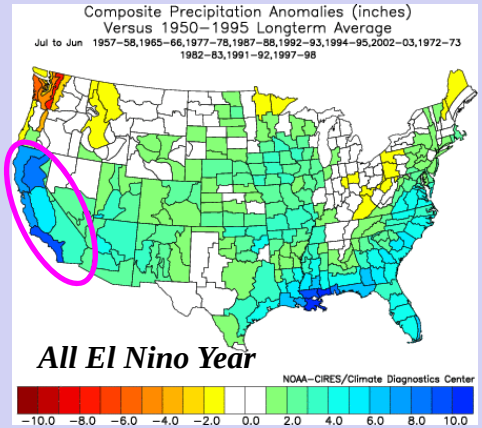
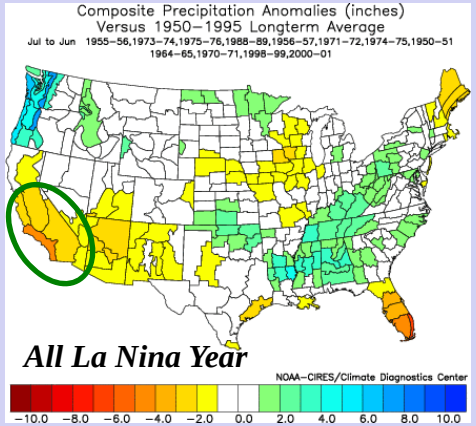
ENSO Impact on CA Precipitation

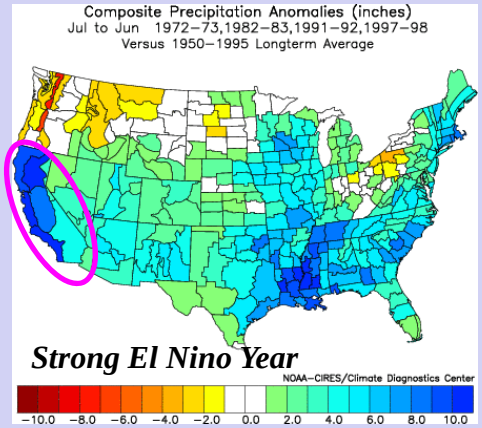
What is the climate influence over precipitation in CA?

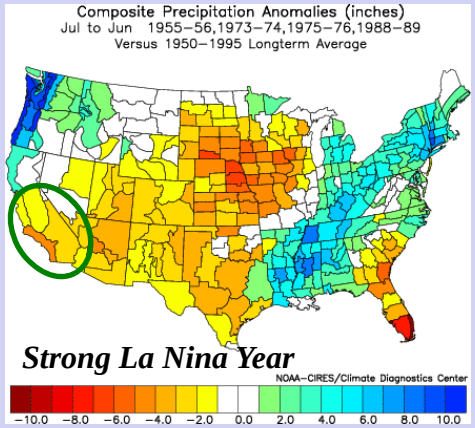
Generally, El Nino has positive impact on annual precip. in whole CA

