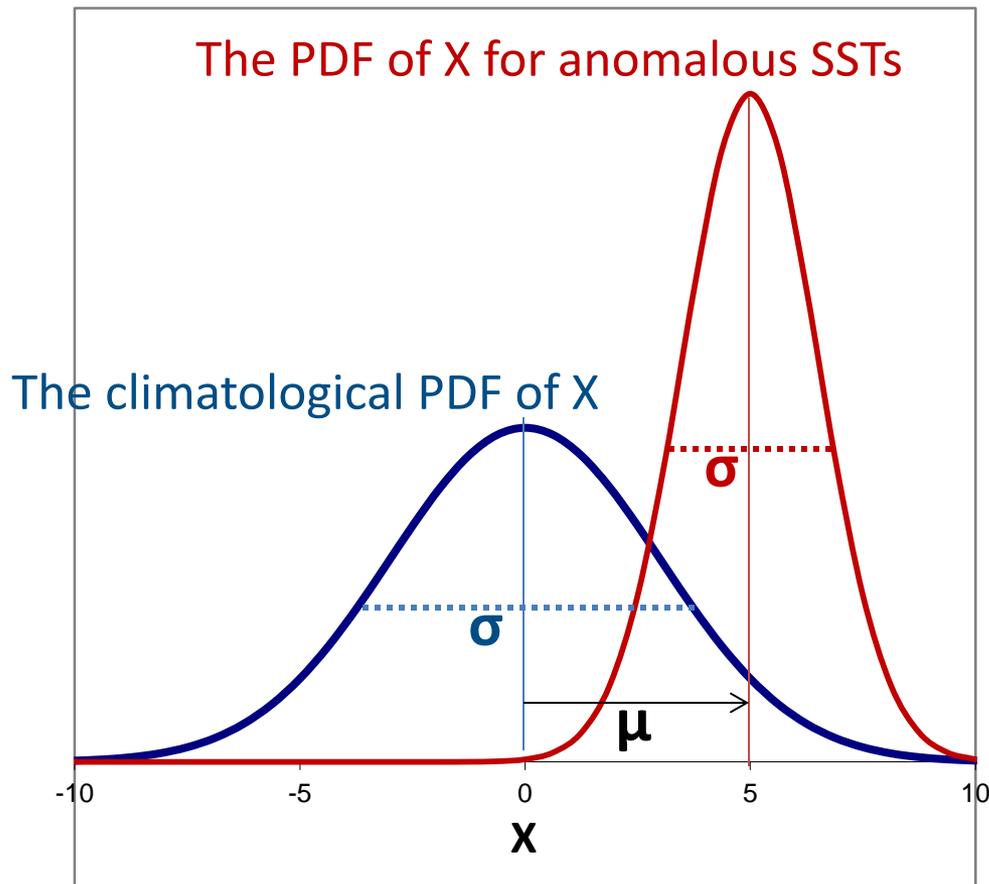


# Influence of ENSO SSTs on the Spread of the Probability Density Function (PDF) for Precipitation and Surface Temperature

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# The predictability of seasonal climate variability



- The predictability for a variable X is determined by the diff. between its PDF for anomalous SSTs from its climatological PDF.
- SSTs could influence the mean and the standard deviation (spread) of the PDF for X;
- Mean shift  $\rightarrow$  signal;
- Spread  $\rightarrow$  noise;
- $SNR = \text{signal}/\text{noise}$ ;

