HAFS-MOM6 coupling: Developments and preliminary results

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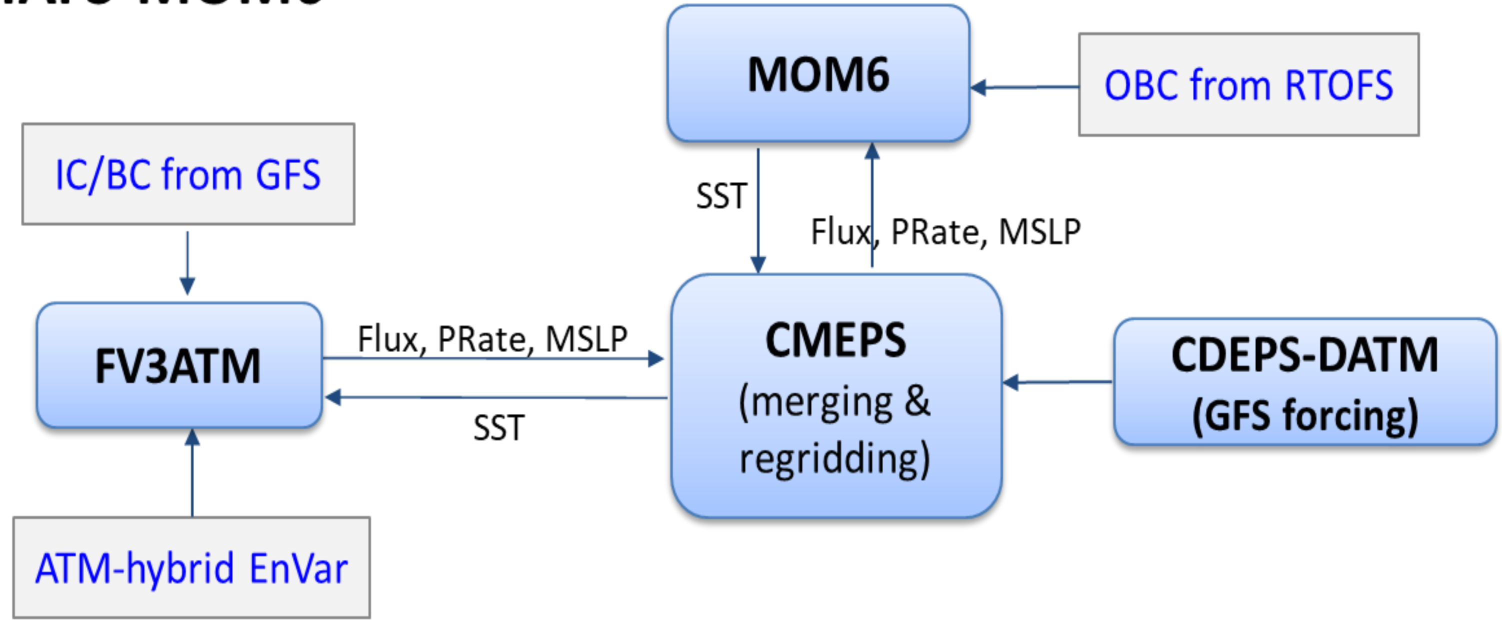
Hyun-Sook Kim[1], Bin Li[2], Lew Gramer[3], HeeSook Kang[4], Maria Aristizabal[2], John Steffen[5], Bin Liu[2], Biju Thomas[2], Zhan Zhang[6] and Avichal Mehra[6]

[1]NOAA/AOML/PhOD; [2]Lynker at NOAA/NWS/NCEP/EMC; [3]University of Miami & NOAA/AOML/HRD; [4]University of Miami & NOAA/AOML/PhOD; [5]SAIC at NOAA/NWS/NCEP/EMC; [6]NOAA/NWS/NCEP/EMC

HAFS-MOM6



IC/BC from GFS

FV3ATM

ATM-hybrid EnVar

Flux, PRate, MSLP

SST

MOM6

OBC from RTOFS

SST

Flux, PRate, MSLP

CMEPS
(merging &
regridding)

CDEPS-DATM
(GFS forcing)

Model Configuration

1. Two operational configurations – HFSA and HFSB
2. No differences from HFSA, except the ocean model is MOM6 instead of HYCOM, and some exchange variable differences
3. **No parameter tuning** (yet)
4. ICs and BCs from global RTOFS, the same as the HYCOM in HFSA.

