NOAA Global Systems Laboratory

Investigating SST Bias in the UFS Seasonal Forecast

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Experiment Setup with UFS Seasonal Forecast System

Components	Resolutions	IC Sources
FV3 Atmosphere	1º, 64 layers	CFSR
MOM6 Ocean	1º, 75 layers	ORAS5
CICE6 Sea Ice	1º	ORAS5

<u>**Model source Code**</u>: UFS Prototypes **P8** & **HR3**

<u>**Initial Conditions**</u>: May 21-25 1991-2022, five ensemble members
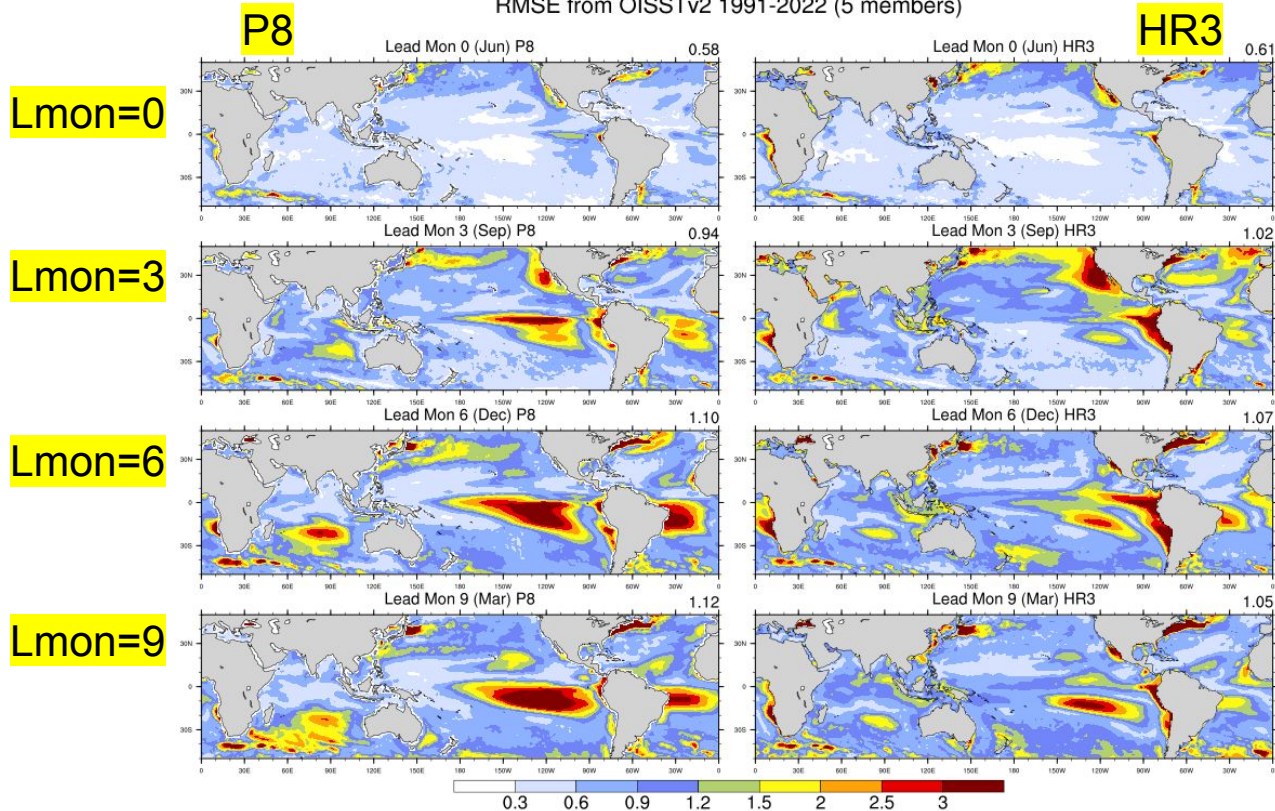
<u>**Integration time**</u>: 12 months

