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Using the S2S Database to Evaluate the Performance of the Navy Earth System Prediction Capability (ESPC) Ensemble

Workshop on Predictability, Dynamics and Applications Research Using the TIGGE and S2S Ensembles

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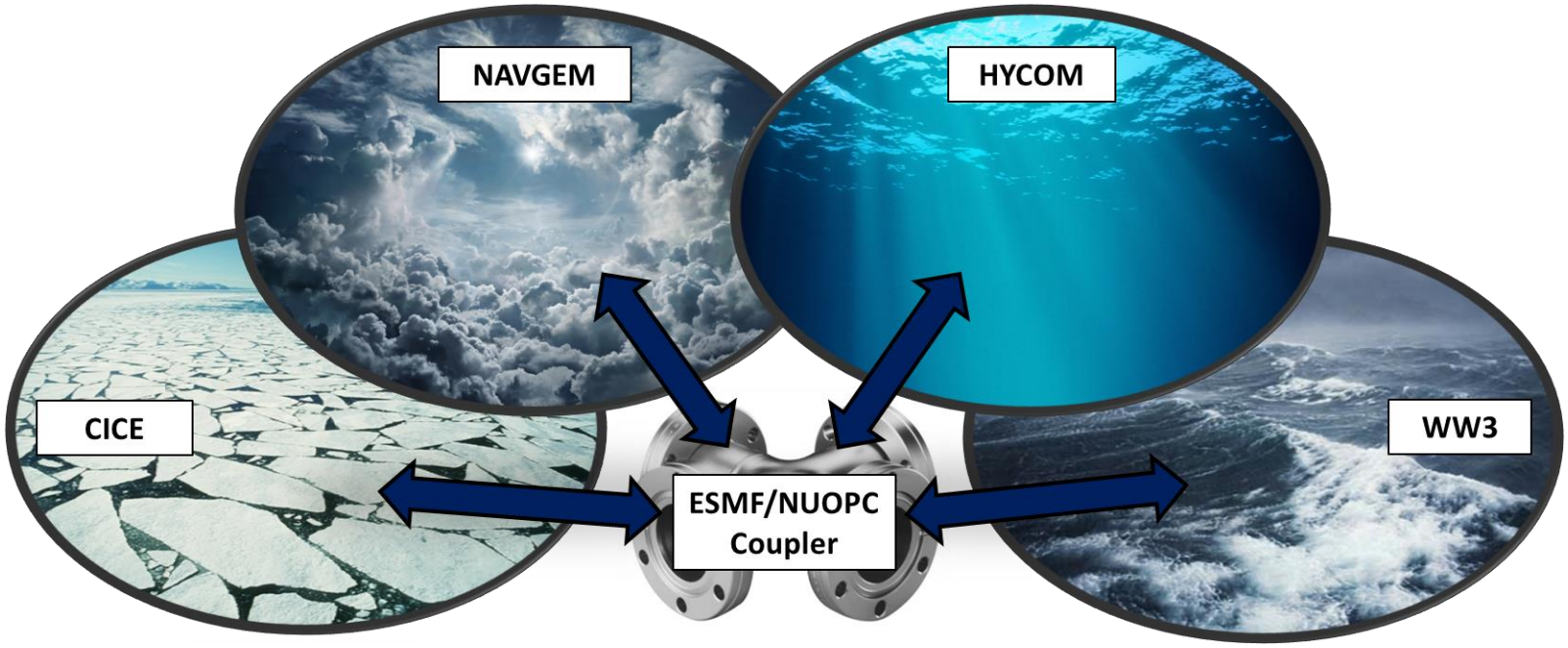
Navy Earth System Prediction Capability



The Navy Earth System Prediction Capability (Navy ESPC) is a global coupled model being developed for subseasonal-to-seasonal (S2S) sea ice, atmosphere, ocean, and wave prediction.

Overview

1) **Wavenumber-frequency filtering diagnostics for subseasonal forecasts (Janiga et al. 2018).**

2) **Composite structure and prediction skill of the Madden-Julian Oscillation (MJO) in the Navy ESPC.**

3) **Preliminary look at ensemble performance and subseasonal tropical cyclone prediction in the Navy ESPC.**

Datasets

Observations:

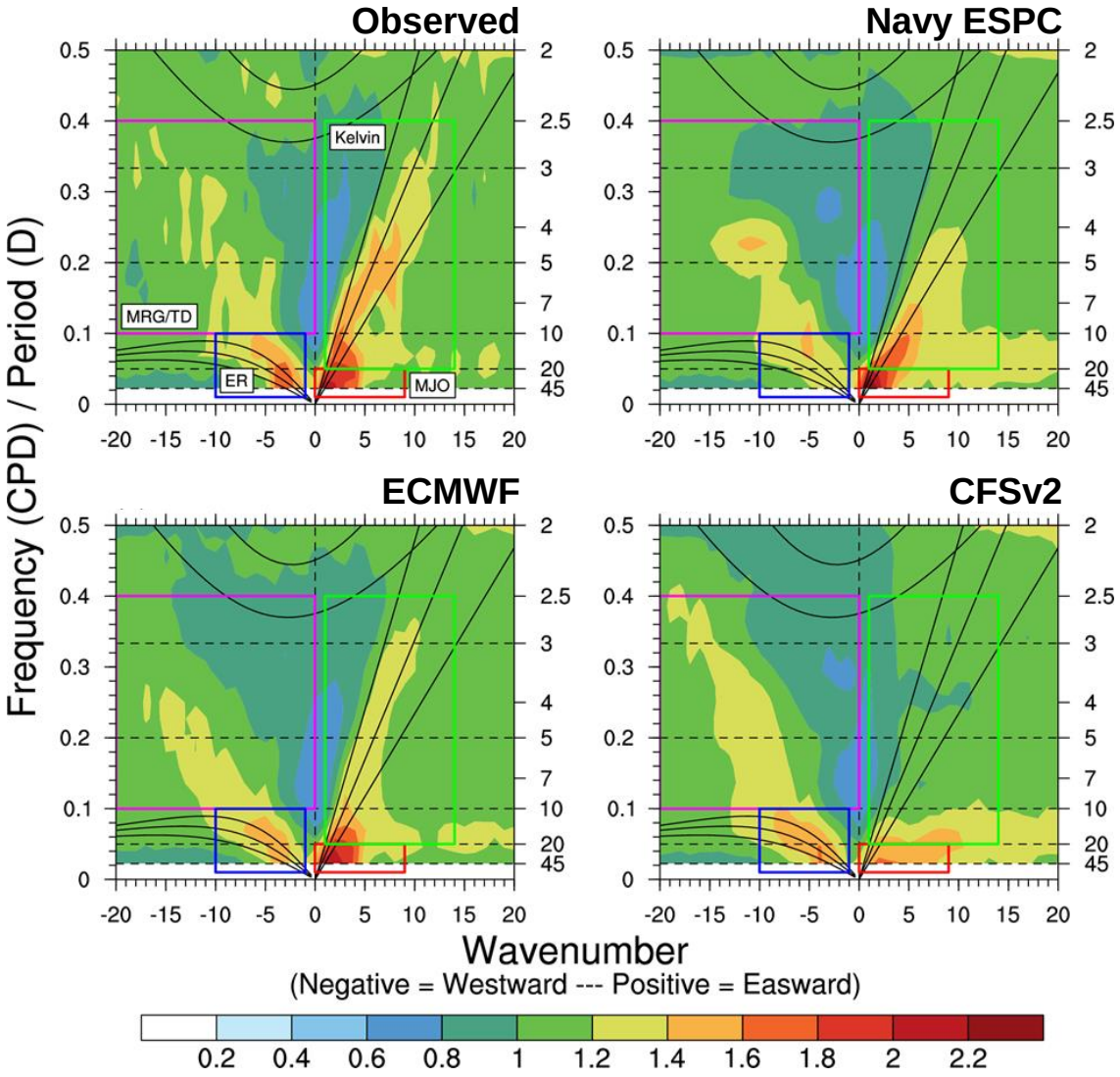
- NOAA OLR (Lee 2014): 2.5°x2.5° daily averages.
- ERA-Interim reanalyses (Dee et al. 2011): 2.5°x2.5° at 00Z and 12Z.

Models:

- NRL (Navy ESPC): Weekly initialization.
- ECMWF: 2x weekly initialization.
- NCEP (CFSv2): Initializations on every 5th day used.

Results are for control member forecasts from 1999-2015 and 2017 ensemble forecasts.

