

The impact of tropical SST biases on the S2S precipitation forecast skill over the CONUS in the UFS coupled model



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1. Introduction



Background

- Systematic sea surface temperature (SST) bias forecasted in ocean-atmosphere coupled models can greatly impact the Subseasonal-to-Seasonal (S2S) forecast skill
- Stan et al. (2022) found that, in the UFS coupled model Prototype 5 (P5), the Pacific SST biases can be linearly related to midlatitude biases in the surface temperature, precipitation, the mid-troposphere large-scale circulation and the storm tracks activity

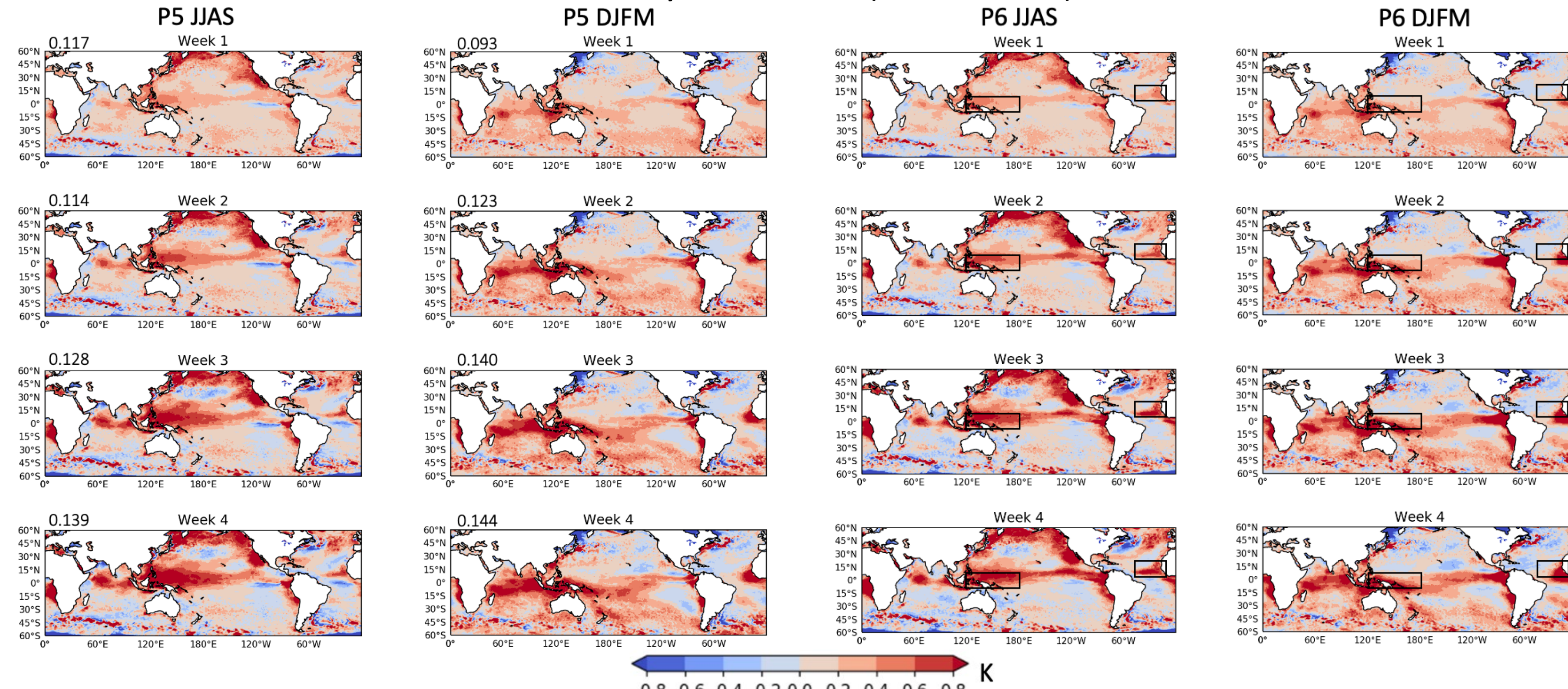
Goals

- Expand on Stan et al. (2022) to understand the physical mechanisms that connect the tropical SST biases to biases in the midlatitudes
- Investigate the impact of the tropical Atlantic on the S2S precipitation forecast skill over the CONUS in the newer version of the UFS model Prototype 6 (P6) along with possible physical mechanisms

