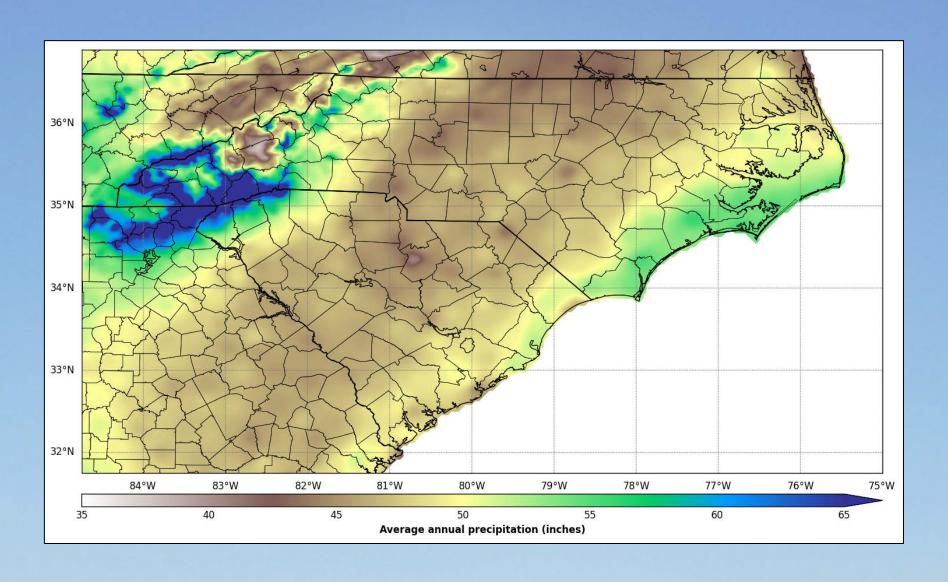


Background



Goal: Develop a spatially detailed, long-term precipitation climatology of the Carolinas that effectively portrays the spatial and temporal variability of precipitation across the region.

→ Hydroclimate extremes atlas

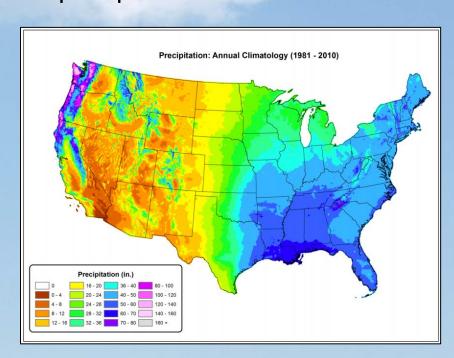
Research Objectives:

- 1) Use recent high-resolution precipitation data to add regional to local scale detail to the precipitation climatology.
- 2) Identify spatially coherent patterns of long-term precipitation change and variability across the region.
- 3) Describe the seasonal evolution of exceptional drought across subregions within the Carolinas.

Data

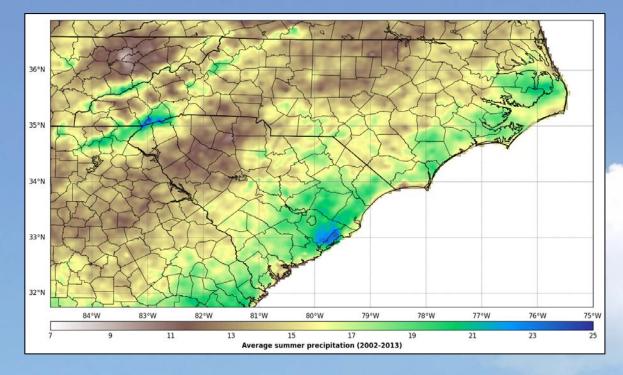
- PRISM (Parameter-elevation Regressions on Independent Slopes Model) is a statistical model that interpolates precipitation from a relatively sparse network of station observations based on changes in elevation across space. Gridded output is available at a 4 x 4 km spatial resolution.
- The spatial resolution of PRISM precipitation fields increases during the period of record spanning 1895 to present as the density of weather observing stations increases.
- The incorporation of radar-derived MPE data into the PRISM model beginning in 2002 has further enhanced the spatial resolution of precipitation fields.

