# Uncertainties in Extend-Range Precipitation Forecasts: Model Biases or Predictability Limits

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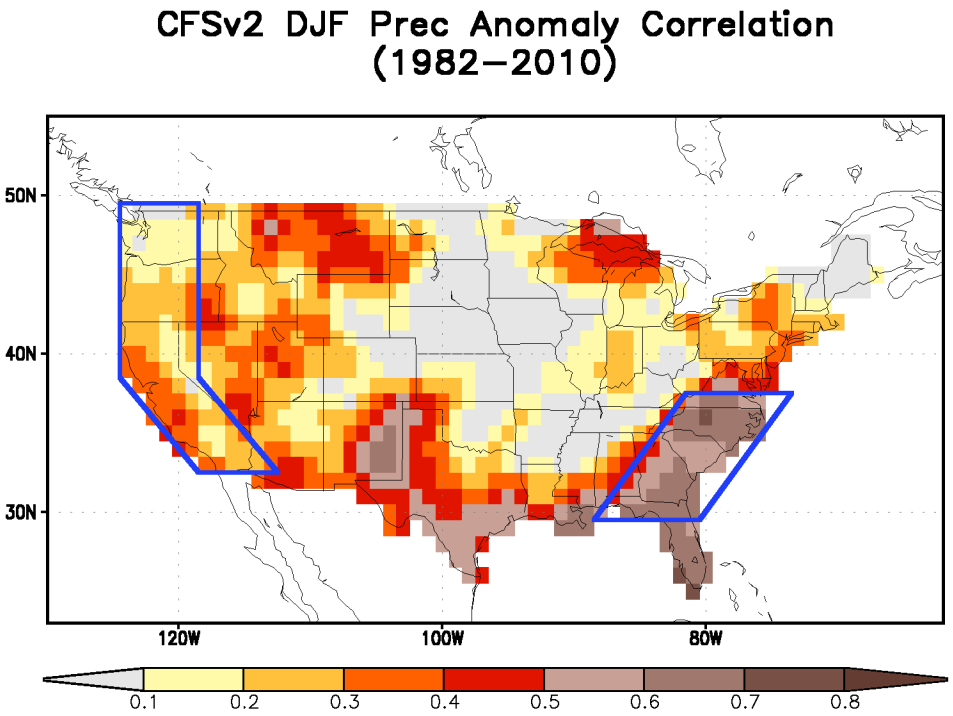
# The context…




- The CFSv2 skill is low in predicting the DJF precipitation anomalies over the US west coast.
- **Question:** Is the low skill in the CFSv2 due to the model biases or inherent predictability limits?

# Analysis approach

- Assess the average skill for predicting DJF precipitation over the US west coast (wCoast) in seven models from the North American Multi-Model Ensemble (NMME), specifically,
  - How is CFSv2 skill compares to that in other models?
- Analyze the US west coast precipitation ENSO response in individual models for individual El Niño events, specifically,
  - To what extent the response in individual El Niño events differ from the composite, i.e. the sensitivity in response to the amplitude or to the flavors of ENSO SSTs?
- Analyze the precipitation ENSO response over the US southeast area (seCoast), where the skill is high, specifically,
  - Whether the SNR is also higher, and the consistency in responses is higher as well?

