The effects of bias, drift, and trends in calculating anomalies for evaluating skill of seasonal-to-decadal initialized climate predictions

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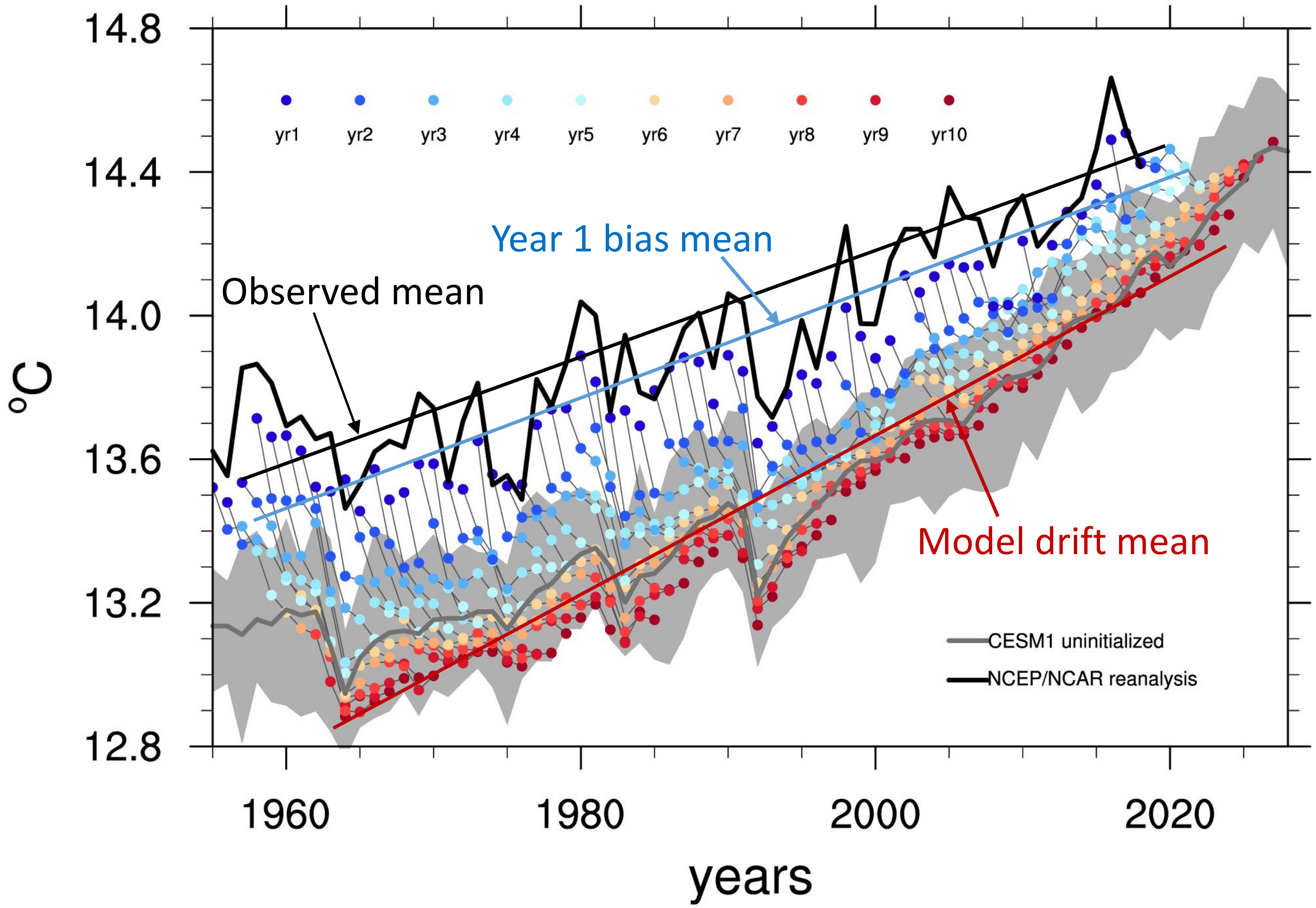
Model error, bias and drift



