A Comparison of the Wind Fields in Hurricane Edna (1954) and Hurricane Juan (2003)

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1. Introduction

Hurricane Juan will go down in the books as one of the great weather disasters of Nova Scotian history. The storm unleashed its fury on the woodlands of central Nova Scotia causing massive tree blowdowns that amounted to approximately one billion board feet of timber loss in the short span of just a few hours (source: Nova Scotia Department of Natural Resources – NSDNR). The last "big blow" that many of the "old timers" tell me about occurred in 1954 with Hurricane Edna. That storm destroyed approximately 0.7 billion board feet of timber across Nova Scotia, but over a much larger area than Juan. The fact that trees were in full, green foliage during these storms greatly increased the impacts, especially when you factor in the amount of deciduous trees in the urban areas and the combination of uprooted trees falling onto power lines.

In this short paper I will compare these two very different storms and discuss the most significant inland impacts of tree blowdowns. In terms of overall timber loss the difference between Edna and Juan is not all that great, but when one looks at the structure of the wind field in each storm, the differences become more apparent. Hurricane Juan was a much more compact storm when it crossed Nova Scotia, and the significant impact was felt within approximately 150 km from the storm center track. On the other hand, Hurricane Edna was a much larger storm, and the center was nowhere near Nova Scotia. Edna tracked over central New Brunswick, but the damaging winds occurred out to approximately 500 km from the storm center track. Hurricane Edna was rapidly undergoing extratropical transition to a large mid-latitude storm unlike Juan, which was a strong, compact hurricane.

2. Synoptic History

(a) *Hurricane Edna*

The track for Edna based on National Hurricane Center (NHC) best track data is shown in Fig. 1a. Edna formed east of the Caribbean Leeward Islands and moved around the outer periphery of the island chain while reaching category-three intensity just off the Bahamas. Edna then skirted along the U.S. Eastern Seaboard, clipping Cape Cod as a category-one hurricane and making landfall near Bar Harbour, Maine, while undergoing extratropical transition. Edna raced across central New Brunswick with a forward speed near 50 knots.

(b) *Hurricane Juan*

The track for Juan from the NHC best track data is shown in Fig. 1b. Juan was a much shorter-lived storm, and formed at a higher latitude (28^{o}N) than Edna (11^{o}N). Juan therefore had less time to intensify, but still reached category-two strength. As Juan moved northward it came under the influence of a stronger deep-layered mean flow, which accelerated the storm toward Nova Scotia. Juan arrived in Nova Scotia just west of Halifax as a marginal category-two hurricane, travelling at approximately 30 knots as it crossed the province.

