

Tropical Precipitation Statistics - Methodology

by Dan McKemy

Introduction

Few studies have been conducted on rainfall climatologies associated with tropical cyclones in the Southeastern United States. Meteorologists and climatologists have estimated how much tropical cyclones contribute to annual rainfall by conducting broad studies over a considerable portion of the United States, but nothing has been done on a statewide level that focuses on various regions in that state. This study addresses in detail the rainfall associated with tropical cyclones across North Carolina from 1980-2009 using more than 350 stations.

Methods

Precipitation data was provided by the State Climate Office of North Carolina's CRONOS database. The majority of the station types used for this study were COOP, ECONET, ASOS, and RAWS. Daily precipitation totals were used for all of the stations, even if some of them reported hourly precipitation to keep the data collection methods consistent.

The methods used to determine the tropical cyclone radius and collect precipitation data in this paper are more flexible and accurate compared to research methods by others. For example, both Nogueira and Kiem (2010) and Gleason (2006) used a fixed radius around the center of the storm (500km and 600km, respectively) regardless of a storm's actual size. For this project, each tropical cyclone was analyzed on satellite and/or radar to determine the radius of its precipitation bands, except for 1 tropical cyclone in 1980, where satellite data was not available. Using PHP/MySQL, a program was written that took the radius of the storm at a specific NHC advisory point and pulled precipitation data from stations within that radius. While more labor intensive than using a fixed radius of influence, this method ensures accurate attribution of rainfall to each tropical cyclone. Storms that cover a much larger geographic extent have equal weighting as those storms that have much smaller horizontal scales. This method also ensures that convective thunderstorm activity outside of the influence of the tropical cyclone is not counted as tropically induced. Precipitation totals for tropical rainfall events can then be easily compared to seasonal and annual precipitation totals to quantify the contribution of tropical cyclones to the overall climate.

The NHC issued advisory points every 6 hours (0z, 6z, 12z, and 18z), and the latest point issued for a given day was 18z (as 0z marks the beginning of a new day). To account for the motion of the tropical cyclone, the radius used for the storm was often extended to account for precipitation that fell after 18z for the day in an area.

Precipitation from tropical cyclones that transitioned into extra-tropical storms were included in the database, as long as the NHC had an advisory issued for it. While Nogueira and Kiem (2010) only included rainfall associated with hurricanes and tropical storms, Knight and Davis (2007) included precipitation of tropical cyclones during and after its transition into a extra-tropical cyclone. For some of the storms, the NHC would issue its last advisory early or mid-way through a day, with precipitation occurring after the advisory had been issued. Unfortunately, due to the setup of how the stations recorded precipitation, anything that fell during the day an advisory was issued was included in the database. Additionally, if the tropical cyclone interacted with a front or some sort of boundary, there was no way to easily separate the precipitation that just was associated with the tropical cyclone, and as a result, the enhanced precipitation rates due to the front/boundary were included in the database. We feel this is appropriate as the presence of rainfall in these situations is likely dominated by the proximity of the tropical cyclone as compared to any approaching synoptic forcing.

Results and Discussion

One purpose of this project was to not only analyze how much tropical precipitation contributes to annual rainfall, but also the percentage of tropical precipitation during "hurricane season", or the warm season as labeled in the graphs below (June-November). While tropical cyclones do form before and after the warm season period, they rarely affect North Carolina and have trivial impacts overall. In fact, the only storms to affect North Carolina outside of the warm season period are Tropical Depression #1 (2009) and Andrea (2007) in the past 30 years.

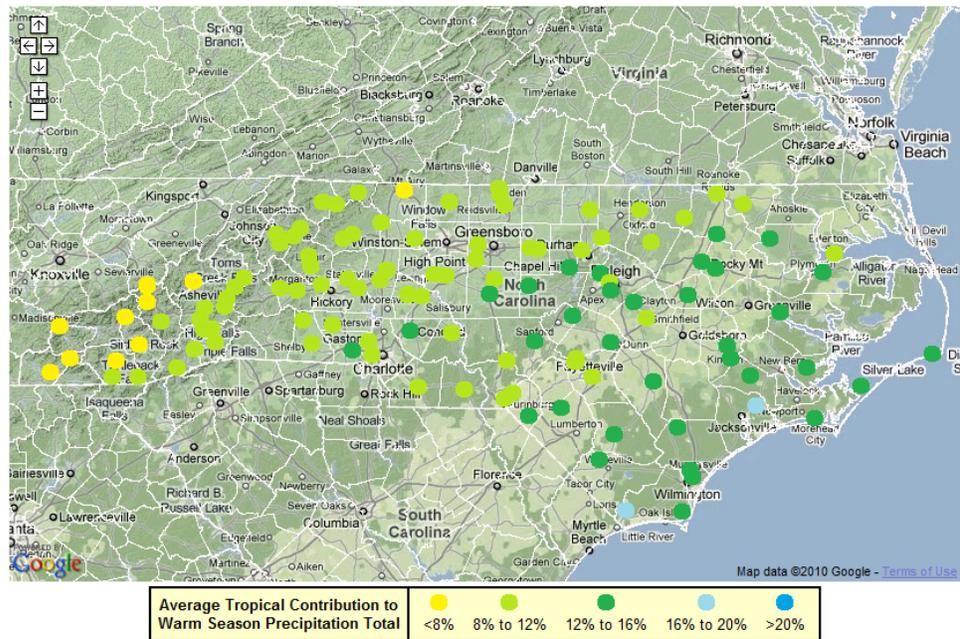


Fig. 1: Contribution of tropical precipitation to the warm season total from 1980-2009. Yellow and light green dots indicate a lower percentage, while dark green and blue dots indicate a higher percentage.

