After Action Review - Severe Thunderstorms November 17 2012

Introduction

The thunderstorm complex formed during a climatologically diurnal minimum period at around 2:30am west of St George and tracked eastwards at between 30 and 35 knots, reaching Brisbane after 10:00am. This large thunderstorm complex developed on the leading edge of a middle level cold pool. Figures 1-4 represent the sequence of events. As the storms moved east they showed signs of development on the northern flank. Between 9:06am and 9:30am, the scale of development on the northern edge increased rapidly possibly due to the presence of a subtle clear air wind change boundary interacting with the storm. Further rapid development occurred on the northern flank between 10:12am and 10:42UTC with a new thunderstorm updraft replacing the earlier storms.

Event Summary

The thunderstorm complex formed during a climatologically diurnal minimum period at around 161830UTC west of St George and tracked eastwards at between 30 and 35 knots, reaching Brisbane airport at 170041UTC. This large thunderstorm complex developed on the leading edge of a middle level cold pool. Figures 1-4 represent the sequence of events. As the storms moved east they showed signs of development on the northern flank. Between 23:06 UTC and 23:30 UTC, the scale of development on the northern edge increased rapidly possibly due to the presence of a subtle clear air wind change boundary interacting with the storm. Further rapid development occurred on the northern flank between 00:12UTC and 00:42UTC with a new thunderstorm updraft replacing the earlier storms.

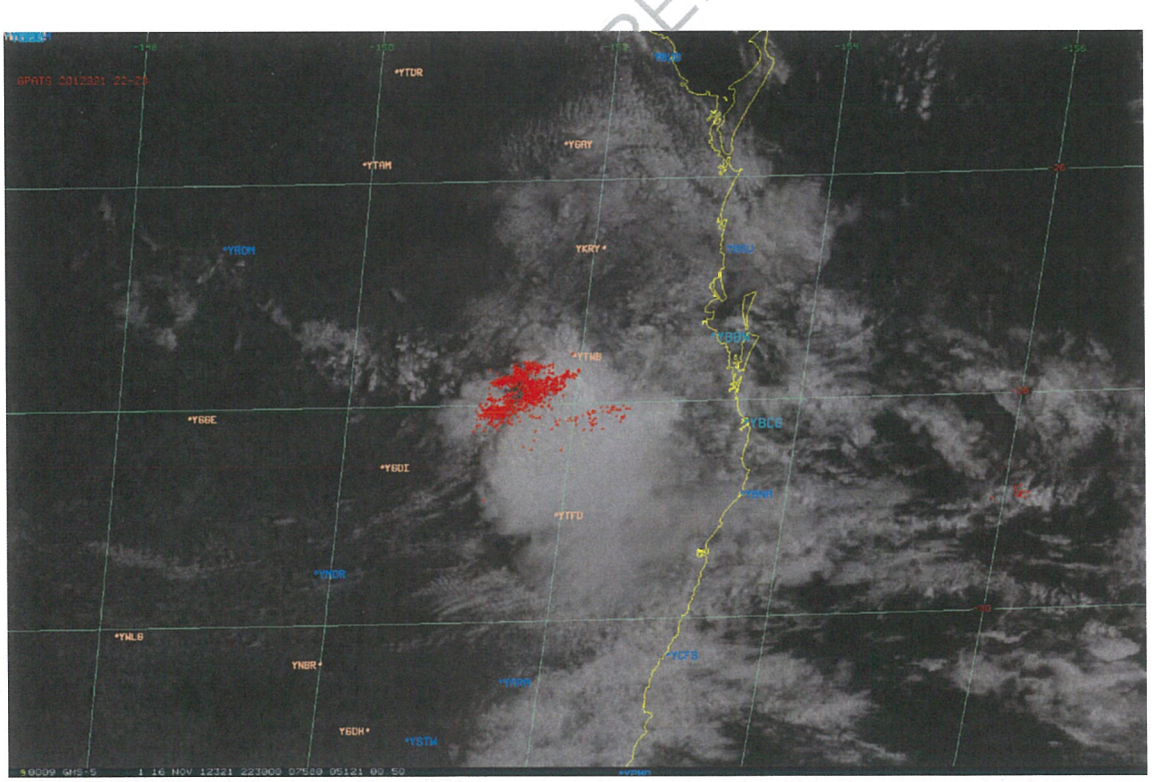


Figure 1: Visible satellite image with lightning strikes 162230UTC

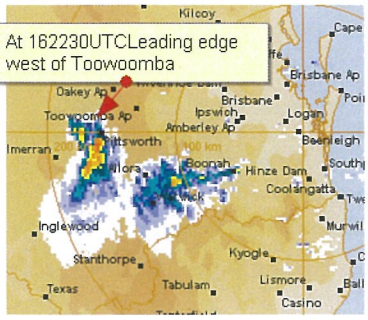


Figure 2: Radar 8:30am

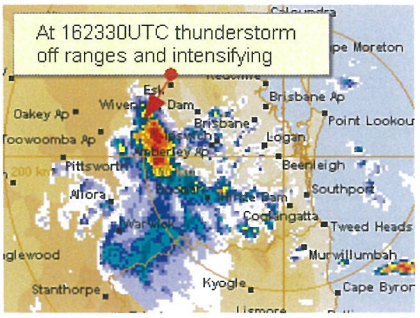


Figure 3: Radar 9:30am

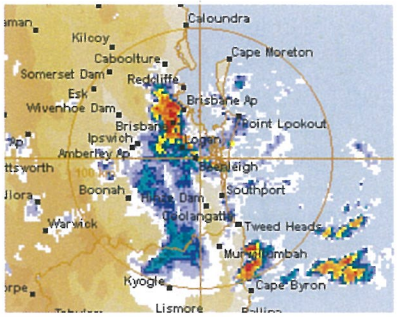


Figure 4: Radar 10:48am

Reports

The most significant reports from the storm were damaging winds and short periods of very heavy rainfall

Damage Reports 17/11/12

Various reports of tree damage across Brisbane City and flooding (due to a combination of higher than normal tides and heavy rainfall) in Bowen Hills

90 km/hr wind gust was recorded at Inner Beacon (Moreton Bay) at 11:24am.

