Statistical prediction of the United States spring-summer precipitation from the Western US spring surface temperature anomalies using canonical correlation analysis

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Spring Land Surface and Subsurface Temperature Anomalies and Subsequent Downstream Late Spring-Summer Droughts/Floods in North America and East Asia

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Abstract Sea surface temperature (SST) variability has been shown to have predictive value for land precipitation, although SSTs are unable to fully predict intraseasonal to interannual hydrologic extremes.

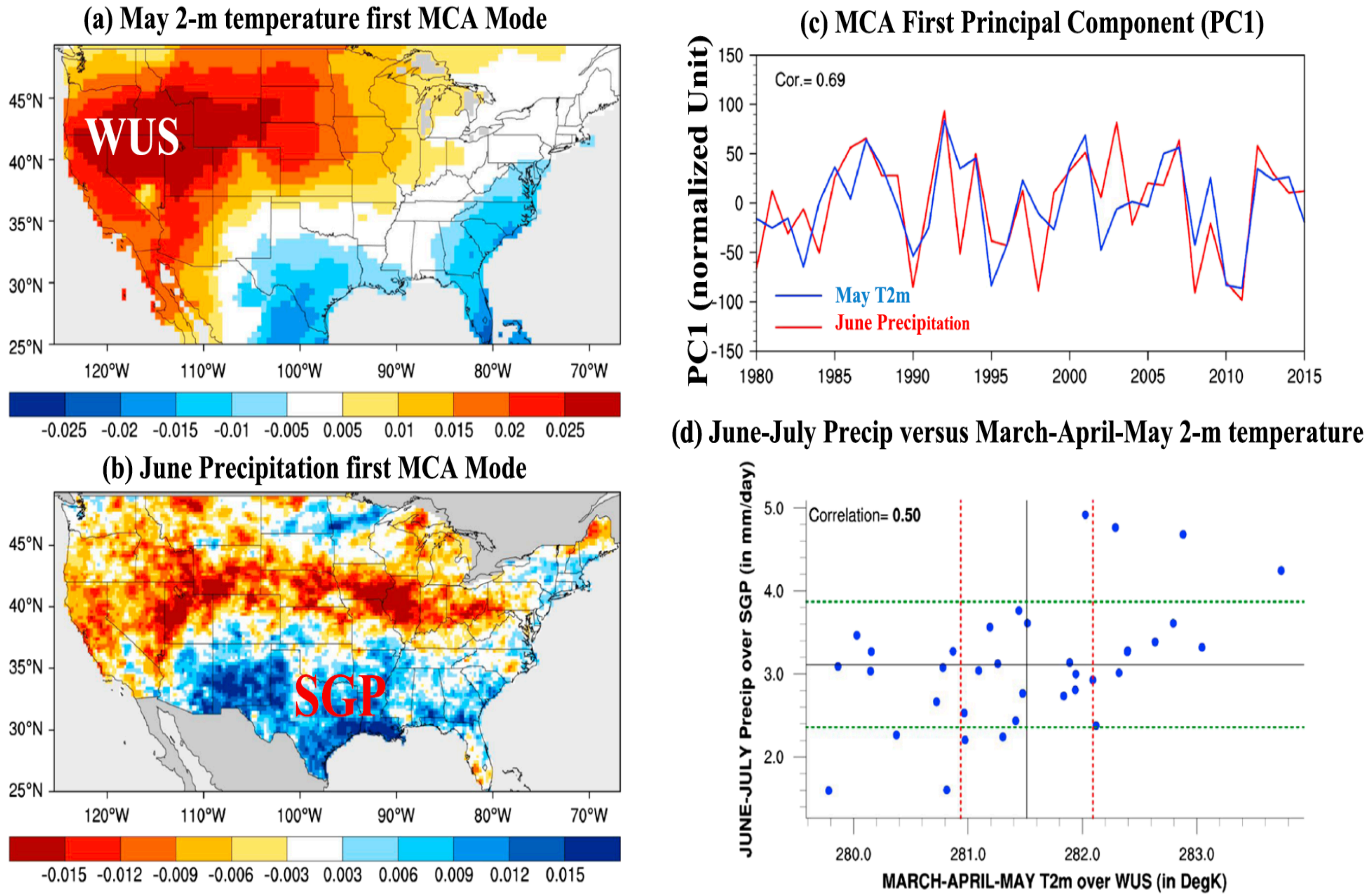

Figure 1. Maximum Covariance Analysis (MCA) over North America. (a and b) Spatial patterns of first MCA mode (MCA1) for May 2-m temperature (T2 m) and June precipitation, respectively. (c) First principal component (PC1) of MCA during 1980–2015 for May T2 m (blue line) and June precipitation (red line). (d) Scatterplots of March-April-May T2 m (in K) over western U.S. (WUS; 110–125°W/33–50°N) and June-July precipitation (in mm/day) over SGP and surrounding areas (88–103°W/29–38°N). In (d), black lines indicate means; green (red) dashed lines denote ±1 (±0.5) standard deviation boundaries for precipitation (T2 m). (a–c) are expressed in normalized unit.

