Adopting NCEP’s Hybrid 4D-EnVar DA to FV3GFS

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**NGGPS FV3**
- FV3 selected as the dynamical core component of NGGPS
  - hydrostatic and non-hydrostatic options
  - Initial prototyping (mostly) with GFS physics
  - lots of technical work to adopt new dynamical core for use with current data assimilation system

**Hydrostatic vs Non-hydrostatic**
- Tested hydrostatic version of the FV3 model with the same data assimilation and compared against non-hydrostatic version and GSM
- From high-resolution cold start forecasts
  - RMSE and ACC are slightly better
- From low-resolution cycled DA perspective
  - Comparable RMSE and ACC
  - Stratosphere / upper Troposphere slightly better in hydrostatic version
- Both FV3 versions worse than GSM in the Stratosphere / upper Troposphere.

**Low resolution Cycled DA**
- Putting together all the above mentioned components, and comparing with operational version of the model:
  - Use of JEDI components e.g. UFO (FY20), OOPS on Native FV3 grid (FY22)
  - Use of all-sky information
  - Use of correlated observation errors
  - Higher model top and increased vertical resolution (FY19)
  - Use of time-lagged ensemble, waveband localization
  - Compute background error covariance based on FV3GFS forecasts (FY19)
  - Initialization through an IAU approach (FY19)

**Testing Paradigm**
- Cold start forecasts from GFS initial conditions
  - CTM (~13km) L64
  - Historical cases and near real-time (over a year’s worth of simulations)

**Stochastic Physics**
- Use of stochastic physics (SHUM+SPPT) show modest improvements in DA
- Comparisons shown with multiplicative inflation

**Fit to Observations**
- Fits to observations comparing FV3 (red) with operational GFS (black) for forecasts from the 00 UTC analyses as a function of lead time as well as the difference (lower panels). The 95% confidence threshold for a significance test (derived from a standard t-test) is also plotted in the lower panels.

**Looking Forward**
- Initialization through an IAU approach (FY19)
- Compute background error covariance based on FV3GFS forecasts (FY19)
- Use of time-lagged ensemble, waveband localization
- Higher model top and increased vertical resolution (FY19)
- Use of correlated observation errors
- Use of all-sky information
- Use of JEDI components e.g. UFO (FY20), OOPS on Native FV3 grid (FY22)