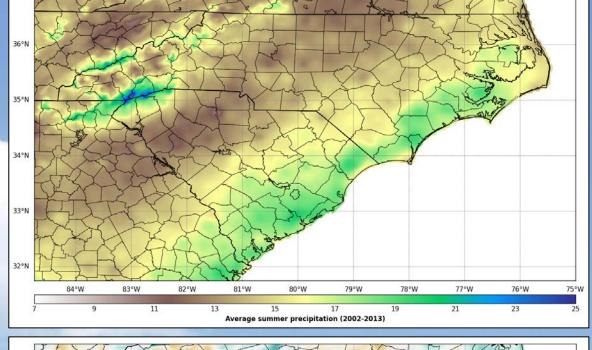




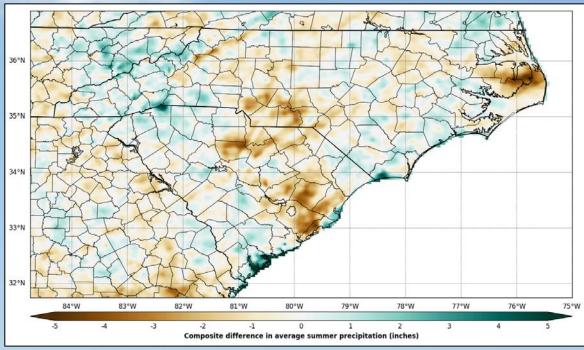
Results

Regional to local variations in precipitation climatology

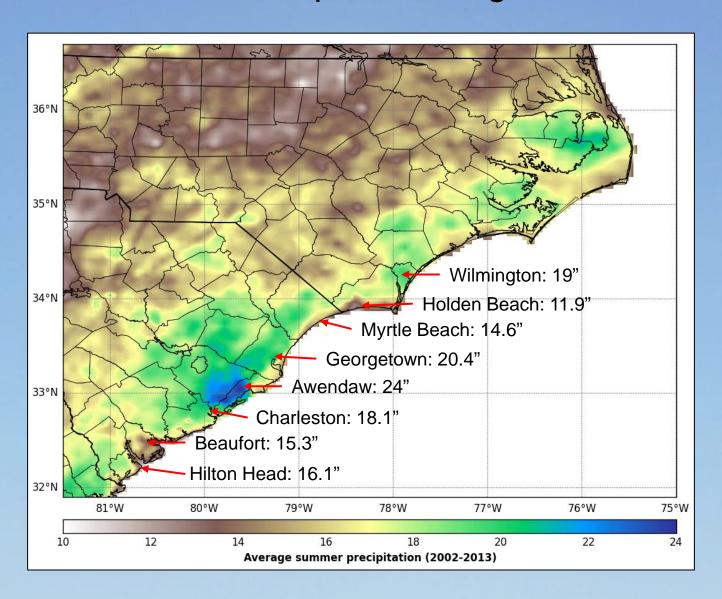




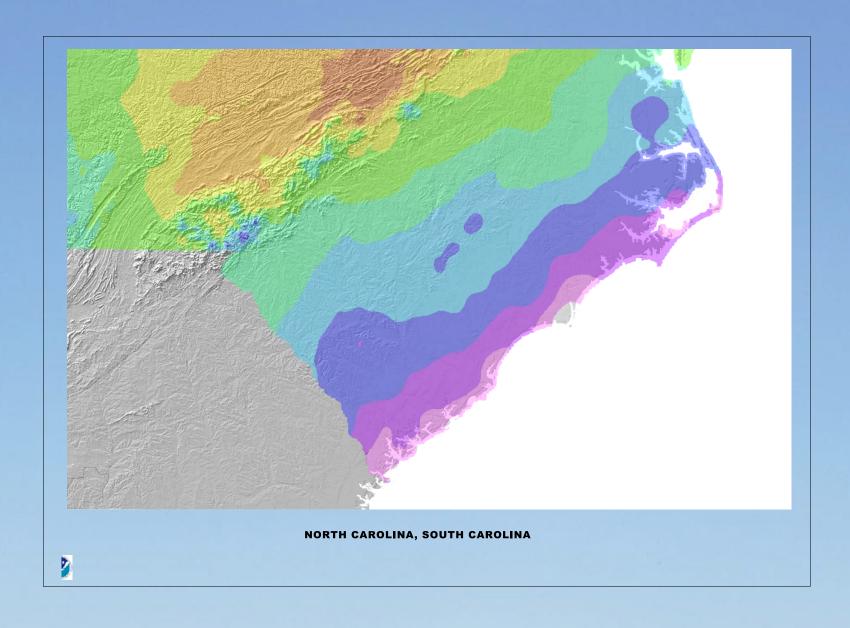
Average summer precipitation (inches) during 2002–2013 based on daily PRISM (top left) and monthly PRISM (top right) data. A composite difference map that subtracts the monthly-scale data from the daily-scale data is shown at bottom right.