2. Forecast biases

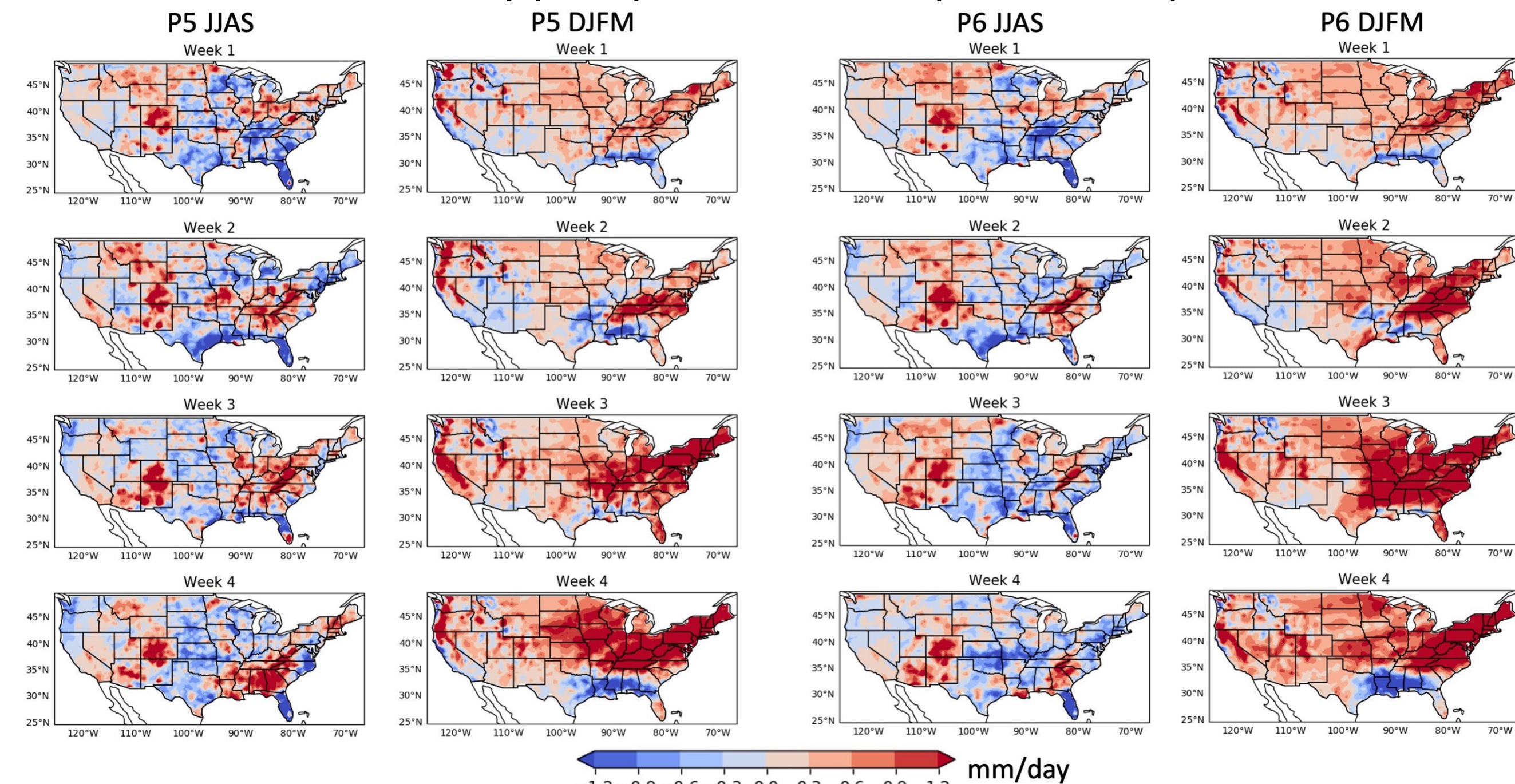


Weekly SST biases (UFS - OISST)