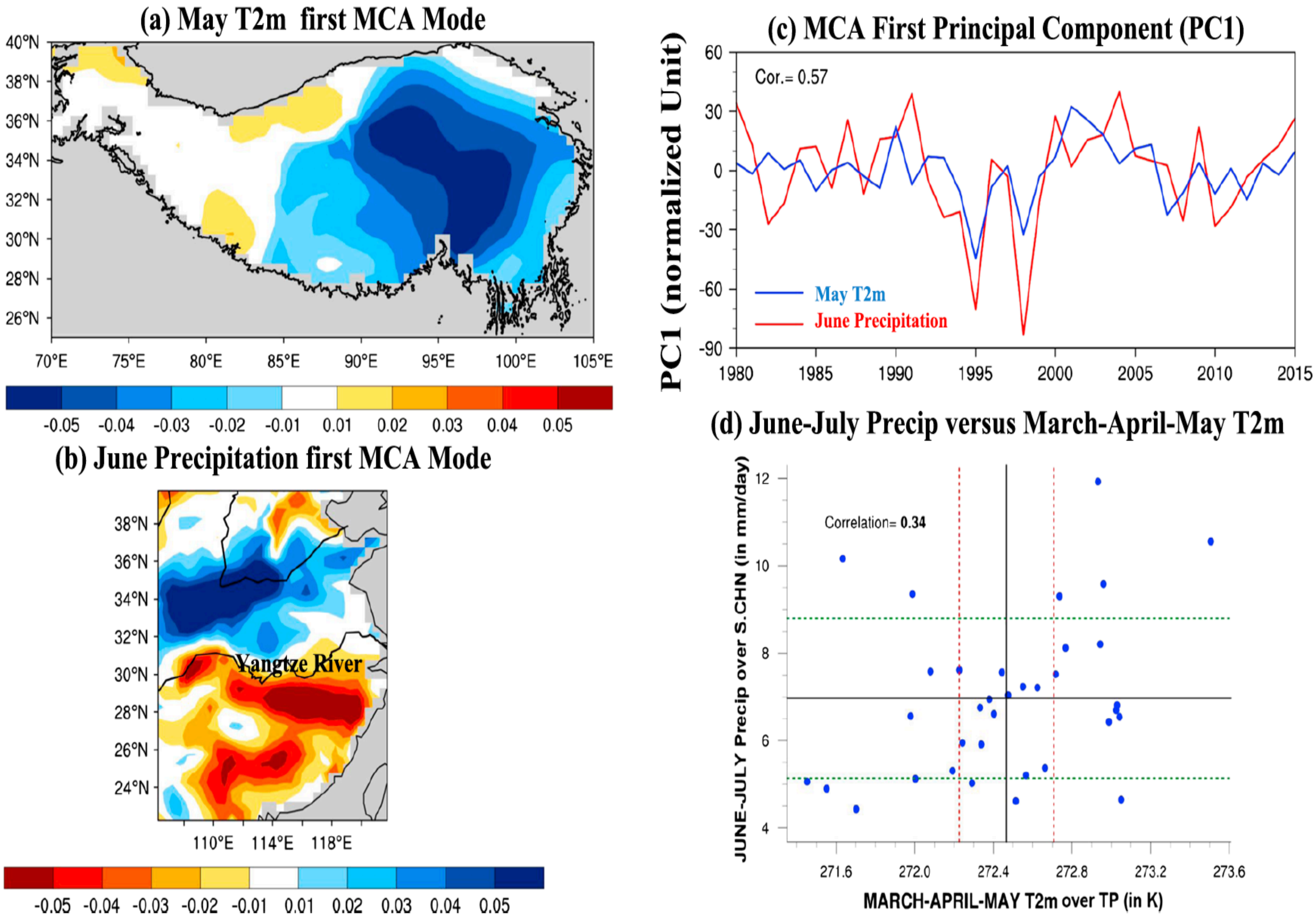

Figure 2. MCA over East Asia. (a and b) Spatial patterns of MCA1 for May T2 m over TP and June precipitation over East Asia, respectively. (c) PC1 of MCA during 1980–2015 for May T2 m (blue line) and June precipitation (red line). (d) Scatterplots of March-April-May T2 m (in K) over TP (28–37°N, 92–102°E) and June-July precipitation (in mm/day) over Yangtze River region (29–32°N, 112–121°E). In (d), black lines indicate means; green (red) dashed lines denote ±1 (±0.5) standard deviation boundaries for precipitation (T2 m). a–c are expressed in normalized unit.

