THE SOUTHERN ENGLAND TORNADOES OF 30 DECEMBER 2006: CASE STUDY OF A TORNADIC STORM IN A LOW CAPE, HIGH SHEAR ENVIRONMENT

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I. INTRODUCTION

On the afternoon of 30 December 2006, a small outbreak of at least 11 tornadoes affected parts of southern and eastern England. The first tornado damage was reported in Winnersh, Berkshire, at around 1545UTC. Tornadoes subsequently occurred at locations progressively further northeast, with the final reported tornadic damage occurring at Ludham, Norfolk, around 1830UTC. Site investigations by TORRO members assessed the most severe damage to be indicative of a tornado of strength T3.

Real-time analysis of radar imagery has suggested that most of the tornadoes on this day were associated with a persistent convective cell.

This paper investigates the synoptic situation in which the tornadoes developed. The storm environment is also analysed using sounding data. The evolution of the cell responsible for the majority of tornadoes is analysed using a sequence of radar images.

II. STORM ENVIRONMENT AND RADAR ECHO ANALYSIS

Surface analysis charts show that the tornadoes developed close to the cold front of a small, developing depression, which tracked east-north-eastwards over southern parts of England. The depression was observed to deepen steadily as it moved across the country, with central pressure falling from 1000 to 997hPa between 1200 and 1800UTC. Convection developed within a pre-existing area of dynamic rainfall, immediately to the south of the depression centre. Analysis of satellite data shows that the convection developed as a dry slot wrapped around the developing depression and approached the cold front from the west.

The environment in which the storm developed was characterised by extremely large 0 - 1 km storm relative helicity (330 m^2s^{-2}) and meagre CAPE. Whilst it is true that the approach of the dry slot may have resulted in rather larger CAPE values in the storm environment than is suggested by available radiosonde data, it is clear that the storm environment was characterised by low CAPE. Interestingly, the majority of CAPE was found to exist at low levels. The maximum parcel buoyancy and maximum wind shear (speed and directional) were both located in the lowest 1 to 2 km above ground level.

The intense radar echoes associated with the convective activity became increasingly isolated with time, as the surrounding precipitation diminished. By 1545UTC the shape of the intense echo over Berkshire had become strongly suggestive of a high precipitation supercell. The forward flank rain core is visible as the northern portion of this echo. A narrow southern segment, on the storm's rear flank, can be seen to progressively bow out with time. The initial bowing out may have occurred as a result of the surging forward of the rear flank downdraft to the southwest of the mesocyclone. The mesocyclone's position is suggested by an area of slightly weaker echoes on the eastern side of the storm. If so placed, the location and track of reported tornadic damage through Berkshire would be consistent with the location and track of the mesocyclone.

Although the radar images suggest transition to a bow echo type feature from about 1630UTC, several more instances of tornadic damage occurred after this time. It appears likely that a bookend vortex developed at the northern end of the bow; rotation is suggested by the development of a large hook shaped echo. Damage from at least one tornado was found to be closely co-located with the tip of this hook (Fig. 1).

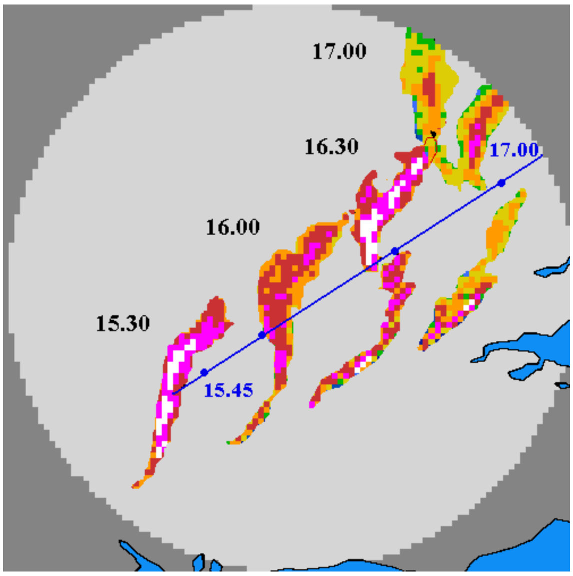

FIG. 1: Met Office radar imagery at 30 minute intervals, showing evolution of storm radar echo. Time corresponding to each echo is shown to the north-west of echo. Blue circles denote locations of tornado damage, with approximate time of occurrence given adjacent where known. All times in UTC.

III. CONCLUSIONS

The storm environment on this occasion was similar to that associated with cool season tornadoes in other parts of the world. However, in this case CAPE values were rather smaller than in many of the previously documented cases. The high shear, low CAPE environment is not uncommon in the UK in the winter months.

Whilst it is not possible, given the available data, to prove beyond all doubt the existence of a supercell, analysis of radar data has suggested that the storm was supercellular for part of its lifetime. Further, the observed evolution of the radar echo during the transition to a bow echo type feature is very similar to the evolution of radar echoes in previously observed supercell to bow echo transitions in the US (Moller *et. al.* 1990).

Given that the vast majority of multiple tornado outbreaks in the UK occur in winter, the possibility that some of these outbreaks may be associated with supercellular convection is raised. Current understanding is that vigorous, non-supercellular convection associated with cold fronts tends to be associated with such events. Detailed analysis of future events is recommended in order to establish more precisely the characteristics of storms which produce such winter-time tornado outbreaks in the UK, and to conclusively determine whether supercell storms are indeed responsible for some of these outbreaks.

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V. REFERENCES

Moller, A. R., Doswell, C. A. III, Przybylinski, R., 1990: High-precipitation supercells: A conceptual model and documentation. Preprints, *16th Conference on Severe Local Storms,* Kananaskis Park, AB, Canada, Amer. Meteor. Soc., 52–57.