Supercell-based Tornadogenesis – Radar Feature Reference Guide

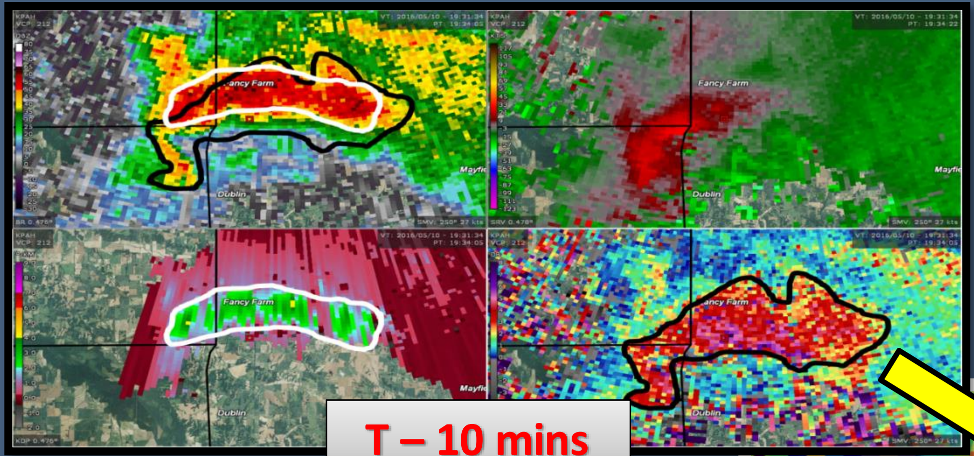
Convective Warning Improvement Project

Radar Feature

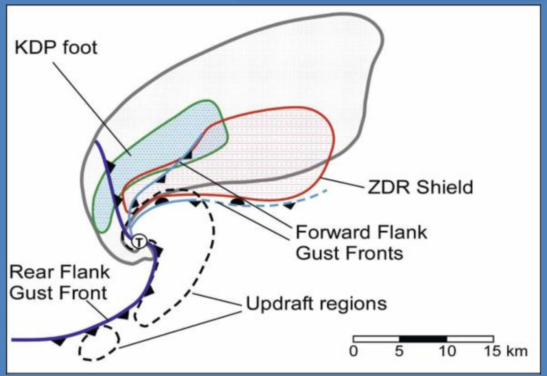
Feature	Primary Application	Skill to Determine Tornadogenesis Potential	Important Note
Z_{DR} Arc (<65 nm from the radar)	Anticipate low-level meso (<2 km) intensity trends	**Moderate** – Infers dynamic lift potential from low-level meso ahead of time	Combine with separation vector angle in weak to moderate low-level SRH (0-1-km <200) environments
Separation Vector Angle (<65 nm from the radar)	Separation between K_{DP} Foot and Z_{DR} Arc can help anticipate low-level meso intensity trends	**Moderate** – Infers potential dynamic lift from low-level meso ahead of time	Value of angle is less critical in stronger low-level SRH (0-1-km >200) environments
Z_{DR} Arc Disruption (<65 nm from the radar)	Degree of negative buoyancy in near-surface airstream below meso	**High** – Stronger negative buoyancy typically inhibits tornadogenesis	Zero/Negative K_{DP} within disruption infers dry hail region that may not significantly add neg. buoyancy; genesis possible despite disruption
Left Flank Velocity Enhancement (LFVE) (<40 nm from the radar)	Track near-surface airstream feeding into region below low-level meso	**High** – Positioning of airstream convergence relative to low-level meso critical for genesis	Convergence signature under meso infers crosswise to streamwise vorticity exchange needed for genesis
Low-level V_r (<65 nm from the radar; feature not illustrated)	Diagnostic tracking of low-level meso intensity trends	**Minimal** – Diagnostic nature limits skill to largely reactionary rather than predictive	Can be used as a diagnostic intensity tool for an ongoing tornado
Storm Depth Max V_r (feature not illustrated)	Diagnostic tracking of maximum full volume meso intensity trends	**Minimal** – Diagnostic nature limits skill to largely reactionary rather than predictive	Can be used as a prognostic intensity tool for an ongoing tornado
Z_H “Hook” Signature (feature not illustrated)	Infers strength of mid-level meso to redistribute precipitation	**Minimal** – Many non-tornadic supercells have hooks	Some hooks infer strong negative buoyancy that inhibits genesis