La Nina has negative impact on annual precip., especially in Southern CA





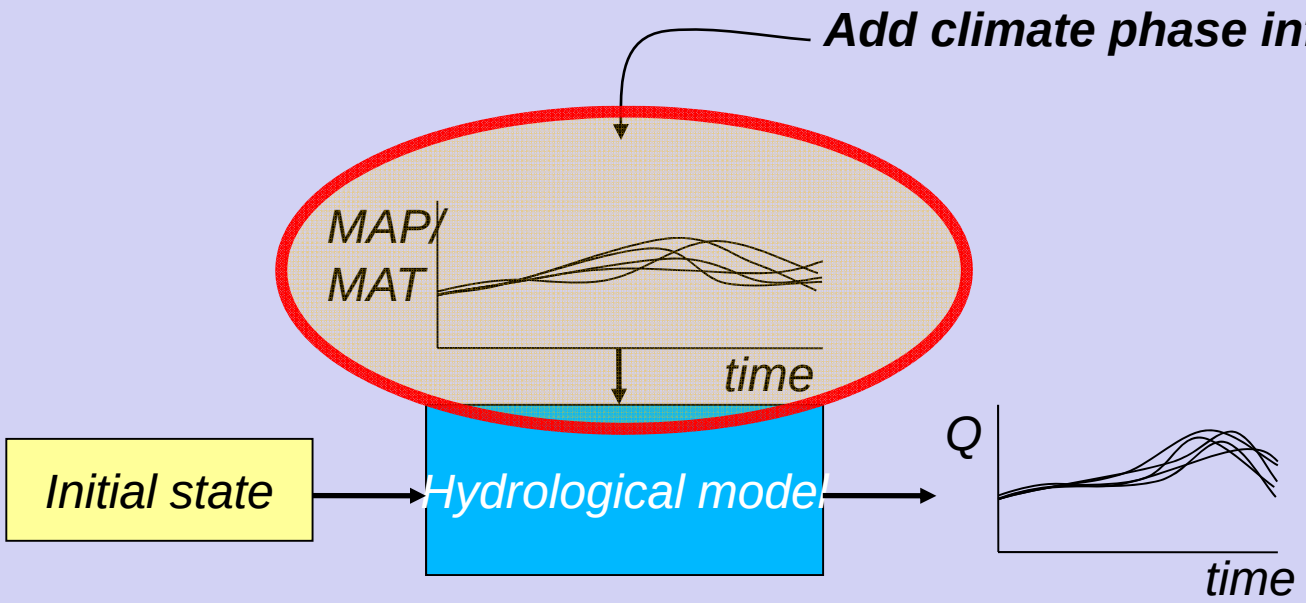




Source: NOAA

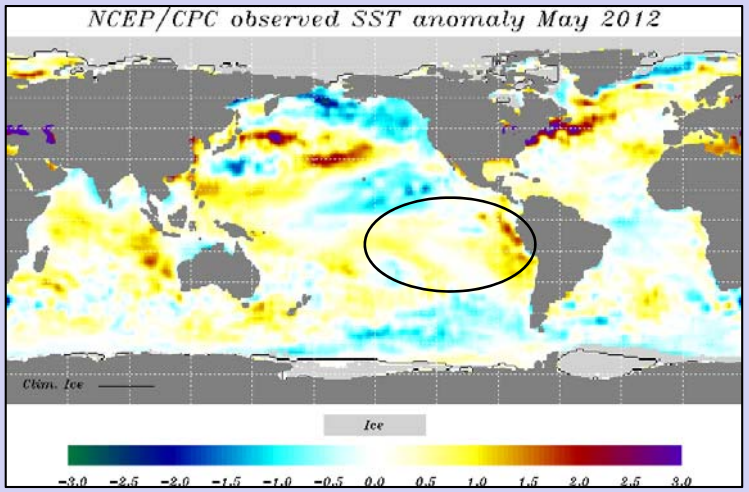
Seasonal Precipitation Forecsts for Hydrologci Modeling

- Providing relabile precipiation (& temperature) forecasts are key successful factors to hydrologic forecasting at seasonal scales
- Adding climate phases to the mean area precipitation (MAP) and mean area temoerature (MAT) forecasting can be useful.



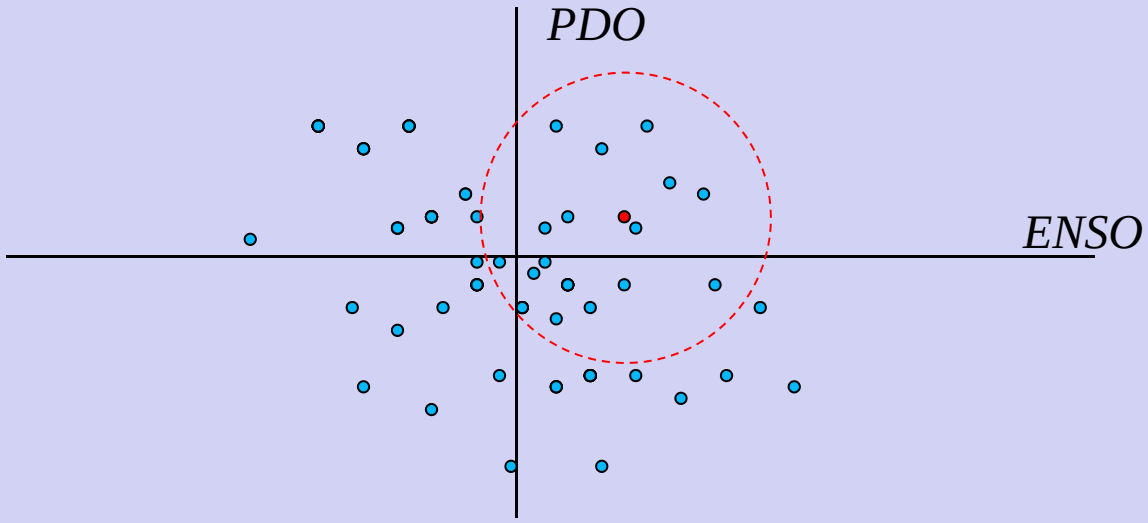
A List of Climate Indices

- Southern Oscillation Index (SOI)
- Nino3.4 (N34)
- Trans-Nino Index (TNI)
- Pacific/North American Teleconnection Pattern (PNA)
- North Atlantic Oscillation (NAO)
- Arctic Oscillation (AO)
- Pacific Decadal Oscillation (PDO)
- Madden-Julian Oscillation (MJO)
- Antecedent Precipitation (PRE)
- and many more …



