Subseasonal Tropical Cyclone Prediction Skill in the Navy Earth System Prediction Capability

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U.S. NAVAL RESEARCH LABORATORY

Overview and Data

The Navy Global Environmental Model (NAVGEM), Hybrid Coordinate Ocean Model (HYCOM), and Los Alamos Sea Ice Model (CICE) are run in a coupled framework in the Navy Earth System Prediction Capability (Navy ESPC).

We examine the prediction skill and biases in two configurations of the Navy ESPC system.
• Navy ESPC single member forecasts performed for the Subseasonal Experiment (SubX) 2009-2015
• Navy ESPC ensemble forecasts which have been produced operationally since August 2020

We compare the skill of Navy ESPC ensemble to the ECMWF, NCEP CFSv2, and UKMO models from the S2S database.

Currently a variety of Navy ESPC forecast products are being produced operationally, including:
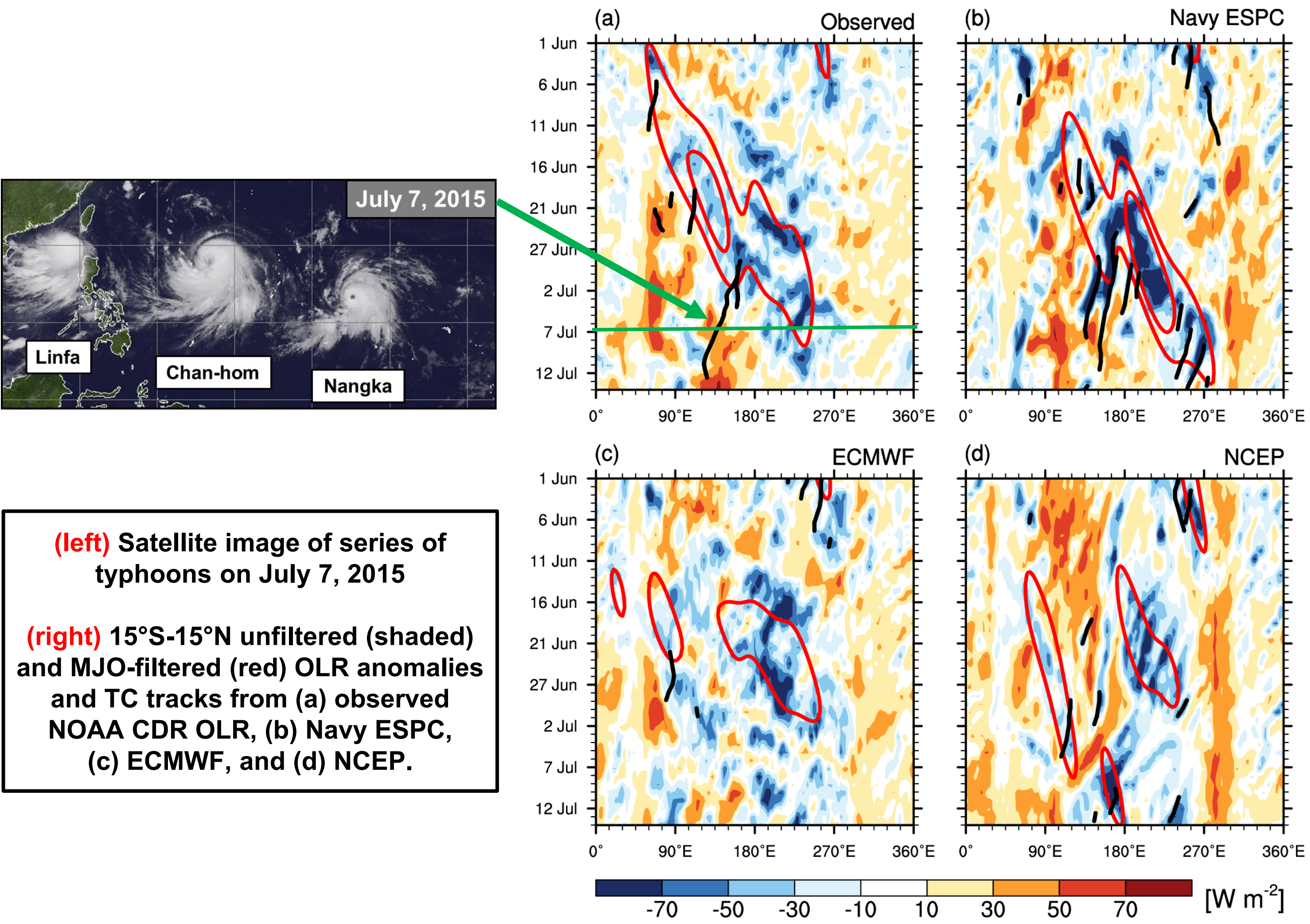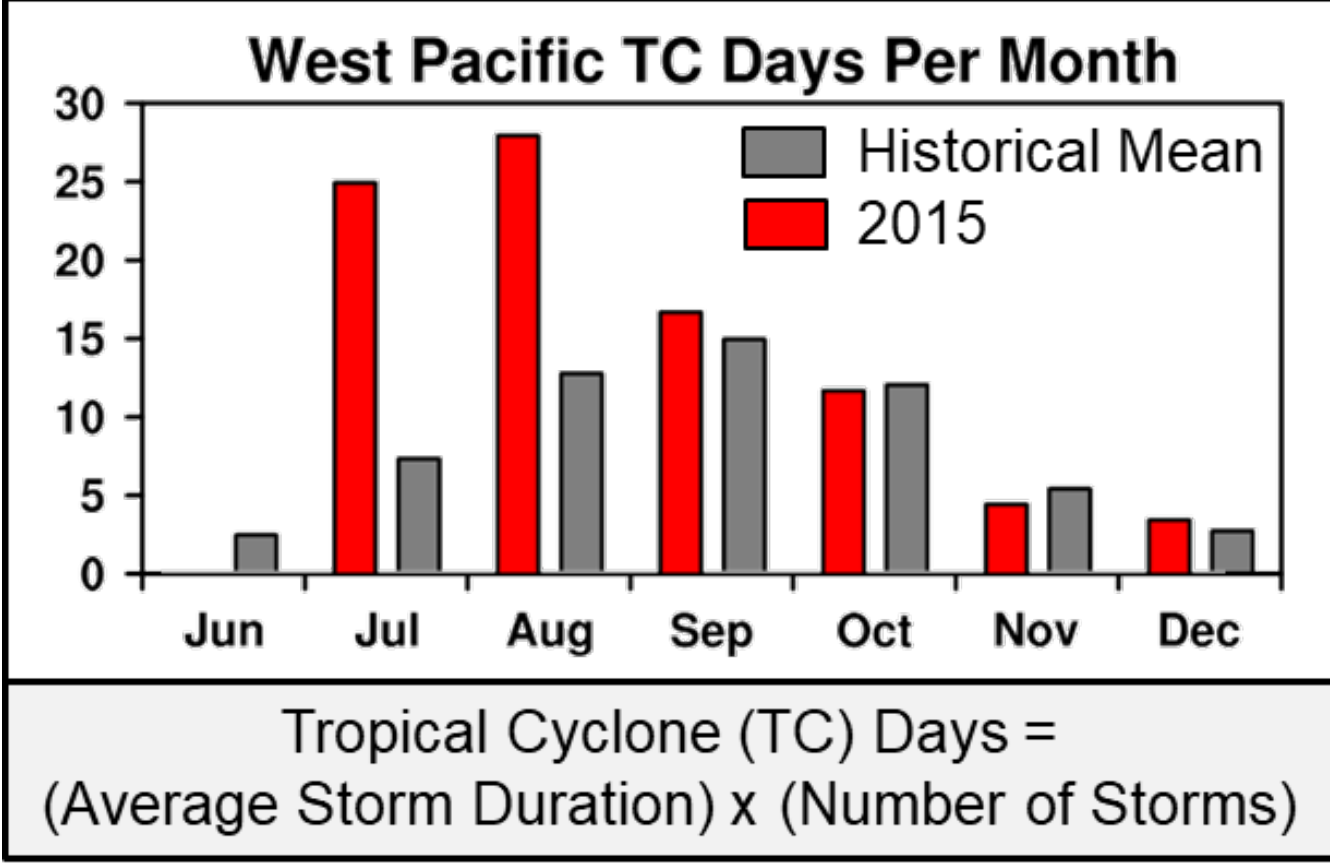• MJO Phase Space
• Wind Shear and Large-Scale Winds and OLR Anomalies

Additional products related to tropical cyclone formation, passage, and accumulated cyclone energy as well as basin-scale statistical dynamical forecasts are in development.

