Navy Earth System Prediction Capability (Navy ESPC; Barton et al. 2020). NAVGEM (37 km), HYCOM (1/12°), CICE (1/12°) 45-day 16-member weekly forecasts, became operational at Fleet Numerical Meteorology and Oceanography Center on 31 August 2020 (also participating in the NOAA Subx project).

• Initial perturbations produced using an Ensemble of Data Assimilation methodology.

- Weakly-coupled DA using NCODA (HYCOM-CICE) and Hybrid NAVDAS-AR (NAVMEN).

Experiments:

• Low-level winds.

Ozone transport depends on wind changes, particularly during the tropics and in the South Asian Monsoon (SAM).

• ERA5 low bias over many ocean basins, high bias over some tropical continental areas, tropical Indian Ocean, tropical West and Central Pacific.

• ACAI reduces positive and negative biases in many regions but increases biases in some regions, like the South Asian Monsoon (SAM).

• The regions where ACAI increases bias are also regions where the bias changes sign/character with forecast time (not shown).

For ACAI and CTL, IVT model bias is dependent on ocean basins, high bias over some tropical continental areas, tropical Indian Ocean, tropical West and Central Pacific.

- ACAI reduces positive and negative biases in many regions but increases biases in some regions, like the South Asian Monsoon (SAM).

- The regions where ACAI increases bias are also regions where the bias changes sign/character with forecast time (not shown).

Global Average JJA Bias Magnitude as a function of forecast lead time for CTL (blue) and ACAI (orange)

14-day Forecast IVT forecast bias

- Bigger improvement from ACAI for Total Precipitable Water (TPW) than for low-level winds.

- Improvement to IVT similar to that for low-level winds. Is IVT bias dominated by wind bias?

- Results for other seasons are similar but magnitude of improvement slightly smaller.

- In both summer and winter, and in both the CTL and ACAI runs, using analyzed winds in the bias calculation reduces the bias magnitude twice as much as using the analyzed moisture for the first few weeks of the forecast.

- This indicates that errors in winds are dominating the IVT biases in a global sense.

Substituting ERA5 Analyses for forecast winds or moisture in the IVT Bias Calculation

14-day Forecast IVT Bias and Impact on Bias Magnitude

- In the Tropical Western Pacific, the IVT bias is dominated by wind errors.

- In the West African Monsoon (WAM), both moisture and wind errors contributed to IVT biases, although wind errors dominate.

- In Northern Arabian Sea and over Northern India, subbing in either analyzed winds or moisture actually increases the bias, pointing to compensating errors.

• ACAI is effective at reducing global average bias magnitude.

• By forecast day 10, global average absolute value of bias reduced by over 30% for moisture and over 20% for IVT and 850-hPa zonal winds.

• Bias reductions are substantially higher in some regions, particularly the tropics.

• Impact of ACAI is location dependent, does not work well where the bias changes with forecast lead time (e.g., over northern Arabian Sea and India).

• ACAI also reduces RMSE throughout the forecast (by about 5%, not shown).

• Wind errors dominate IVT biases out to three weeks, but this is location dependent.

• Using ERA5 winds reduces IVT MAE twice as much as using ERA5 moisture (not shown).

• In some regions, substituting analyzed winds or moisture in for the forecast fields increases biases and errors, indicating compensating errors.

Summary, References, and Acknowledgments


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