Recent development on HAFS-SAR

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Weiguo Wang, Lin Zhu and others in EMC hurricane team

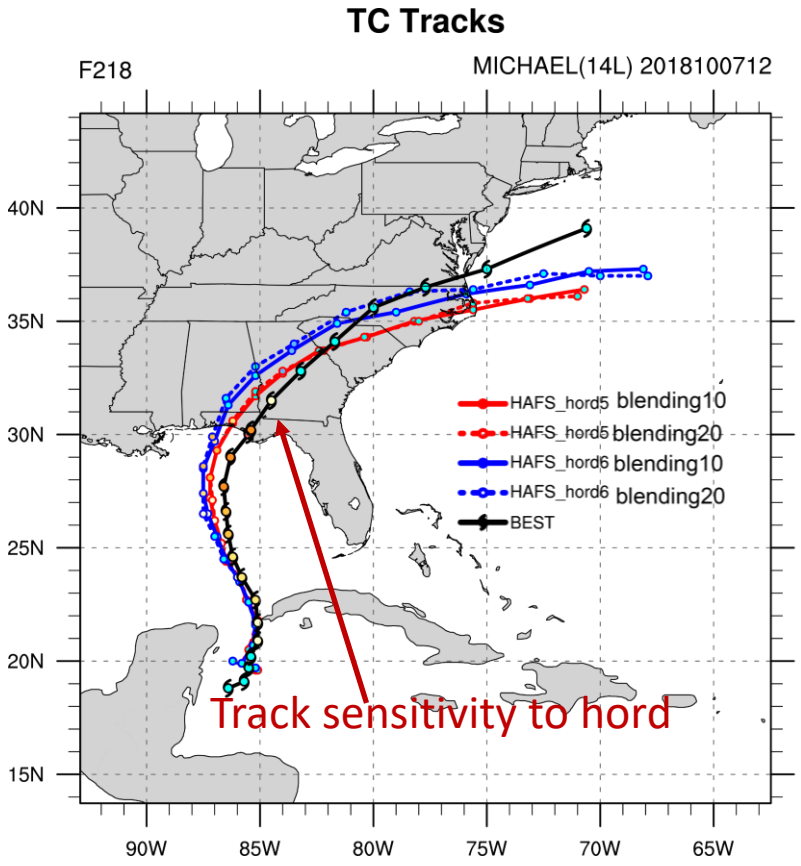
Thanks to Jim Purser, Tom Black and Jeff Beck

- Dynamics
  - Horizontal advection (and lateral boundary blending)

- Grid specification/resolution
  - Increasing horizontal resolution
  - Extended Schmidt Gnomonic (ESG) grid

