Persistence and Dissipation of Lake Erie- and Lake Ontario-Crossing Mesoscale Convective Systems

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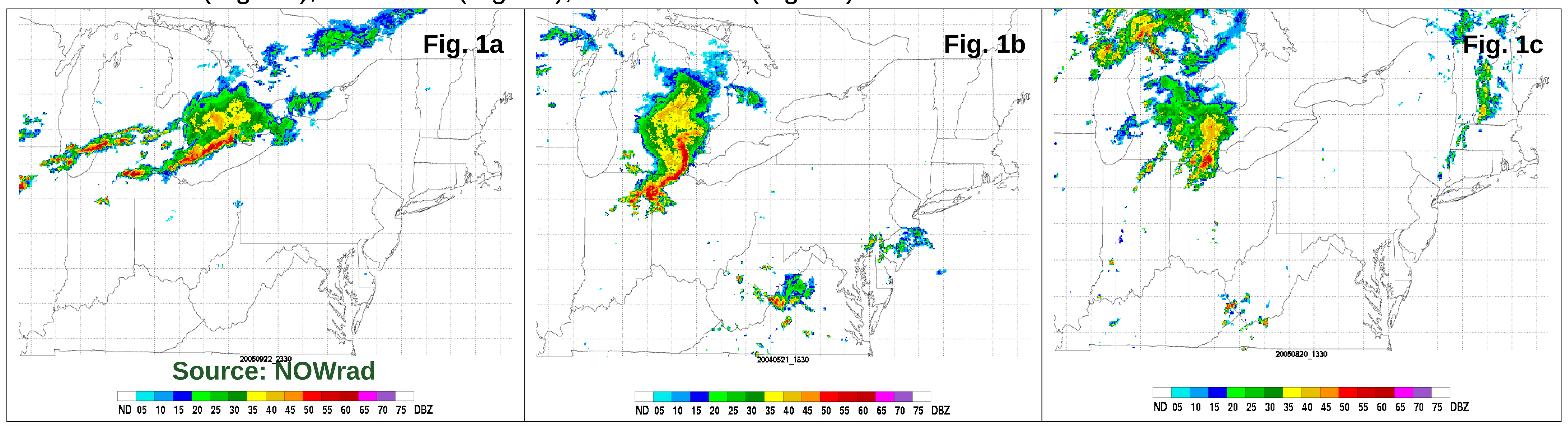
Introduction:

As mesoscale convective systems (MCSs) approach Lakes Erie and Ontario, operational forecasters can struggle to assess if the MCS will persist and remain a threat downwind of the Great Lakes. Thus, it is essential to determine parameters that influence the persistence or dissipation of MCSs upon crossing the easternmost Great Lakes.

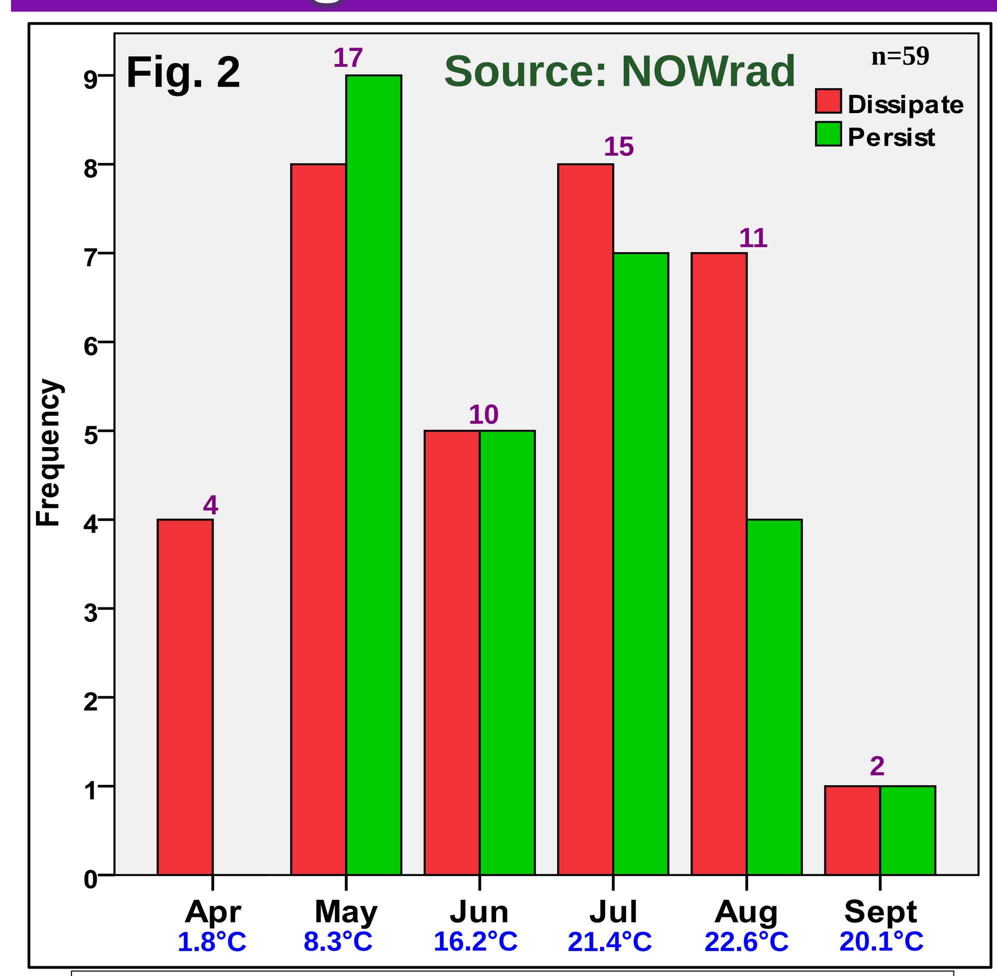
Methodology:

