Changes in rainfall patterns in the Southeast U.S.A.

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- **Baigorria, G.A., J.W. Jones and J.J. O'Brien. 2007. Understanding rainfall spatial variability in the southeast USA. International Journal of Climatology, 27(6):749-760.**

Objective

To characterize the spatial and temporal changes of rainfall in the Southeastern USA during the last 90 years

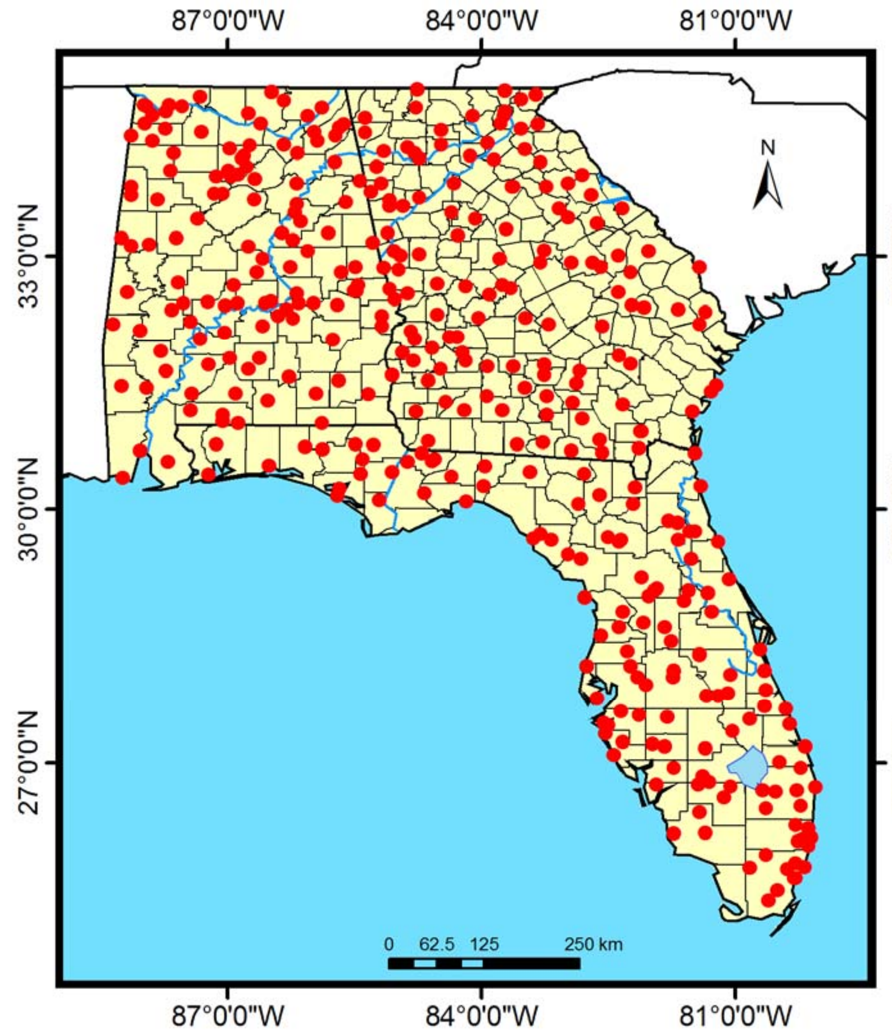
Data

Historical daily rainfall data record from 1048 weather stations obtained from the National Climate Data Center NOAA-NCDC §