Test cases (19 storms, 542 cases)

2022: Danielle, Earl, Fiona, Gaston, Ian

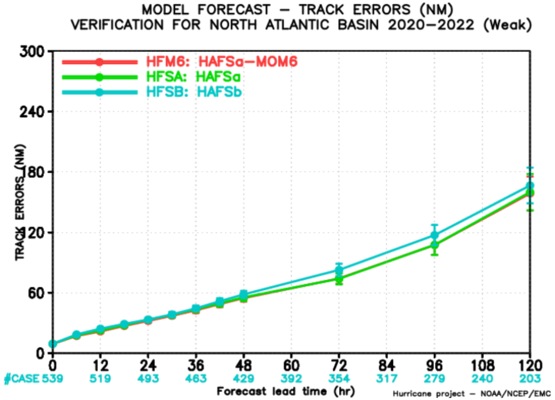
2021: Elsa, Fred, Grace, Henri, Ida, Larry, Sam

2020: Hanna, Isaias, Laura, Marco, Sally, Teddy, Delta, Zeta

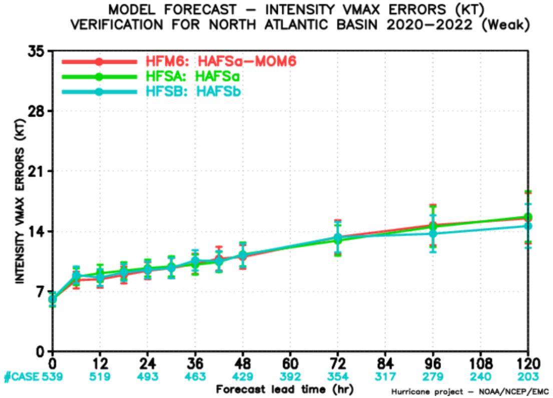
Verification

Mean Absolute Error (MAE)