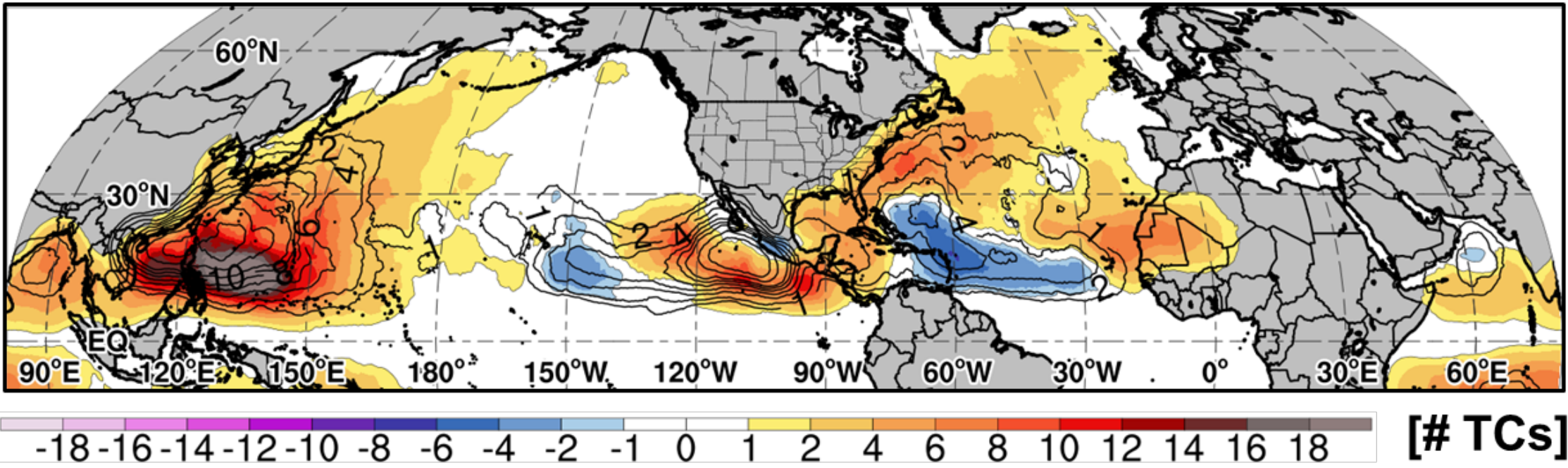| Forecast	Time Range, Frequency	Atmosphere (NAVGEM)	Ocean (HYCOM)	Ice (CICE)
Navy ESPC SubX	0-45 days 1 Members 4X Week	T359L60 (37 km) 60 levels	1/12° (9 km) 41 layers	1/12° (9 km)
Navy ESPC Ensemble V1	0-45 days 16 Members each Sunday	T359L60 (37 km) 60 levels	1/12° (9 km) 41 layers	1/12° (9 km)

Tropical Cyclones and the MJO

**West Pacific TC days per month during 2015 compared to the long-term mean**

West Pacific TC Days Per Month
(Historical Mean, 2015)

Tropical Cyclone (TC) Days = (Average Storm Duration) x (Number of Storms)

July 7, 2015 — Linfa, Chan-hom, Nangka

(left) Satellite image of series of typhoons on July 7, 2015

(right) 15°S-15°N unfiltered (shaded) and MJO-filtered (red) OLR anomalies and TC tracks from (a) observed NOAA CDR OLR, (b) Navy ESPC, (c) ECMWF, and (d) NCEP.

(a) Observed, (b) Navy ESPC, (c) ECMWF, (d) NCEP [W m⁻²]

TC and GPI Biases

Week 4 TC Count Bias (Navy ESPC - IBTrACS) (JJASON 2009-2015)
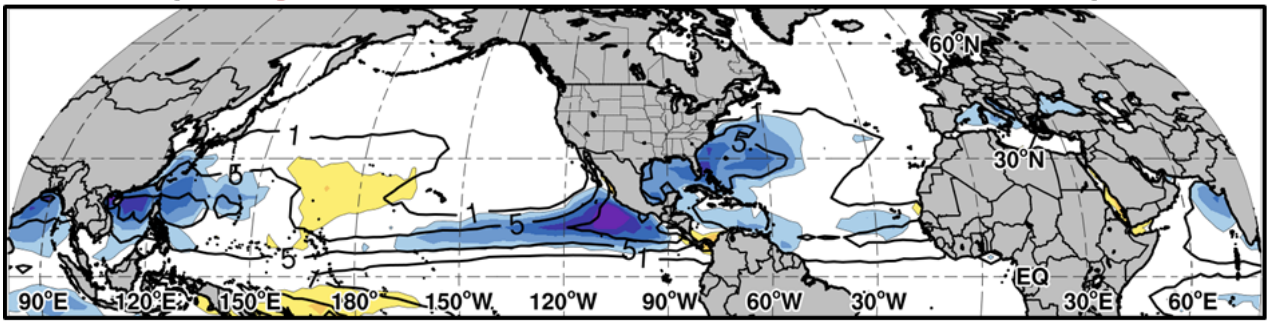

