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AN ANALYSIS OF THE RECORD-BREAKING 9-10 NOVEMBER 1996 RAINFALL IN THE SAINT LAWRENCE AND CHAMPLAIN VALLEYS

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1. INTRODUCTION

The purpose of this research is to understand the thermodynamic and dynamic processes associated with extreme cold-season precipitation events in extratropical latitudes.

An excellent example of such an extreme case is that of 9-10 November 1996. Montreal (Dorval) received its all-time record 24-h precipitation amount of 134 mm. Considerable flloding occurred in both the Saint Lawrence and Champlain Valleys. A precipitation analysis for this period (not shown) indicates a broad region of approximately 100,000 km^2 that extends northward from upstate New York into central Quebec, with amounts exceeding 80 mm.

The relatively large-scale character of such an event (Fig. 1a) suggests that synoptic-scale circulation features may play a significant role in defining such this event.

2. ANALOGS

An improved understanding of such a record-breaking precipitation event may be derived by a comparison with another event defined by relatively similar synoptic-scale features.

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The relatively long record of data currently available from the National Centers for Environmental Prediction (NCEP) reanalysis (Kalnay et al. 1996) allows a reasonable chance that good analogs for such an event may be found.

We compute anomaly correlation (AC) fields (Roebber and Bosart 1998; Gyakum and Roebber 2001) for sea-level pressure (SLP) and 1000-500 hPa thickness in the region encompassed by 110°-50°W and 25°-65°N. The anomalies of SLP and thickness are computed with respect to a 30-year (1967-96) NCEP reanalysis monthly climatology. The search was conducted for the months of September through Feburary, for the 34-year period of 1963 through 1996.

We find four analogs, whose anomaly correlation values exceed 0.60. The best of these AC values is 0.81 for the case of 11 November 1977. The excellent large-scale agreement is illustrated with a comparison of the SLP and 1000-500 hPa thickness fields (Fig. 1).

Each case is characterized by a strong meridionally-oriented thickness trough with a large-scale surface trough extending through New England and coastal regions of the United States. Strong flanking surface anticyclones are found in southern Texas and in the northwestern North Atlantic basin in each case. Relatively strong southerly geostrophic surface flow is indicated from the middle Atlantic coast northward into Labrador.

However, a comparison of area-averaged precipitation amounts reveals substantially different results.

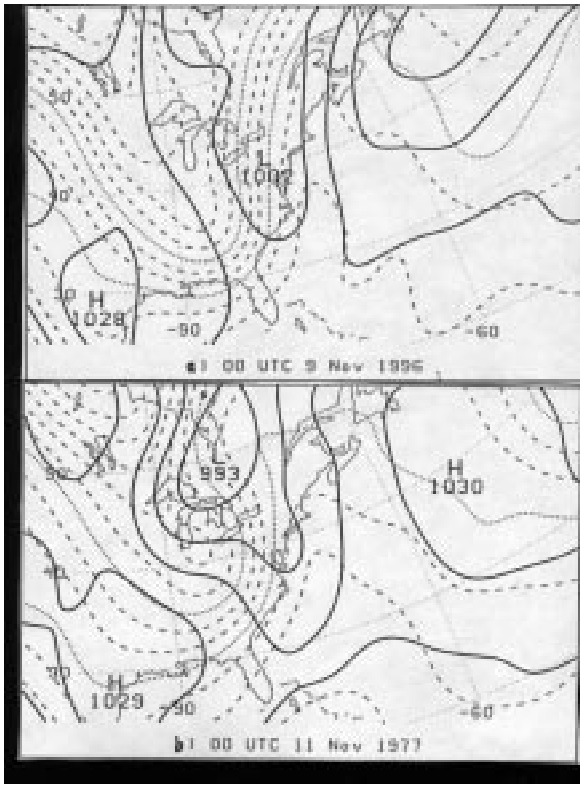

Figure 1. Sea-level pressure fields (solid, 8-hPa contour interval) and 1000-500 hPa thickness fields (dashed, 6-dam contour interval) for (a) 0000 UTC 9 November 1996 and (b) 0000 UTC 11 November 1977. The 540- and 558-dam thickness contours are dotted.

The largest precipitation amount recorded for the analog of 11 November 1977 was 35 mm. The area-averaged amount in the analog was only 20 mm, compared with 75 mm for the Saint Lawrence River Valley (Durnford 2001).

Although the large-scale patterns are very similar, there are important mesoscale details that are likely to be important in distinguishing the extreme event of 9 November 1996 from its more benign analog of 11 November 1977.

First, a mesoscale low center developed in a region of strong surface frontogenesis to the southwest of the primary heavy precipitation during the 1996 case. The primary surface circulation in the 1977 case was located approximately 200 km to the northwest.

Second, the precipitable water values throughout the Saint Lawrence Valley were at least 10 mm larger in the 1996 case (about 35 mm) than in the 1977 case.

Third, there were stronger and more coherent structures of water vapor transport into the Saint Lawrence Valley region from the southeast during the 1996 case than in the 1977 event.

Fourth, there is larger synoptic-scale ascent, associated with weaker stratification in the 1996 case than is occurring in the 1977 event.

Although all of these distinguishing factors are generally well known to the forecaster, identifying these and other crucial mesoscale details from the conventional forecast guidance remains a challenge. Our future work focuses on the identification and quantification of these mesoscale details.

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