(A) Track

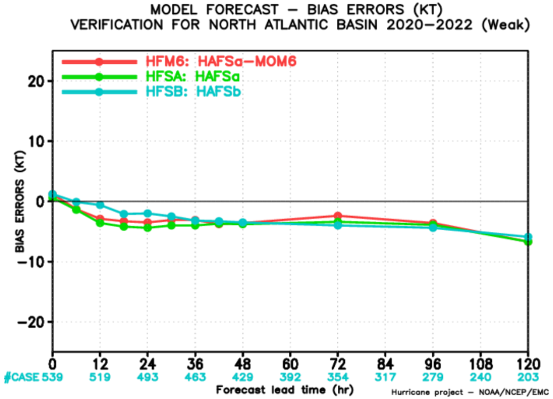


(B) Vmax

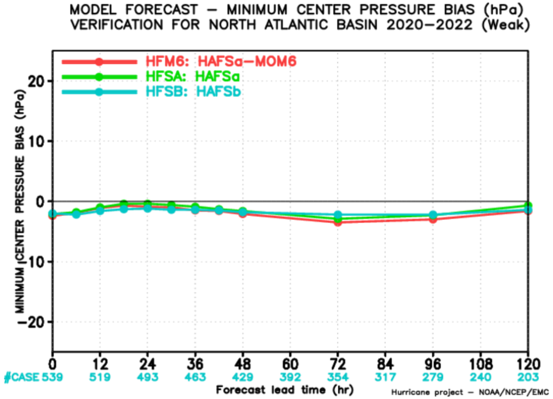


Bias

(A) Vmax



(B) Pmin



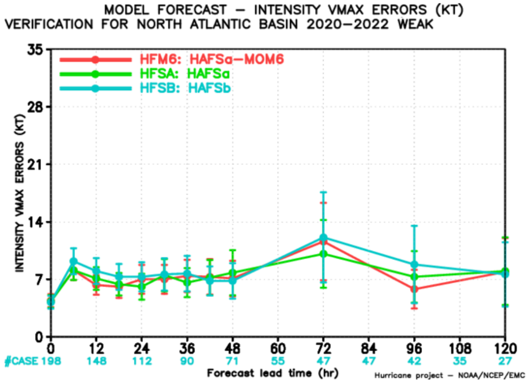
Intensity stratified verification

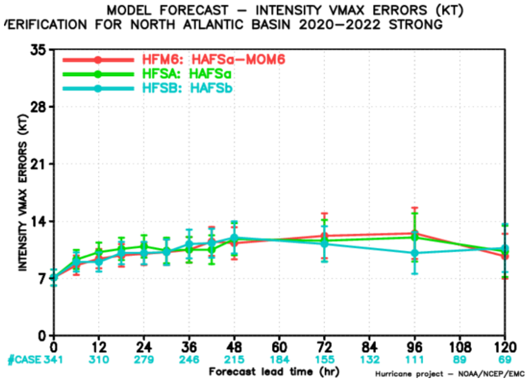
Vmax

(a) Weak

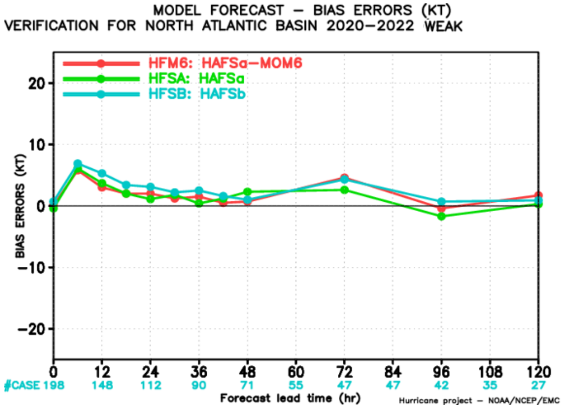
(b) Strong

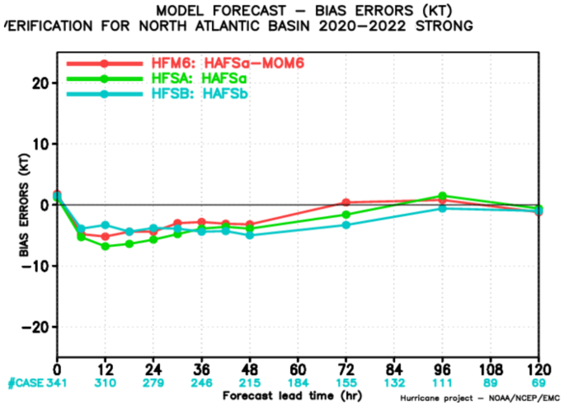
MAE





