Breakout Group b:
Ensemble system development for weather, S2S, including reanalysis and reforecast

Philip Pegion (OAR/PSL)

Bing Fu (NWS/EMC)

Neil Barton (NWS/EMC)

The spread-error relationship at the weather time-scales is not meaningful at the S2S timescales since the spread in the atmosphere saturates. What are the correct methods of evaluating ensembles at these longer timescales?

- Although gridded fields such as 2m temperature and precipitation spread saturates by week-2. Slower modes of variability (e.g. MJO, NAO), and spatially filtered fields (e.g. NINO3 index) still have error and spread that grows over these longer timescales.
- look at full PDF of forecasts and verification.
- How to examine the extremes?

ECMWF, EC, CMA etc. produce reforecasts on the fly. This compresses the upgrade schedule. What are the pros and cons of this methodology? Can NCEP adopt this strategy?

Pros:

- Reduces the time between the code freeze and operational implementation by about 1 year.
- Can better utilize white space on operational computer
- Faster updates for post-processing and training for AI/ML

Cons:

- Post-processing takes time.
- Need for full annual cycle for some post-processing.
- How does this re-forecast schedule fit with the production of a reanalysis?

Constraints:

- Extreme Forecast Index (EFI) is relative to the ECMWF reforecasts from a 5 week period (2002-2023) centered on the week this forecast was initialized.
- Different methods exist for producing the re-forecast climatology, all methods have a smoothing across initializations. Office of Water prediction's needs have to be considered.

Improvements:

- Possibility of merging CPC and EMC diagnostics
- E.g., CPC had issue with the using GEFSv11 and post-processing methods
- Use a subset of CPC's tools

Many modeling centers are moving away from SPPT and towards SPP. This greatly increases the complexity of the model uncertainty scheme going from 1 degree of freedom to 20+ variables that are perturbed. Does having SPP put pressure on the physics developers to not upgrade to new physics packages?

Work closely with physics team to understand the uncertainty

- Design the physics interface to make SPP easier
- Environment Canada's physics developers implemented SPP into their schemes

Testing of the SFS system will begin before there is a proper reanalysis, and the ocean and sea ice analysis available is fairly dated. How do we properly initialize our models without initial conditions that will be consistent with our DA system?

- Without reforecasting, pick out case studies, extremes, interesting events
  - Difficulties in initialize ocean and sea ice due to spare observations and model biases.
  - Possibility for just doing an ocean and sea ice analysis (based on Wesley's talk, we can use the CORe ensemble member to force an ocean ensemble).
  - Cost of reanalysis is very high in terms of people and compute
  - Ocean's long memory make reanalysis and reforecasting more difficult (spinup, initial errors stick around).
  - Interplay between observing system (new observing types) and model biases
  - Use of replay for in-between model upgrades

Discussion point: Even with all of the effort in building reliable ensemble forecast systems, all evidence shows that multi-model forecasts outperform a single modeling system.

- Cost of running multiple models is high. This is more of a problem for the regional forecasting applications since none of other operational centers besides Environment Canada have a regional system to covers NOAA's area of interested. For global applications, there are several operational ensembles that can be combined.
- Dependent on variable. E.g., if one particular model is obviously the best at a variable, the multiple model spread may not be the best.
- Can you build one good model to reduce the need for multi-model ensemble?

Other points brought up

- need to find methods to improve feedback between model developers and model diagnostics.
  - Need for better communication between developers and diagnostic
  - Relationships between developers and forecasters
  - How to feedback model bias to developers?
  - How to have more connection between CPC and EMC?
  - Identify POCs for particular modeling result/aspect between CPC and EMC

- Need to improve/expand the use of observations in the model development cycle.
- There is a large latency for getting new observing types into the operational system
- Private companies are produce many new observations (including satellites)
- How many model runs are needed for these new observations?
-
- Does SFS need inline bias correction during forecast? PSL is working on this