Multiple climate indices

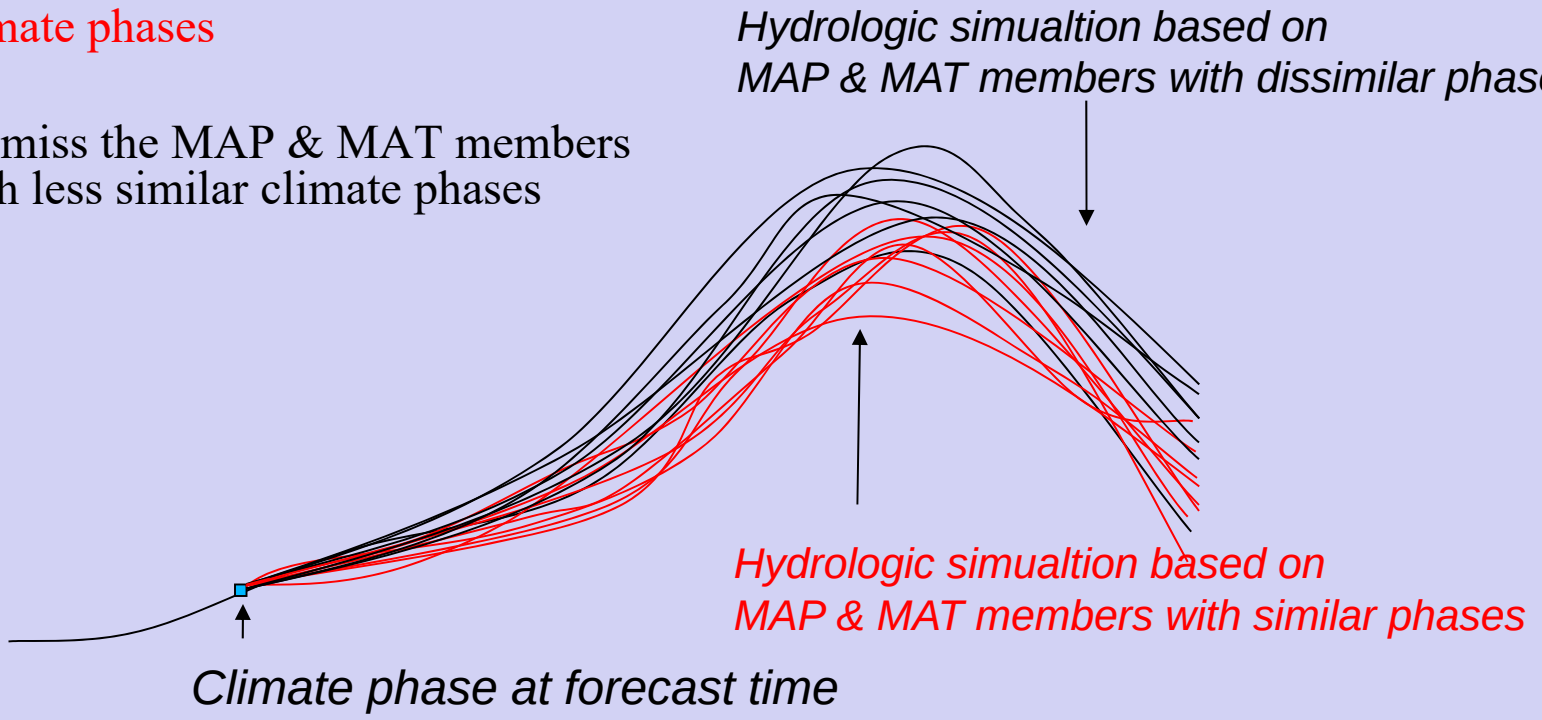
- Select similar years from Euclidian distance (squared difference)
- Dismiss those years that are not very close to the index at current time



Select Historical Events based on Climate Information

For each month in the hindcast suite, select the years with most similar climate indices (at current & forecast time)

- Assign higher weighting factors to the MAP & MAT members with similar climate phases
- Dismiss the MAP & MAT members with less similar climate phases



Select Ensemble Members based on Likelihood Measurement

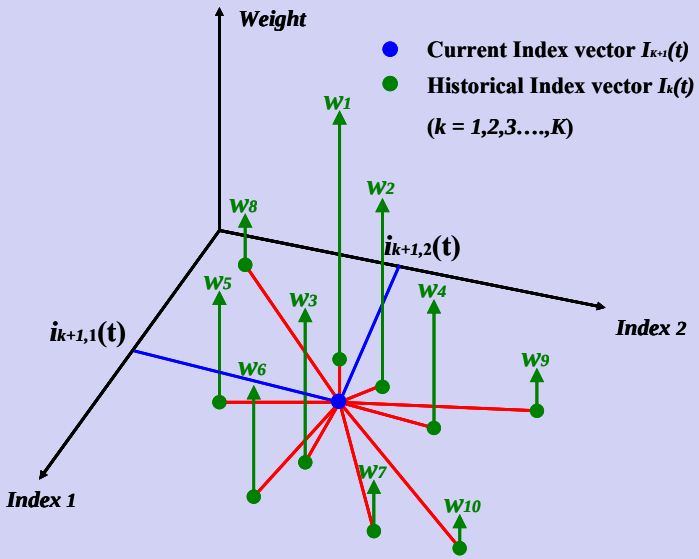
Multiple Model Ensemble (MME)