Supercell-based Tornadogenesis – Radar Feature Reference Guide

Feature	Primary Application	Skill to Determine Tornadogenesis Potential	Important Note
Z_{DR} Arc (<65 nm from the radar)	Anticipate low-level meso intensity trends	Moderate – Infers dynamic lift potential from low-level meso ahead of time	Combine with separation vector angle in weak to moderate low-level SRH (0-1-km <200) environments

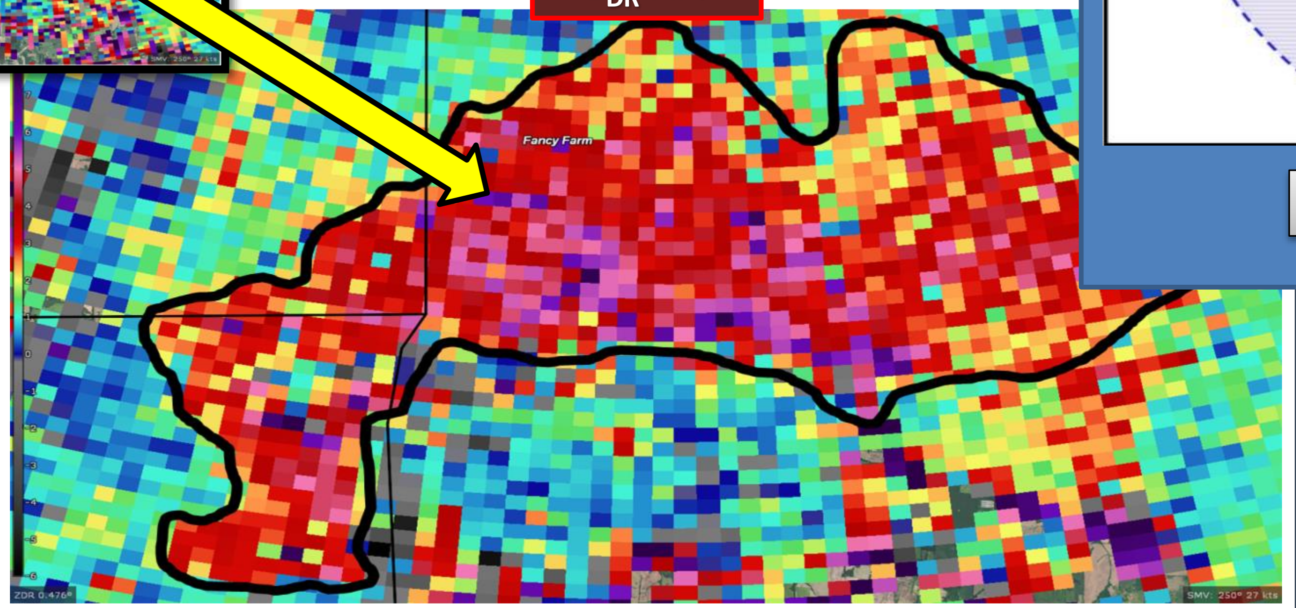


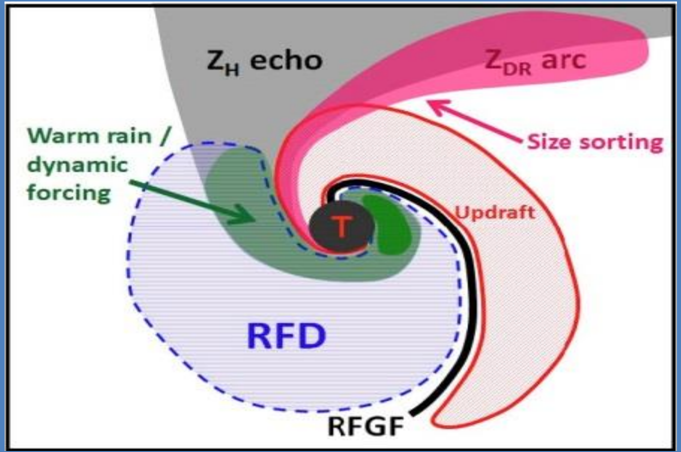
T – 10 mins



Adapted from
Romine et al., 2008

Z_{DR} Arc