from 1915 to 2004

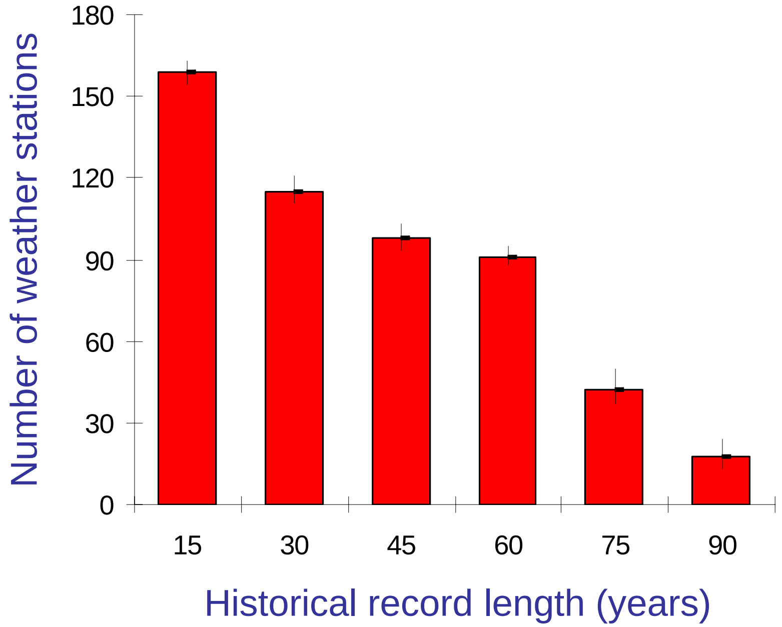
Weather station network

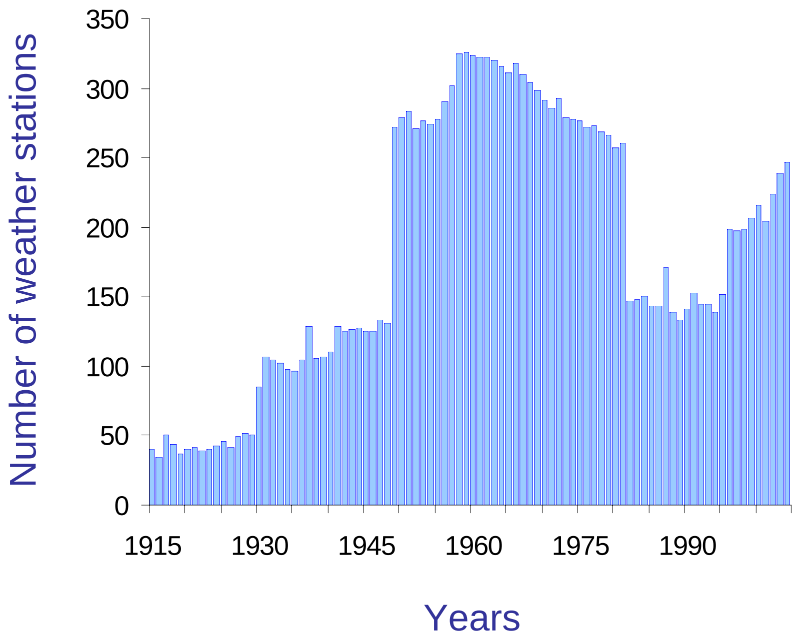
Final 523 weather stations



§ *http://nndc.noaa.gov/?home.shtml*

Temporal analysis of the weather station network





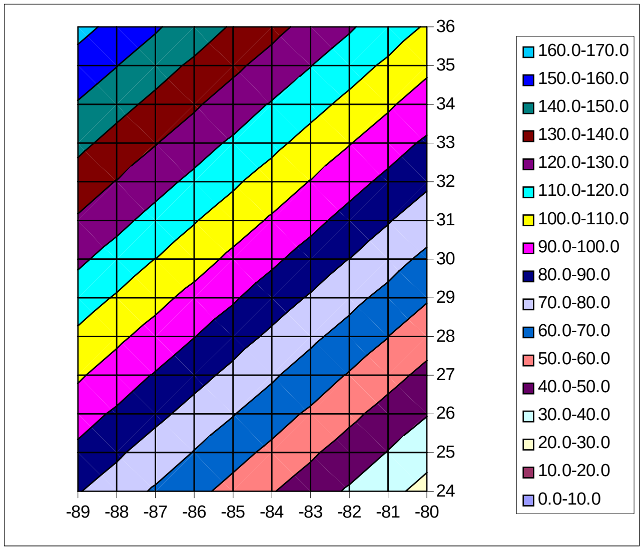
Methods: Quality control

- Range errors and zeros that had been substituted for replacing missing values were deleted
- For monthly analyses, months with fewer than 20 days of data were not considered
- Weather stations beyond their State and County limits for which coordinates could not be corrected were deleted