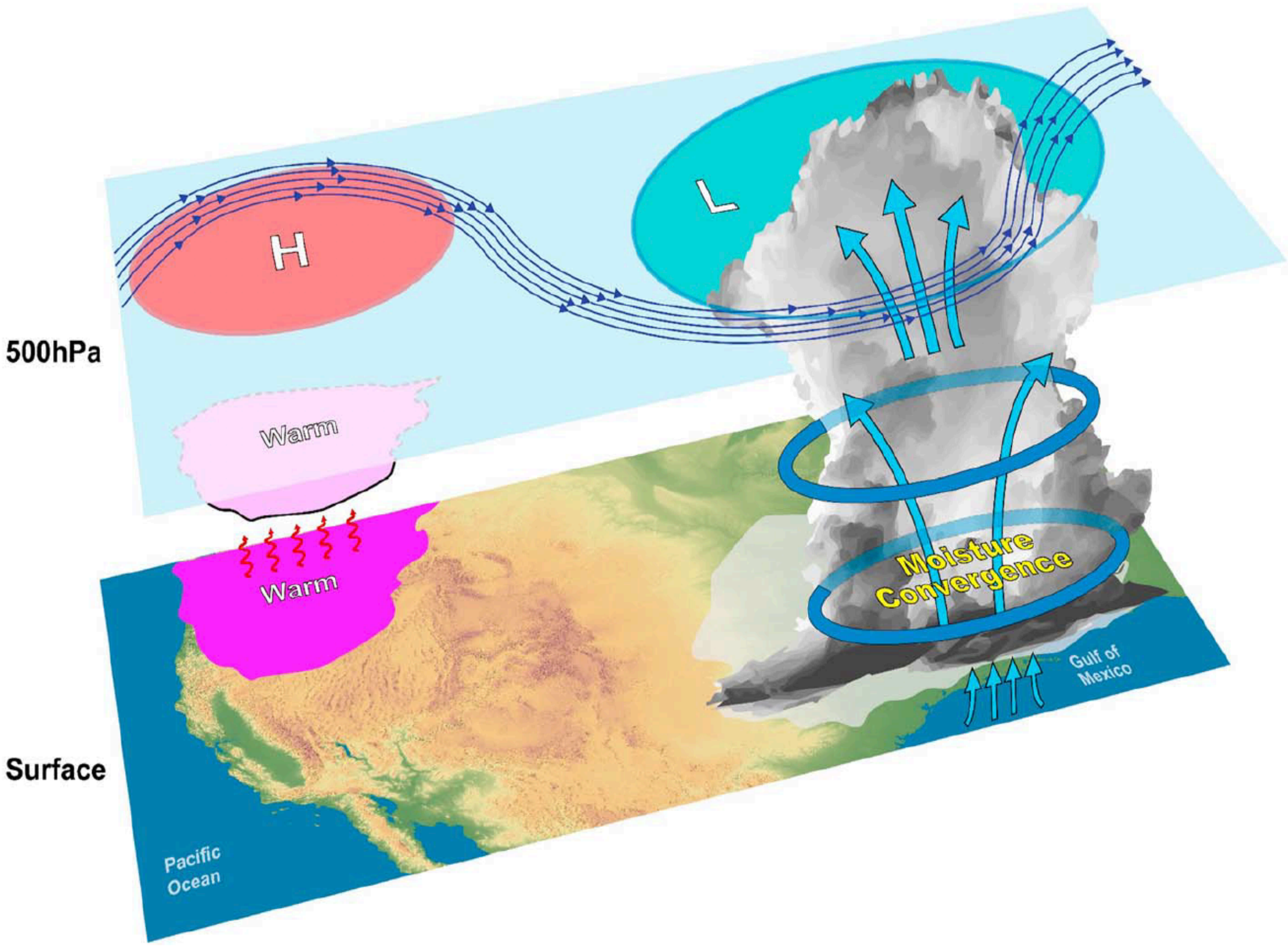

Figure 13. Schematic diagram describing the processes associated with the impact of LST and SUBT anomalies affecting downstream precipitation.

Question:

Can one develop an optimal way to utilize the predictability explored in Xue et al. (2018) for the downstream precipitation prediction in the monthly scale?

(This is a feasibility study.)