An 81 km/hr wind gust was recorded at Brisbane Airport at 11:11am.

A 70 km/hr wind gust was recorded at Brisbane City at 10:54am.

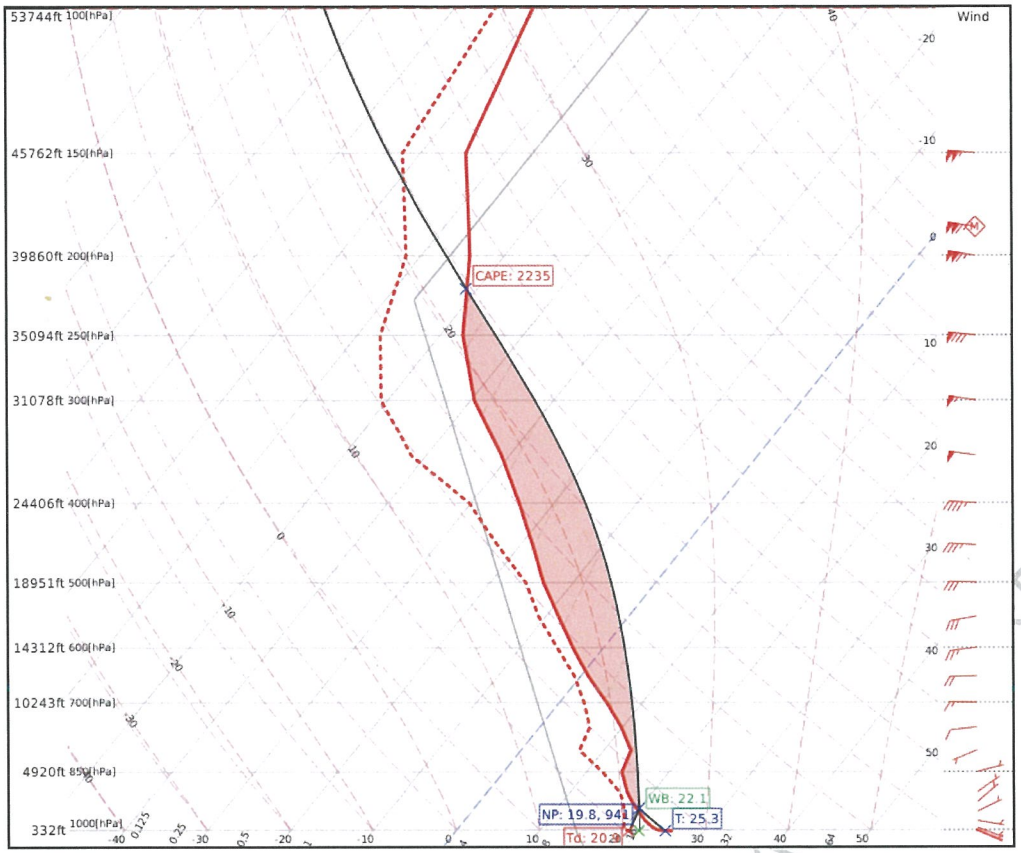
The duty night shift senior forecaster wrote in the Forecast Policy issued at 2:41am EST on Saturday 17 November 2012;

> "Surface trough near stationary on SE coast, becoming a convergence line and curves back into the Darling Downs to the SW. This trough then merges with western trough over the Darling Downs as a "V". Maximum instability over the SE region with the convergence and heating will lead to early thunderstorm build up and will increase into the afternoon with possible severe cells."

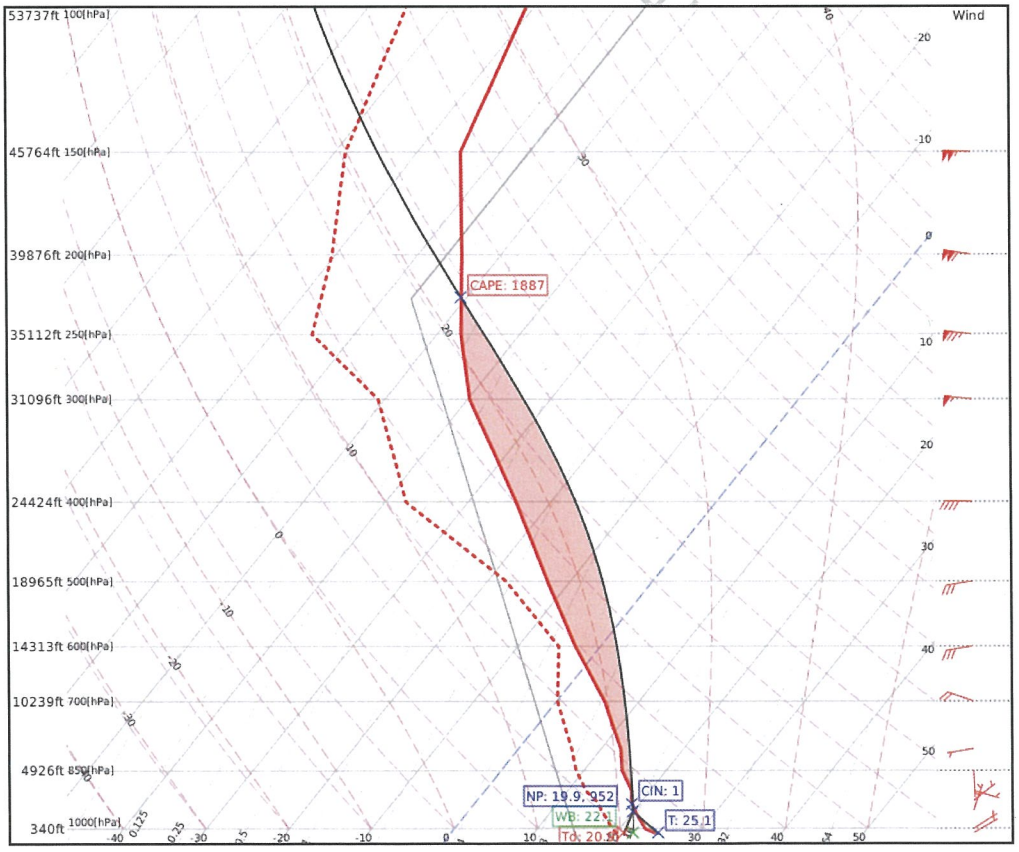
This indicates that the Brisbane RFC was anticipating early thunderstorm build up in parts of the south-east Queensland region with possible severe cells developing as additional heating took place.