CESM1 LE and DPLE Global ANN TAS

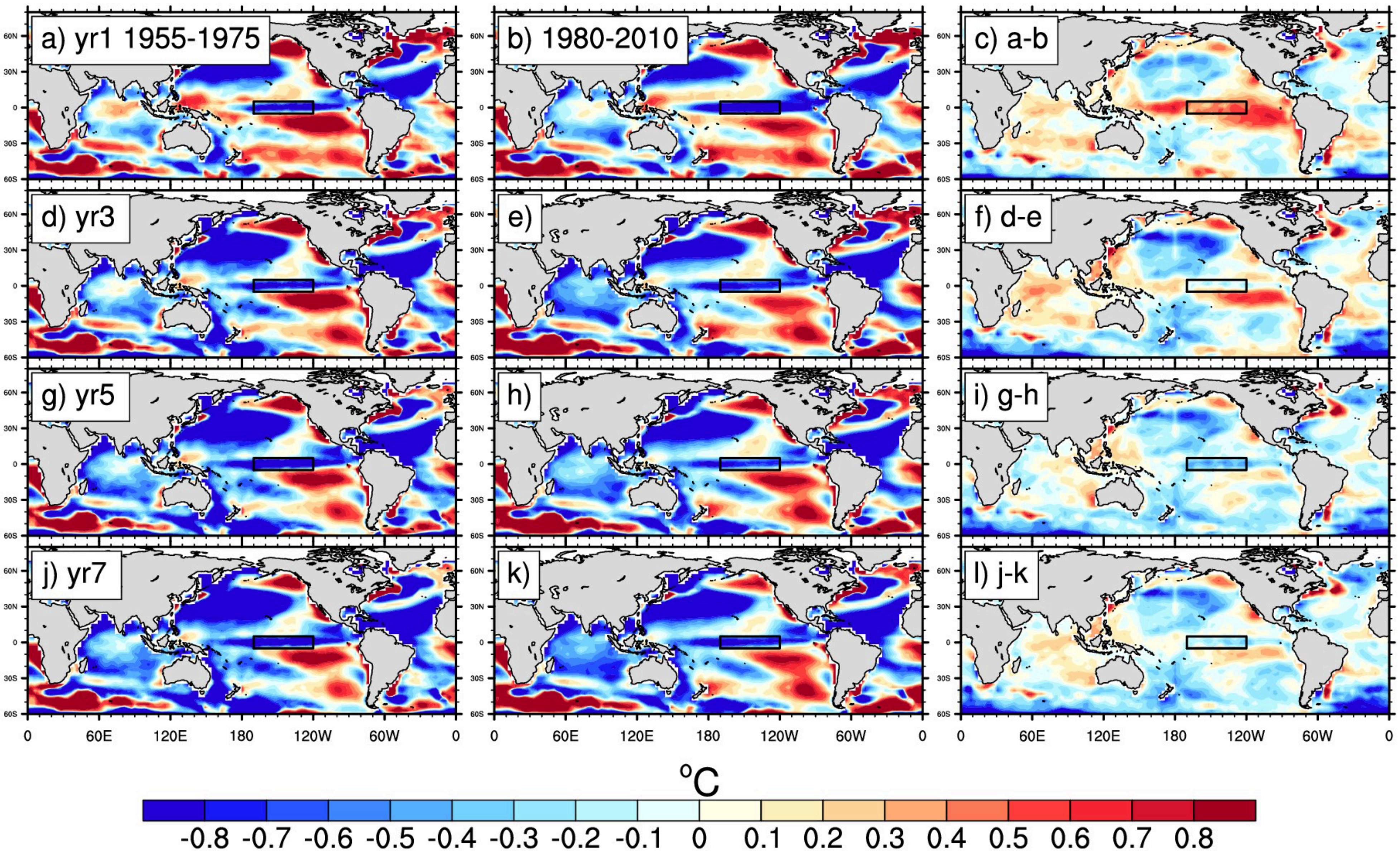
Trends in climatology are less of a problem for shorter timescales:

S2S: 1999-2016 (18 yrs)

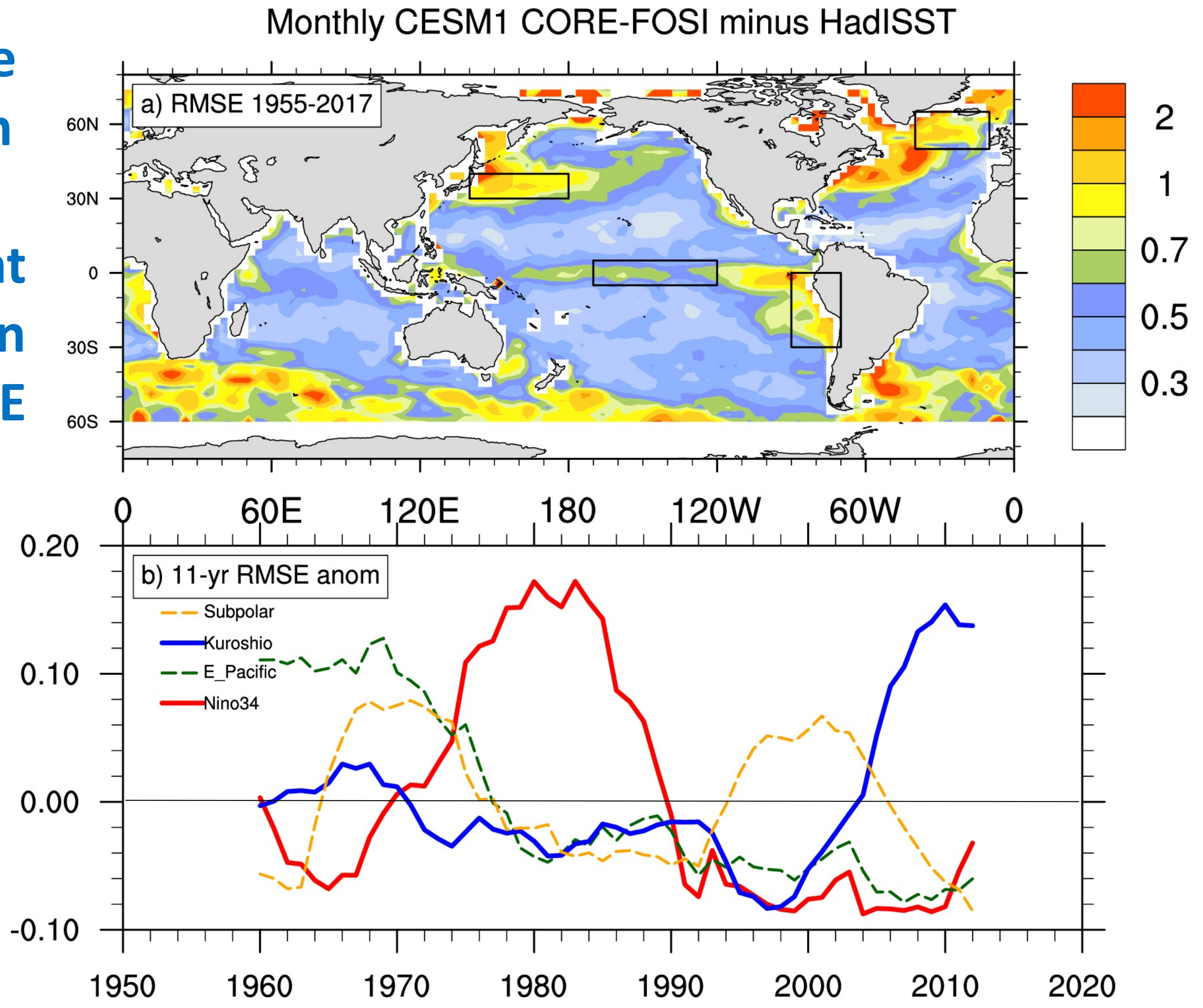
S2I (NMME): 1981-2010 (30 yrs)