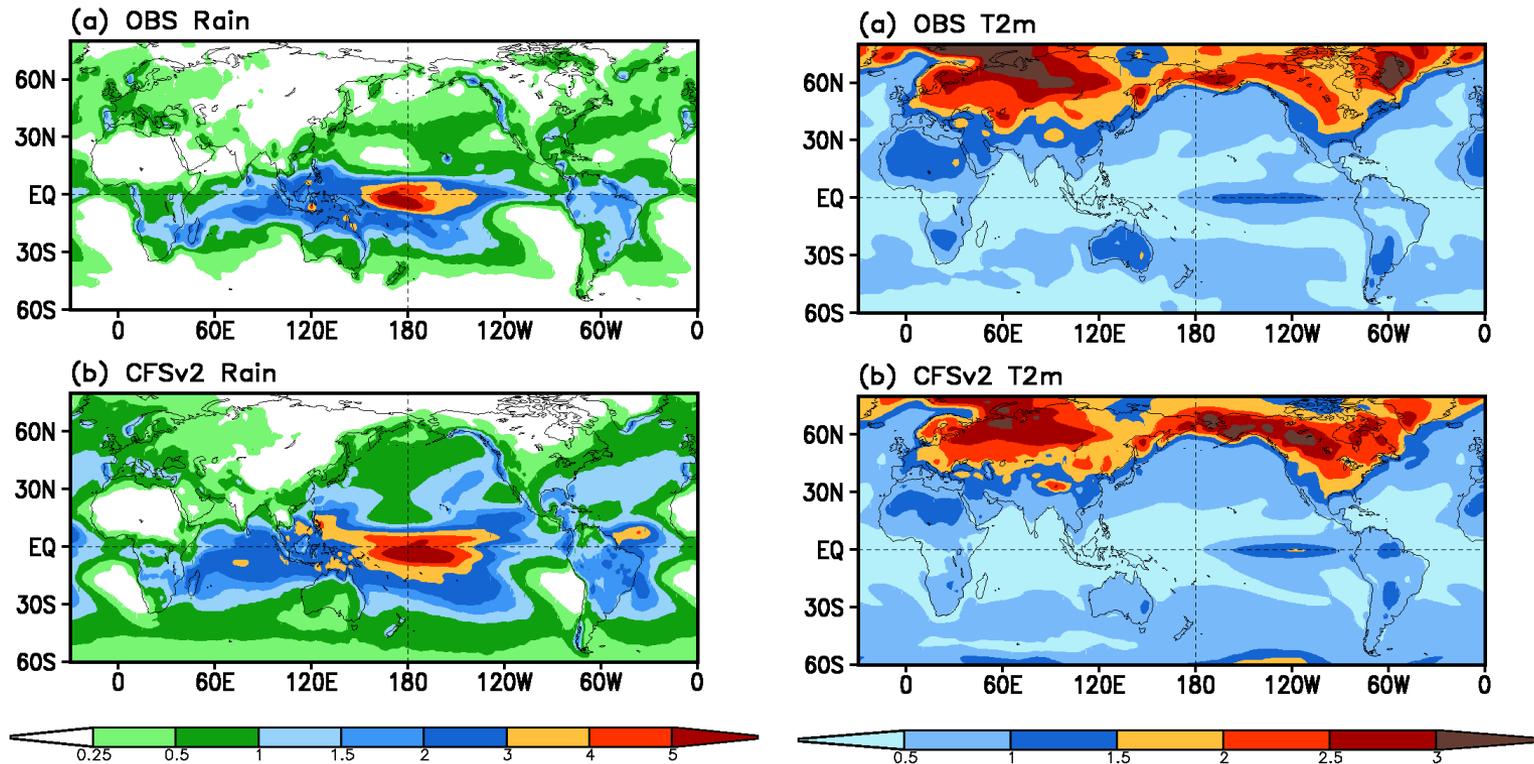
# Objective

- To assess the relative contribution to the potential predictability in seasonal climate system from changes in the mean and spread of the PDF due to the interannual variations in ENSO SSTs.

# Data and Analysis Approach

- Variables:
  - DJF rainfall and T2m;
- Model data:
  - 1982-2012 CFSv2 hindcasts and real time forecasts;
  - 20 members from initial conditions of Nov. 7, 12, 12, 22, & 27;
- Observation data:
  - Rainfall: CAMS-OPI (Janowiak and Xie 1999);
  - T2m: CDAS2;
  - SST: OI SST (Reynolds et al. 2002);
- Methodology:
  - The mean (signal) of the PDF = the ensemble mean of 20 members;
  - The spread (noise) of the PDF = the standard deviation of departure of the individual forecast members from the ensemble mean;
  - Total variability = the standard deviation of individual members in the ensemble forecasts;
  - Linear regression of the signal and noise against Nino3.4 SST;
  - Composite, 5 warm and 5 cold years  $> |$ one standard deviation of Nino3.4 SST $|$ ;