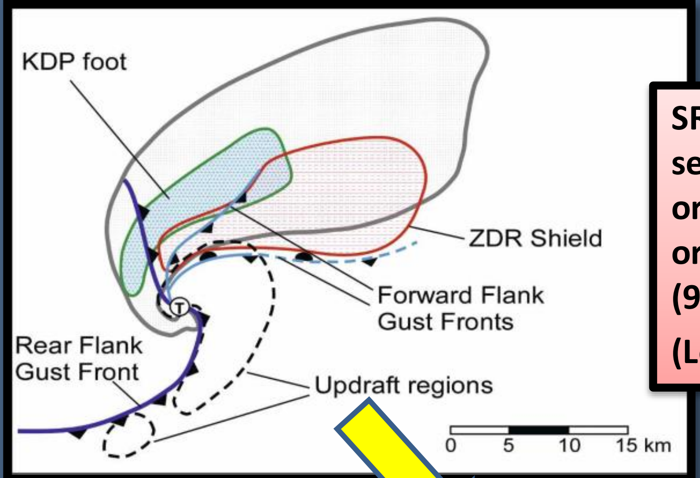




Kumjian 2011

Supercell-based Tornadogenesis – Radar Feature Reference Guide

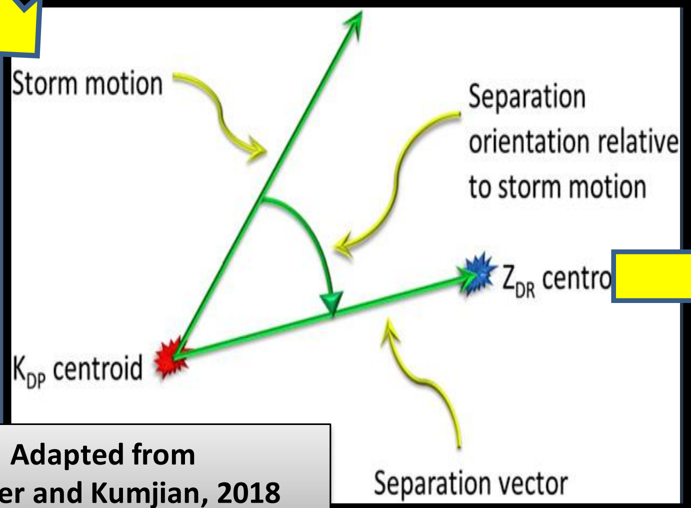
Feature	Primary Application	Skill to Determine Tornadogenesis Potential	Important Note
Separation Vector Angle (<65 nm from the radar)	Separation between K_{DP} Foot and Z_{DR} Arc can help anticipate low-level meso intensity trends	Moderate – Infers potential dynamic lift from low-level meso ahead of time	Value of angle is less critical in stronger low-level SRH (0-1-km >200) environments



