



# Including climatic variability in stochastic rainfall for flood catastrophe modelling

## The effect of ENSO and SOI in China

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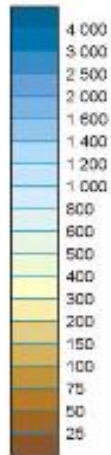


**Risk Management Solutions, Inc. – London**

# GOALS

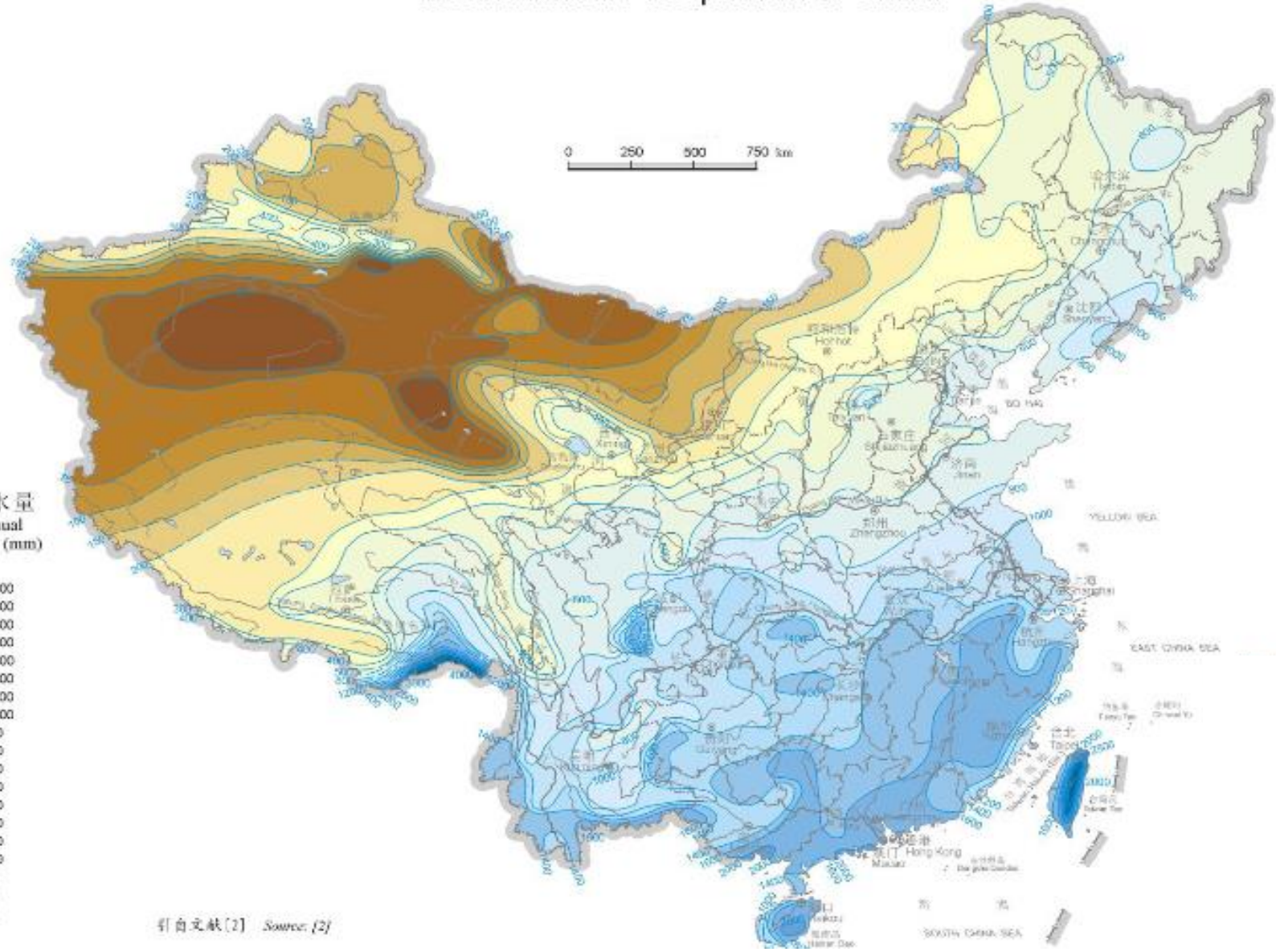
- Provide a **continuous** simulation input (10k yrs) set to describe **extreme events**
- Preserve the observed **climatology** and **space-time correlation** structure
- Combine a stochastic set of **tropical cyclone** (TC) rainfall with **nonTC** rainfall stochastic continuous simulation
- Link nonTC rainfall amounts to **hydroclimatic indices** (e.g. **ENSO** and **SOI**)

年均降水量  
Mean Annual  
Precipitation (mm)