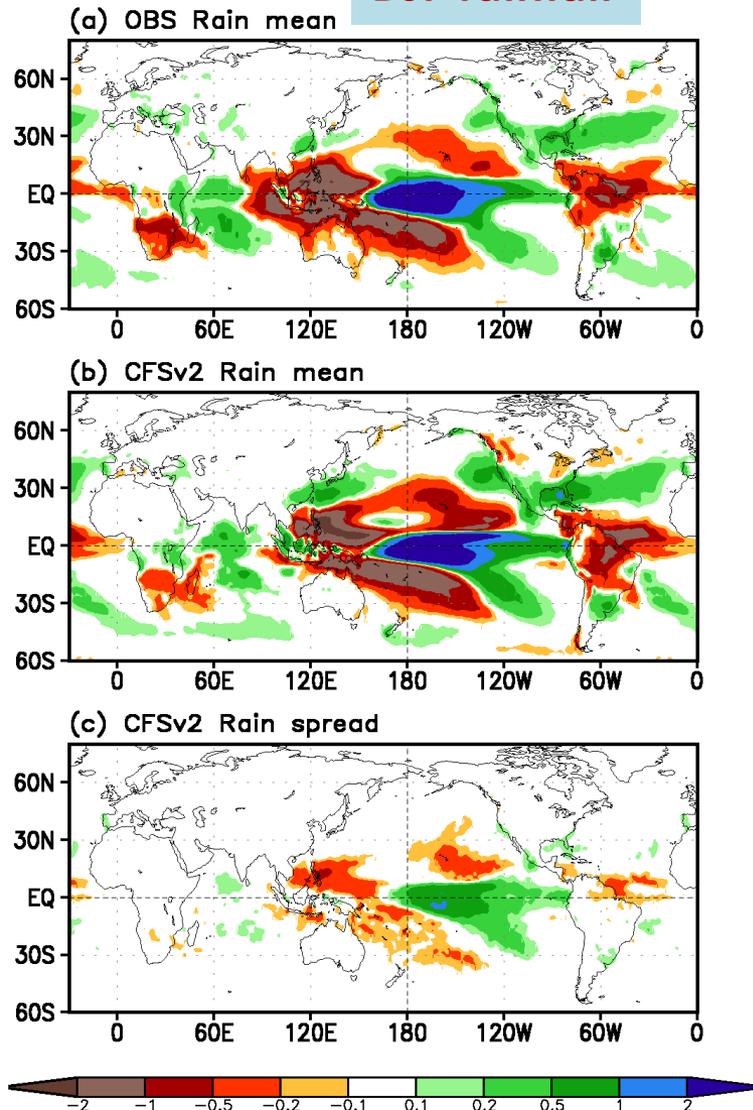
# Total variability of DJF rainfall and T2m



- In general, both Rainfall and T2m CFSv2 show good agreement with observation in spatial pattern and amplitude.
- In details, CFSv2 rainfall variability shows slightly larger amplitude than the observation.
- CFSv2 T2m variability is slightly larger amplitude over NA, and smaller over Europe.