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Ensemble Canonical Correlation Analysis (ECCA)

Jan-Feb-Mar

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The predictors used in this forecast are :

ECCA method developed by Sam Shen, Bill Lau, K.M. Kim, and G.L. Li in 2001

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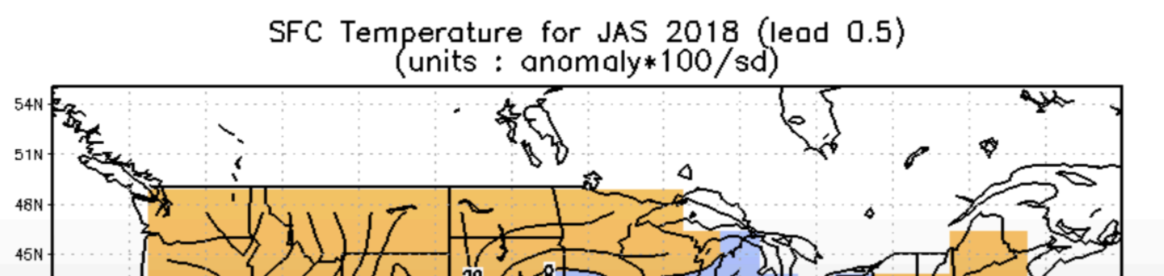

Superensemble Statistical Forecasting of Monthly Precipitation over the Contiguous United States, with Improvements from Ocean-Area Precipitation Predictors

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2016 paper

ABSTRACT

Extended precipitation forecasts, with leads of weeks to seasons, are valuable for planning water use and are produced by the U.S. National Weather Service. Forecast skill tends to be low and any skill improvement could be valuable. Here, methods are discussed for improving statistical precipitation forecasting over the contiguous United States. Monthly precipitation is forecast using predictors from the previous month. Testing shows that improvements are obtained from both improved statistical methods and from the use of satellite-based ocean-area precipitation predictors. The statistical superensemble method gives higher skill compared to traditional statistical forecasting. Ensemble statistical forecasting combines individual forecasts. The proposed super-ensemble is a weighted mean of many forecasts or of forecasts from different prediction systems and uses the forecast reliability estimate to define weights. The method is tested with different predictors to show its skill and

NASA/TM—2001–209989

2001 paper based Tim Barnett's 1987 paper

A Canonical Ensemble Correlation Prediction Model for Seasonal Precipitation Anomaly

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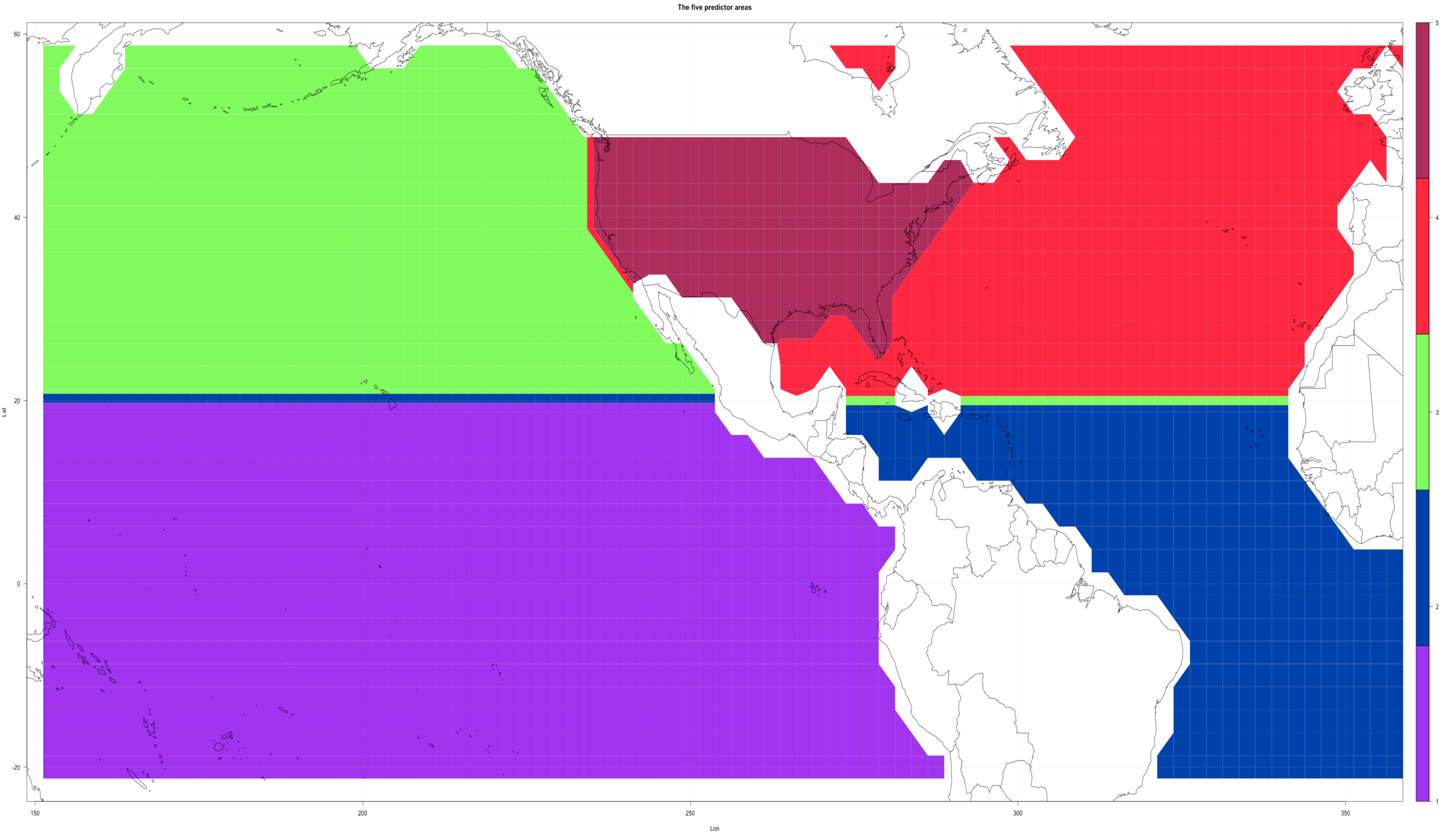
Five Regions of Predictors



