GSL HFIP runs 2021

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GSL global modeling team
Overview

- Some explanation of what we wanted to do and what we ended up doing
- Some results from HFIP
  - METexpress TC verification and grid to grid profile verification
  - Some general NWP scores and comparisons to RAOBS over CONUS
  - AOML website
- Bias and error comparison (grid to grid) from all runs at different levels
- What next..
Initial plans: 3 runs, starting at 00z, based on GFSFV3, but:

- Use GFS physics, but replace GFS PBL parameterization with GSL’s MYNN EDMF scheme. Slightly improved version to improve intensity, but random hang-ups when initializing – runs are missing frequently
- Use GFS physics, but replace convective parameterization (SAS) with Grell-Freitas (GF) scheme
  - Initially we wanted to use the version with aerosol microphysics (possible impact of dust?)
  - The aero version was pulled after the first 2 weeks, since precipitation forecasts were deficient (significant decrease in precip rates) – will go back to that version (fixed a few things)
  - Since July 26 stable runs with expected results (similar to HFIP 2018, the last time we only changed one physics package at a time)
- Use GFS physics, but replace GFDL microphysics with Thompson-Eidhammer microphysics
  - The latest version of TH (from RRFS/HRRR), fixed TH aerosol climatology emissions, sub-cycling applied for stability
  - GFS physics produced large negative values of qv as well as hydrometeors – this caused TH runs to overproduce precipitation by 25% from clipping
    - we were not aware of this GFS-physics feature, does not happen with GSL physics. TH cannot take any very small negative moisture values, so it clips before going into the routine – usually with only very minor impact)
    - This is now fixed with a neg_adj routine, borrowing – really more stealing - from other layers – this may also not be a good solution (possible very diffusive impact)

For best comparison to GFS, use C768 resolution, L127, GFS analysis for initial conditions

GSL runs are using CCPP for physics coupling, and an updated version of GFSFV3 (June 14 ufs-community develop branch)
Track errors – TH, GFS, GF

Note: these results are preliminary, amount of data is not sufficient to provide significance!!
Temperature Conus domain – Hr120 against 7/25 - 9/13/2021

RMSE

| GFS | GSL |

| GFS | RAOBS |

| GFS+GF |

| GFS+THMP |

Bias

| GFS |

| GSL |

Note: GSL here is the whole GSL physics package, HFIP runs were not in our RAOBS verifications.
Temperature bias in tropics for GF runs shows warm bias in mid levels – Comparing to GFS Analysis

We saw a similar result when running GFS+GF for a whole year October 2019 – October 2020

By tuning the coupling to radiation and hydrometeor detrainment the bias can be removed or at least much improved, but we don’t know how ACC scores react!
Again, not enough data for results to be significant, but for GF runs agreement to previous 1 year worth of runs as well as HFIP2018
Improving temperature bias profiles

HFIP GF
HFIP GF but increased hydrometeor detrainment
HFIP GF as in (2), but increased hydrometeor detrainment in low levels (below max mass flux)
Super Typhoon Chanthu, from AOML website

JTWC forecast from 15z/7 Sep
The GF had the most consistent track forecasts, keeping all forecast tracks east of Taiwan.
These are all the GFS forecasts.
These are all the HWRF forecasts; the HWRF did not move the storm as much to the west but did hit Taiwan on some runs.
A second intensification occurs after 48-h out. Some increase in TH forecast winds as well as HWRF.
Total Precipitation Errors and Differences

- GFS – IMERG
  Average Total Precipitation Errors
  0% forecasts, GFS-IMERG

- HFIP GF2 – IMERG
  Average Total Precipitation Errors
  0% forecasts, HFIP GF2-IMERG

- HFIP MYNN – IMERG
  Average Total Precipitation Errors
  0% forecasts, HFIP MYNN-IMERG

- HFIP THMP – IMERG
  Average Total Precipitation Errors
  0% forecasts, HFIP THMP-IMERG

- HFIP GF2 – GFS
  Average Total Precipitation Differences
  0% forecasts, HFIP GF2-GFS

- HFIP MYNN – GFS
  Average Total Precipitation Differences
  0% forecasts, HFIP MYNN-GFS

- HFIP THMP – GFS
  Average Total Precipitation Differences
  0% forecasts, HFIP THMP-GFS
**Convective Precipitation and Differences**

- **GFS**
  - Average Convective Precipitation
  - 00h forecasts

- **HFIP GF2**
  - Average Convective Precipitation
  - 00h forecasts

- **HFIP MYNN**
  - Average Convective Precipitation
  - 00h forecasts

- **HFIP THMP**
  - Average Convective Precipitation
  - 00h forecasts

- **HFIP GF2 – GFS**
  - Average Convective Precipitation Differences
  - 00h forecasts (HFIP GF2-GFS)

- **HFIP MYNN – GFS**
  - Average Convective Precipitation Differences
  - 00h forecasts (HFIP MYNN-GFS)

- **HFIP THMP – GFS**
  - Average Convective Precipitation Differences
  - 00h forecasts (HFIP THMP-GFS)
SFC Downward Short-Wave Radiative Flux Errors and Differences

GFS – CERES

HFIP GF2 – CERES

HFIP MYNN – CERES

HFIP THMP – CERES
Zonal – Height Temperature Error Contours
Summary

- Negative mixing ratios from GFS physics
  - Impact the Thompson runs very significantly
  - Probably also impact GF runs slightly (maybe impacting the aero version more?)
- Initial results for track error look promising for GF runs, not enough data for any significance yet
- ACC scores look improved, but again, more verification data are needed
- Compared to GFS analysis, GF runs have a significant warm bias in the tropics the upper levels, but improved bias over CONUS, also compared to RAOBS
- Warm bias can be improved with tuning
- Work still in progress to find out why MYNN run hangs randomly with initialization
- Exchanging one scheme at a time can lead to very different radiation balances
  - Tuning especially the coupling with radiation is important for future
- Can we learn something from the fact – caused by having to clip large negative mix ratios - for TH runs, acc scores as well as biases are improved, yet radiation balances are worse, precipitation is over forecast?