Wavenumber-Frequency Spectra



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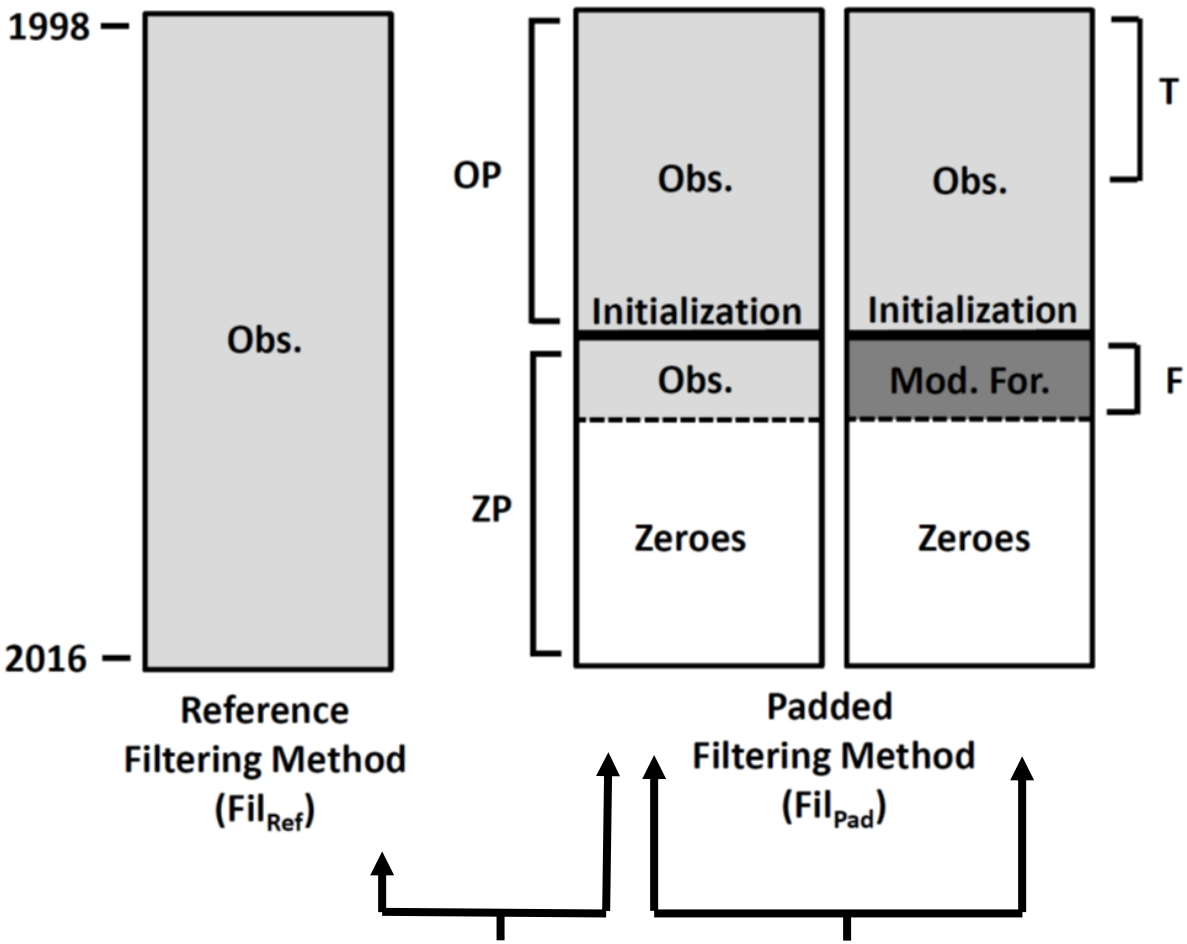
Methodology



Janiga et al. (2018): Subseasonal Forecasts of Convectively Coupled Equatorial Waves and the MJO: Activity and Predictive Skill. *Mon. Wea. Rev.*

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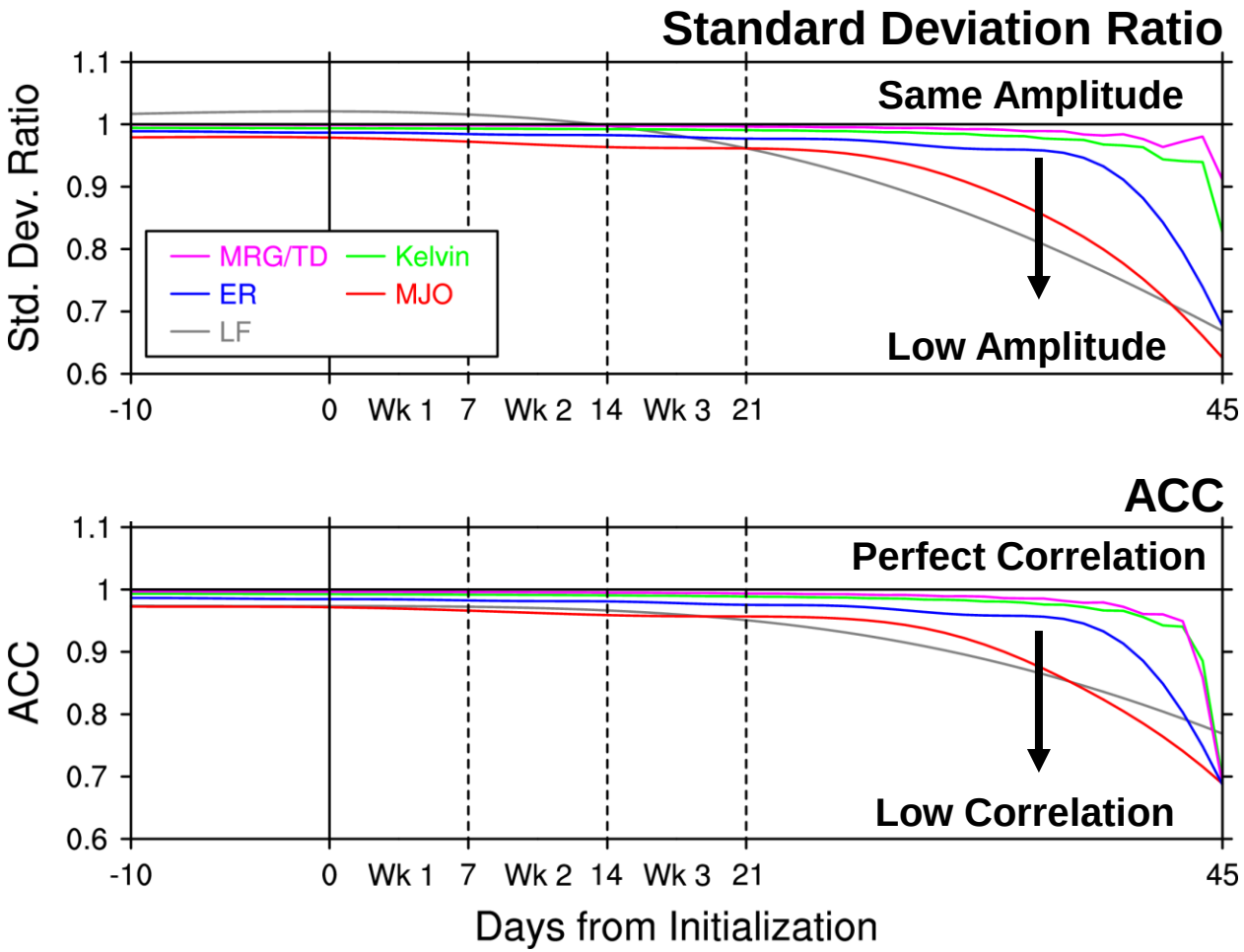
Methodology Evaluation



The padded filtering method is a good approximation for the reference filtering method over the first three weeks.

(top) Standard deviation ratio and (bottom) anomaly correlation between the padded and reference filtering methods over 30°S-30°N 1999-2015.

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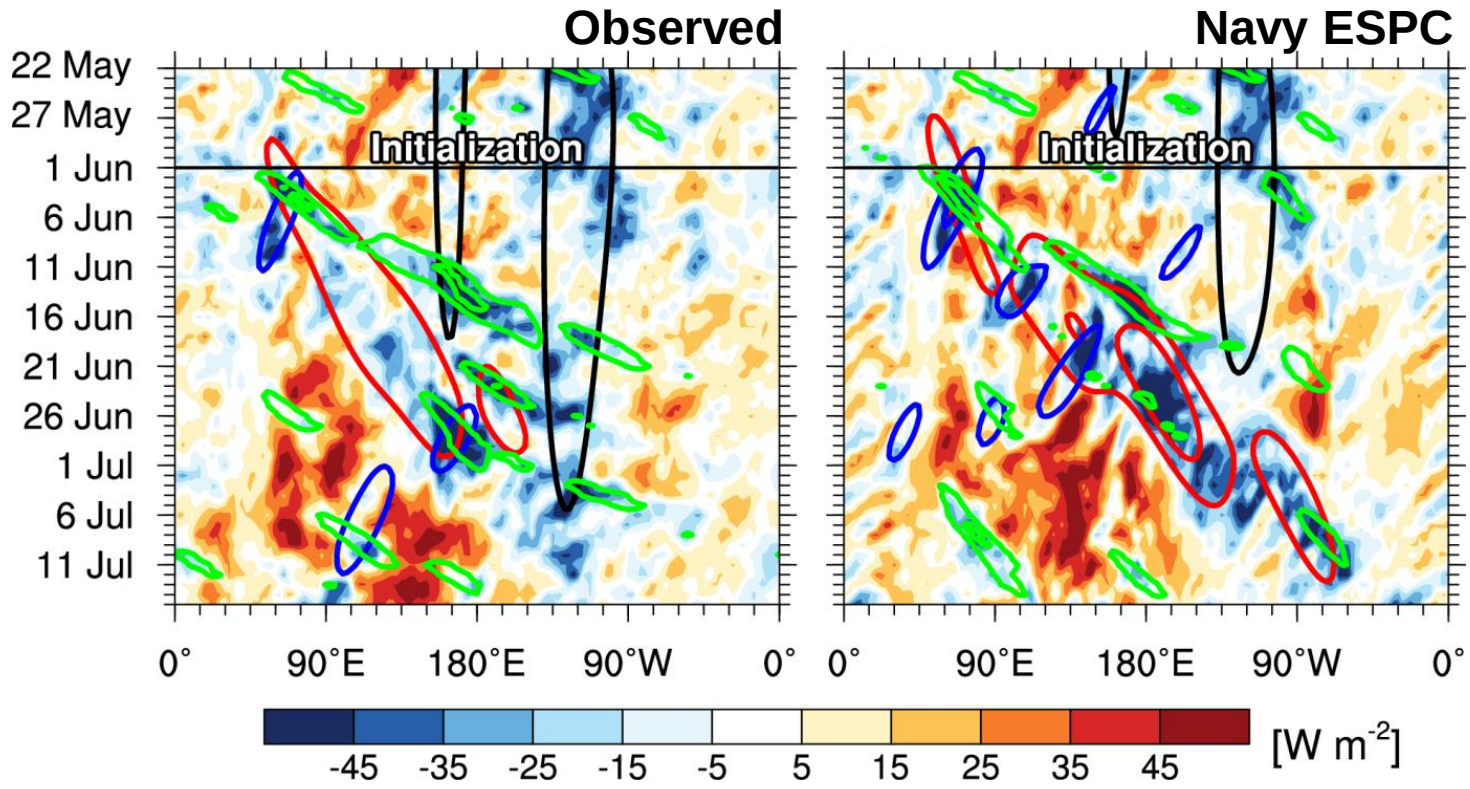
Example



OLR anomalies (10°S-10°N) from (a) satellite observations and (b) Navy ESPC. **>100 d,** **MJO**, **Kelvin**, and **ER** anomalies are contoured every 15 W m^{-2} and unfiltered OLR anomalies are shaded.