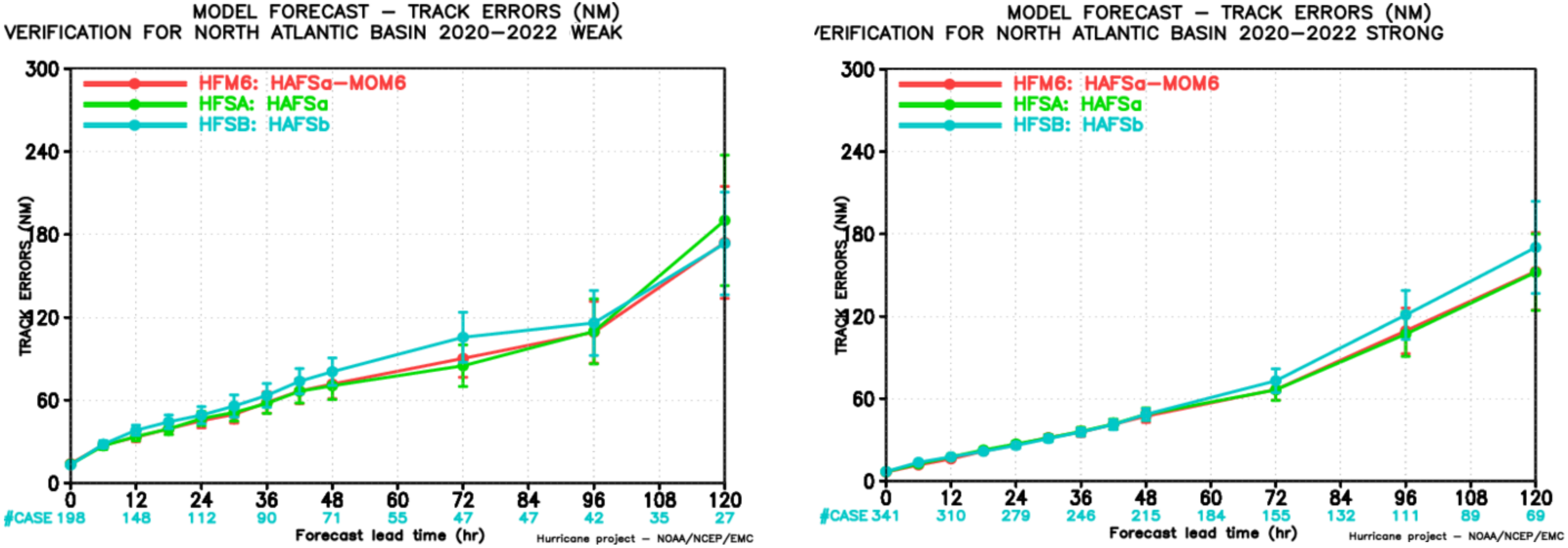
Bias





Intensity stratified verification

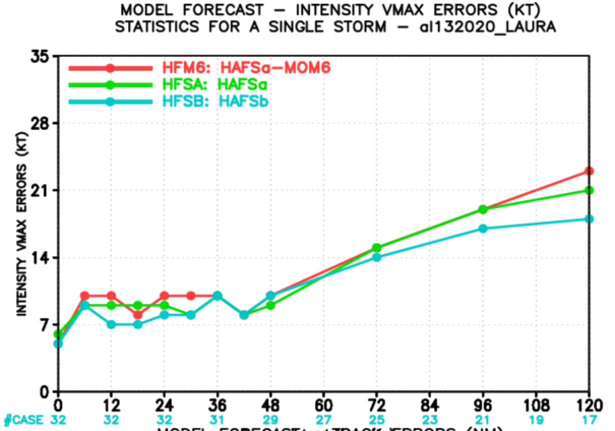
Track

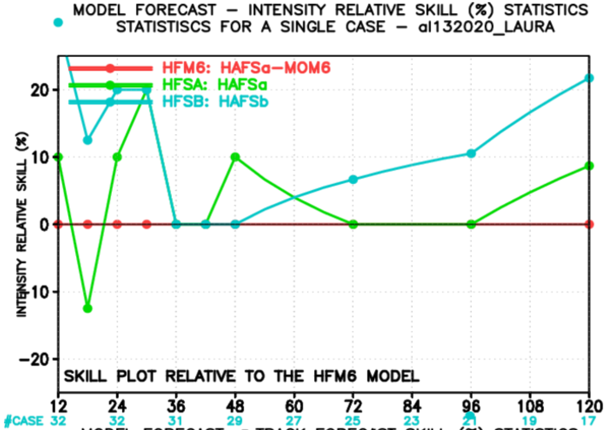


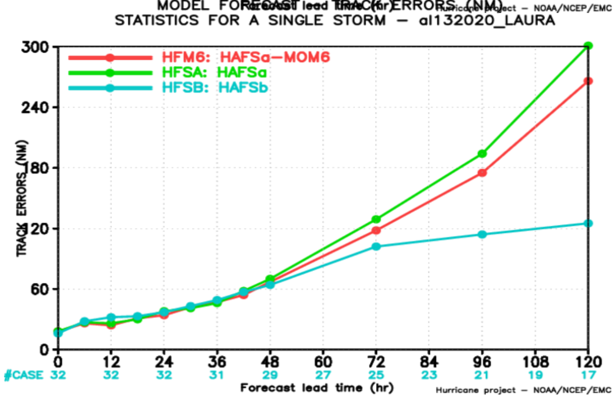
(a) Weak

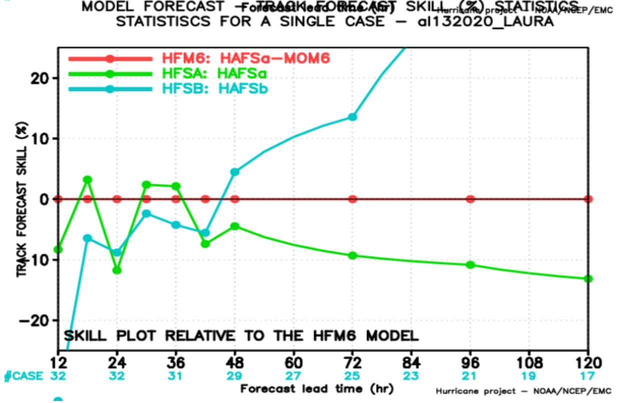
(b) Strong

Hurricane Laura (among worse simulations, including Elsa (2021), Henri (2021) and Earl (2022))


