Characteristics of warm season supercell thunderstorms over the Gauteng and Mpumalanga Provinces of South Africa

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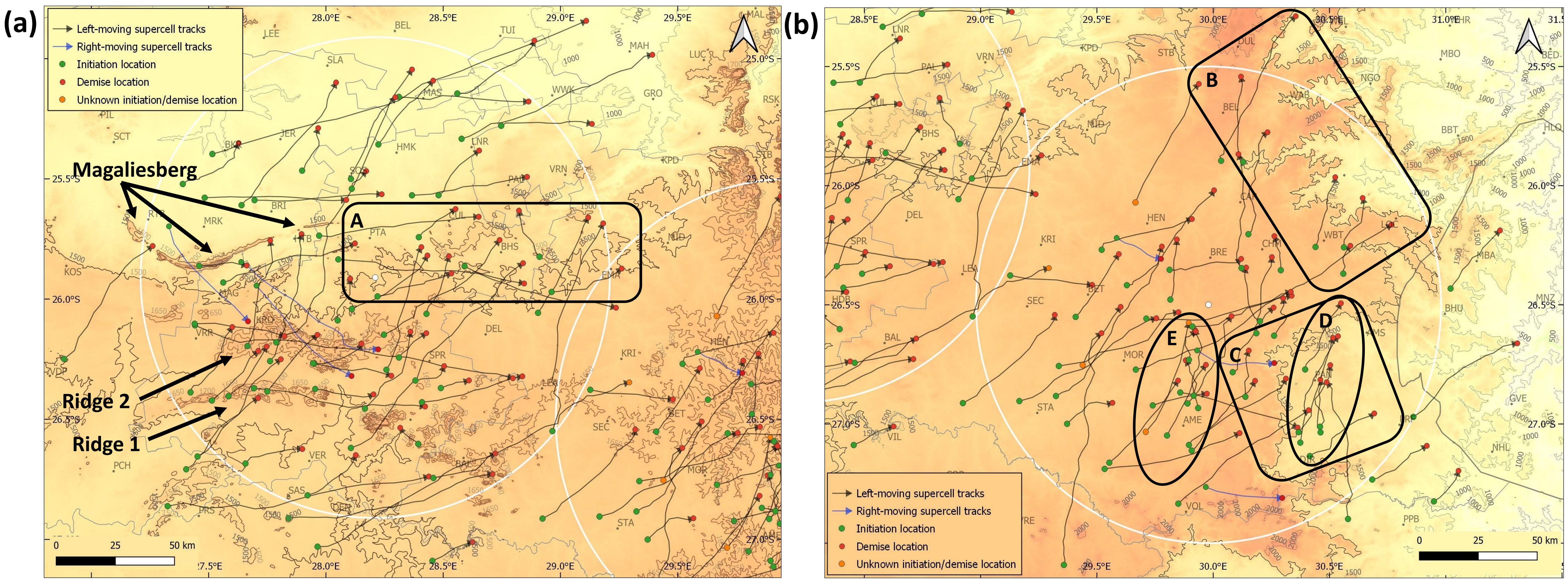


Figure 1: *The initiation and demise location as well as the track of all left-moving (black arrow) and right-moving (blue arrow) supercells over (a) Gauteng (the 1500 to 1800 m AMSL contours in 50m intervals are also shown) and (b) Mpumalanga (only every 500 m contour shown). The white circles indicate the 100 km range (most reliable area) from the Irene and Ermelo radar (white dots at the centre of the circles), which were used to identify the supercells. The Highveld (1500 m AMSL and greater) is indicated by the black outline.*

Some local observations linking topography to supercell initiation and demise were observed (Figure 1). Over the south-western parts of Gauteng a number of events were found to develop along Ridge 1, travel north-eastwards and decay along Ridge 2. A similar pattern was observed along Ridge 2 and the Magaliesberg Mountain range. Over the north-eastern parts of Gauteng and north-western Mpumalanga (area A on figure 1 (a)), numerous events were found to decay along the edge of the Highveld (1500 m AMSL contour) and in the lower elevation areas just north of the Highveld, thus it is possible that topography influenced the decay of supercell features in this region. A similar observation was made over the eastern parts of Mpumalanga (areas B and C on figure 1 (b)). Topography may also have played a role over the lower lying south-eastern parts of Mpumalanga (area D on figure 1 (b)) where at least 5 events were confined to the area. Not all hotspots in supercell initiation and demise showed to have an obvious link with topography, such as the area south of Ermelo (area E on figure 1(b)), where it is relatively flat, although small scale topographical features cannot be excluded.

