

# The Tornado Climatology of Australia 1795-2014

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## SUMMARY

- Trusting the existing climatology or its summary statistics for tornadoes in most countries is a significant leap of faith – substantial numbers of events go unrecorded if the events aren't being looked for.
- In 2013, a total of 63 tornadoes were identified using searches of social media and online print resources, comparing to 22 in the official database. This included 27 tornado days and 4 'outbreak' events of five or more tornadoes in one day.
- Despite suggestions that 2013 was a busy year, annual frequency in the late 1890s and early 1990s was either equal or greater, and no event occurred outside the range of the known climatology. This, combined with existing evidence, suggests that the annual frequency of tornadoes in Australia is 30-80 per year.
- Numerous candidate tornado events have been identified displaying damage characteristics of violent tornadoes. As no tornado has been officially rated above F3 for Australia (only 19% in official record were rated, and not all scientifically), this suggests results drawn from the existing record of intense tornadoes should be handled with care.
- Environmental conditions supportive to tornado development in a single year appear to encompass most of the known sub-groups (Tropical Cyclone, Cool Season, Localized Vorticity/Merger, Classic Plains).

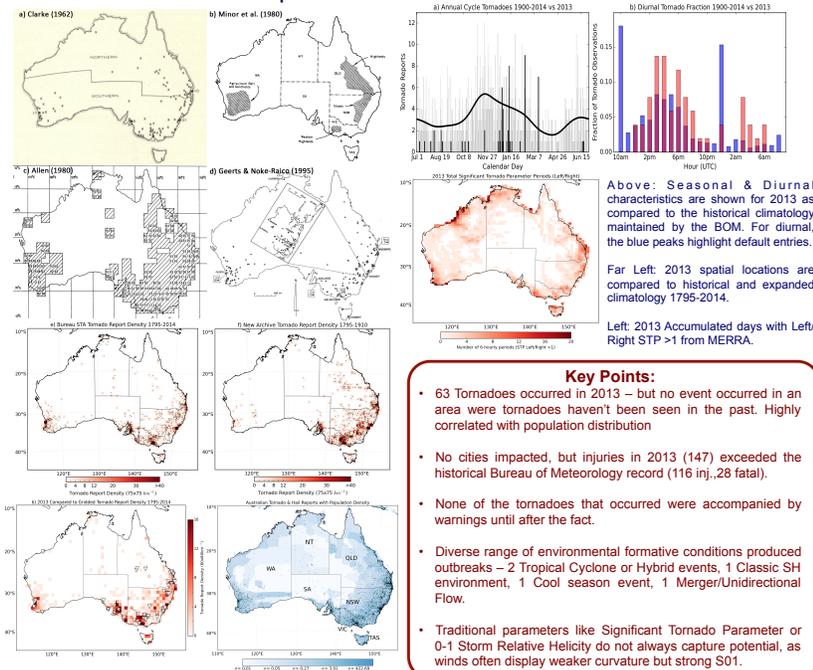
## DATA

- National Library of Australia (TROVE) digitized records searched using keyword optimization to identify tornadoes (categorized as definite, likely, possible) while reflecting changes to language (>80,000 records).
- Australian Bureau of Meteorology National Severe Storms Archive data for tornadoes 1795-2013, accessible via: <http://www.bom.gov.au/australia/stormarchive/>
- Existing climatologies, case studies and original Bureau Records
- MERRA Reanalysis for 2013 Outbreak Case Studies

## MOTIVATION

- Tornadoes documented in Australia since 1795, though actual frequency remains unknown due to an incomplete historical climatology.
- Efforts to extend climatology limited by scope or resources to investigate (e.g. Evesson 1969; Allen 1980, Geerts & Noke-Raico 1995).
- Recently, digitized newspaper and documentary records have been used to extend limited tornado climatologies (Ruahala et al. 2012) – Australia has an excellent archive for these.
- The unknown frequency means that the risk of destructive or fatal tornadoes is unknown, and needs to be quantified to understand risk – Here we ask: 'Was 2013 exceptional or unusual relative to known climatology?'

