The 'Cross-Border' Tornado Outbreak of 24 Aug 2016 – Add Two Tornadoes from Ontario

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1. The Tornadoes

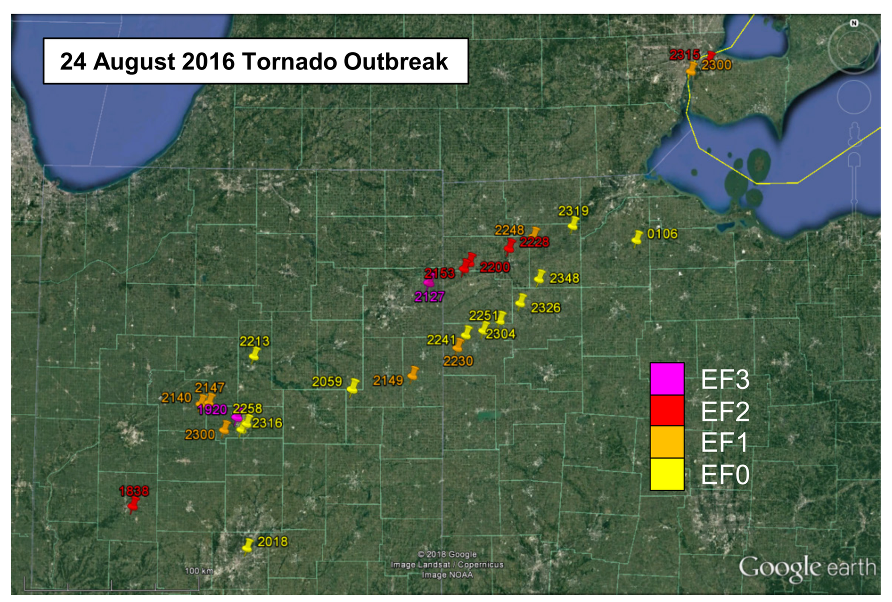


Figure 1. Map showing the 24 US tornadoes from the NCEI archive and the two Canadian tornadoes. Start times in UTC are labelled and colours indicate EF-scale ratings. The tornadoes developed in the warm sector of a low-pressure system centred over northwestern Ontario. CAPE and deep-layer shear were favourable for the development of supercell thunderstorms, and low-level shear and LCL were conducive to supercell tornado development.

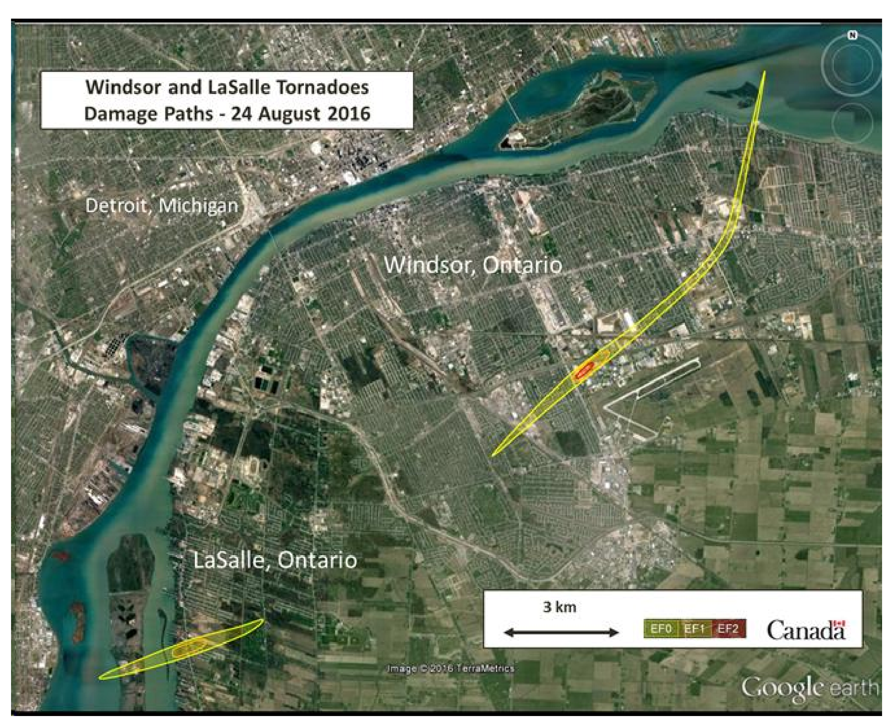


Figure 2. Map showing the paths and EF-scale contours for the LaSalle and Windsor tornadoes. Path lengths were 4.6 km and 12.7 km, respectively, while the maximum width of each path was 300 m. Both tornadoes caused up to EF1 damage to residential and commercial areas with some roofs partially removed. The Windsor tornado destroyed a vacant metal-construction warehouse and caused significant damage to other industrial buildings, all rated at EF2. Just four injuries were reported, all with the Windsor tornado.

