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Sounding-derived characteristics associated with some supercell storms over the Gauteng Province of South Africa

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ABSTRACT

The eastern highland region of South Africa is prone to frequent and often violent thunderstorms typically most prevalent in the summer months. The province of Gauteng, nestled within the high-altitude grassland of the southern African Highveld is therefore vulnerable to a variety of adverse effects relating to severe thunderstorms. Such storms may be associated with large hail, strong winds, tornadoes, flash-flooding or even a combination of these invariably destructive phenomena. Supercell storms are known to be efficient producers of such extreme weather, the effects of which are often exacerbated by the longevity and typical long-track nature of such storms.

In this study, a dataset of 15 typical austral left-mover supercell cases occurring within a 200km radius of the S A Weather Service Irene S-band RADAR facility were selected on the basis of RADAR and/or visually observed criteria associated with such storms. In each supercell storm case, a corresponding 12H00UTC Irene proximity sounding was sought in order to assess the pre-storm state of the atmosphere.

A range of storm- and shear-related indices pertaining to this supercell dataset were calculated. The Bulk Richardson Number (BRN), as well as the shearing component thereof were utilised in order to quantify deep shearing in the 0-6km AGL layer. Similarly, speed and directional shearing, quantified by storm-relative helicity (SRH) (Davies-Jones et al., 1990) through varying layers within the first 3km AGL were also calculated. Furthermore, CAPE of various forms was assimilated, while the Supercell Composite Parameter (SCP) (Thompson et al., 2002; 2003) was also calculated for each case. Measures of distribution as well as extreme values of each of the aforementioned were also calculated, especially in relation to the components of SCP. The median BRN for this study was 20, while the interquartile range extended from 11 to 37, squarely within the range of BRN established by Weisman & Klemp (1982; 1984) as being optimal for supercell development. SRH within the surface to 3km AGL layer returned a Q1 value of -112, similar in absolute terms to other published results, where Q1 = +150 (Thompson et al., 2002) and Q1 = +100 (Thompson et al., 2003) were quoted. Similarly, Q1 of BRN shear in this study was calculated to be 46.7 whilst the corresponding values for the Thompson et al. (2002; 2003) studies were 40.0 and 20.0 respectively. Hodographs for the 0-3km AGL layer were also plotted for each supercell case, revealing a curved or sickle-shaped profile, so characteristic of supercells in 73% (or 11/15) of the cases. In the remaining 27% (or 4/15) of the cases, a predominantly linear hodograph profile, associated with unidirectional shear was observed. A linear hodograph profile is typically associated with an environmental regime favouring storm-splitting. In addition, a mean skew T / log p sounding profile was constructed, based on average values of temperature, dewpoint, wind speed and wind direction at each mandatory isobaric level, for the 15 individual atmospheric profiles. An eye-catching feature of the winds associated with the averaged supercell sounding was a marked shift from north-easterly surface inflow, thence progressing to northerly flow immediately above the surface flow and ultimately to stronger north-westerly winds from 1500m AGL upwards. An anticlockwise shearing tendency with increasing altitude favours a helical updraft, typified by strong negative SRH in the southern hemisphere and favours left-moving supercells (Allen, 2012). Whilst supercell storm climatologies abound in the literature, there is a comparative paucity of such information in an austral context. At the present time, in the absence of a full climatology of southern African supercell storms, the authors are hopeful that this preliminary study, though modest in size, may at least contribute towards improved understanding of this often devastating storm-type in an austral setting.

References:

Allen, J. (2012). Supercell Storms: Melbourne's white Christmas 2011. Bulletin of the Australian Meteorological and Oceanographic Society, 25(3), 47-51.

Davies-Jones, R., Burgess, D. & Foster, M. (1990). Test of helicity as a tornado forecast parameter. Preprints, 16th Conference on Severe Local Storms, 588-592.

Thompson, R., Edwards, R. & Hart, J. A. (2002). Evaluation and Interpretation of the Supercell Composite and Significant Tornado Parameters. Preprints: 21st Conference on Severe Local Storms San Antonio, Texas: American Meteorological Society.

Thompson, R., Edwards, R., Hart, J.A., Elmore, K.L. & Markowski, P. (2003). Close proximity soundings within supercell environments obtained from the Rapid Update Cycle. Weather and Forecasting, 18, 1243-1261.

Weisman, M.L., & Klemp, J. (1982). The dependence of numerically simulated convective storms on vertical wind shear and buoyancy. Monthly Weather Review, 110, 504-520.

Weisman, M.L. & Klemp, J.B. (1984). The structure and classification of numerically simulated convective storms in directionally varying wind shears. Monthly Weather Review, 112, 2479-2498.