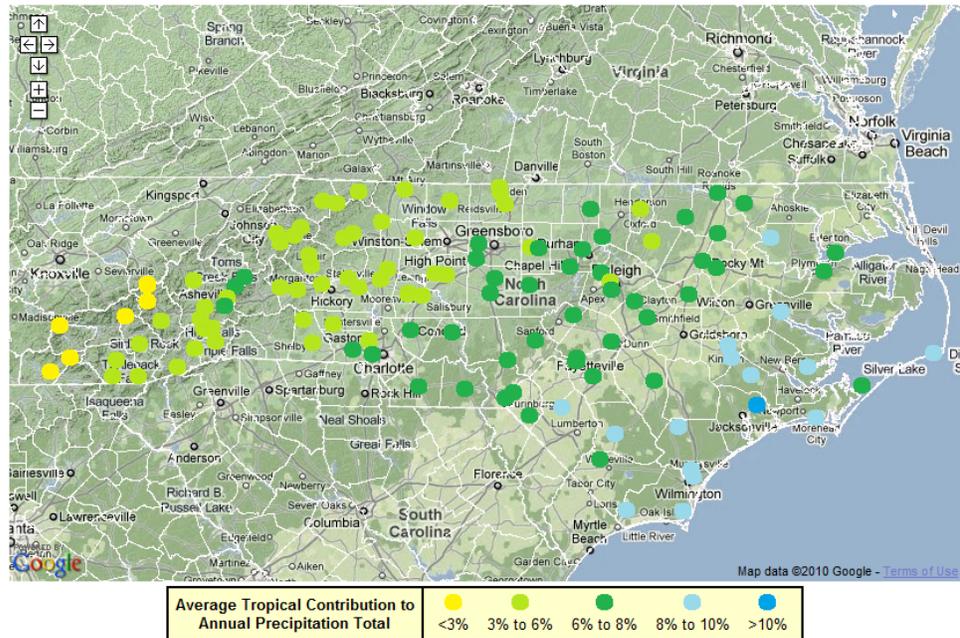


Fig. 2: Contribution of tropical precipitation to the annual total from 1980-2009. Yellow and light green dots indicate a lower percentage, while dark green and blue dots indicate a higher percentage.

Region	Average annual tropical precip.	Percentage of tropical precip. during the warm season	Percentage of tropical precip. during the year	Standard deviation of tropical precip.
Mountains	2.7 in.	8.9%	5.0%	4.4 in.
Piedmont	2.9 in.	11.6%	6.7%	3.4 in.
Coastal Plain	4.1 in.	13.6%	8.2%	4.9 in.
North Carolina	3.3 in.	11.5%	6.7%	4.3 in.

Table 1: Precipitation statistics for 1980-2009.

Figure 1 reveals that the coastal plain of North Carolina receives the most precipitation per year on average than anywhere else across the state, with the mountains ranking last in all of the categories above. Surprisingly, the coastal plain only averages about 3% more tropical precipitation per year than the mountains do (although that 3% amounts to over an inch of extra precipitation). The standard deviation for each region and the state were quite high, and this is due to the irregular year-to-year frequency of tropical cyclones that affect the state.

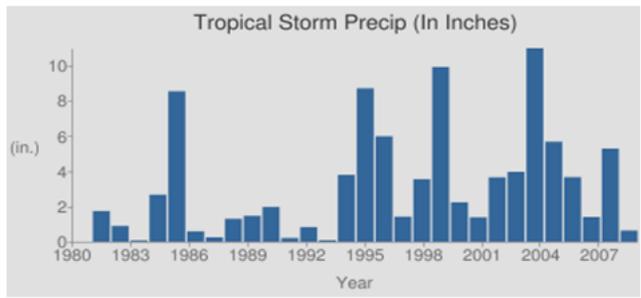


Fig. 3: Average annual tropical precipitation for North Carolina from 1980 to 2009.

Figure 3 demonstrates the irregular frequency of tropical cyclones that affect North Carolina, but there is general pattern that can be made out. Except for 1985, the 1980-1994 period was relatively calm for North Carolina. From 1995-2009, there appears to be an increase in tropical storm precipitation, and the figures and tables below support that notion.