S2D (DPLE): 1954-2015 (62 yrs)

DPLE SST bias and drift due to model error and differing trends



The initial state errors in the model (differences between model initial states and observations they are meant to represent) show a pattern and a time evolution in DPLE



Three methods of computing anomalies:

1. **Lead year differences from a model climatology (e.g. Doblas-Reyes, et al 2013: Boer et al., 2016 for DCPP)**

(trends in bias and drift introduce enhanced skill estimates for earlier and later in the hindcast period)

2. **Bias-adjusted lead year differences from the previous 15 year average from observations (e.g. Meehl et al., 2016)**

(unrealistic skill can be introduced when low frequency variability in the observations is large compared to the hindcasts on timescales greater than 15 years)

3. **Lead year differences from the previous 15 year average of model initial states**

(somewhat lower skill compared to each of the previous methods, but less difficulties with long term trends in the model climatology, and no unrealistic situational skill from using observations as a reference)

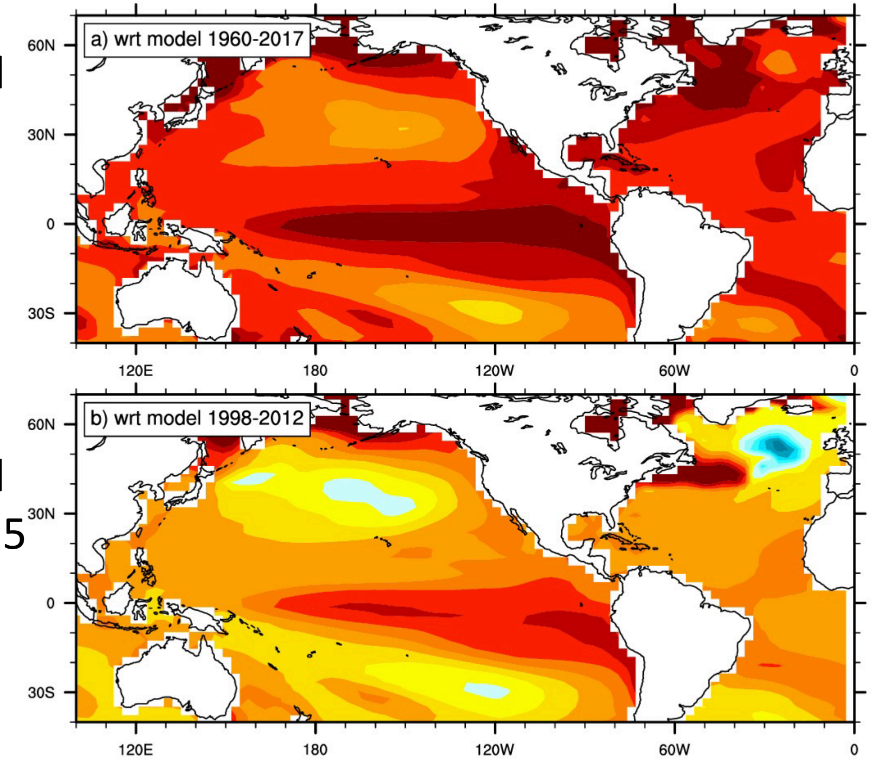
Computing anomalies for verification—the issue of trends

Prediction initialized in 2013 for IPO transition in 2015-2019 (after Meehl et al., 2016)