Methods: Geographical Trends

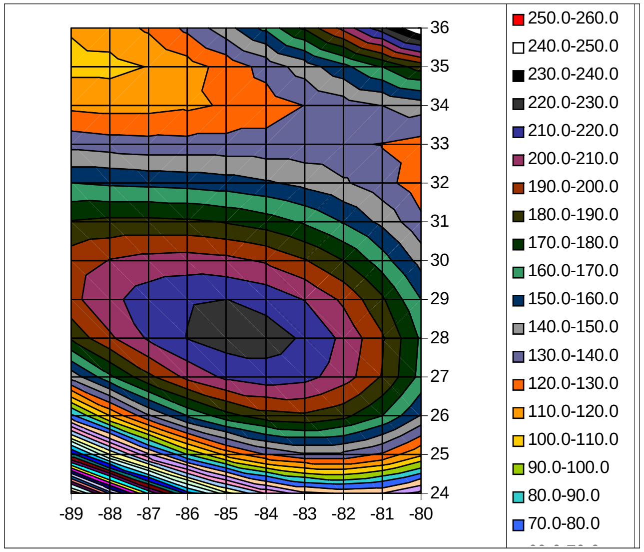
- Polynomial equations for each month and year were fitted using least squares method. The degree of the polynomial equation for each month and year was selected by comparing the sum of the squared residuals as a percentage of the original variation

January



$$\hat{R} = b_0 + b_1\phi + b_2\lambda$$

July



$$\hat{R} = b_0 + b_1\phi^3 + b_2\phi^2\lambda + b_3\phi\lambda + b_4\phi\lambda^2 + b_5\lambda^3$$

ϕ = Latitude λ = Longitude

Methods: Interpolation

- After removing the geographical trend, semivariograms were calculated

$$\gamma(h) = \frac{1}{2N(h)} \sum_{(i,j)|h_{ij} \approx h} \left(x_i - x_j\right)^2$$

γ Semivariance
h Distance
x Rainfall residual

- Model fitting by the Stable model

$$\hat{\gamma}(h) = \delta_o + \delta_1 \left[1 - e^{-(h/A)^{\beta}}\right]$$

δ_o Nugget
δ_1 Sill
A Range

$\delta_o = 0$ *Nugget was forced to zero to preserve observed rainfall values*

Methods: Interpolation

- Rainfall residuals were interpolated using Ordinary Kriging (grid cells of 5 km x 5 km)

- Resulting monthly maps were divided into 6 periods of 15 years each

I	II	III	IV	V	VI
1915	1930	1945	1960	1975	1990
1916	1931	1946	1961	1976	1991
…	…	…	…	…	…
…	…	…	…	…	…
1929	1944	1959	1974	1989	2004