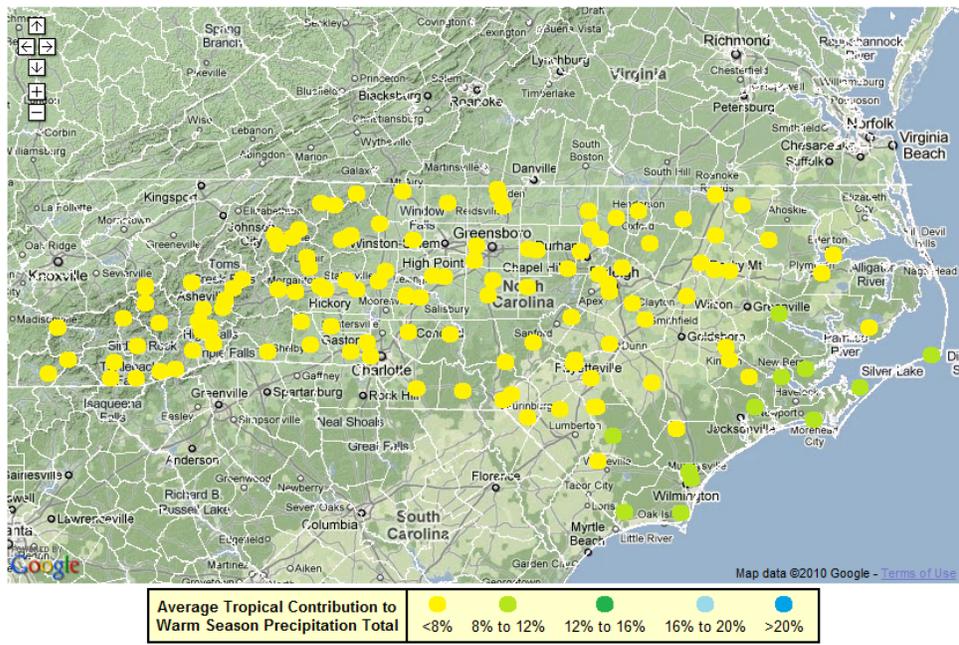


Fig. 4: Contribution of tropical precipitation to the warm season total from 1980-1994. Yellow and light green dots indicate a lower percentage, while dark green and blue dots indicate a higher percentage.

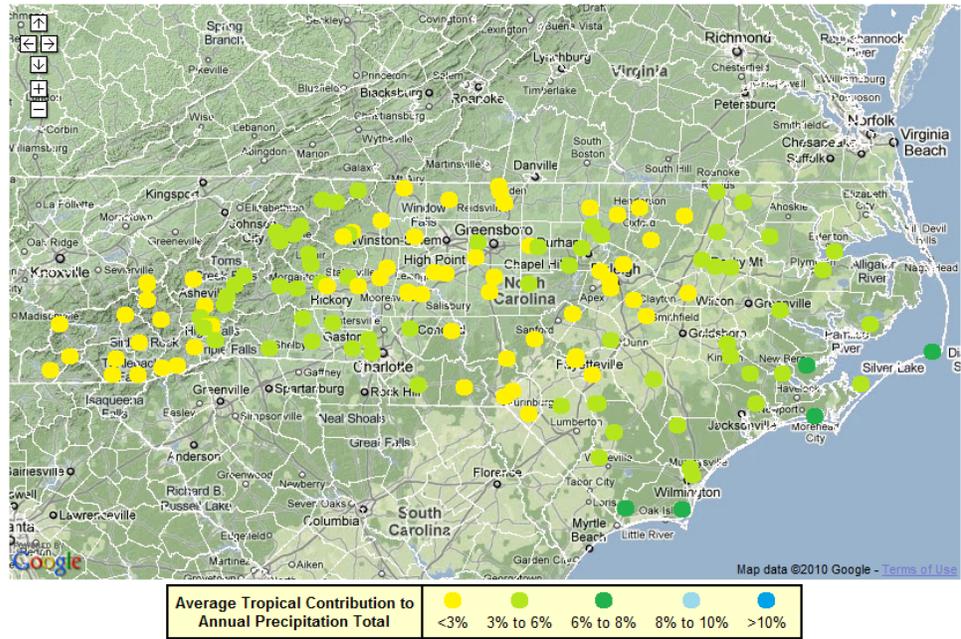


Fig. 5: Contribution of tropical precipitation to the annual total from 1980-1994. Yellow and light green dots indicate a lower percentage, while dark green and blue dots indicate a higher percentage.

Region	Average annual tropical precip.	Percentage of tropical precip. during the warm season	Percentage of tropical precip. during the year	Standard deviation of tropical precip.
Mountains	1.6 in.	5.2%	2.9%	2.8 in.
Piedmont	1.3 in.	5.2%	2.9%	2.2 in.
Coastal Plain	2.0 in.	7.2%	4.2%	3.4 in.
North Carolina	1.6 in.	5.9%	3.4%	2.9 in.

Table 2: Precipitation statistics for 1980-1994.