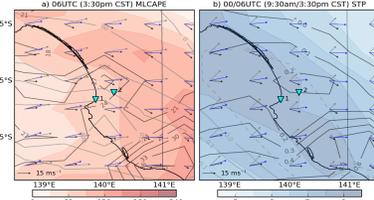
## How do Recent Observations Compare to the Past?



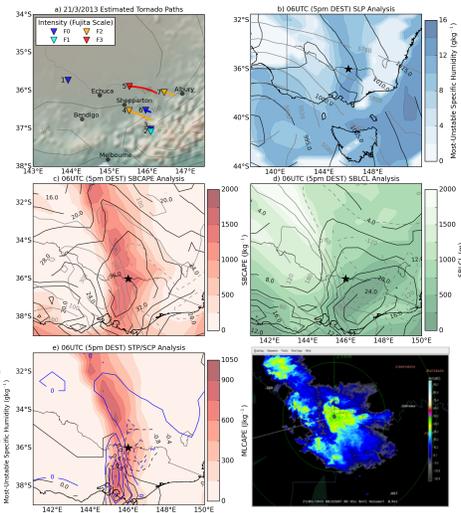
## Case Studies

To explore potential formative environments for tornadic storms in Australia, a series of case studies were undertaken. These highlight the diversity of conditions that can produce these events, suggesting the need to look beyond U.S. specialized parameters.

### South Australia – Cool Season (Low CAPE, high Shear) 23/03/2015 – 03UTC: 2 Confirmed Tornadoes

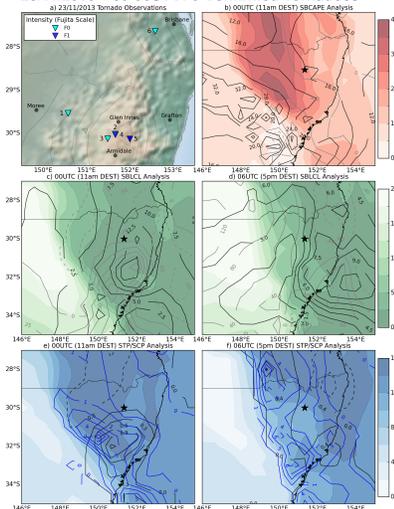


### Victoria – Classic Left Moving Regional Outbreak 23/03/2015 – 00-06UTC: 7 Confirmed Tornadoes



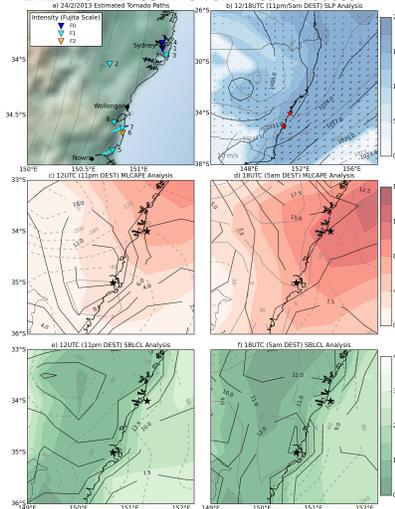
## Ben Lomond - Mergers/Unidirectional Shear

### 23/11/2015 – 00-06UTC: 6 Confirmed Tornadoes



## NSW East Coast Low – Like TC tornadoes.

### 24/2/2015 – 12-18UTC: 8 Confirmed Tornadoes



## Takeaway Points

- Just because existing climatology for a country has few tornadoes, does not mean they don't occur.
- Meta-searching approaches need to be explored globally for each country to ensure local climatology adequate for handling regional warning and forecasting information operationally.
- 2013 was anything but an exceptional year in terms of Australia's tornado history – more like the average.
- Tornadoes are much more widespread in Australia than the official existing climatology currently suggests, with extrapolated return rates for many locations less than 40 years.

## Ongoing Work

- Continue expanding 1795-2014 dataset via public crowdsourcing and the hand-digitized original Bureau records.
- Exploring further the environmental relationships using reanalysis data to develop forecasting guidelines and climatology.
- A one year case study exploring formalizing the work on the 2013 tornadoes and their implications for warning and climatology for Australia (AMOU).
- Review Article of Severe Thunderstorms in Australia shortly to appear in press in *Atmospheric Research*