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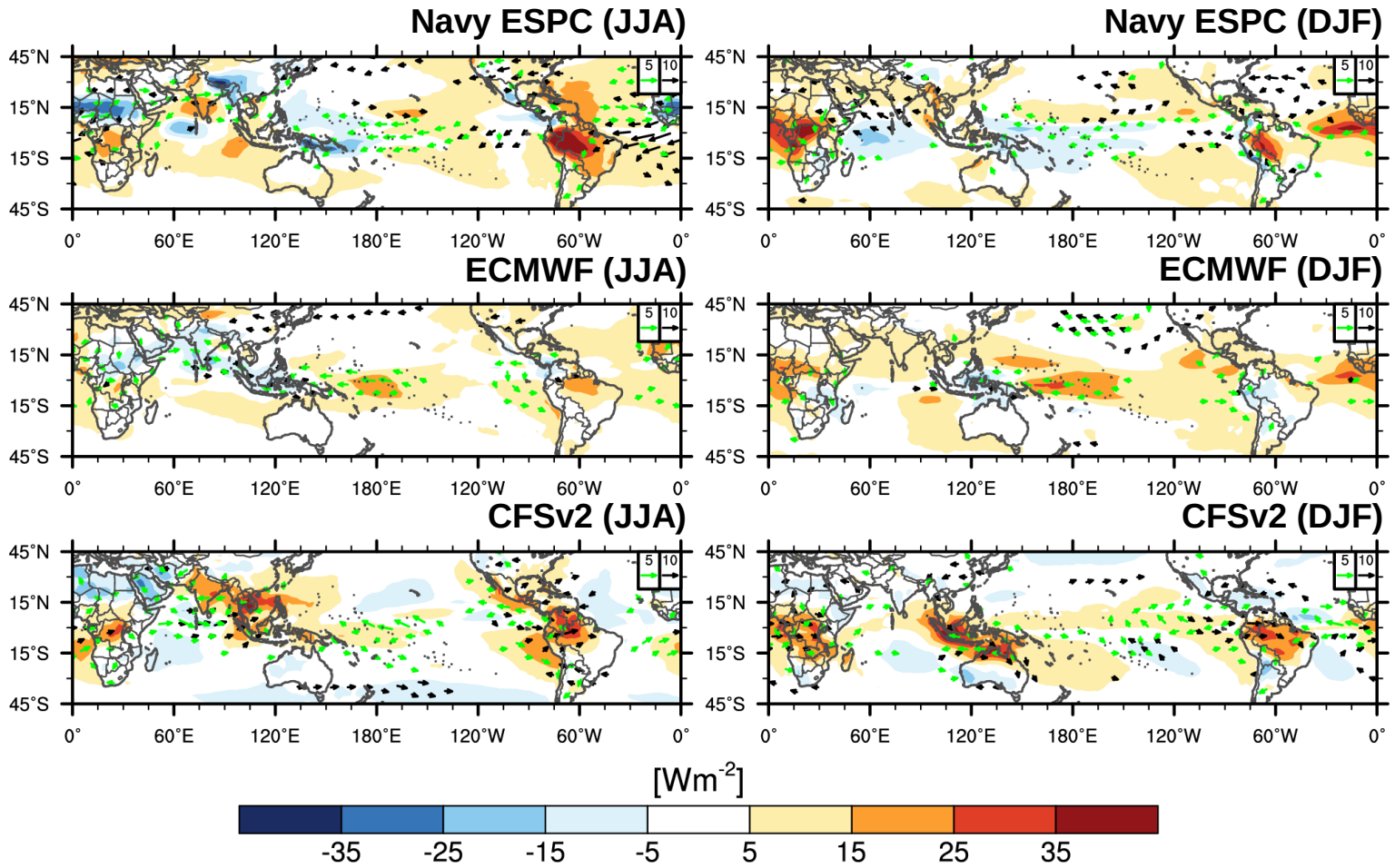
Mean Biases



Means biases of OLR (shaded, Wm^{-2}) and 850 hPa (green vectors, ms^{-1}) and 200 hPa (black vectors, ms^{-1}) winds integrated over F0-45 d during (left) JJA and (right) DJF.

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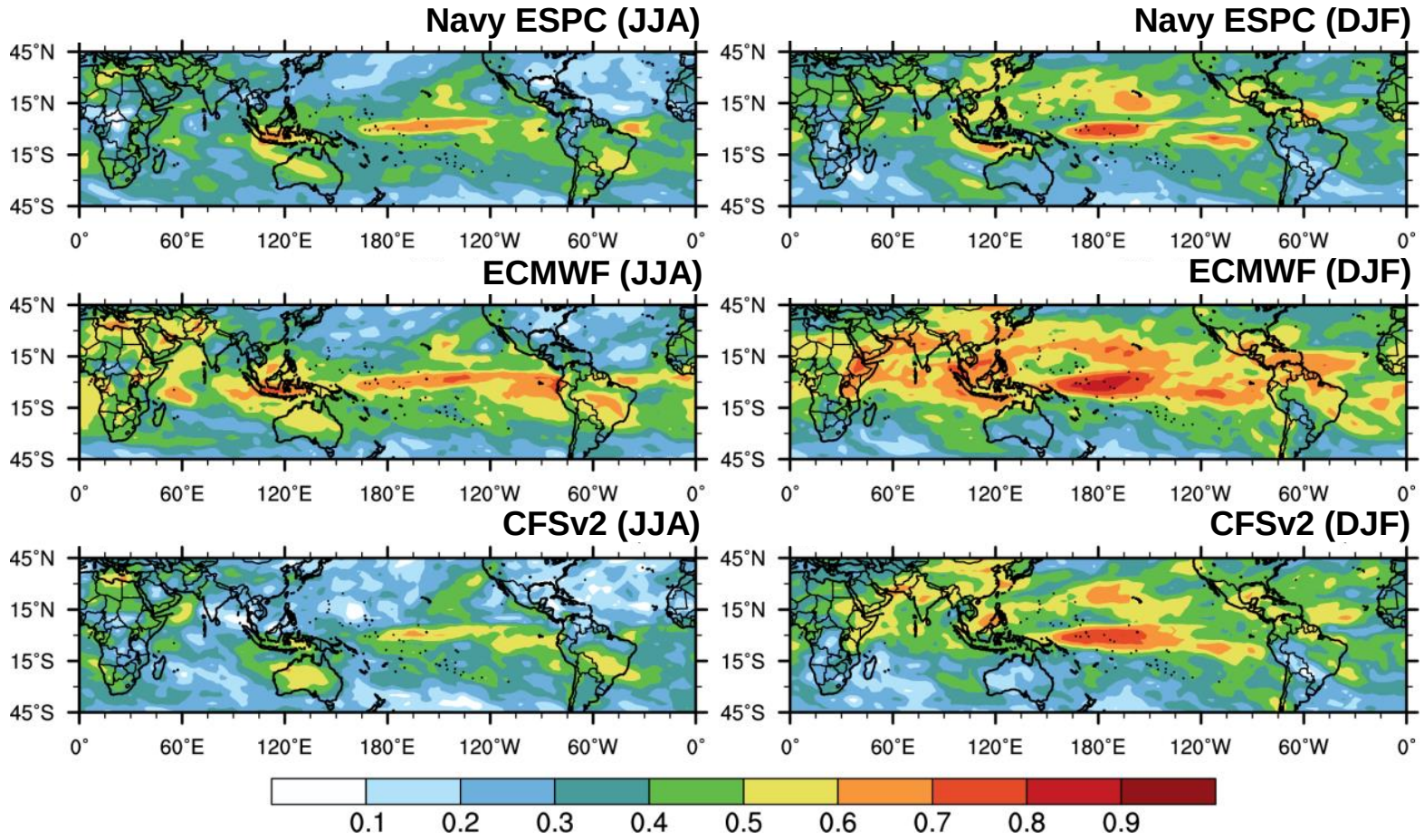
Correlation of Unfiltered OLR



Anomaly correlation (shaded) between forecasted and observed unfiltered OLR at week 2 (F7-14d) during (left) JJA and (right) DJF.