2. Engineering Analysis

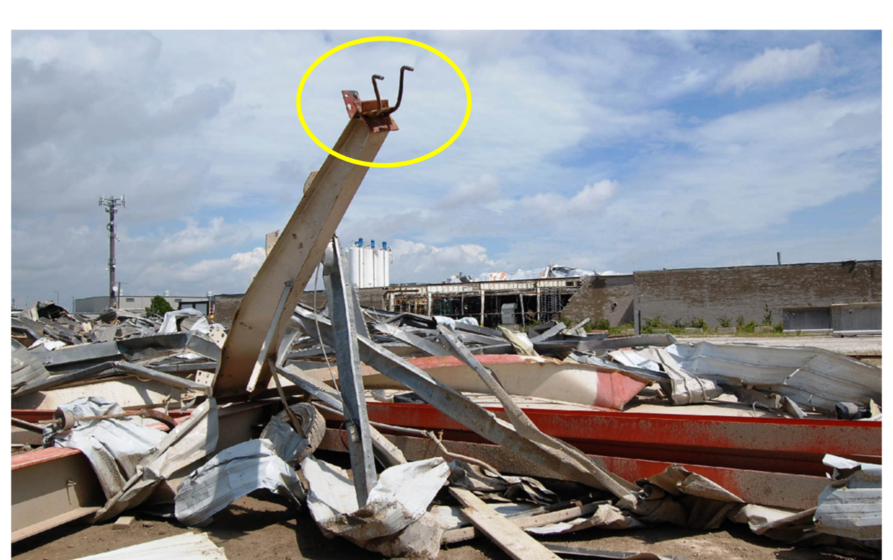


Figure 3. Assessment of the damaged structures included inspection of failed connections and structural members. In the location of the EF2 damage, a metal warehouse building collapsed completely and was partially moved off its foundation. Unexpected material failures were found to have occurred at the connections between the foundation and the bases of the columns (one of which is circled in the photo).

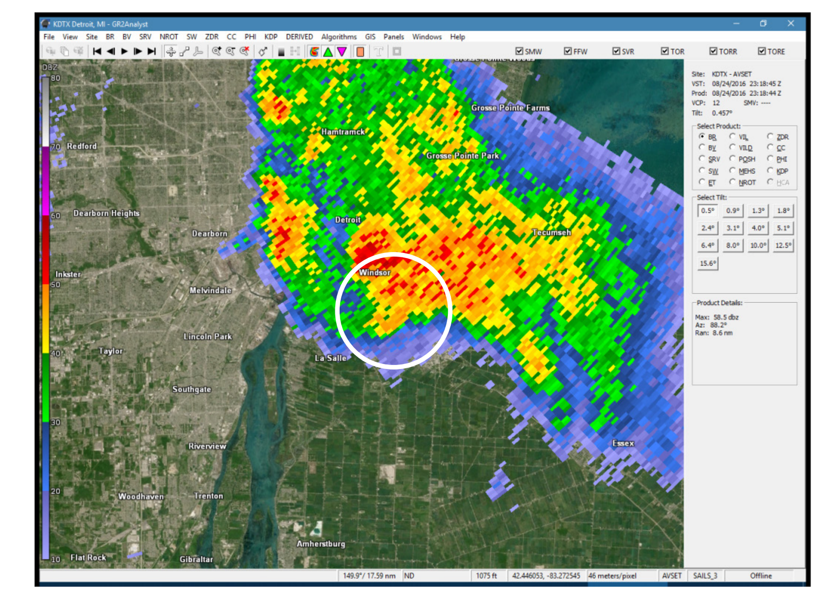
Hypothesis

Two Ontario tornadoes occurred in a similar storm environment as, and by a similar process to, the 24 Indiana / Ohio tornadoes in the 2016 outbreak

Results

Storm environments differed somewhat, but storm / tornado development differed significantly

