Case Studies with the Unified Forecast System Limited Area Configuration

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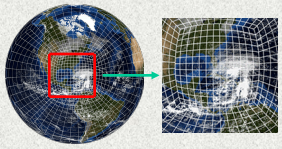
Abstract

The Developmental Testbed Center (DTC) released the limited area configuration of the Unified Forecast System (UFS) to the public in March 2021 as the Short-Range Weather (SRW) app v1.0.0. It is the foundation for building NOAA's future convection-allowing Rapid Refresh Forecast System (RRFS). In this study, we adopt the SRW app v1.0.0 to investigate the cases (https://ufs-case-studies.readthedocs.io/en/develop/) developed as part of the UFS Case Studies project, which until now has been restricted to using the global configuration of the UFS. The limited area configuration needs less computer resources and allows running the model in high resolution and refresh rapidly. Thus the case studies with the SRW app v1.0.0 will be a useful supplement for the global configuration case studies. The catalog currently contains 10 cases that cover known biases of the GFS operational implementations v15 and v16, such as hurricanes, mid-latitude storms, heat waves and cold blast events, and one cold air damming case. The physics suites used in this study include the v15p2, v16beta, and RRFS suites. The results from UFS SRW app v1.0.0 are compared with the results from Medium Range Weather (MRW) app v1.0.0. The model horizontal resolution is 13km in this study for both MRW and SRW apps; however the model version in SRW app is newer than that in MRW app.

Setting for different physics suites

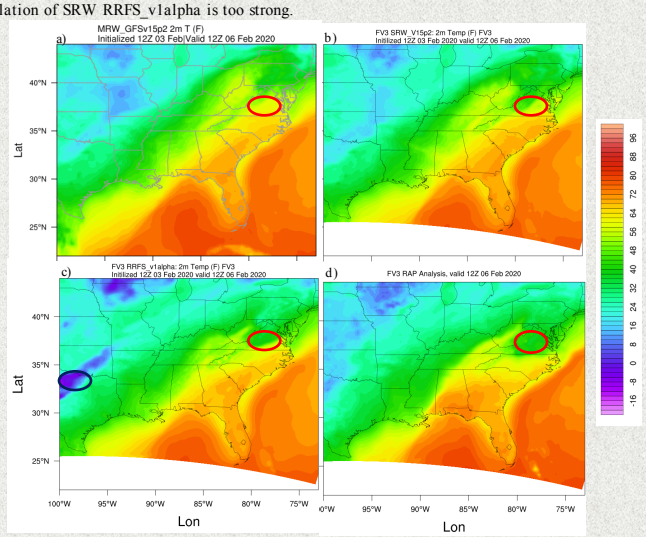
	GFSv15p2	GFSv16beta	RRFS_v1alpha
Deep convection	SA-SAS	SA-SAS	SA/AA-GF
Shallow convection	SA-MF	SA-MF	MYNN-EDMF and GF
Microphysics	GFDL	GFDL	AA-Thompson
Saturation adjustment in dycore	True	True	False
PBL/Turbulence	Hybrid EDMF	SA-TKE-EDMF	MYNN-EDMF
Land Surface Model	Noah	Noah	Noah MP
nord	2	2	2
dddmp	0.1	0.1	0.1
d4_bg	0.12	0.12	0.15
vtdm4	0.02	0.02	0.02
sponge	30	10	24
tau	5	10	5
hord_mt	6	5	6
hord_vt	6	5	6
hord_tm	6	5	6
hord_dp	-6	-5	-6