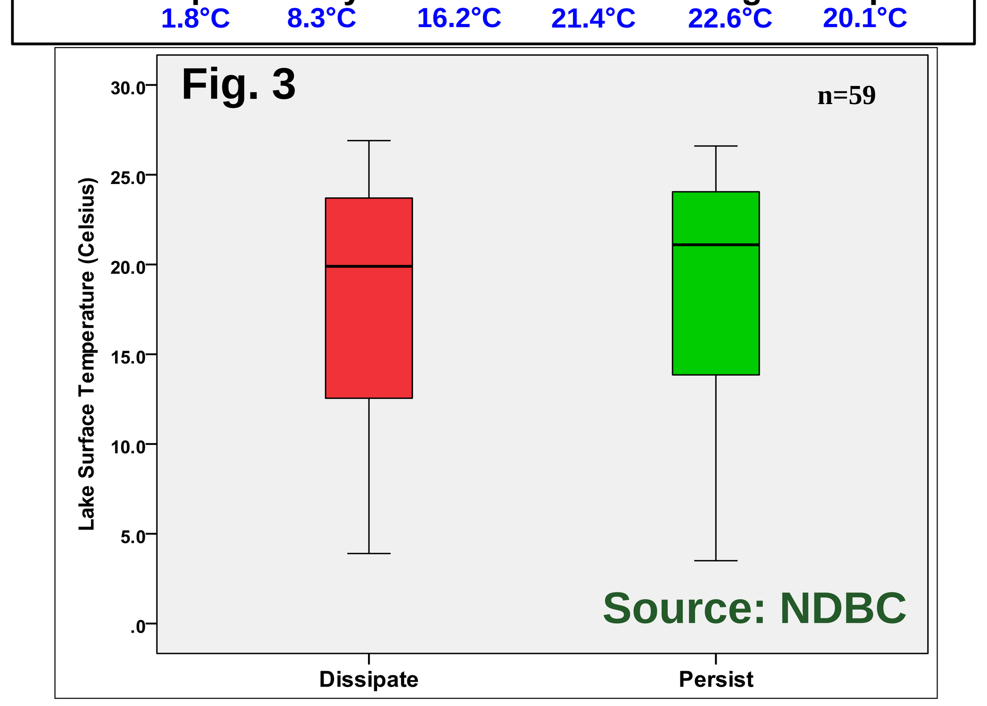
NOWrad composite radar reflectivity imagery spanning the warm seasons (April–September) of 2002–2007 was analyzed to create a climatology of Lake Erie- and Lake Ontario-crossing MCS events. MCSs in this study were 100 km by 50 km in size for at least three consecutive hours before intersecting the lake and contained a 100 km or longer line of 45 dB*Z* or greater convection (Metz 2011). To persist, an MCS had to maintain size and reflectivity criteria while crossing the lake, and produce at least one severe wind report downstream or the lake.