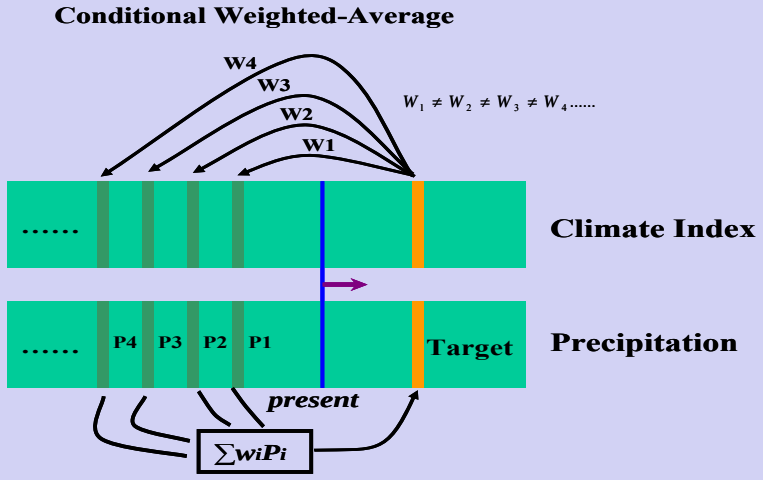
Likelihood function

$$P(\vec{I}_{K+1}(t) \mid \vec{I}_k(t)) = \frac{1}{\sigma_I \sqrt{2\pi}} \exp\left(- \frac{\left\| \vec{I}_{K+1}(t) - \vec{I}_k(t) \right\|^2}{2\sigma_I^2} \right)$$

Weights for historical precipitation traces

$$\omega_k(t) \sim P(\vec{I}_k(t) \mid \vec{I}_{K+1}(t)) = \frac{P(\vec{I}_{K+1}(t) \mid \vec{I}_k(t)) \cdot P(\vec{I}_k(t))}{\sum_{i=1}^{k} P(\vec{I}_{K+1}(t) \mid \vec{I}_i(t)) \cdot P(\vec{I}_i(t))}$$