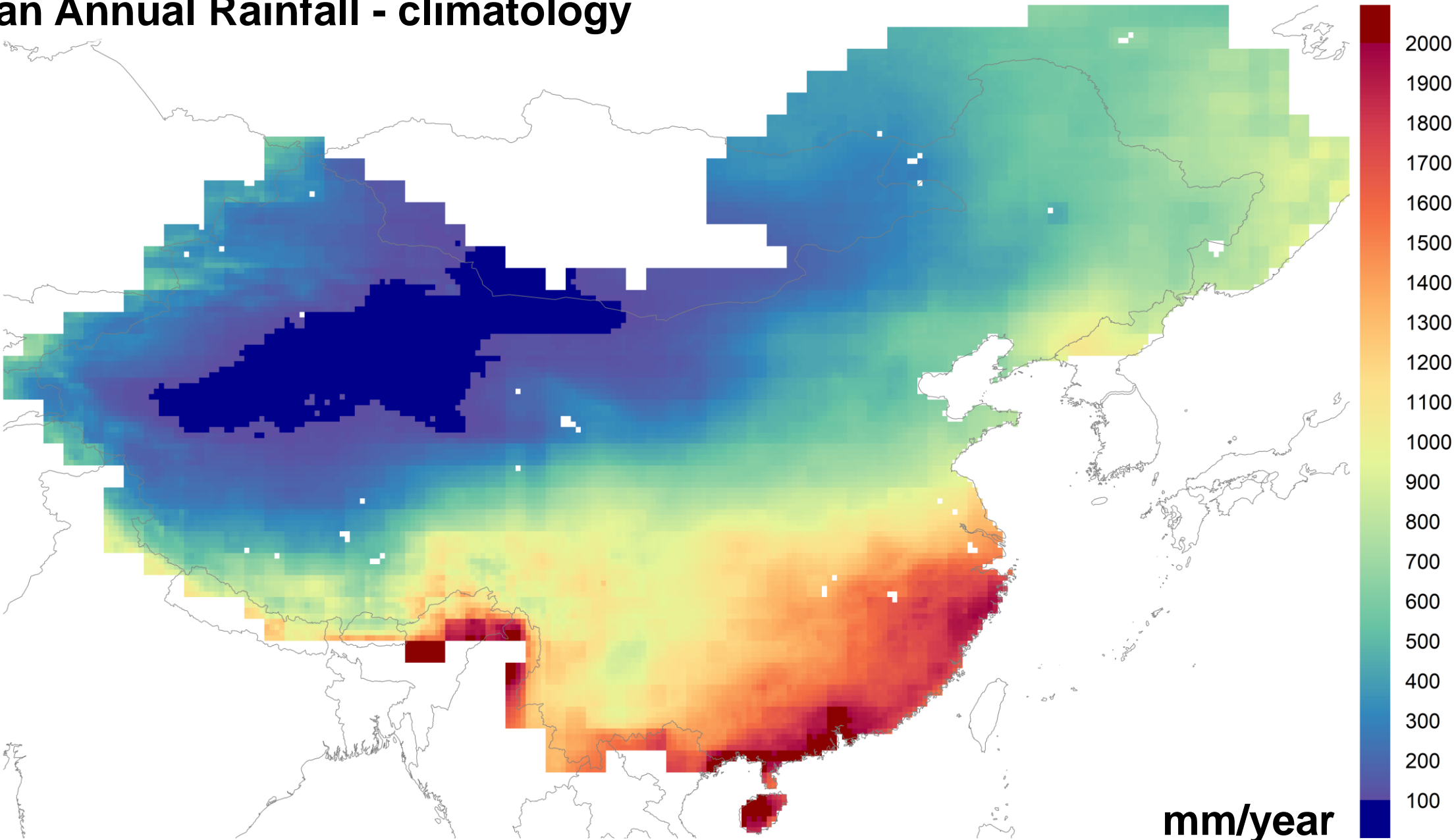
引自文献[2] Source: [2]