- In both seasons and both prototypes, the strongest tropical (warm) SST biases are found over the tropical Pacific, the tropical east Atlantic, and the tropical Indian Ocean
- SST biases increase with the forecast lead time in both P5 & P6
- Compared to P5, the warm SST biases in P6 improve moderately over the tropical Indo-west Pacific Ocean but deteriorate over the tropical east Pacific and tropical east Atlantic

Weekly precipitation biases (UFS - CPCU)



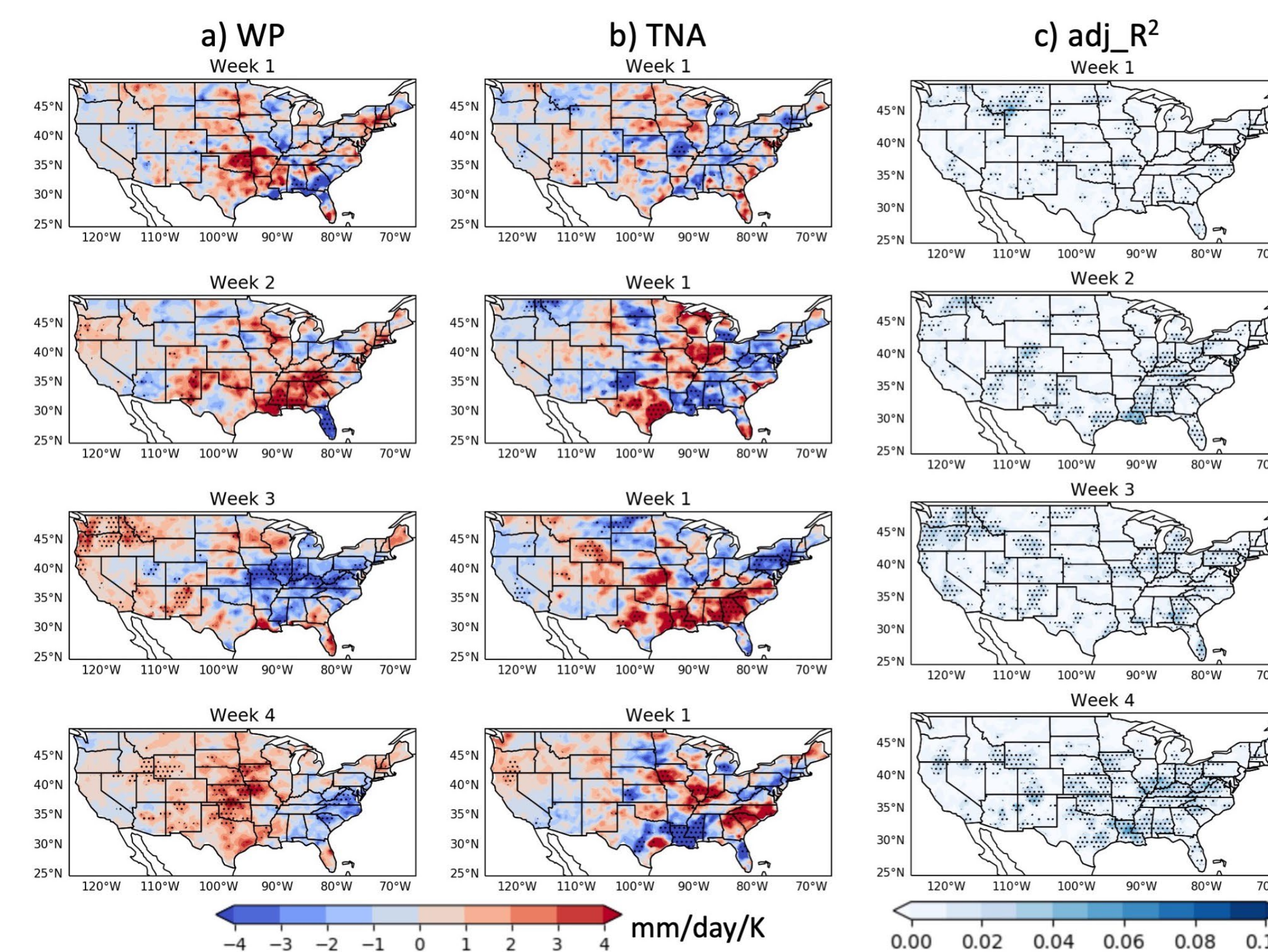
- Biases are both positive and negative in summer
- A wet bias dominates the east US in winter
- Precipitation biases in P6 are generally consistent with P5