<u>**Observations**</u>: OISSTv2 & CERES

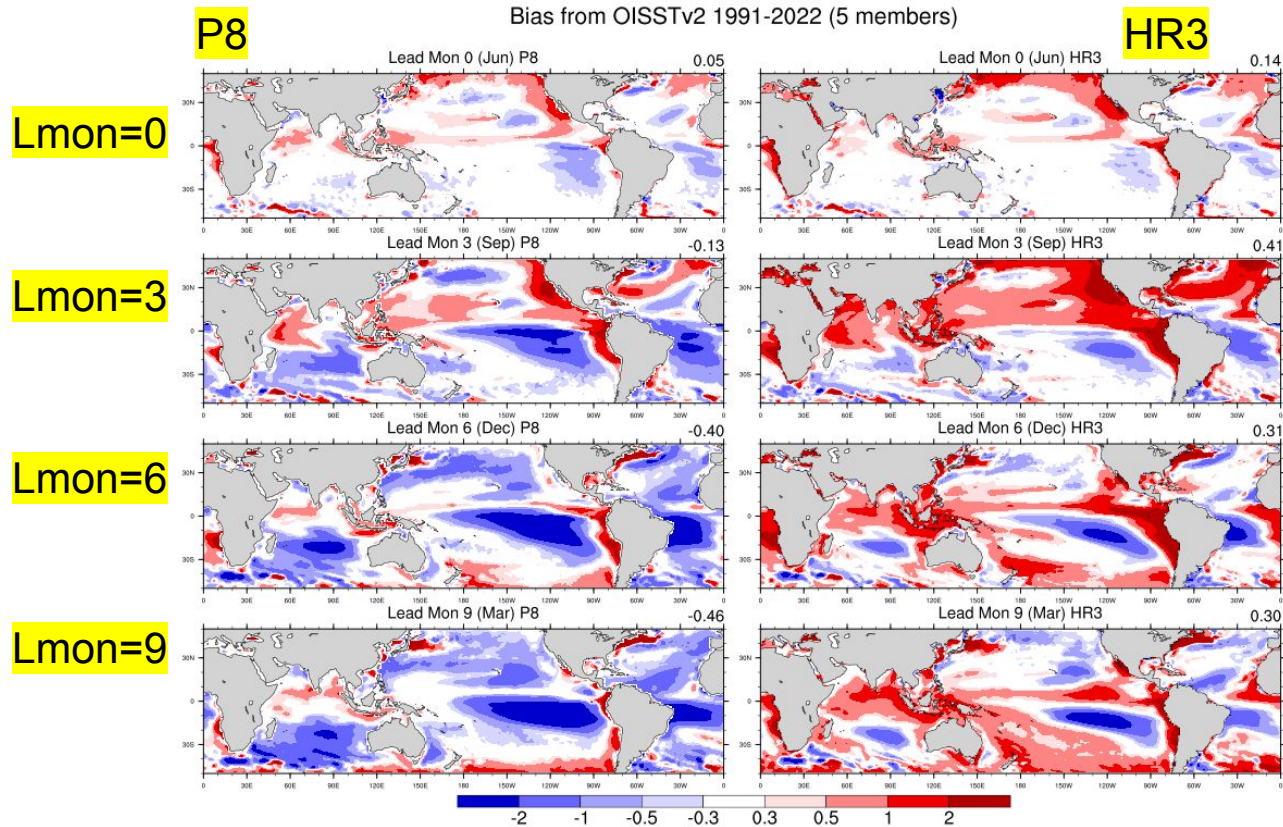Ensemble mean is used in all evaluations

RMSE in SST in Seasonal Forecast System
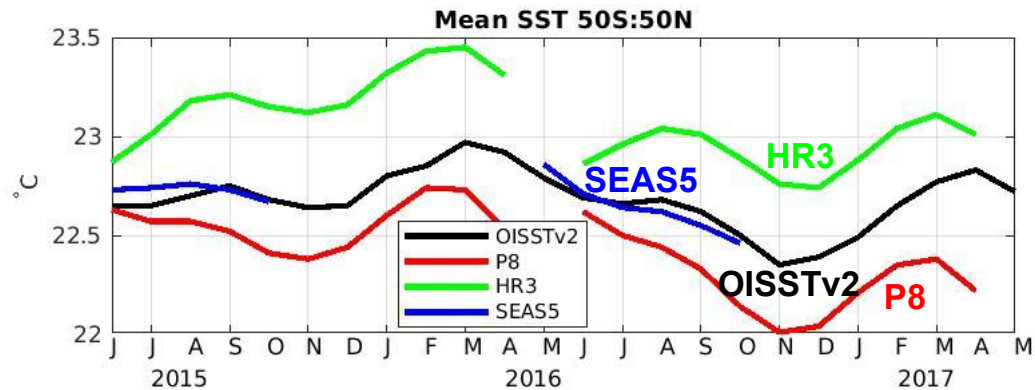
RMSE from OISSTv2 1991-2022 (5 members)

RMSE in SST is smaller in HR3 than in P8 in SE Pacific, EQ Atlantic and S Indian Ocean, but is bigger along the east coast of Pacific