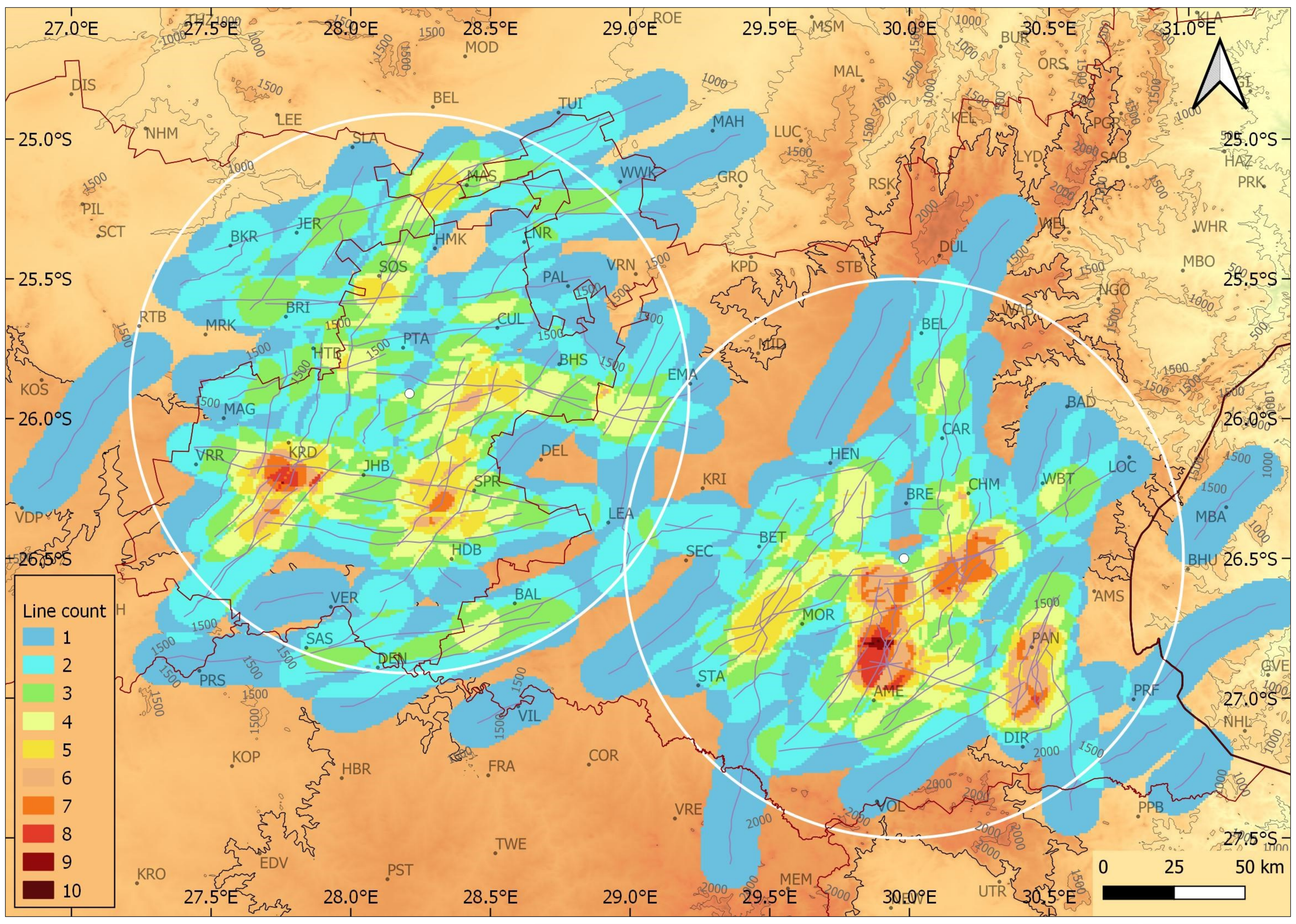
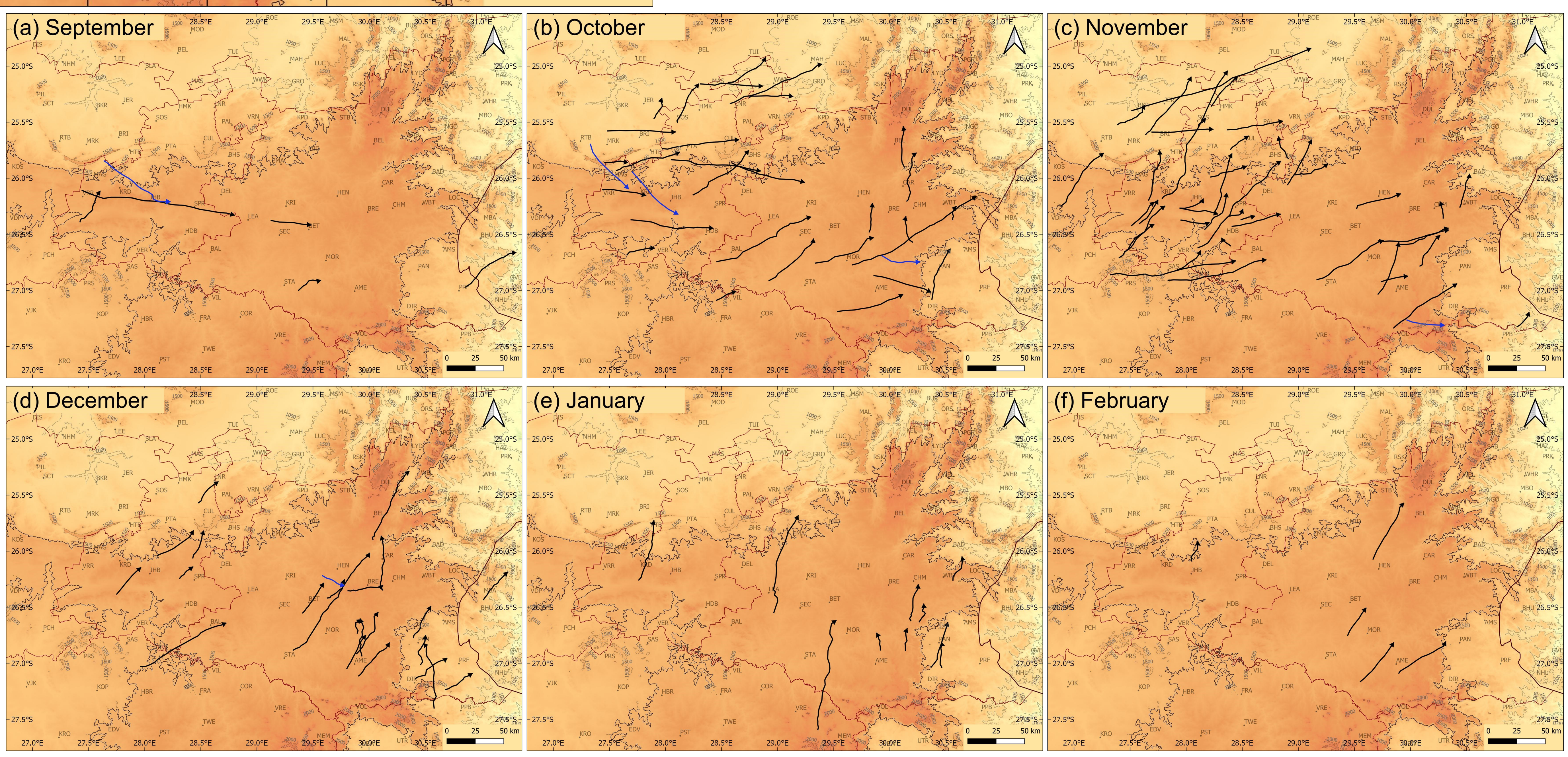


