EXAMINING THE SENSITIVITY AND IMPACT OF ANTHROPOGENIC CLIMATE CHANGE ON NORTH ATLANTIC MAJOR HURRICANE MAJOR HURRICANE LANDFALL DROUGHT AND ACTIVITY

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INTRODUCTION

Anthropogenic forcing has increased in prevalence in the past several decades, as recent years in the past decade yield some of the warmest sea surface temperatures on record in the main development region of the North Atlantic Ocean. Anthropogenic climate change has been known to decrease weaker tropical cyclone (TC) frequencies, but increase intense TC frequencies.

In the North Atlantic Ocean, there was a great contrast in major hurricane landfall (MHL) activity in the last two decades: 2004 and 2005 experienced very active seasons (3 and 5 MHL), while there were no MHL after the 2005 hurricane season until the active 2017 hurricane season during which 3 MHL occurred. This raises questions as to how anthropogenic climate change will influence the MHL frequencies and potential droughts in the future.

METHODOLOGY

As documented in Hart (2016), MHL frequency depends on how landfall is defined. To assess MHL sensitivity to the Atlantic Coast of the US, 6 different "buffers" were created using QGIS that extend the coastline. There distances range from 0 km to 500 km and alter the definition of a hurricane making landfall. As opposed to the coastline, if a hurricane's center passed through the buffer, it was considered to have made landfall. To examine which buffer distance most similarly estimates MHL frequency to observational data, referenced hurricane data from 1900-2015 was run through all six buffers and MHL frequencies were compared between the buffers and referenced observational data from NHC.

To analyze the impact of anthropogenic forcing on MHL frequency, the high-resolution HiFLOR model was utilized. Three groups were analyzed with all six buffers: observational data from 1900-2015, a 1990 control (300-year simulations taking anthropogenic forcing taken into account), and an 1860 control (1,200-year simulation taking pre-industrialization conditions into account. MHL drought frequencies were recorded in 116-year moving means to account for the different time frames of each group. It was hypothesized that the 1990 control would illustrate a greater frequency of longer MHL droughts than the 1860 control because the drought from 2005-2017 occurred during years in which anthropogenic climate change played a key role.

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CONCLUSION

Landfall and MHL frequencies were largely dependent on buffer distance, supporting Hart's reasoning that an arbitrary definition of landfall leads to a change in frequencies. The 200 km buffer illustrated MHL frequencies that were most similar to the reference recorded data between 1900-2015. The mean yearly MHL frequency and correlation between year and MHL frequency is closest to the observational reference with the 200 km buffer than any other buffer.

In most cases, the high-resolution model underestimates MHL frequencies and overestimates MHL droughts. Regardless the general trends of MHL droughts are present among all buffers. The 1990 control depicts fewer frequencies of long MHL droughts than the 1860 control. This indicates that the HiFLOR model does not support an association between anthropogenic forcing and an increase in frequency of MHL drought events.

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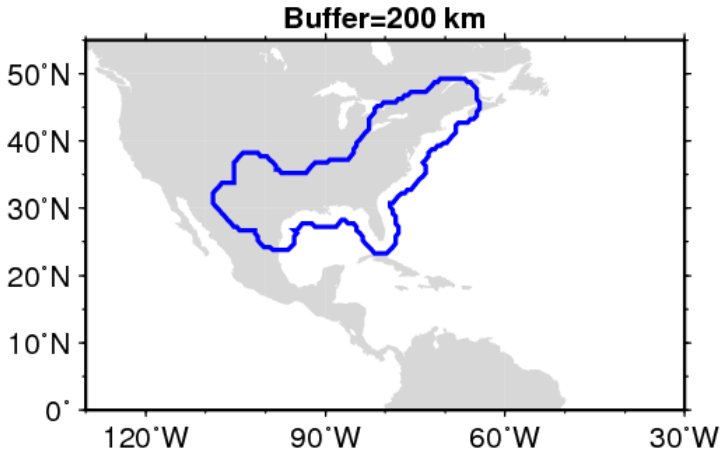

Fig. 1. A depiction of the 200 km buffer. When a hurricane's center passes over the blue line, it is considered to have made landfall.