Bias in SST in Seasonal Forecast System
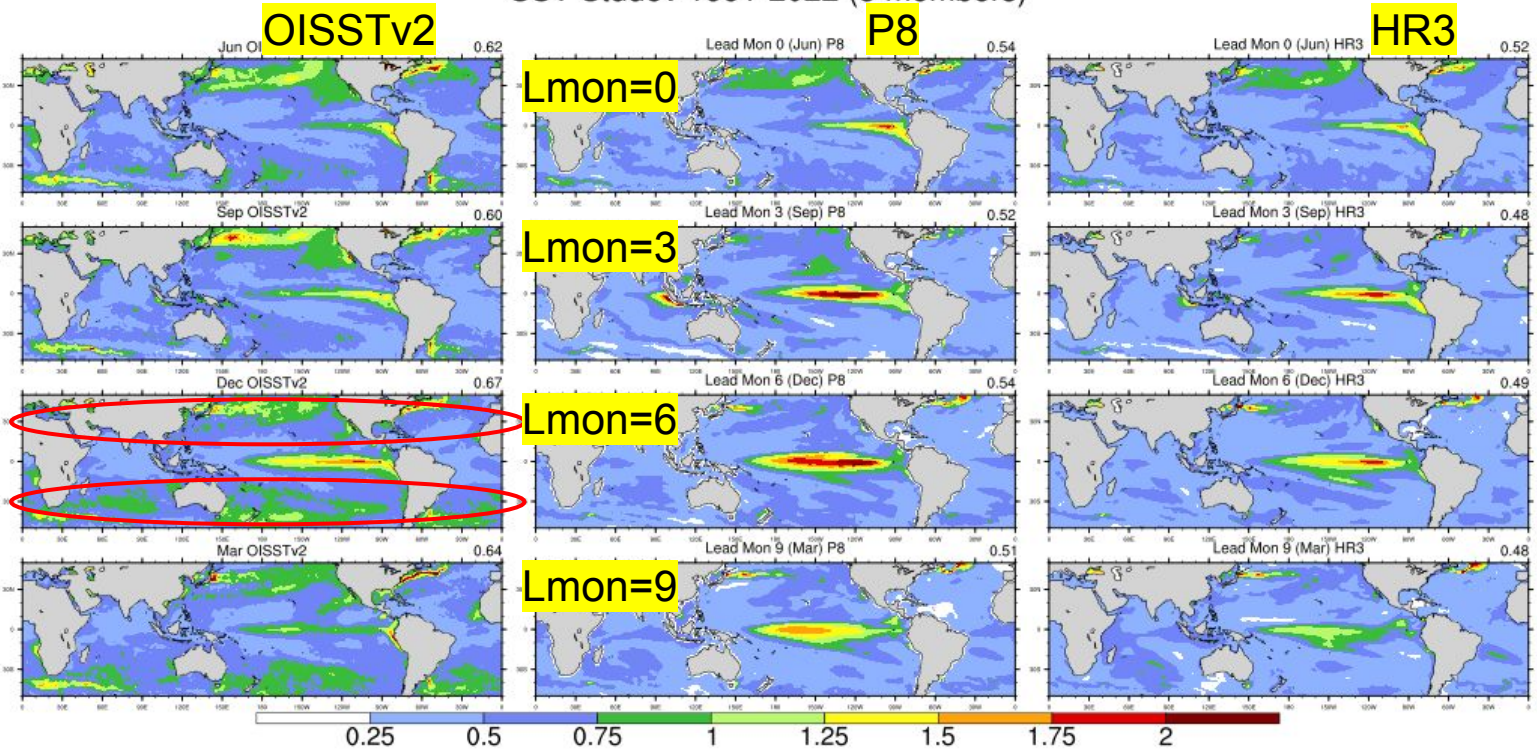

P8 has a cold bias, and HR3 has a warm bias

Global Mean SST in Seasonal Forecast System

Mean SST 50S:50N

- Near global SST in HR3 has a warm bias, while P8 has a cool bias, compared to OISSTv2