MODEL FORECAST – INTENSITY VMAX ERRORS (KT)
STATISTICS FOR A SINGLE STORM – al132020_LAURA

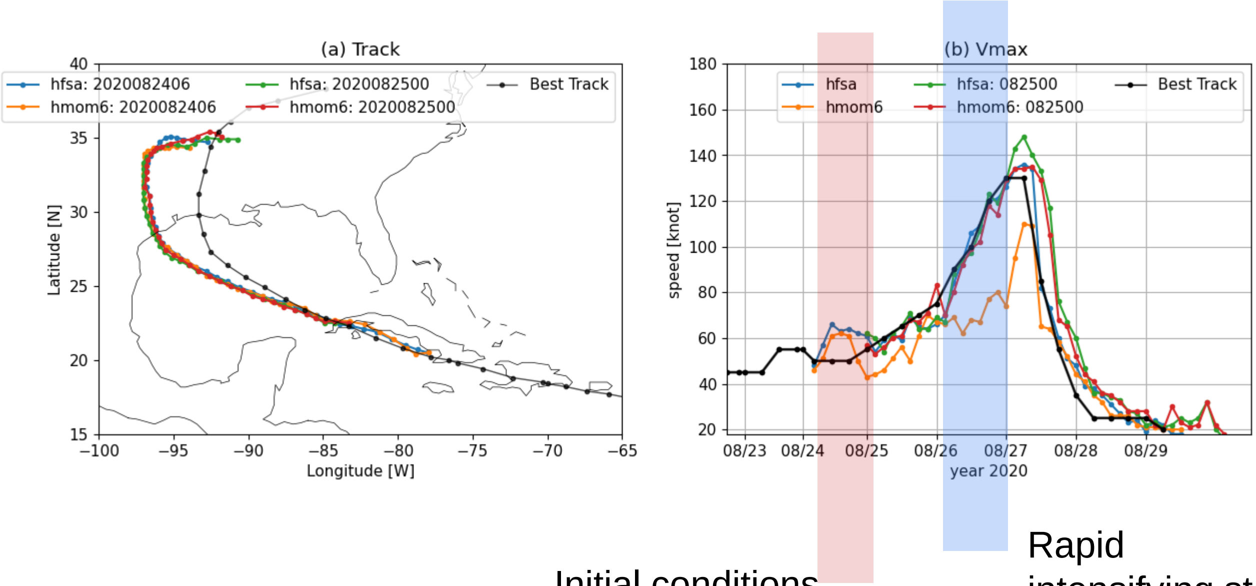

MODEL FORECAST – INTENSITY RELATIVE SKILL (%) STATISTICS
STATISTISCS FOR A SINGLE CASE – al132020_LAURA


MODEL FORECAST – TRACK ERRORS (NM)
STATISTICS FOR A SINGLE STORM – al132020_LAURA


MODEL FORECAST – TRACK FORECAST SKILL (%) STATISTICS
STATISTISCS FOR A SINGLE CASE – al132020_LAURA

Hurricane Laura (13L) 2020