Mean Annual Precipitation of China

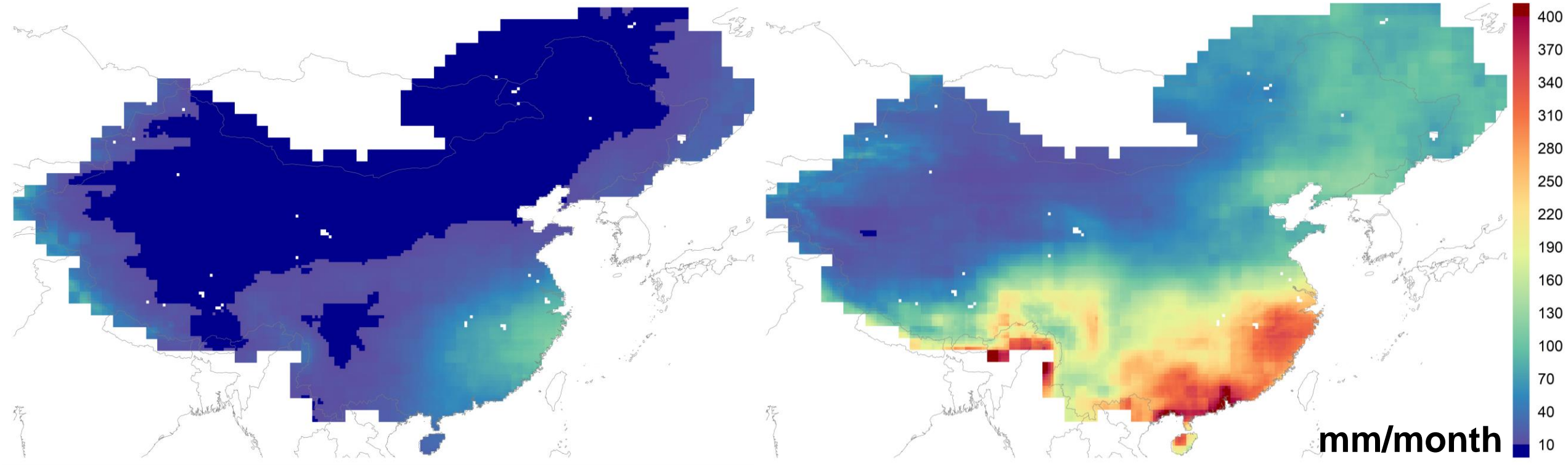


Source: Atlas of Natural  
Disaster Risk of China

# Mean Annual Rainfall - climatology



# Strong seasonality



**FEBRUARY**

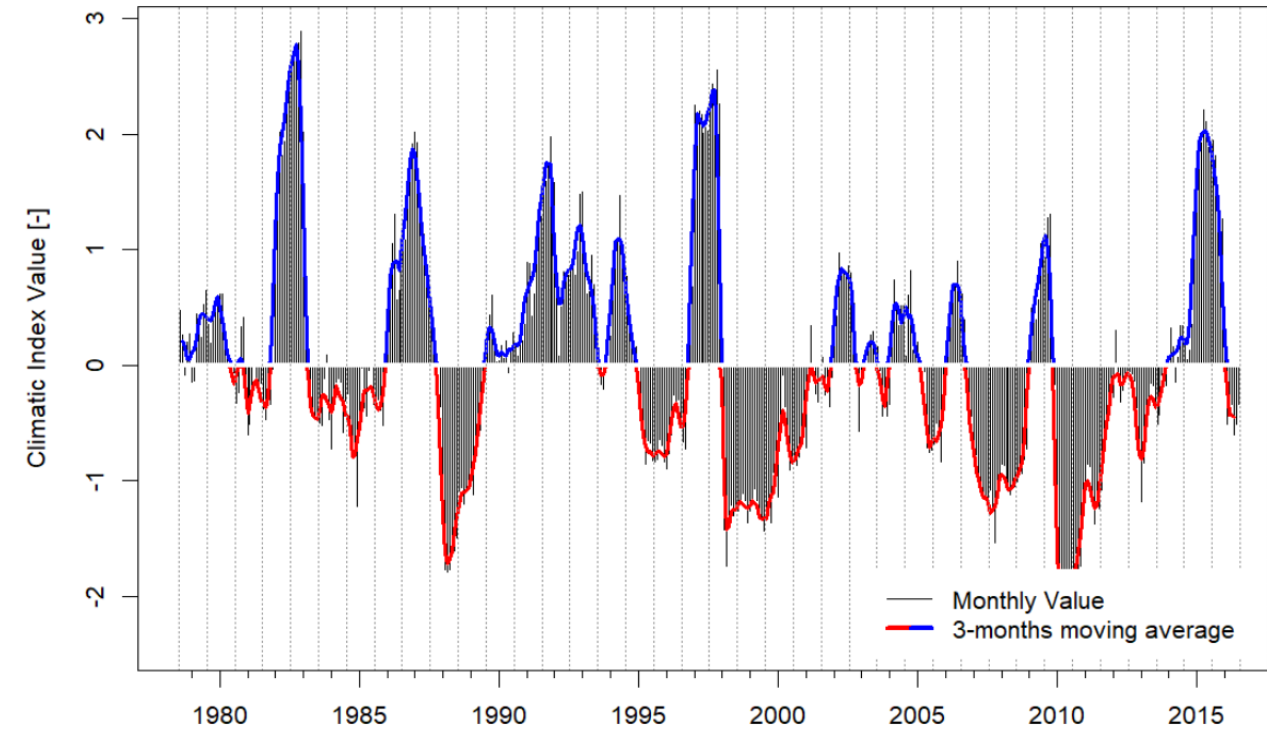
**JUNE**

**Mean Monthly Rainfalls - climatologies**



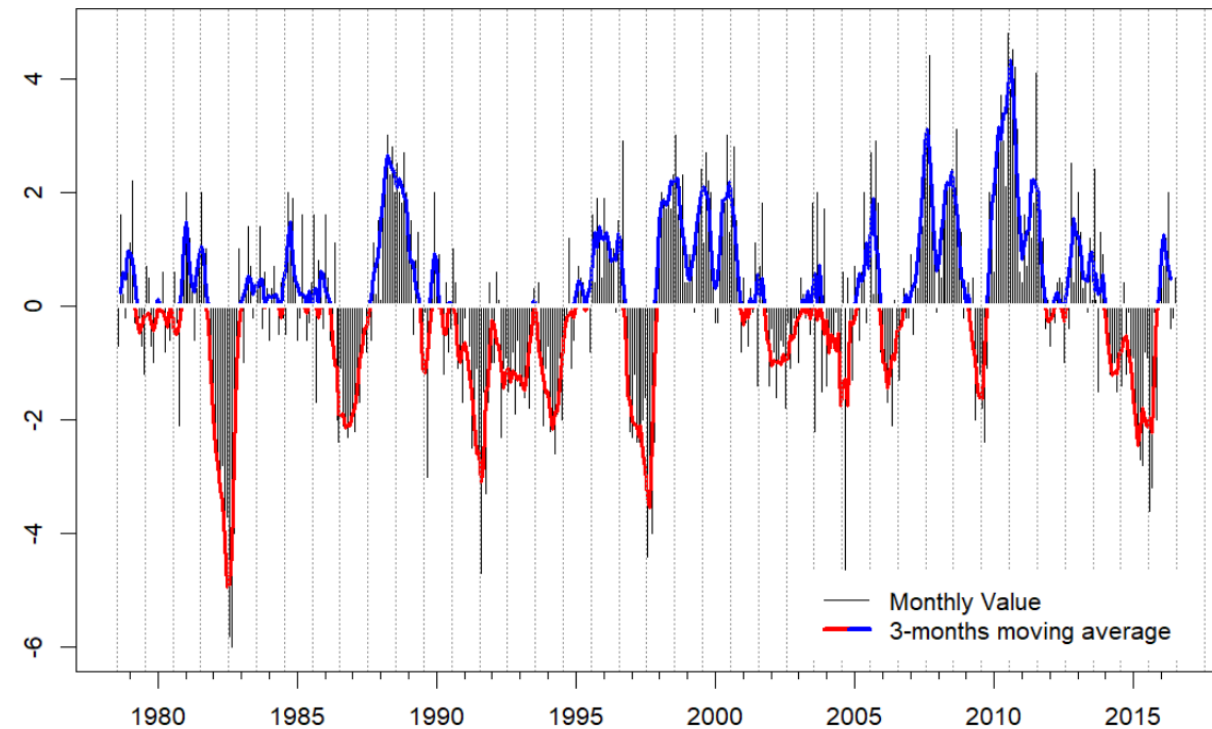
# Potential indices

El Niño-Southern Oscillation (Multivariate ENSO Index v2)



