Outline

SST’s influence in North American droughts

SST-precipitation links: Drought reconstruction: A key role for the Atlantic, especially the AMO

SST-precipitation links: Mechanism/processes

The 1950s-80s drying of the Sahel
The Great Plains
(35°-45°N; 90°-100°W; almost a million Km²)

Precipitation Anomaly
Smoothed P index

‘Dust Bowl’ drought 1931 Summer – 1939 Fall
The 1950s drought 1953-1956
The 1980s wetness 1982-1986

r (P_smth, PDSI_smth) = 0.91
Great Plains Droughts

The Dust Bowl 1931-1939
A Spring-Summer drought

Precipitation Anomalies contoured at 0.15 mm/day

The 1950s Drought 1953-1956
A Summer-Fall drought
What is the extent of SSTs’ Influence on North American Summer Hydroclimate?

- Climate models are rapidly improving but not yet ready for making the assessment for *regional* extreme events (e.g., droughts).

- Shouldn’t the 20th Century observational record itself be analyzed for scoping out the SST influence on droughts, in the interim?
Reconstruction of North American Droughts from Pacific and Atlantic SST Principal Components

*Contemporaneous* linear regressions of the seasonal SST principal components (7 Pacific & 4 Atlantic) on seasonal precipitation are the building blocks in drought reconstruction.

Reconstruction proceeds, simply, from multiplication of each SST PC with its ‘temporally fixed’ regression pattern, followed by summing of the 11 elemental contributions.
PRECIPIATION Reconstruction

(\text{CI}=0.15 \text{ mm/day})

<table>
<thead>
<tr>
<th></th>
<th>Dust Bowl</th>
<th>Dust Bowl</th>
<th>1950s</th>
<th>1950s</th>
<th>1980s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spring</td>
<td>Summer</td>
<td>Drought</td>
<td>Drought</td>
<td>Wet</td>
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<td></td>
<td>(1931-39)</td>
<td>(1931-39)</td>
<td>Summer</td>
<td>Fall</td>
<td>Period</td>
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<tr>
<td>PAC + ATL</td>
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<tr>
<td>PACIFIC</td>
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<td>ATLANTIC</td>
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OBSERVED

Maps showing precipitation patterns for different regions and time periods.
**TABLE-1:** Percentage contribution of the Pacific and Atlantic SST variability modes to Great Plains Droughts and Wet episodes in the 20° latitude-longitude box (103-83W, 30-50N) covering ~4 million Km² and outlined in red in the previous figure. *A Key Role for the Atlantic*

<table>
<thead>
<tr>
<th>Hydroclimate Episodes</th>
<th>Canonical ENSO (ENSO⁻ + ENSO⁺)</th>
<th>ENSO&lt;sup&gt;NC&lt;/sup&gt;</th>
<th>PDV&lt;sup&gt;NP&lt;/sup&gt;</th>
<th>SST-Trend</th>
<th>AMO</th>
<th>Atlantic Nino (Nino⁻ + Nino⁺)</th>
<th>TOTAL (from eleven modes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dust Bowl <em>Spring</em> (1931-39) Great Plains <em>Deficit: 0.25 mm/day</em></td>
<td></td>
<td>8</td>
<td></td>
<td>26</td>
<td><strong>55</strong></td>
<td>12</td>
<td>92</td>
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<tr>
<td>Dust Bowl <em>Summer</em> (1931-39) Great Plains <em>Deficit: 0.29 mm/day</em></td>
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<td>9</td>
<td></td>
<td>22</td>
<td>12</td>
<td><strong>31</strong></td>
<td>82</td>
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<tr>
<td>1950s <em>Fall</em> Drought (1953-56) Southern Plains <em>Deficit: 0.63 mm/day</em></td>
<td></td>
<td>23</td>
<td></td>
<td>29</td>
<td>24</td>
<td></td>
<td>78</td>
</tr>
<tr>
<td>1980s <em>Fall</em> Wetness (1982-86) Southern Plains <em>Surplus: 0.69 mm/day</em></td>
<td></td>
<td>14</td>
<td></td>
<td>19</td>
<td></td>
<td><strong>37</strong></td>
<td>75</td>
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</tbody>
</table>
SST-Precipitation Links: AMO Pathway
(1900-2009 Hadley SST analysis)

• CRU TS3.0 Precipitation (*shaded* at 0.075 mm/day, first visible contour at 0.15)
• 20CR Reanalysis Geopotential 700 hPa (*contoured* at 2 m)
• 20CR Reanalysis Stationary Column Moisture Flux [*vector*, Sfc-300, in Kg/(m s)]
Great Plains Precipitation and the AMO

Corr (GP-large, AMO-PC) = −0.77
Corr (GP-Sieg, AMO-PC) = −0.65
Corr (GP-RBN, AMO-PC) = −0.75
The Great Plains drought analysis is published

Sahel Rainfall

June-August 1901-2002
(20W-40E; 10-20N)

- **OBSERVED (CRU TS2.1)**
- **RECONSTRUCTED (from Pacific & Atlantic PCs; 0.91, 0.72)**
  - from SST Secular trend
  - from **PACIFIC** SST variability (mostly PDV-NP)
  - from **ATLANTIC** SST variability (mostly AMO)
  - from just AMO and PDV-NP (correlation with OBS = 0.83)