Doppler Radar and Storm Environment Observations of a Maritime Tornadic Supercell in Sydney, Australia

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Motivation

- Late morning of 16 December 2015: EF-2 tornado 4 km from Sydney Airport
- AWS recorded a wind gust of 59.2 m s\(^{-1}\) (213 km/h, 115 kts) at 10:33 am LT (an Australian record outside of a tropical cyclone)
- The most costly disaster of the Australian 2015/2016 summer (AU$206M)
Motivation
Introduction
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- supercell tracked over water just off the east Australian coast
- several RFD pulses and strong gate to gate velocity couplets
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Early Results: SRH based on AMDARs
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\[ \omega = \nabla \times \mathbf{u}_h(z) = -\frac{\partial v}{\partial z} \mathbf{i} + \frac{\partial u}{\partial z} \mathbf{j} \]

[1] Select point at height \( z \) within storm inflow layer

[2] Tangent to hodograph marks the shear vector

\[ \frac{d\mathbf{u}}{dz} = \frac{\partial u}{\partial z} \mathbf{i} + \frac{\partial v}{\partial z} \mathbf{j} \]

\[ \mathbf{u} = \mathbf{u}_h(z) \]

[3] Vorticity vector is 90° counter-clockwise from shear vector

[4] Observed or predicted storm motion vector \( \mathbf{c} \)

[5] Streamwise component of the total vorticity vector

What is storm-relative helicity?
Early Results: SRH based on AMDARs
Early Results: SRH based on Dual Doppler

2325 UTC at 1.5 km AGL

2331 UTC at 2.5 km AGL
Early Results: SRH based on Dual Doppler
Early Results: SRH based on Dual Doppler

23:19 UTC
Early Results: SRH based on Dual Doppler

Vertical Profile of streamwise vorticity through the SRH maxima southeast of Kurnell in previous plots

23:13 UTC

23:19 UTC
Rapid removal of an early morning inversion due to:
(a) Precipitation into a dry layer on top of the marine inversion
(b) Lifting acting on the inversion layer
Vital tool for event reconstruction

Identification of RFD surges, low-level vortex spin-up

Essential lead indicator for tornado warning service

Via Dual Doppler, augments kinematic observations
Early Conclusions Regarding Radar Application

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