In the absence of the low level routine temperature and sounding information, forecasters reverted to the use of other sources of data to analyse the environment. Combining surface temperature and dewpoint conditions and the modelled upper atmosphere, forecasters felt that the storms were not sourcing surface air and that the likelihood of severe weather was lower than requiring a warning. AMDAR data is still being sourced and this will allow additional analysis of the environment the storm experienced, in particular the low level environment

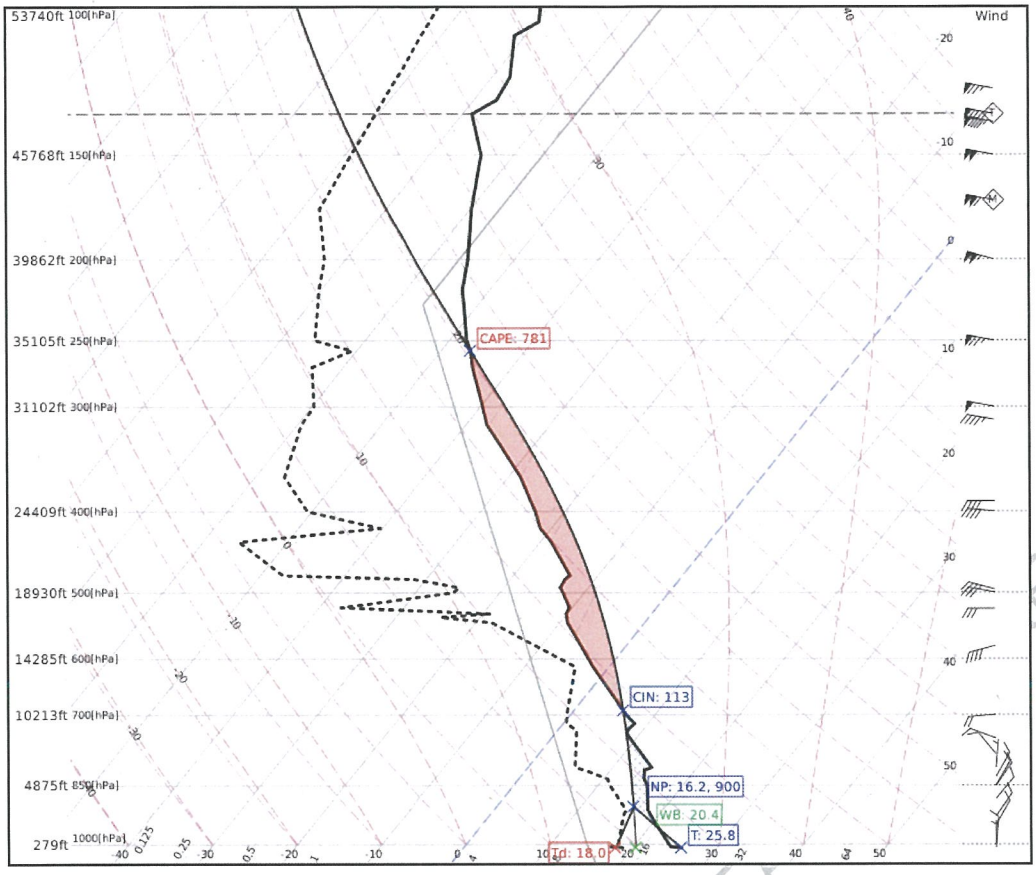
US GFS Trace, 00Z timestep and 00:30Z Brisbane obs of T:25.1 and Td 20.8 giving CAPE of 2235 J/kg:



ECMWF Trace, 00Z timestep and 00:30Z Brisbane obs of T: 25.1 and Td 20.8 giving CAPE of 1887 J/kg.



F160 from 3pm (05z) 17/11/12 with Brisbane city obs of T: 25.8 and Td: 18.0 giving elevated CAPE of 781 J/kg.



F160 from 9pm (11z) 17/11/12 with Brisbane Airport obs of T: 23.8 and Td: 22.1 giving elevated CAPE of 2276 J/kg.

Available computer modelling indicated that the atmosphere near Brisbane was fairly stable and that heating would further destabilise the environment increasing the likelihood of thunderstorms later in the day. Between 162200 and 170000 forecasters were closely tracking the thunderstorm complex. The senior forecaster was working under the premise that the thunderstorm complex would weaken after moving away from the ranges. When it became clear that the complex had not weakened and in fact was developing on the northern flank as it moved east, a severe thunderstorm warning was issued. The fast movement of the thunderstorm complex was a factor in the short lead time as was the two phases of new development on the northern flank.