The R Code for the SECCA

R

Name	Date Modified	Size	Kind
Data	Mar 11, 2018 at 11:34 PM	--	Folder
Figures	Yesterday at 10:36 AM	--	Folder
Functions	Mar 11, 2018 at 11:33 PM	--	Folder
Main.R	Yesterday at 10:45 AM	4 KB	R Source File
Plots.R	Mar 6, 2018 at 7:35 PM	Zero bytes	R Source File
Predictor_Areas	Mar 6, 2018 at 7:50 PM	40 KB	TextEdit

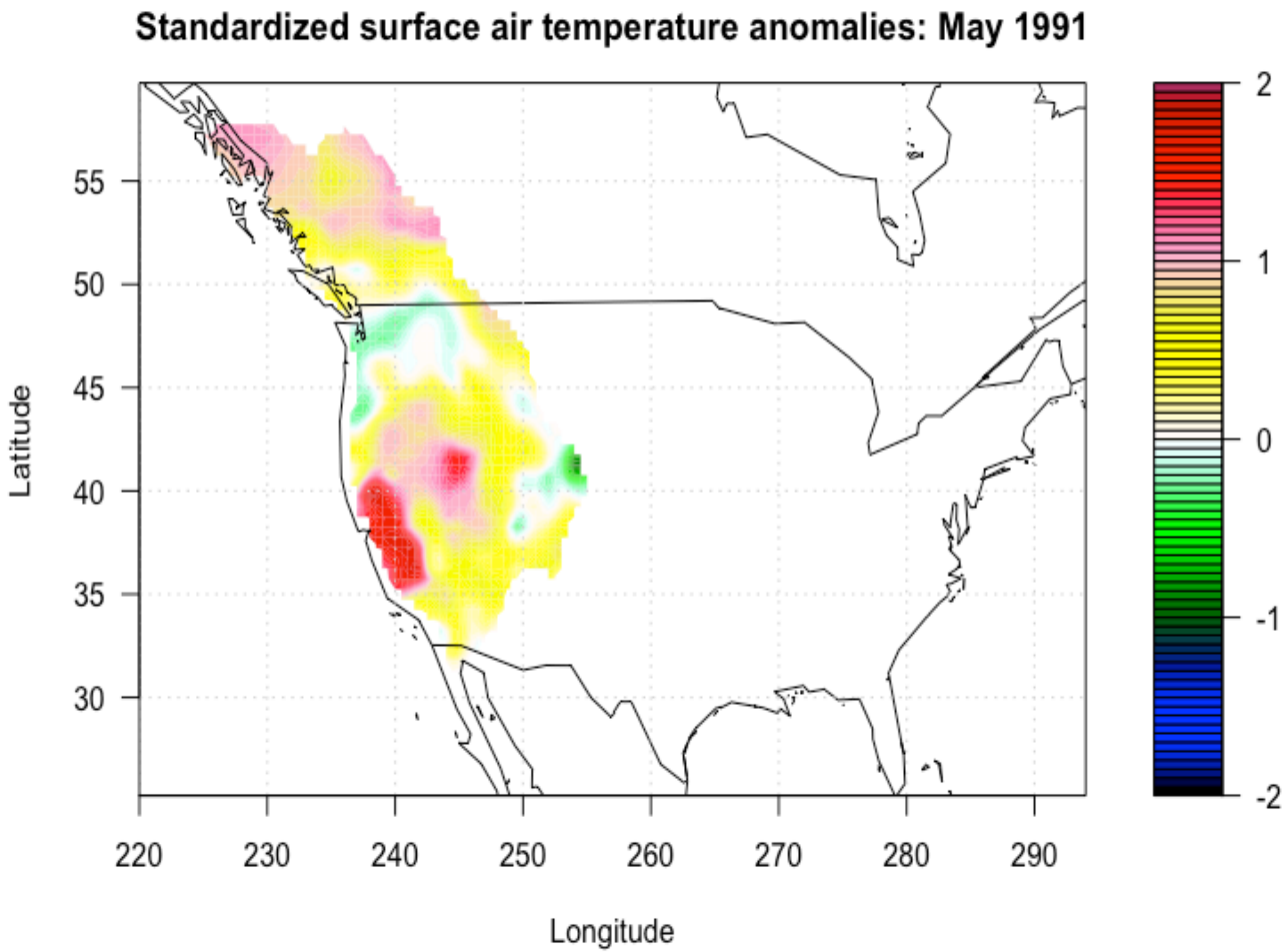
An R code tutorial in the book "Climate Mathematics" by Shen and Somerville, June 2019