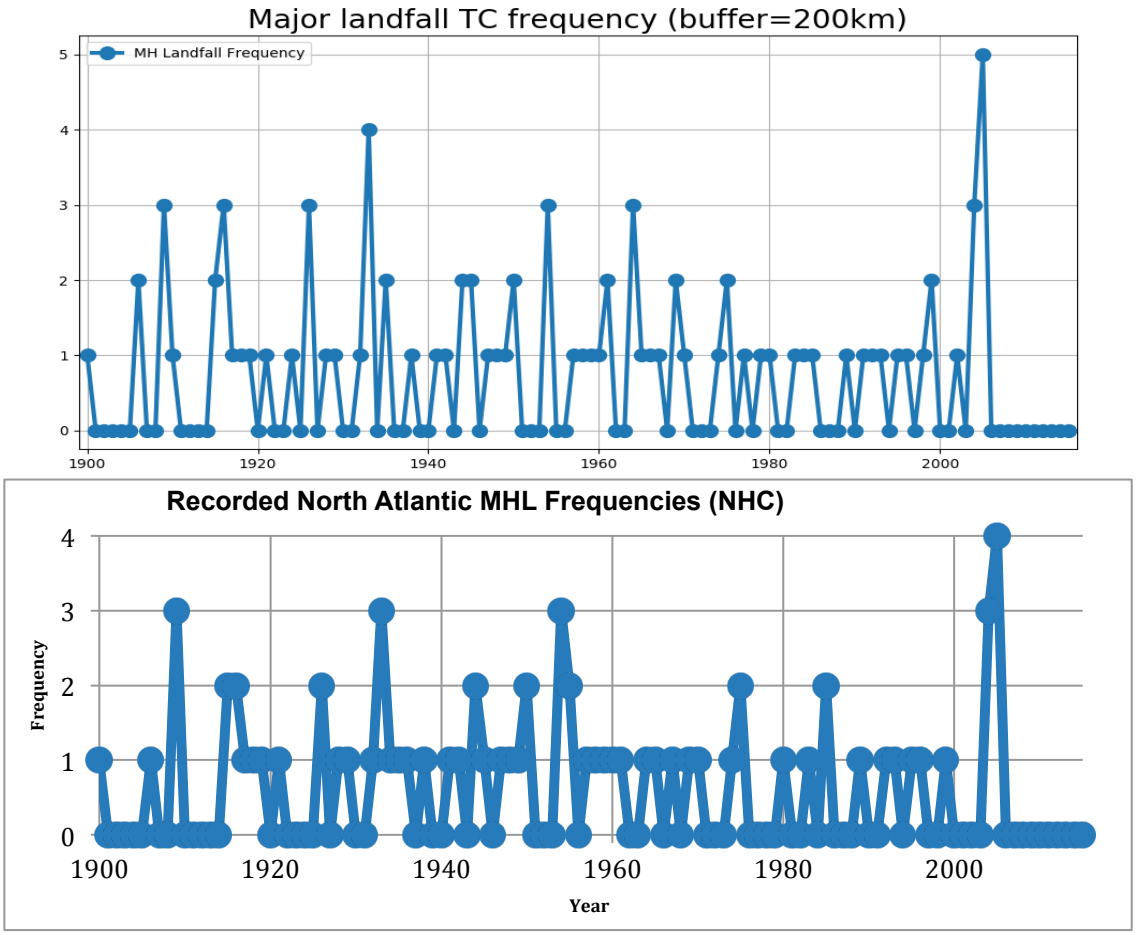

Fig. 2. The MHL frequencies between 1900 and 2015 as predicted by the 200 km buffer and (top) and the observational reference MHL frequencies (bottom).

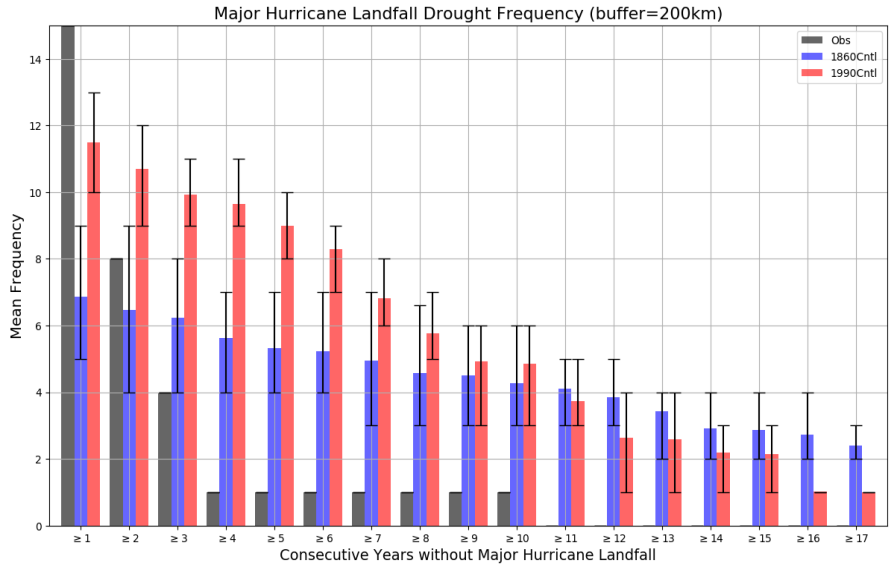

Fig. 3. The HiFLOR MHL drought frequencies for all three groups. Note how the model groups (red and blue) overestimate the MHL drought frequencies and how the 1860 control depicts a greater frequency of MHL droughts longer than 11 years than the 1990 control.