3. Impact of SST biases

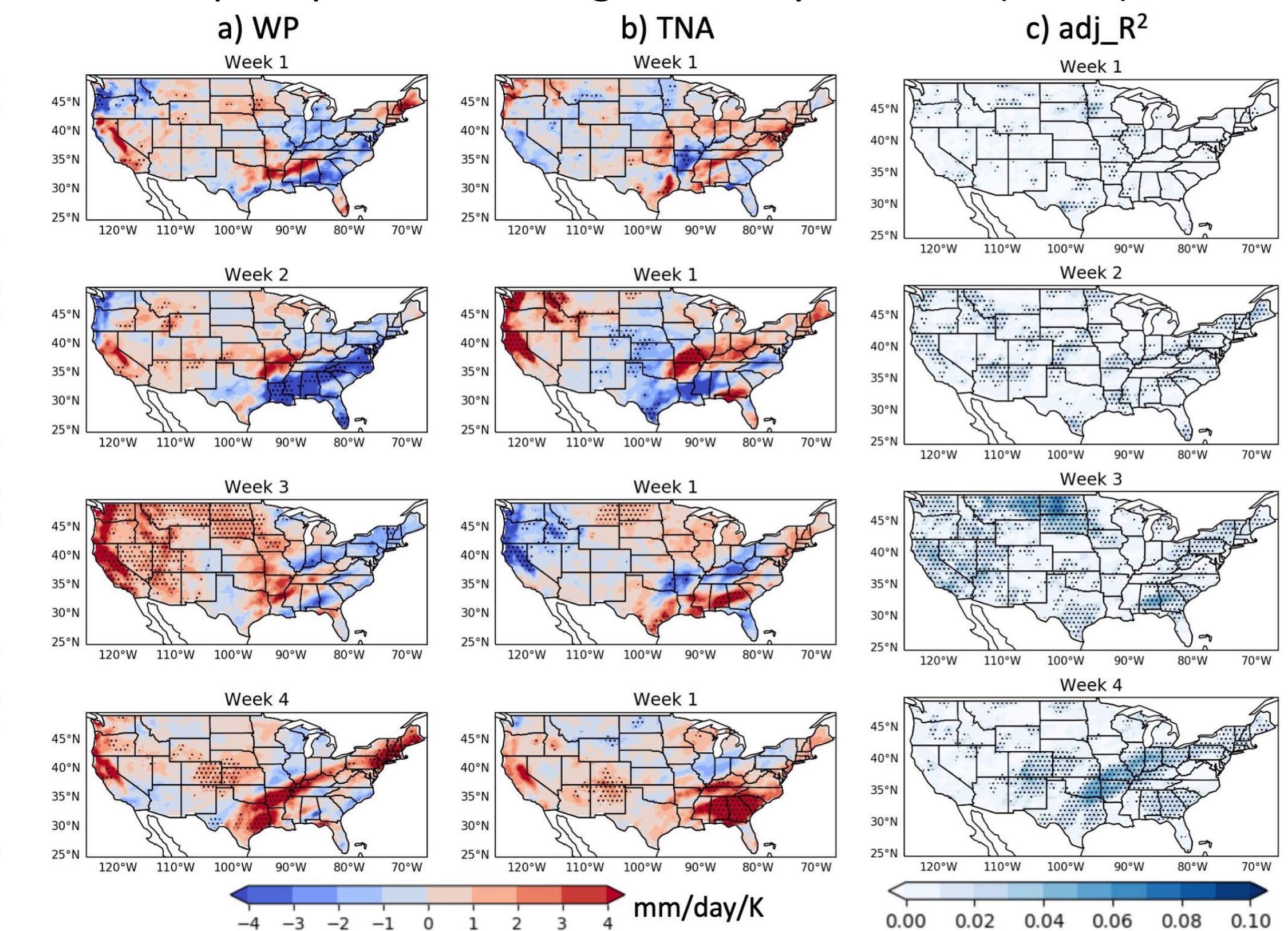


Multivariate linear regression

P6: Weekly multilinear regression of daily precipitation bias