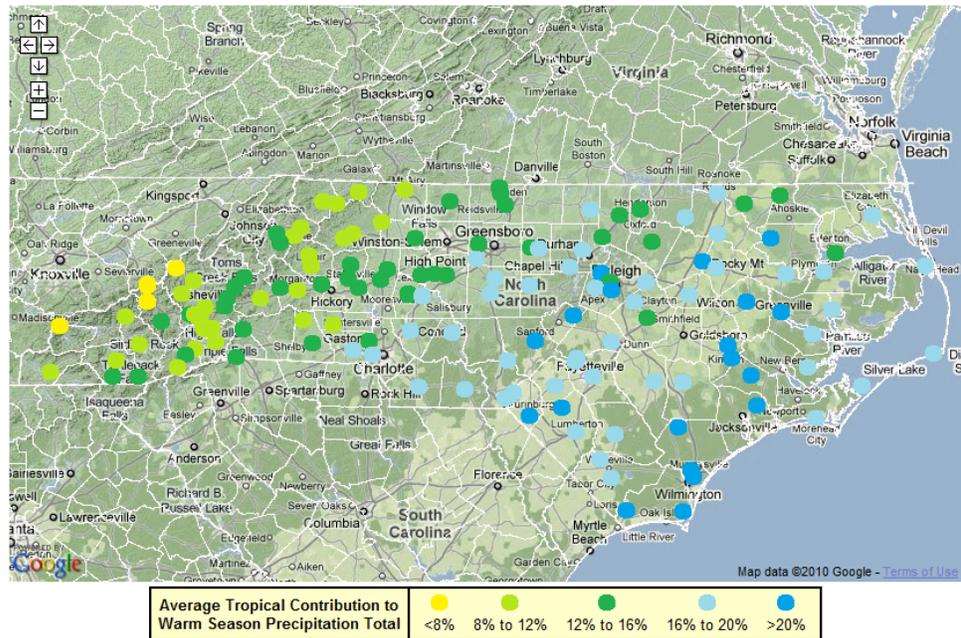


Fig. 6: Contribution of tropical precipitation to the warm season total from 1995-2009. Yellow and light green dots indicate a lower percentage, while dark green and blue dots indicate a higher percentage.

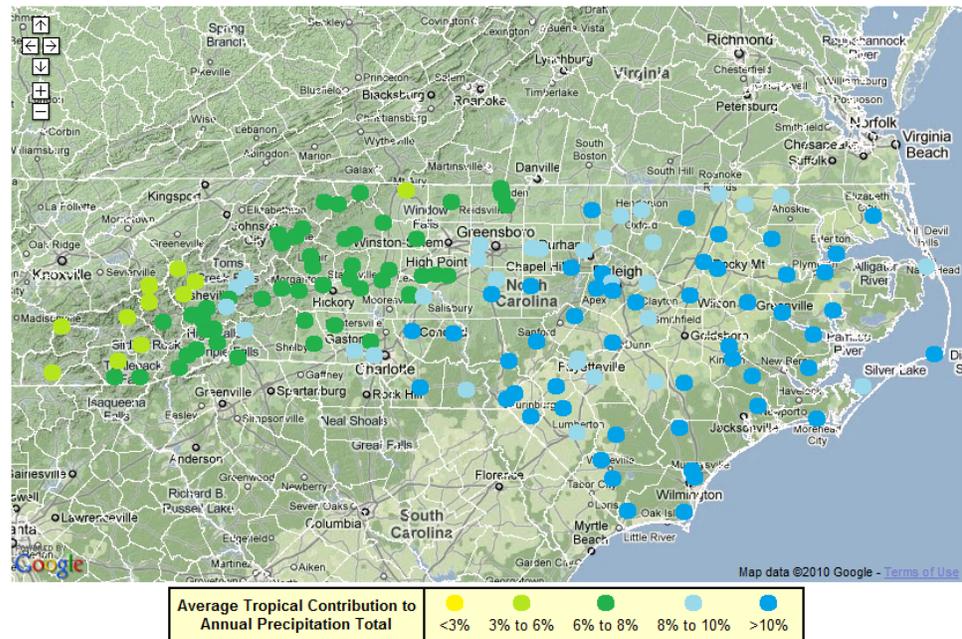


Fig. 7: Contribution of tropical precipitation to the annual total from 1995-2009. Yellow and light green dots indicate a lower percentage, while dark green and blue dots indicate a higher percentage.

Region	Average annual tropical precip.	Percentage of tropical precip. during the warm season	Percentage of tropical precip. during the year	Standard deviation of tropical precip.
Mountains	3.6 in.	11.8%	6.7%	5.1 in.
Piedmont	4.0 in.	15.8%	9.1%	3.6 in.
Coastal Plain	5.4 in.	17.8%	10.8%	5.2 in.
North Carolina	4.4 in.	15.3%	9.0%	4.8 in.

Table 3: Precipitation statistics for 1995-2009.

The two distinct periods have large differences, with warm season precipitation varying as much as 200-300% between the two periods. The average tropical precipitation is two to three times higher in the 1995-2009 period, with the coast having the highest annual average at 5.4 inches. An interesting observation is that the standard deviation for the piedmont remains relatively low compared to the mountains, coast, and the state of North Carolina for all time periods. One likely reason for this may be due to the track of tropical cyclones across Southeast. For example, a tropical cyclone tracking up through the Gulf of Mexico could have its precipitation affect parts of the mountains and western piedmont, but the coast is more than likely going to miss out on most of the precipitation. Another possibility is that a tropical cyclone could track up along the Southeastern U.S. coastline, affecting the coastal plains and piedmont of North Carolina, but leaving the mountains fairly dry. In both situations, the piedmont receives precipitation from the tropical cyclones, leading to lower standard deviation values.