Figure 2: *The track distribution of all left-moving supercells identified within the warm seasons of 2010 to 2020. This figure was created using a Kernel Density Estimation analysis and was done using the left-moving supercell's vector path (based on the centroid position of the thunderstorm). A 1 km by 1 km grid was created over the data and was used to count the number of lines (shown by the colours in figure 2) that occurred within a 10 km search radius of each grid cell.*

A number of hotspots in active supercell regions were identified (figure 2). This included the south-western and eastern Highveld of Gauteng and south-eastern parts of Mpumalanga (warm shades). The hotspot in supercell activity over south-western Gauteng was found to occur between the two ridges in the area (figure 1). In general, higher activity was observed over the Highveld of Gauteng, although an area of moderate activity was observed over the lower lying north-western parts. Moderate activity was also observed east of the Irene radar along the edge of the Highveld, where topography may have had an influence. Over Mpumalanga, the hotspots and areas of moderate activity south, south-east and west of the Ermelo radar, were also found on the Highveld but lacked any significant topographical features, although small scale influences cannot be excluded. However, hotspot located to the far south-east was found to occur in a lower lying area, where topography may have had an influence. An area of very low activity was observed north-west of the Ermelo radar (within 100 km) but no obvious topographical features can explain this area of low activity.

Figure 3: *All left-moving (black arrow) and right-moving (blue arrow) supercell tracks during the warm seasons of 2010 to 2020 that occurred in (a) September, (b) October, (c) November, (d) December, (e) January and (f) February.*



The mean track direction was found to be from the south-west for left-moving supercells and, although based on only 5 events, right-moving supercells had a mean track from the north-west. This mean track direction corresponds to a deviation to the left (right) of the mean 0 to 6 km environmental winds for left-moving (right-moving) supercells. A shift in the track direction of left-moving supercells was observed as the season progressed (figure 3), which corresponded to a shift in the mean 0 to 6 km environmental winds. Events travelled from the west south-west in September and October, south-west in November, south south-west in December and then from the south by January, shifting back to south south-west in February. A shift in the spatial distribution of supercells was also observed corresponding to a shift in the atmospheric conditions conducive for severe thunderstorms over the region. Overall activity was found to start over the southern Highveld early in the season, spreading north and peaking in November (the same month Gauteng also saw a peak in the number of events). By December, a significant drop in activity was observed over Gauteng, while the more active area was found to shift to the south-eastern parts of Mpumalanga (which is the same month Mpumalanga observed its peak in activity). A further drop in supercell activity was observed, especially over Gauteng, in January and February, and those events that did occur, predominantly occurred over the south-eastern parts of Mpumalanga.