Average summer precipitation (inches) over the Carolinas coastal plain during 2002–2013



NOAA Atlas 14: Average one year recurrence interval for 60 minute precipitation



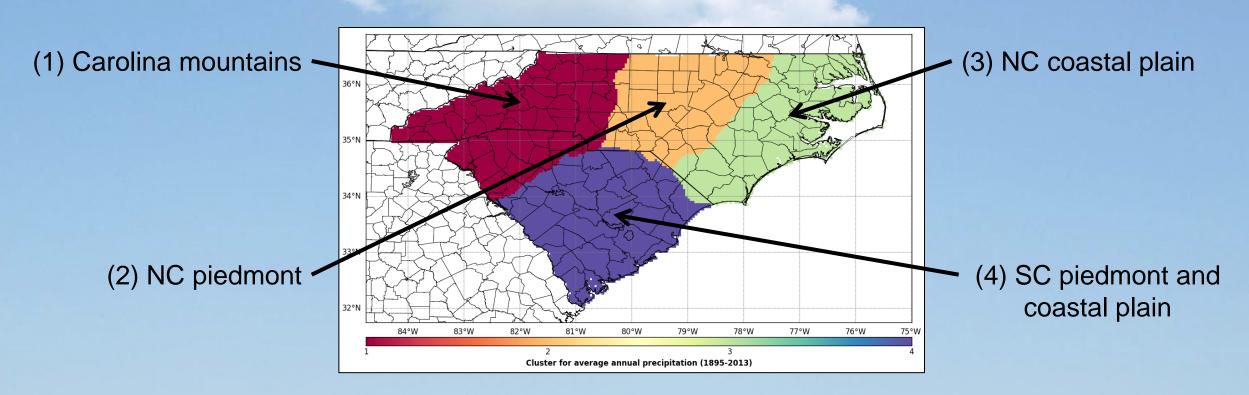
Comparison of daily precipitation estimates from PRISM and station gauges across the Carolinas region from 1981–2013

Results

Spatial patterns of secular precipitation variability

Cluster analysis

- A clustering method that is most suitable for large gridded datasets, known as CLARA (Clustering Large Applications), was used to identify spatially coherent regions in which annual precipitation exhibits similar patterns.
- Average annual precipitation values for each 4 x 4 km pixel within the Carolinas domain were standardized relative to their baseline distribution from 1895–2013.
- For this type of clustering procedure, the user determines the most appropriate number of clusters. After testing for sensitivity, we chose 4 clusters (shown below) since this most closely matches the 4 principal geographic regions of the Carolinas.