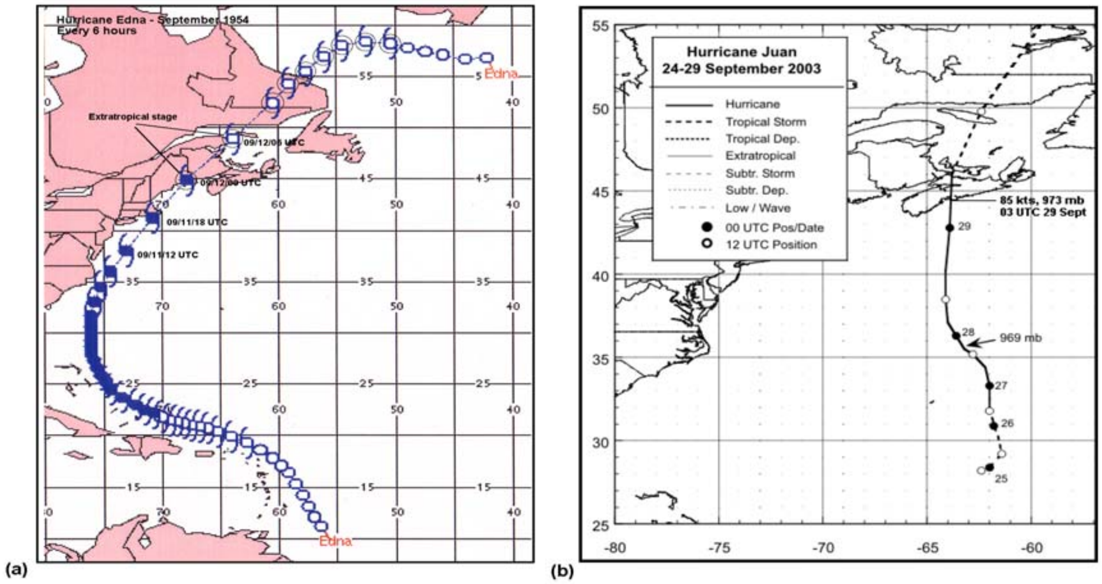

Fig. 1. NHC best track maps for (a) Hurricane Edna and (b) Hurricane Juan

3. Upper-level Analyses

Fig. 2 shows the 500-mb analyses from the National Center for Environmental Prediction (NCEP) for Hurricanes Edna and Juan. The flow patterns differ considerably between the two cases. For example, Edna appears well embedded in the 500-mb flow contours while Juan is just moving into the region of stronger flow. The 500-mb pattern for Edna is certainly characteristic of a storm in mid extratropical transition. Note that Edna was moving to the northeast at 50 knots at this time while Juan was moving about 30 knots at landfall. The proximity of the mid-latitude trough is much farther west in the case of Juan.

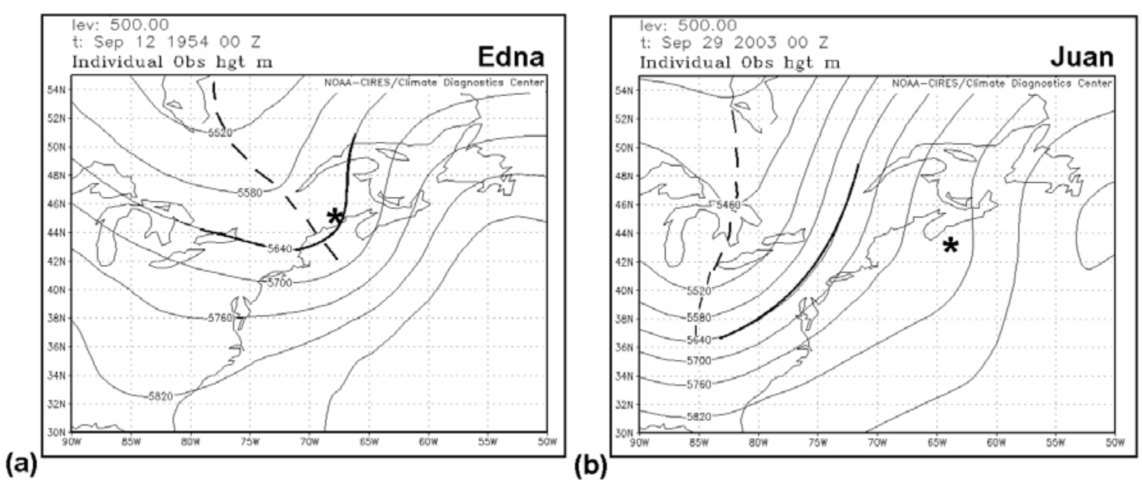

Fig. 2. 500 mb geopotential height (m) from NCEP reanalyses for (a) Edna and (b) Juan. The asterisk shows the position of the surface low. The 564-dam contour is highlighted for comparison. The primary mid-latitude trough is shown as a dashed line.

4. Analyses of Wind and Pressure Fields

Surface weather plots and manual sea level pressure analyses of Edna and Juan are shown in Fig. 3. The maps show each storm near the time of landfall. Note the drastic difference in the size of these storms. Edna (Fig. 3a) is clearly a much larger storm with the tightest pressure gradient situated over mainland Nova Scotia and well away from the center of the low. Juan, on the other hand (Fig. 3b), is a much more compact storm and the tightest pressure gradient is confined to the central Atlantic coast of Nova Scotia.