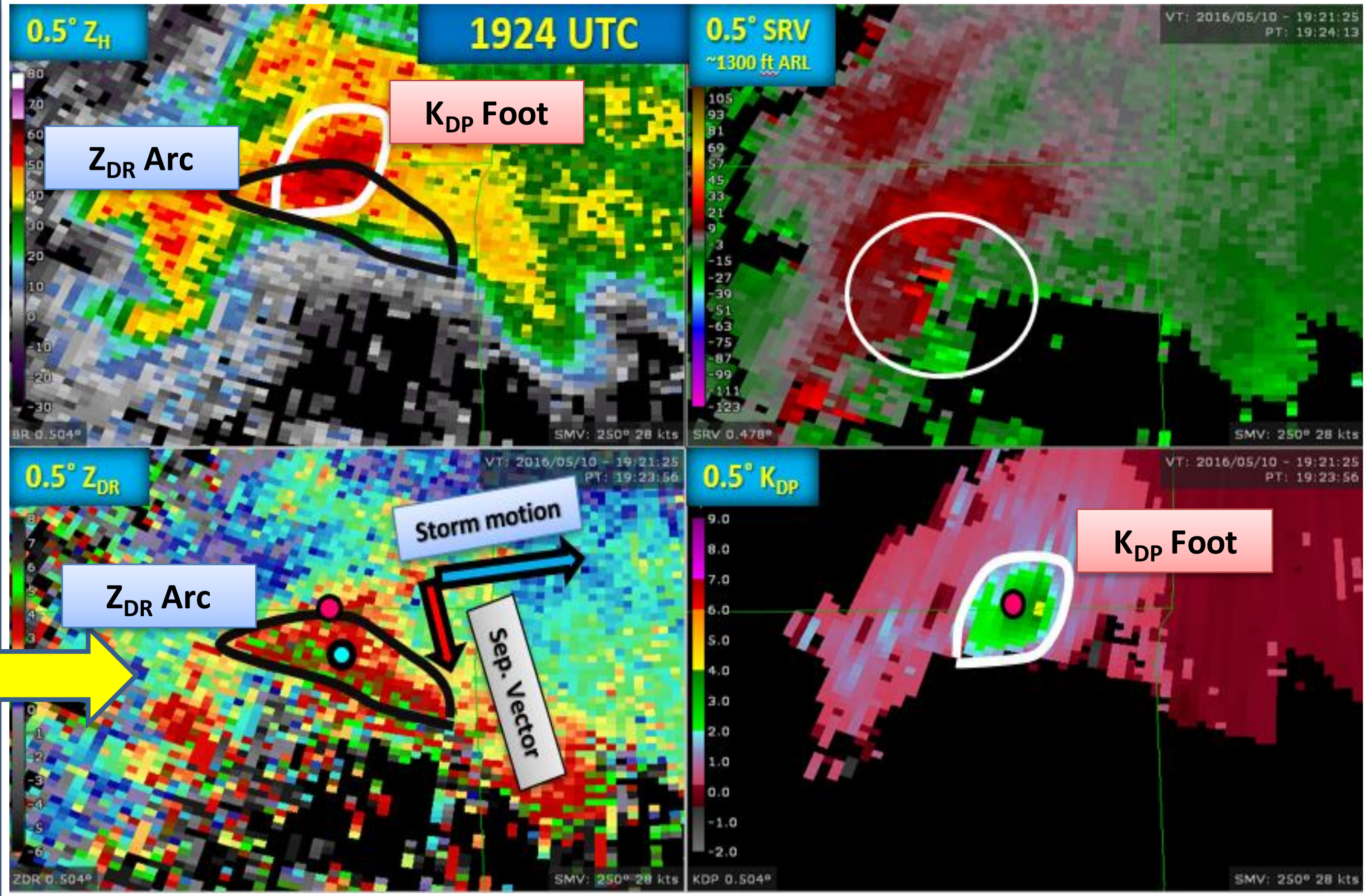
Adapted from Romine et al., 2008

SRH increases with separation vector orientations approaching orthogonal to storm motion (90° to the right)

(Loeffler and Kumjian, 2018)