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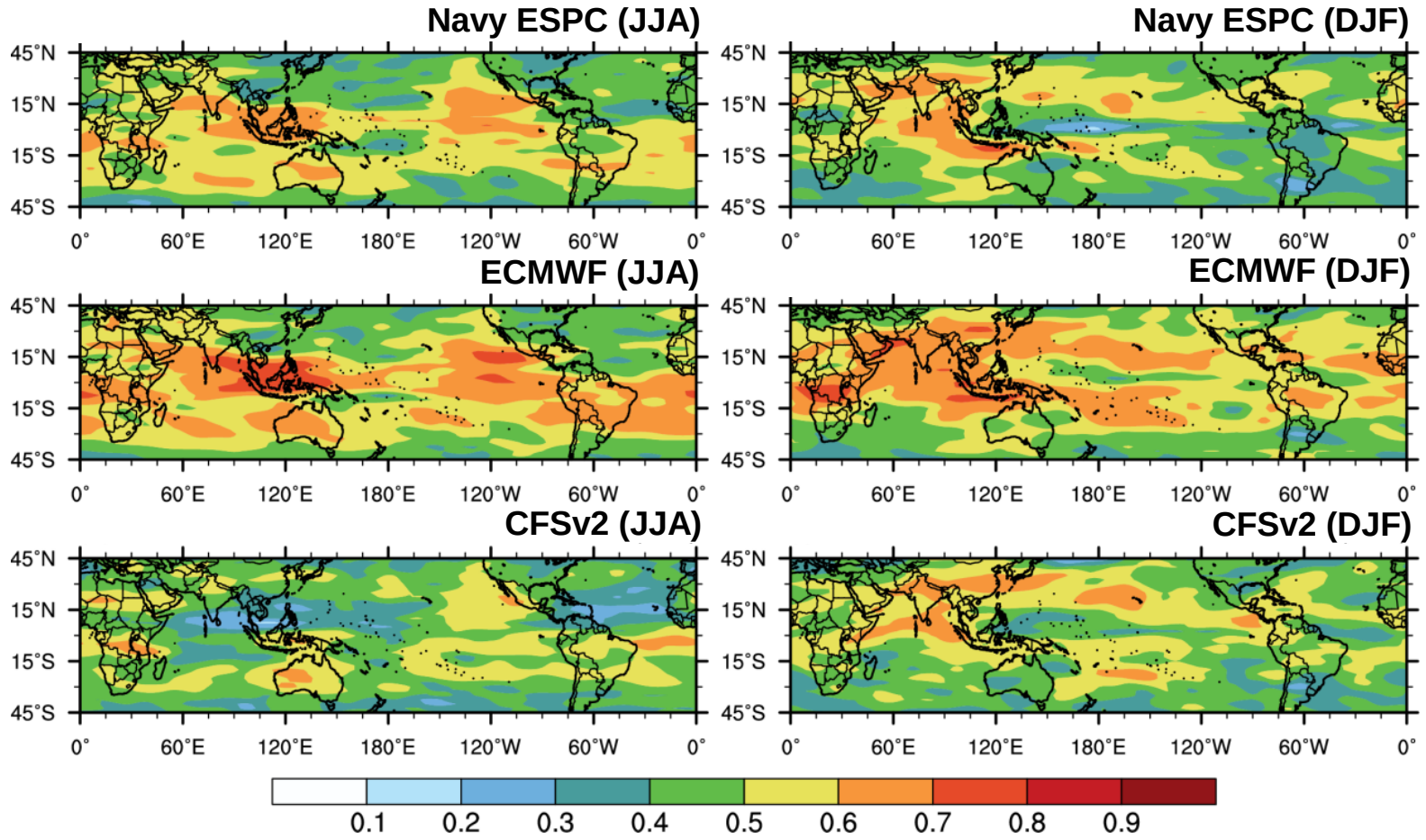
Correlation of MJO-Filtered OLR



Anomaly correlation (shaded) between forecasted and observed MJO-filtered OLR at week 2 (F7-14d) during (left) JJA and (right) DJF.

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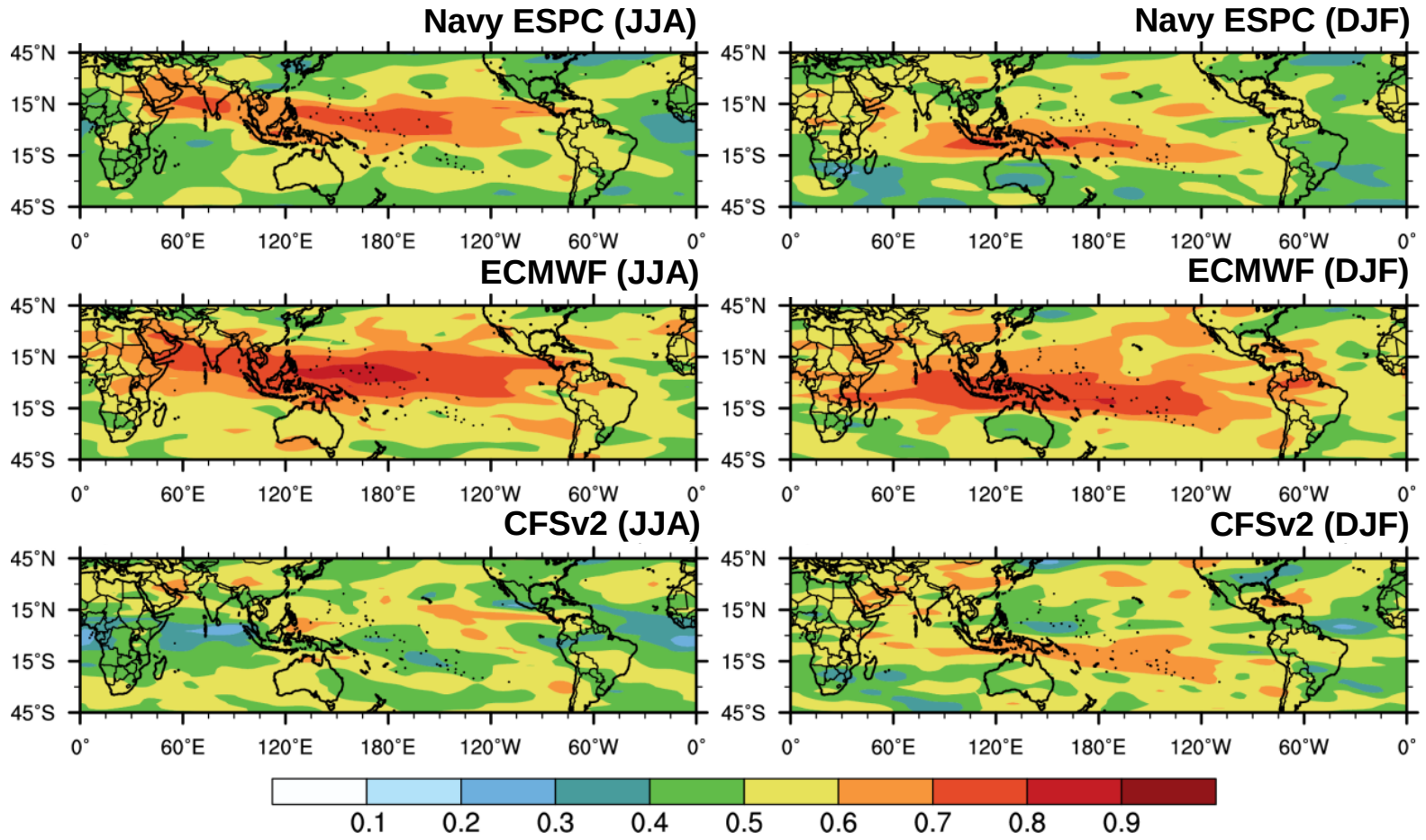
Correlation of MJO-Filtered U850



Anomaly correlation (shaded) between forecasted and observed MJO-filtered U850 at week 2 (F7-14d) during (left) JJA and (right) DJF.

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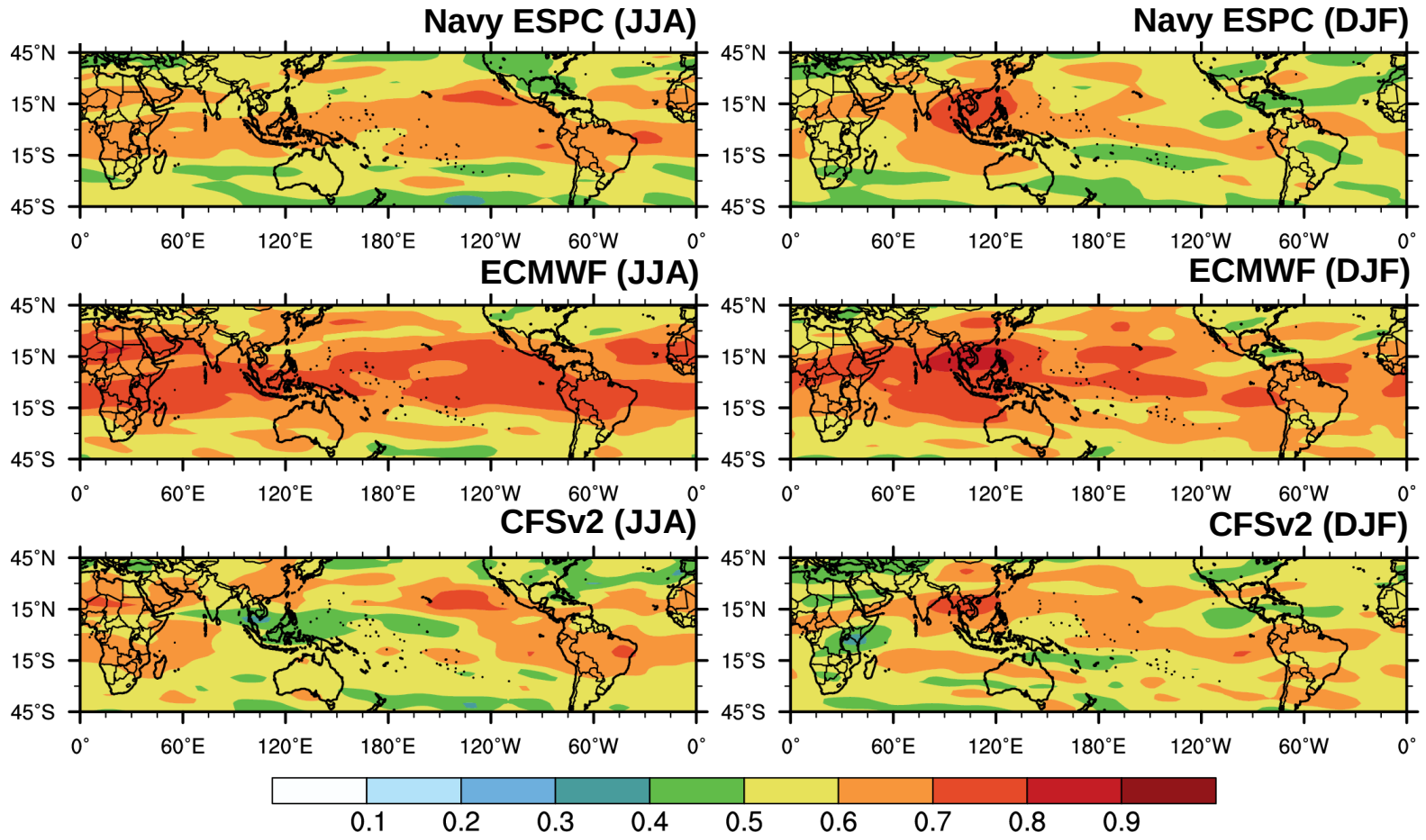
Correlation of MJO-Filtered U200



Anomaly correlation (shaded) between forecasted and observed MJO-filtered U200 at week 2 (F7-14d) during (left) JJA and (right) DJF.