Conclusions

Tropical cyclones have respectable impacts on rainfall climatologies in North Carolina as they can make up anywhere between 8-13% of the warm season precipitation. While the amount of precipitation received per year from tropical cyclones is temperamental, there is a general pattern in which activity has increased over the past 15 years (1995-2009) compared to the previous 15 years before that (1980-1994). This is associated with the general increase in tropical cyclone activities that increased beginning in 1995 and is often associated with the shift in phase of the Atlantic Multidecadal Oscillation.

Future work with this project should expand on the number of states analyzed, with the main goal being to include all of the Gulf Coast, Southeastern, and Mid-Atlantic states. Additionally, data beyond 1980 should be included for future studies so it can be comparable to other articles such as Nogueira and Kiem (2010), which had data from 1960-2007. Having a larger timeframe will also make it more useful to compare active and non-active periods to phases of ENSO, the AMO, and other large scale phenomena that affect global atmospheric circulation. However, there are challenges in collecting accurate precipitation associated only with tropical cyclones in the periods prior to active satellite monitoring.

Acknowledgements

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References

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Appendix

All stations are located in North Carolina

1980-2009 Annual: Tropical contribution to annual precipitation from 1980-2009

1980-2009 Warm Season: Tropical contribution to warm season precipitation from 1980-2009

1980-1994 Annual: Tropical contribution to annual precipitation from 1980-1994

1980-1994 Warm Season: Tropical contribution to warm season precipitation from 1980-1994

1995-2009 Annual: Tropical contribution to annual precipitation from 1995-2009

1995-2009 Warm Season: Tropical contribution to warm season precipitation from 1995-2009

Station	ID	Lat.	Lon.	1980-2009 Annual	1980-2009 Warm Season	1980-1994 Annual	1980-1994 Warm Season	1995-2009 Annual	1995-2009 Warm Season
Albemarle	310090	35.40	-80.20	6.70%	11.50%	2.30%	3.70%	11.10%	19.20%
Andrews	310184	35.20	-83.84	--	--	1.40%	2.70%	--	--
Apex	310212	35.74	-78.84	--	--	--	--	10.60%	18.10%
Arcola	310241	36.29	-77.98	6.60%	11.30%	2.70%	4.50%	10.50%	18.10%
Asheboro	310286	35.70	-79.84	6.80%	12.40%	3.00%	5.50%	10.50%	19.30%
Asheville	310301	35.60	-82.56	4.50%	8.20%	2.50%	4.70%	6.50%	11.70%
Asheville	310724	35.50	-82.60	4.80%	8.50%	3.10%	5.50%	6.60%	11.60%
Aurora	310375	35.39	-76.78	--	--	--	--	10.30%	17.20%
Banner Elk	310506	36.16	-81.87	5.00%	9.00%	3.40%	5.80%	6.70%	12.10%
Bayboro	310576	35.13	-76.82	8.80%	14.20%	6.10%	9.30%	11.50%	19.10%
Belhaven	310674	35.57	-76.58	--	--	--	--	11.10%	18.10%
Bent Creek	311420	35.55	-82.70	--	--	--	--	7.90%	13.80%
Black Mountain	310843	35.61	-82.36	6.10%	10.40%	3.70%	6.80%	8.40%	14.00%
Black Mountain	316236	35.66	-82.35	5.20%	9.20%	3.30%	6.00%	7.10%	12.30%
Blowing Rock	310901	36.15	-81.70	5.10%	8.40%	3.70%	6.30%	6.40%	10.40%
Boone	310982	36.21	-81.64	5.10%	8.60%	3.30%	5.90%	6.80%	11.20%
Brevard	311055	35.23	-82.74	--	--	--	--	7.40%	12.60%
Bridgewater	311081	35.74	-81.84	5.80%	9.80%	3.80%	6.50%	7.70%	13.10%
Brunswick	319354	34.26	-78.69	--	--	--	--	10.30%	17.50%
Burlington	311239	36.06	-79.45	5.60%	10.10%	2.70%	4.90%	8.50%	15.40%
Butner	311285	36.14	-78.77	6.20%	10.70%	3.10%	5.90%	9.20%	15.60%
Buxton	311458	35.23	-75.62	8.50%	14.50%	6.30%	10.70%	10.70%	18.20%
Carthage	311515	35.33	-79.41	7.80%	13.30%	2.90%	4.70%	12.60%	21.80%
Casar	311538	35.50	-81.61	5.00%	8.80%	3.40%	5.90%	6.50%	11.70%
Cataloochee	311564	35.64	-83.10	2.70%	5.30%	1.90%	4.00%	3.40%	6.50%
Catawba	311579	35.74	-81.08	5.00%	8.80%	2.60%	4.50%	7.40%	13.10%
Cedar Island	311606	34.98	-76.30	7.80%	12.70%	5.60%	9.40%	10.00%	16.10%

