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Tornado outbreaks associated with landfalling hurricanes in the north Atlantic Basin: 1954–2004

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With 10 Figures

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Summary

Tornadoes are a notable potential hazard associated with landfalling hurricanes. The purpose of this paper is to discriminate hurricanes that produce numerous tornadoes (tornado outbreaks) from those that do not (nonoutbreaks). The data consists of all hurricane landfalls that affected the United States from the North Atlantic basin from 1954 to 2004 and the United States tornado record over the same period. Because of the more than twofold increase in the number of reported tornadoes over these 51 years, a simple least-squares linear regression (“the expected number of tornadoes”) was fit to the annual number of tornado reports to represent a baseline for comparison.

The hurricanes were sorted into three categories. The first category, outbreak hurricanes, was determined by hurricanes associated with the number of tornado reports exceeding a threshold of 1.5% of the annual expected number of tornadoes and at least 8 F1 and greater tornadoes during the time of landfall (from outer rainbands reaching shore to dissipation of the system). Eighteen hurricane landfalls were classified as outbreak hurricanes. Second, 37 hurricanes having less than 0.5% of the annual expected number of tornadoes were classified as nonoutbreak landfalls. Finally, 28 hurricanes that were neither outbreak nor nonoutbreak hurricanes were classified as midclass hurricane landfalls.

Stronger hurricanes are more likely to produce tornado outbreaks than weaker hurricanes. While 78% of outbreak hurricanes were category 2 or greater at landfall, only 32% of nonoutbreak hurricanes were category 2 or greater at landfall. Hurricanes that made landfall along the southern coast

of the United States and recurved northeastward were more likely to produce tornadoes than those that made landfall along the east coast or those that made landfall along the southern coast but did not recurve. Recurvature was associated with a 500-hPa trough in the jet stream, which also contributed to increased deep-layer shear through the hurricane, favoring mesocyclogenesis, and increased the low-level shear, favoring tornadogenesis. The origin of the hurricane, date of landfall, and El Niño-Southern Oscillation phase do not appear to be factors in outbreak hurricane creation. The results of this study help clarify inconsistencies in the previous literature regarding tornado occurrences in landfalling hurricanes.

1. Introduction

Wind damage, storm surges, and inland flooding are hazards faced by coastal communities in the southern and eastern United States due to landfalling hurricanes. Neumann et al (1999) found that the United States Atlantic and Gulf coasts experience an average of 1.7 landfalling, or near-landfalling, hurricanes per year. Hurricane-related property losses accounted for nearly 40% of all insured losses in the United States from 1984 to 1993, exceeding earthquake losses by a factor of four (Pielke and Pielke, 1997).