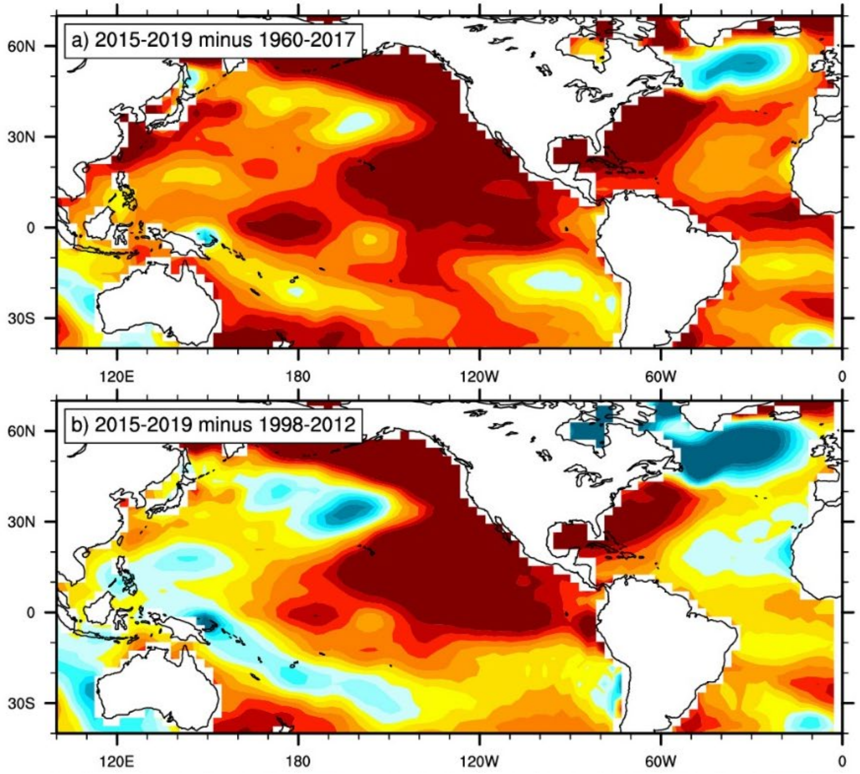
DPLE Yr3-7_SST_initialized_2013(2015-2019) minus model clm