1. Hord and LBC blending for HAFS

Cyc: 2018/10/07/12

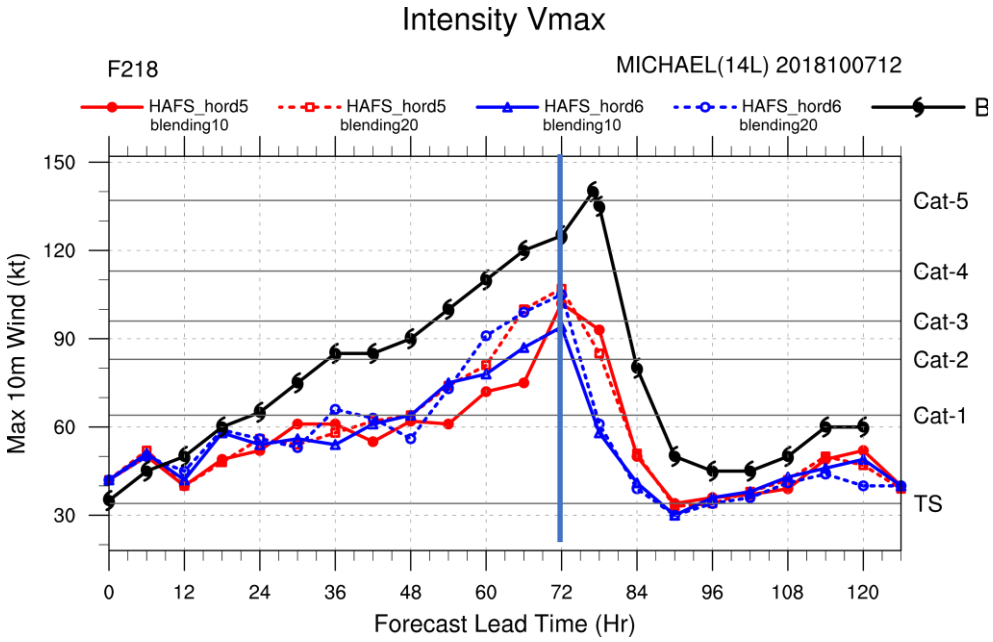


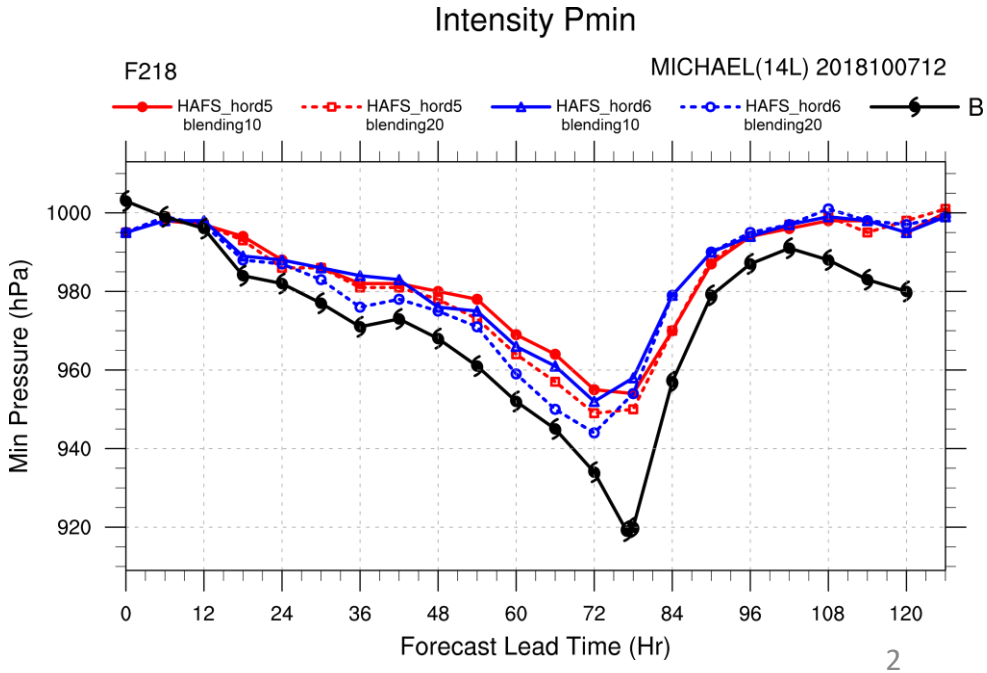
Hord=5

Hord=6

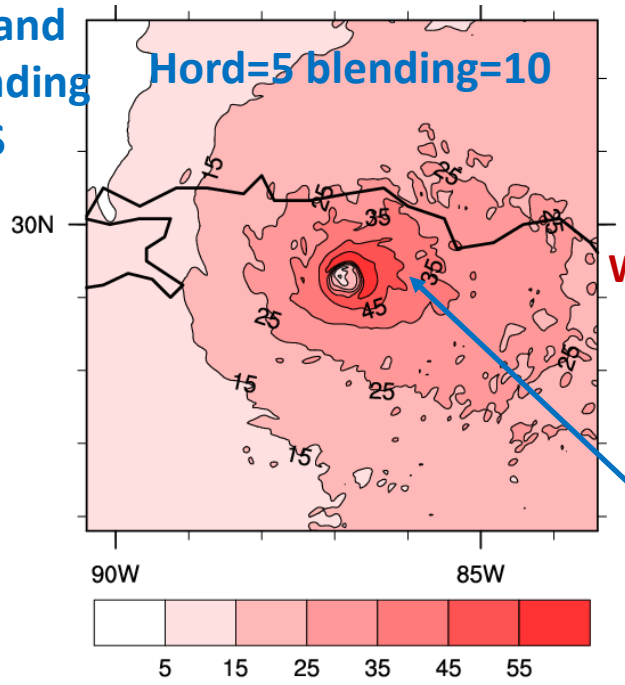
Blending rows=10

Blending rows=20



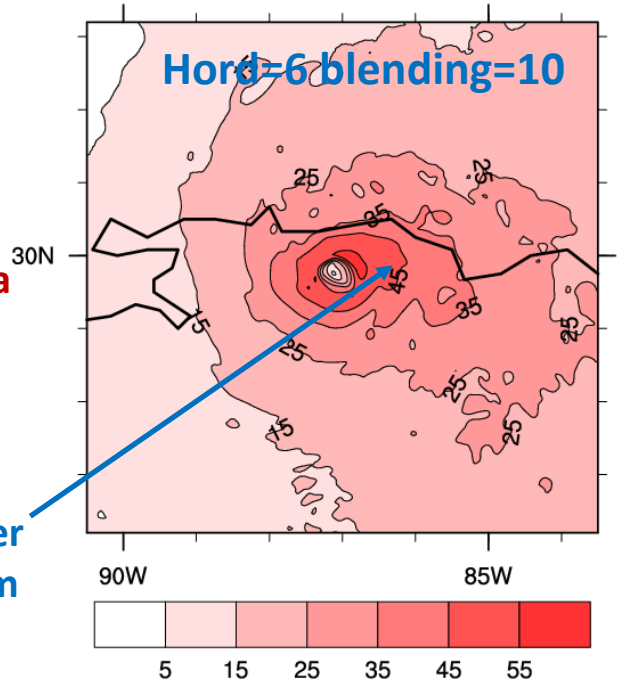


1. Hord and LBC blending for HAFS

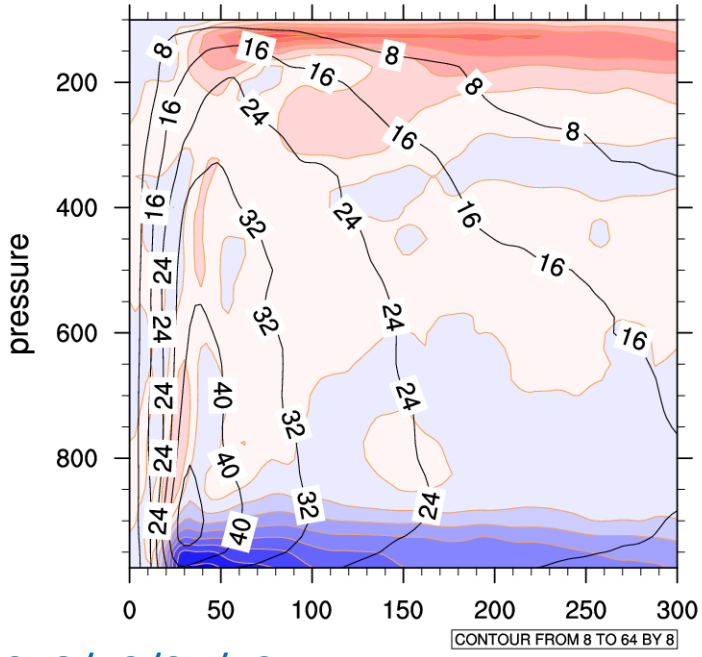


T=72 hrs

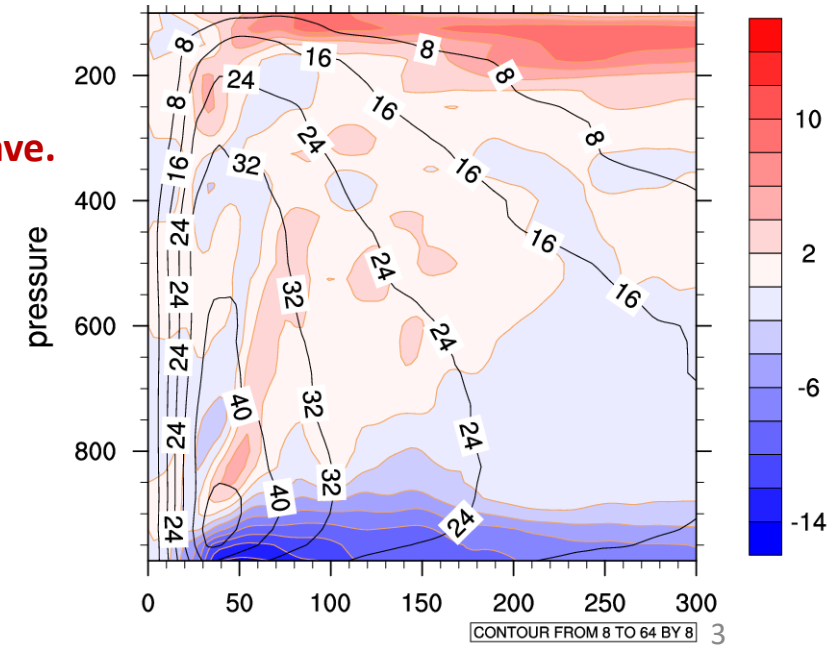
Wind spd at 900 hPa



Hord6: Smoother and bigger storm



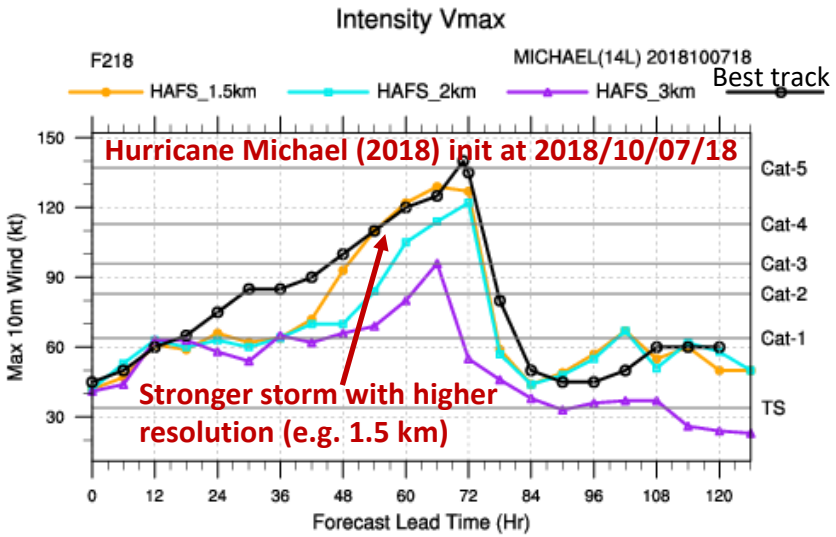