Two applications for UFS

2020 Cold Air Damming

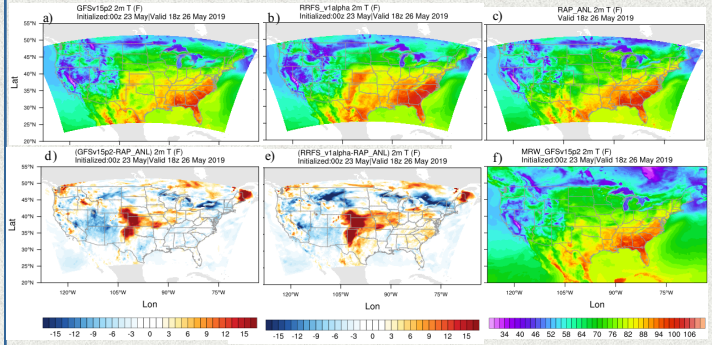
The cold air damming signal in Virginia (red circle) is slightly stronger in the simulation of RRFS_v1alpha than that in the simulation of SRW v15p2. The results from SRW v15p2 is more realistic than that from MRW v15p2. However, the cold signal over north Texas (blue circle) in the simulation of SRW RRFS_v1alpha is too strong.



2m temperature for a) MRW v15p2, b) SRW v15p2, c) SRW RRFS_v1alpha, and d) RAP analysis

2019 Memorial Day Heat Wave

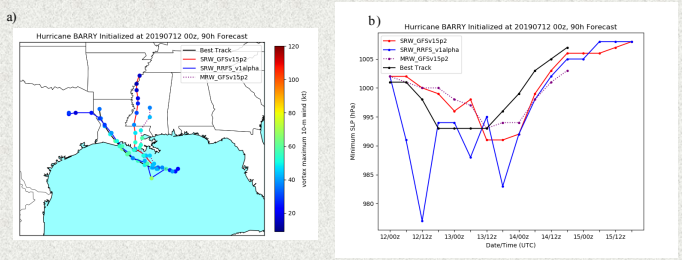
The signal in RRFS_v1alpha is much stronger than that of SRW v15p2 and MRW v15p2.



2 m temperature for a) SRW GFSv15p2, b) SRW RRFS_v1alpha, c) RAP analysis, d) GFSv15p2-RAP ANL, e) RRFS_v1alpha – RAP ANL, and f) MRW GFSv15p2

Hurricane Barry

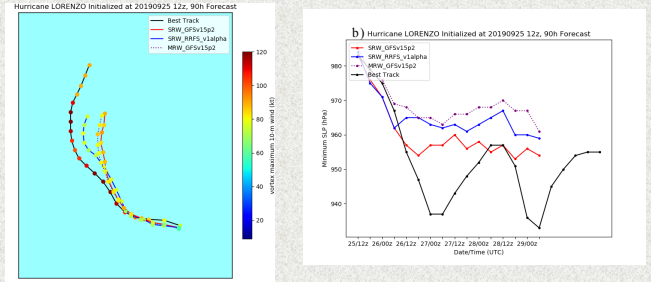
The simulation with RRFS_v1alpha is closer to the best track, and its central pressure has big variation.



HurricaneBarry track (left) and central pressure (right) from different physics suites.

Hurricane Lorenzo

The simulation with RRFS_v1alpha is closer to the best track; however its strength is weaker than the observation.



HurricaneLorenzo track (left) and central pressures (right) from different physics suites

Summary

- Nine cases are studied using SRW app 1.0.0 with RRFS_v1alpha and GFSv15p2, and the results are compared with MRW app 1.0.0 results.
- SRW RRFS_v1alpha has slightly better cold air damming signal than that in SRW GFSv15p2, and the results from SRW GFSv15p2 is better than that from MRW GFSv15p2
- The heat wave signal in SRW RRFS_v1alpha is stronger than that in SRW GFSv15p2 and RAP analysis.
- SRW RRFS_v1alpha tends to simulate better hurricane tracks.
- ***On-going work:***
  - Extending the results to 3km horizontal resolution and v16beta
  - Investigating the physics mechanisms behind those biases
  - Extending the current case study website to include the SRW results.

More information: https://ufs-case-studies.readthedocs.io/en/develop/index.html *Email:* Linlin.Pan@noaa.gov

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