**Introduction**

- Temperature and Precipitation are two important components to assess climate variability.
- Historic monthly climate variability was analyzed for North Carolina, USA.
- North Carolina has one of the most complex climates in the United States. The average temperature varies more than 20°F from the lower coast to the highest elevation in all the seasons of the year. Average annual temperature on the southern part of the lower coast is nearly as high as that of interior southern Florida, while the average on the summit of Mount Mitchell is lower than that of Buffalo, NY (Bisalome, 2005).
- Maximum temperature (Tmax), minimum temperature (Tmin), and precipitation were analyzed for 249 ground-based stations in North Carolina for the period 1950-2009. The significance and magnitude of the trends of the periods were determined using non-parametric Mann-Kendall (MK) test and Theil-Sen Approach (TSA), respectively. The Sequential Mann-Kendall (SQMK) was also applied to find the initiation of abrupt trend changes.

**Study Area, Datasets and Tools**

- The statewide climate variability was evaluated for 249 ground-based stations in North Carolina for the period of 1950-2009.
- The Sequential Mann-Kendall (SQMK) was applied to find the initiation of abrupt trend changes.
- Logistic regression analysis was used to adjust the serial correlation prior to the application of MK test and TSA approach (von Storch, 1995).

**Results and Discussion**

**Trend test by Mann-Kendall (MK):**

- The MK test is one of the most widely used non-parametric tests to detect trends in hydro-meteorological series. The MK test can detect the trend even in the presence of serial correlation (see von Storch, 1995).
- The data sets were analyzed for North Carolina, USA. The MK test is widely used to test the null hypothesis of no trend against the alternative hypothesis of trend. The test statistic ZMK is calculated as follows:

\[
Z_{MK} = \frac{T - \frac{1}{2}}{\sqrt{\frac{T(T-1)}{12N}}}
\]

where T is the number of data points, N is the number of time periods, and ZMK is the standard normal test statistic (ZS).

- Rejection of the null hypothesis at the 95% (99%) confidence level requires ZMK to be greater than 1.96 (2.57). If the null hypothesis is rejected, a trend is detected.

**Trend magnitude by Theil-Sen Approach (TSA):**

- The Theil-Sen Approach is a robust method for estimating trend magnitude in hydro-meteorological series. It is insensitive to outliers or extreme values and competes well against simple least squares even for normally distributed data in the time series.

**Trend magnitude by Sequential Mann-Kendall (SQMK):**

- The SQMK test is an extension of the MK method that is widely used to detect trends in hydro-meteorological series. The SQMK test is applied in the Precipitation data series for the month of May accounting for the whole period of 1950-2009 in North Carolina.

**Conclusions**

- In this monthly scale historic trend analysis, Tmax showed more pronounced decreasing trends than increasing and vice versa for Tmin.
- The statistically significant trend results were used to develop spatial distribution of trends. Month of May for maximum temperature, June for minimum temperature, and February for precipitation was chosen and represented spatially.
- Overall, increasing/decreasing trends for precipitation are not significant in North Carolina.

**References**