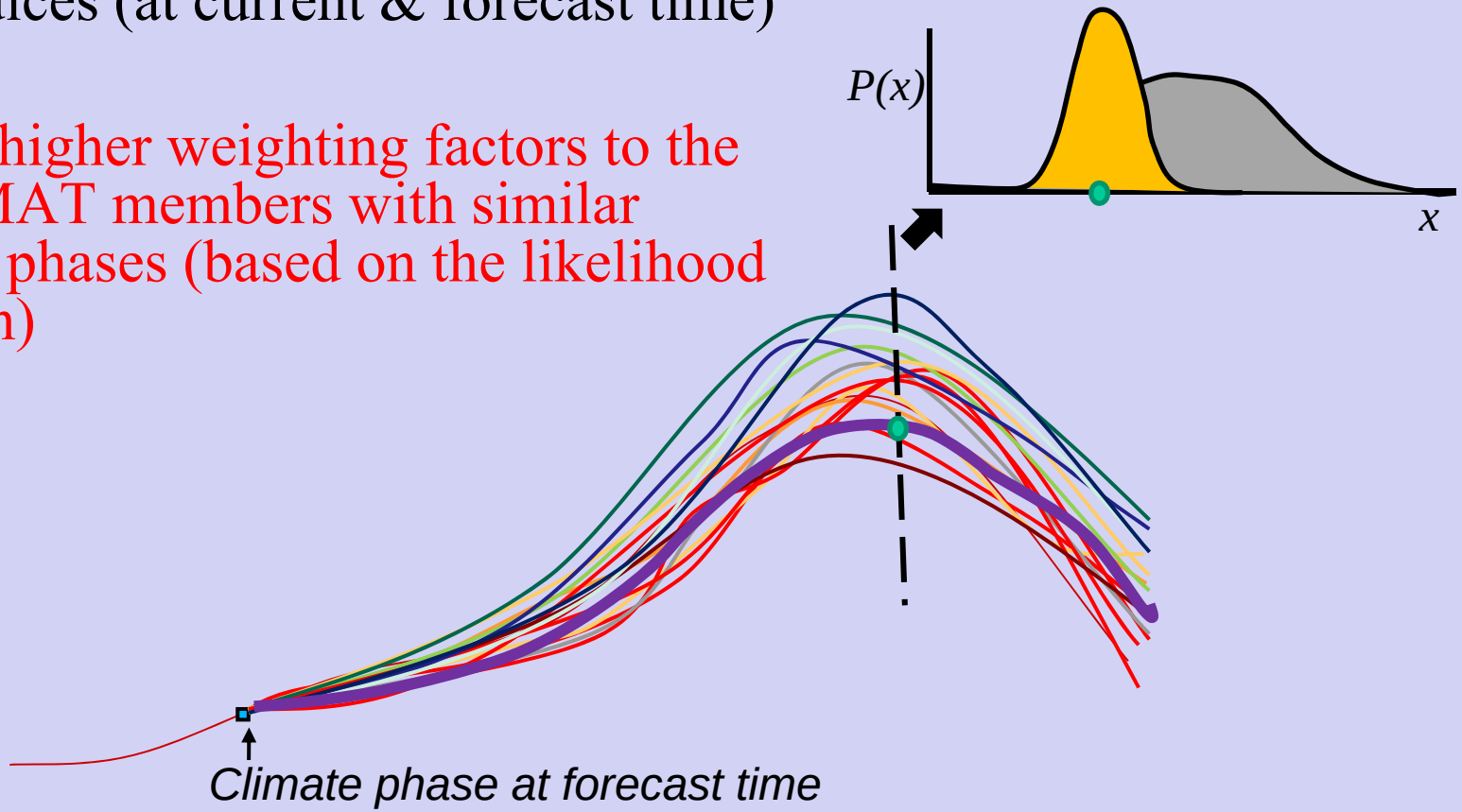




Select Historical Events based on Climate Information

For each month in the hindcast suite, select the years with most similar climate indices (at current & forecast time)

- Assign higher weighting factors to the MAP/MAT members with similar climate phases (based on the likelihood function)

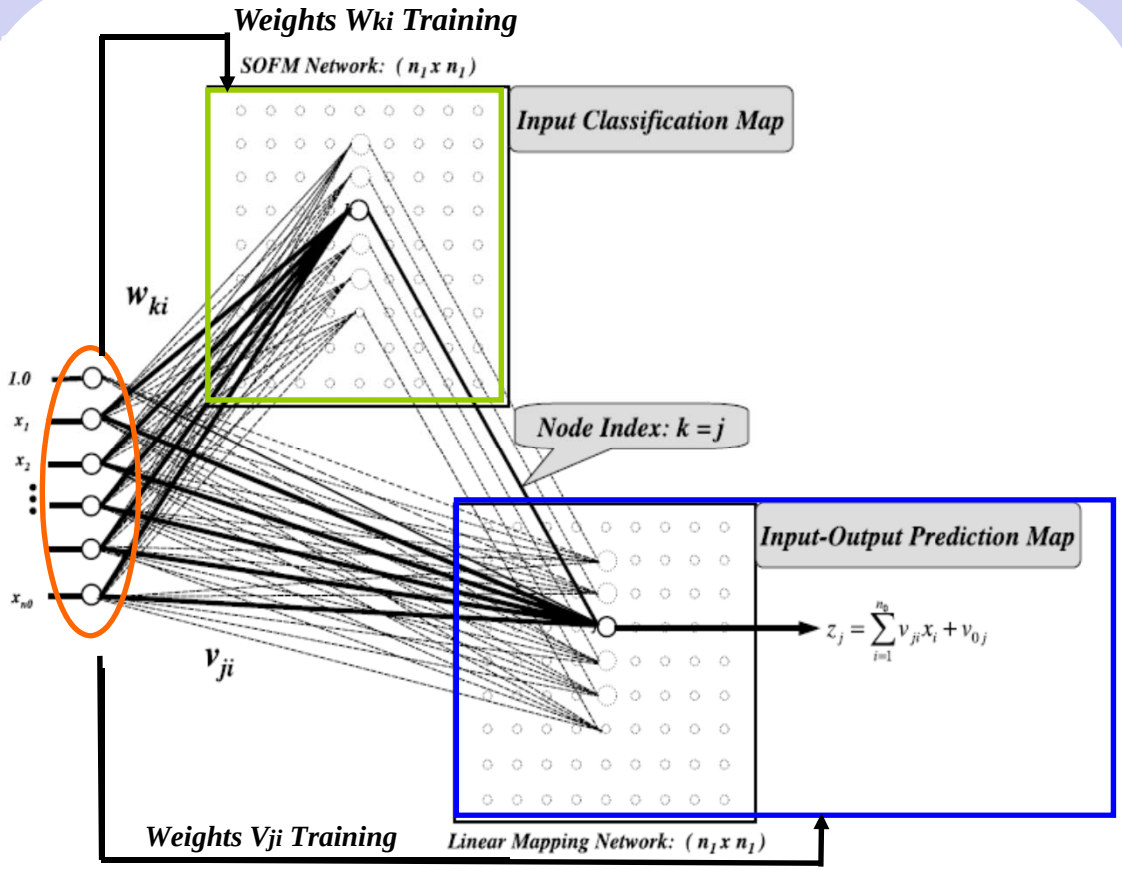


Nonlinear Regression Approach

Artificial Neural Network (ANN): Self-Organizing Linear Output map (SOLO)