# Linear regressions with Nino3.4 SST

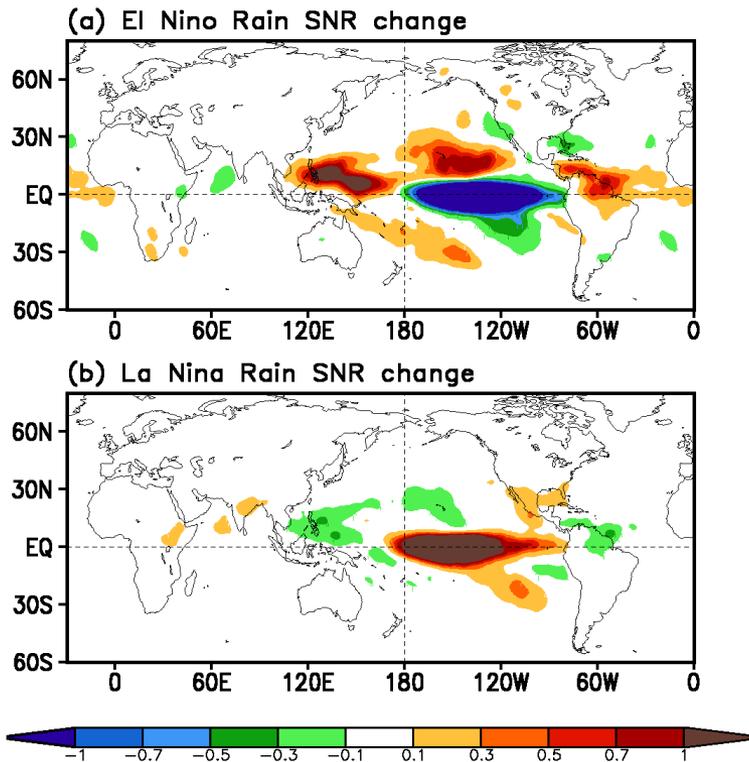
## DJF rainfall



- The response to ENSO SSTs in model is very similar with observation.
- The rainfall response to the ENSO SSTs has a large-scale spatial structure.
- The regression for the interannual variability in the spread of PDF resembles the spatial patterns for the mean.
- But, the amplitude is much smaller than that for the regression with the mean of the PDF.
- Large amplitude changes are confined over tropics.

# Contribution of changes in the spread of PDF to the predictability

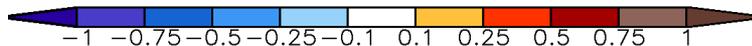
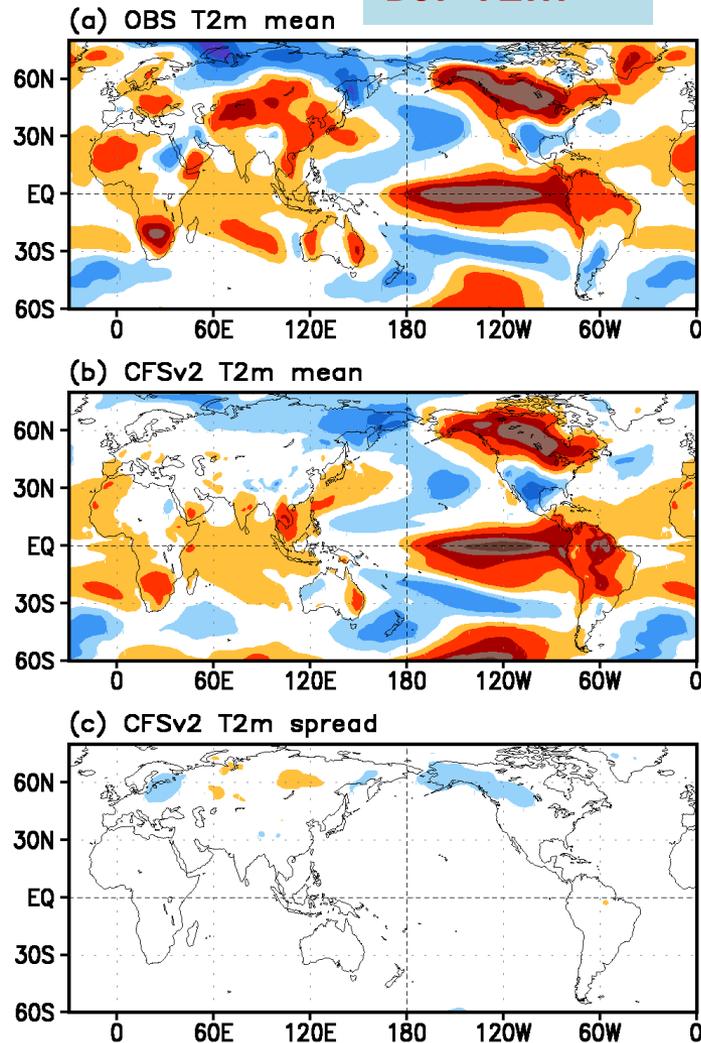
## DJF rainfall



- $\Delta SNR = \frac{S_{ENSO}}{N_{ENSO}} - \frac{S_{ENSO}}{N_{all}}$
- Major differences are located over the tropics;
- Reduction of SNR (predictability) in El Niño years over the central-eastern equatorial Pacific;
- Increase of SNR in La Niña years;
- The change in predictability over other regions are very limited. Therefore, the dominant contribution to the predictability comes from the impact of ENSO SSTs on the mean of the PDF.