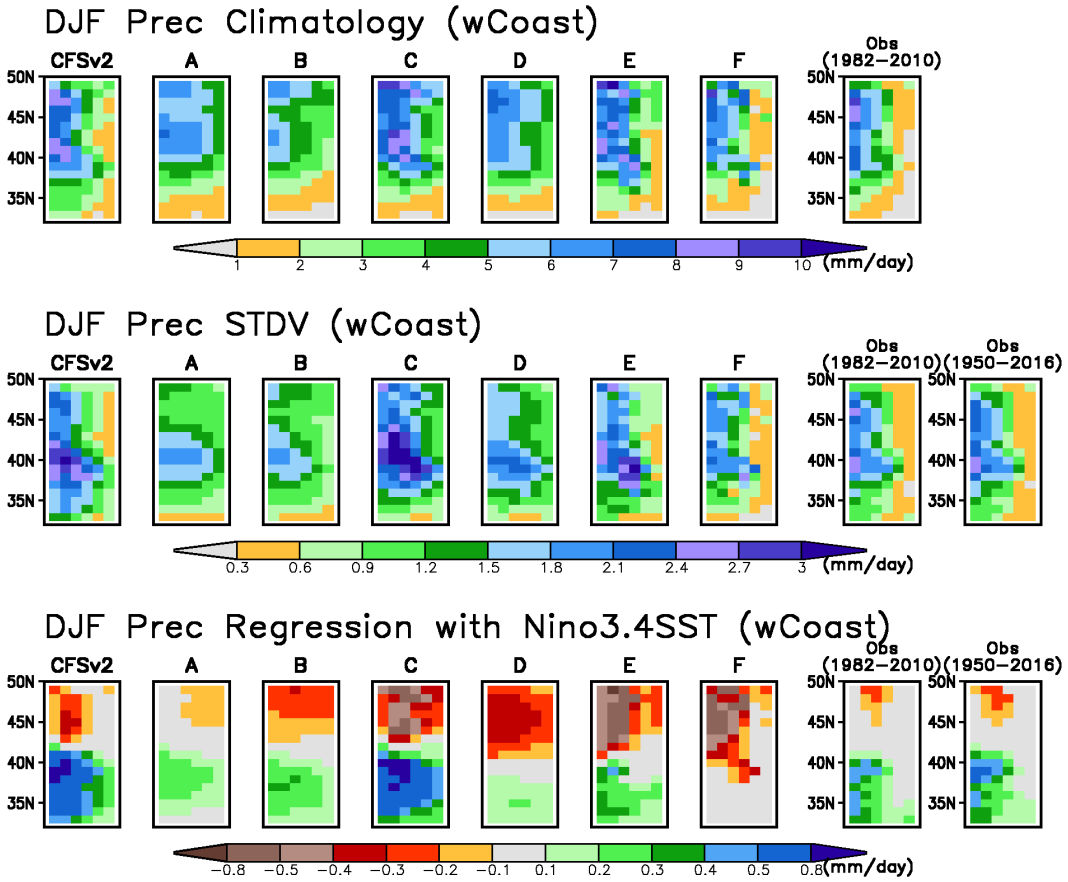
# Data

- **Model data:**
  - 1-month-lead December-January-February (DJF) mean precipitation ensemble forecasts from seven dynamical climate forecast systems in the NMME (Kirtman et al. 2014);
  - 1982-2010 hindcasts and 2011-2016 real-time forecasts;

| Model | Ensemble size | Initial conditions |
|---|---|---|
| CFSv2 | 24 | 00, 06, 12, 18UTC on Oct. 18, 23, and 28, and Nov. 2, 7, and 12 |
| A | 10 | 00UTC on Nov. 1 |
| B | 10 | 00UTC on Nov. 1 |
| C | 10 | 00UTC on Nov. 1 |
| D | 10 | 00UTC on Nov. 1 |
| E | 24 | 00UTC on Nov. 1 |
| F | 11 | 4 members every 5$^{th}$ day in Nov and 7 members on the last day of Oct. |

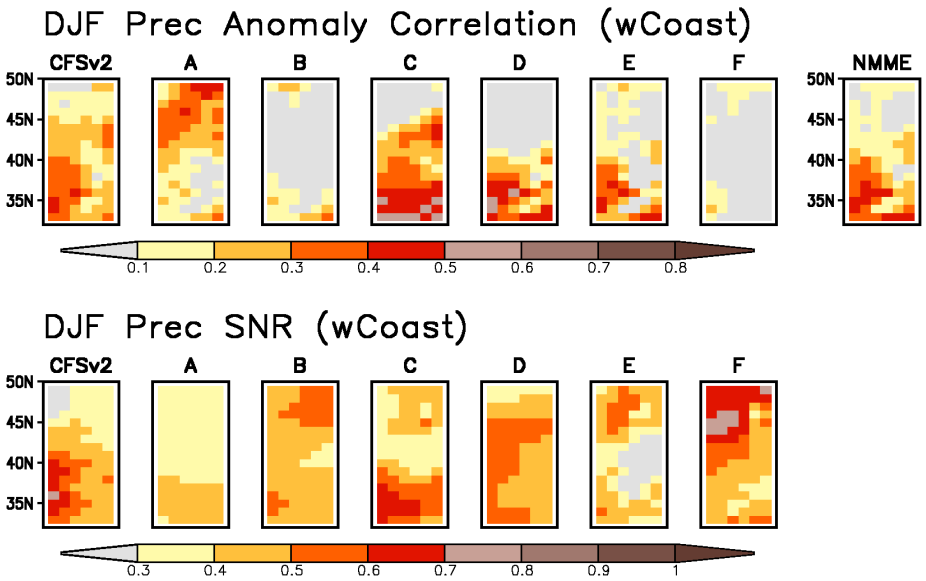
- **Observation data:**
  - Precipitation: the CPC monthly precipitation reconstruction over land (PREC-L, Chen et al. 2002);
- Seasonal mean anomalies based on climatology of 1982-2010;