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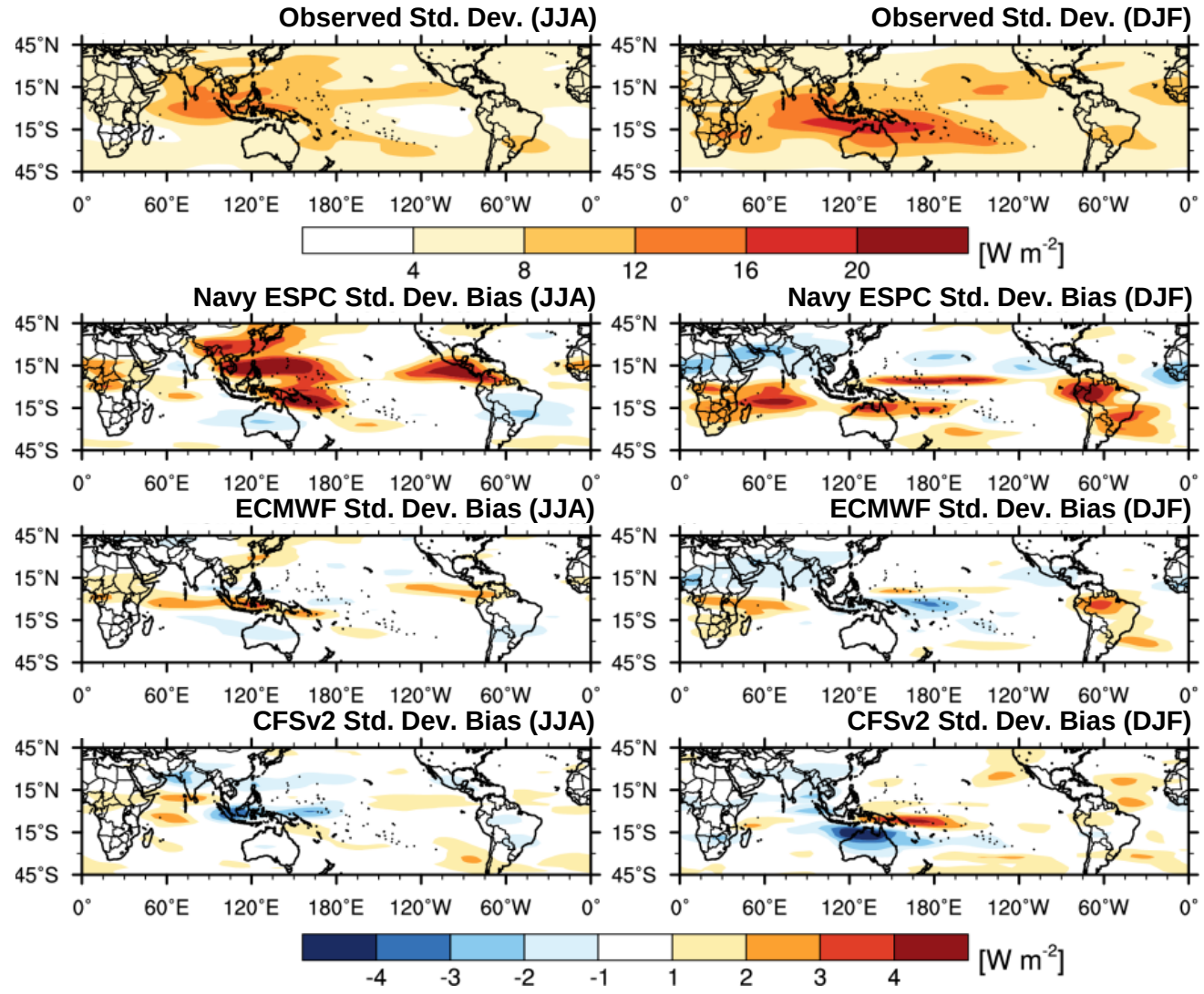
MJO-Filtered OLR Activity Biases



(top) MJO-filtered OLR standard deviation during week 2-3 (W m^{-2}, shaded).

(bottom) Standard deviation biases during week 2-3 from Navy ESPC, ECMWF, and CFSv2. (W m^{-2}, shaded).

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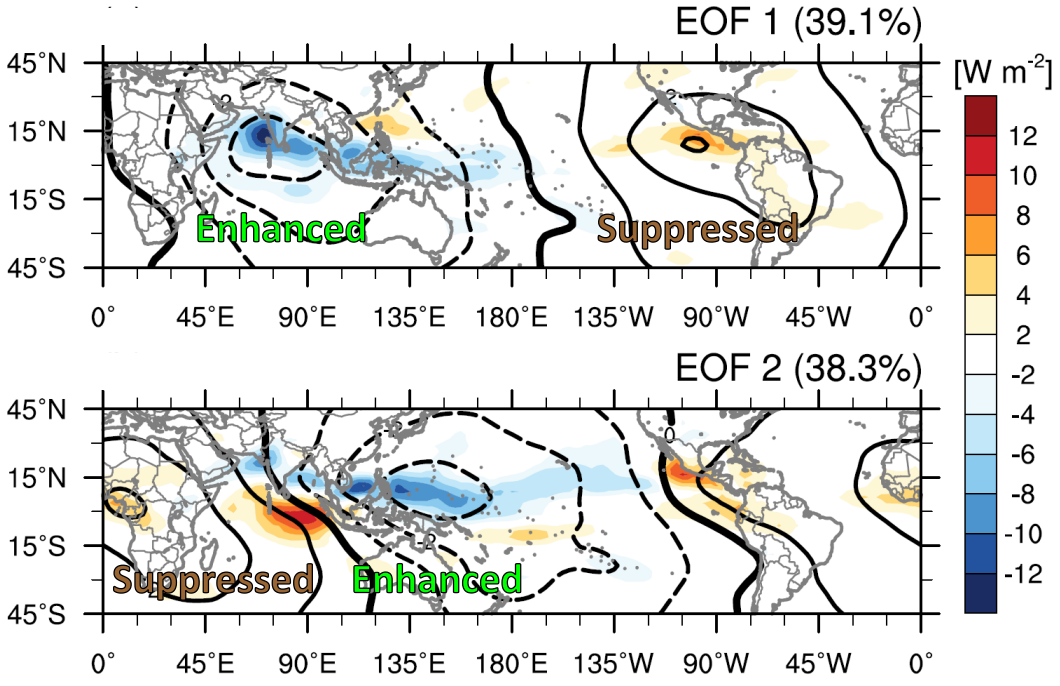
MJO Index - Methodology



Regression between OLR (W m^{-2}, shaded) and 200 hPa velocity potential (x10^6 m^2 s^{-1}, contours) and the PCs of the two leading EOFs of MJO-filtered 200 hPa velocity potential.

Step 1:

Calculate leading 2 EOFs (2D lat-lon) of global MJO-filtered 200 hPa velocity potential.

Step 2:

Project model forecasts of MJO-filtered 200 hPa velocity potential onto the 2 EOFs to get a time-series of each EOF.

Results shown for JJA 1999-2015 reforecasts.