Three-Layer architecture:

- Input layer:
  climate index data
- SOFM layer:
  climate index classification (the feature map)
- SOLO layer:
  Precipitation Forecasting by PCA preprocessing and multivariate nonlinear regression



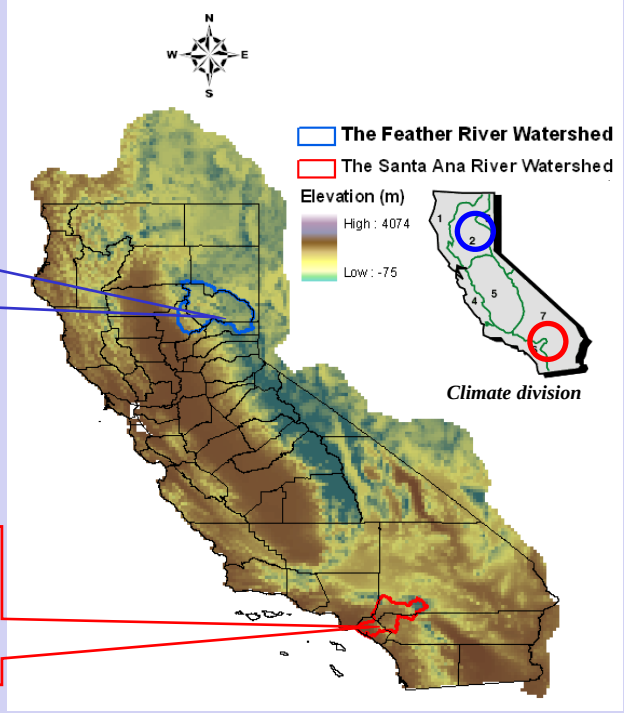
Case Study

The Feather River Watershed

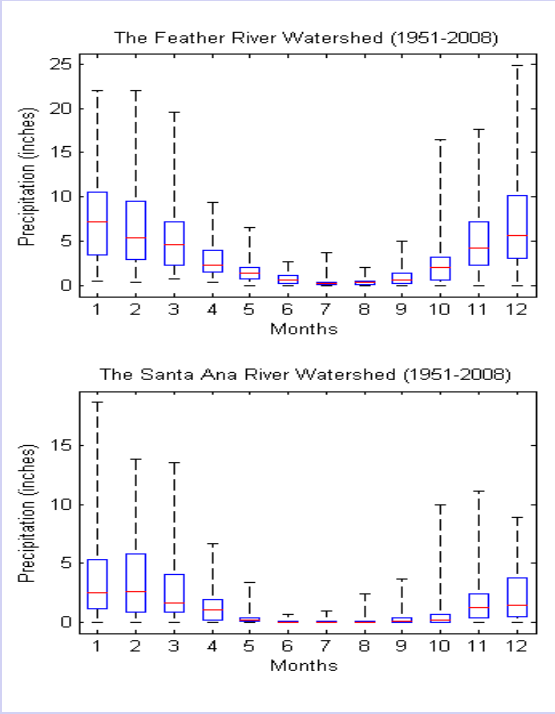
- *Watershed Area: 3,222 mi²*

The Santa Ana River Watershed

- *Watershed Area: 2,800 mi²*



Mean Areal Precip. (MAP)