**ENSO**

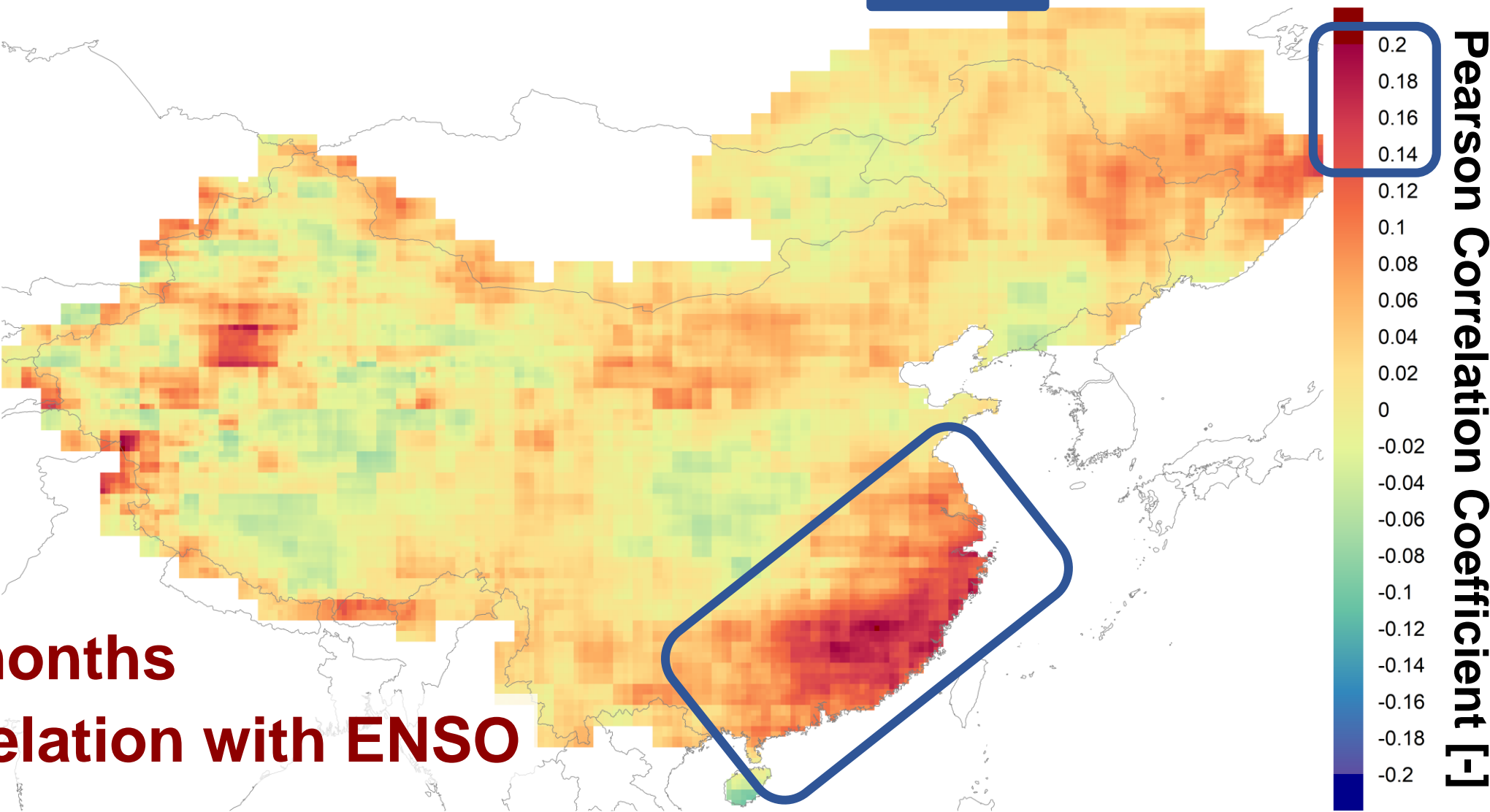
Southern Oscillation Index (SOI)



**SOI**

# Results – correlations of monthly rainfall amounts

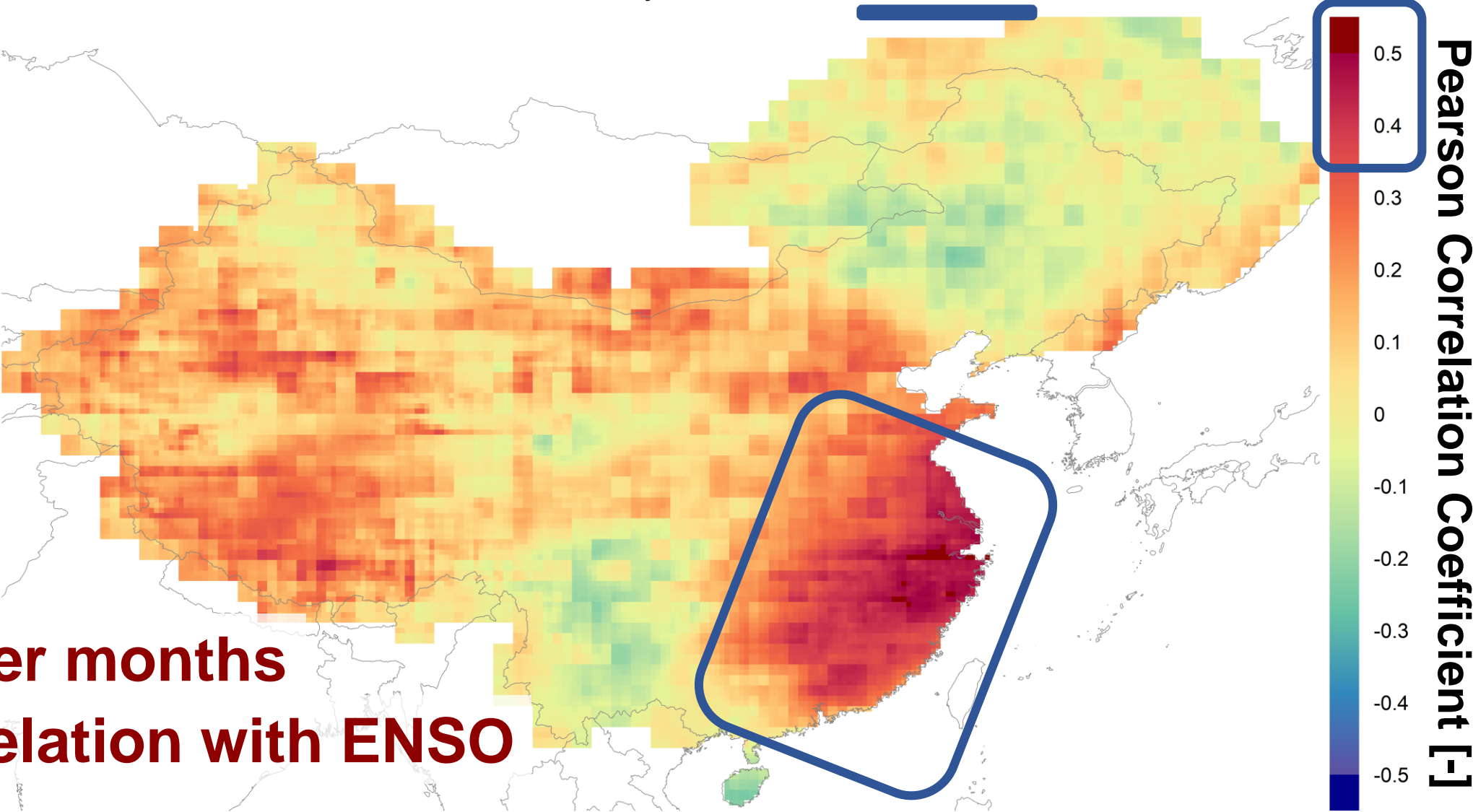
Correlation Between Monthly Rainfall and ENSO - ALL MONTHS



