Session 6 Breakout Discussion notes (Potvin)

Model/forecast bias

Useful to isolate forecast bias from total error – often illuminates model bias

Should make more use of existing ensemble-based methods for identifying model biases and their sources (e.g., spread-skill curves; initial tendencies/analysis increments)

Should make better use of existing observations for identifying processes/features not represented well in models (e.g., ZDR arc – size sorting)

Operational community should be leveraged to identify conditional biases

Model bias inhibits effective assimilation of new obs (model returns to its "attractor") and can produce especially large errors in unobserved variables

Inconsistencies between different types of physics (e.g., radiation and microphysics) can result from ignorance of developers about each other's schemes

Model vs. IC error – which dominates at different lead time scales? This can be tested with full-physics ensembles. These types of experiments could be useful for prioritizing improvements to model/ensemble design and obs network.

Compensating model biases can make it more difficult to simultaneously improve model *accuracy* and *realism*

Are microphysics schemes a leading source of error at O(1 h) lead times?

Observational limitations

Observations of many processes very rare or practically impossible (e.g., conversion of cloud ice to crystals), impeding verification of physics schemes → Motivates development of schemes that predict measurable properties (e.g., P3 microphysics)

Leading predictability limiters are very regionally dependent. One cause: climatology of physics errors is regionally dependent.

Limited observations/forecasts of extreme events (which we often care most about) → don't know how models handle these events

Need more direct state measurements, both for improved data assimilation and for verification of forecasts and physics schemes

More observations both of environment and within deep convection are needed. Experiments can be designed to determine whether intra-storm or environmental obs are most needed (for a given lead time, convective mode, etc.)

PBL profiles of temp, humidity could be especially useful at O(1 h) lead times, especially pre-CI

Improvements to automated, real-time QC

Target field campaign observations to improving model representation of specific processes

Under-utilizing existing obs (e.g., dual-pol) due to physics scheme deficiencies

Satellite DA and feature (e.g., ZDR column) assimilation could be useful for accelerating ensemble spinup

Will take time to learn how best to assimilate cloudy radiances – should not give up too quickly

Need better representation of expected obs error in DA. Prescribed errors could be spatially/flow dependent. Probabilistic obs error information could be incorporated into DA systems.

Could use ensemble sensitivity analysis (ESA) or OSSEs to identify regions where having more observations would substantially reduce forecast uncertainty (e.g., off west coast or in Rockies)

Multi-scale DA approaches

Needed since (1) different observation types have different spatiotemporal footprints or different spacings, and (2) even for the same observation type, it may be advantageous to assimilate some of the obs at larger scales (e.g., with larger localization radii) to precondition the model/ensemble state to more effectively assimilate remaining observations at smaller scales

One way to more effectively utilize large 4D volume of obs. More frequent assimilation should lead to smaller analysis increments, but may require "gentler" approach to avoid rapid error growth in unobserved parts of state. 4D assimilation approaches (e.g., asynchronous LETKF) required to maximally leverage high-frequency obs.

May be way to get Running-In-Place (RIP) to work at CAM scales.

Problem: Noisy ensemble covariances at large distances from each obs
Solutions: Spectrally filter ensemble perturbations; use hybrid approaches (i.e., leverage static covariances)

Verification

Should be largely feature-based, distinguish between phase and amplitude errors, etc.

Useful to frame errors relative to climatology (ideally within that particular region or meteorological scenario)

Needed resources

Computing/storage – enable more reforecasts, which may sometimes be more useful than generating new forecasts (e.g., of a new spring season); higher resolution; larger ensembles; more complex physics

Need more focus on training forecasters to maximally leverage ensembles

Need more ensemble forecast post-processing techniques, e.g., cluster analysis of multimodal solutions

Data latency → near-storm environment sometimes poorly initialized in WoF ensemble. Would be useful to run retrospective tests to assess impacts of high-latency obs. Can money solve this problem?

Need more coordinated development of physics schemes