HIGH-LATITUDE MESOSCALE CONVECTIVE SYSTEMS: AN 8-YR CLIMATOLOGY OF SUMMERTIME MCSS IN FINLAND

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I. INTRODUCTION

We do not know much about the occurrence of mesoscale convective systems (MCSs) and their synoptic and mesoscale environments in high-latitude areas. This lack of knowledge and understanding becomes concrete as convective weather forecasts fail and the extent and longevity of episodes of deep moist convection surprise forecasters. Although most results from MCS studies in the United States are undoubtedly valid in high-latitude areas, knowing the special characteristics of local MCSs is priceless when forecasting organized deep moist convection. As this study shows, summertime MCSs, which are sometimes even intense, are a frequent occurrence in Finland and nearby regions.

II. DATA AND METHODS

Eight warm seasons (Apr–Sep 2000–2007) of CAPPI composite radar images were manually browsed to find mesoscale areas of convective precipitation. Areas with the maximum dimension of at least 100 km, duration of at least 4 hours, and maximum radar reflectivity exceeding 40 dBZ lasting over two hours were classified as MCSs. If maximum reflectivity exceeded 50 dBZ during at least two hours, the MCS was classified as intense. Similar or nearly similar definitions were also used by Punkka and Bister (2005), who studied two warm seasons of CAPPI data in Finland, and by Geerts (1998), who surveyed the occurrence of MCSs in the southeastern United States.

In this study, duration is not the same as lifetime because of the limited size of the study area. Thus, an MCS can form and/or decay beyond the range of the Finnish radar network.

This MCS definition allows fairly weak mesoscale precipitation areas to be classified as MCSs, which partly explains their frequent occurrence. Most non-intense MCSs do not cause damage, and many of them do not even produce lightning. However, the definition is consistent with earlier radar studies on MCSs (e.g. Geerts 1998; Parker and Johnson 2000) and with the general MCS definition by Houze (1993). To demonstrate the variety of MCSs included in this study, Fig. 1 shows an example of a typical non-intense MCS, an intense well-organized MCS, and an intense but poorly organized MCS.

III. RESULTS AND CONCLUSIONS

Over 200 MCSs were found on average each year out of which one third were intense (Fig. 2). Only 10–20% of the MCSs were intense in spring, but 53% were intense in July (Fig. 2).

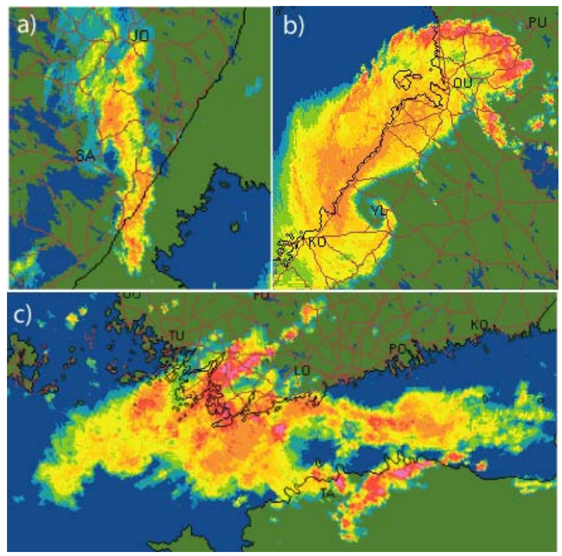

FIG. 1: Radar imagery of a) a typical non-intense MCS, b) an intense and well-organized MCS, c) an intense but poorly organized MCS. (Red 40–50 dBZ, violet > 50 dBZ)

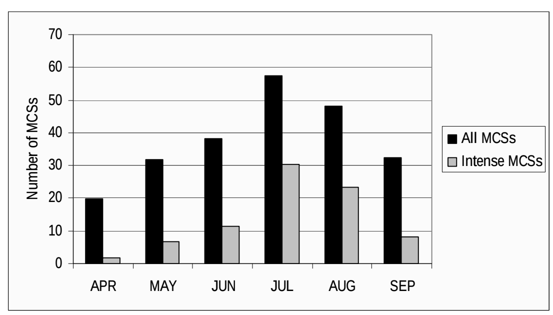

FIG. 2: Average number of all MCSs and intense MCSs in Finland 2000–2007.

The average duration of all MCSs was 10.7 hours, with durations of 4–5 hours being most common. The mid-summer (Fig. 3) and afternoon MCSs were shortest-lived (9–10 h), whereas spring and nocturnal systems lasted a couple of hours longer (12–13 h).