A computation example by R

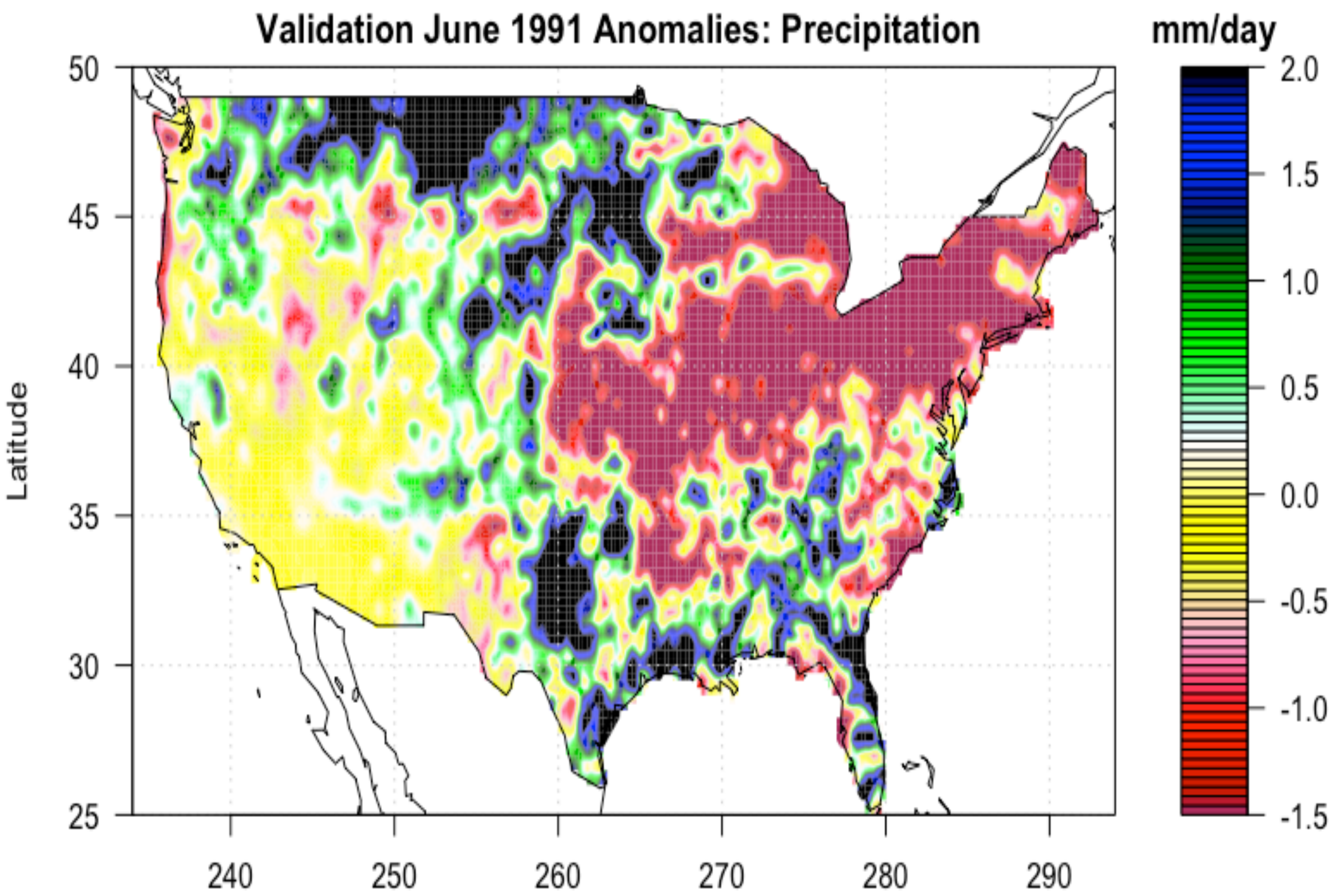
This is a preliminary prediction rest of using the May Western United States (US) temperature to predict the June US precipitation