Azimuthal ave. Ut and Ur

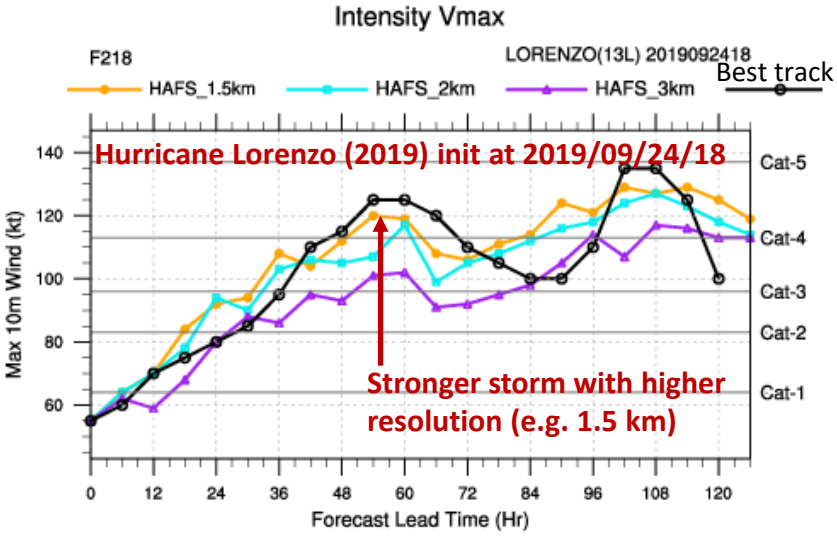


Cyc: 2018/10/07/12

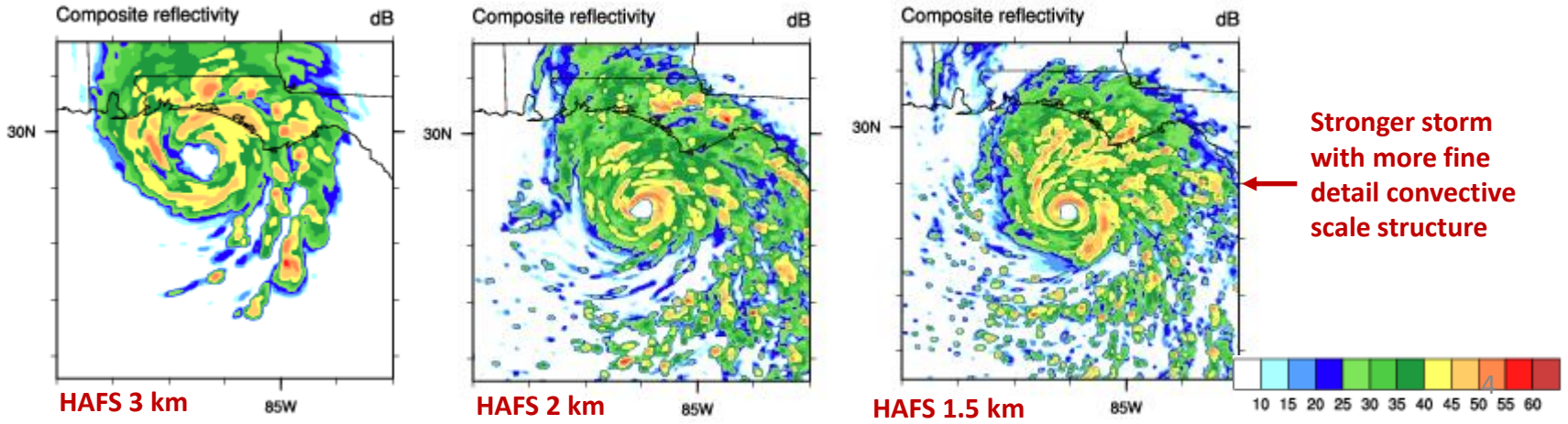
2. Increasing horizontal resolution for HAFS-SAR

- Explore the sensitivity of HAFS intensity forecasts to horizontal resolution
- Increasing horizontal resolution from ~ 3km (2019 HAFS) to 2 km and 1.5 km with static HAFS SAR domains: stronger storm predicted with higher resolution





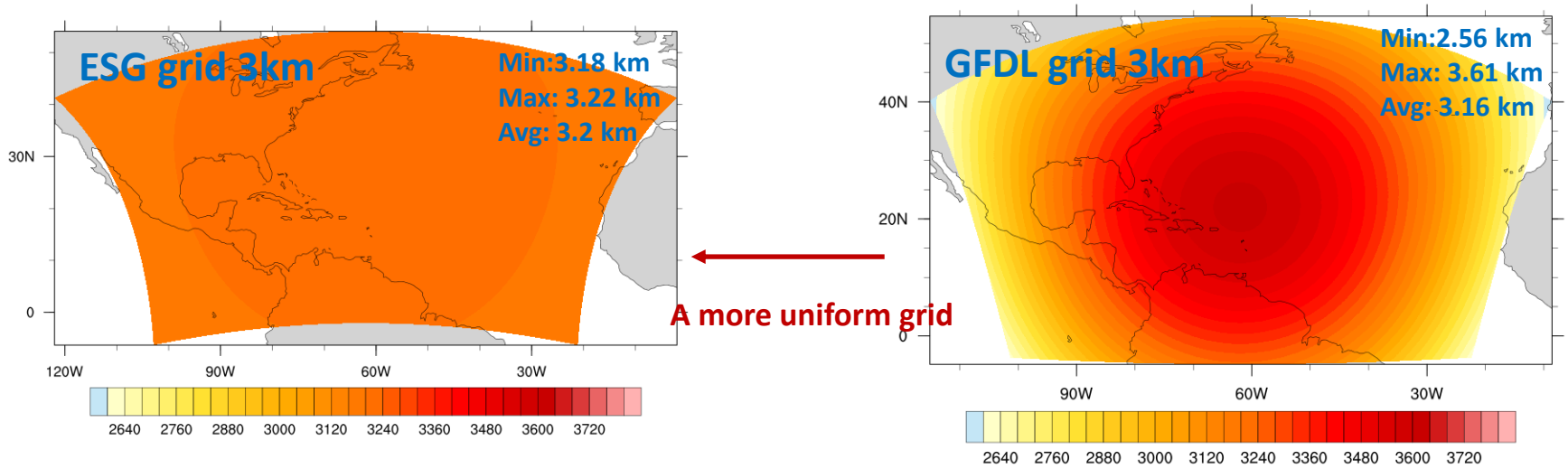
Composite reflectivity for Hurricane Michael valid at 2018/10/10/12