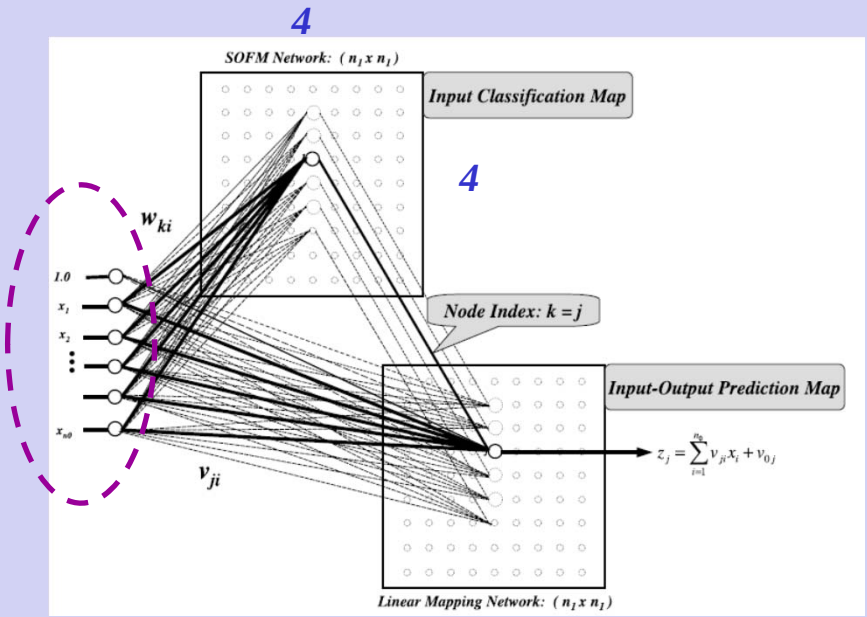


Nonlinear Regression Approach: ANN-SOLO

- The ANN-SOFM size: 4 nodes × 4 nodes

- SOLO inputs :

  Including previous season precipitation and selected climate index (SOI ,N34, TNI, PNA, NAO, AO, PDO, PRE)



Evaluation

- Seasonal mean area precipitation (MAP) forecasts are evaluated.

- Objective Functions:
  - RMSE, Correlation coefficient, BIAS
  - Skill Score (MSESS)

$$MSESS = 1 - \frac{MSE}{MSE_{\text{climatology}}}$$

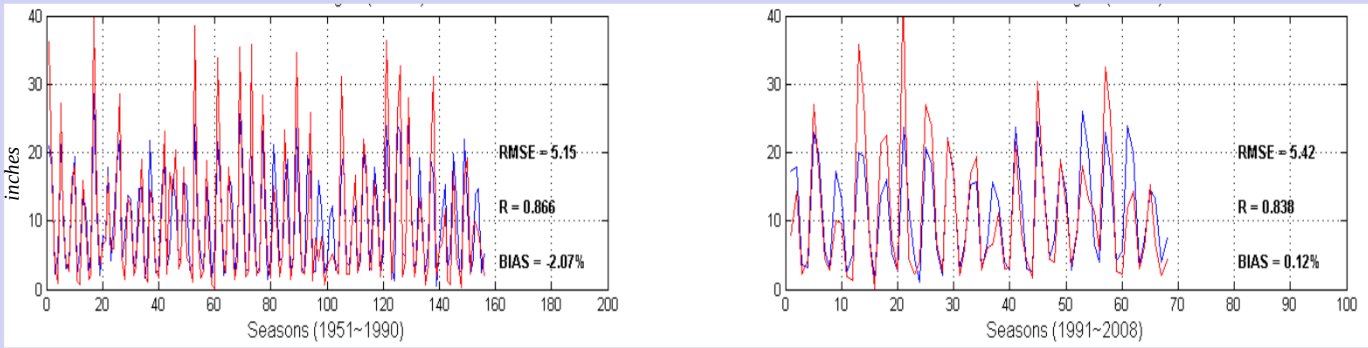
MSESS >0 Better than climatology
MSSESS<0 Worse than climatology

MSE: mean square error

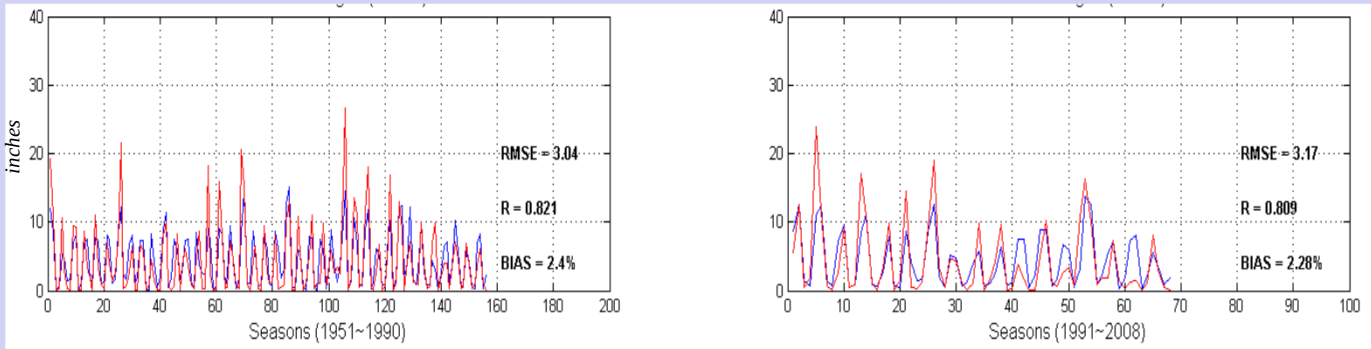
Case Study: Nonlinear Regression (ANN-SOLO)