- The bias in both P8 and HR3 is larger than that in SEAS5 from ECMWF

SST Interannual Variabilities in SFS
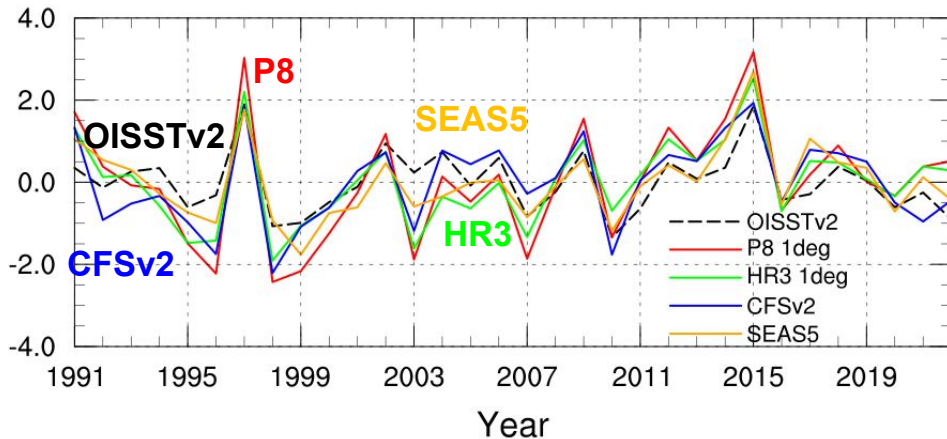

SST Stddev 1991-2022 (5 members)

SST interannual variability in HR3 is closer to OISSTv2 than in P8
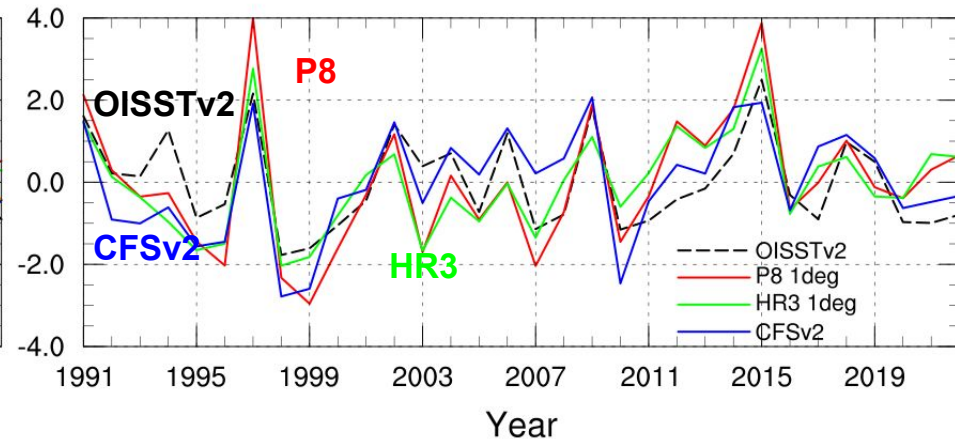
It is still too small in regions away from EQ

