Subseasonal ocean forecast along US West coast in NCEP/EMC's UFS-based Global Coupled Modeling System

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ENSO dominates predictability of SST along the US West coast across timescales through its atmospheric and oceanic teleconnections. NOAA's next generation S2S effort involves developing a fully coupled Unified Forecast System (UFS) that includes providing reliable ocean forecasts along the US West coast. These forecasts could then be used as boundary conditions for dynamically downscaled forecasts of the California Current System (CCS). Here we present **Week 3&4 forecasts** of key surface and subsurface variables of interest along the US West coast in **UFS Prototype 8**.

UFS Prototype 8

A discrete system prototype built to ensure forecast system integrity. Last of the 8 prototypes before tailored development towards operational targets takes place.

Benchmark runs

35 day deterministic forecast runs
April 2011 to March 2018
Initialized 1st and 15th of each month
total 7 years of 168 forecasts

Configuration

Atm: FV3 DyCore; GFS physics; NoahMP land; CCPP driver; C384; 127 levels; ICs from GEFSv12 reanalysis

Ocn: MOM6; 1/4° tripolar; 75 hybrid levels; ICs from CPC-3DVar

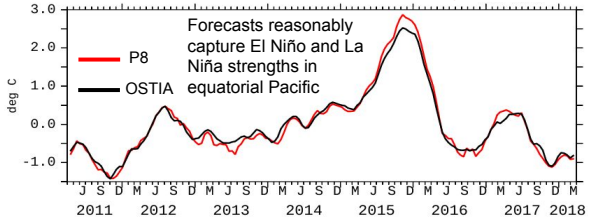
Ice: CICE6; 1/4° tripolar; 5 thickness categories, Mushy; ICs from CPC ice analysis

Waves: WAVEWATCH III; 1/2° regular; ST4 physics; ICs from GEFS forcings

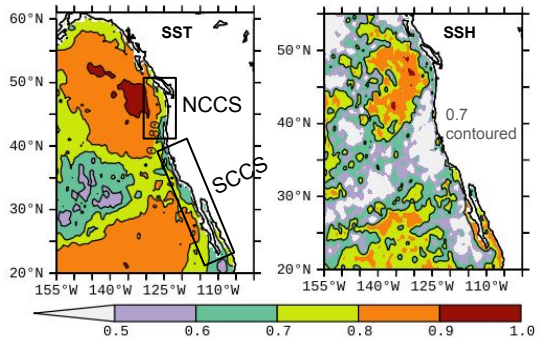
Aerosols: GOCART; One-way coupling; Prescribed anthropogenic, biogenic, wildfire, volcanic emissions. FENGSHA dust scheme

Skill in Week 3&4 forecasts

Week 3&4 forecast of Niño 3.4 SST anomaly



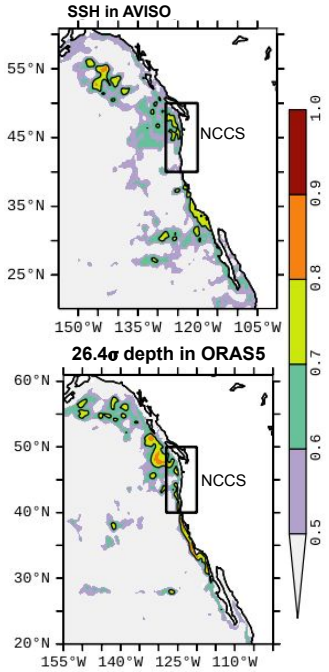
Anomaly Correlations Validation dataset - OSTIA, AVISO



Along the coast SST AC reach **0.8**, particularly in the northern CCS (NCCS). SSH AC are relatively weaker and with an alongshore gradient in AC that reaches **0.7** in southern CCS (SCCS) - suggesting oceanic teleconnection.

Evidence of Coastally Trapped Waves (CTW) in validation datasets

Lag correlation (21 days) in SSH and 26.4σ depth anomaly



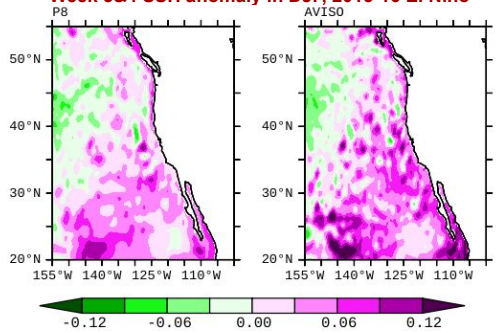
Oceanic teleconnections propagate northward via CTWs - generated both locally and remotely. The later following westerly wind events prior to an El Niño in the western equatorial Pacific.