against daily SST bias (JJAS)

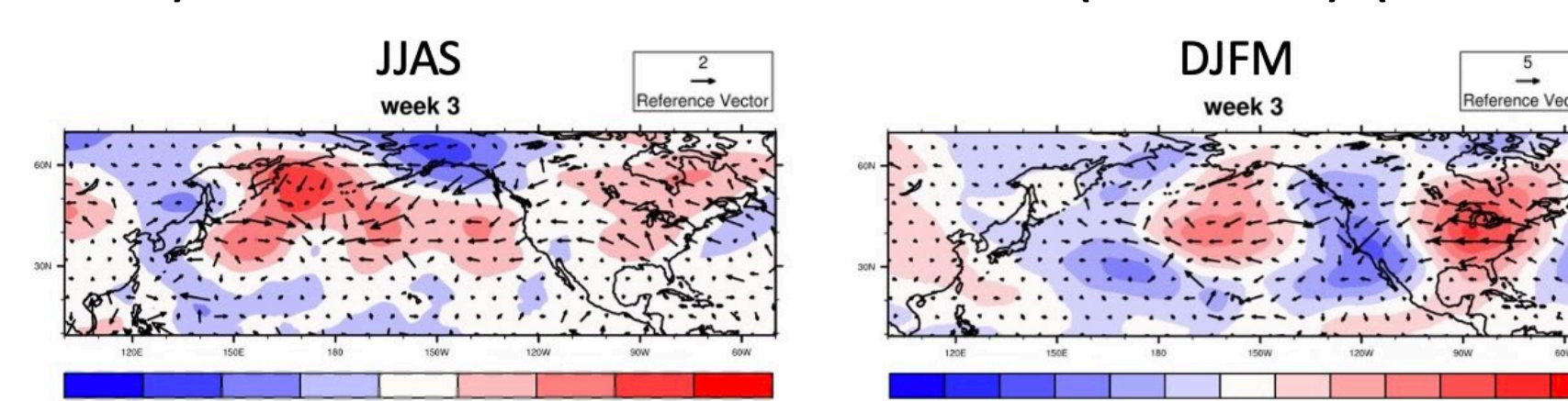


P6: Weekly multilinear regression of daily precipitation bias against daily SST bias (DJFM)