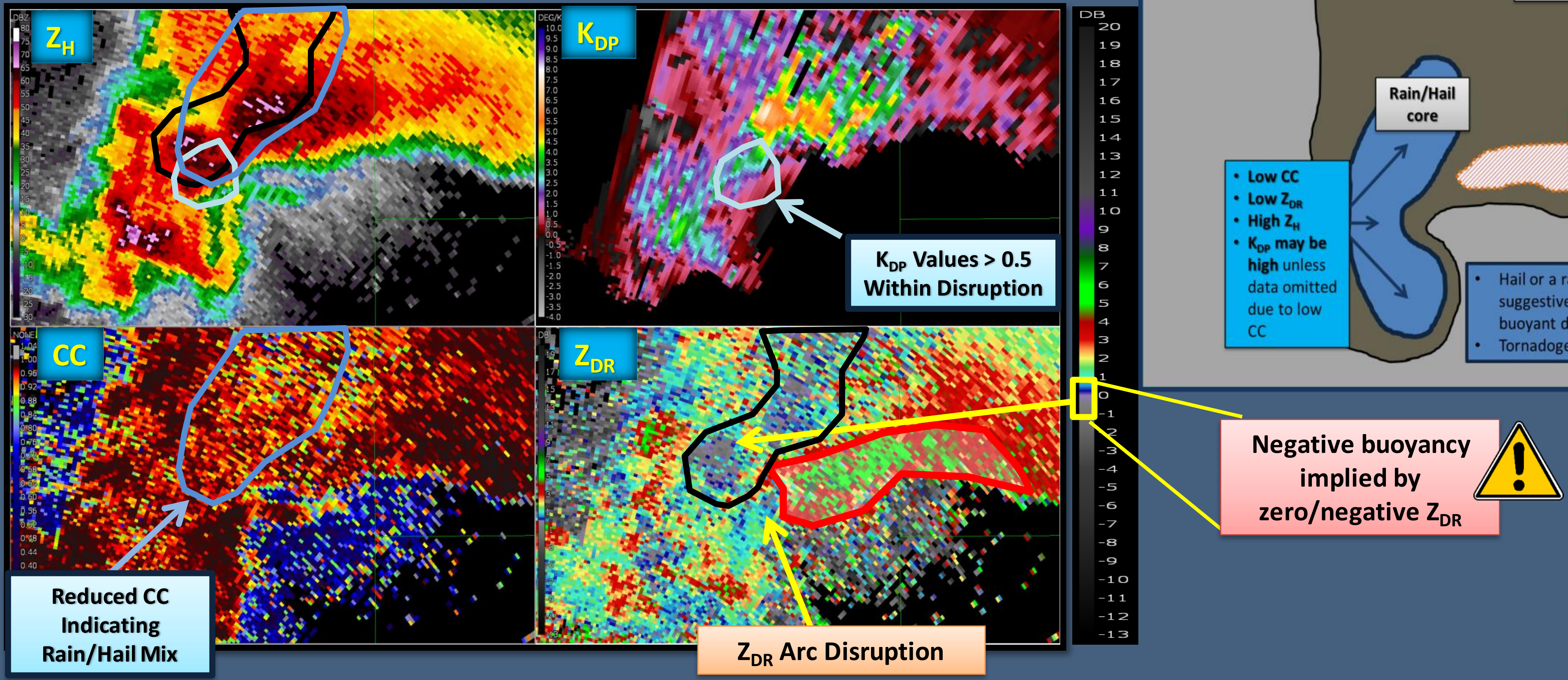


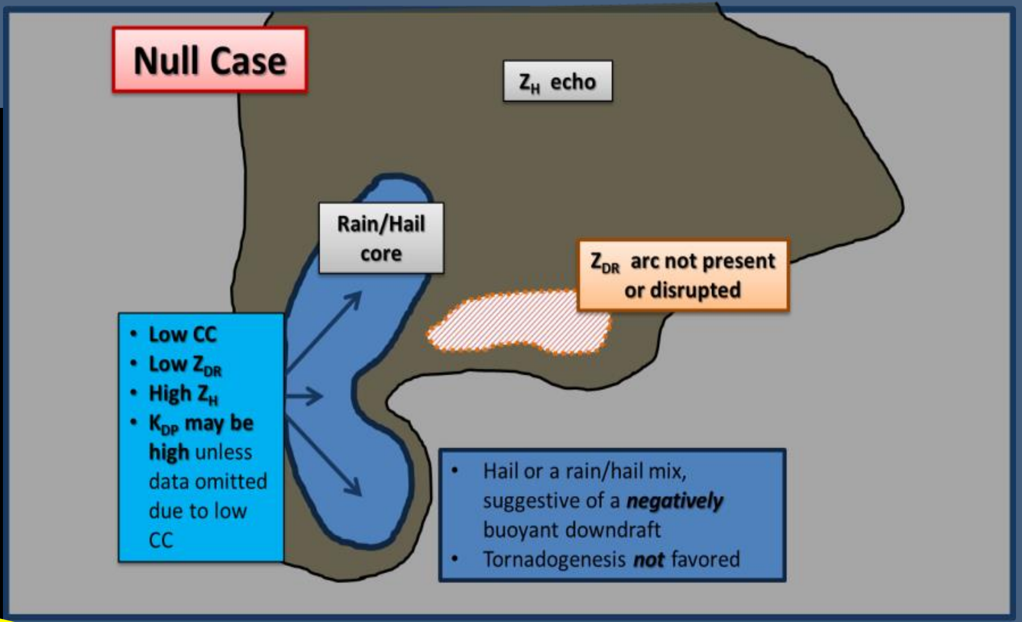
Adapted from Loeffler and Kumjian, 2018



Supercell-based Tornadogenesis – Radar Feature Reference Guide

Feature	Primary Application	Skill to Determine Tornadogenesis Potential	Important Note
Z_{DR} Arc Disruption (<65 nm from the radar)	Degree of negative buoyancy in