Different types of convective organization may result from different dynamic conditions. Thus, MCSs were classified as either linear (Fig. 1a), bow-echo (Fig. 1b), or non-linear (Fig. 1c).

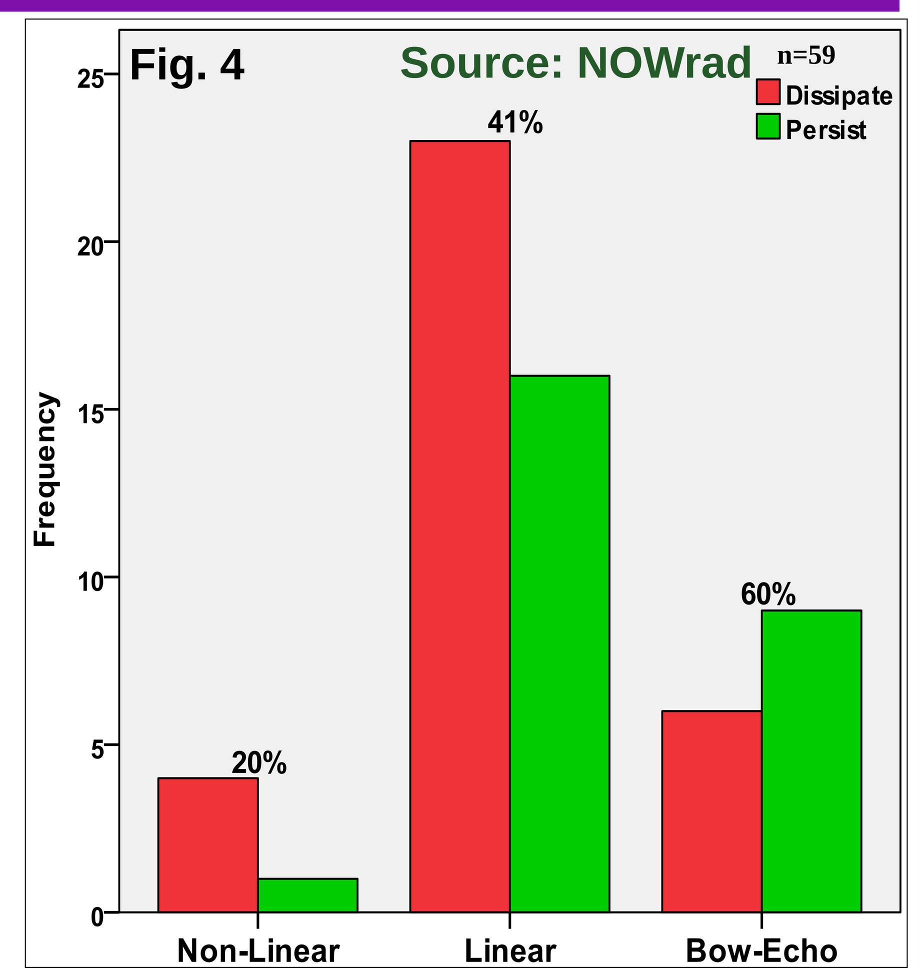


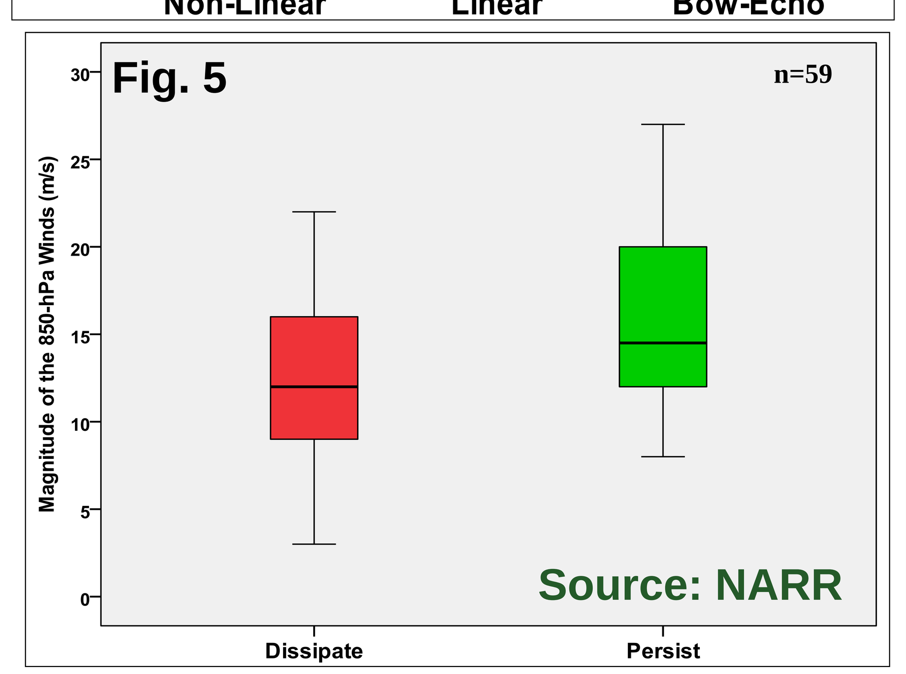
Climatological Results:





Fifty-nine lake-crossing MCSs were identified in the six-year climatology. Of these, 33 (55.9%) dissipated and 26 (44.1%) persisted. On average, persisting MCSs lasted 15.9 hours, while dissipating MCSs lasted 11.1 hours. There was a maximum of 17 MCSs in May and a minimum of 2 in September. May featured more persisting cases than dissipating (Fig. 2). Lake temperature for each month did not correlate to whether MCSs persisted or dissipated (Fig. 3). The number of dissipating and persisting cases in each organization type varied, with 20% of non-linear, 41% of linear, and 60% of bow-echo events persisting, respectively (Fig. 4). The mean maximum magnitude of the LLJ for persisting (dissipating) cases was 15.7 m s^{-1} (12.7 m s^{-1}) (Fig. 5). Thus, persisting MCSs generally featuring a stronger LLJ.

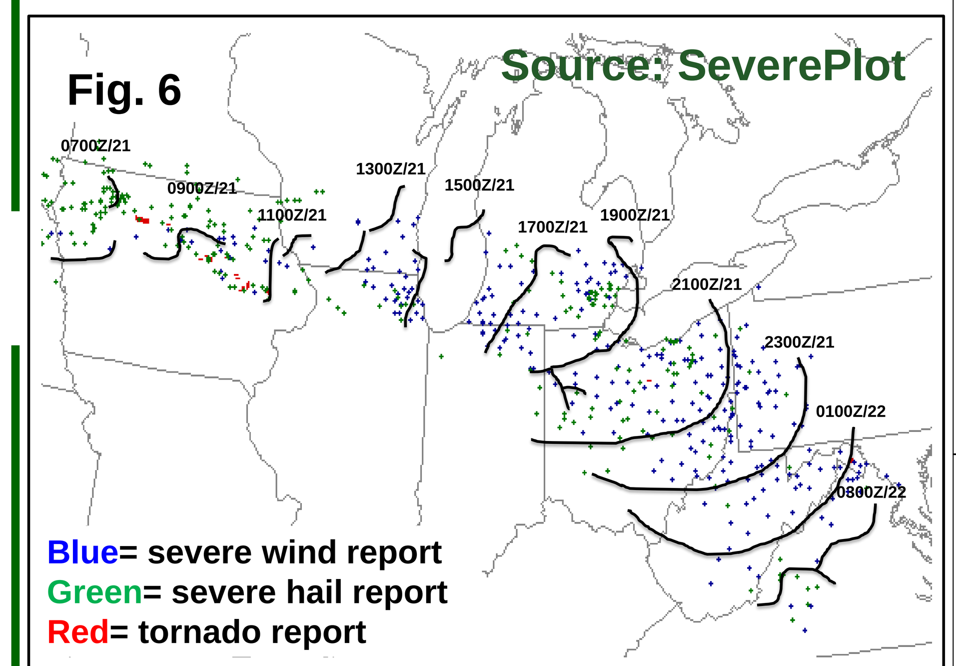


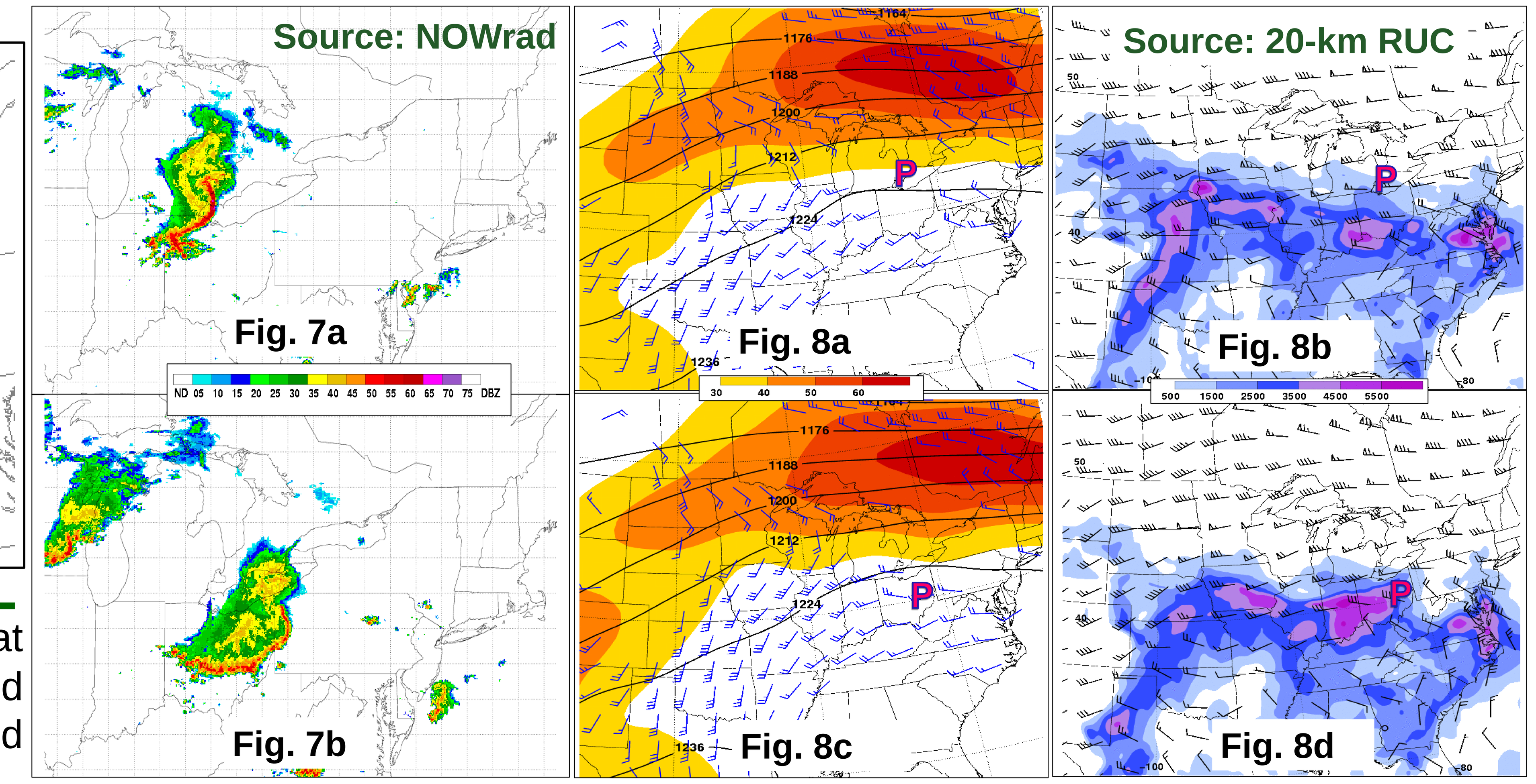


Case Studies:

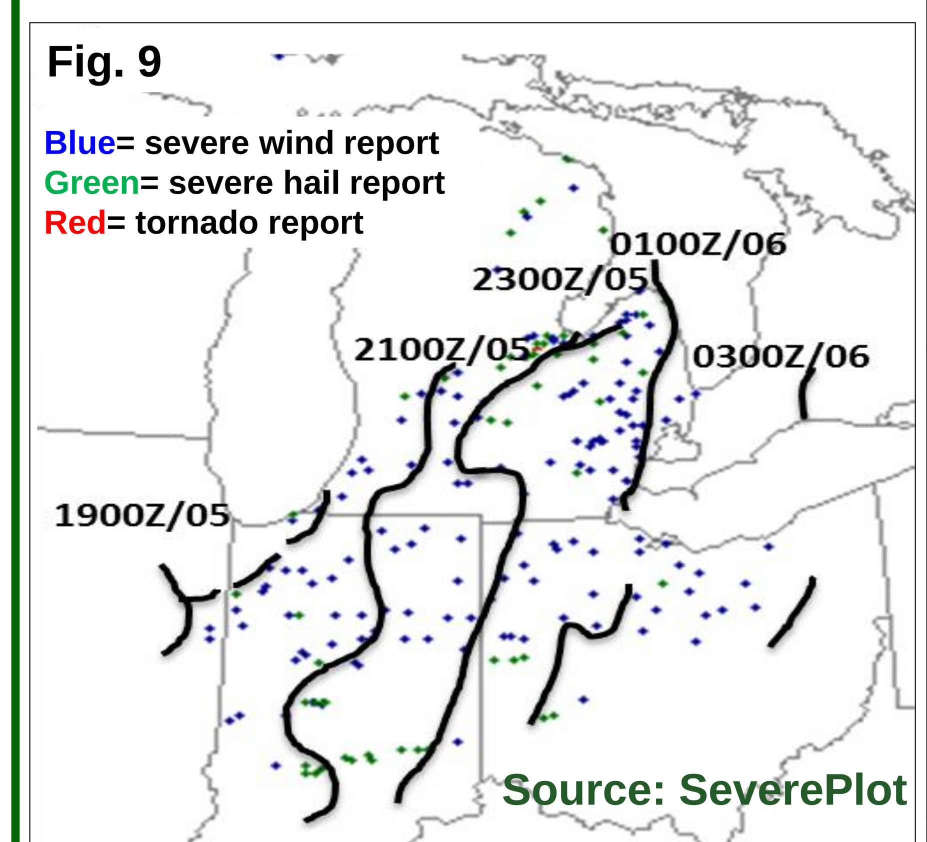
Persisting: After forming at 0430Z on 21 May 2004 (0430Z/21), this MCS left produced numerous severe reports (Fig. 6). At lake intersection time, 1900Z/21 (Fig. 7a), the MCS was located on the anticyclonic shear side of a robust 60 m s^{-1} upper-level jet (ULJ) and near the terminus of a 12.5 m s^{-1} LLJ (Fig. 8a). The MCS progressed eastward along a CAPE gradient, where values ranged from 500-5500 J kg^{-1} (Fig. 8b). In addition, nearly 25 m s^{-1} of 0-6-km shear was present over and to the north of the MCS.