3. Meteorological Analysis



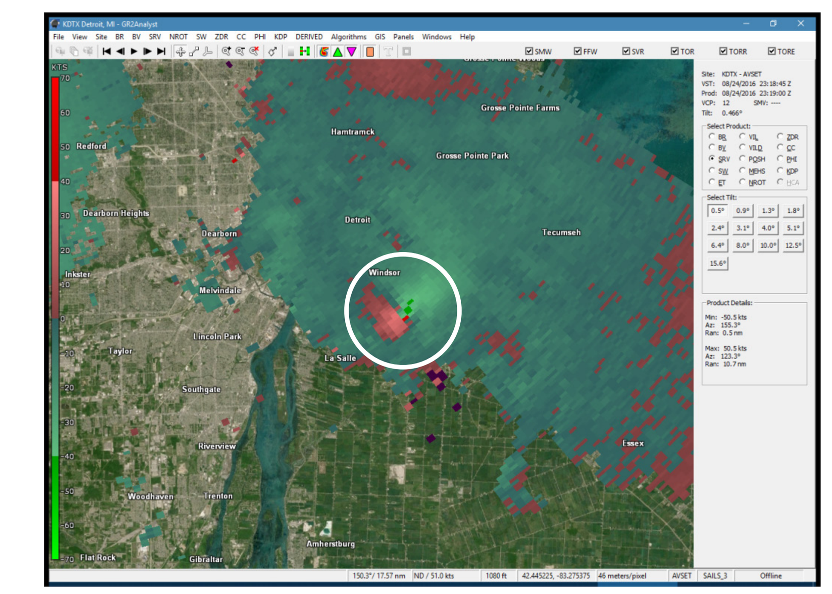
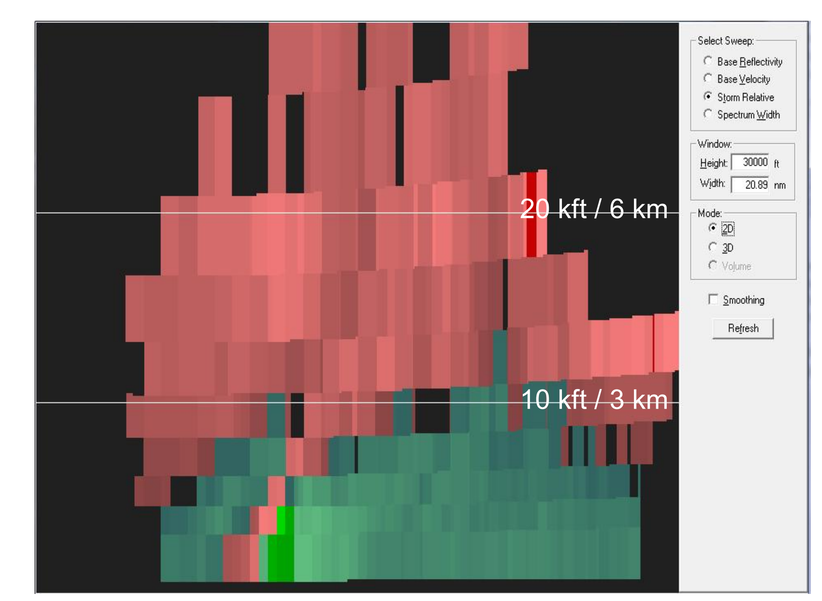


Figure 4 (left) shows the lowest-level (0.5º) reflectivity from the DTX NEXRAD radar at 2319 UTC, close to the time that EF2 damage was occurring. Figure 5 (right) shows the associated storm-relative radial velocity at the same time. Note the lack of classic supercell features such as a strong reflectivity core / gradient and hook echo. The storm began to develop at 2234 UTC over Michigan, with radar echo tops increasing from less than 9 km to nearly 14 km by 2301 UTC (when the first lightning flash was also recorded). The LaSalle tornado developed simultaneously at 2300 UTC.



