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Atmospheric Research 83 (2007) 36 – 54

ATMOSPHERIC RESEARCH

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On the precipitation and related features of the 1998 Ice Storm in the Montréal area

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Received 30 October 2005; received in revised form 31 December 2005; accepted 28 March 2006

Abstract

A major freezing rain storm causing catastrophic losses occurred in early January 1998 over eastern Canada and the northeastern United States. The types of precipitation and associated precipitation structures of this storm are described and discussed with a particular emphasis on the Montréal area. Using operational Doppler radar as well as other information, it is shown that a variety of precipitation types (snow, freezing rain, ice pellets and rain) occurred. The characteristics and overall organization of precipitation structures varied considerably and, in some instances, these were linked with topographic features. Hydrometeor growth often occurred within the storm almost down to the surface. The two periods of significant freezing accumulation were characterized by more organized precipitation than at other times. Other major storms over the region have illustrated a similar pattern of precipitation types (snow, freezing rain, ice pellets and rain), implying comparable organizational processes. In addition, pronounced lightning activity occurred of both negative and positive polarity in association with different phases of precipitation.

Keywords: 1998 Ice Storm; Radar observations; Freezing rain; Precipitation structures; Lightning

1. Introduction

Winter storms commonly occur over Canada and the United States. Such storms bring precipitation in the form of snow, rain, freezing rain and ice pellets, and they often cause major problems for society. There continues to be a substantial amount of research conducted on these storms, but the amount is far less than that focused on severe summer weather. However, there is a growing recognition that winter storm issues need to be studied in more detail (Cortinas et al., 2004). For example, the United States is in the process of developing a winter storm research program (Ralph et al., 2005). This program has identified some of the key American priorities spanning scales from the storms' large-scale environment to their small-scale internal structure and precipitation. In Canada, there is an awareness of the impact of winter storms and the types of storms that occur (Stewart et al., 1995), but there is not yet an organized program to examine these events.

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0169-8095/$ - see front matter © 2006 Published by Elsevier B.V.
doi:10.1016/j.atmosres.2006.03.006

The importance of winter storms was certainly clear in the wake of the January 1998 Ice Storm that caused huge problems to eastern Canada and the northeastern United States. Freezing precipitation fell between January 4 and January 10, 1998 and brought particular hardship to the Montréal area. The Ice Storm seriously affected the electricity supply to 3.5 million people, shut down transportation, restricted emergency services, and damaged farms, trees and personal property. The longest residential blackouts lasted 33 days and 80% of the trees on Montréal's Mount Royal were damaged. The mobilization of the Canadian Armed Forces for relief effort was the largest humanitarian assistance mobilization in the country's history (Abley, 1998). There were an estimated 28 deaths in Canada and 19 in the United States (Klaassen et al., 2003) and $4 billion US of damage caused by the Ice Storm in Canada and the United States (Cortinas, 2000) with $1 billion US of damage in New York and Maine (DeGaetano, 2000). In excess of 840,000 insurance claims in Canada and the United States from the damage in the Ice Storm, this is 20% more than for Hurricane Andrew, which, until 2005, was considered by the re-insurance industry to be the worst natural disaster in United States history (Lecomte et al., 1998). According to a recent issue of MacLeans magazine, the Ice Storm was "the biggest thing that's happened in Canada" in terms of property loss (MacQueen, 2005). For a more detailed description of the amount of damage caused by the Ice Storm in Canada and the northeastern United States, please refer to Lecomte et al. (1998), Kerry et al. (1999), Milton and Bourque (1999), DeGaetano (2000), Gyakum and Roebber (2001), Roebber and Gyakum (2003) or Cortinas et al. (2004).

Even though there have been many ice storms during the 20th century over North America, the quantity of ice accumulation and the persistence of the 1998 Ice Storm is often considered unprecedented (Kerry et al., 1999; DeGaetano, 2000; Gyakum and Roebber, 2001), or the worst in living memory (Milton and Bourque, 1999). It has been estimated that there have been 25 significant freezing rain events over southern and eastern Ontario since the 1880s and 22 in the northern U.S. states bordering southern and eastern Ontario during the period 1909–2002 (Klaassen et al., 2003). Therefore, major ice storms are a relatively common event occurring approximately every 5 years in the northeastern U.S states and southern and eastern Ontario. Given that ice storms are a relatively common event and that calls had been made after the ice storm in 1972 to remember the lessons learned after that particular event (Roger, 1999), it can be appreciated how disruptive the 1998 Ice Storm was.

There is no one factor that determines the severity of an ice storm. Mahaffy (1961) noted that an ice storm occurred in December 1942 in the Montréal area and had a greater ice accumulation than an event in February 1961, but the later event was more severe due to the high winds that also occurred. Four factors are considered necessary for a damaging ice storm event. These are the total ice accumulation, duration of the event, wind speed and area affected. As such, the determination of classifying severity can at times be subjective.

Despite the devastation caused by the Ice Storm, little research has been conducted on it. The few papers that have been published have mainly focused on the planetary and synoptic scales with some discussion of topographic effects (Gyakum and Roebber, 2001; Roebber and Gyakum, 2003) and on climatologies of ice storms including the 1998 event (DeGaetano, 2000; Higuchi et al., 2000). None of these articles focused on the smaller scale features of the storm.

Given the significance of the Ice Storm and the lack of research on its smaller scale features, the main objective of this study is to document and better understand its internal structure, in particular the organization of its precipitation, although considerable attention is also paid to the occurrence of lightning.

2. Description of the datasets

This study will mainly utilize observational datasets. Many of these (including Doppler radar and lightning network information) have not previously been examined in connection with this storm. The primary dataset was 1 km by 1 km S-band radar data from the McGill system at the J.S. Marshall Radar Observatory (Sainte-Anne-de-Bellevue). The radar was upgraded to make Doppler measurements in 1992 and dual-polarization measurements in 1999 (after the 1998 Ice Storm). With a 700 kW Klystron transmitter and a 9 m dish, the McGill S-band radar is the largest weather radar in Canada. For more information on the McGill radar, see Fabry (1993).

Operational surface measurements were also utilized in this study. Hourly surface weather observations were obtained for many operational sites but the primary ones used here were Dorval International Airport in Montréal (now Montréal—Pierre Elliot Trudeau International Airport), Mirabel International Airport just outside Montréal, Jean Lesage International Airport in Québec City and MacDonald—Cartier International Airport in Ottawa. These sites were chosen as they were all major airports at the time and therefore had manned observers.