[# TCs]

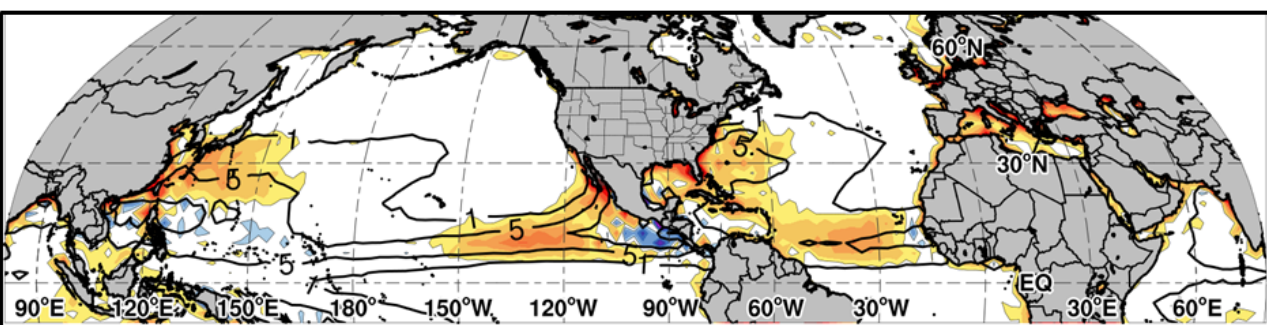**Bias in TC days at week 4 within a 500 km radius of each point**
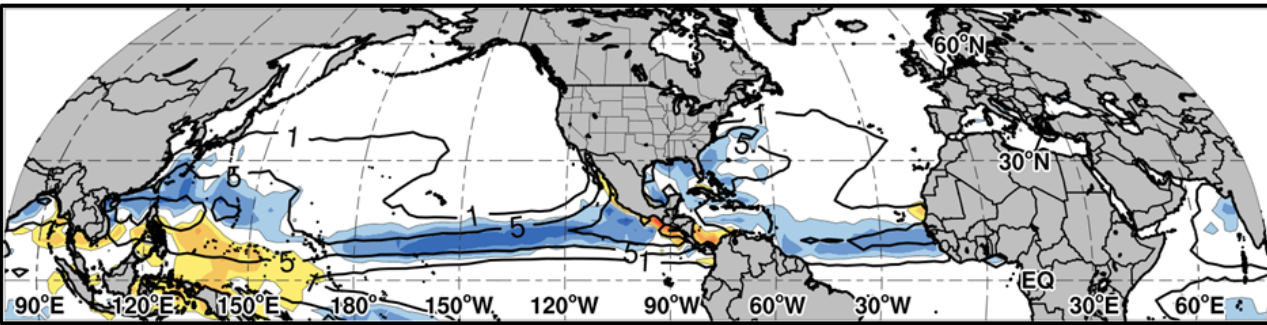
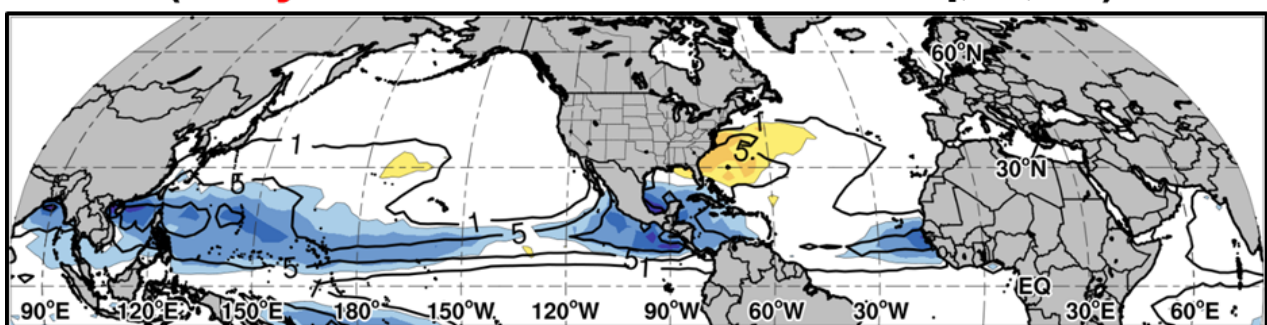Week 4 GPI Bias Relative to ERA-Interim (Navy ESPC η and ERA-Interim PI, H, V)