Some of the contributing factors for this short advice were:

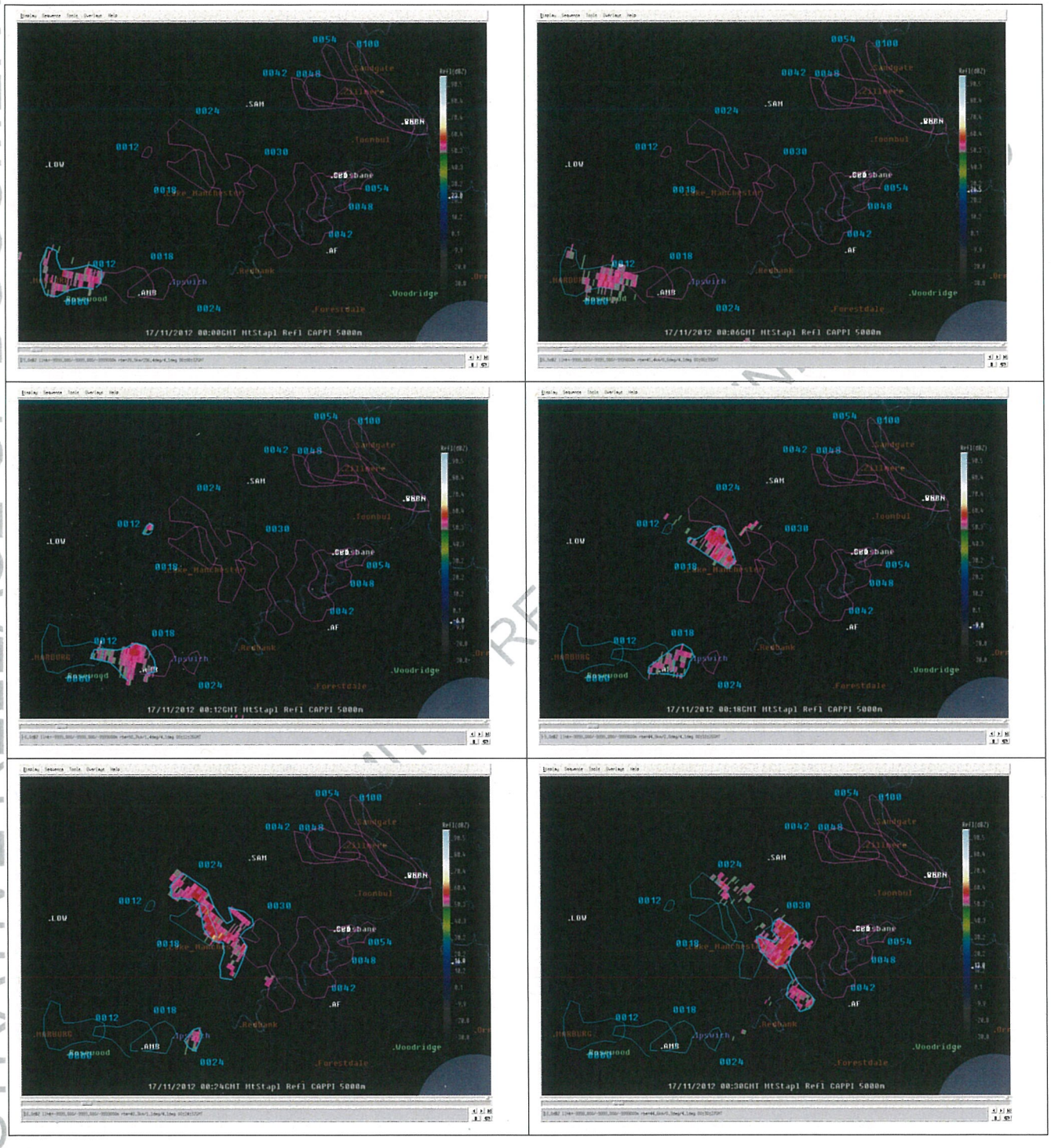
1. The absence of scheduled temperature and stability soundings at 161100 and 162300UTC owing to failure of a computer card in the sounding equipment. This meant that judgement regarding the type of atmosphere the thunderstorms were moving into was made more difficult. Humidity sensors on aircraft would make AMDAR data even more useful in similar events.
2. Fast movement of the complex thunderstorm 30 to 35 knots. The assumption by the senior forecaster was that the modelled atmosphere was more stable nearer the airport and the system would weaken.
3. The two phases of rapid development on the northern flank of the storm meaning the northern-most portion of the complex extended to Brisbane Airport.
4. Thunderstorm occurred at a climatological minimum, which is rare.