Calibration (1951-1990) ***Validation (1991-2008)***

The Feather River



The Santa Ana River

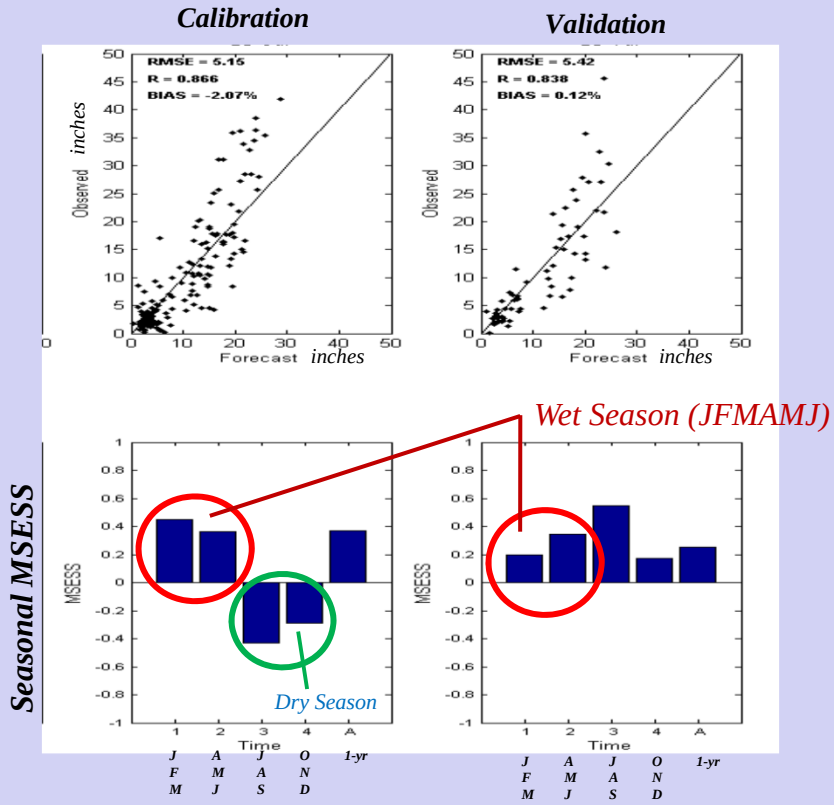


Obs.
Forecast

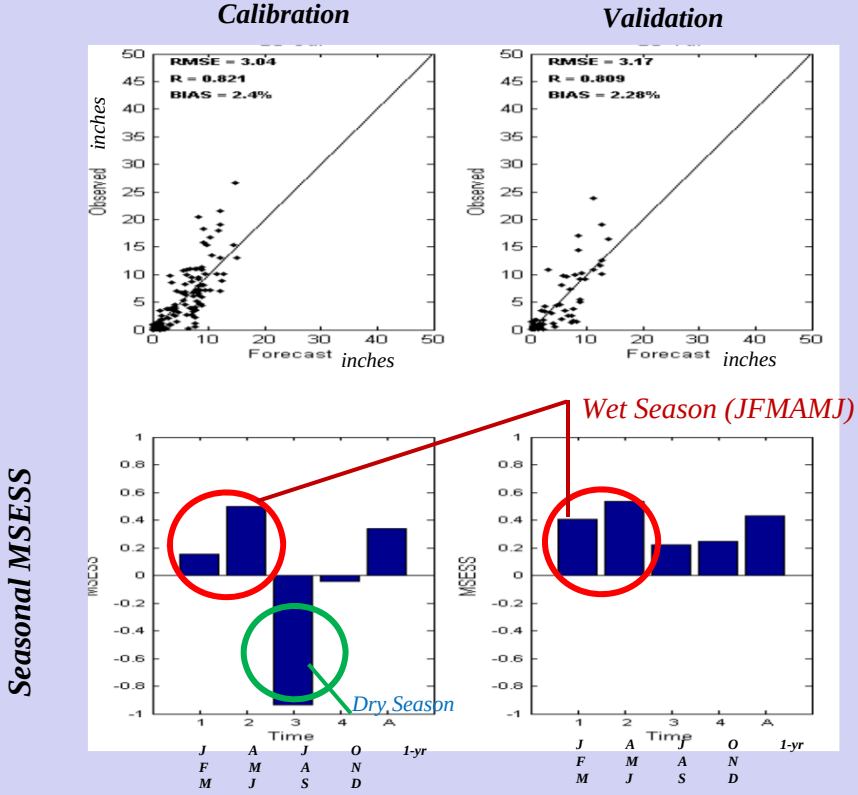
Case Study: Nonlinear Regression (ANN-SOLO)

ANN-SOLO Forecasting Results

The Feather River



The Santa Ana River



Summary

- *Seasonal forecasting methods of future precipitation using statistical ensemble of historical data and nonlinear regression (ANN) approaches are discussed.*

- *Experiments on forecasting seasonal precipitation using nonlinear regression approach (ANN-SOLO) show that the improved forecasting skills over the wet seasons for Feather River and Santa Ana River watersheds can be obtained .*