Assessment on Simulation Uncertainties of the Unified Forecast System Medium-Range Weather Application v1.0 in Multiscale Atmospheric Processes

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UFS Medium-Range Weather Application

- The Unified Forecast System (UFS) is a community-based, coupled, comprehensive Earth modeling system.
- Supports the Weather Enterprise and to be the source system for NOAA's operational numerical weather prediction applications.
- The Medium-Range Weather (MRW) App focuses on the prediction of weather phenomena out to approximately two weeks.

Overall Objectives

- Contribute to the Hierarchical Testing Framework (HTF) by
  - creating a set of **case studies** to illustrate model biases.
  - facilitating the inspection of **tendencies** and other diagnostics from the physical parameterizations.
  - exercising the HTF to provide direction for **physics development** for UFS.

UFS MRW App v1.0 Configuration

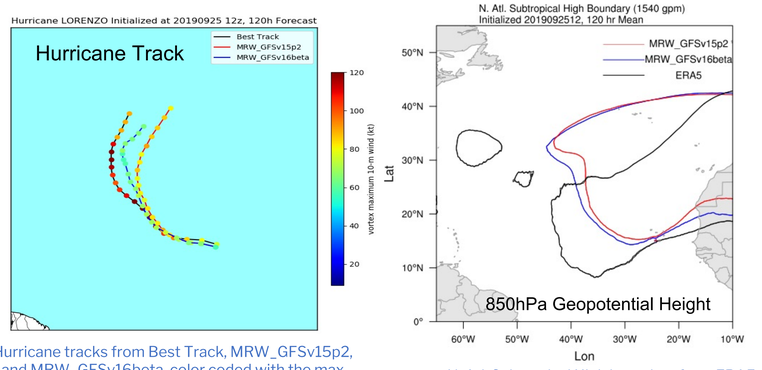
- **Model:** UFS Weather Model v1.0
- **Compsets**: GFSv15p2 and GFSv16beta*, referred as MRW_GFSv15p2 and MRW_GFSv16beta hereafter
- **Initial conditions**: GFS operational dataset in NEMSIO format
- **Resolution:** 65 vertical levels and C768 spatial resolution (~13km)

**The MRW_GFSv16beta configuration is different from the official GFSv16, thus the biases shown here will not be applicable to the operational GFSv16.*

Parameterization Schemes

	MRW_GFSv15p2	MRW_GFSv16beta
Land surface model	Noah	Noah
PBL scheme	K-based EDMF	TKE-based EDMF
Microphysics	GFDL	GFDL
Radiation	RRTMG	RRTMG
Convection	SAMF	SAMF

2019 Hurricane Lorenzo (*2019/09/25 12Z, F120*)

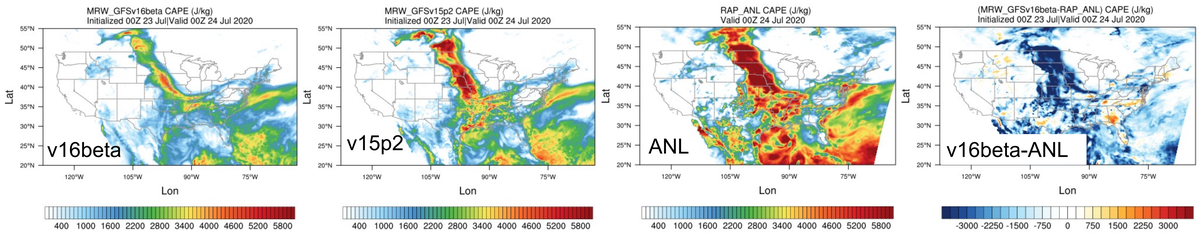


Hurricane tracks from Best Track, MRW_GFSv15p2, and MRW_GFSv16beta, color coded with the max wind speed.

N. Atl. Subtropical High boundary from ERA5, MRW_GFSv15p2, and MRW_GFSv16beta

- Right-of-track bias for hurricane Lorenzo over the Atlantic.
- Poorly/Lower simulated hurricane intensity in the MRW App.
- The misrepresentation of the position and/or strength of the subtropical ridge may be a key element to explain Lorenzo's forecast too-early recurvature.

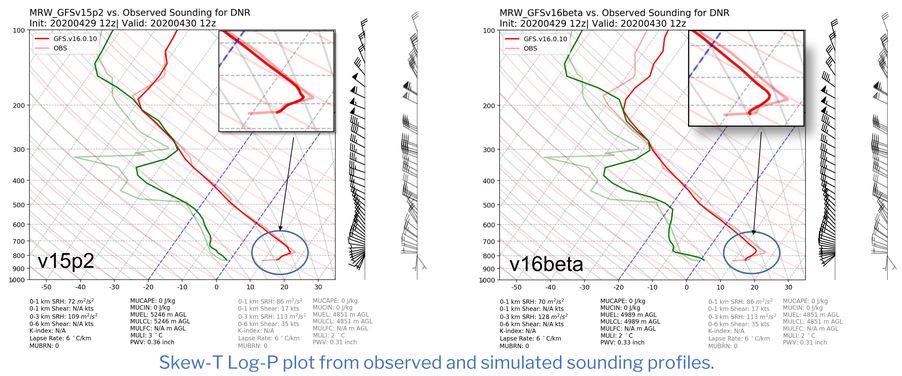
2020 July CAPE Case (*2020/07/23 00Z, F24*)



Convective Available Potential Energy (CAPE) from MRW_GFSv16beta, MRW_GFSv15p2, RAP analysis, and difference between RAP analysis and MRW_GFSv16beta

- Both MRW_GFSv15p2 and MRW_GFSv16beta underestimate the CAPE values compared with RAP ANL.
- The summertime lower CAPE values accompanied with dryer and warmer boundary layer structures were associated with the drier surface soil moisture in GFS.

2020 Denver Radiation Inversion Case (*2020/04/29 12Z, F24*)



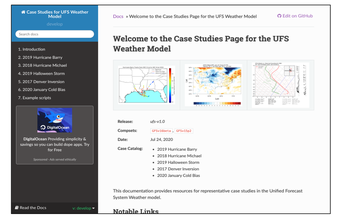
Skew-T Log-P plot from observed and simulated sounding profiles.

- MRW_GFSv15p2 and MRW_GFSv16beta underestimate the temperature inversion strength with a warmer near surface temperature.

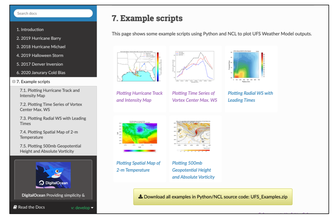
UFS-Case-Studies Website

A platform to share UFS model representative case study configurations, datasets, results, and example visualization scripts.

Website: https://ufs-case-studies.readthedocs.io



Read the Docs



GitHub

Future Work

- Maintain the platform to keep up with model development, including providing instructions and results using UFS Short-Range Weather App v1.0 (see poster by Pan *et al.)*
- Leverage the new Common Community Physics Package (CCPP) capabilities to output physics tendencies to investigate how the different physics schemes impact the simulated weather phenomena, *e.g.,* summer convection.
- Investigate how land surface characteristics, such as roughness length and soil states impact the life cycle of stable boundary layer events using a combination of CCPP Single Column Model (SCM) and UFS.

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