near-surface airstream below meso	**High** – Stronger negative buoyancy typically inhibits tornadogenesis	Zero/Negative K_{DP} within disruption infers dry hail region that may not significantly add neg. buoyancy; genesis possible despite disruption





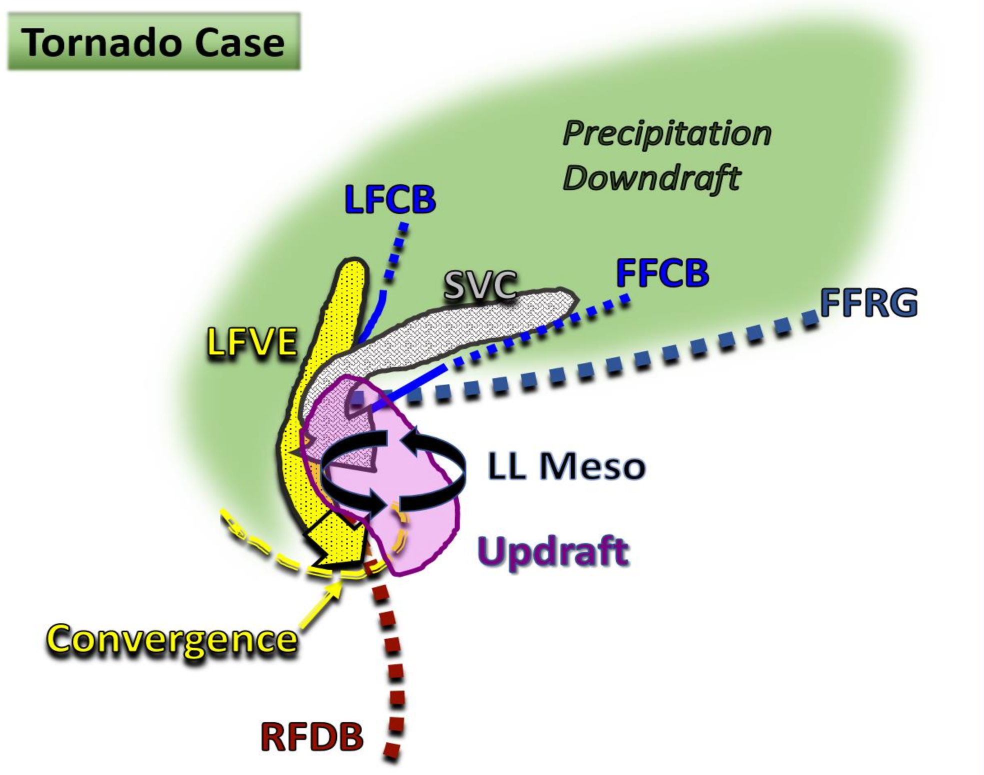
Supercell-based Tornadogenesis – Radar Feature Reference Guide

