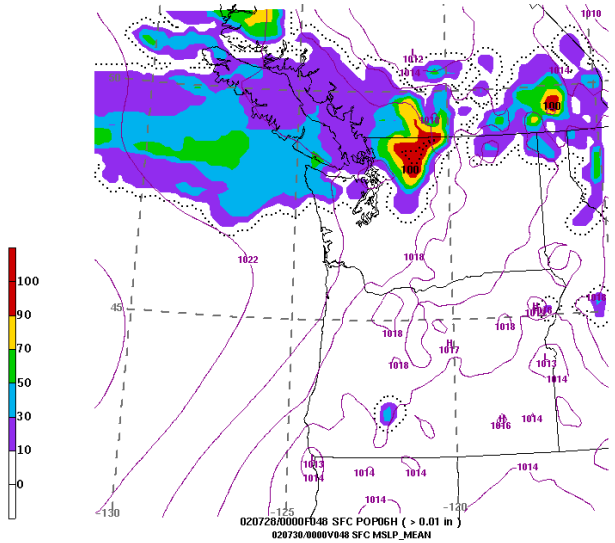
- The NWS has been more effective in fostering synoptic ensembles both internally and in cooperation with other nations (e.g., NAEFS)





Better Grades

- A number of U.S. groups have valuable experience with mesoscale ensemble prediction (e.g., NSSL/OK, University of Washington, NCEP EMC, NCAR, NOAA ESRL, NRL Monterey).



Better Grades

- Strong private sector that has extensive web-weather outlets that could be used as conduits for probabilistic information.
- National open data policy.
- Increased computational capabilities by operational agencies.
- NCAR's Developmental Testbed Center stands ready to contribute substantially to probabilistic prediction R&D.

A Recognition That We Must Act

- A number of national reports (e.g., NAS Completing the Forecast)
- The establishment of the AMS Ad-hoc Committee on Uncertainty Forecasts (ACUF) and their town hall gatherings at AMS annual meetings.
- The recognition by the NWS that high-quality probabilistic prediction is required to support the FAA NEXGEN system and other needs.

This is not going to be easy

- The science and technology is not fully ready for the challenge and R&D is still required.
    - Example: We really don't know how to properly sample model and initial state diversity.
    - Example: We lack the ability to provide high-resolution probabilistic forecasts for secondary quantities (e.g., ceiling, visibility).
    - Example: We are still not sure about the best approaches for post-processing-BMA, EMOS, reanalysis

Not Easy

- Example: 0-6 hr probabilistic prediction and analysis
- Example: Ensemble-based data assimilation appears to have great promise but requires more testing and development.

Not Going to Be Easy

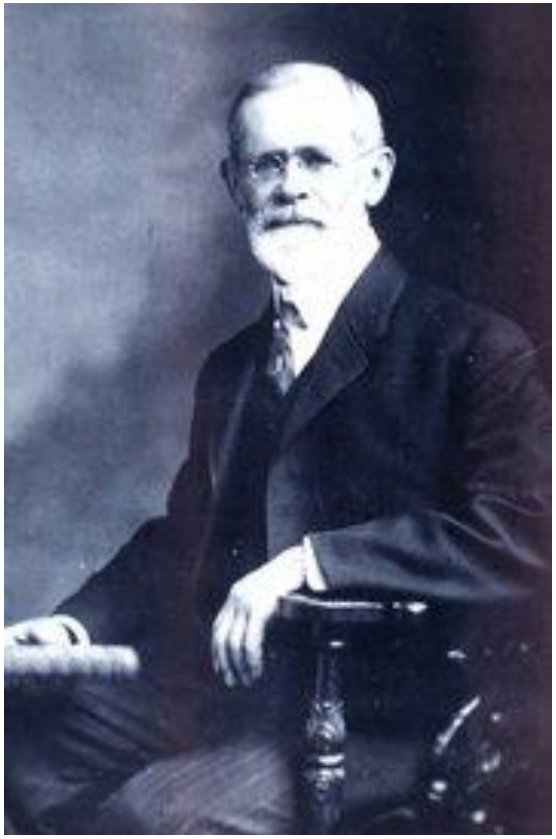
- Even more daunting is the communication and application of probabilistic information.
  - We don't know how to package the information to the general public to be accessible. We can't overwhelm them with a mountain of information.
  - How can we make this information usable for a wide variety of more sophisticated users.

Editorial

If we pull this off, it will represent a new paradigm of enterprise-wide cooperation that could benefit other aspects of weather prediction.

140 years since old “Ol Probs” told us that we must work towards probabilistic prediction

- Cleveland Abbe issued the first public “Weather Synopsis and Probabilities” on February 19, 1871
- It is time for us to complete the work and make high-resolution probabilistic prediction the centerpiece of the U.S. weather forecasting enterprise.



Professor Cleveland Abbe

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