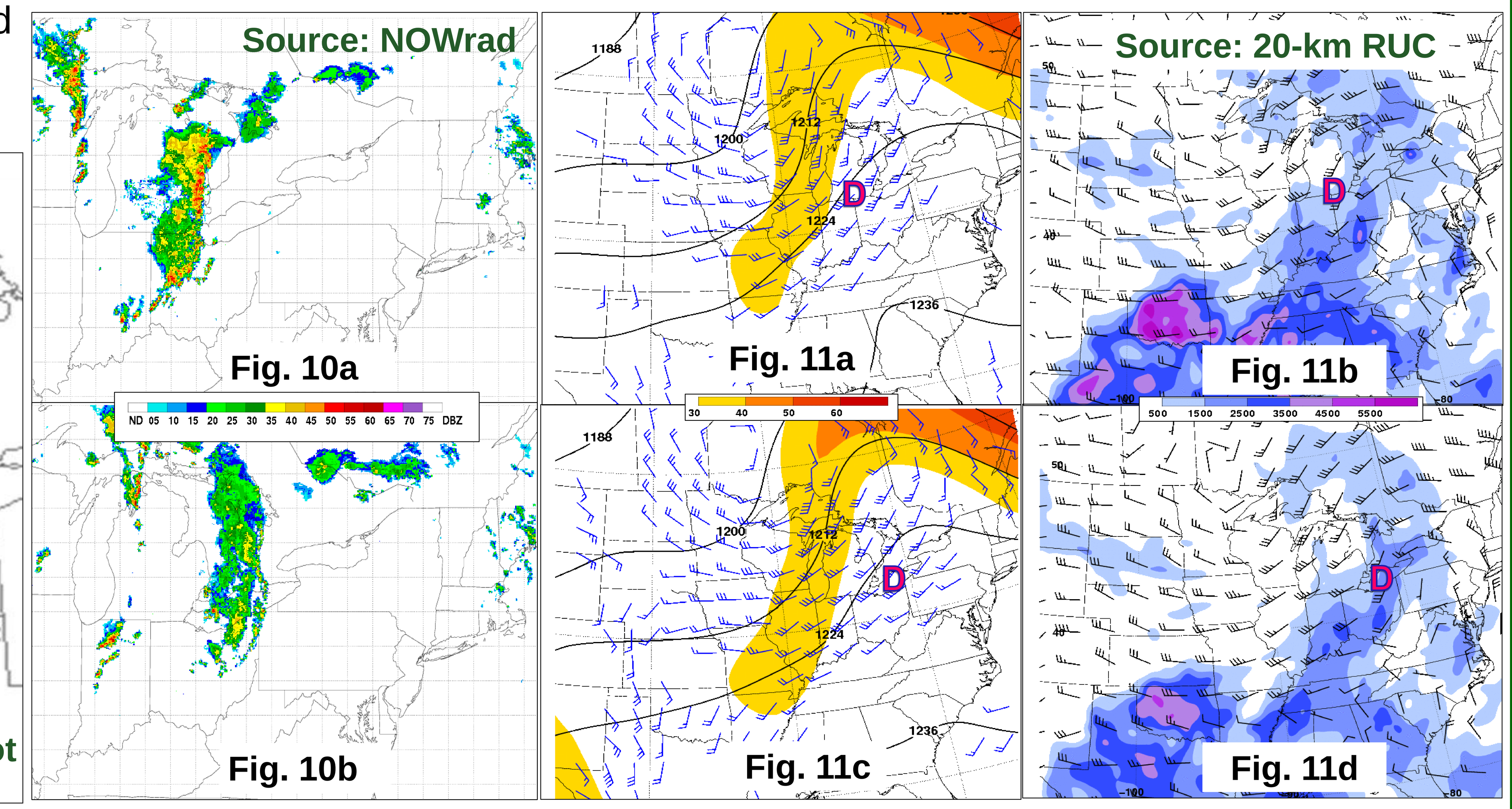
At 2200Z/21 (Fig. 7b), the MCS had crossed Lake Erie, and was located farther equatorward of the 60 m s^{-1} ULJ but remained in the core of a 12.5 m s^{-1} 850-hPa LLJ (Fig. 8c). The MCS had progressed toward higher CAPE values, and was in a region of 15-25 m s^{-1} of 0-6-km shear (Fig. 8d).





Dissipating: After forming at 1900Z on 5 June 05, this MCS produced numerous severe reports (Fig. 9) and intersected Lake Erie at 0030Z/06. At 0100Z/06 (Fig. 10a), the MCS was located near the core of a 15 m s^{-1} LLJ (Fig. 11a), CAPE of 500-1500 J kg^{-1}, and 0-6 km shear of 10-15 m s^{-1} (Fig. 11b). The MCS dissipated by 0400Z/06 (Fig. 10b) still within a 15 m s^{-1} LLJ core. However, the MCS had moved eastward of a 30–40 m s^{-1} ULJ (Fig. 11c). CAPE remained around 500-1500 J kg^{-1} with 15 m s^{-1} of 0-6 km wind shear located over the MCS, and lesser values to the south (Fig. 11d).





Conclusions:

Lake Erie- and Lake Ontario-crossing MCSs can occur during all months of the warm season. However, these MCSs are most favored to occur and persist during May. The water temperature of the lakes has no significant relationship to whether MCSs will persist or dissipate. Rather, the two representative case studies reveal that the synoptic-scale environment provides the main control on whether these lake-crossing MCSs will persist or dissipate. MCSs often persist in environments with robust CAPE and shear over and downstream of the lakes. In addition, persisting MCSs often are located in the core of an intense 850-hPa low-level jet stream and on the anticyclonic shear side of a strong 200-hPa jet stream. Further, as MCSs become increasingly well organized, the persistence percentage increases. This result is intuitive given the importance of the synoptic-scale environment to MCS organization.

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References: Metz, N. 2011: Persistence and dissipation of Lake Michigan crossing mesoscale convective systems. Ph.D. Thesis, The University of Albany, 237 pages.