cycle 2020082406 vs 2020082500

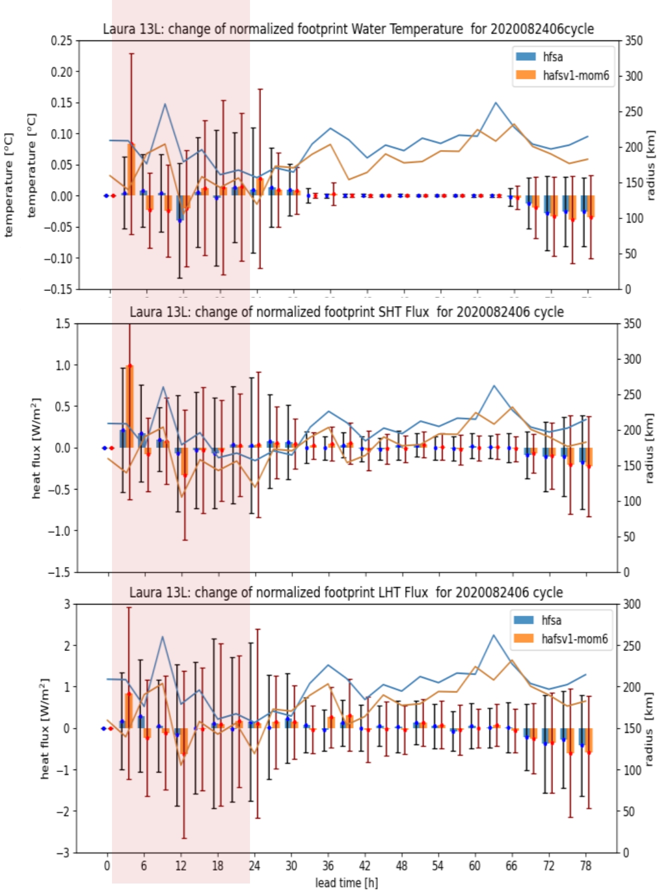


Initial conditions and development in early lead time

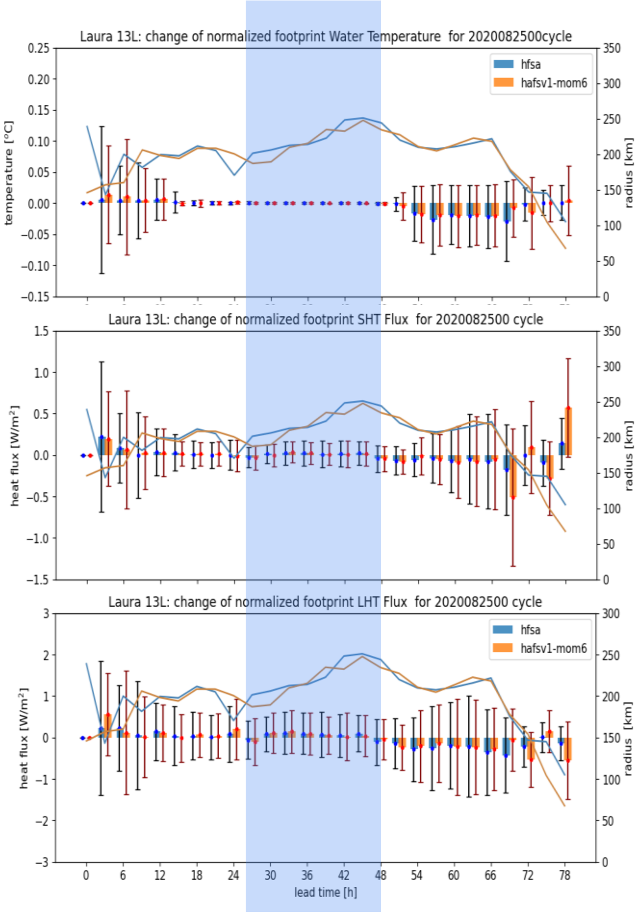
Rapid intensifying stage

Thermal properties in the air-sea interaction zone

(A) 2020082406



(B) 2020082500



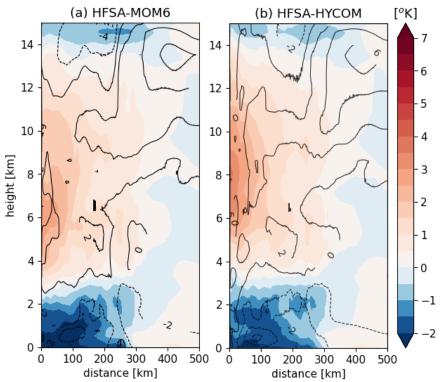
ΔWTMP

ΔSHT flux

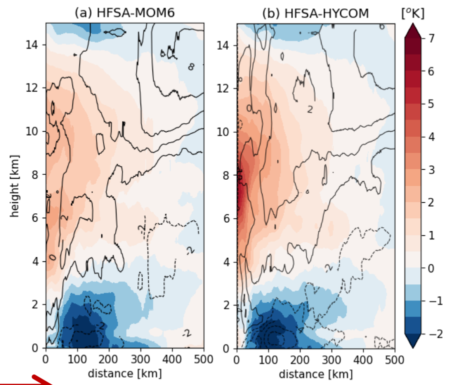
ΔLHT flux

Initial conditions and development stage (2020082406)

