Generating a more unified perspective of the North American Monsoon variability and change: from the paleoclimate to climate change projection timescales

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Motivation:

To understand the variability of the NAMS as a multi spatiotemporal scale process

Outline:

**Past:** Low frequency variability (50-100 year) of the North American Monsoon

**Future:** Climate variability of the North American monsoon using a set of CMIP3 dynamically downscaled products from NARCCAP
Methods and datasets:

Data:

PAST (tree-ring chronology)

FUTURE (DD high resolution simulations: NARCCAP)

Methods:

EOF (Empirical Orthogonal Functions) (Lorenz, 1956).
Wilks (1996): EOF is a multivariate statistic technique that reduces a data set containing a large number of variables to a data set containing few new variables. The new variables are chosen to contain the maximum variability of the original data set.

MTM-SVD (Multi Taper Method – Singular Value Decomposition).
Mann and Park (1994, 1996): MTM-SVD is a frequency domain multivariate statistic technique that enhance signal detectability in the low frequency regime.

SPI (Standardized Precipitation Index)

Pearson Correlation: time and space
PAST climate

Low frequency variability (50-100 year) of the North American Monsoon as diagnosed through tree-ring chronologies

Location of tree-ring sites

Tree-Ring Sites: ▲ ponderosa pine ▼ Douglas-fir

Blue and red triangles are for ponderosa pine and Douglas-fir respectively. Other pine and fir in grey. Terrain elevation in shaded.
EOF1 spatial variability EW (left) versus winter SPI (right)

PC1(EW) vs. SPI(P−NOAA)
1895~2008 Evar=57%  Nov−Apr

σ(PC1[site],SPI) Nov−Apr
1895~2008 Evar=73%

PC1 time series of both EW (blue) and winter SPI (red)

σ(EW, SPI)=0.81

Tree-ring

SPI
MTM-SVD analysis: LFV Spectrum of winter SPI and Earlywood:
instrumental era

Local significance at the 90% level is indicated in oblique lines and its field significance is shown in the lower left on each plot.

Reconstructed ENSO pattern

3-6 year band

Local significance at the 90% level is indicated in oblique lines and its field significance is shown in the lower left on each plot.
Drought signal: LFV spectrum of both Earlywood and Latewood chronology obtained with a ~350 years record.

Temporal reconstructed pattern of the drought signal for both EW in (red) and LW in (blue).
Spatial reconstructed pattern of the drought signal (50-100 year)

Blue arrows indicate extreme drought event in southwestern U.S.

Temporal reconstructed pattern of the drought signal for both EW in (red) and LW in (blue)

Spatial reconstructed pattern of the drought signal (50-100 year)
FUTURE climate

Climate variability of the North American monsoon using a set of CMIP3 dynamically downscaled NARCCAP simulations

Summer precipitation (July-August) for the 20th and 21st century
Summer SPI time series for NARCCAP simulations for both 20\textsuperscript{th} (left panel) and 21\textsuperscript{st} (right panel) century

RCM simulations forced with same GCM shows a similar variability (grouped with same colors)
Observed SST observational analysis: MTM-SVD

SST correlation

SPI correlation

2-6 year

10-15 year
NARCCAP: 20\textsuperscript{th} (left) and 21\textsuperscript{st} (right) century

Summer SPI correlation maps for ENSO (2-6 year) spectral band

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SPI observation: 2-6 year
NARCCAP GCMs 21C: LFV and ENSO SST mode (2-6 year)

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- **cgcm3**
- **hadcm3**
- **gfdl**
- **ccsm**
Key Findings:

1. Evidence of low frequency variability in tree-ring (50-100 year) chronologies

2. HRM3[Hadcm3] (CMIP3) is the well-performing model for the Southwest for the 20 and 21 century. It has a drier future than the ensemble mean.