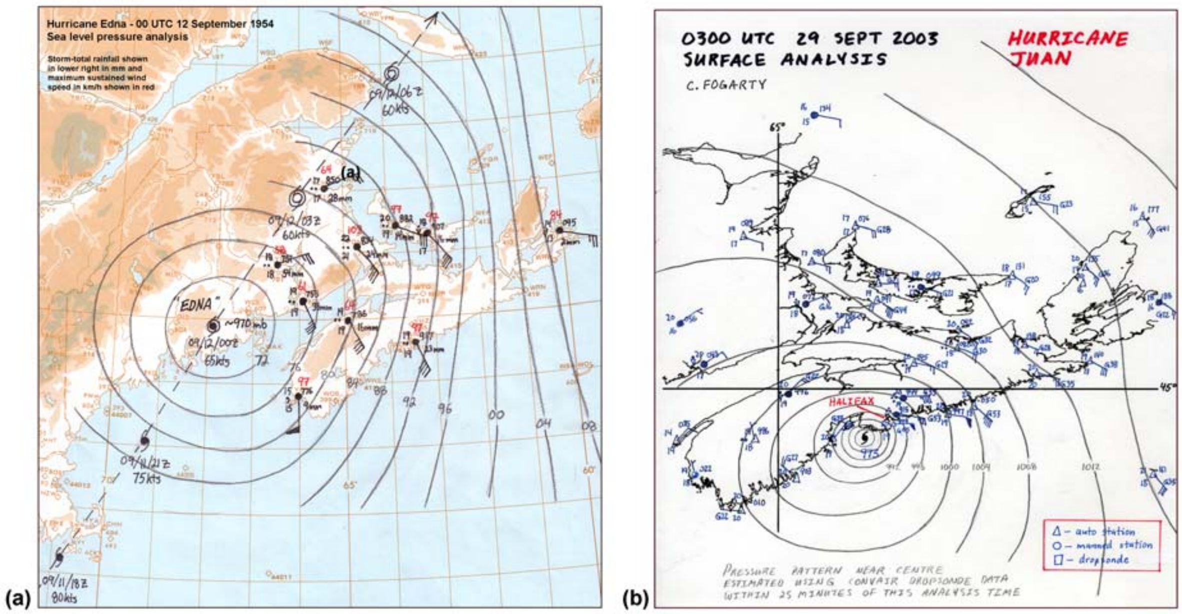

Fig. 3. Surface weather maps and sea level pressure analyses for (a) Hurricane Edna and (b) Hurricane Juan. The red numbers in (a) are the highest sustained wind speeds in km/h for each of the stations throughout the storm. Some dropsonde data from a research flight were incorporated into the Juan plot (b). Storm-total rainfalls are also plotted in (a).

During Hurricane Juan, the highest winds were reported just east of the storm track. For example, at Shearwater (YAW), the maximum winds were 100 gust 130 km/h, at Halifax International (YHZ) they were 100 gust 142 km/h and at Charlottetown 94 gust 139 km/h. The highest winds from a land station were at McNab's Island in Halifax Harbour with winds of 151 gust 176 km/h. In Edna, the wind gust data are not available, but the maximum sustained winds in the storm were 97 km/h at four stations (Yarmouth and Shearwater, Nova Scotia, and Charlottetown and Summerside, Prince Edward Island). Moncton, New Brunswick reported maximum sustained winds of 103 km/h. In terms of the sustained winds, there seems to be little difference between the storms. It is clear that these winds were more widespread in Edna. Near the storm track in Fredericton and Saint John, New Brunswick, winds were only sustained at 60 km/h and likely gusted to 80 or 90 km/h. This would normally be enough to break a few large tree braches, but nothing like what was happening further east. If Hurricane Juan's wind field were overlaid onto Edna's track, one would find the worst winds over the Saint John and Fredericton areas. Based on my experience here in Nova Scotia, one can expect to see trees being uprooted when winds are sustained around 80 km/h and gusting to hurricane force (120 km/h).

5. Conclusions

Here you can see clearly different storms occurring around the same time of year (September) with differing wind fields, yet producing comparable magnitudes of tree fall damage. The aerial extent of high winds is much larger in the Hurricane Edna case than Hurricane Juan. Given the total amount of tree damage per unit area based on NSDNR estimates, Hurricane Juan was characterized by more extreme and localized damage – more trees fallen per unit area, if you will. We saw after Juan that there were many large patches of woodlands completely flattened as if a giant foot had stomped upon the earth. I am not familiar with what the tree damage patterns in Edna would have been like, but it would be reasonable to assume that there were fewer large swaths of downed trees, but a wider expanse of tree clusters and individual trees downed. Nonetheless, Edna was certainly one of the most memorable hurricane-related storms in Nova Scotia in the latter half of the 20th century.

From a weather forecasting perspective, these two events represent a realistic range of forecast problems regarding the expanding wind field of a hurricane undergoing extratropical transition. In the case of Juan, the significant wind threat/damage extended from 20 km left of to 150 km right of the storm track while in Edna, the threat/damage was from approximately 100 to 500 km right of the track. The most interesting observation, which prompted me to compare/contrast these two cases, was that extreme wind damage occurred in a situation where winds were not associated with the eyewall of the hurricane. Clearly the winds in Edna that swept across Nova Scotia were not eyewall winds, yet were due to combined effects of a rapidly-moving cyclone whose wind field was expanding radially-outward into an area of high pressure to the east. The isobars (and air parcel trajectories) follow generally straight lines on the right side of the storm in this example of extratropical transition. The centrifugal component of the wind field is essentially absent in this case, thereby permitting higher surface winds for a given pressure gradient than for the same gradient in highly curved flow as in the hurricane core or on the left side of a rapidly-moving cyclone.

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