# Linear regressions with Nino3.4 SST

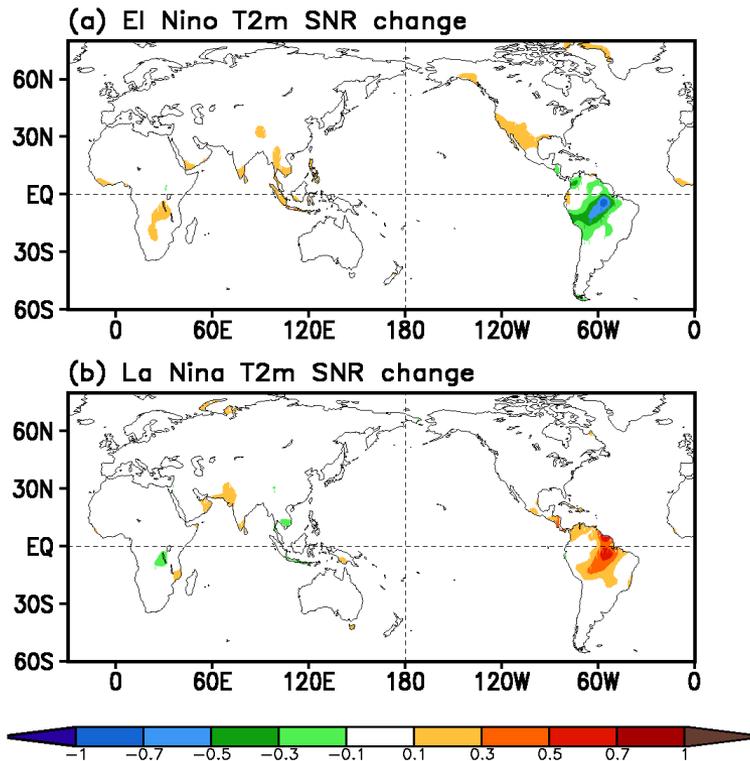
## DJF T2m



- The response to ENSO SSTs in model is very similar with observation.
- T2m response to the ENSO SSTs also has a large-scale spatial structure.
- In contrast to the mean, the regression for the interannual variability in the spread of PDF does not have a systematic large-scale spatial structure and amplitude is much smaller than that for the mean of PDF.
- Only small reductions in the spread of the PDF over northwest Canada to Alaska and some spotty areas over the Eurasia areas.