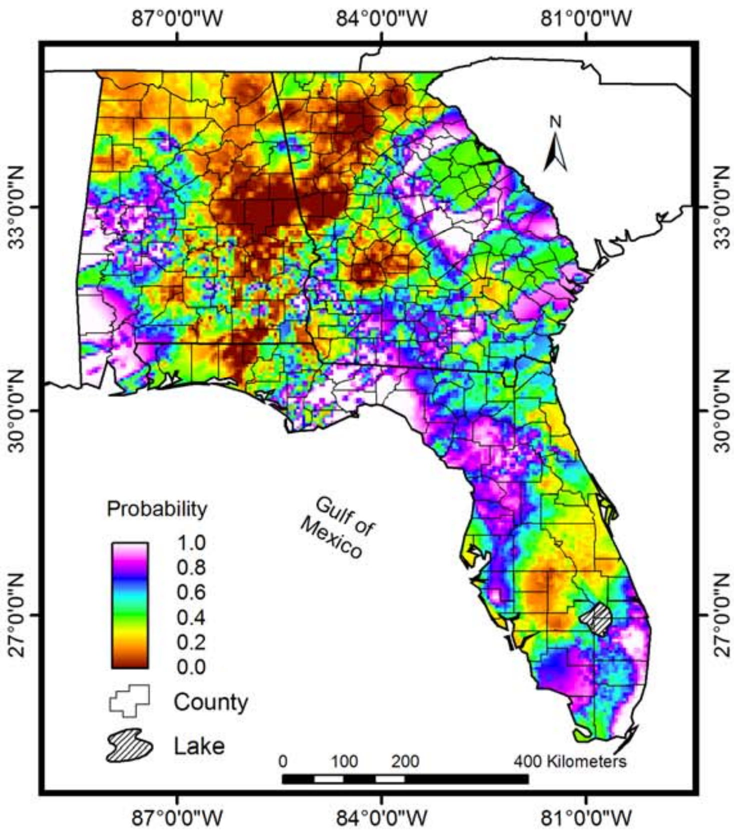
Methods: Statistical Analysis

- Analysis of Variance *F*-statistics for each grid cell in the geographical domain was performed
- Duncan's multiple range test was performed for each grid cell where significant differences were found ($P \leq 0.05$)
- Monthly matrices of maps showing the areas where statistical differences were detected when comparing each 15-year period against the other periods were obtained

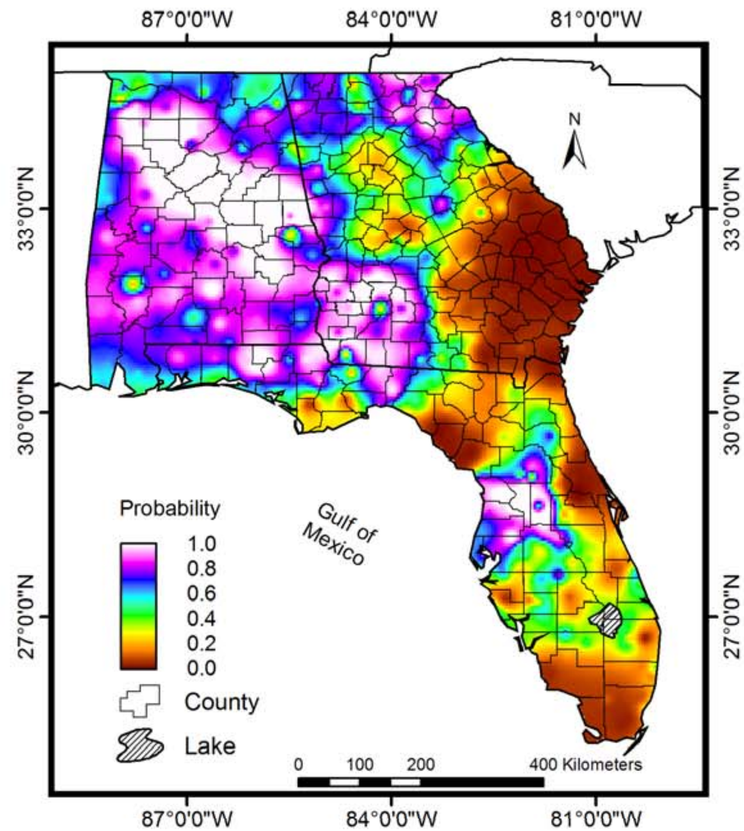
Results: Differences Between 15-Year Periods

Maps of probability value that the F-test statistics
is at least as large as the observed F-value ($\alpha = p$).