Stronger storm with more fine detail convective scale structure

3. ESG (Extended Schimdt Gnomonic) grid for HAFS-SAR

Horizontal resolution (m)

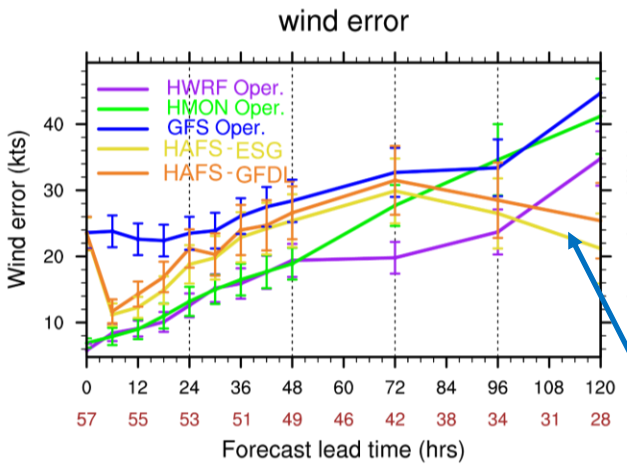


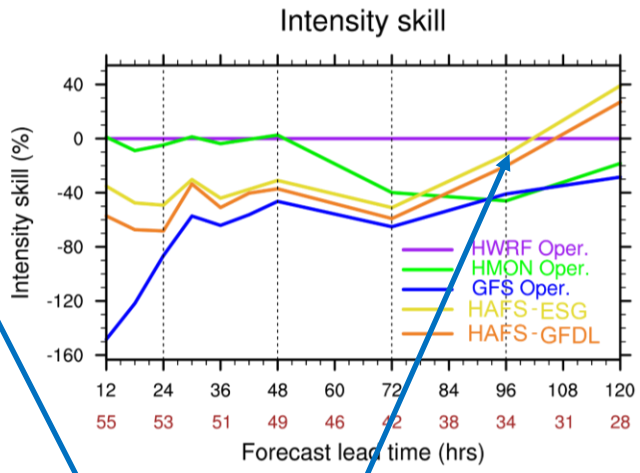
Computing cost (Hera)

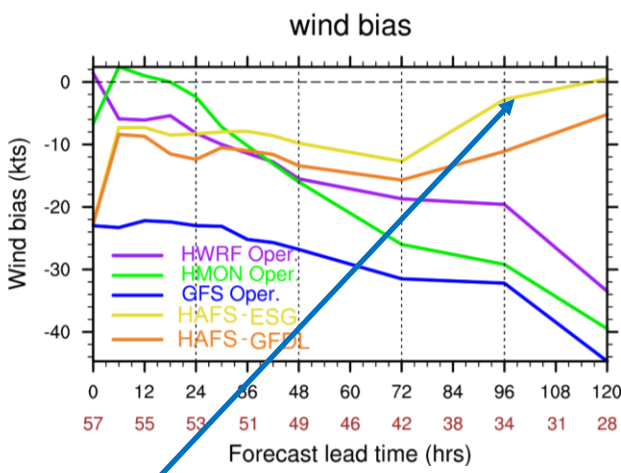
	GFDL 3km	ESG 3km
node #	66	66
walltime	192 min	150 min
dimension	2880x1920	2880x1920

ESG grid 3km: 22% computing time reduced compared to GFDL 3km by increasing timestep

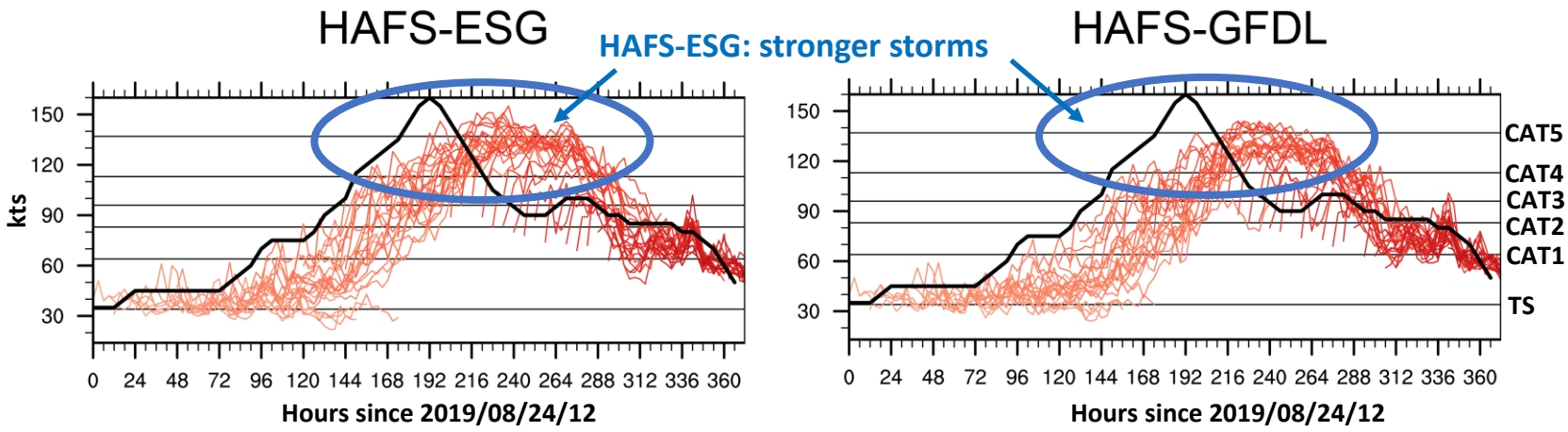
3. ESG grid for HAFS-SAR: track and intensity forecasts for Dorian







HAFS-ESG: smaller intensity error, better intensity skill and reduced negative wind bias



- Track forecasts close to each other
- ESG improve on intensity forecast and reduce negative wind bias
- Size similar; ESG tend to reduce size error in longer lead times
- ESG predicted stronger TC: more cat4 and cat5

Summary

- ESG grid:
  - a more homogeneous grid
  - helps to reduce computing cost
  - 2020 real-time HAFS V0.1J; continue to explore:
    - Lower model top and increase vertical resolution (L75)
    - hord
    - Scale-aware cumulus convection

- Hord and boundary blending
  - Track sensitivity to hord; hord6 smoother than hord5 with larger storm size
  - More cases to test hord5 stability and compare to hord6 in track, intensity and size forecasts
  - Further test on blending rows (20, 10 or less?)