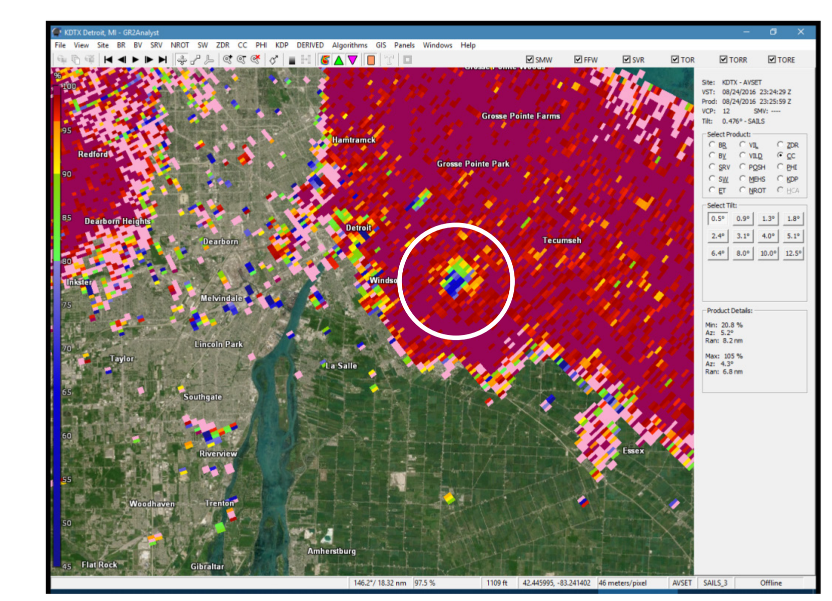
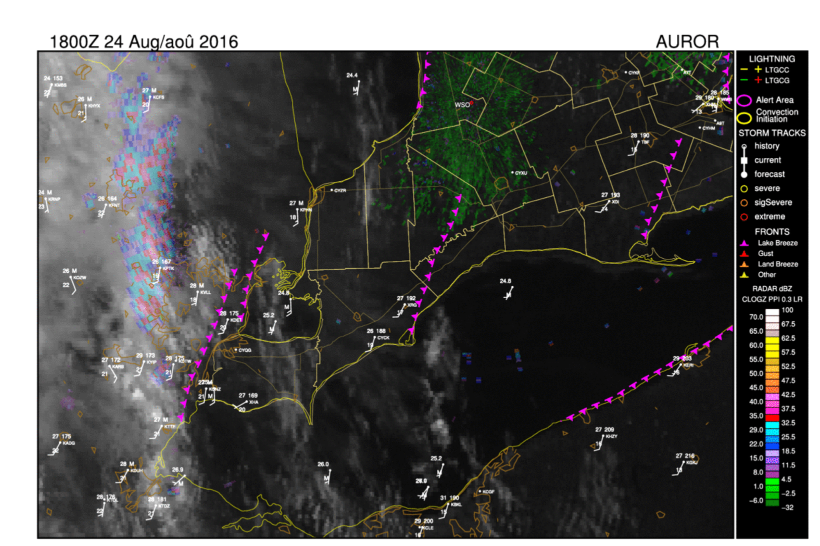


Figure 6 (left). Cross-section through storm-relative radial velocity data from the DTX radar at 2319 UTC when the tornado was at its strongest. Note that all rotation is confined below 3 km, with the strongest rotation below 1.5 km. A mid-level mesocyclone appears to be absent, suggesting tornadogenesis in this case may have been a hybrid of supercell and non-supercell processes.

Figure 7 (right). The 0.5º DTX Cross-Correlation dual-pol product showing evidence of lofted tornado debris at 2324 UTC, shortly after the tornado was at its strongest.

4. Influences on Tornadogenesis



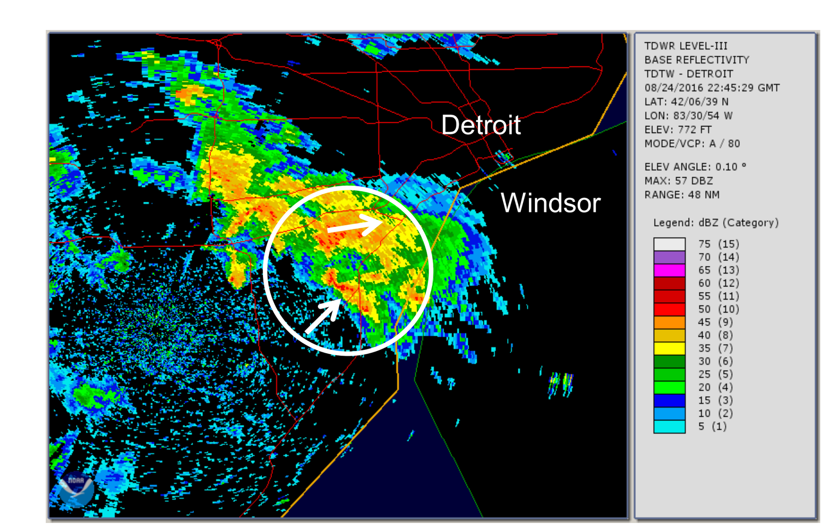


Figure 8 (left). Mesoanalysis showing the positions of manually analyzed lake-breeze fronts (magenta) during the afternoon preceding the event (valid 1800 UTC). The lake-breeze fronts were not able to be detected with confidence later in the evening prior to the event.

Figure 9 (right). TDWR radar from Detroit Metro Airport showing a cell merger about to occur just as the cluster began to cross the Detroit River from the west. There was no lightning at this time (2245 UTC).

5. Acknowledgements

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