Correlation matrices for average seasonal precipitation by cluster

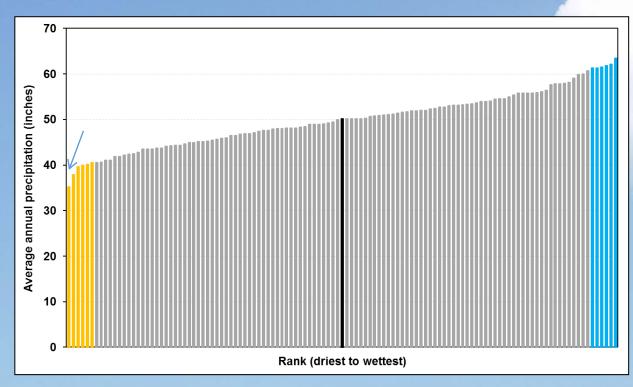
Winter (DJF)				
	Carolina mtns	NC pdmnt	NC coast	SC pdmnt & coast
Carolina mtns	1	0.84	0.67	0.64
NC pdmnt	0.84	1	0.91	0.81
NC coast	0.67	0.91	1	0.86
SC pdmnt & coast	0.64	0.81	0.86	1

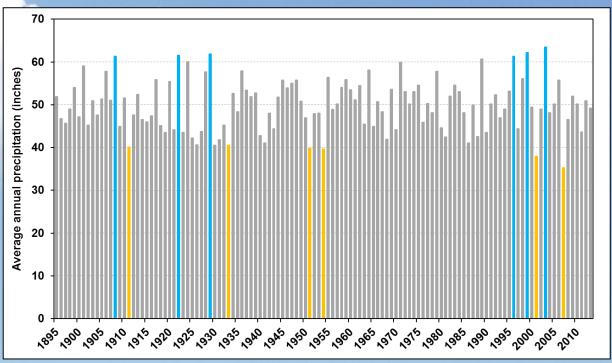
Spring (MAM)					
	Carolina mtns	NC pdmnt	NC coast	SC pdmnt & coast	
Carolina mtns	1	0.80	0.63	0.77	
NC pdmnt	0.80	1	0.88	0.75	
NC coast	0.63	0.88	1	0.73	
SC pdmnt & coast	0.77	0.75	0.73	1	

Summer (JJA)				
	Carolina mtns	NC pdmnt	NC coast	SC pdmnt & coast
Carolina mtns	1	0.79	0.56	0.76
NC pdmnt	0.79	1	0.80	0.71
NC coast	0.56	0.80	1	0.62
SC pdmnt & coast	0.76	0.71	0.62	1

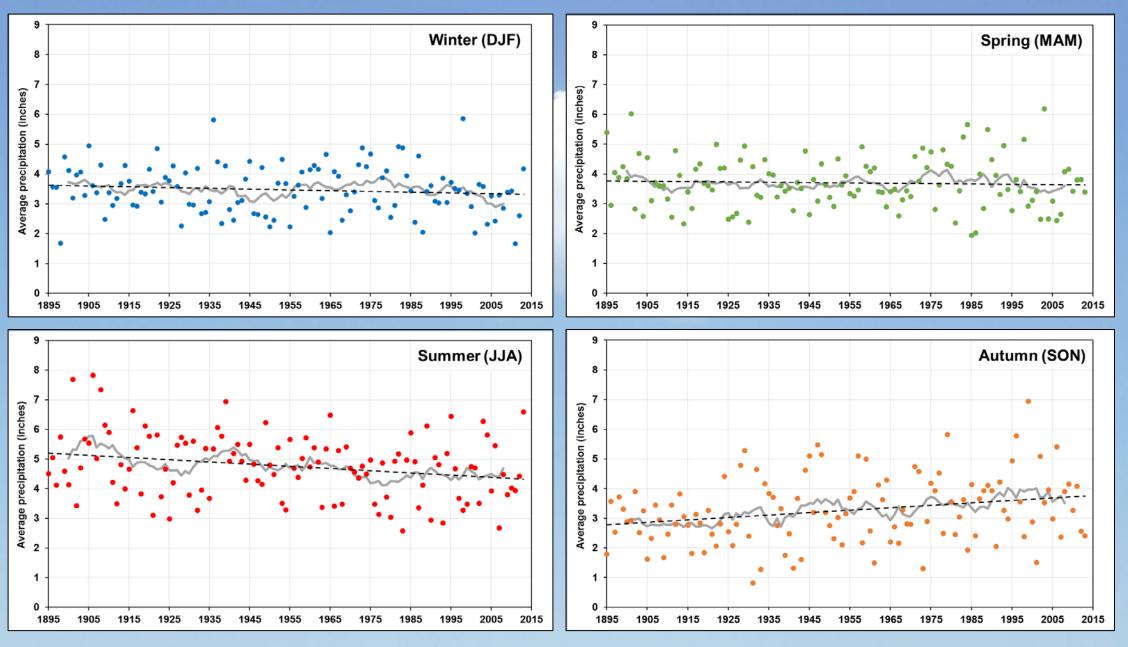
Autumn (SON)				
	Carolina mtns	NC pdmnt	NC coast	SC pdmnt & coast
Carolina mtns	1	0.76	0.53	0.75
NC pdmnt	0.76	1	0.86	0.79
NC coast	0.53	0.86	1	0.67
SC pdmnt & coast	0.75	0.79	0.67	1