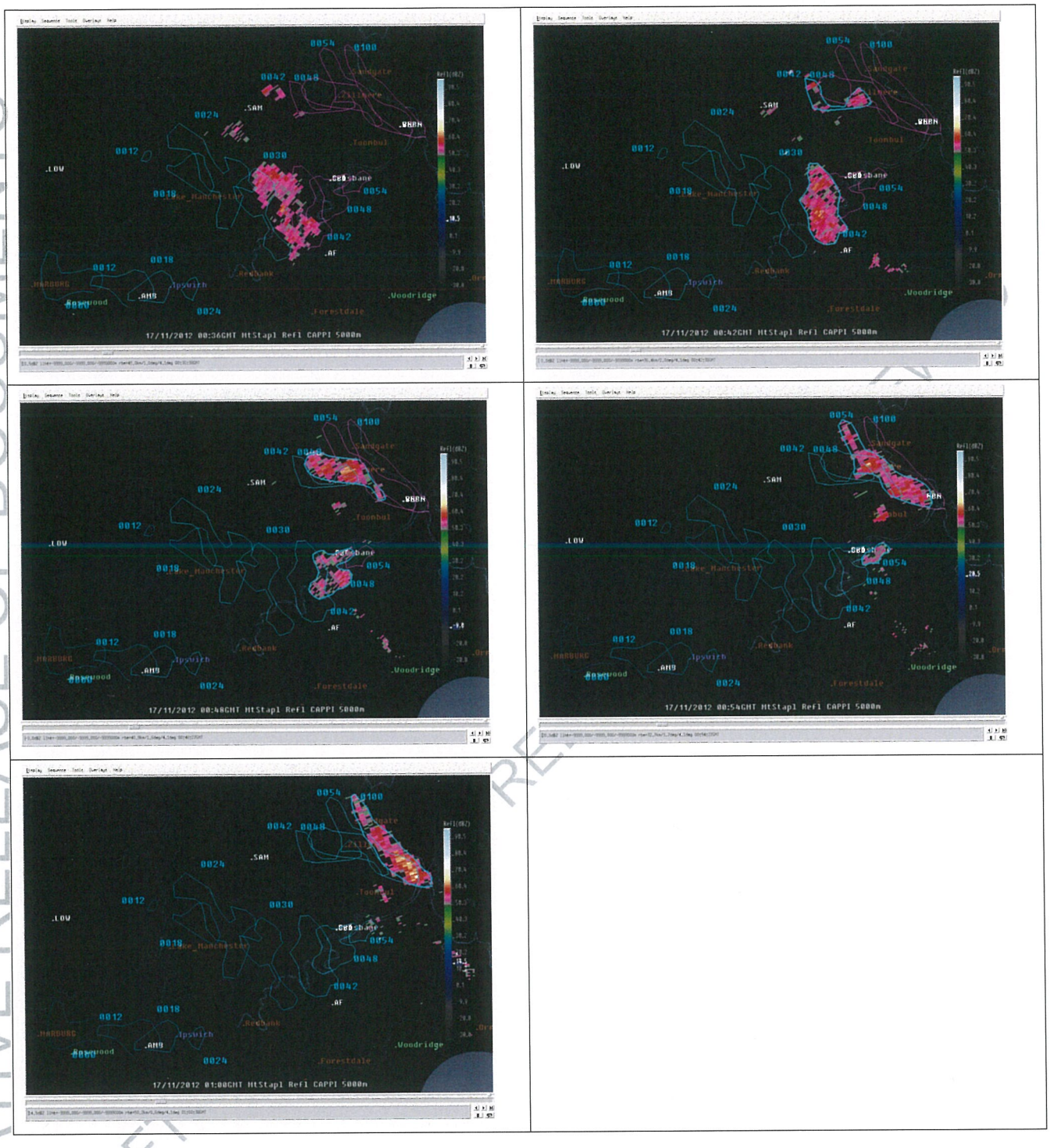
The strength of the storm at the surface may have been enhanced by large amounts of hail melting in the upper atmosphere adding momentum to the downdraft.

Post-event radar analysis – a full report into storm is in preparation.

To somewhat "conceptualise" the morning convection of Saturday 17 November 2012

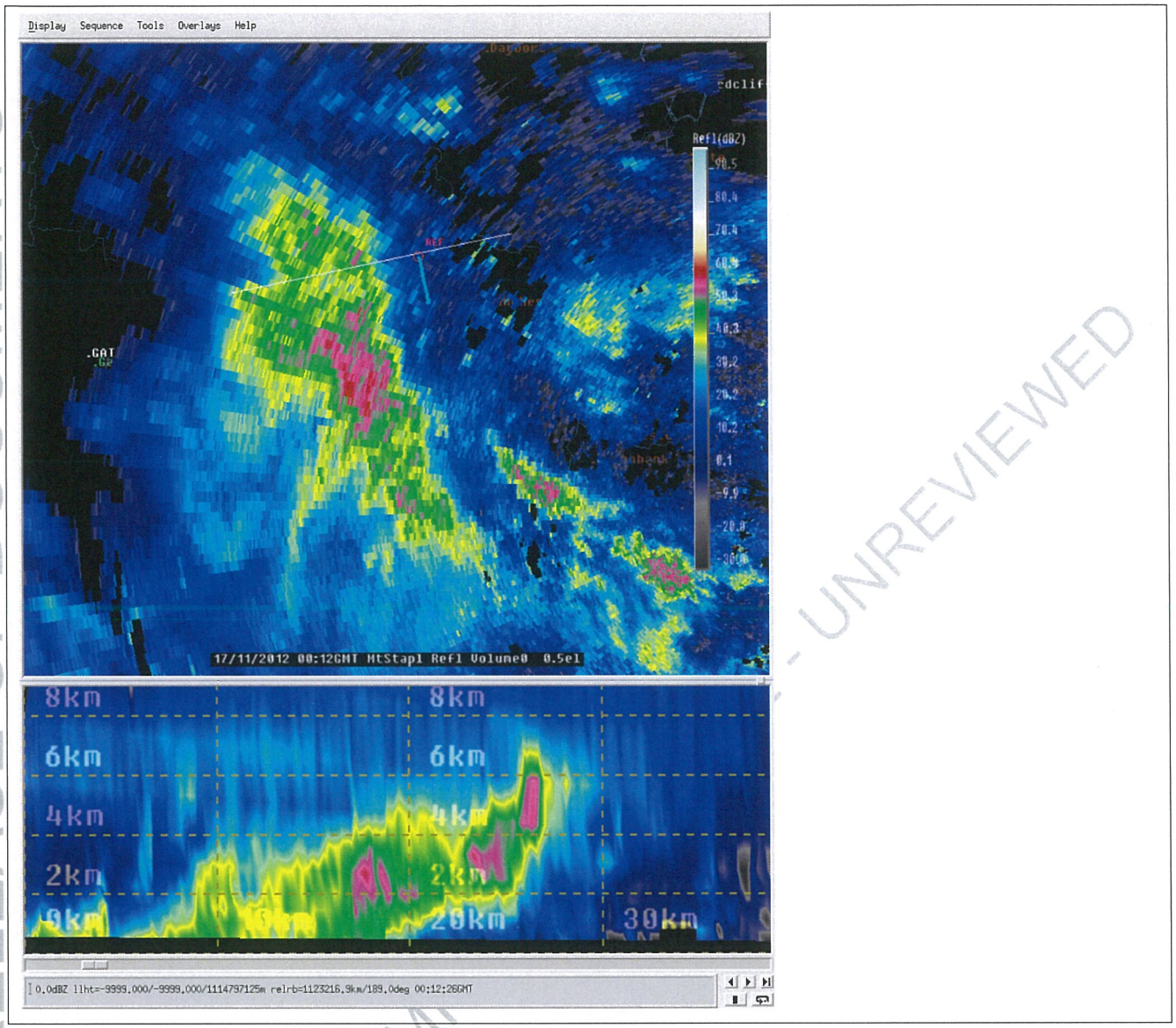
in the Brisbane area, looking at radar data above the surface provides useful insight. The images below are taken from 00z to 01z at approximately the -10 C level (or 5km above the surface). This level is significantly lower than the standard CAPPI level we use for monitoring severe convection, which is closer to -25 C.