Anomalies computed relative to entire climatology

Anomalies computed relative to previous 15 years



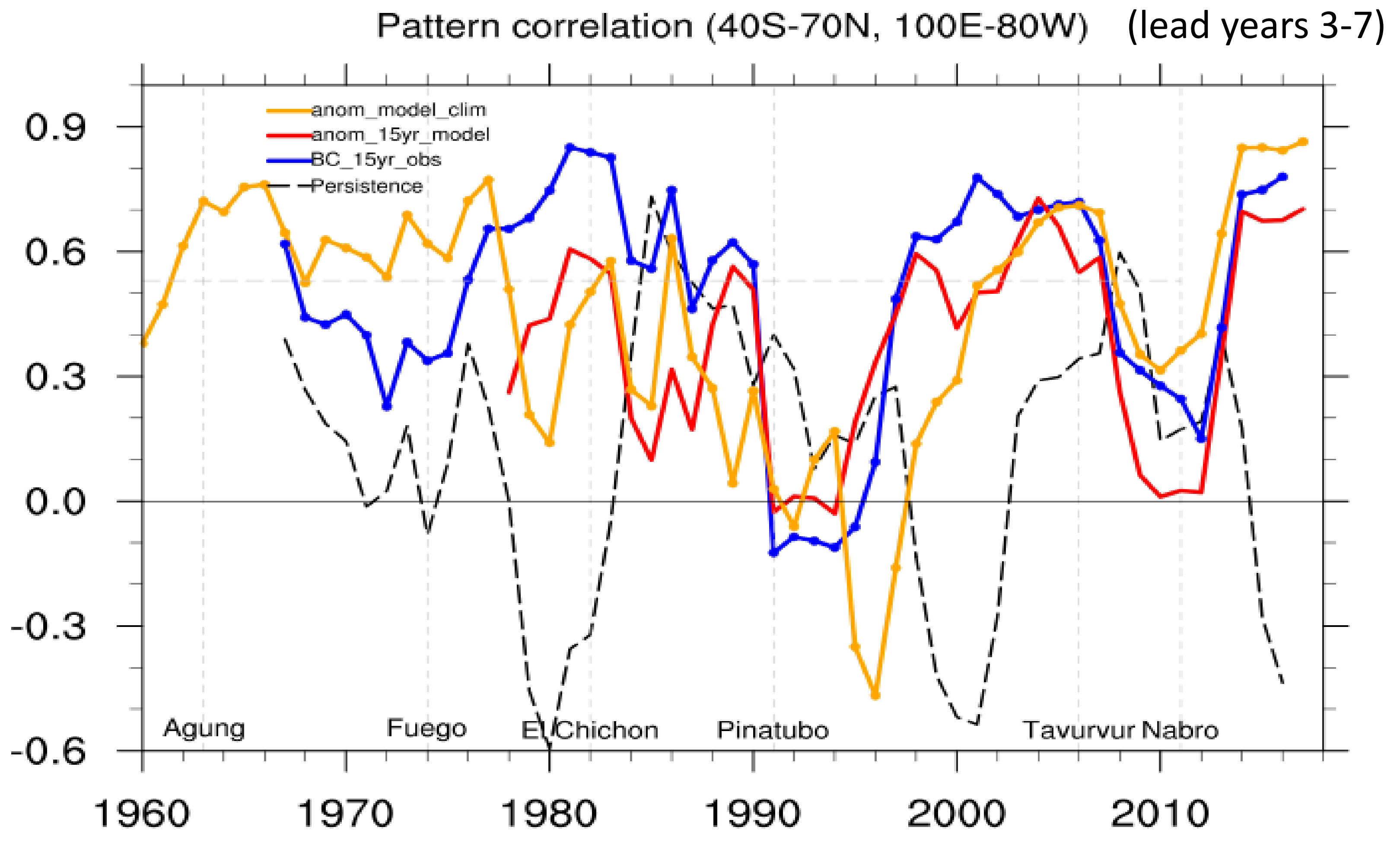
NCEP/NCAR observations



Pcorr= +0.88

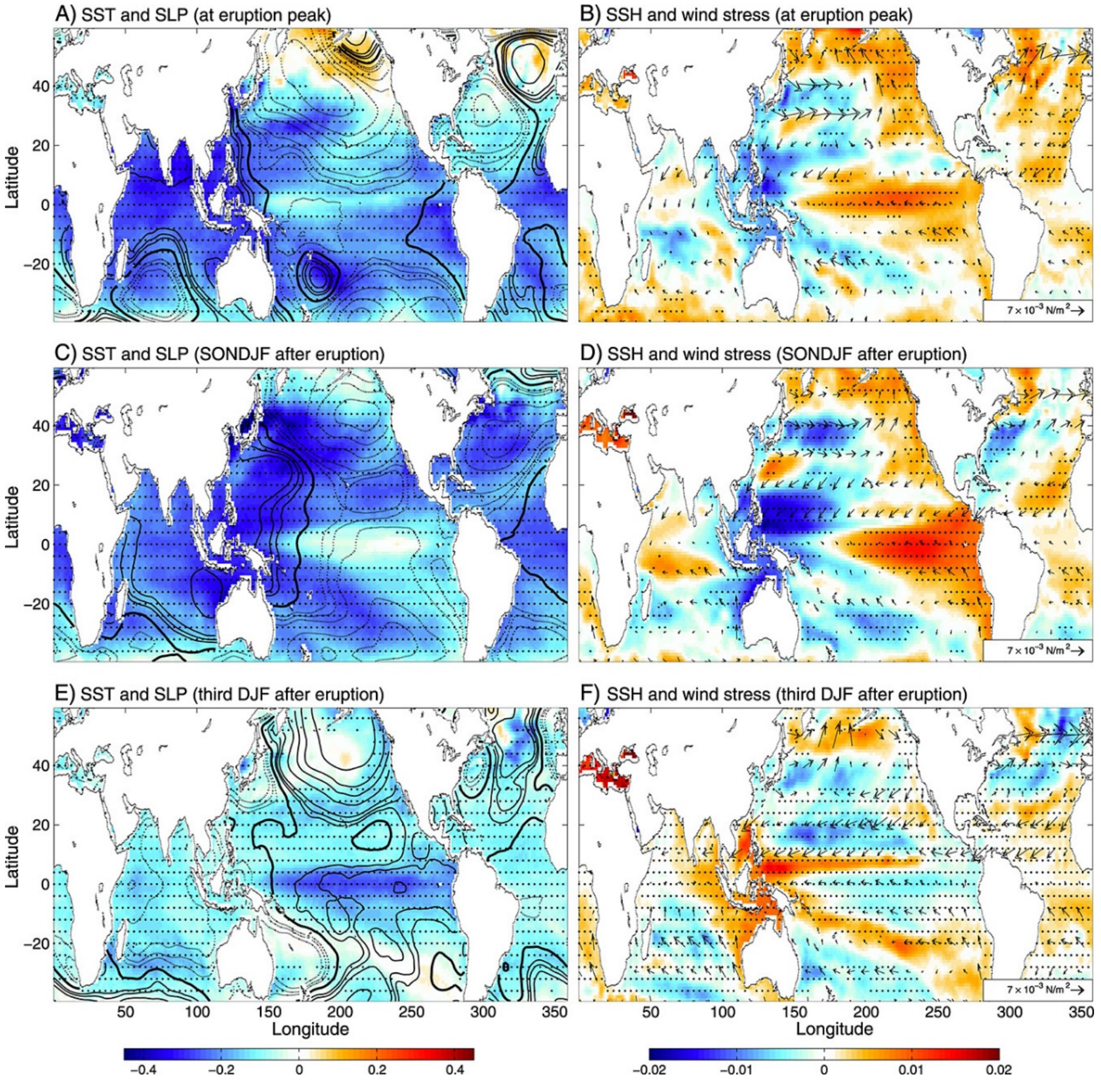
+0.70

Anomaly pattern correlations for the Pacific show drops in skill after Pinatubo (early 90s) and Tavurvur/Nabro (mid-2000s)



The problem of volcanoes for predicting PDV

Multi-eruption multi-model average response to a Volcanic eruption: weak El Niño-like response followed by La Niña-like response three years later (Maher et al., 2015)