Most MCSs reach their maximum intensity during afternoon, early evening, or morning. The afternoon peak mainly consists of intense MCSs and the morning peak of non-intense MCSs (Fig. 4). Although the afternoon peak coincides with the time of maximum heating, why the morning peak occurs is less certain, but this agrees with results from the United States (e.g. Geerts 1998) and results from studies on mesoscale convective complexes, MCCs

(Laing and Fritsch 2000). However, a one-to-one comparison of non-intense MCSs and MCCs is not possible.

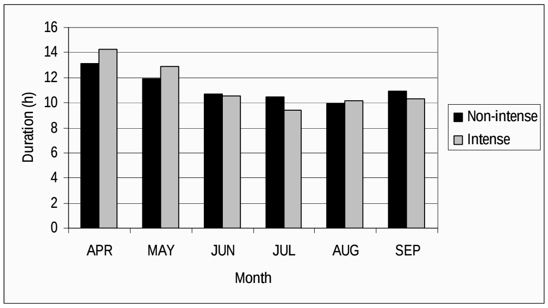

FIG. 3: Average duration of non-intense and intense MCSs in Finland 2000–2007.

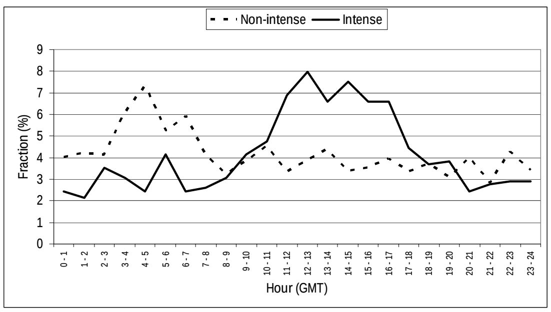

FIG. 4: Distribution of time of maximum intensity for non-intense and intense MCSs in Finland 2000–2007. Local time is GMT + 3 h.

Although half of the MCSs that developed during afternoon became intense, only a quarter of those that developed during the night became intense (Fig. 5). The gap between the time of initiation and maximum intensity was 3 h for intense afternoon systems and 6 h for intense nocturnal systems.

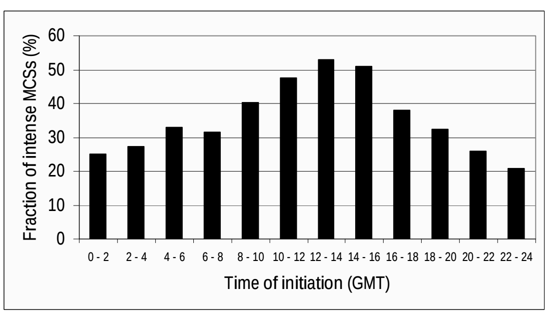

FIG. 5: Fraction of intense MCSs as a function of time of initiation.

A notable fraction of the intense MCSs developed south of Finland or entered the study area from the south (not shown). Moreover, the most common direction of system movement was northeast. For linear systems, southwest–northeast, south–north and southeast–northwest line orientations were most common (Fig 6).

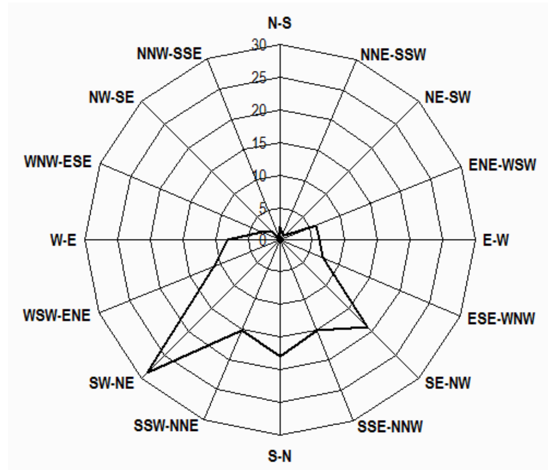

FIG. 6: Distribution of the line orientation for linear MCSs in Finland in 2002–2007. A S–N-oriented line moves toward the east and a N–S-oriented line moves toward the west.

MCSs in Finland can produce wind damage, large hail, tornadoes, or flash floods. Knowing the statistical behaviour of convective systems over a certain area may help in MCS forecasting in general. However, issuing forecasts or warnings in an occasional weather situation will still rely on an understanding of the synoptic, mesoscale and storm-scale environments. Therefore, studying the synoptic and mesoscale environment favourable for MCS development is the next inevitable step to take on the way toward improved MCS forecasts in high-latitude regions.

IV. ACKNOWLEDGMENTS

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