# Contribution of changes in the spread of PDF to the predictability

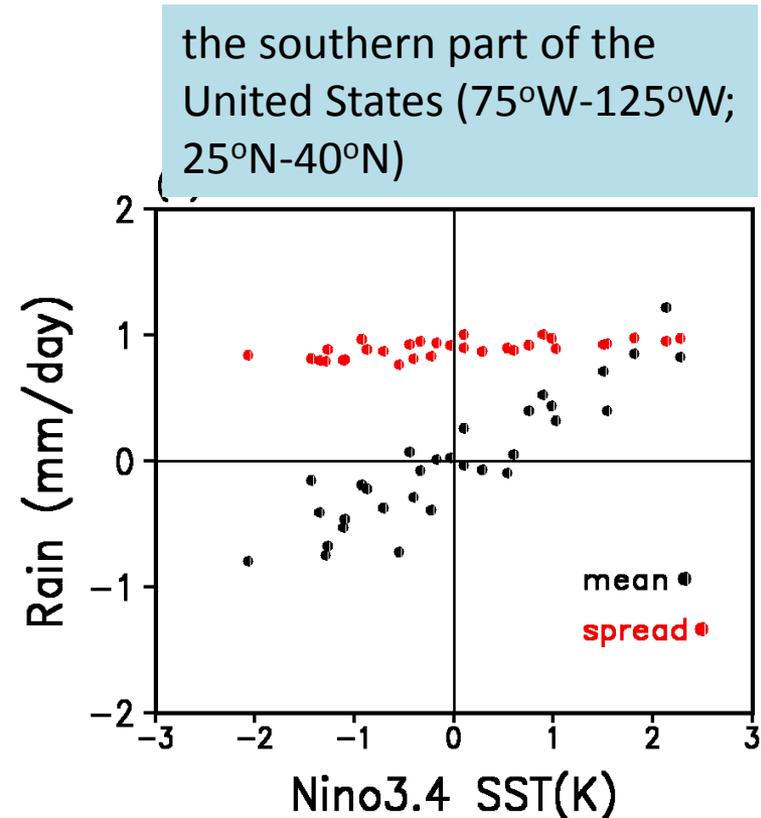
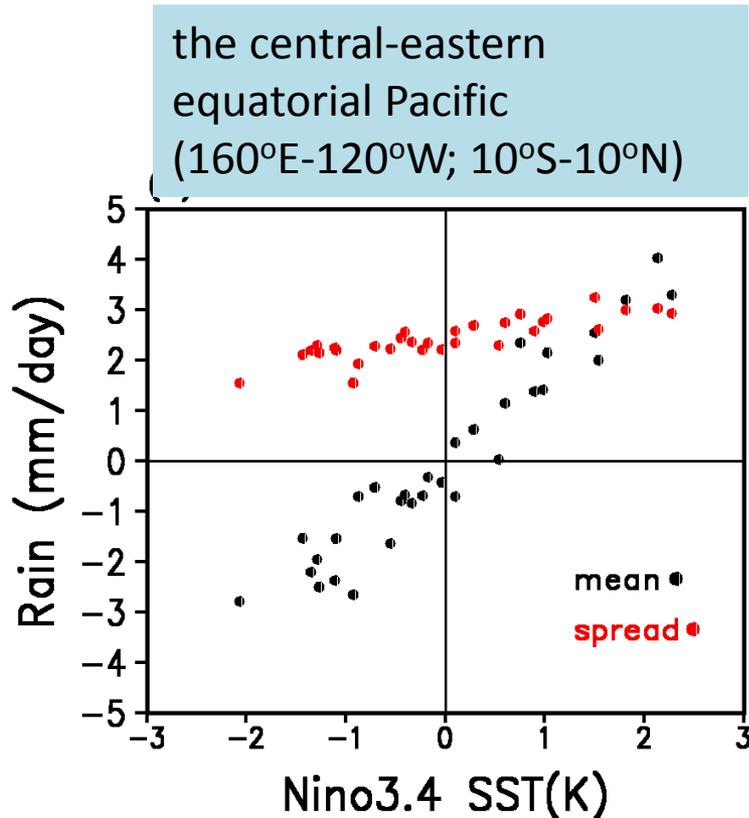
## DJF T2m



- $\Delta SNR = \frac{S_{ENSO}}{N_{ENSO}} - \frac{S_{ENSO}}{N_{all}}$
- Only showing the land T2m because its spread of PDF and change in the spread of PDF are small over the tropical oceans;
- The most noticeable impact on the predictability is over the northeast of Brazil;
- Reduction of SNR (predictability) in El Niño years;
- Increase of SNR in La Niña years;
- The change in predictability over other regions are very limited. Therefore, the dominant contribution to the predictability comes from the impact of ENSO SSTs on the mean of the PDF.