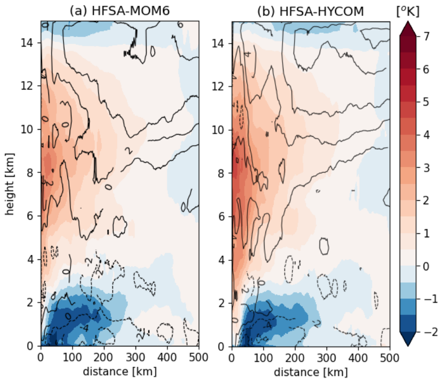
cycle 2020082406: f000



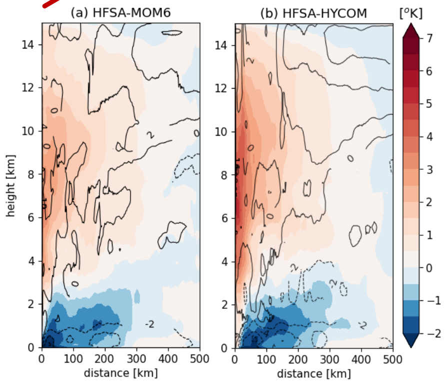
cycle 2020082406: f006



cycle 2020082406: f012

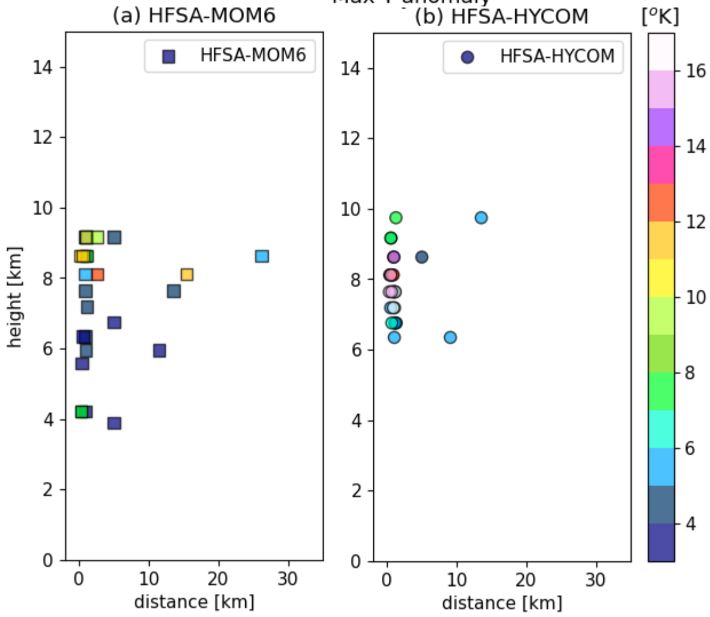


cycle 2020082406: f018

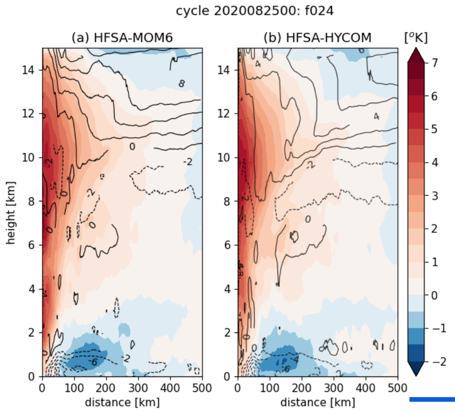


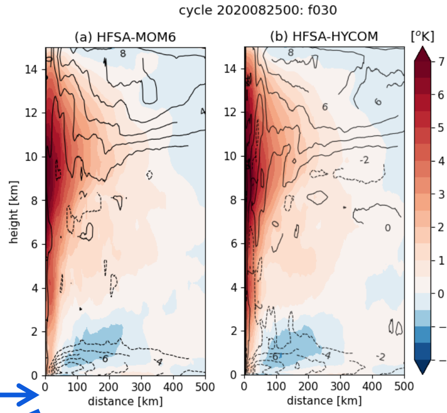
Laura (13L): IC=2020082406

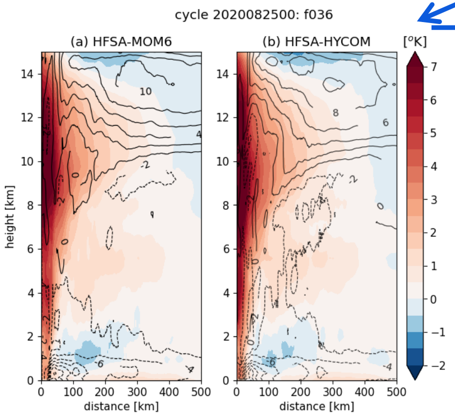
Max T anomaly

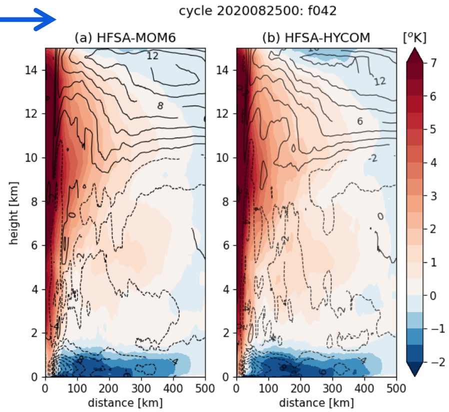


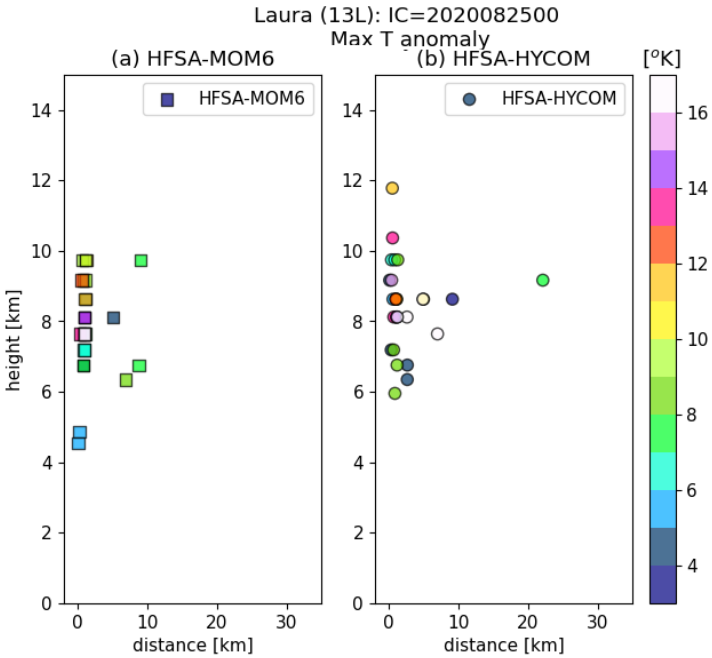
Rapid intensifying stage (2020082500)