# Validation of precipitation variability in model forecasts




- All models replicated the observed north-south variations in DJF precipitation climatology and its STDV, although there are differences in details.
- The ENSO linear signal in all models is similar to the typical ENSO signal patterns with negatives in north and positives in south.
- Differences in amplitude of linear responses across models.
- A stronger response does not necessary lead to higher prediction skill.

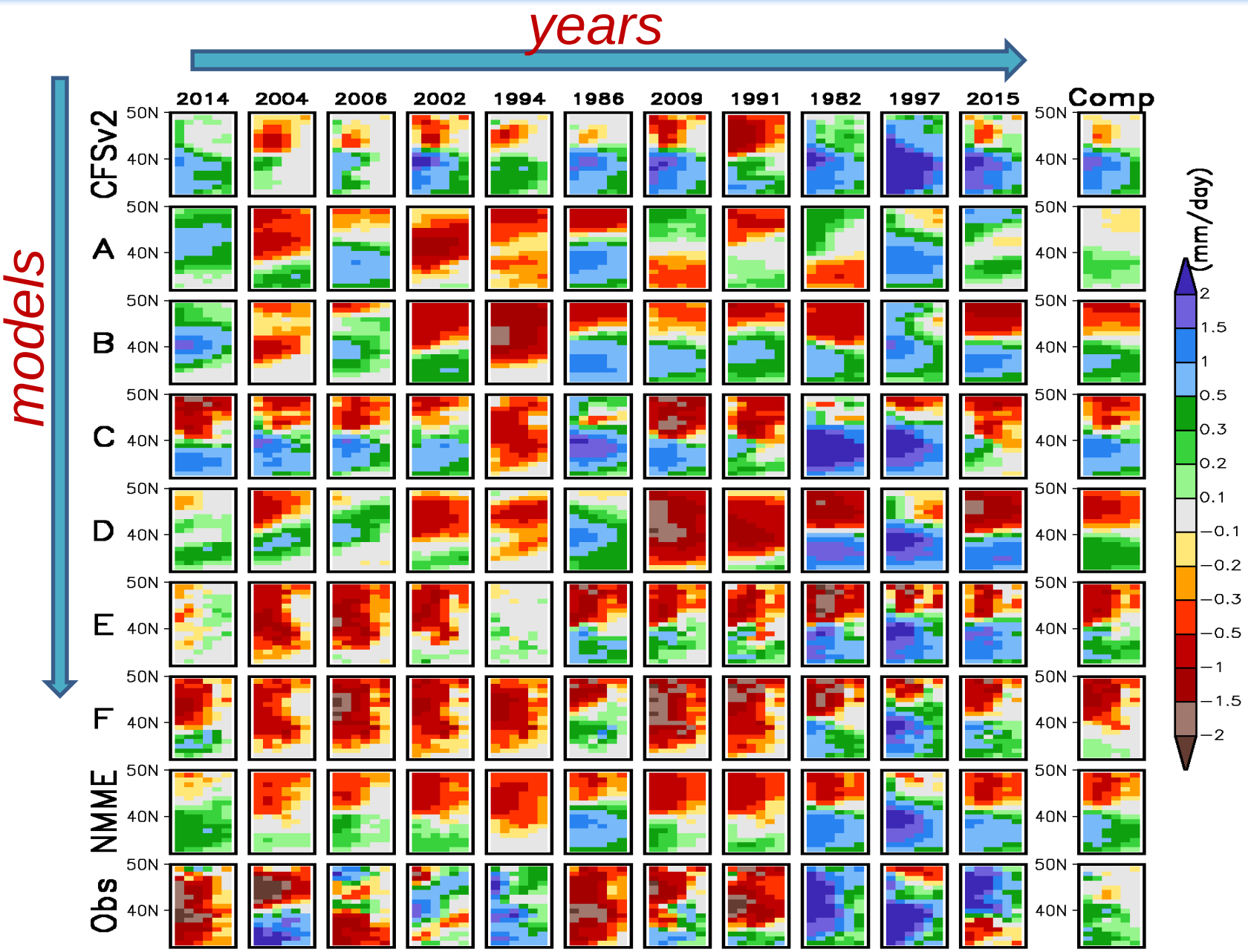
# Prediction skill and signal-to-noise ratio (SNR)