January



July

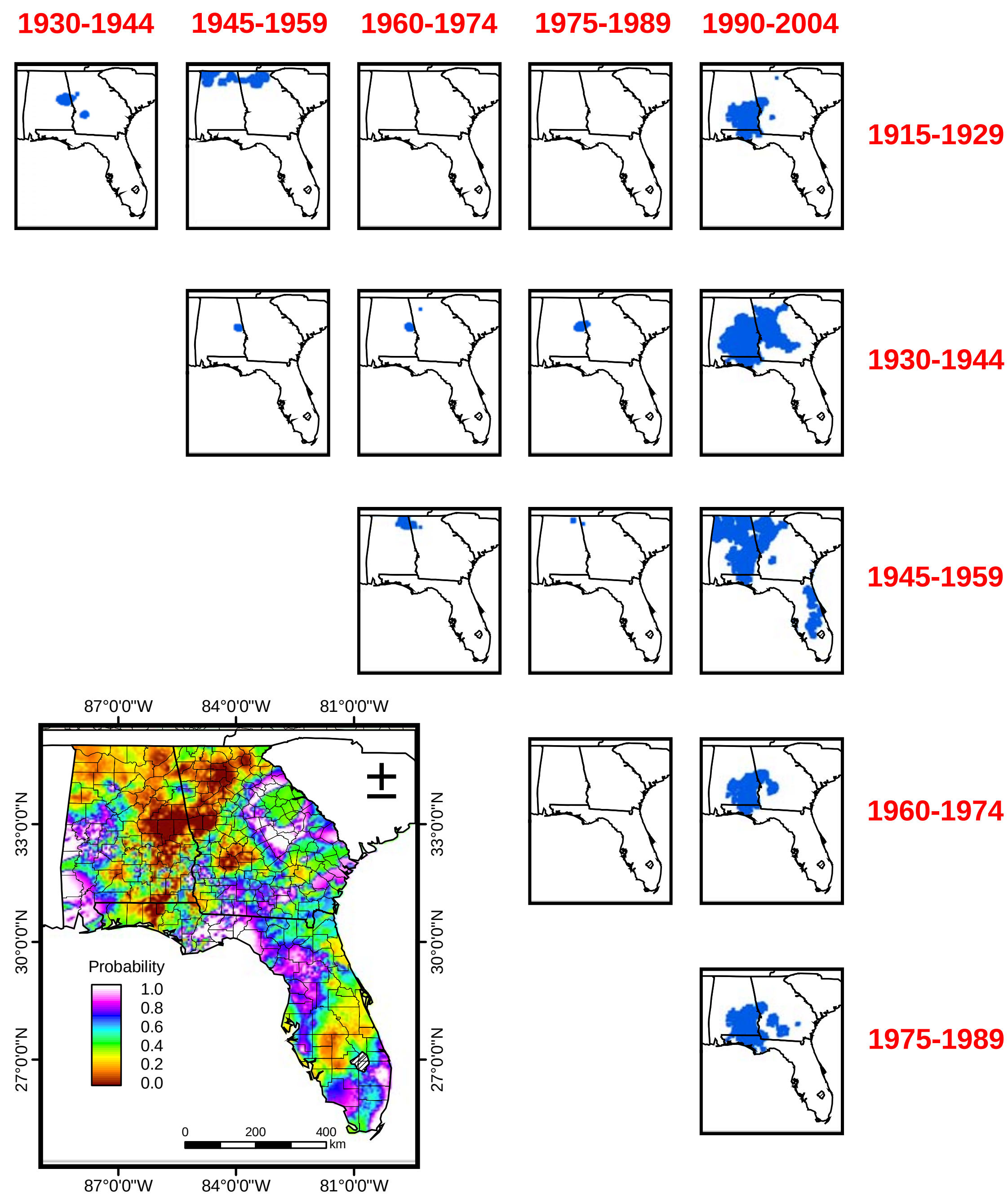


Results: Identifying differences over space & time

January

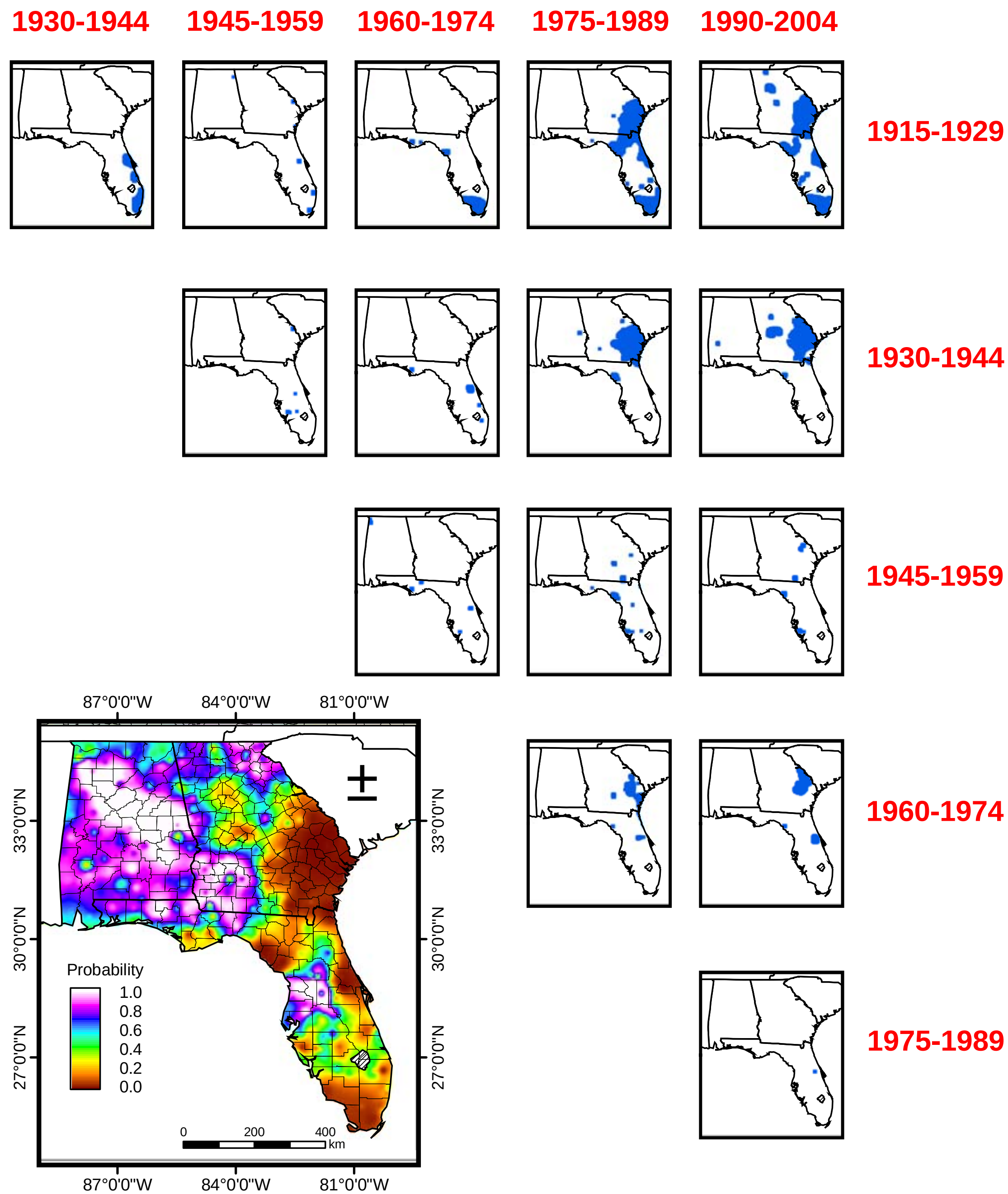
Maps of Duncan's multiple range tests

- Statistically significance difference (blue)
- Non-significant (white)



Results: Identifying differences over space & time

July



Maps of Duncan's multiple range tests

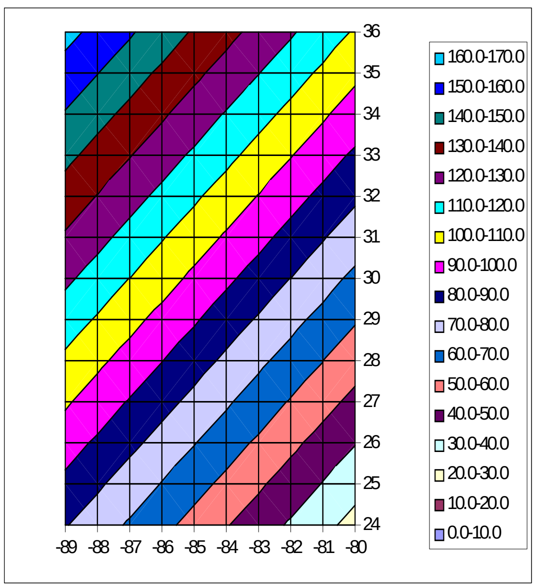
- Statistically significance difference (blue)
- Non-significant (white)

