The 08 May 2009 Missouri Derecho: Mesoscale and Radar Analysis over Southwest Missouri

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A historic wind storm with embedded tornadoes occurred during the morning of 08 May 2009 from southeast Kansas through southern Illinois. Incredible wind damage occurred with this system in which many homes, businesses in smaller communities, and farmsteads were damaged or destroyed by damaging winds or tornadoes. Individual large swaths of damaged trees extending from 75 to 100 km in length and 30 to 40 km wide were documented during damage assessments. Within these swaths, complete deforestation was revealed owing to intense microburst or individual burstswaths within the microbursts. Much of the intense wind damage occurred within and south of an eastward moving "bookend vortex". Surface wind gusts were estimated over 50 to 55 m s-1 within these swaths. Most of the individual tornadic damage tracks mainly occurred from the Springfield Missouri into the southwest part of the WFO St. Louis County Warning Area (CWA). The overall area of wind damage extended from southeast Kansas through parts of the southern third of Missouri and into southern Illinois. While this windstorm impacted a large area and was prolonged in nature, the main focus of this study will be environmental and radar characteristics across southwest Missouri. The synoptic scale setup will briefly be examined and will specifically focus on what was a favorable setup for a rapidly forward propagating Mesoscale Convective System (MCS). The first part of this study will indentify the effects of environmental shear and system cold pool balance. The second part of this study will then focus on the initial identification and growth of three mesovortices with respect to the line. The orientation and magnitude of low level shear vectors within the 0-3 km layer appeared to have major implications on the structure and longevity of the MCS. While low level shear vectors will initially be examined from a synoptic scale standpoint, it does appear that wind profiles were affected by a matured bookend vortex. This modification of low level shear vectors south of the bookend vortex likely played a key role in not only line structure and longevity, but also the location of mesovortex genesis. From north to south across southwest Missouri, the MCS simultaneously exhibited "shear dominant", "balance between system cold pool and environmental shear", and "cold pool dominant" characteristics. Shear/cold pool balance also seemed to play at least an indirect role on the placement of stratiform precipitation with respect to the surface convergence zone. "Leading stratiform" precipitation was favored in areas where the line was shear dominated. This area of leading stratiform appeared to resemble the 'Leading Stratiform archetype' described by Parker and Johnson (2000). In contrast, "trailing stratiform" precipitation was dominant in areas of the line that were balanced or cold pool dominant.

A good correlation appeared to exist between the magnitude of low level shear vectors and the development of mesovortices. Based on RUC 00 hr data magnitudes of the 0-3 km shear over southwest Missouri exceeded 25 m s-1. Trapp and Weisman (2003) documented such a relationship using 0-2.5 km shear magnitudes. The development of low-level mesovortices also seemed to be heavily tied to those areas of the line that were either balanced or slightly shear dominant near the updraft/downdraft low-level convergence zone. The orientation and propagation of the Rear Inflow Jet (RIJ) appeared to play a critical role in the location and development of mesovortices. The majority of mesovortices developed near or just to the south of the bow echo apex where the RIJ impinged from the rear resulting in a near 'balanced state' and region of tall convective towers. Relative to the southeastward moving bow, multiple mesovortices tended to migrate north and west along the updraft/downdraft convergence zone. This migration resulted in these mesovortices being displaced into a portion of the MCS characterized as slightly shear dominant with leading stratiform. While mesovortices tended to form near or just south of the apex of the bow, the southeastward shift of the RIJ and 'balanced region' supported additional mesovortex development equatorward along the line. Rotational velocity (Vr) traces will highlight the characteristics of three mesovortices and time of tornado occurrence. The Vr traces will show an average lead time of 10 to 15 minutes from initial mesovortex identification and time of tornado occurrence. It will be shown that mesovortices which moved north of the bow apex ingested stratiform precipitation from the east and gave the convergence zone-reflectivity field a wavy-like appearance. As these mesovortices continued to mature and ingest greater than 50 dBZ reflectivities, they took on a small comma-shaped pattern. These mesovortices went on to spawn multiple tornadoes east of the Highway 65 corridor. The locations of these mesovortices with respect to the leading stratiform precipitation yielded unique challenges to radar operators when constructing Tornado Warning polygons. Additionally, determining the location and size of Severe Thunderstorm Warning polygons was challenging as the strongest winds were occurring well behind the front edge of the leading stratiform precipitation. Recognition of the shear and cold pool characteristics of a linear MCS are critical to mesoanalysts and radar operators alike when assessing the likelihood of damaging straight line winds and tornadoes. Additionally, identifying the location of the updraft/downdraft convergence zone in relation to stratiform precipitation is essential to understanding MCS structure and corresponding threats to life and property.