Celo	311624	35.83	-82.18	6.50%	11.10%	4.00%	7.30%	9.00%	14.80%
Chapel Hill	311677	35.91	-79.08	7.30%	13.00%	3.80%	6.70%	10.80%	19.40%
Charlotte	311690	35.22	-80.96	6.60%	11.80%	3.40%	6.10%	9.80%	17.50%
Clayton	311820	35.64	-78.46	7.10%	12.30%	2.90%	5.60%	11.30%	19.10%
Cleveland	317508	35.70	-80.62	5.30%	9.90%	2.90%	5.30%	7.70%	14.40%
Clinton	311881	35.02	-78.28	7.10%	12.40%	4.30%	7.30%	10.00%	17.50%
Concord	311975	35.42	-80.60	7.10%	12.50%	3.70%	6.70%	10.60%	18.40%
Conover	311990	35.82	-81.19	5.20%	9.80%	3.70%	6.40%	6.80%	13.10%
Coweeta	312102	35.06	-83.43	4.70%	9.20%	2.40%	4.70%	7.00%	13.60%
Cullowhee	312200	35.31	-83.17	3.90%	7.60%	2.20%	4.30%	5.60%	10.90%
Danbury	312238	36.41	-80.22	5.30%	9.30%	2.70%	4.80%	7.90%	13.80%
Dobbins Heights	311913	34.93	-79.62	7.10%	11.80%	2.40%	3.90%	11.80%	19.70%
Dunn	312500	35.32	-78.69	7.10%	12.40%	3.20%	5.20%	10.90%	19.50%
Durham	312515	36.04	-78.96	6.10%	11.20%	3.20%	5.90%	9.10%	16.60%
Eden	312631	36.47	-79.74	4.80%	8.60%	2.30%	4.00%	7.30%	13.10%
Eden	318196	36.52	-79.75	4.80%	8.60%	2.30%	4.00%	7.30%	13.10%
Edenton	312635	36.02	-76.55	7.20%	11.60%	4.30%	7.30%	10.10%	16.00%
Elizabeth City	312719	36.31	-76.20	--	--	--	--	10.10%	16.80%
Elizabethtown	312732	34.60	-78.65	7.90%	13.20%	4.70%	8.10%	11.10%	18.30%
Elkin	312740	36.25	-80.86	4.50%	7.90%	2.80%	5.20%	6.10%	10.60%
Enfield	312827	36.17	-77.68	6.90%	11.80%	3.10%	5.50%	10.80%	18.10%
Enka	312837	35.54	-82.65	--	--	--	--	7.20%	12.00%
Fayetteville	313017	35.06	-78.86	6.20%	10.80%	3.00%	5.40%	9.50%	16.30%
Fayetteville	313168	35.18	-79.02	6.30%	11.00%	2.70%	4.50%	10.00%	17.50%
Fayetteville	316891	35.17	-79.01	--	--	2.50%	4.20%	--	--
Fayetteville	319427	34.84	-78.83	--	--	3.60%	6.30%	--	--
Fletcher	310296	35.43	-82.48	4.80%	8.20%	2.80%	4.90%	6.70%	11.40%
Fletcher	310300	35.43	-82.54	4.80%	8.20%	2.80%	4.90%	6.70%	11.40%
Fletcher	313101	35.45	-82.48	--	--	3.20%	5.70%	--	--
Fletcher	313106	35.43	-82.56	4.90%	8.60%	3.10%	5.30%	6.80%	11.90%
Forest City	313150	35.27	-81.93	--	--	3.90%	7.00%	--	--
Forest City	317906	35.27	-81.93	--	--	3.90%	7.00%	--	--
Franklin	313228	35.18	-83.39	3.70%	7.00%	1.90%	3.60%	5.40%	10.40%
Gastonia	313356	35.27	-81.14	6.90%	12.20%	4.10%	6.90%	9.70%	17.40%
Graham	313555	36.05	-79.37	6.30%	11.30%	3.10%	5.60%	9.40%	16.90%
Grandfather Mountain	313565	36.10	-81.83	5.80%	9.60%	4.10%	6.70%	7.50%	12.50%
Greensboro	313630	36.08	-79.95	6.10%	10.50%	3.20%	5.80%	9.00%	15.20%
Greenville	313638	35.64	-77.40	--	--	--	--	12.70%	21.20%
Hamlet	313784	34.89	-79.69	7.10%	11.80%	2.40%	3.90%	11.80%	19.70%
Henderson	313969	36.35	-78.41	5.60%	10.00%	3.00%	5.00%	8.30%	14.90%
Hendersonville	313976	35.33	-82.45	4.90%	8.80%	3.30%	5.90%	6.40%	11.60%
Hickory	314020	35.74	-81.38	--	--	2.90%	5.20%	--	--
High Point	314063	35.97	-79.97	6.00%	10.60%	2.70%	5.00%	9.30%	16.20%
Highlands	314055	35.05	-83.19	4.70%	8.50%	2.10%	4.00%	7.20%	13.00%
Hot Springs	314260	35.90	-82.83	--	--	--	--	3.50%	6.70%
Jackson	314456	36.40	-77.42	6.30%	10.30%	3.60%	6.10%	9.00%	14.60%
Jackson Springs	314464	35.19	-79.68	6.50%	11.30%	2.40%	3.90%	10.70%	18.80%
Jefferson	314496	36.42	-81.43	5.10%	9.40%	3.80%	6.80%	6.30%	11.90%
Kinston	314684	35.20	-77.54	8.50%	14.10%	4.60%	7.70%	12.40%	20.40%