Nino3.4 in Seasonal Forecast System

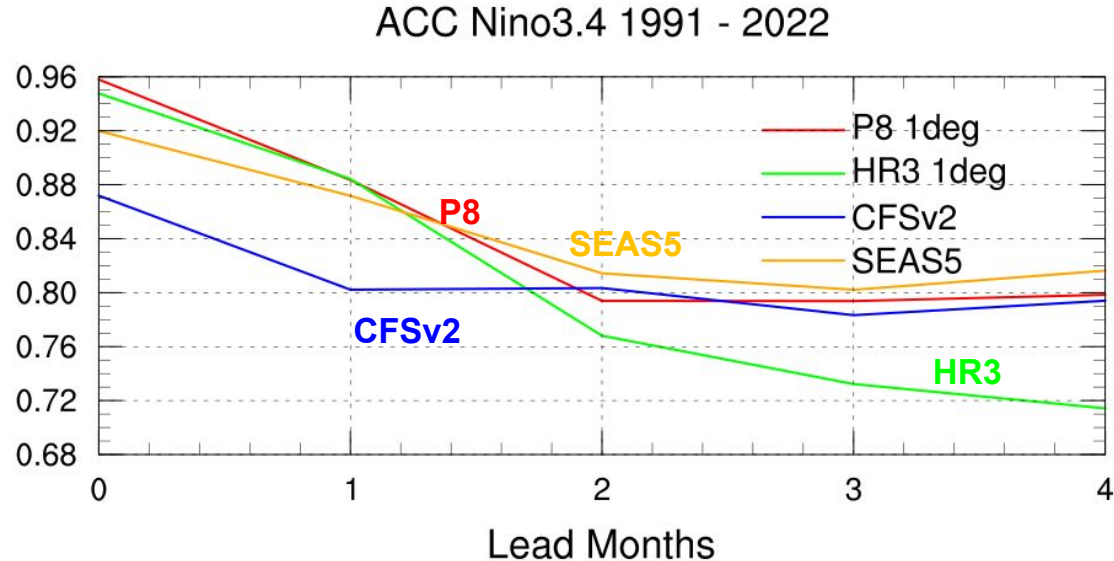
Nino3.4 in Sep (lead mon 3)

Nino3.4 in Dec (lead mon 6)

- P8 & HR3 appears to have similar Nino3.4 skill. They are comparable to CFSv2 at both lead months of 3 and 6
- SEAS5 runs started 1 month earlier than the rest of the models

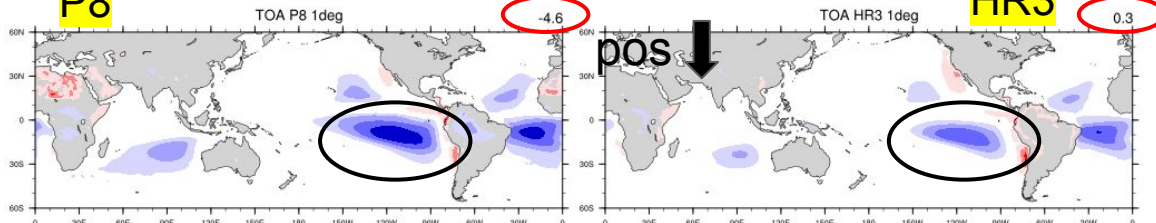# ACC Nino3.4 in Seasonal Forecast System

ACC Nino3.4 1991 - 2022

- The ACC of Nino3.4 from HR3 is close to that from P8 at lead months 0 and 1, but is behind P8 at lead month 2 and beyond
- SEAS5 started 1 month earlier than the rest of the models
- There are uncertainties in this evaluation with five ensemble members