Evidence of CTW propagation (Amaya et al., 2022) and its effect on NCCS ocean conditions has been earlier found (Kurapov et al, 2022; Ray et al., 2022)

~50% of daily SSH and 26.4σ depth variations averaged in the NCCS is explained by variations in SSH and 26.4σ depth from south of its domain along the west coast - likely effect from CTW.

Do forecasts capture ENSO teleconnections along the coast?

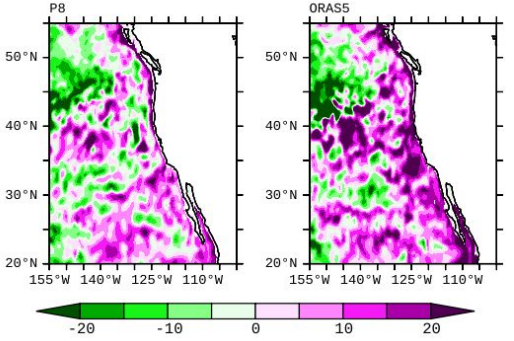
Week 3&4 SSH anomaly in DJF, 2015-16 El Niño



+ve SSH anomaly forecasts along the coast captured in P8 as in observations.

Relatively **weaker +ve anomaly** in P8 likely indicates **weaker teleconnections**

Week 3&4 26.4σ depth anomaly in DJF, 2015-16 El Niño



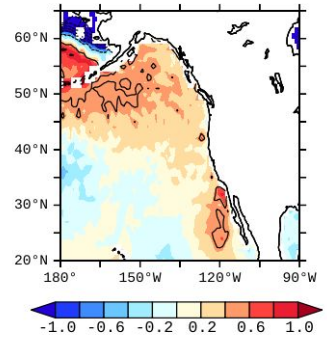
Mean 26.4σ depth along the coast is between 200-300m

Anomalously deeper 26.4 σ depth in P8 forecasts along the coast captured as in observations.

Relatively **weak deepening** indicates **weaker teleconnections**

Do the forecasts capture the mean state of the ocean along the coast?

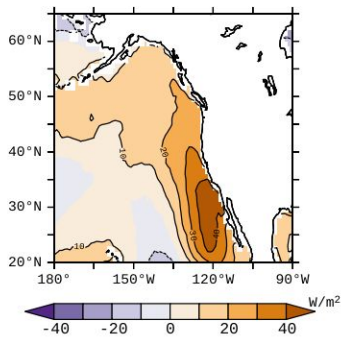
Week 3&4 SST bias



Warm SST bias along the US west coast as well as off-shore dominates the week 3&4 forecasts

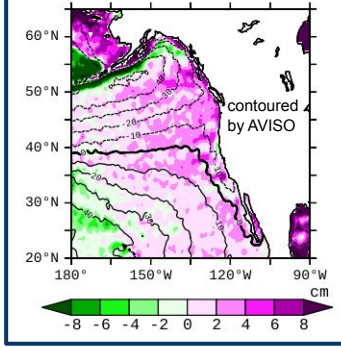
Excess shortwave radiation largely drives this warm SST bias

Week 3&4 SW bias



+ve cycl(τ) drives upwelling of cooler waters off-shore along the US west coast, which drives -ve SSH

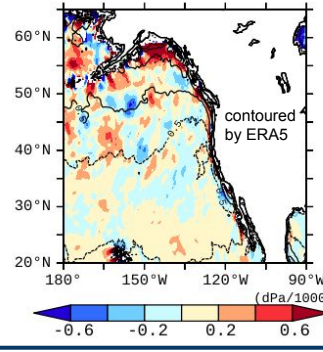
Week 3&4 SSH bias



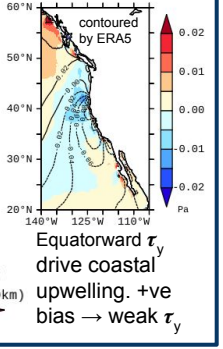
+ve SSH bias → **likely weak upwelling** but +ve cycl(τ) bias very close to coast → **too strong upwelling**

τ_y is likely too strong off-shore in P8, but tends to be weaker on-shore - not enough resolution to assess

Week 3&4 cycl(τ) bias



Week 3&4 τ_y bias



Equatorward τ_y drive coastal upwelling. +ve bias → weak τ_y

Summary

- Forecasts show relatively better SST skill northward and better SSH skill southward along the US west coast
- ENSO strength is relatively close to observation, although teleconnections along the US west coast is weaker
- Warm SST forecast bias along the coast is largely driven by excess shortwave radiation and countered by strong wind-driven Ekman upwelling
- +ve SSH bias likely indicates less cooling from depths below and consistent to the warm bias at the surface
- To assess coastal upwelling and oceanic teleconnection via coastally trapped waves, higher model resolution and/or dynamical downscaling is beneficial to resolve processes closer to the coast

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