Week 4 GPI Bias Relative to ERA-Interim (Navy ESPC H and ERA-Interim η, PI, V)
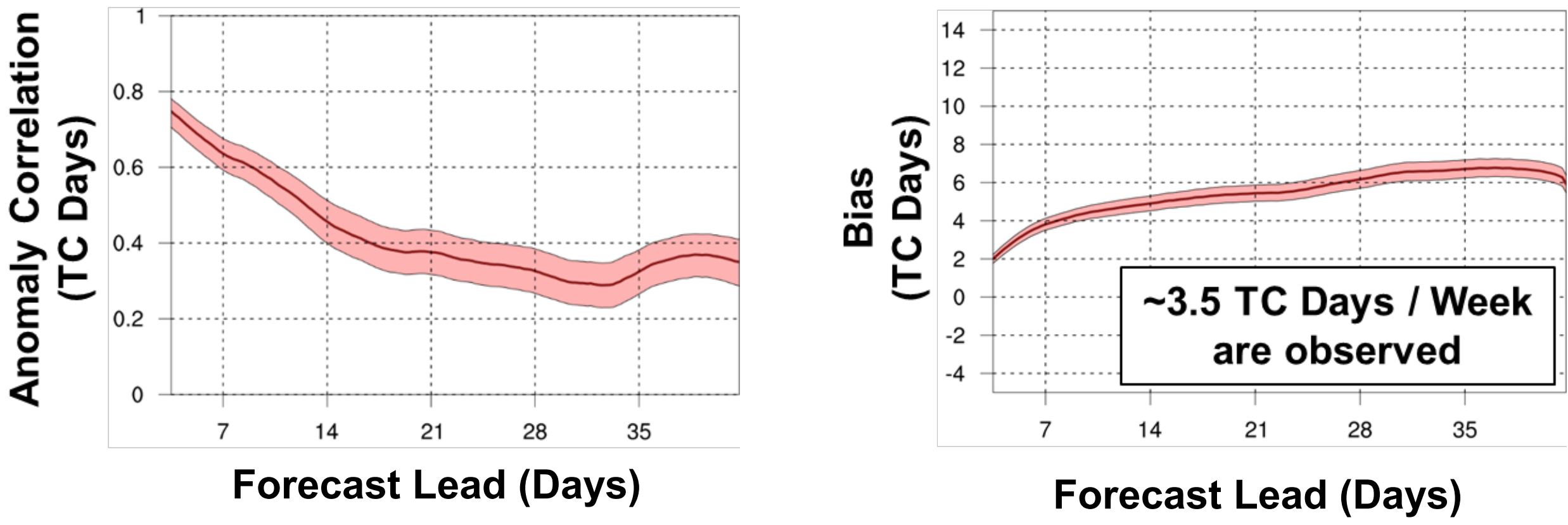Week 4 GPI Bias Relative to ERA-Interim (Navy ESPC PI and ERA-Interim η, H, V)
Week 4 GPI Bias Relative to ERA-Interim (Navy ESPC V and ERA-Interim η, H, PI)