Tropical West Pacific

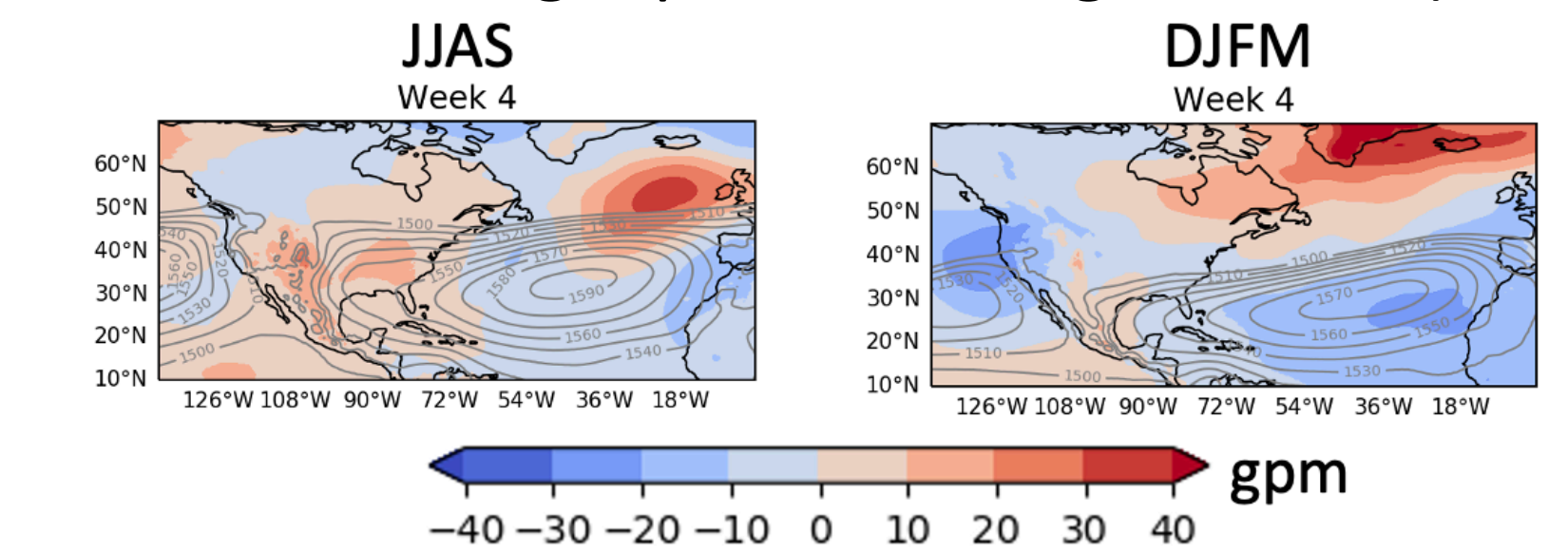
P6: Week 3 500-hPa horizontal Wave Activity Flux biases (vectors) and streamfunction biases (shaded) (UFS - ERAI)