LFVE Conceptual Model

Feature	Primary Application	Skill to Determine Tornadogenesis Potential	Important Note
Left Flank Velocity Enhancement (LFVE) (<40 nm from the radar)	Track near-surface airstream feeding into region below low-level meso	**High** – Positioning of airstream convergence relative to low-level meso critical for genesis	Convergence signature under meso infers crosswise to streamwise vorticity exchange needed for genesis

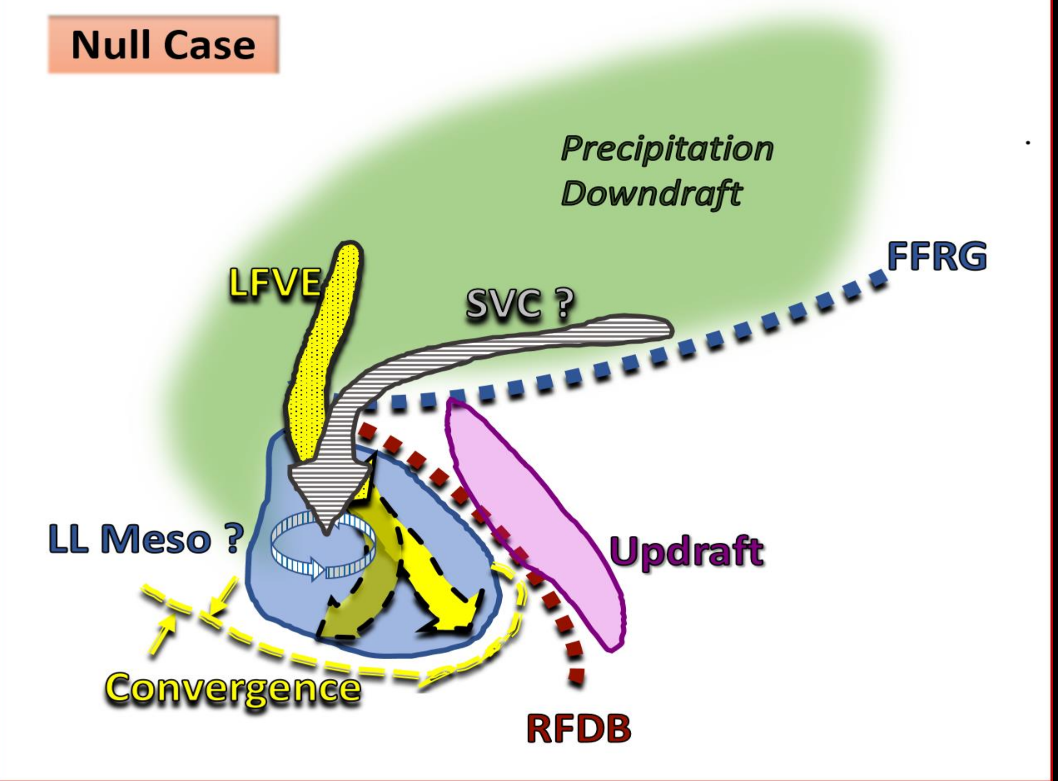
- Radar Viewing angle dependent (could be inbound or outbound)
  - Difficult to interpret when LFVE is orthogonal to the radar beam
- Best viewed <1 km (<40 nm from the radar)

Tornado Case



LFCB – Left-Flank Convergence Boundary
FFCB – Forward-Flank Convergence Boundary
SVC – Streamwise Vorticity Current
FFRG – Forward-flank Reflectivity Gradient
RFDB – Rear-flank Downdraft Boundary