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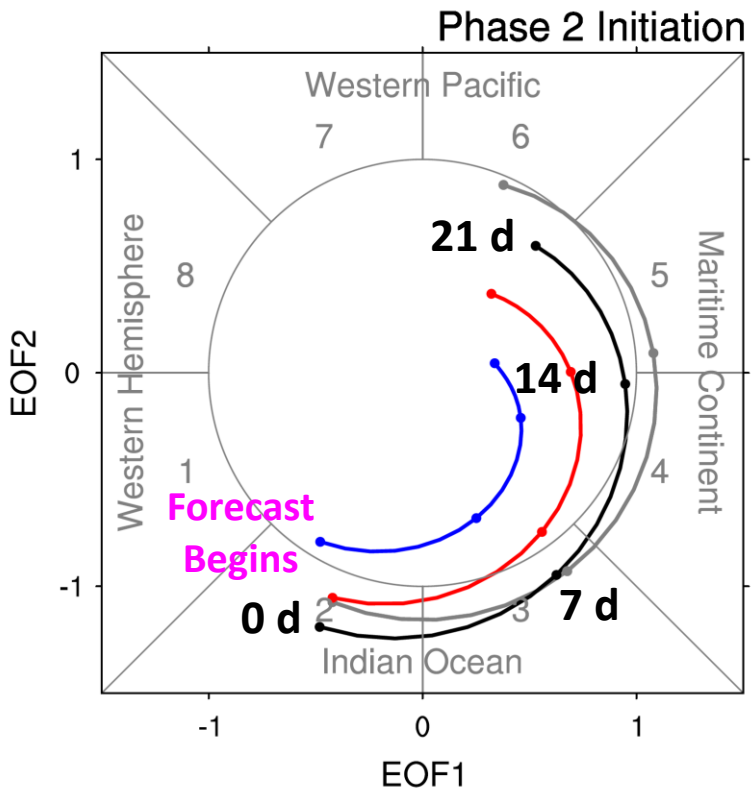
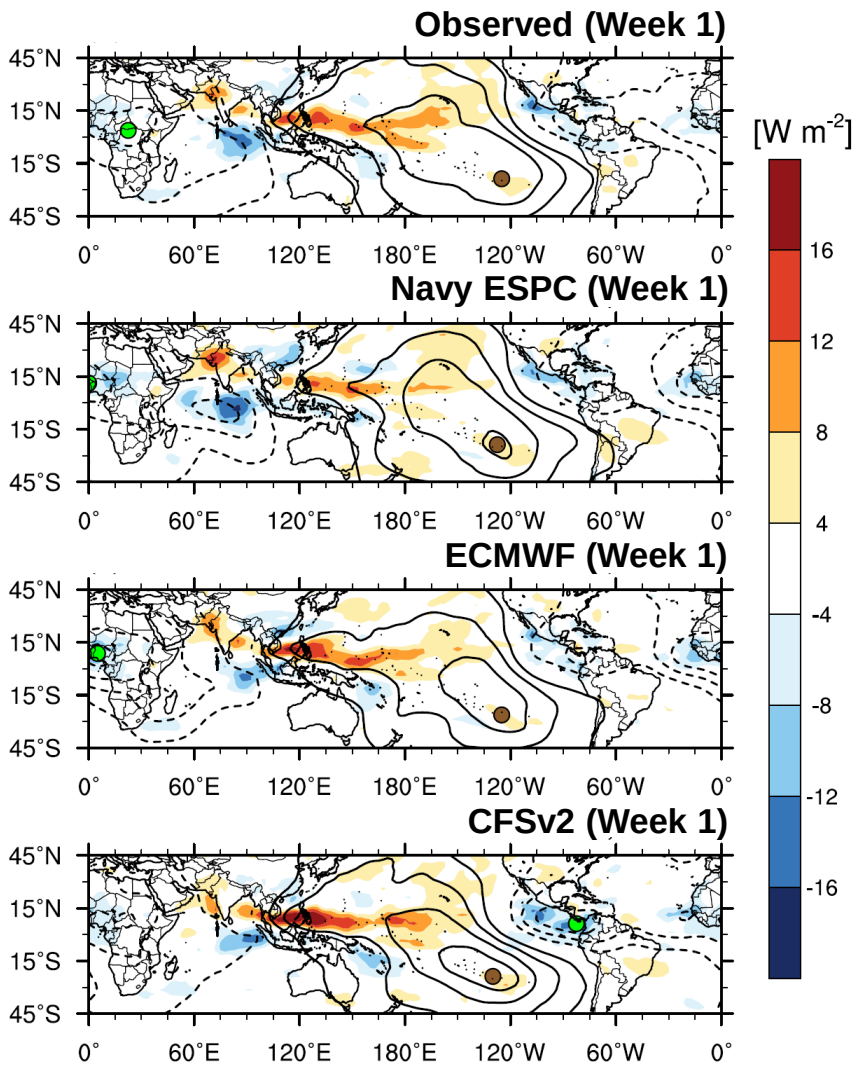
MJO Composite Evolution (Week 1)



Composite evolution of the two EOFs for an initial state over the Indian Ocean (Phase 2) from JJA 1999-2015 reforecasts.

Obs., Navy ESPC, ECMWF, CFSv2



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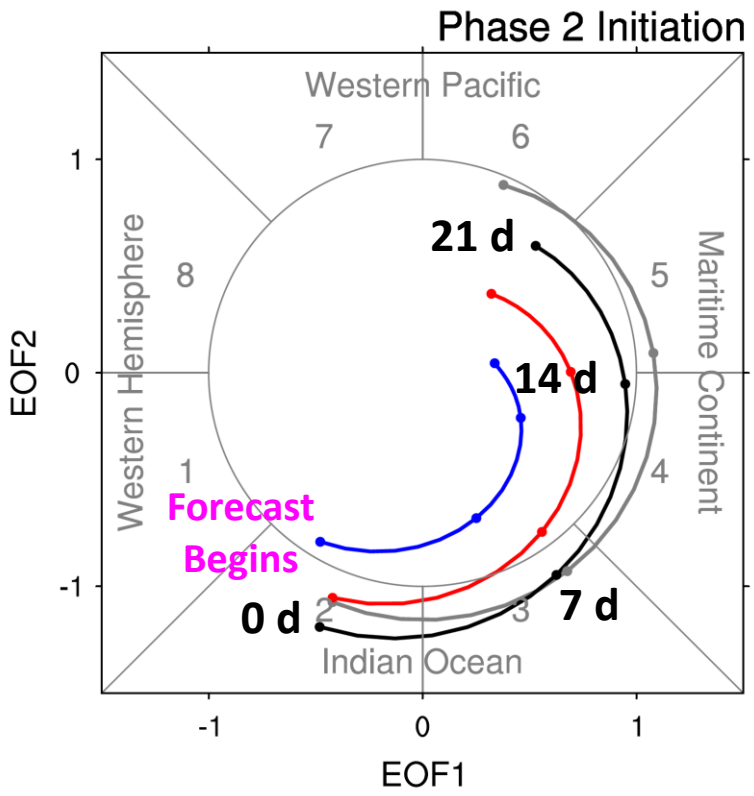
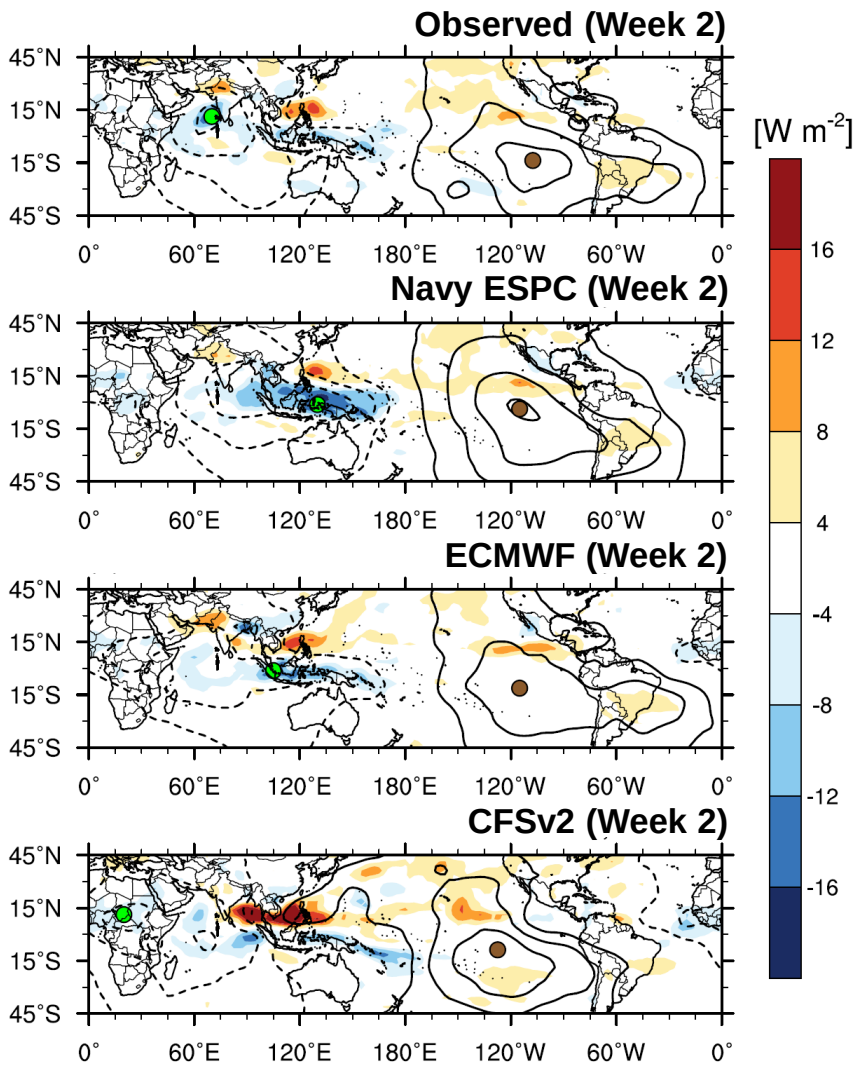
MJO Composite Evolution (Week 2)



Composite evolution of the two EOFs for an initial state over the Indian Ocean (Phase 2) from JJA 1999-2015 reforecasts.