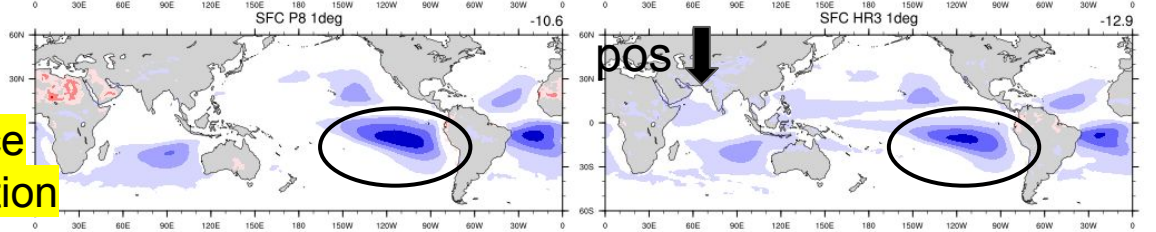Bias in Radiative Heatflux TOA & SFC (W/m^2) 2000-2022 ANN Late May ICs

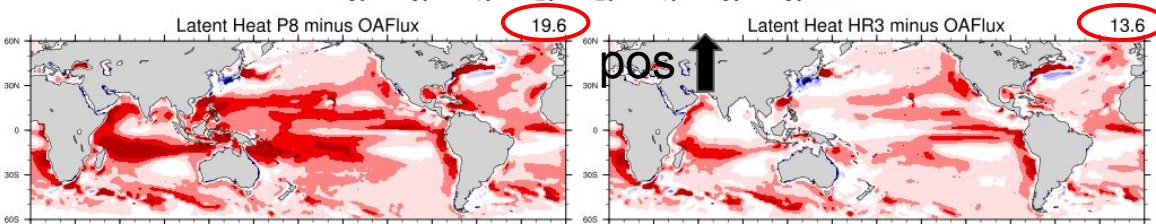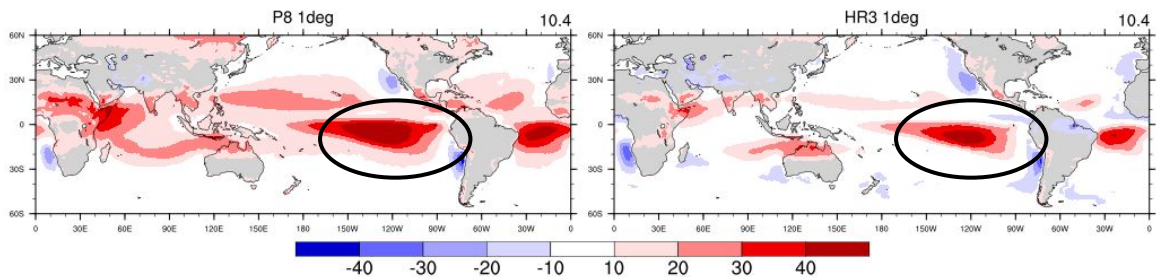The bias in both radiative and latent heat flux from HR3 is smaller than in P8

The bias in latent heat in HR3 is still too large

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Annual Heatflux at TOA & SFC