Null Case



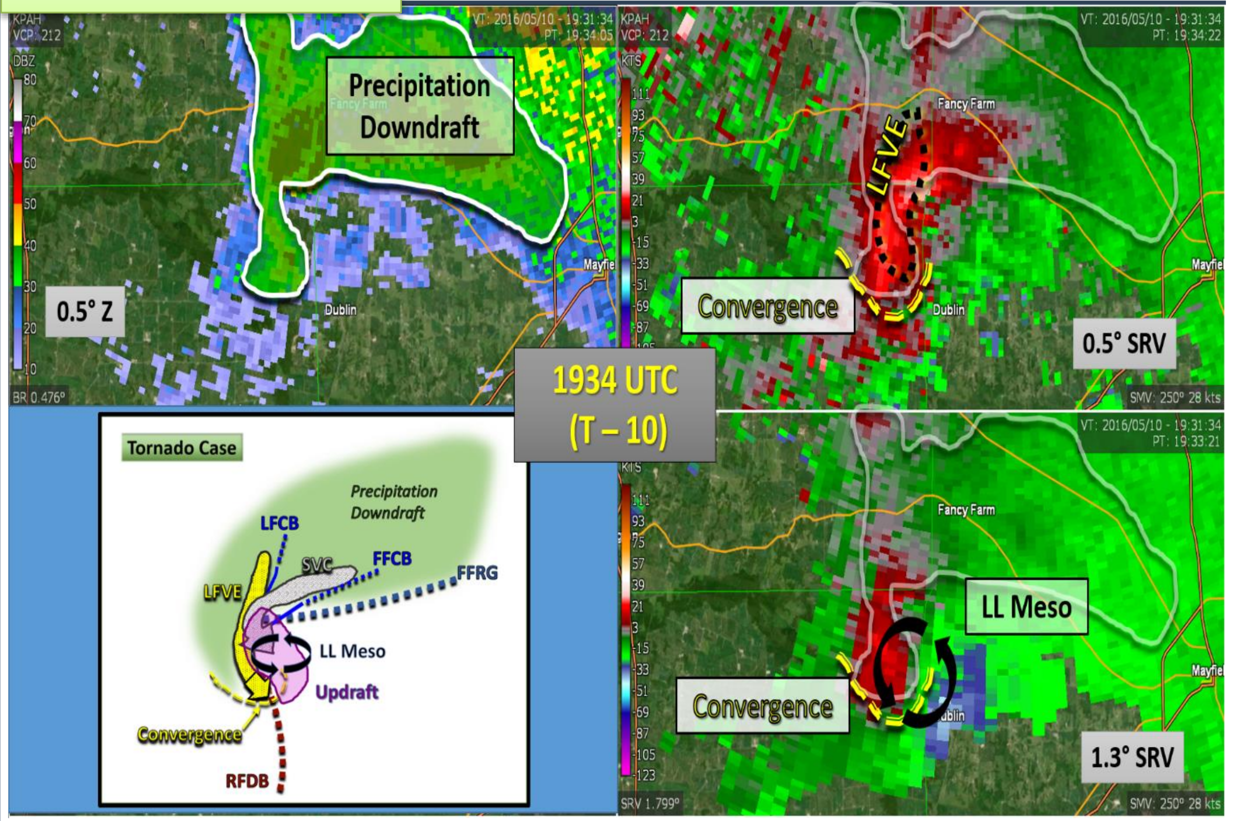
Supercell-based Tornadogenesis – Radar Feature Reference Guide

LFVE Examples

Feature	Primary Application	Skill to Determine Tornadogenesis Potential	Important Note
Left Flank Velocity Enhancement (LFVE) (<40 nm from the radar)	Track near-surface airstream feeding into region below low-level meso	**High** – Positioning of airstream convergence relative to low-level meso critical for genesis	Convergence signature under meso infers crosswise to streamwise vorticity exchange needed for genesis

- Radar Viewing angle dependent (could be inbound or outbound)
    - Difficult to interpret when LFVE is orthogonal to the radar beam
- Best viewed <1 km (<40 nm from the radar)

Tornadic



Non-Tornadic