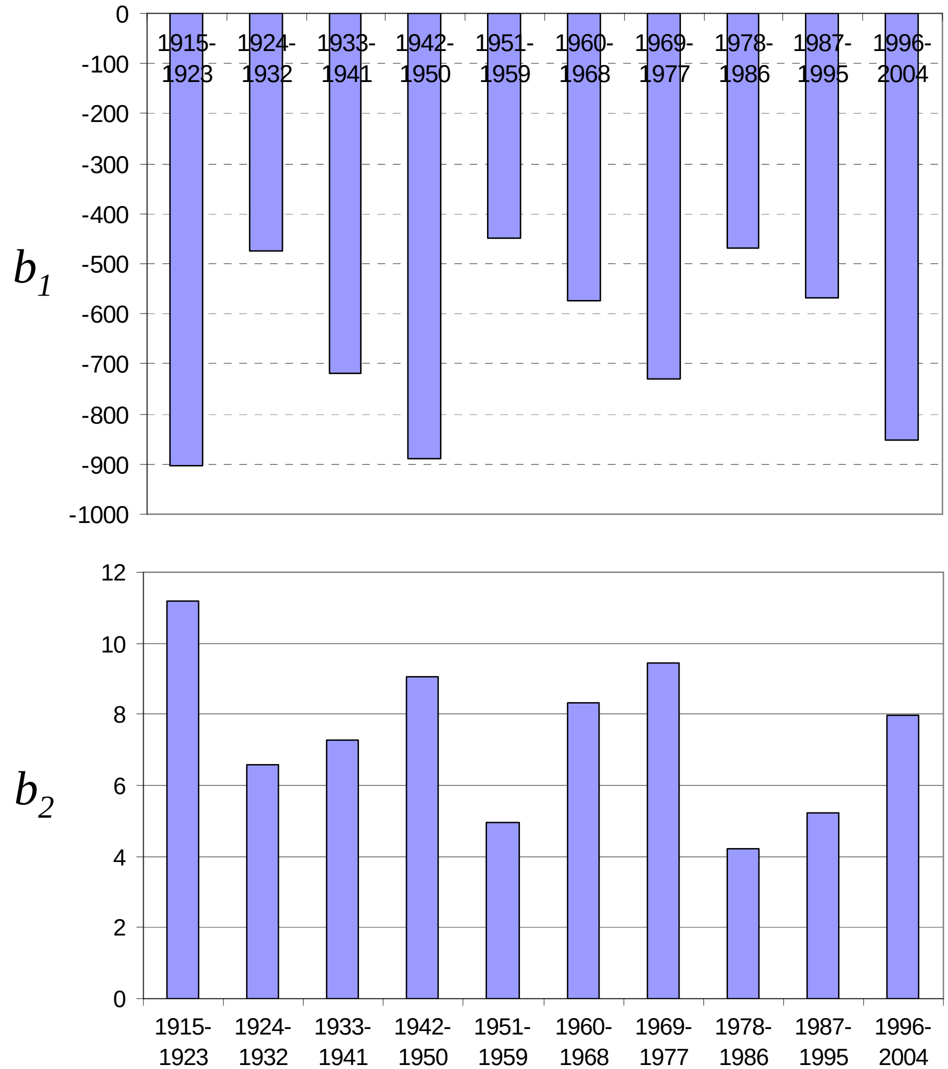
Results: Temporal pattern in the geographical trend

January

$$\hat{R} = b_0 + b_1\phi + b_2\lambda$$

ϕ = Latitude λ = Longitude





Conclusions

- Changes in rainfall patterns occurred in some areas but not over the entire region
- Changes in rainfall were detected across time during the last 90 years, not only during the last 15-year period
- In areas where changes occurred, rainfall tended to increase during winters and decrease during summers over the 90-year time period
- Isolines of high rainfall amounts in January shifted from the Southeast to the Northwest in a 27-year cycle