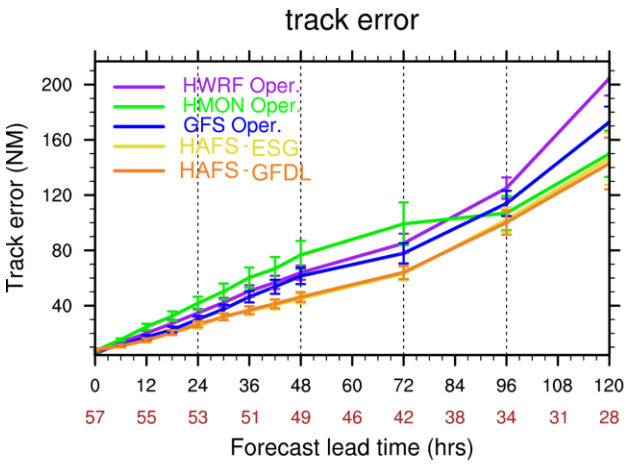
- Manuscript on the 2019 HFIP real-time HAFS-SAR experiments submitted to *Atmosphere* and in revisions

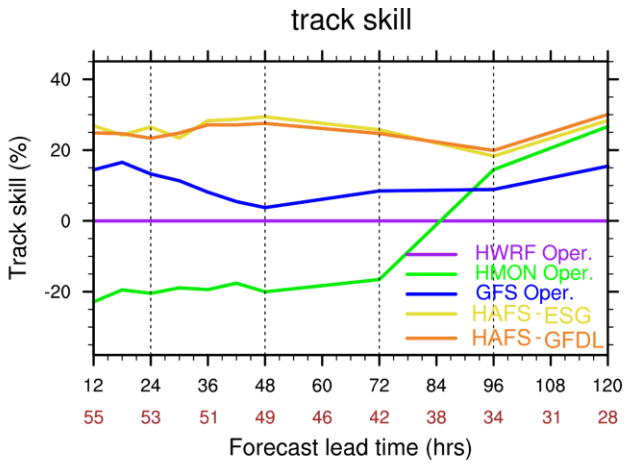
Backup slides

ESG grid for HAFS-SAR: exp setup

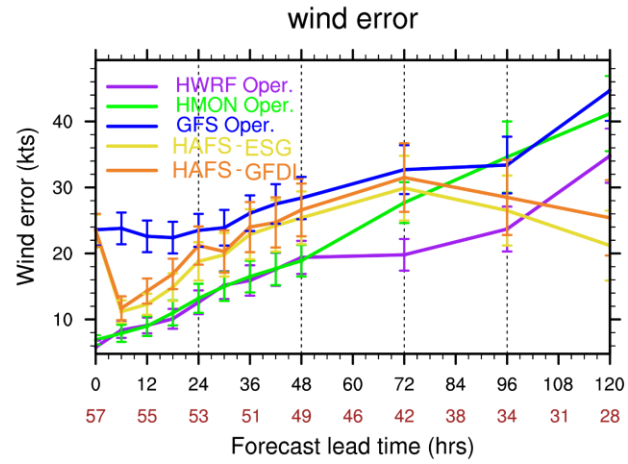
- Same dynamics/physics
- GWD turned off
- Same source code (ufs-weather-model Apr. 23)/platform (xjet)
- Both 64 levels
- Increased timestep for ESG

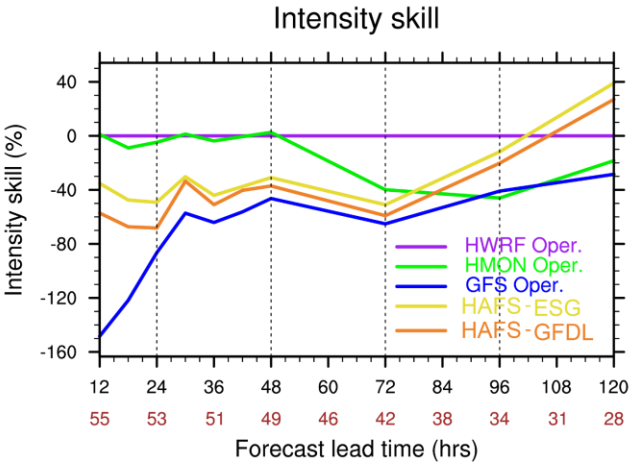
ESG grid for HAFS-SAR: track and intensity forecasts for Dorian

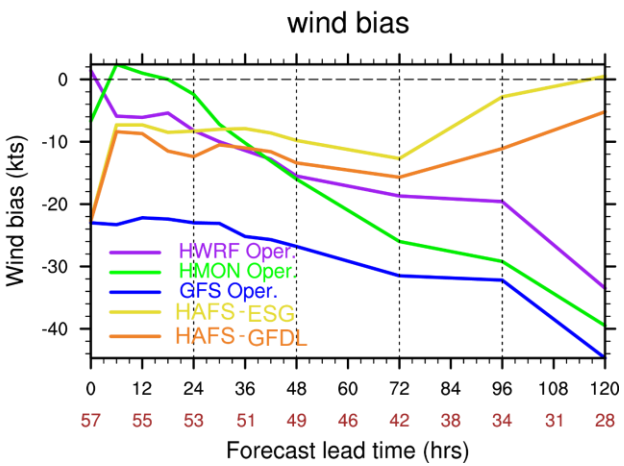




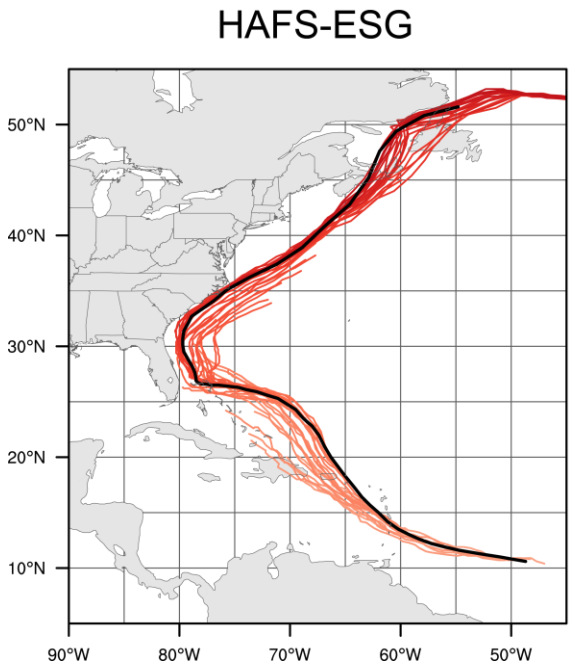
- Track forecasts close to each other
- Improve on intensity forecast and reduce negative wind bias