Obs., **Navy ESPC**, **ECMWF**, **CFSv2**



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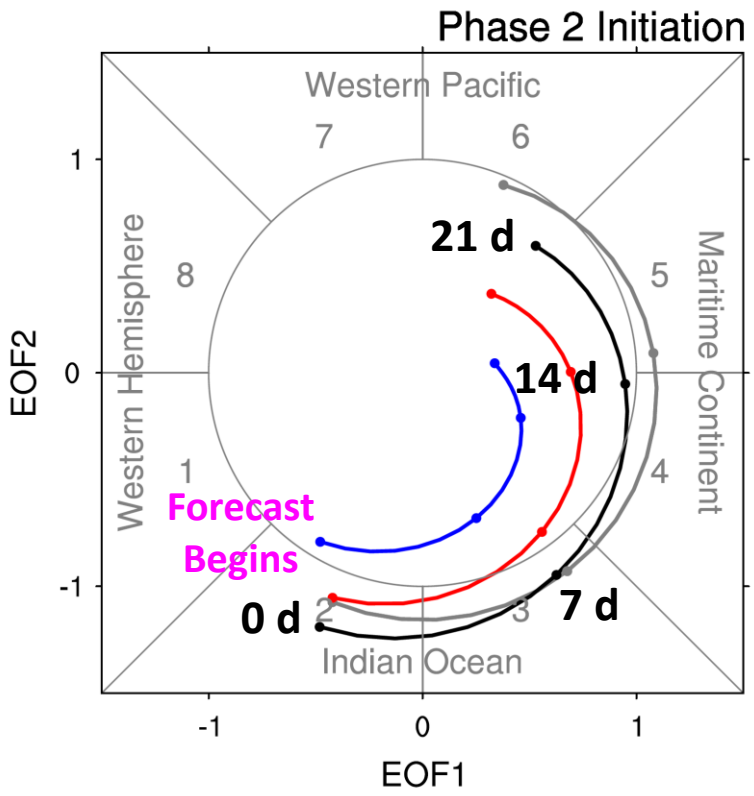
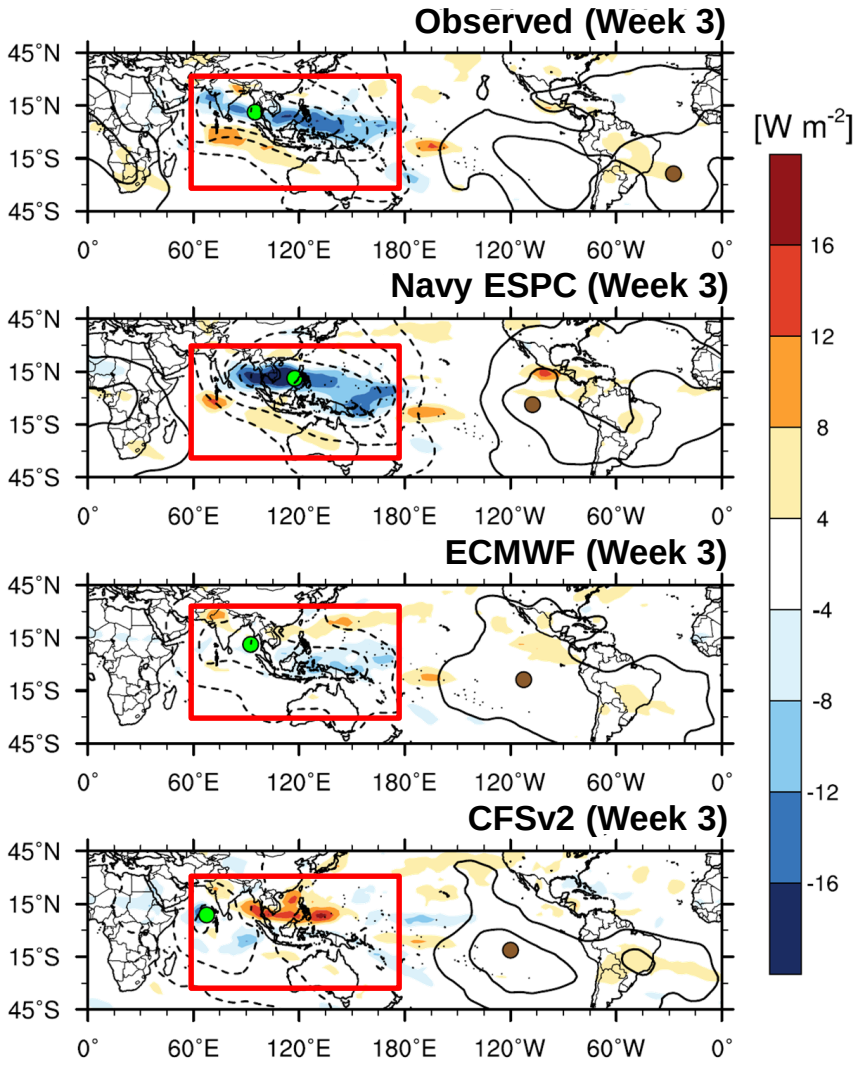
MJO Composite Evolution (Week 3)





Composite evolution of the two EOFs for an initial state over the Indian Ocean (Phase 2) from JJA 1999-2015 reforecasts.

Obs., Navy ESPC, ECMWF, CFSv2

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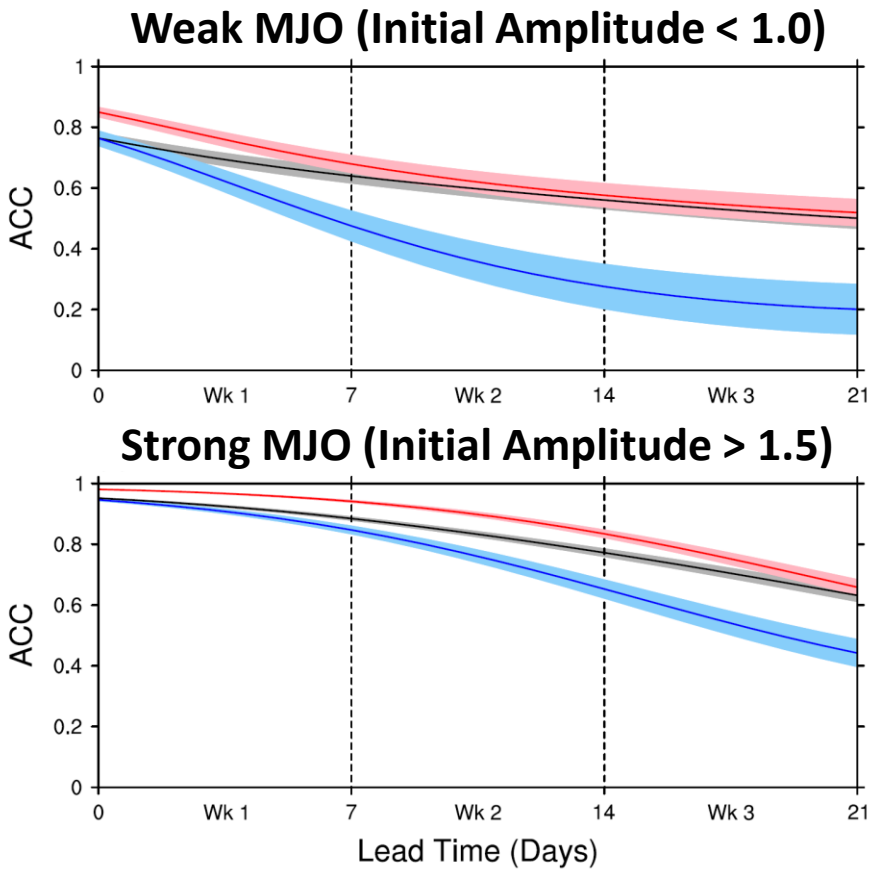
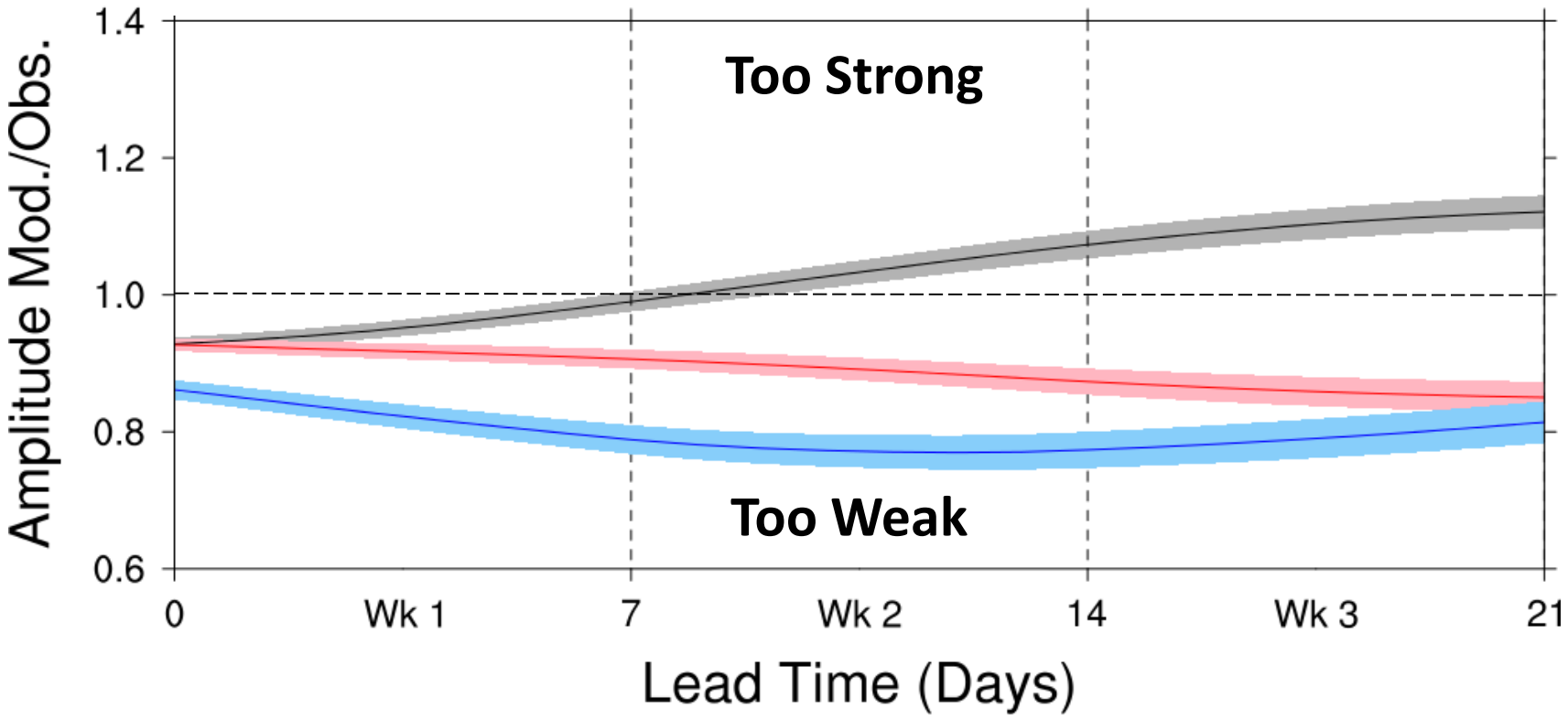
MJO Index Anomaly Correlation