Relative contributions of each term in the Emanuel and Nolan (2004) genesis potential index (GPI) equation to GPI biases for SubX forecasts initialized during JJASON 2009-2015. For each term one term uses Navy ESPC data while the other terms use ERA-Interim data.

TC Skill and Biases

Anomaly Correlation (TC Days) — Forecast Lead (Days)
Bias (TC Days) — Forecast Lead (Days)
~3.5 TC Days / Week are observed

West Pacific Basin TC days anomaly correlation and bias for SubX forecasts initialized during JJASON 2009-2015.

MJO Skill and Biases

Bivariate Correlation of RMM PCs
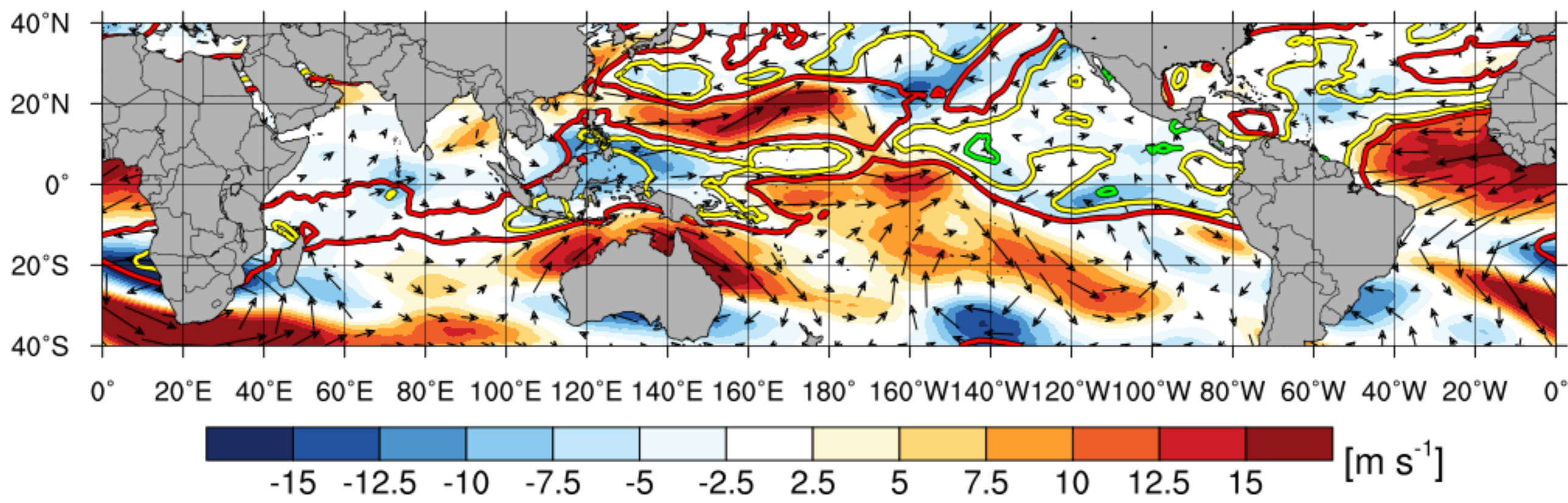RMSE of RMM PCs
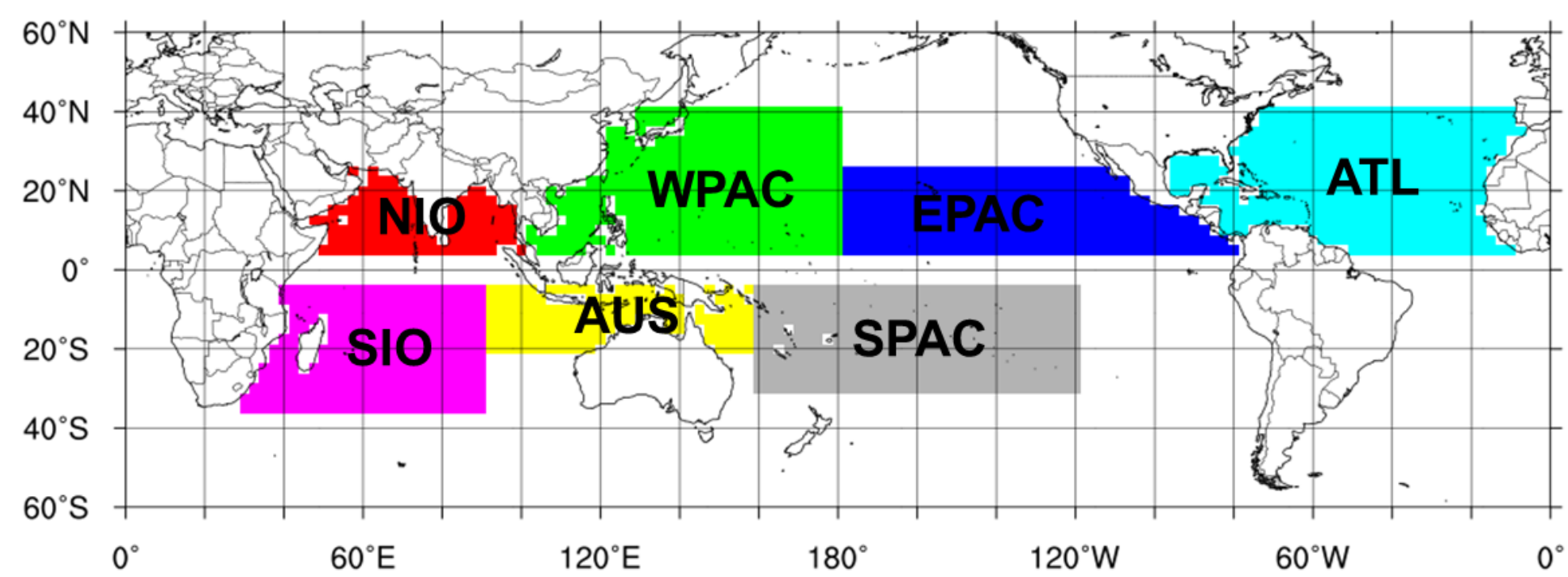Phase Bias of RMM
Amplitude Bias of RMM
Tau (Days)
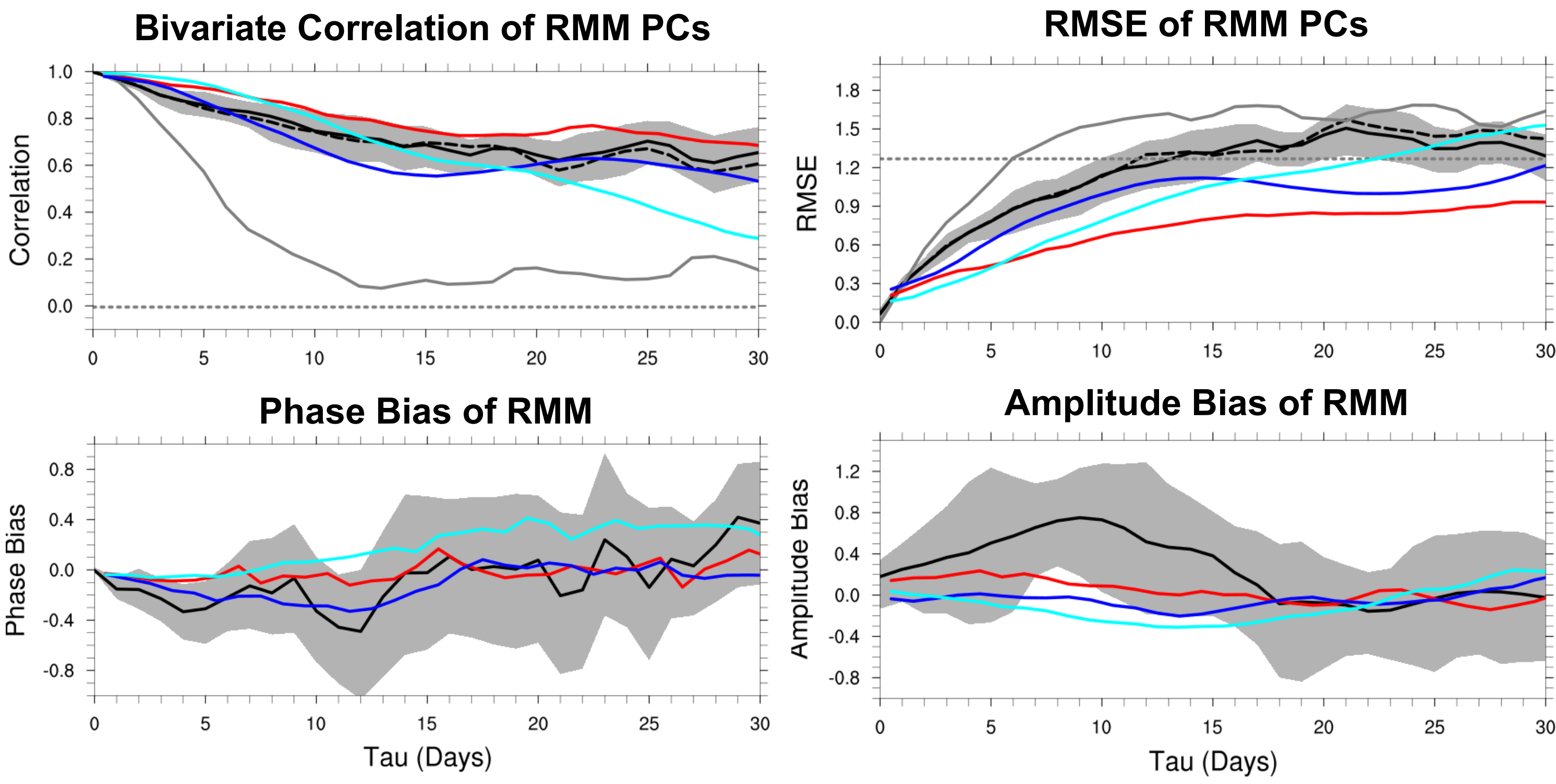
Bivariate correlation (σ), bivariate RMSE (σ), phase bias (phases), and amplitude bias (σ) of the Real-Time Multivariate MJO (RMM) index during May 2020 - June 2021 initializations.
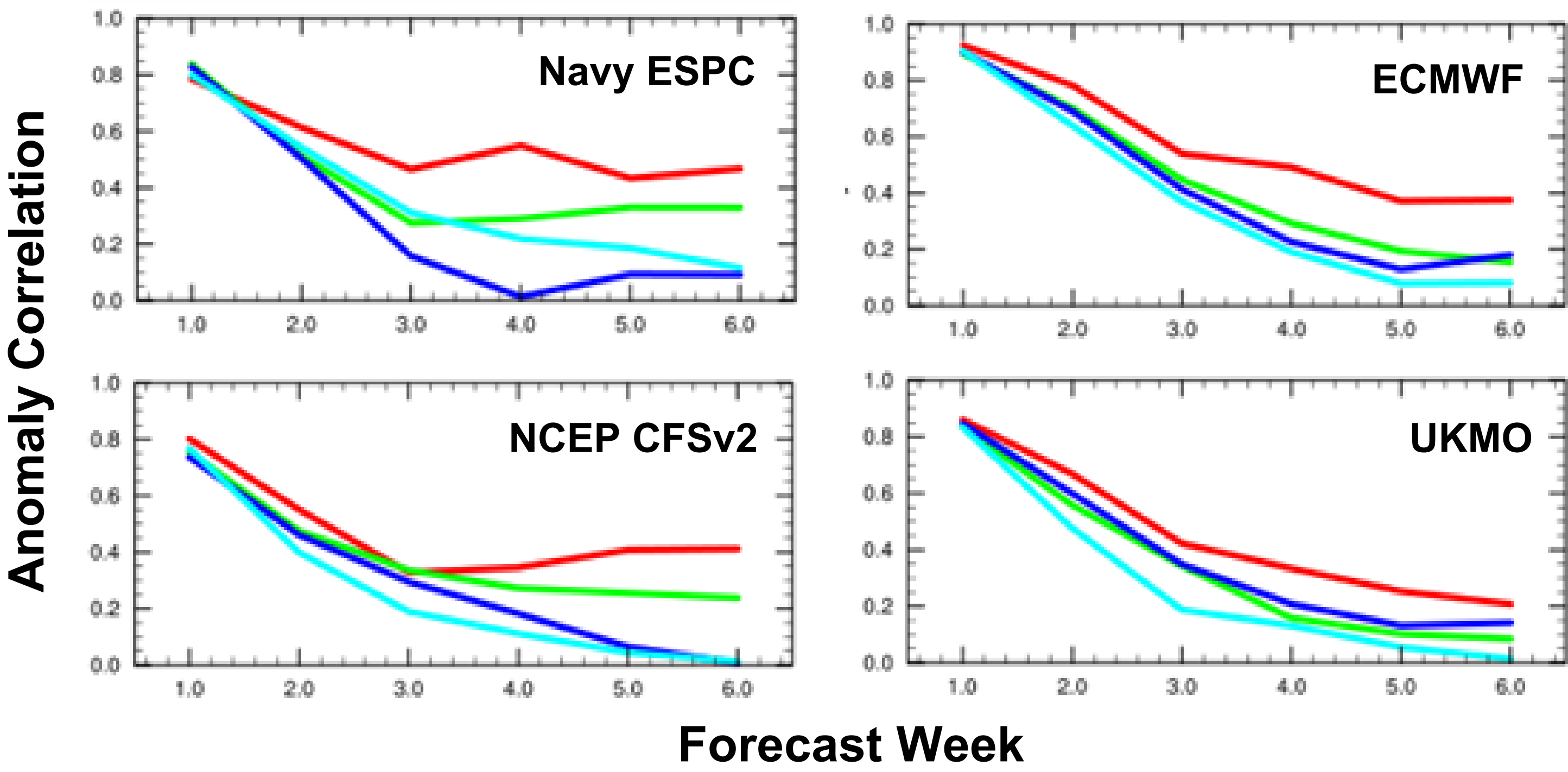
Wind Shear Skill in Navy ESPC

Navy ESPC Weekly-Averaged Wind Shear Graphic

[m s⁻¹] -15 -12.5 -10 -7.5 -5 -2.5 2.5 5 7.5 10 12.5 15

TC Environment Evaluation Domains

NIO, WPAC, EPAC, ATL, SIO, AUS, SPAC

850-200 hPa Wind Shear Anomaly Correlation

Navy ESPC, ECMWF, NCEP CFSv2, UKMO
Anomaly Correlation — Forecast Week

(top) Example Navy ESPC weekly-averaged wind shear forecast (contours at 5, 10, and 15 ms⁻¹) and **(bottom)** 850-200 hPa wind shear anomaly correlation over different TC basins during May-November 2020 initializations.