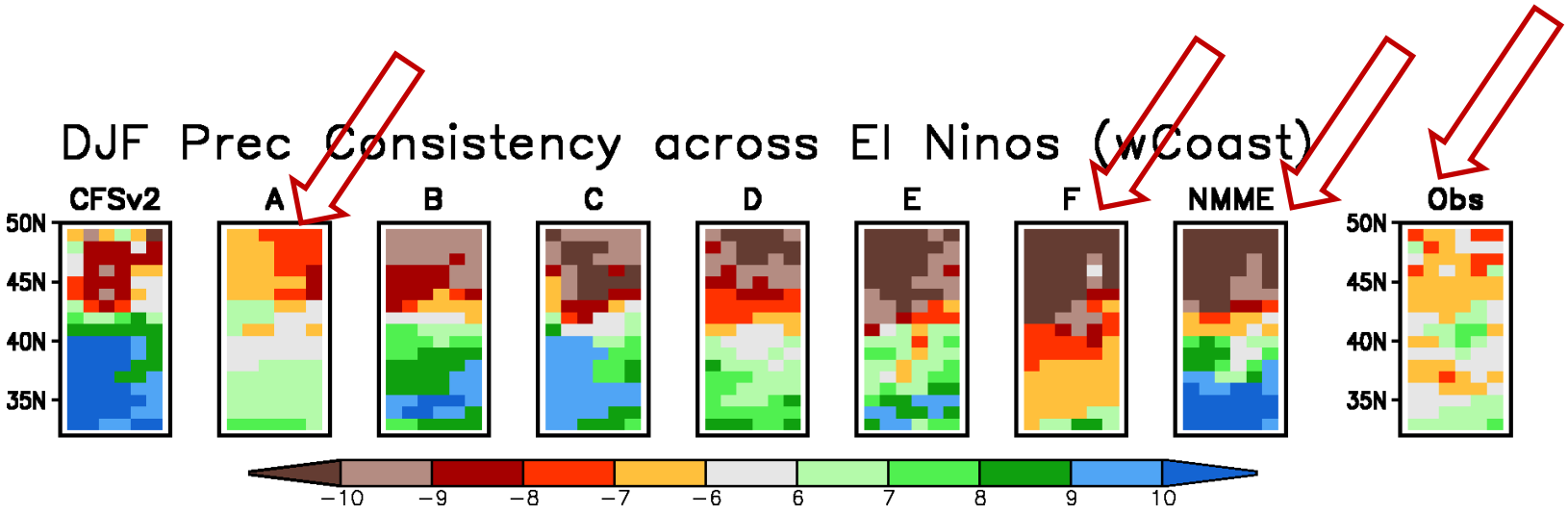

- The prediction skill across all the models is unanimously low.
- Further, the SNR is low for all models, and there is also a lack of correspondence between SNR and skill.
- No indication of low prediction skill in the CFSv2 is due to model biases; it is likely due to inherent noise in nature.