Training period: May from 1961-1990

Prediction period: June from 1991-2017

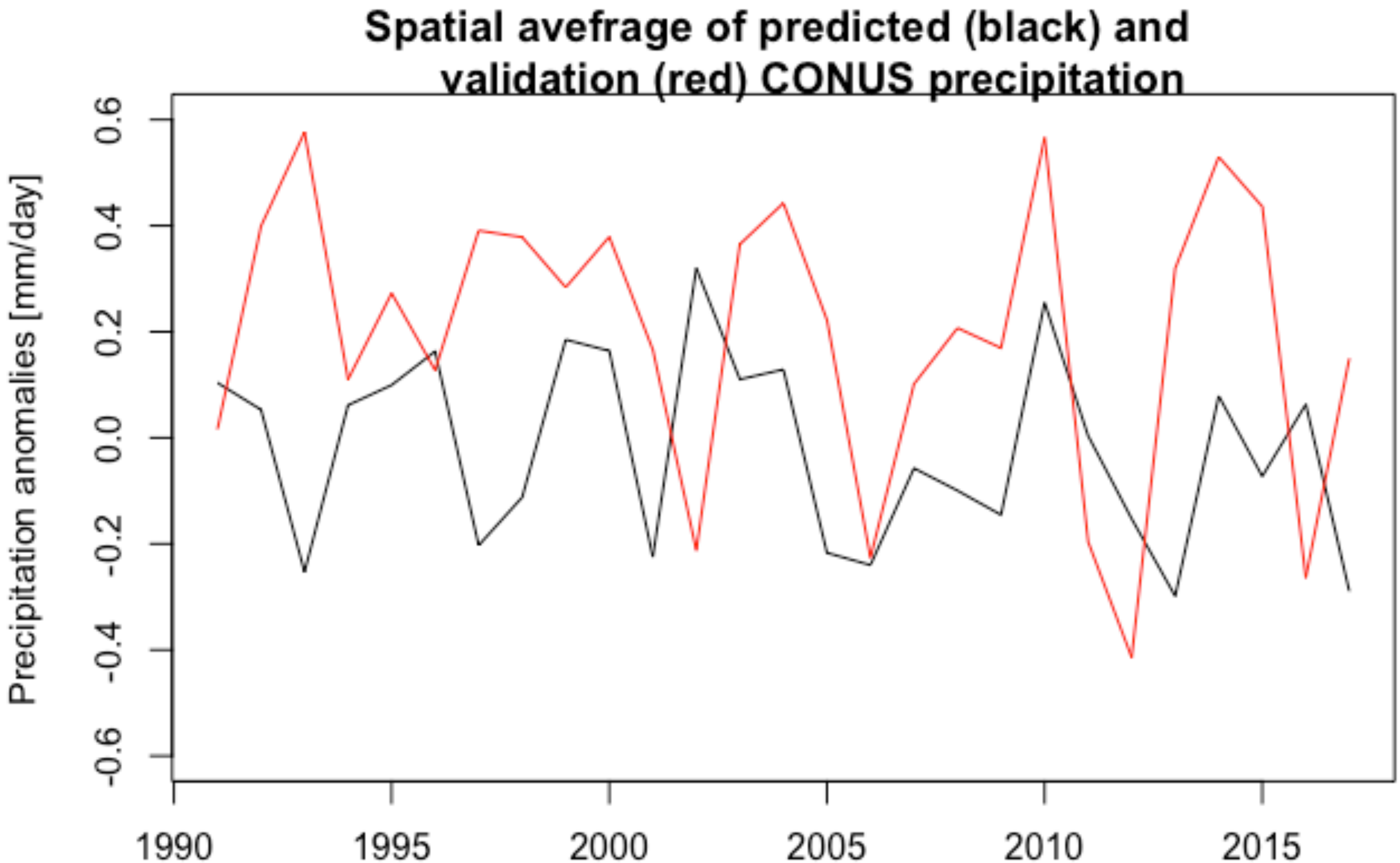


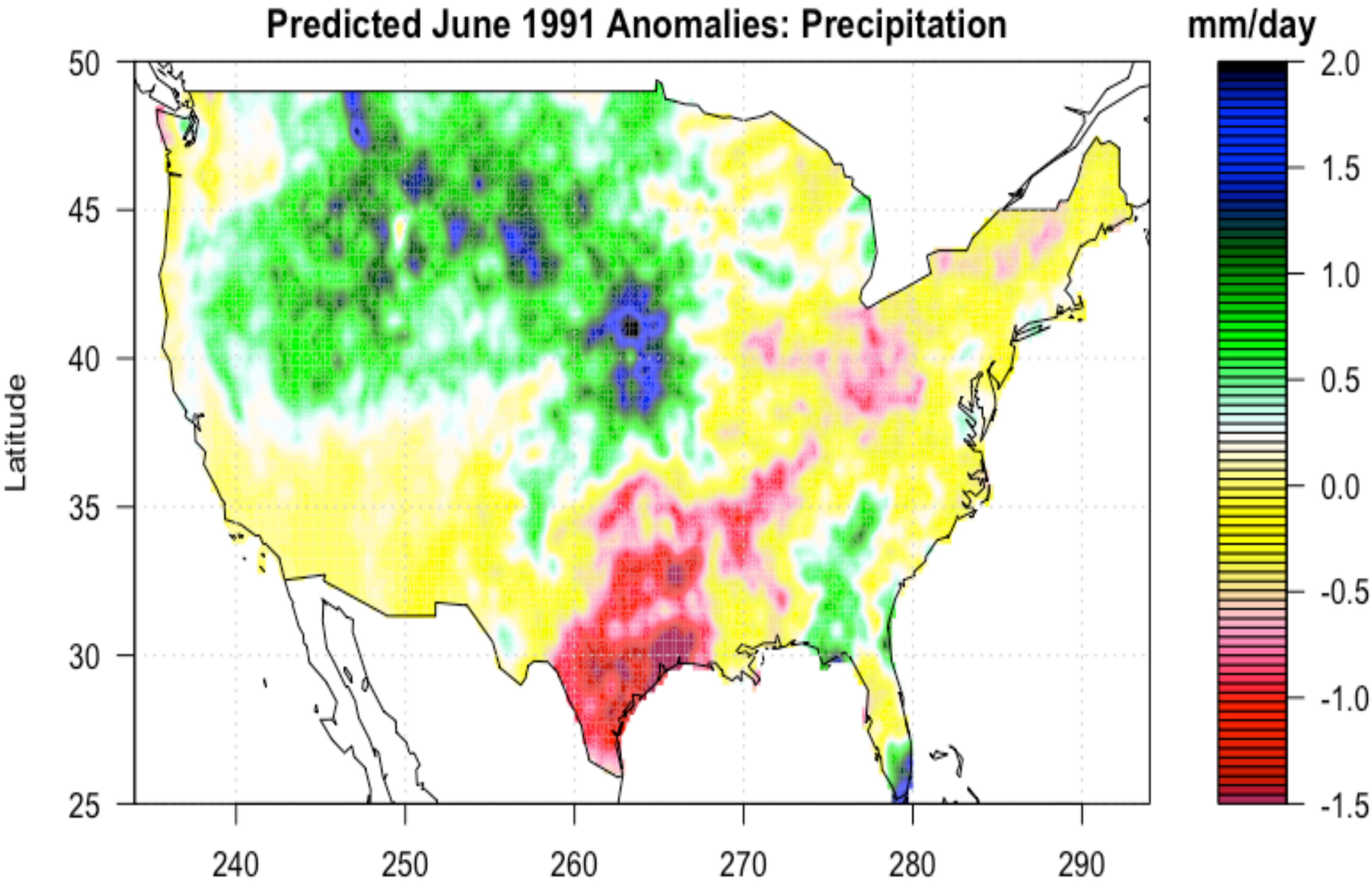
Standardized surface air temperature anomalies: May 1991
Latitude
55
50
45
40
35
30
220
230
240
250
260
270
280
290
Longitude
2
1
0
-1
-2



Validation June 1991 Anomalies: Precipitation
mm/day
Latitude
50
45
40
35
30
25
240
250
260
270
280
290
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5

June CONUS precipitation





Predicted June 1991 Anomalies: Precipitation
mm/day
Latitude
50
45
40
35
30
25
240
250
260
270
280
290
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5

Conclusions

- It is feasible to incorporate the May western US temperature into a super-ensemble CCA prediction for the June precipitation.
- The R code is easy to develop and to implement. See Shen/Somerville book "Climate Mathematics" including R, linear algebra, statistics, calculus, and math modeling.
- More experiments will be carried out between Xue's group at UCLA and Shen's group at San Diego.