**All months  
Correlation with ENSO**

# Results – correlations of monthly rainfall amounts

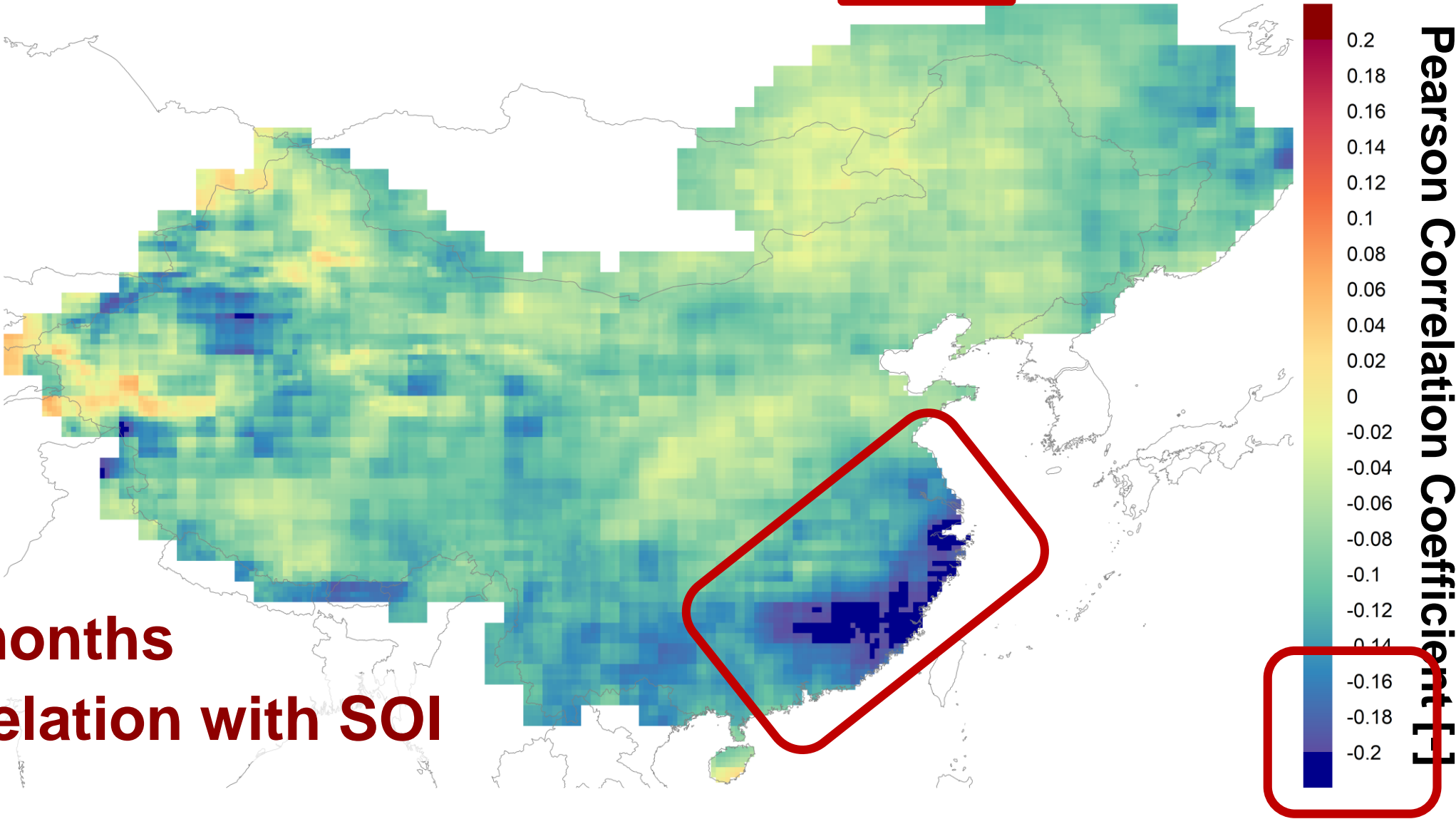
Correlation Between Monthly Rainfall and ENSO - WINTER MONTHS