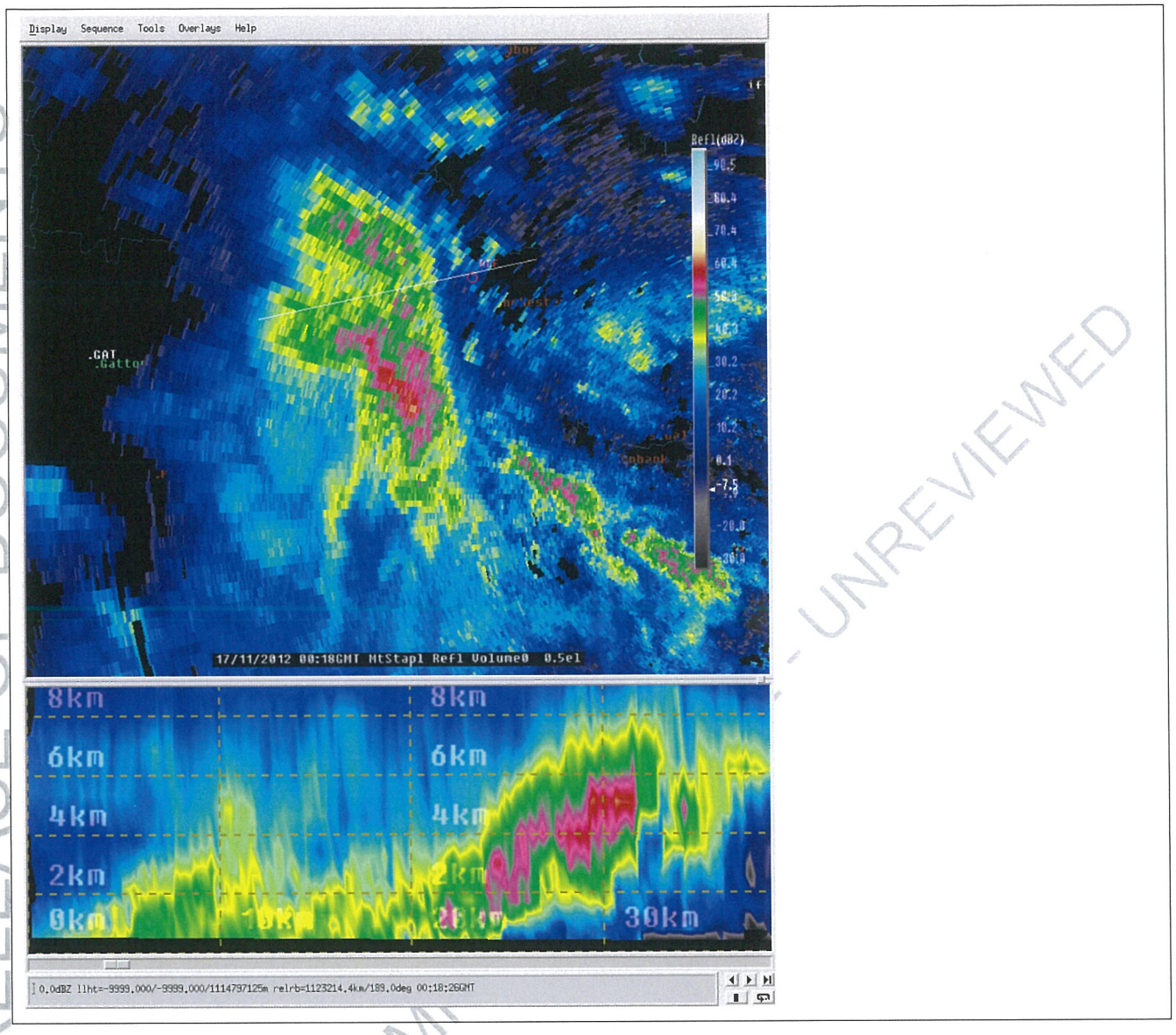


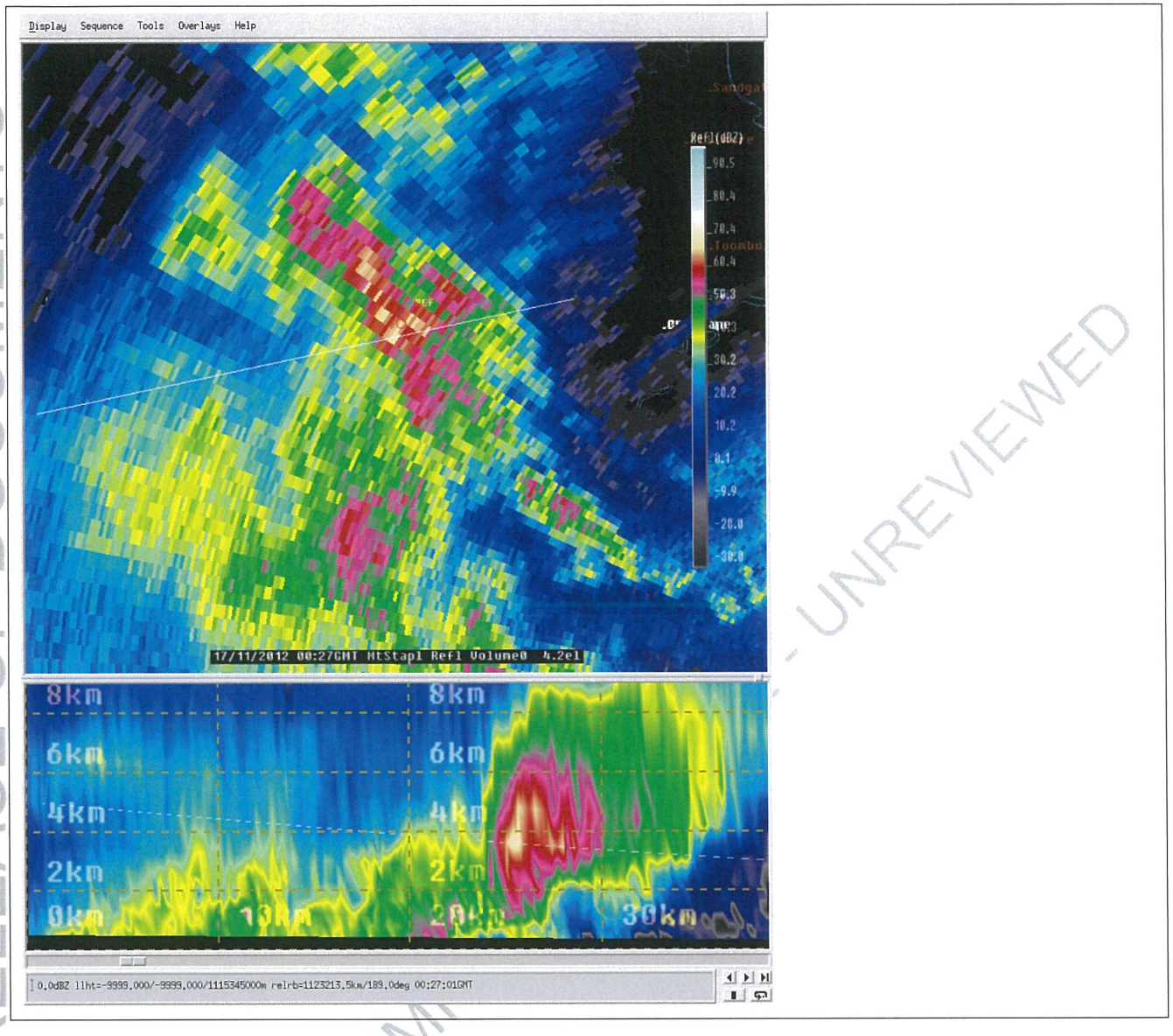


In that 1-hour period there are three 'episodes' of stronger convection, with the first tracking from Marburg to Ipswich, where the elevated core has decayed appreciably. Around 0012 UTC, a "handover" process commenced, initially in the form of a couple of new elevated cores initiating off the northern