Distribution and time series of annual precipitation totals averaged across the NC coastal plain cluster (1895–2013)



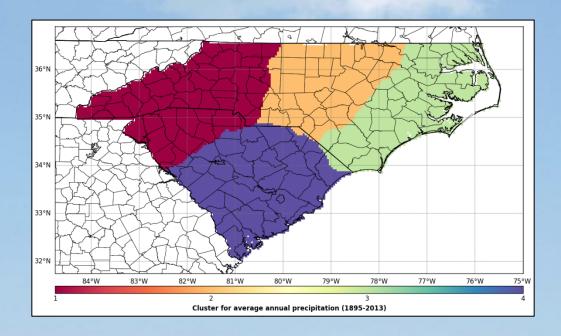


NC piedmont: Scatter plot with linear regression of average precipitation by season (1895–2013)



How does the percent change in average seasonal precipitation vary across the Carolinas from 1895–2013?

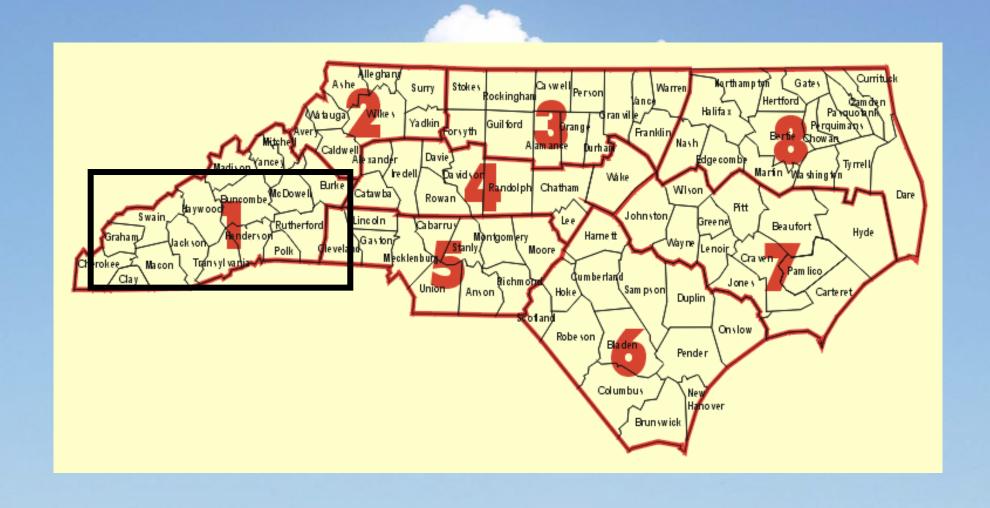
Percent Change in Average Precipitation by Season (1895–2013)				
Cluster	Winter	Spring	Summer	Autumn
Carolina mtns	-6.0%	1.4%	-18.9%	26.8%
NC pdmnt	-7.9%	-3.4%	-17.1%	34.2%
NC coast	-6.6%	-0.3%	-12.5%	37.8%
SC pdmnt & coast	-1.9%	2.3%	-9.8%	20.9%