Kinston	314689	35.30	-77.57	8.60%	14.20%	4.60%	7.50%	12.70%	20.80%
Lake Lure	314764	35.42	-82.19	--	--	--	--	8.40%	14.10%
Lake Toxaway	314788	35.11	-82.96	--	--	3.00%	5.20%	--	--
Laurel Springs	318694	36.39	-81.30	5.30%	8.90%	3.80%	6.90%	6.70%	10.90%
Laurinburg	314860	34.75	-79.47	7.50%	12.70%	2.90%	4.90%	12.00%	20.50%
Lenoir	314938	35.92	-81.54	5.00%	8.70%	3.60%	6.30%	6.40%	11.20%
Lewiston	314962	36.13	-77.17	8.40%	13.90%	4.50%	7.70%	12.40%	20.10%
Lexington	314970	35.85	-80.26	5.10%	9.20%	2.60%	4.80%	7.60%	13.70%
Lexington	319667	35.86	-80.36	5.20%	9.30%	2.40%	4.50%	8.00%	14.20%
Lincolnton	314996	35.46	-81.33	5.20%	9.40%	4.00%	7.10%	6.40%	11.60%
Longwood	315116	34.01	-78.54	9.60%	15.80%	6.10%	10.70%	13.20%	20.90%
Louisburg	315123	36.10	-78.30	5.70%	10.00%	2.30%	4.10%	9.20%	15.80%
Lumberton	315177	34.63	-79.03	--	--	--	--	9.80%	16.70%
Manteo	315303	35.92	-75.70	--	--	--	--	9.60%	16.80%
Marion	315340	35.66	-82.03	--	--	--	--	7.40%	12.00%
Marshall	311437	35.70	-82.77	--	--	--	--	5.90%	11.10%
Marshall	315356	35.80	-82.67	3.80%	7.00%	2.40%	4.00%	5.30%	9.90%
Maysville	314144	34.84	-77.30	10.30%	16.10%	6.00%	9.70%	14.50%	22.50%
Mocksville	315743	35.84	-80.50	--	--	--	--	6.90%	12.90%
Monroe	315771	34.98	-80.52	6.80%	11.50%	3.60%	5.90%	10.10%	17.10%
Morehead City	315830	34.73	-76.74	9.20%	15.20%	6.30%	10.60%	12.10%	19.90%
Morganton	315838	35.73	-81.67	5.10%	9.10%	3.60%	6.30%	6.70%	11.90%
Morrisville	317069	35.87	-78.78	7.60%	13.00%	3.00%	5.60%	12.20%	20.30%
Mount Airy	315890	36.50	-80.65	3.70%	6.40%	2.10%	3.80%	5.20%	9.10%
Mount Holly	315913	35.33	-80.99	5.20%	9.30%	3.20%	5.70%	7.20%	13.00%
Mount Mitchell	315923	35.76	-82.27	6.70%	11.00%	3.80%	7.10%	9.50%	14.90%
Murfreesboro	315996	36.45	-77.08	--	--	--	--	9.10%	14.80%
Murphy	316001	35.10	-84.02	2.40%	4.90%	0.90%	1.60%	3.90%	8.20%
New Bern	316108	35.07	-77.05	--	--	5.50%	9.00%	--	--
New Holland	316135	35.45	-76.21	--	--	4.90%	7.90%	--	--
Newport	319122	35.77	-83.10	2.80%	5.30%	1.90%	3.70%	3.70%	6.80%
North Wilkesboro	316256	36.16	-81.15	4.50%	8.00%	2.90%	5.00%	6.20%	11.10%
Oconaluftee	316341	35.53	-83.31	2.80%	5.60%	1.30%	2.60%	4.20%	8.60%
Oxford	316507	36.30	-78.62	--	--	2.80%	4.80%	--	--
Oxford	316510	36.30	-78.61	--	--	--	--	8.70%	15.60%
Patterson	316602	36.00	-81.56	5.10%	8.70%	3.70%	6.30%	6.50%	11.10%
Pisgah Forest	316805	35.27	-82.65	4.50%	8.10%	2.70%	4.70%	6.40%	11.50%
Plymouth	316853	35.87	-76.66	7.60%	12.80%	4.30%	7.00%	11.00%	18.60%
Pope AFB	315275	35.20	-79.02	6.30%	11.00%	2.70%	4.50%	10.00%	17.50%
Pumpkin Center	315420	34.83	-77.30	10.30%	16.10%	6.00%	9.70%	14.50%	22.50%
Raleigh	316091	35.92	-78.57	--	--	2.30%	4.30%	--	--
Raleigh	317074	35.73	-78.68	7.60%	12.80%	2.20%	4.00%	12.90%	21.60%
Raleigh	317079	35.79	-78.70	5.80%	9.90%	2.30%	4.20%	9.20%	15.60%
Randleman	317097	35.82	-79.79	6.20%	11.10%	3.00%	5.30%	9.30%	16.90%
Red Springs	317165	34.81	-79.16	8.00%	13.70%	3.70%	6.50%	12.30%	20.90%
Reidsville	317202	36.38	-79.69	4.70%	8.40%	2.10%	3.80%	7.20%	12.90%
Rhodhiss	317229	35.77	-81.44	5.60%	10.00%	4.20%	7.30%	7.00%	12.70%
Roanoke Rapids	317319	36.48	-77.67	6.60%	11.30%	3.50%	6.10%	9.80%	16.50%
Rocky Mount	317395	35.95	-77.82	7.80%	13.30%	3.10%	5.50%	12.40%	21.00%