**Winter months  
Correlation with ENSO**

# Results – correlations of monthly rainfall amounts

Correlation Between Monthly Rainfall and SOI - ALL MONTHS

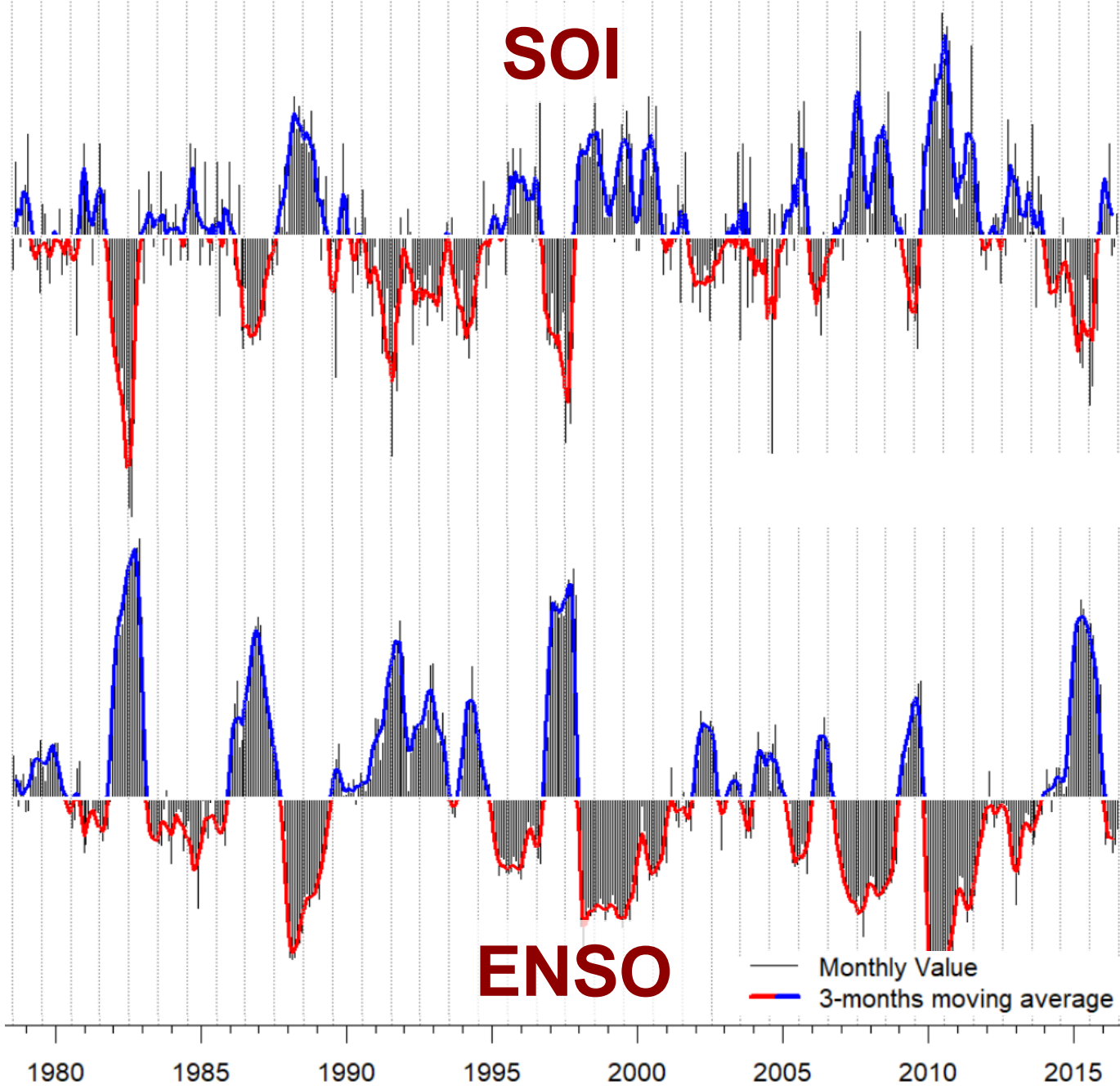


**All months  
Correlation with SOI**

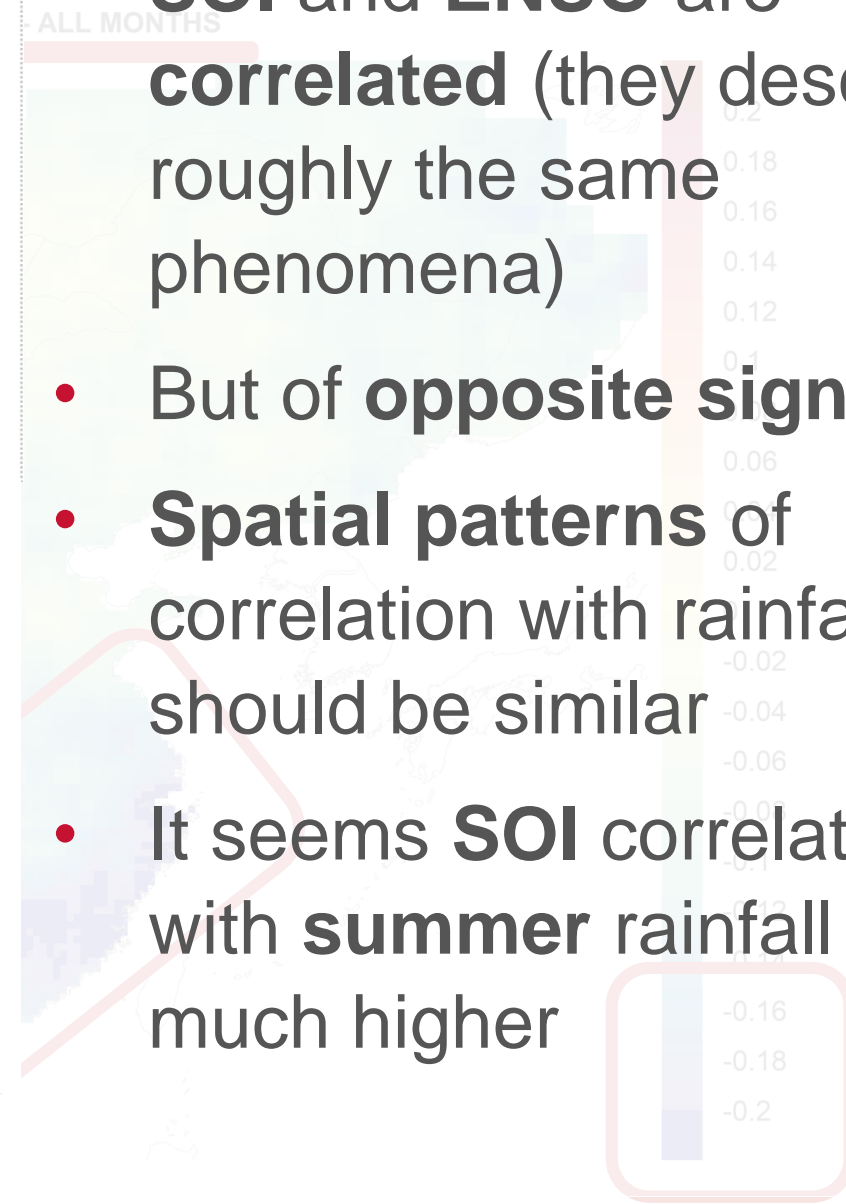


# SOI

# ENSO

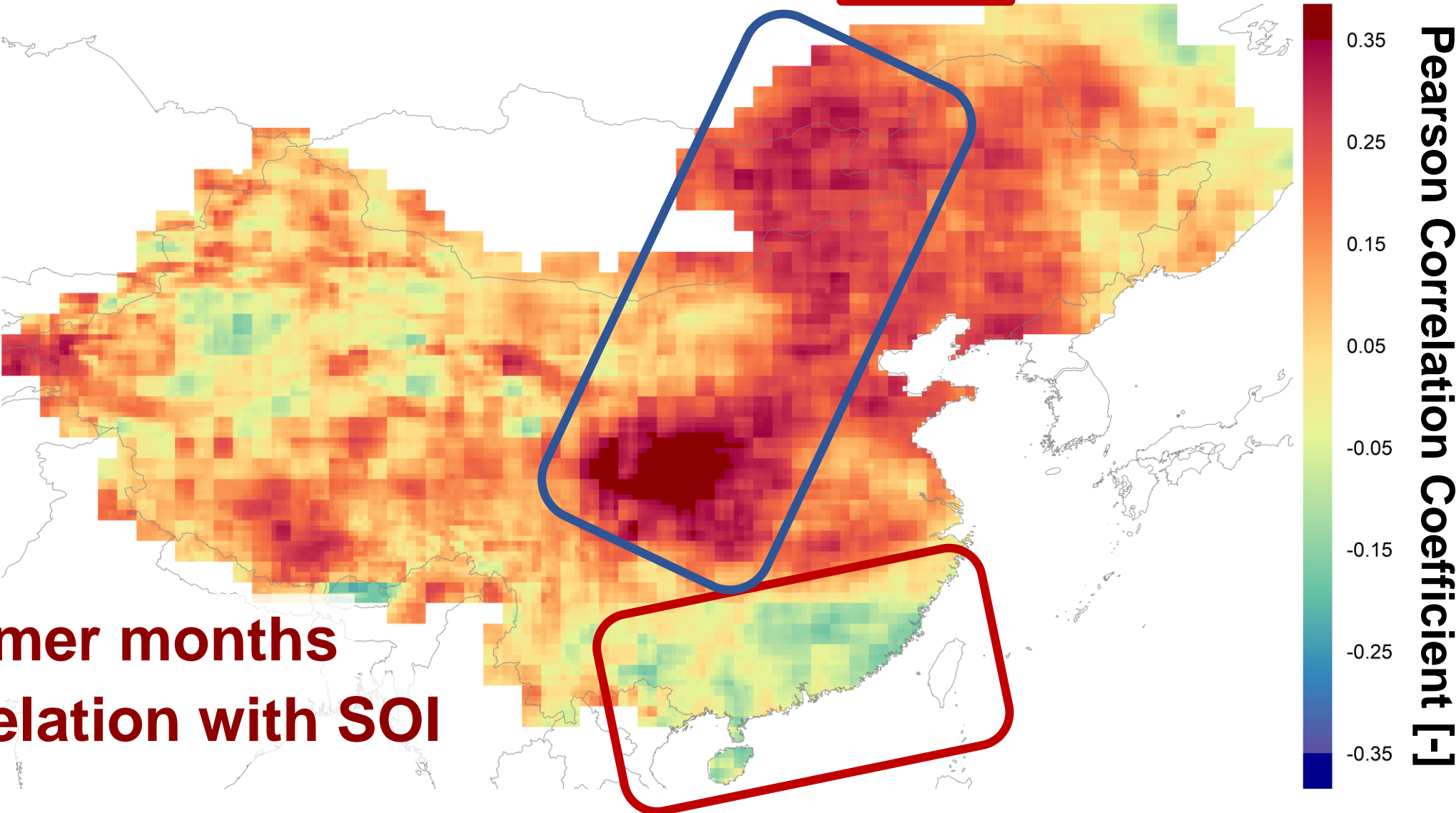


- **SOI** and **ENSO** are **correlated** (they describe roughly the same phenomena)
- But of **opposite sign!**
- **Spatial patterns** of correlation with rainfall should be similar
- It seems **SOI** correlation with **summer** rainfall is much higher