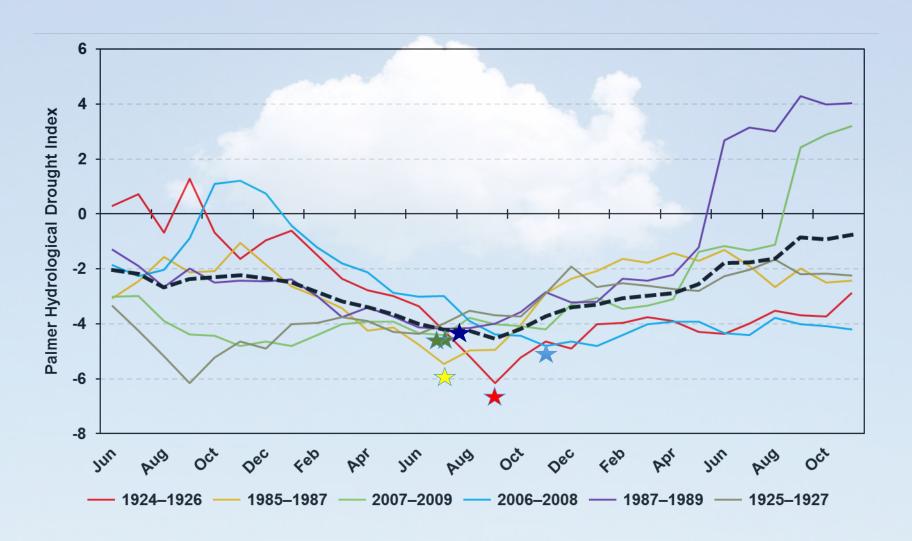
Results

Seasonal evolution of exceptional drought across the Carolinas

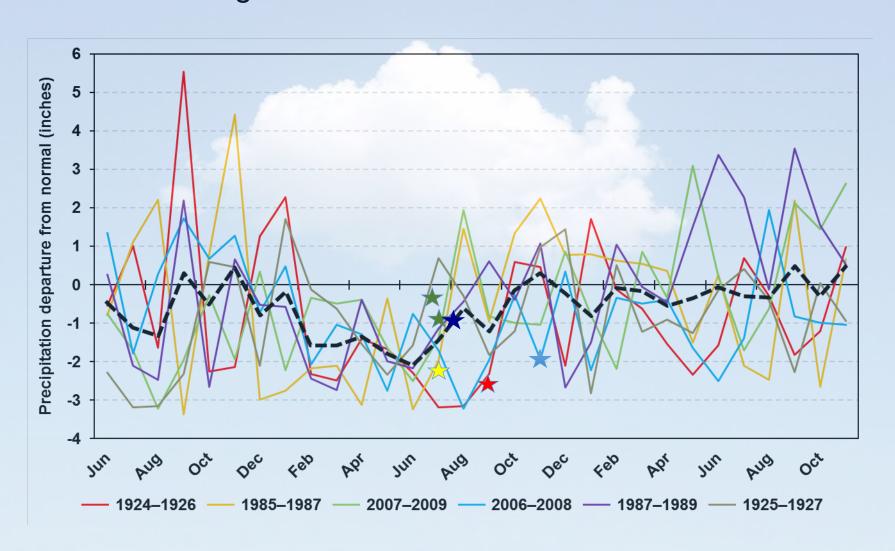
Evolution of extreme hydrological drought



Evolution of the PHDI during the most extreme long-term droughts across the NC Southern Mountains



Monthly precipitation departure from normal during the most extreme longterm droughts across the NC Southern Mountains



Preliminary Findings

- Daily PRISM 2002-2013 reveals that mean summer precipitation is much less along the immediate Carolinas coastline and increases markedly 10+ km inland from the coast.
 This pattern is driven by the sea breeze front and is not present on current climatologies.
- For the Carolinas region as a whole and each of the four sub-regions individually, average precipitation has decreased significantly during the summer and increased substantially during the autumn from 1895–2013. Winter precipitation has decreased slightly and spring precipitation has remained stable during this period of record.
- We are currently examining the seasonal evolution of the most exceptional droughts across the Carolinas.

Questions?

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Acknowledgements