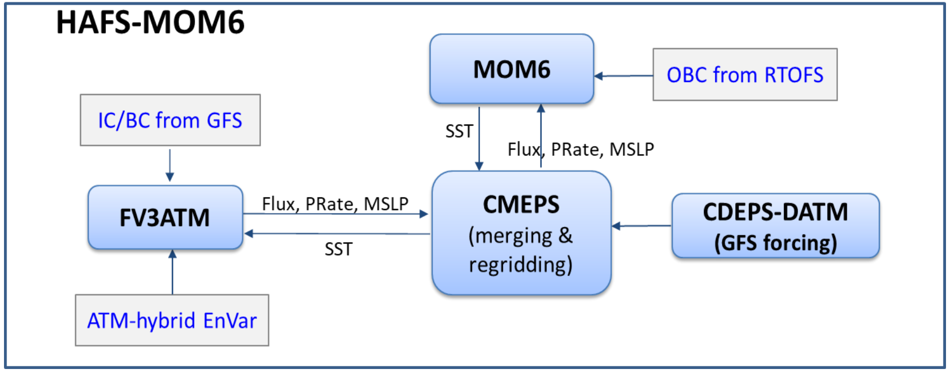








UFS Technical challenge for regional application



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MOM6

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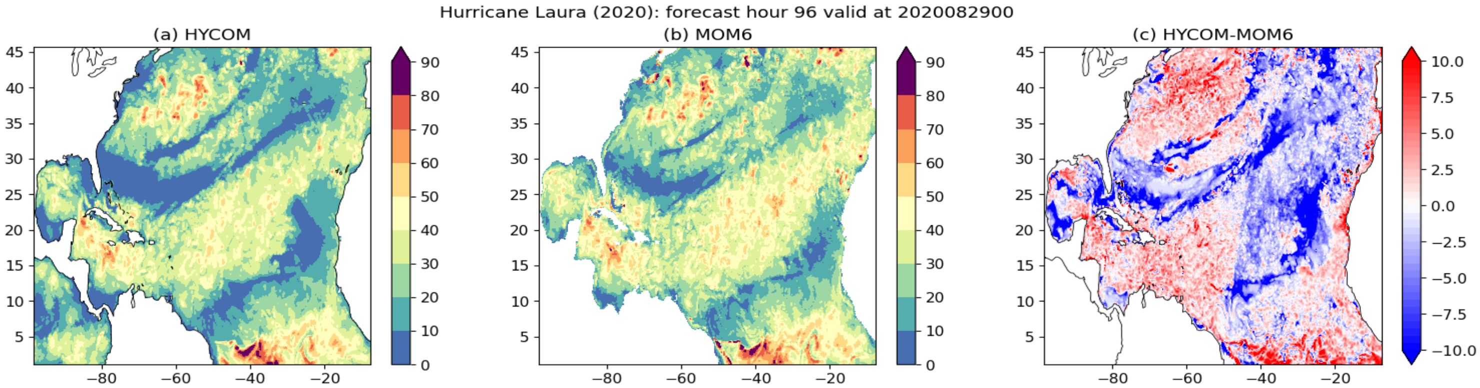
(GFS forcing)

ATM-hybrid EnVar

merged flux $= flux^{fv3} * \delta + flux^{cdep} * (1 - \delta)$

where $\delta = 1$ in overlapped regions
$\delta = 0$ in non-overlapped regions

Mixed Layer Depth (MLD) after 96 hour integration



Hurricane Laura (2020): forecast hour 96 valid at 2020082900

(a) HYCOM
(b) MOM6
(c) HYCOM-MOM6
45
40
35
30
25
20
15
10
5
−80
−60
−40
−20
90
80
70
60
50
40
30
20
10
0
10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0

Concluding remarks

HFSA is insensitive to an ocean model component, where tests are done for HYCOM vs MOM6. Noted is that both the systems use the same ocean IC.

However, the TC structures are different, especially thermal properties.
There is significant T anomalies for HFSA-HYCOM exhibiting significant contrast in the anomaly, and warming at higher altitude, relative to the counterpart HFSA-MOM6.

To support this finding, extended analysis is in progress.

UFS's regional application challenge:

Treatment for state variables to cover non-overlapped areas for the FV3 and MOM6 domains.