# Results – correlations of monthly rainfall amounts

Correlation Between Monthly Rainfall and SOI - SUMMER MONTHS



# How do we include it in the stochastic rainfall?

- Monthly rainfall amounts per season are decomposed using PCA
- Stochastic rainfall is simulated generating independent PC time series, and then temporally disaggregating to sub-daily time scales
- We impose a correlation of some PCs with stochastic climatic indices
- Stochastic climatic indices are synthetically generated time series that conserve the statistical properties and autocorrelation structure of observed ENSO and SOI

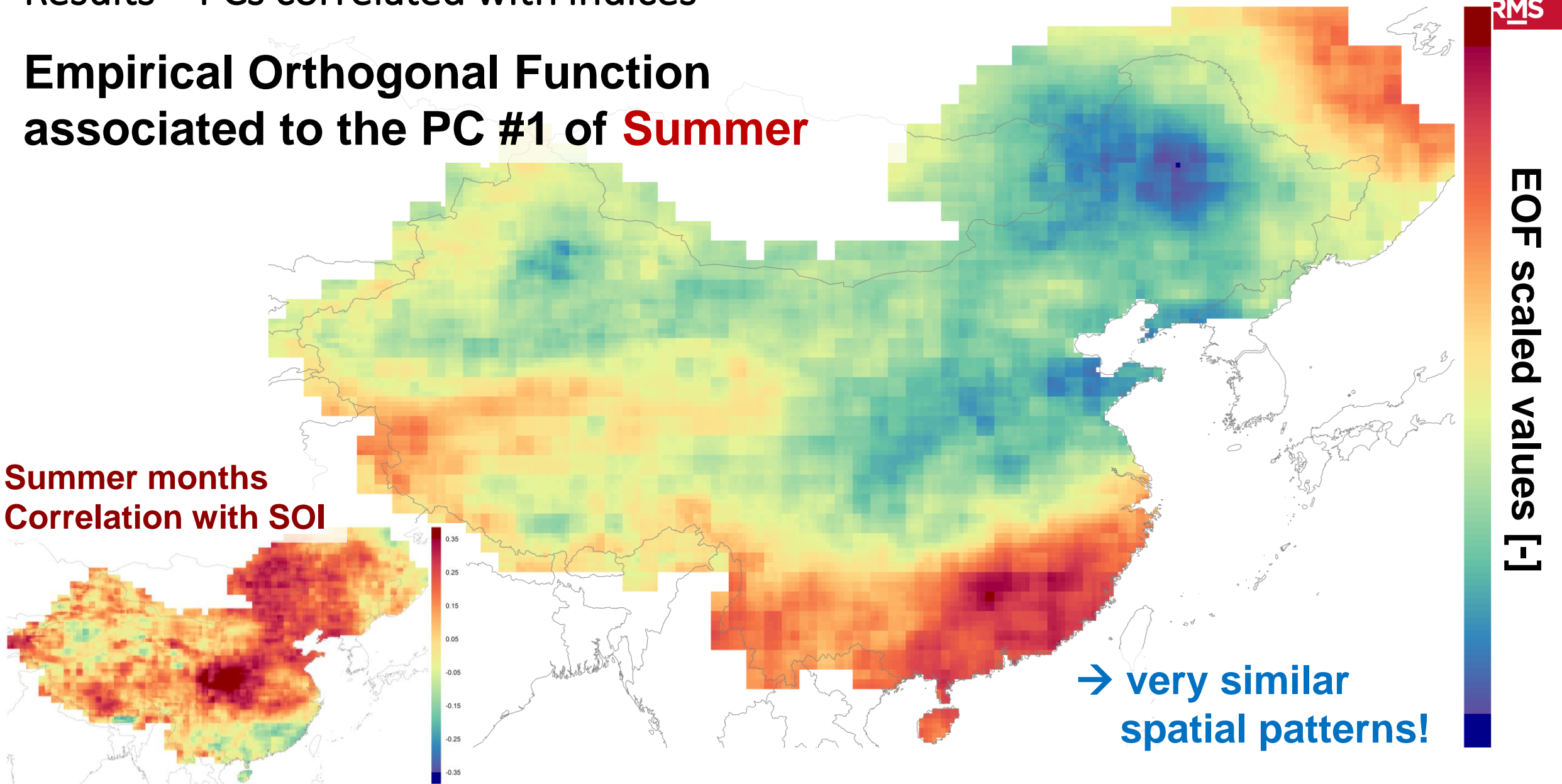
## Results – PCs correlated with indices