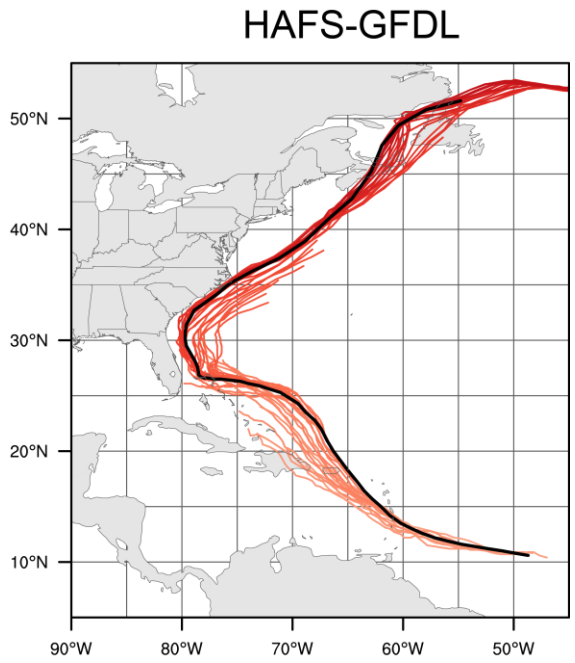


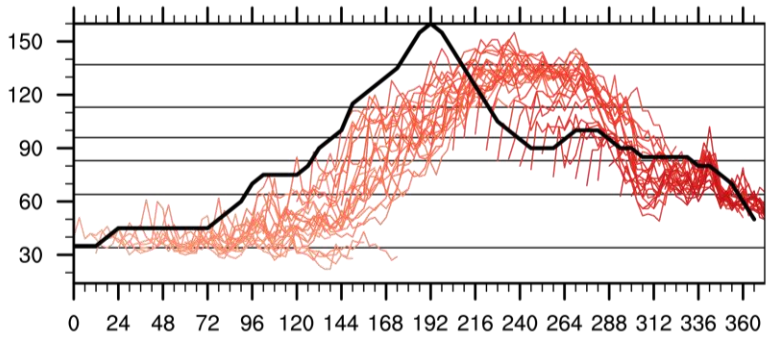


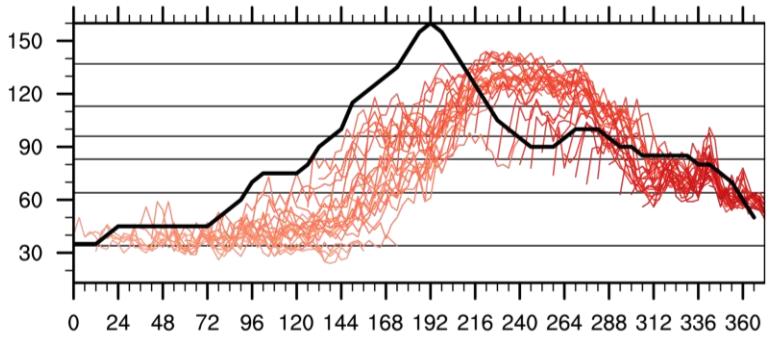


ESG grid for HAFS-SAR: track composite for Dorian

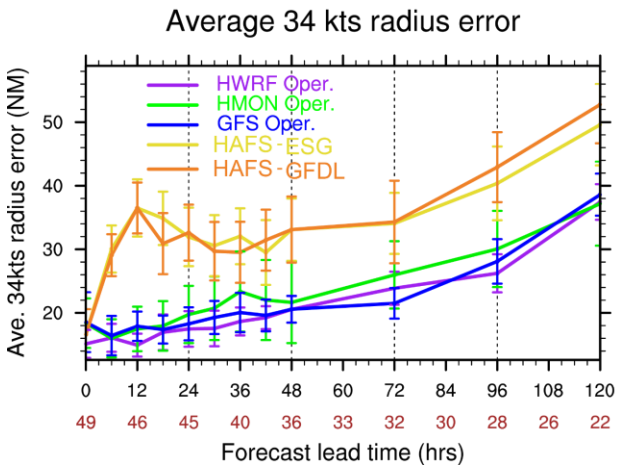


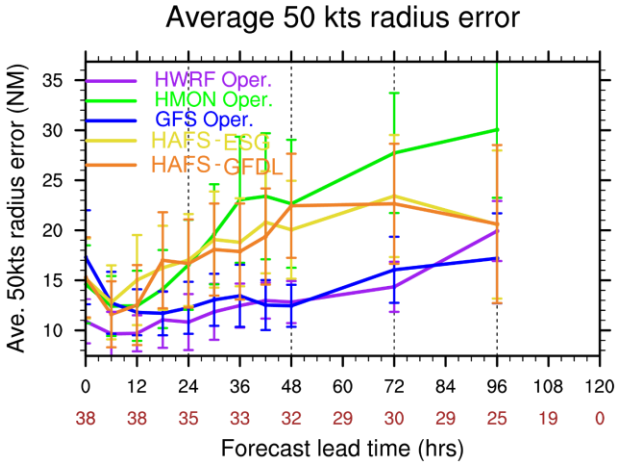


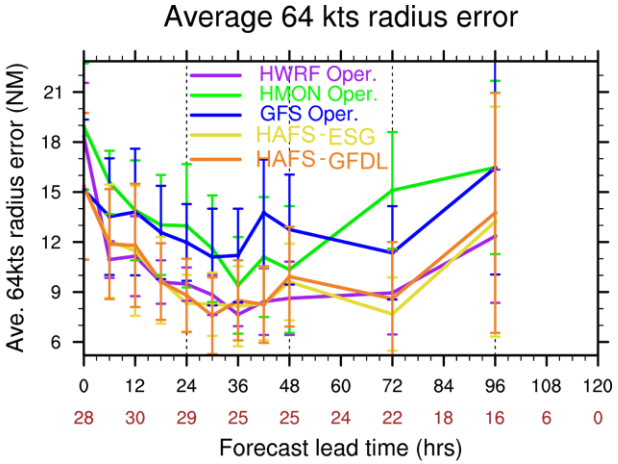




ESG grid for HAFS-SAR: size forecasts for Dorian







Hord and LBC blending for HAFS-SAR

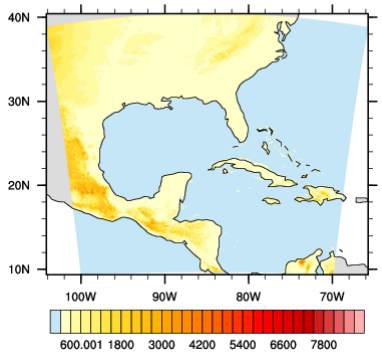
HAFS-SAR horizontal advection and boundary blending exp setup

- Motivation: the least diffusive hord5 caused instability over lateral boundary for HAFS-SAR; Tom Black's lateral boundary blending for relaxation of external BC to alleviate instability issue