# Mean and spread corresponding to Nino3.4 SST

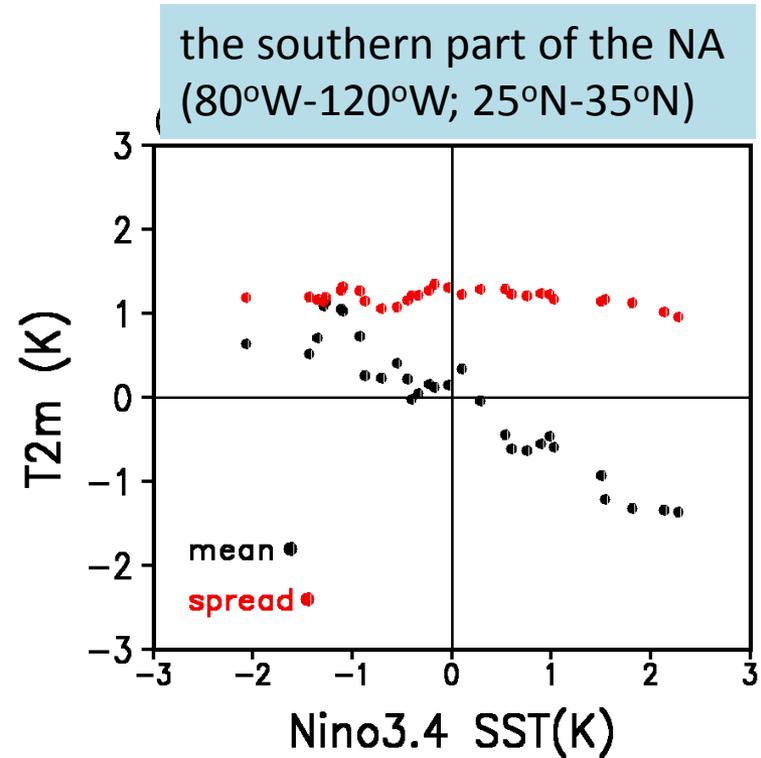
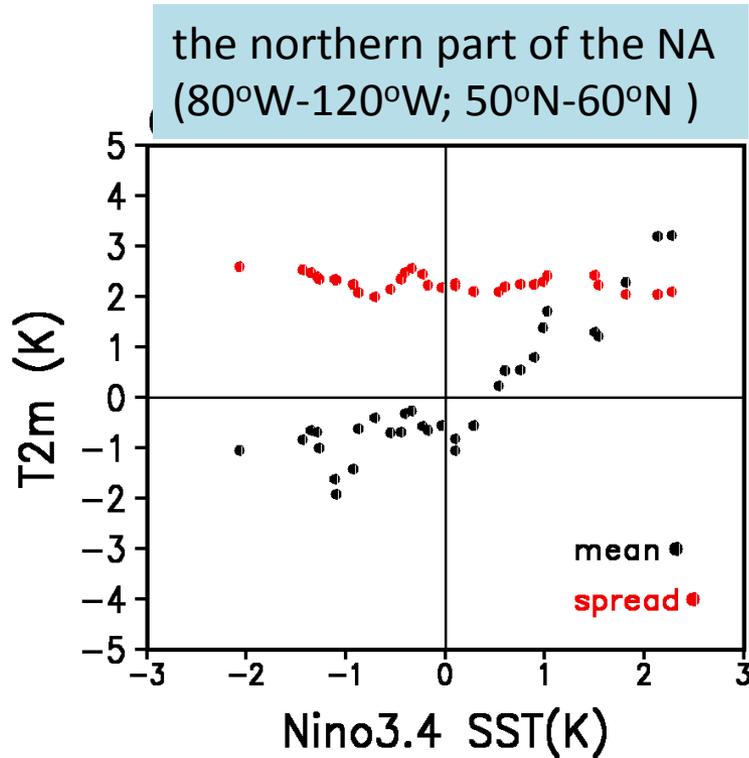
## DJF Rainfall



- Over the tropics, both rainfall mean and spread increase with Nino3.4 SSTs;
- Over the S. US, almost no change in spread;

# Mean and spread corresponding to Nino3.4 SST

## DJF T2m



- The spread over both regions stays almost constant with the amplitude of Nino3.4 SSTs.

# Summary

- The impact of the ENSO SSTs on the spread of PDF for DJF rainfall and T2m was analyzed based on CFSv2 hindcasts and forecasts.
- For DJF rainfall,
  - The spatial pattern of the ENSO SST induced changes on the PDF spread strongly resembles changes in the mean but have a smaller amplitude.
  - Over the central-eastern equatorial Pacific, changes in spread lead to a reduction in the SNR during El Nino years while to an increase in the SNR during La Nina years.
  - Over extra-tropics, the changes in spread are relatively small.
- For DJF T2m,
  - The changes in spread have little systematic dependence on the ENSO SSTs.
  - The amplitude of the changes in spread is much smaller than corresponding changes in ensemble mean.
- Over those regions with small changes in the PDF spread, for example, the extra-tropics for rainfall and most of global areas for T2m, the major contribution to seasonal predictability comes from the impact of ENSO SSTs on the mean of the PDF.