Precipitation response in individual models during individual El Niño events

# Precipitation response during individual El Nino events

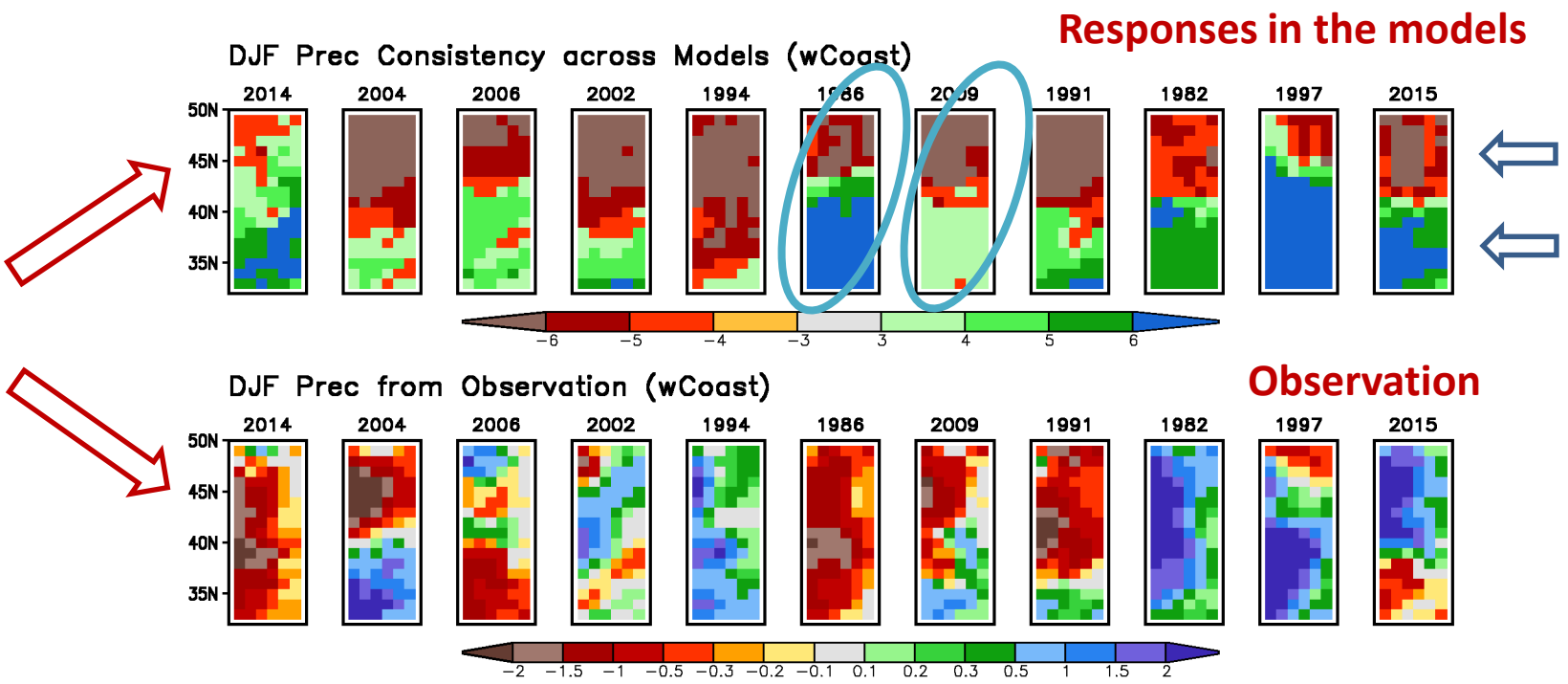


# Consistency in the precipitation responses across El Niños



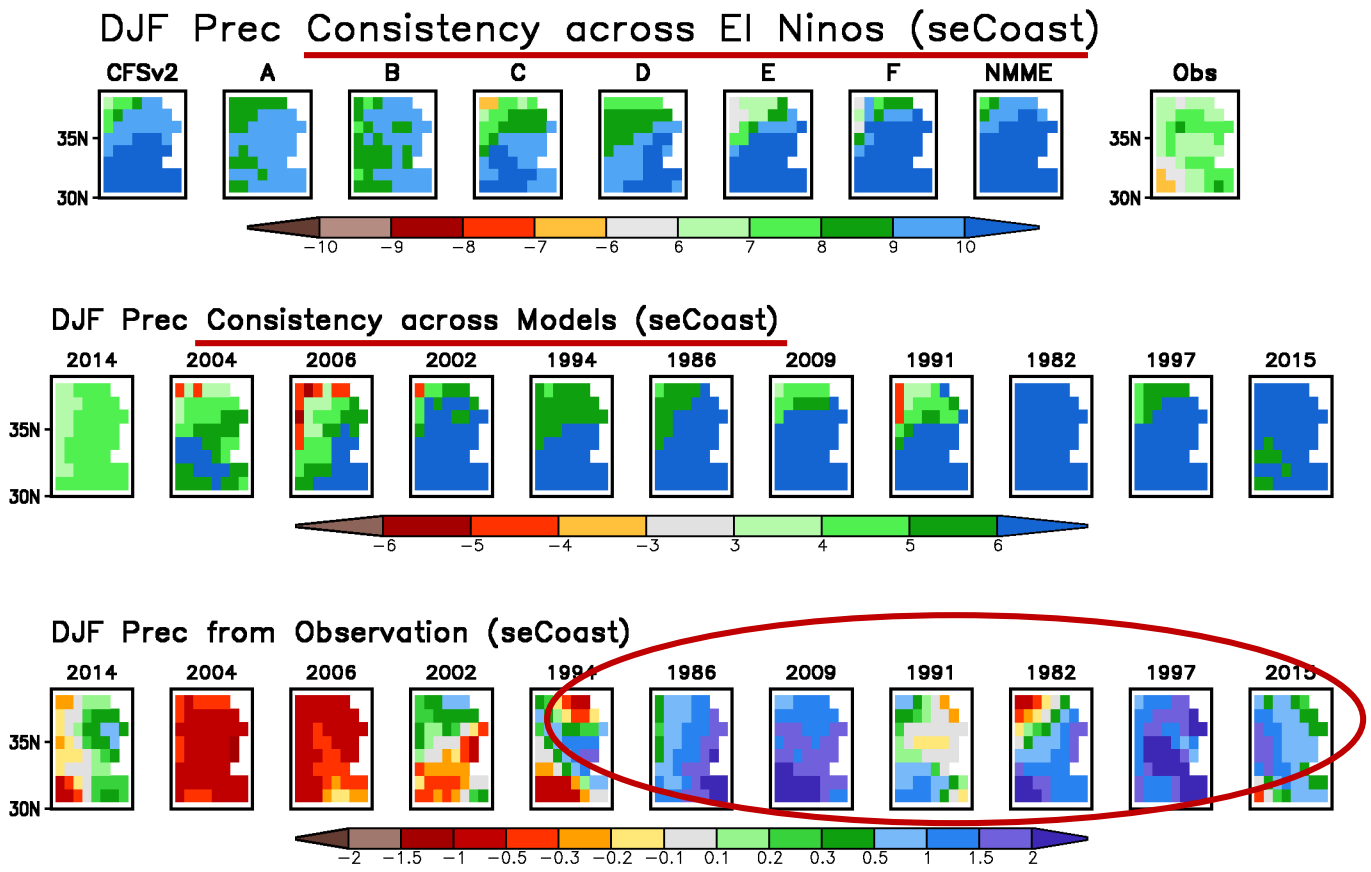

- Lower consistency in the observation due to contribution from noise;
- Good consistency in the NMME both over northern and southern areas;
- Different levels of consistency for different models, stronger consistency over the northern than southern;
- The consistency depends on the SNR in the models;
- High consistency in the response does not necessary lead to high skill.

# Consistency in the Precipitation responses across models during different El Niño events




- High consistency in the northern latitudes than over southern parts; but it does not results in higher skill there;
- No clear indication of definitive conclusions for the consistency across models;
- The model responses have different signs from the observed anomalies in most of events;
- May indicate the contributions from the large noise in observation (unpredictable).

# Prediction responses over the US southeastern area




- The consistency across different El Niños in model responses is high.
- The consistency across different models is high and improves as the El Niño amplitude gets stronger.
- The model responses has the same sign with the observed anomalies for moderate to strong events.
- All facts are consistent with higher skill.

# Summary

- Low skill in CFSv2 for predicting seasonal mean precipitation along the US west coast was also found in predictions from other NMME models;
- Various analysis approaches point to a low SNR regime;
- For low SNR regions, it is hard to make inferences about higher order influence of ENSO (even with large datasets).