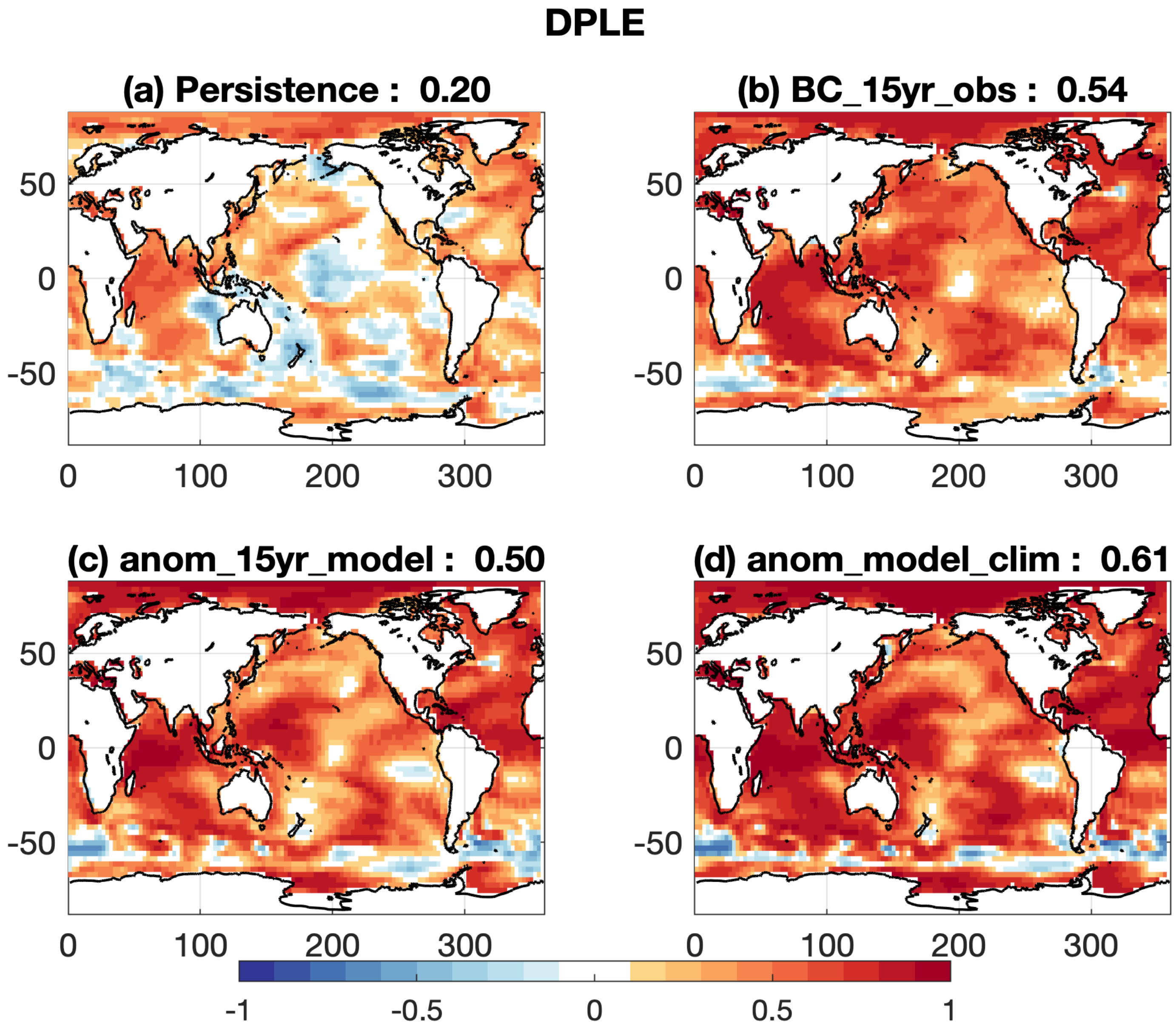


If the post-eruption ENSO sequence in the single realization of observations does not happen to match the ensemble mean model response to volcanoes (left) there will be a negative impact on prediction skill

(Meehl et al., 2015)

If volcanoes are not included in predictions, the verifying observations do include their effects and that will have a negative impact on prediction skill

Less skill in the tropical Pacific in temporal correlations due in part to complicating effects of volcanic eruptions



Summary

In initialized S2D hindcasts, the model biases (differences between the observed and model initial states) and drifts (the rapid model drift away from the initial state due to model systematic errors) are among the greatest challenges facing initialized prediction today.

The bias and drift, and differences in trends between initial states and drifted states, introduce uncertainties in calculating anomalies to assess skill of initialized predictions.

Three methods of computing anomalies are analyzed:

1. **Differences from a model climatology** (trends in bias and drift introduce enhanced skill estimates for earlier and later in the hindcast period)
2. **Differences from the previous 15 year average from observations** (unrealistic skill can be introduced in situations where low frequency variability in the observations is large compared to the hindcasts on timescales greater than 15 years)
3. **Differences from the previous 15 year average of model initial states** (somewhat lower skill compared to each of the previous methods, but less difficulties with long term trends in the model climatology, and with unrealistic situational skill from using observations as a reference)

The complicating effects of the tropical Pacific SST response to volcanic eruptions, which have been noted previously, contribute to difficulties with all three methods