Legend:
- TOA CERES
- TOA P8
- SFC P8
- TOA HR3
- SFC HR3
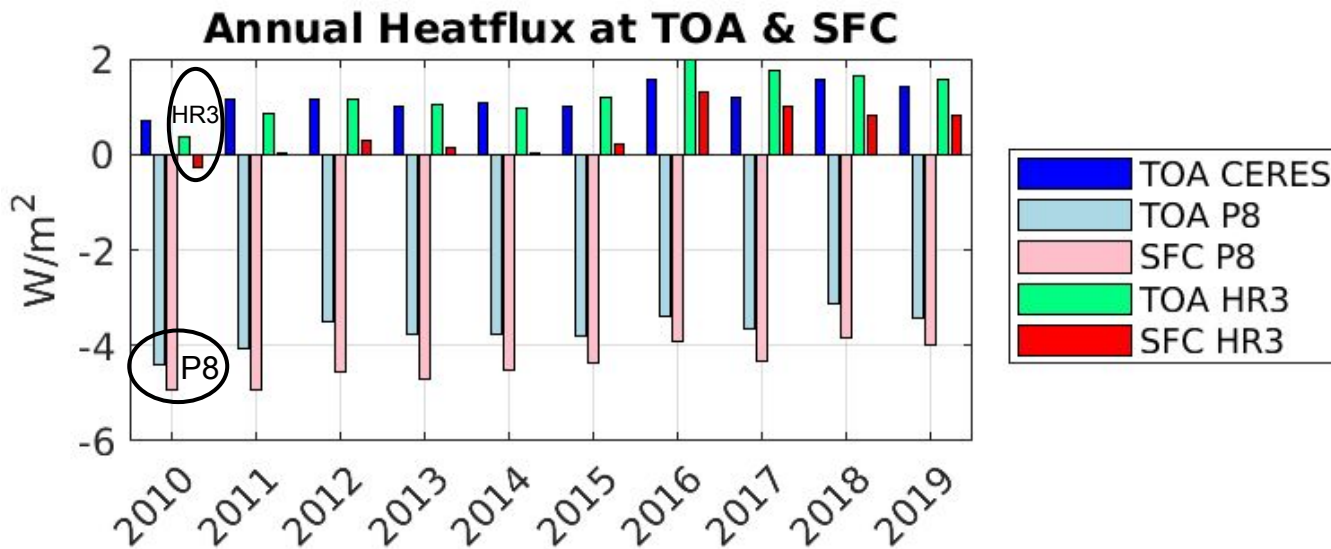
- Net heat flux from HR3 is much closer to CERES compared to P8, likely due to the improvement in latent heat representation

- The atmospheric model 'absorbed' ~ 0.5 - 1 W/m^2, accounting for the difference in net heat flux between TOA and the surface

Summary

- Two sets of preliminary SFS experiments, P8 and HR3, utilizing a 1º atmosphere, ocean, and sea ice model were conducted for the period 1991-2022 with five ensemble members initialized in late May

- In both sets, the resulting Nino 3.4 index is comparable to the current operational CFSv2 from NOAA and lower than SEAS5 from ECMWF

- The interannual variabilities in SST from HR3 are closer to OISSTv2 than from P8, despite a warm bias in the near-global mean SST

- Further adjustments in atmospheric physics are currently underway.