- Summer rainfall shows the highest pixel-by-pixel correlation with Southern Oscillation Index (SOI)
- We find a **significant correlation** between the time series of the **Summer PC #1** and **SOI** of  $r = -0.43$

Results – PCs correlated with indices

# Empirical Orthogonal Function associated to the PC #1 of Summer

Summer months  
Correlation with SOI





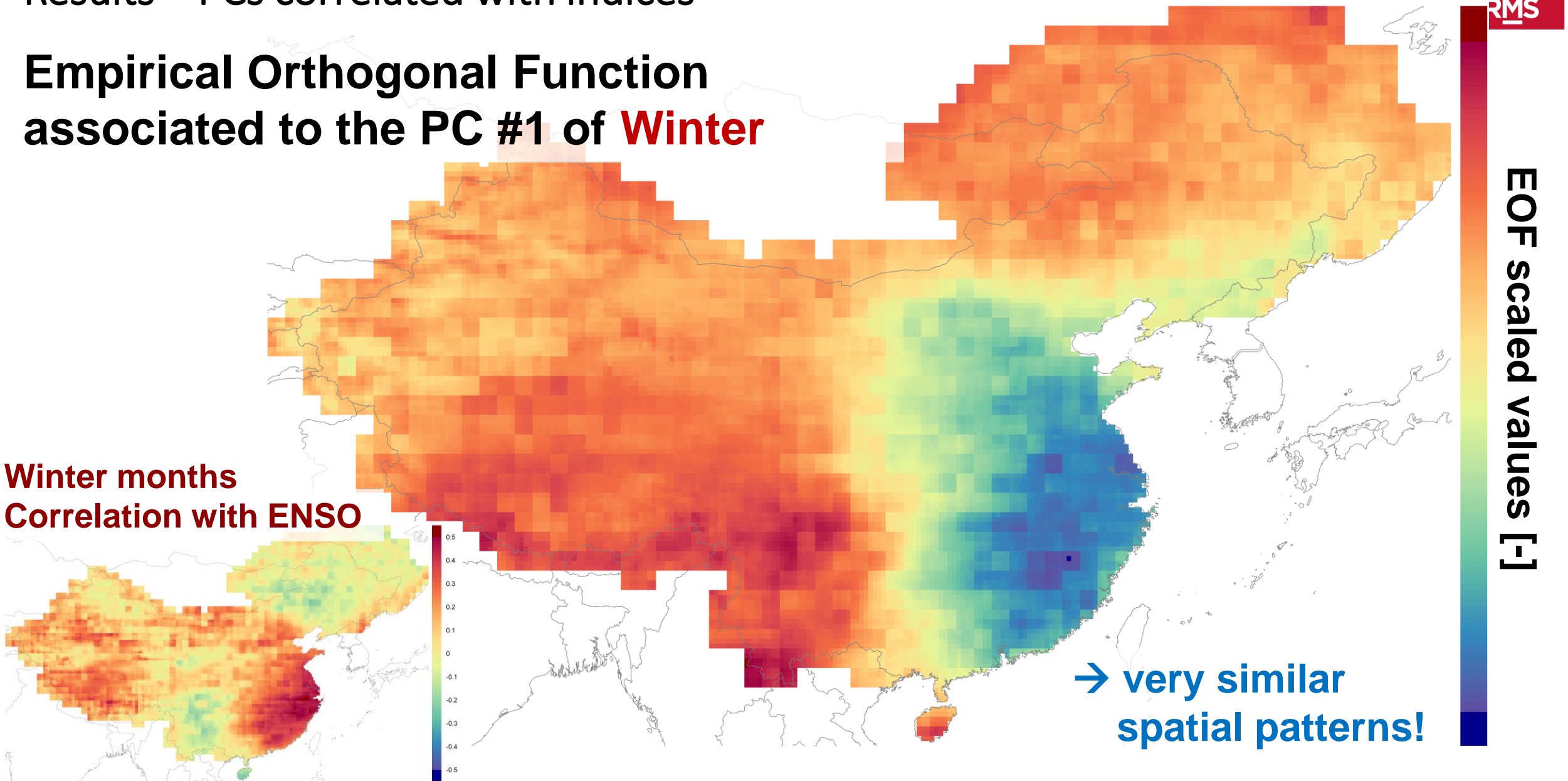
## Results – PCs correlated with indices

- Summer rainfall shows the highest pixel-by-pixel correlation with Southern Oscillation Index (SOI)
- We find a **significant correlation** between the time series of the **Summer PC #1** and **SOI** of  $r = -0.43$
- Winter rainfall shows the highest pixel-by-pixel correlation with ENSO
- We find a **significant correlation** between the time series of the **Winter PC #1** and **ENSO** of  $r = -0.49$

Results – PCs correlated with indices

## Empirical Orthogonal Function associated to the PC #1 of **Winter**

**Winter months  
Correlation with ENSO**





# Thank you!

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