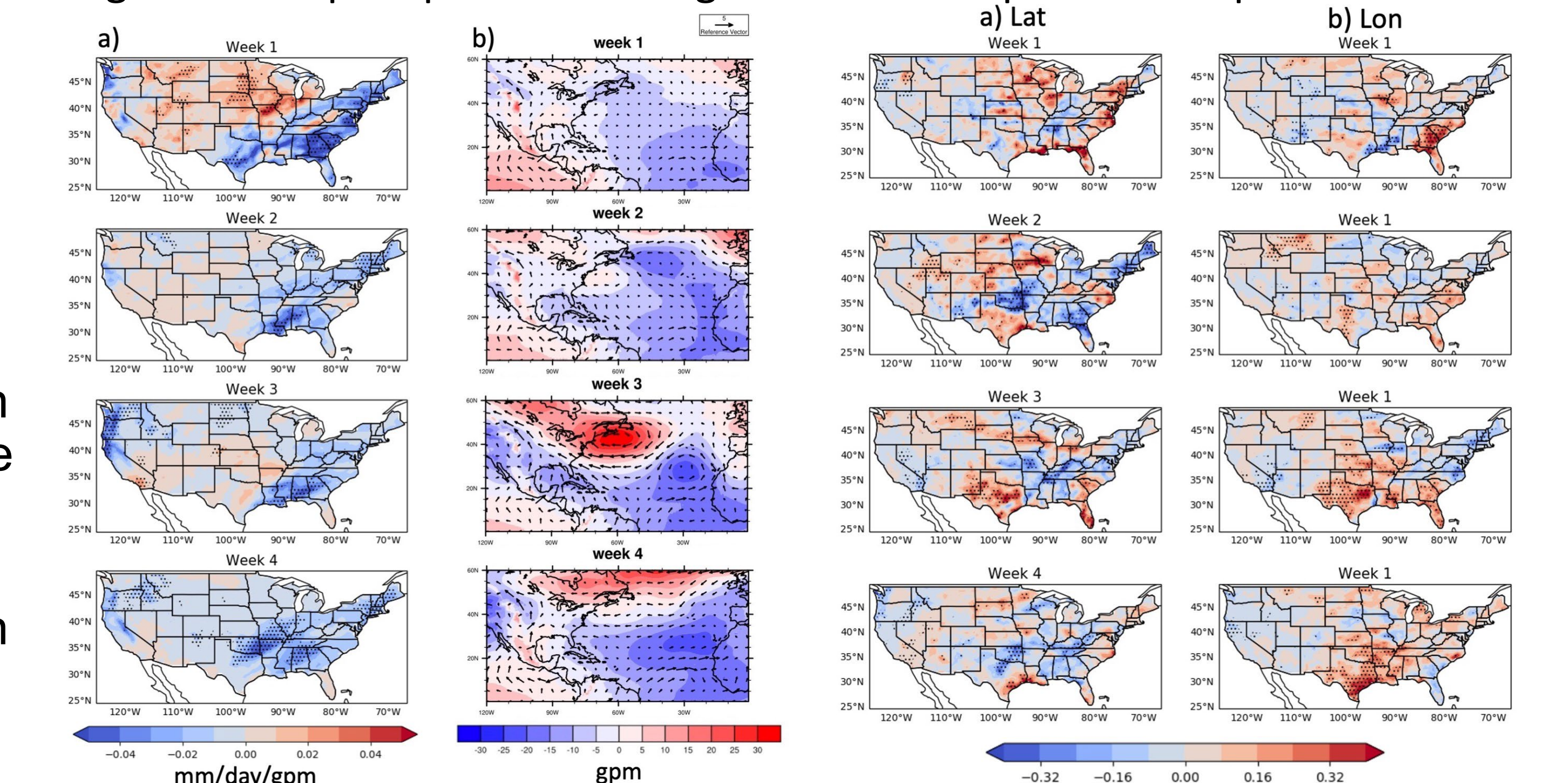
- Tropical West Pacific warm bias may influence the CONUS precipitation remotely through the wave-activity flux in both seasons
- In boreal winter, a warm SST bias over the tropical Atlantic partly affects the pressure center of the North Atlantic Subtropical High (NASH), which in the forecast is weaker than in reanalysis. The weaker NASH favors an enhanced moisture transport from the Gulf of Mexico, leading to increased precipitation over the southeast US
- In boreal summer, the NASH pressure center is weaker and in addition, its position is displaced to the northeast, thus further regulating the CONUS summer precipitation

Tropical North Atlantic

P6: Week 4 850-hPa geopotential height biases (UFS - ERAI)



Regression of precipitation bias against NASH amplitude and position biases



5. Conclusions



- In both seasons, SST biases over both tropical oceans show significant influence on the CONUS precipitation bias. The variance explained by the SST biases increases from week 1 to 4, up to about 5% in the summer and 10% in the winter
- Tropical west Pacific SST biases can impact the S2S CONUS precipitation via Rossby wave train propagation
- A warm tropical north Atlantic SST bias results in a weaker NASH, which can further impact the CONUS precipitation

Reference: Stan, C., V. Krishnamurthy, H. Bai, B. Li, A. Mehra, J. Meixner, S. Moorthi, L. Stephanova, J. Wang, J. Wang., D. Worthen, F. Yang, 2022: The impact of tropical SST biases on the S2S forecast skill over the North America in the UFS global coupled model. *J. Clim.*, in revision