Future Variations in Cool Season Precipitation along the US East Coast

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Cool season, coastal cyclones are capable of producing heavy snow, high winds, and inland flooding, resulting in catastrophic damage along the highly populated northeastern U.S. coastal region. Future variations in storm frequency, track and the associated precipitation will qualitatively and quantitatively alter these regional impacts, influencing the safety of local residents as well as local water resources. Therefore, it is important to understand the variations of these high impact events in the future to allow for adequate preparation. Towards this end, the presented work will focus on anticipated variations in cool season precipitation over the Northeast.

Coupled Model Intercomparison Project Phase 5 (CMIP5) data was used to evaluate the distribution and frequency of cool season (November to March) precipitation over the northeastern U.S. during both the past and future. To assess the ability of the CMIP5 data to capture regional precipitation characteristics, fourteen CMIP5 models were compared with the Climate Prediction Center (CPC) Unified precipitation (0.5^{o} resolution) and the CPC merged precipitation analysis (2.5^{o} resolution), for the 1979-2005 historical period. For this 26-year period, the CMIP5 mean accurately reproduces the offshore precipitation maximum associated with the western Atlantic storm track, as depicted in the CPC merged analysis, though the CMIP5 mean over predicts the maximum by 50-150 mm. Over the Northeast, the high resolution Unified dataset shows a ~500 mm precipitation maximum along the coast, with values decreasing inland to ~375 mm. The CMIP5 mean over predicts the regional precipitation by ~100 mm (20%), and is unable to capture finer scale features associated with modifications from lakes and terrain. The over prediction may be due to the tendency for the CMIP5 to over predict higher precipitation events, especially those resulting in >10 mm day^{-1} of regional precipitation. Spatially, the CMIP5 accurately reproduces the coastal maximum and regional gradient.

To assess future regional precipitation variations, the mean CMIP5 precipitation analyses over the historical period was compared to three future periods; the early 21^{st} century (2009-2038), mid-21^{st} century (2038-2068), and late 21^{st} century (2069-2098). In the early 21^{st} century, Northeast precipitation increases 5-10% (10-30 mm), though by the late 21^{st} century, Northeast precipitation increases by 80-120 mm (15-20%). Much of this increase is likely due to a greater number of relatively heavy precipitation events, with a reduction of the <1mm day^{-1} events and an increase in the >25 mm day^{-1} events in the future. The CMIP5 mean suggests a 50% increase in >25 mm day^{-1} events during the early 21^{st} century with a 400-500% increase by the late 21^{st} century, indicating a dramatic increase in extreme precipitation events in the next 50-75 years.

Future efforts will utilize numerical simulations to evaluate the dynamic and thermodynamic contributions to these regional changes in precipitation, including variations in the track, intensity, and frequency of coastal winter cyclones as well as anticipated variations in atmospheric moisture.