Navy ESPC, ECMWF, CFSv2

MJO Index – Amplitude Bias



Navy ESPC, ECMWF, CFSv2

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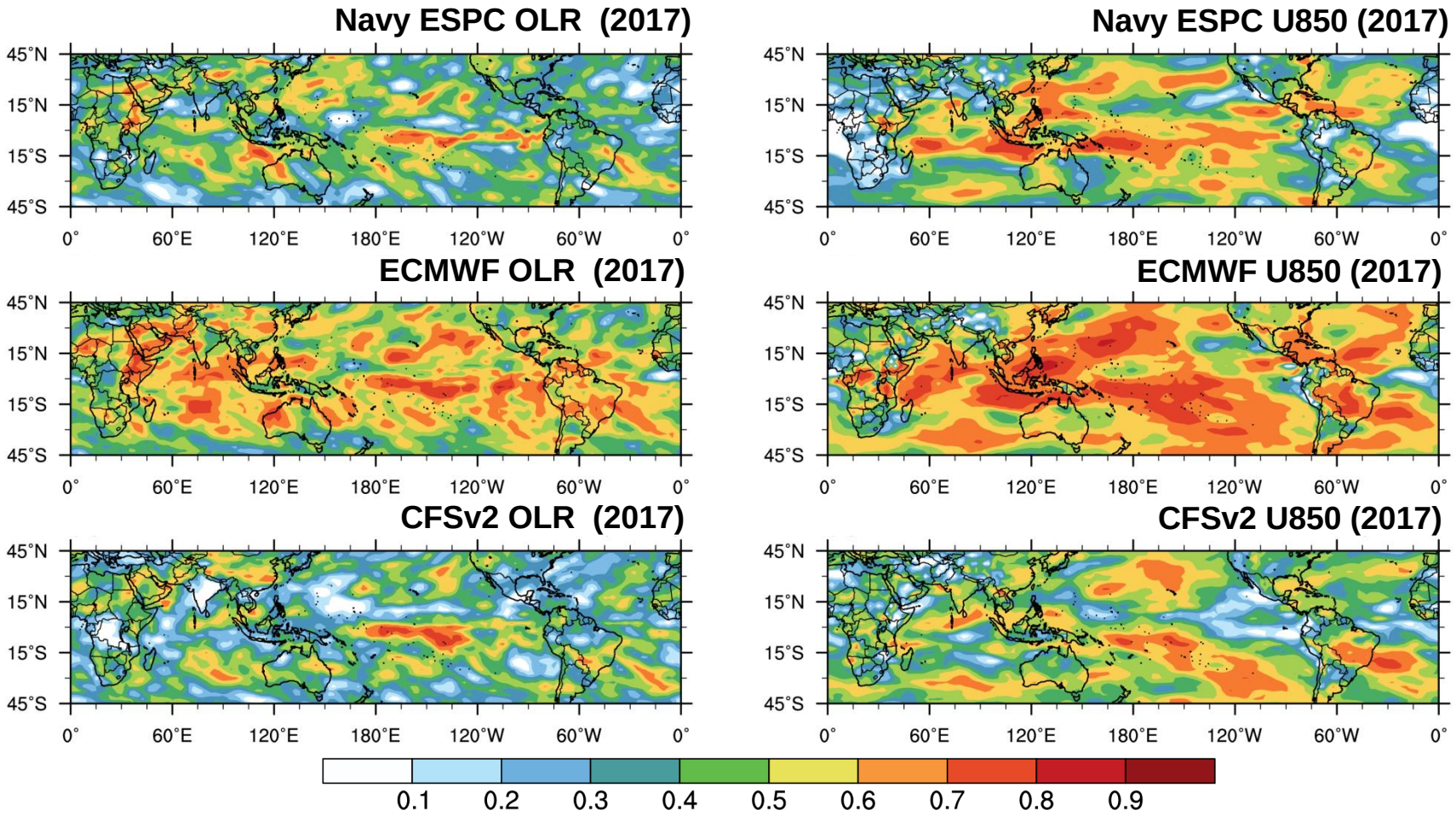
Ensemble Performance During 2017



Anomaly correlation (shaded) between forecasted and observed week 2 (F7-14d) OLR (left) and U850 (right). First 16 members used.

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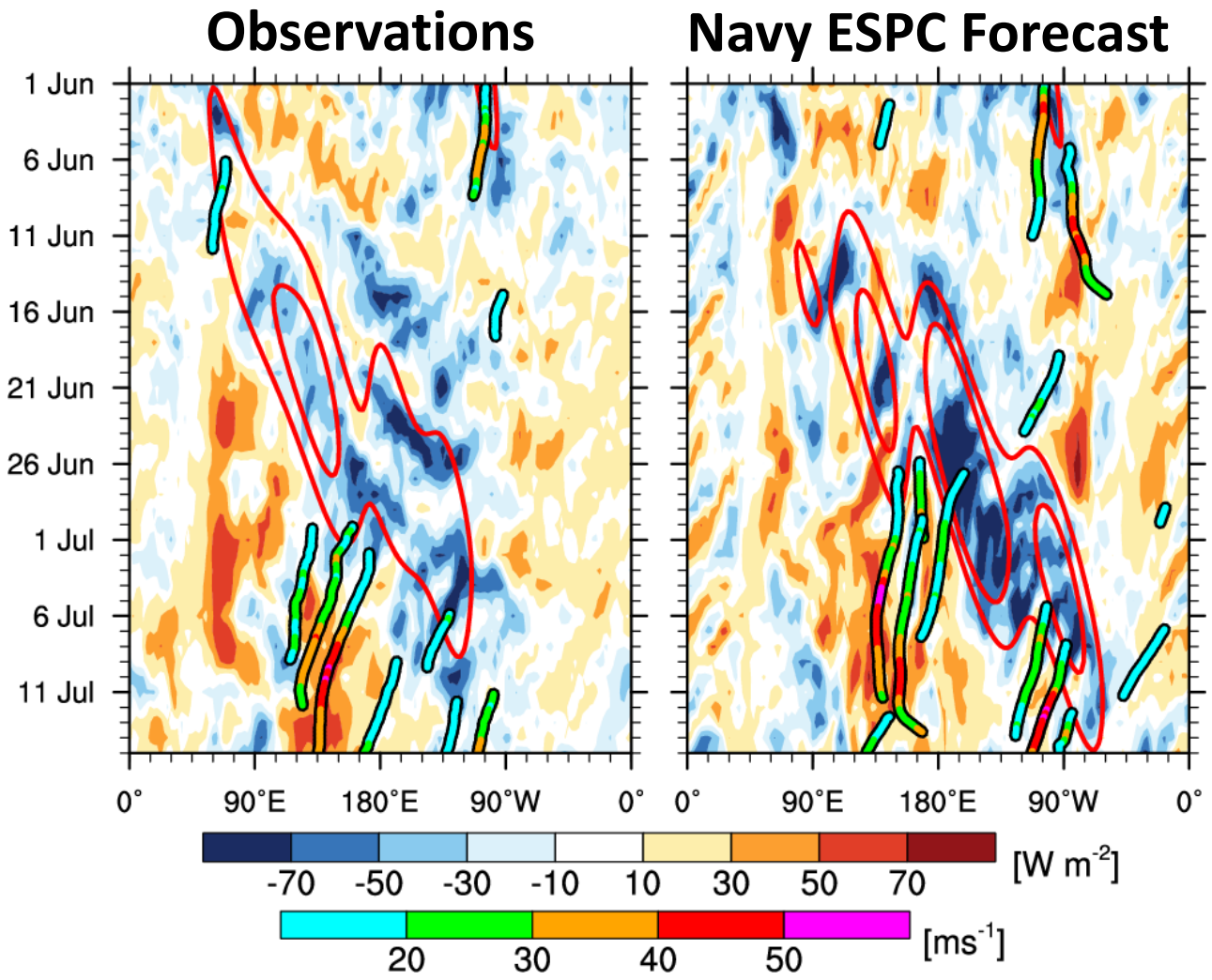
Tropical Cyclone Case Study



Model Initialization (June 1, 2015)

OLR anomalies averaged over 0-10°N from (left) observations and (right) a 45 d Navy ESPC forecast are shaded.

Negative MJO-filtered OLR anomalies are contoured in red every 15 W m^{-2} .

TC tracks are colored by 10 m max windspeed.

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Summary and Future Work

Summary:

- The ability of a model to predict the position of the MJO convective envelope may be a more relevant test of MJO predictive skill than global MJO indices.
- The Navy ESPC has fairly unique MJO biases (too fast and too strong).
- Preliminary looks at active tropical cyclone periods indicate that extreme events may have predictive skill beyond 1 month

Future Work:

- Closer examination of the performance of the Navy ESPC ensemble
- Multi-year analyses of the predictability of tropical cyclone genesis and track density at S2S time scales.

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