Group 2: Building a National Mesoscale Ensemble System

Chair: Tony Eckel

Original Charter for Group 2

How can a system be created that provides sufficient diversity and detail? How many members, at which resolution, which domains, driven by which large-scale models, using what approach for physics and surface diversity? What are the issues with domain size and lateral boundary conditions. What has been learned by previous attempts that we can apply? What computational resources are required? How can they be secured?

Goal

Build a manageable ensemble able to provide a high quality probabilistic forecast and provide cost-effective value to key users (i.e., stand to benefit the most?)
Timeframe: Operational by 2015

Group 2 Task:

Come up with specific recommendations that address the following questions. Where that is not possible, outline a feasible experiment or course of action that will support a decision in the near future.

------------------------------------MODELING DETAILS----------------------------------

- Resolution?
- Domain(s)?
- Forecast Length(s)?
- Forecast update frequency?
- Timeliness of Production?
- # of Members?

- How do we balance and weigh the importance of each of these?
- Can we set minimum thresholds for each, based on both science and user requirements?

Top Down Approach: Who are the key users and what are their requirements?
Bottom up approach: How do we simulate the key atmospheric phenomenon that likely impact the majority of users?

Model	Domain	Resolution	Fcst Length	Update Freq	# of Members
GFS	Global	15km	15 days	12h	20
NAM	North America	4km	48h	3h	20
NAM	CONUS	1km	12h	1h	20
?	relocatable	TBD	TBD	TBD	TBD

- Timeliness of production?

NCEP has pre-defined product delivery times (e.g, SREF 45 minute limit)
Improving quality of previous forecast can buy time?
Previous forecasts need to be available to users
Users are weary of forecast “jumping”. Should forecast PDF change as much as a deterministic forecast?

--------------------------------------COMPUTER RESOURCES-----------------------------------

• What computational resources are required?
• How can they be secured?
• How can we convincingly justify the required computers?

Reforecasts are a separate issue from hardware for **real-time hardware** requirements. Recommend outsourcing to meet reforecasting needs.

Recommend breaking NCEP paradigms
- Computer resource dedicated to ensemble production
- Explore alternative (i.e., cheeper!) hardware solutions

For white paper, come up with ballpark number of processors and $$$ to cover ensembles above.
- Estimate from current NCEP ops and use other recent experiments with existing hardware to compare
    - NCEP: Geoff DiMego and Jun Du
    - Jeff Whitaker and Fuqing Zhang on FIM requirements
    - CAPS experience with 4 km WRF ARW/NMM

Testing

To refine hardware requirements, run full up timing tests on ensembles above
- DTC?
- Test CAPS system on NOAA research computers (obtain conversion factor)

---PERTURBATIONS---------------------------------------

Objective:

• Ensemble IC approach?
Sample analysis PDF to produce the best possible forecast PDF

Baseline to beat: Cold start from the global ensemble

Testing:
- Can EnKF or ETKF beat baseline?
- Focus on benefit of include radar and surface data at convective scale
- Start from comprehensive evaluation of current CAPS results w.r.t. ensemble performance
- Focus on ensemble forecast evaluation at short range, sensible wx, and include Value metrics
- Suggest further CAPS experiments if current ones can't answer the question.

• Model perturbation approach?
Assuming robust IC perturbations, aim for simulating model uncertainty to support a statistically consistent forecast PDF (constrained by maintenance cost)

Test Multi-model vs. rigorous approaches

- **Multi-model** – *different models and/or different physics schemes (do not want artificial clustering in results)*
- **Stochastic Physics** – *structured perturbations to state variables' tendency during model integration*
- **Stochastic Backscatter** – *return dissipated energy via scale-dependent perturbations to wind field*
- **Random Parameters** – *randomly perturb parameters (e.g., entrainment rate) during integration*
- **Perturbed Parameters** – *" " , but hold constant during integration*
- **Perturbed Field Parameters** – *SST, albedo, roughness length, etc.*
- **Stochastic Parameterizations** – *explicitly model stochastic nature of subgrid-scale processes (strong emphasis)*
- **Coupling with ocean and land surface ensemble**

• Lateral boundary conditions approach? (consider domain size and fcst length)
Linking to global model may not be enough…

---OTHER---

• Recommendations for key improvements to the EPS foundation (i.e., deterministic modeling system)?

Should eliminate barriers between ensemble developers and physics developers
Unified physics schemes
Changing one physics scheme impacts the others
Capture uncertainty in schemes

Tom’s Proposals:

- <u>Regional ensemble (***high end***)</u>:
  - (1) SREF on large regional domain (similar to current domain, covering N America) at 4 km L100 M20, 4x daily to 24h lead, thereafter 12kmL50 M20 to 87-h lead. Accompanying reforecasts in order to statistically post-process.
  - (2) Limited-area, high-impact, on-demand ensemble prediction system run within SREF domain. 2 km, L100 M20 to 24-h lead. Assume 4 regional domain ensembles computed per day. Assume domain will cover 1/4 the size of the existing SREF domain in both E-W and N-S directions (1/16th the area). No reforecasts.
  - 3906x more CPU than current; 1283x more mass storage than current.

- <u>Regional ensemble (***low end***)</u>:
  - (1) 12-km L50M20 4x daily to 87h. Regional 4-km ensemble to 24-h, run ~4x daily.
  - (2) Reforecasts with 12-km ensemble, 10 members, every 3rd day.
  - (3) Total: 265x more CPU than current; 61x more mass storage