segment of the gust front of old quasi-linear system. That gust front looked rather weak as did the original line segment.

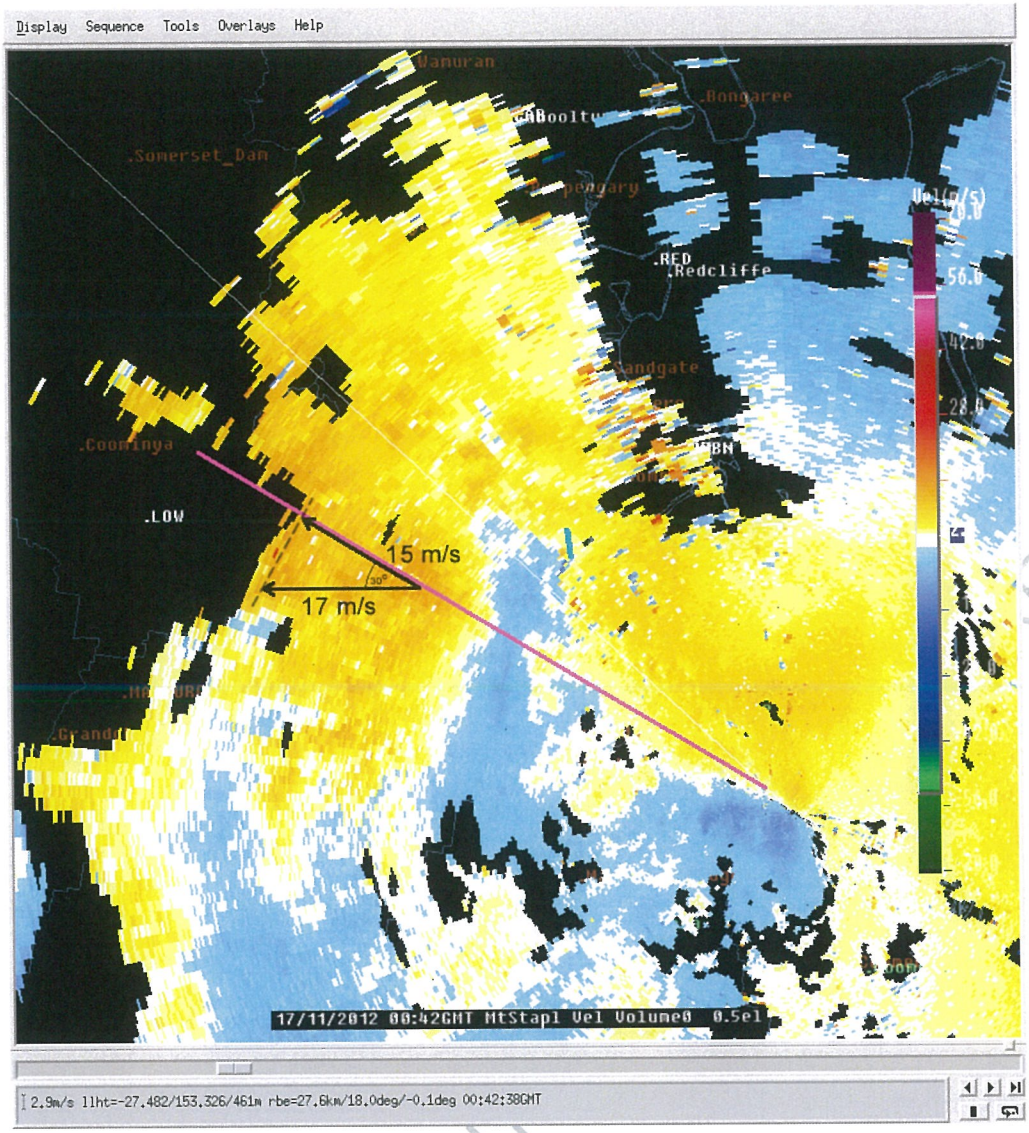
While the southern end of the line segment decayed, the new convection develops a decent hail core with reflectivities in the mid 60s, but at a relatively unimpressive altitude of around 4 km ARL (see 3 cross sections below).







