WRF SIMULATIONS OF THE ONSET OF THE 2009 CONVECTIVE SEASON IN THE SOUTHEAST UNITED STATES

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Abstract

Isolated precipitation features (IPF) are short-lived, small, and spatially heterogeneous features that are most predominant during the summertime in the southeast United States. They are thermodynamically driven and comprise 30%-50% of the total summer precipitation. Using radar data and a precipitation organization classification algorithm, Rickenbach et al. (2015) established that the springtime transition to predominantly IPF occurs abruptly between the months of March and June. The goal of this study is to investigate whether the Weather Research and Forecasting model (WRF) is able to capture the observed springtime transition to increased IPF and shed light on the mechanisms for the shift. WRF simulations for March through June 2009 will be run using a set-up similar to that in Nissenbaum (2016). The results of this study will then be used to study the effect of climate change on the abrupt onset of the IPF rainy season in the southeast United States.

Keywords – precipitation organization, regional climate modeling

1. INTRODUCTION

The southeast United States receives rainfall throughout the year. In winter, the region is dominated by precipitation associated with synoptic scale baroclinic systems (Rickenbach et al., 2015) whereas in summer localized precipitation events are more dominant (Rickenbach et al., 2015). Rickenbach et al. (2015) created a precipitation feature organization climatology using National Mosaic and Multi-Sensor QPE (NMQ) radar data. They classified precipitation features by size into mesoscale precipitation features (MPF) that are larger than 100 km and smaller isolated precipitation features and used their results to uncover an abrupt increase in isolated precipitation features (IPF) that occurs in late May over the southeast United States. The study proposed herein will use the Weather Research and Forecasting (WRF) model created by the National Center for Atmospheric Research and the National Center for Environmental Prediction (NCEP) to develop a better understanding of this abrupt transition.

2. DATA SETS AND METHODOLOGY

Wells (2018) used NMQ radar data between the months of March and August from 2009-2012 to study the onset of the IPF convective season in the southeast United States. She showed that onset dates vary by region and from year-to-year across the southeast United States. The year of 2009 had the clearest onset especially over southern Florida (Wells, 2018). Generally, onset was seen over the southeast United States to begin in May or June (Wells, 2018). Therefore, in order to capture the onset of the 2009 convective season in the southeast United States, the WRF simulations will run from March through June 2009. Details of the datasets, modeling approach, and precipitation feature algorithm can be found below.

2.1 Data Sets

The WRF simulation will use Global Forecast System (GFS) reanalysis dataset to obtain the model boundary conditions, which is provided by the National Oceanic and Atmospheric Administration's National Centers for Environmental Information (NCEI) and has a 0.5° (~55 km) resolution with 6-hour output. The sea surface temperatures will be provided by NCEP's real-time, daily global sea surface temperature (RTG-SST) dataset with a 0.5º global resolution.

2.2 Methodology

WRF-ARW version 3.9 will be run on the Cheyenne supercomputer in Boulder, CO. The parent domain will cover North America and the adjacent oceans with a 27-km horizontal resolution. Two smaller 9-km and 3-km resolution will be nested inside the parent domain. The 9-km resolution will be centered over the continental United States and the 3-km resolution will be centered over the southeast United States. The simulation will have 50 vertical layers and the complete list of the physics options is visible in Table 1. This follows the work by Nissenbaum and Nieto-Ferreira (2016) except for the microphysics scheme for domain 3. Previous work completed by Sikder & Hossain (2016) and Samala et al. (2011) showed a higher accuracy in precipitation using the Thompson microphysics scheme. Local testing by rerunning the model completed by Nissenbaum and Nieto-Ferreira

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(2016) showed a slight accuracy increase for the capturing of precipitation.

	Domain 1	**Domain 2**	**Domain 3**
Grid Spacing	27 km	9 km	3 km
Microphysics	WRF Single Moment 3	WRF Single Moment 3	Thompson
Cumulus Parametrization	Betts-Miller-Janjic	Betts-Miller-Janjic	Betts-Miller-Janjic
Land-Surface	Noah	Noah	Noah
Radiation	RRTMG	RRTMG	RRTMG
Boundary Layer	Yonsei	Yonsei	Yonsei

TABLE 1: DETAILS ON WRF GRID AND CORRESPONDING PARAMETRIZATIONS

2.3 Precipitation Feature Identification Algorithm

The precipitation feature identification algorithm that will be used was developed by Rickenbach et al. (2015). The algorithm analyzes 15-minute WRF precipitation fields and identifies continuous features with a rain rate above 0.5 mm/h (Nieto Ferreira, Nissenbaum, & Rickenbach, 2018). Features greater than 100 km in size are classified as MPF (Nieto Ferreira, Nissenbaum, & Rickenbach, 2018). Features smaller than 100 km in size are classified as IPF (Nieto Ferreira, Nissenbaum, & Rickenbach, 2018). The algorithm will be applied to the precipitation from the 3-km domain.

3. CONCLUSION

This study will develop a better understanding of the abrupt transition to the convective season in the southeast United States. Using WRF, the months of March through June 2009 will be simulated. The precipitation feature algorithm developed by Rickenbach et al. (2015) will be applied to the WRF precipitation fields to study the change in types of precipitation features. This study will later provide a baseline for comparison with a future climate scenario simulation to study the effect of climate change on precipitation features and convective season onset in the southeast United States.

4. REFERENCES

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