- Smaller domain test for two single cycles of Hurricane Michael (2018): 960x960

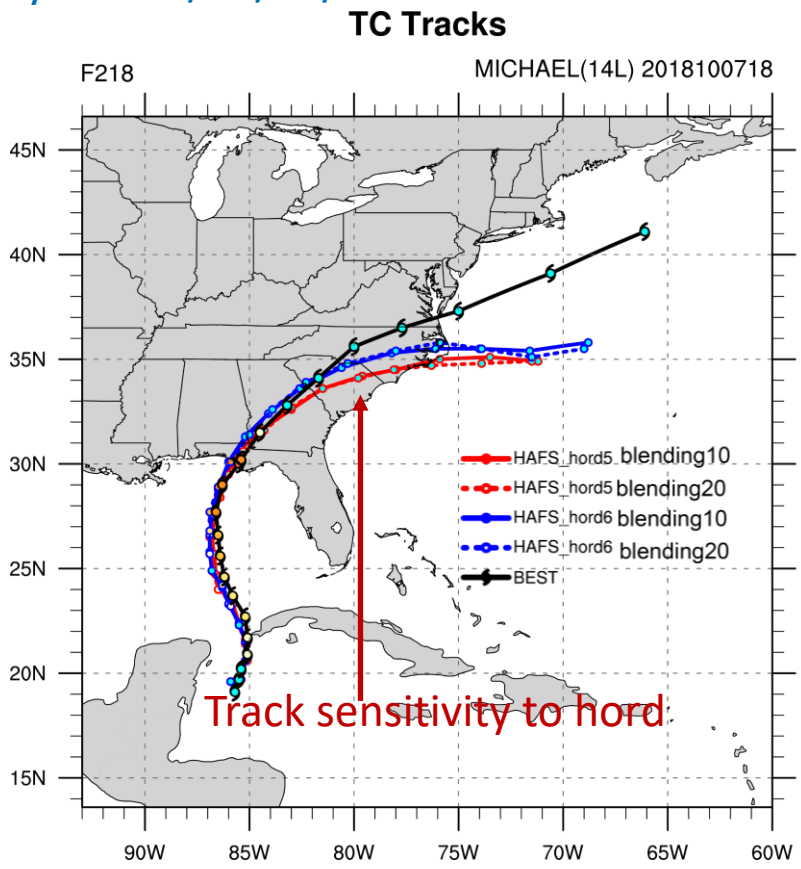
- Run through 126 hours for HAFS-SAR (with CCPP) with hord=5 and hord=6 without crashing