In the absence of any large hail reports, it appears that the descending, sublimating and melting hail core of this multicell was associated with a cool descending outflow of considerable strength. That strength is not obvious to me at 00:42 UTC in the 0.5 degree radial velocity. The next image shows a patch of outbounds to the west of the West End - Kelvin Grove line (in light blue). The maximum radial velocity in that patch at that time is around 15 m/s. After viewing angle correction (a projection onto an east-west line aligned with the rear inflow notch of the system) we have 17 m/s or 34 knots of total estimated near-surface wind at that time. The radar data would suggest no warning on the grounds of observed near-surface wind speed.



The next three timesteps then trend 15 m/s --> 17 m/s --> 20 m/s --> 27 m/s in the radial velocities below 600m ARL.

It appears the 7.5km core of the system looked marginal. In an emerging field, one of the predictors for the damaging wind potential (including lower-topped storms) might be the presence of significant hail loading above the freezing level – this is being tested on the Gap storm. The notion of hail importance in downdraft strength is supported by international leaders in the field but remains the focus of study e.g. Roger Wakimoto. At 0045z ~65 dBZ was noted at around 5 km, at 0050z that maximum core is apparent between 2-3 km, and at 00:55z when the core enters the Brisbane CBD, a much diminished core sports the maximum reflectivies closer to 1 km ARL. This is evidence of a descending (and melting) hail core

Summary of events

- Excellent lead in to event with significant media coverage of impending dangerous weather and severe weather forecast within SE Coast District Forecast
- Detailed Warnings issued with no lead time during the morning
- Excellent escalation of later storms

- Media coverage during Saturday afternoon and Sunday continued to cover the events of Saturday morning which was sometimes at the expense of reporting on more dangerous storms during this period.
- Meteorology
    - Storms at a climatological minimum
    - No prior reports of severe weather
    - A subtle boundary moving across the main storm changes
    - First storm of the season and hence damage was enhanced
    - Flooding exacerbated by high tides and sea level anomalies driven by NE winds
    - Rain rates did not exceed any thresholds defined as severe
    - Low level reflectivity was significant but velocity images did not support warnings

Key Actions and future learning

Actions for 2013/14

- As part of the pre-season training and preparedness, ensure all forecasters are briefed on the storm and the implications to the warning services.
    - Highlight the positives of the early warnings provided in the days leading up the event
    - Use as an opportunity to provide refresher on the use of AMDAR data and ways to assess the environment
    - Impress upon forecasters longer lead-times associated with Regional STS Warnings
- Once completed. provide the meteorological report into the event to all forecasters involved in producing STS services
- Establish better control of key phones in the Regional Forecast Centre – install a dedicated media line and change the phone numbers of key telephones to allow better
- Continue to follow work on melting hail and it's role in downdraft production
- Feed learnings from the incident into future national reviews of warning systems

First Metro warning 17/11/12:

IDQ20038
Bureau of Meteorology
Queensland Regional Office

TOP PRIORITY FOR IMMEDIATE BROADCAST

SEVERE THUNDERSTORM WARNING - SOUTHEAST QUEENSLAND

for DAMAGING WIND

For people in the BRISBANE CITY, REDLAND CITY, North Stradbroke Island and parts of the GOLD COAST CITY, LOGAN CITY and MORETON BAY Council Areas.

Issued at 10:50 am Saturday, 17 November 2012.

The Bureau of Meteorology warns that, at 10:55 am, severe thunderstorms were detected on weather radar near Brisbane CBD, Logan City and Strathpine. These thunderstorms are moving towards the east. They are forecast to affect Cleveland, Sandgate and Brighton by 11:25 am and Point Lookout, southern Moreton Island and Tangalooma by 11:55 am.

Damaging winds are likely.

Emergency Management Queensland advises that people should:
* Move your car under cover or away from trees.
* Secure loose outdoor items.
* Seek shelter, preferably indoors and never under trees.
* Avoid using the telephone during a thunderstorm.
* Beware of fallen trees and powerlines.
* For emergency assistance contact the SES on 132 500.

The next warning is due to be issued by 11:50 am.

Warnings are also available through TV and Radio broadcasts, the Bureau's website at www.bom.gov.au or call 1300 659 219. The Bureau and Emergency Management Queensland would appreciate warnings being broadcast regularly.