"NSST" vs. "SkinSST" in UFS Seasonal Forecast System

SST RMSE w.r.t. OISSTv2, Lead Mon 3 (Sep), 1991-2022 (5 members)
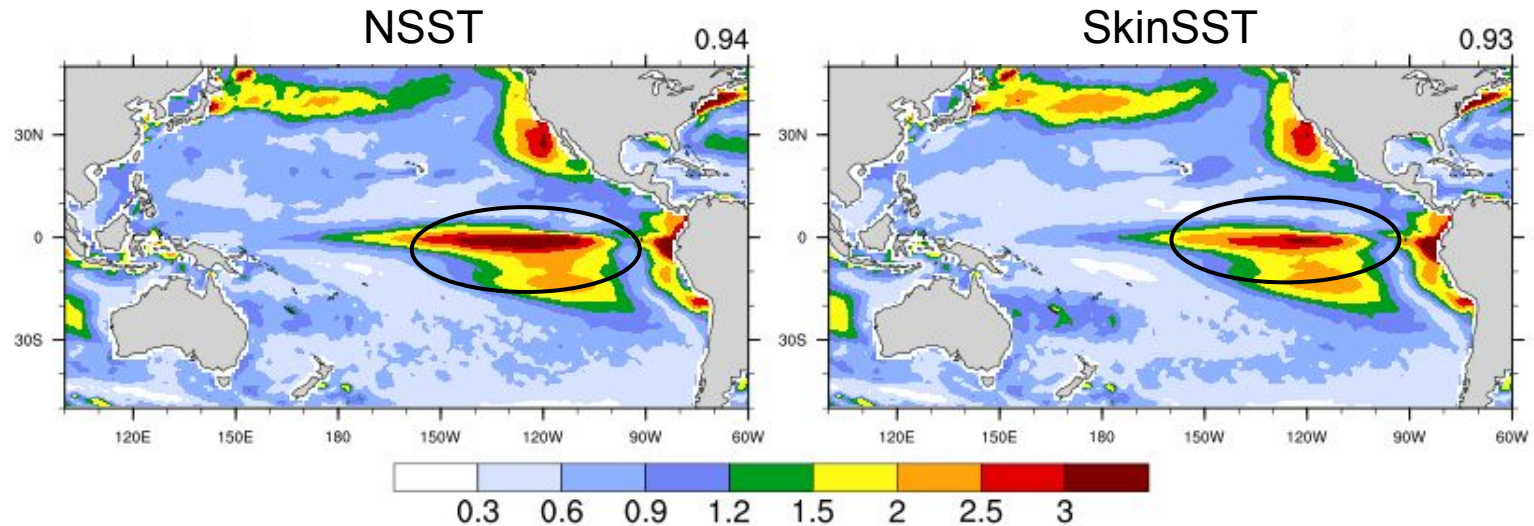
ACC Nino3.4 in Seasonal Forecast System
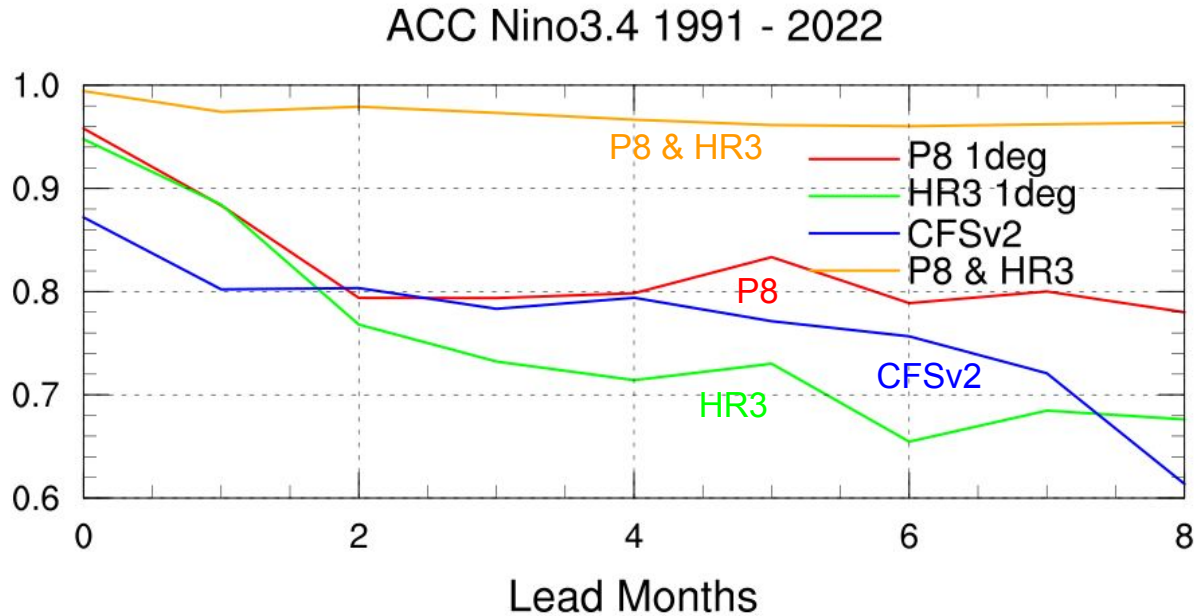
The ACC between Nino3.4 from HR3 & P8 is very high at >0.96 up to 8 month lead times