Rocky Mount	317400	35.89	-77.68	7.30%	12.40%	3.30%	6.00%	11.30%	18.80%
Rosman	317486	35.13	-82.82	4.50%	8.10%	2.60%	4.60%	6.30%	11.60%
Rougemont	317499	36.21	-78.86	--	--	3.10%	5.60%	--	--
Roxboro	317516	36.35	-78.89	6.50%	11.60%	2.80%	4.80%	10.30%	18.50%
Salisbury	317615	35.68	-80.48	5.70%	10.50%	1.90%	3.80%	9.40%	17.20%
Salisbury	317618	35.70	-80.62	5.30%	9.90%	2.90%	5.30%	7.70%	14.40%
Sanford	317656	35.53	-79.05	7.70%	12.90%	2.70%	4.50%	12.80%	21.30%
Shelby	317845	35.31	-81.53	5.20%	9.20%	3.80%	6.40%	6.60%	12.10%
Siler City	317924	35.76	-79.46	7.00%	12.80%	3.40%	5.80%	10.60%	19.80%
Silver City	317056	34.99	-79.22	--	--	--	--	10.90%	19.00%
Smithfield	317994	35.52	-78.35	6.10%	10.60%	2.90%	5.50%	9.20%	15.80%
Southport	318113	33.99	-78.01	9.80%	15.40%	6.20%	9.90%	13.40%	20.90%
Sparta	318158	36.48	-81.09	5.30%	9.10%	3.40%	6.40%	7.10%	11.70%
Statesville	318292	35.81	-80.88	5.20%	9.40%	2.90%	5.40%	7.50%	13.40%
Tapoco	318492	35.46	-83.94	2.40%	4.70%	1.00%	1.90%	3.80%	7.50%
Tar Heel	311449	34.83	-78.80	--	--	3.60%	6.30%	--	--
Tarboro	318500	35.88	-77.54	--	--	3.20%	5.80%	--	--
Taylorsville	318519	35.92	-81.17	--	--	--	--	6.70%	12.50%
Trenton	318706	35.06	-77.35	8.60%	14.10%	4.60%	7.60%	12.70%	20.60%
Tryon	318744	35.21	-82.25	--	--	--	--	7.80%	14.20%
Turnersburg	318778	35.89	-80.81	4.80%	8.50%	2.20%	4.00%	7.40%	13.10%
Wadesboro	318964	34.96	-80.08	6.20%	10.40%	2.60%	4.20%	9.90%	16.60%
Warsaw	319081	35.01	-78.00	--	--	--	--	11.60%	20.00%
Washington	319100	35.56	-77.07	9.30%	15.60%	5.10%	8.40%	13.50%	22.70%
Waterville	319123	35.77	-83.10	2.80%	5.30%	1.90%	3.70%	3.70%	6.80%
Waynesville	319147	35.49	-82.97	4.60%	8.90%	2.30%	4.80%	6.80%	13.00%
Wendell	319923	35.79	-78.35	--	--	--	--	9.10%	16.10%
Whiteville	319357	34.41	-78.79	7.10%	12.40%	3.90%	6.80%	10.30%	18.10%
Wilkesboro	319406	36.15	-81.18	--	--	3.30%	5.70%	--	--
Wilkesboro	319555	36.13	-81.23	4.60%	8.10%	2.90%	5.00%	6.20%	11.30%
Willard	319423	34.66	-78.05	8.10%	13.80%	4.40%	7.30%	11.90%	20.30%
Williamston	319440	35.85	-77.03	--	--	--	--	12.30%	19.50%
Wilmington	319457	34.27	-77.90	9.30%	14.70%	5.10%	8.40%	13.50%	20.90%
Wilmington	319467	34.32	-77.92	9.30%	15.10%	5.40%	9.10%	13.20%	21.00%
Wilson	319476	35.69	-77.95	7.00%	12.20%	2.70%	5.10%	11.30%	19.30%
Yadkinville	319675	36.13	-80.55	4.60%	8.30%	2.30%	4.20%	6.90%	12.50%