- Blending rows tested: 10, 20



Hord and LBC blending for HAFS

Cyc: 2018/10/07/18

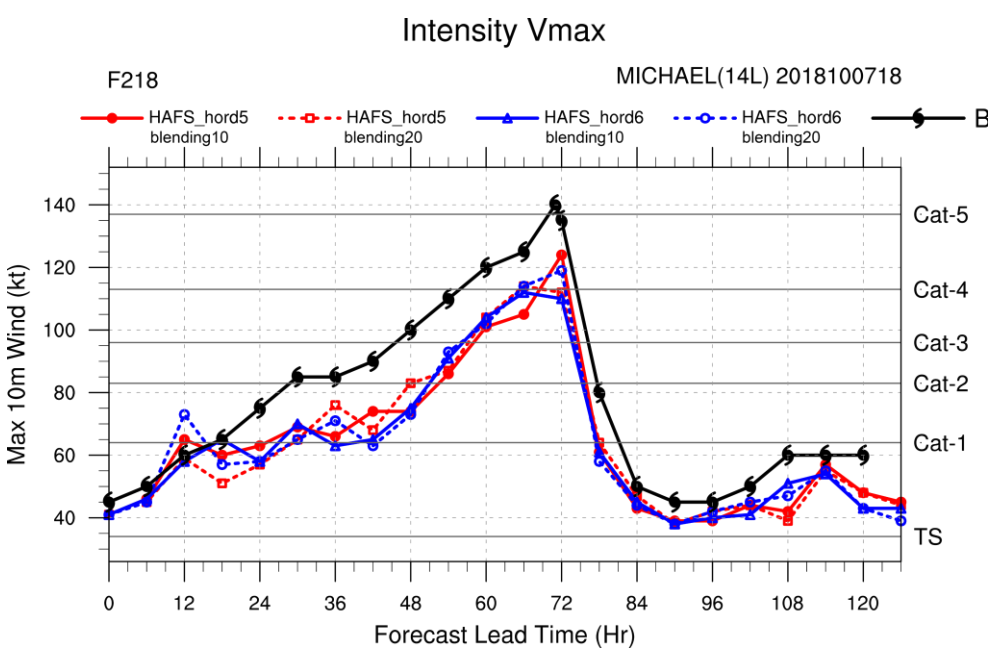


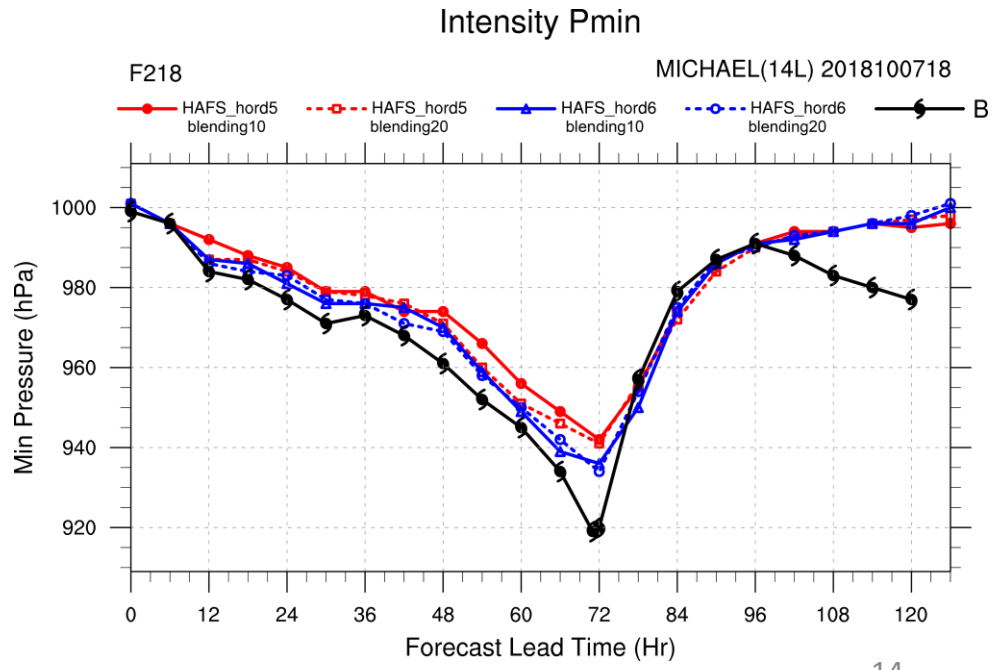
Hord=5

Hord=6

Blending rows=10

Blending rows=20





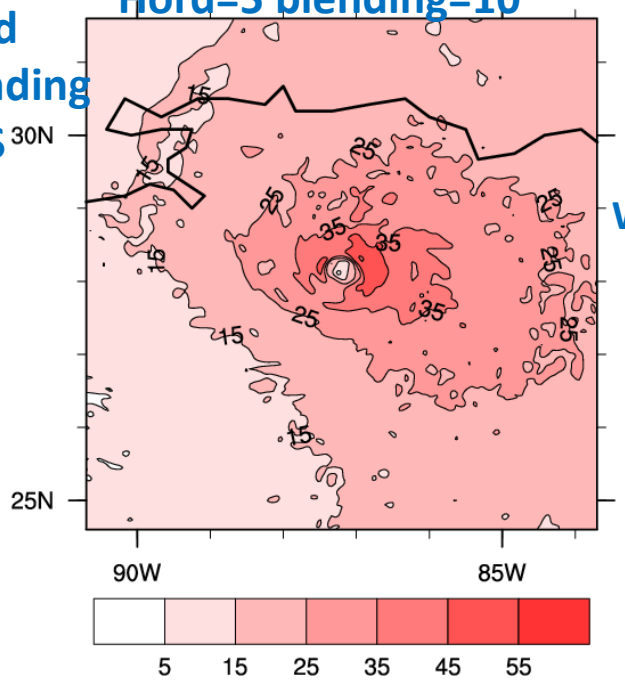
Hord and LBC blending for HAFS

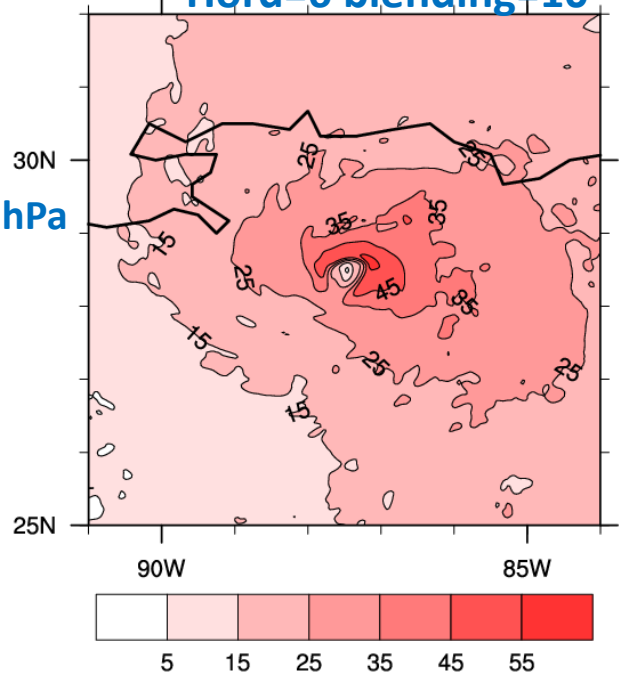
Hord=5 blending=10

T=66 hrs

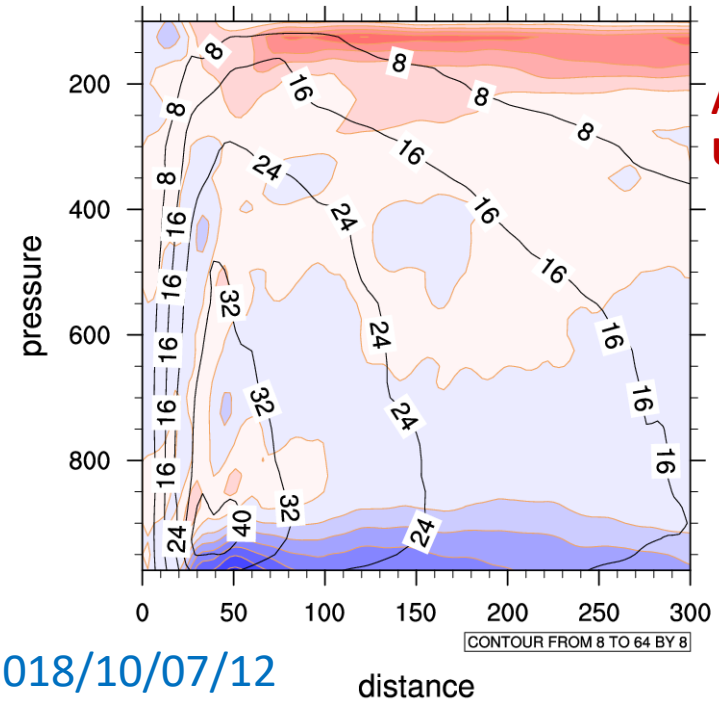
Hord=6 blending=10

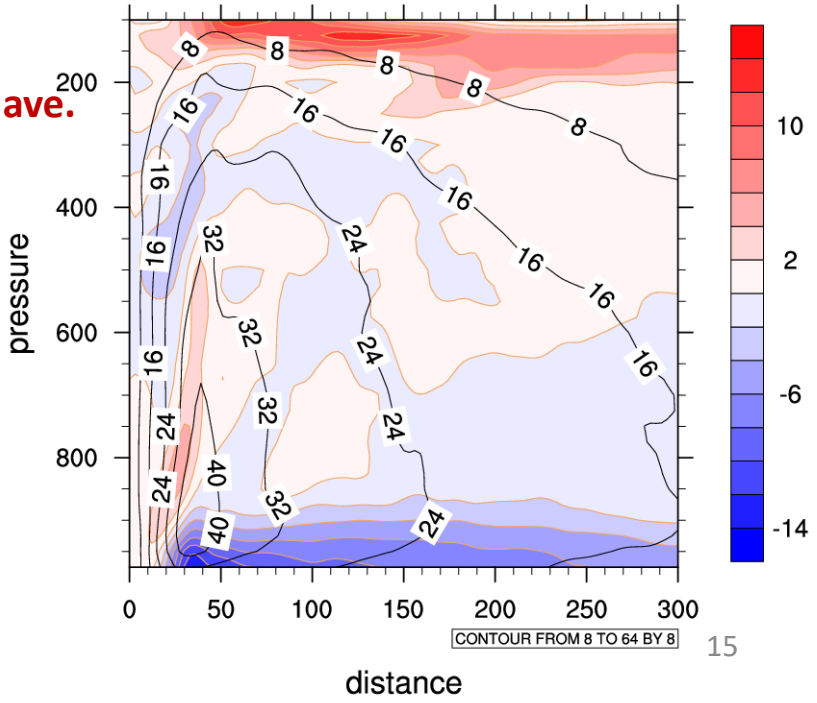
Wind spd at 900 hPa





Azimuthal ave. Ut and Ur





Cyc: 2018/10/07/12

Computing cost (xjet)

	2019 HAFS-SAR GFDL	2020 HAFS-SAR ESG
node #	112	70
walltime	240 min	270 min
dimension	2880x1920	2880x1920