HARDEN UP QUEENSLAND

GREEN CROSS Australia

CASE STUDY: Queensland Floods, January 2008

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Track of tropical low (ex tropical cyclone *Helen*?)

The track of the tropical low associated with the flooding rains (Fig. 1) shows its long track from the southeastern Gulf of Carpentaria, over to the Townsville region and then down through the centre of Queensland from 8 January to the 19 January 2008.

Ex tropical cyclone Helen was located just inland from the southeastern Gulf of Carpentaria on 7 January. The mean sea level (MSL) low associated with this system weakened and fluctuated in positions and intensity over the next 3 days.

However from model analyses the 850hPa cyclonic circulation remained a coherent feature moving south-westwards into the Burketown region by the 10 January and in Fig 2 the analysis from the European Centre for Medium Range Weather Forecasting (EC) at 1200UTC 10 January (9pm EST) shows a strong cyclonic circulation at 850hPa just south of Burketown. Therefore there is strong evidence in referring to the tropical low as ex tropical cyclone *Helen.*

Intensification near Townsville

The low then moved east and intensified as it interacted with a middle to upper level trough. From Fig. 3 the low then moved out to sea before turning back towards Townsville and appeared to reach tropical cyclone intensity soon after landfall. A severe weather warning was issued just after landfall for flash flooding and soon after was upgraded to include damaging winds. Trees were blown down at Cape Cleveland (just to the east of Townsville) as it came ashore. Later there were widespread areas of fallen trees between Townsville and Charters Towers as it moved inland and intensified. From radar it appeared to reach maximum intensity around 0150UTC 15 January (11.50 am EST) while located between Townsville and Charters Towers. It passed to the east of Charters Towers at 3pm EST where average winds of 52 knots were estimated with a MSL pressure of 993hPa which indicated that the central pressure was near 988hhPa at this time. Torrential rain fell at Charters Towers causing severe flash flooding and 147mm was reported there as the low passed the station.

Wind structure associated with heavy rainfall near Townsville

The heavy rain fell in a region where the wind directions turned anti-clockwise with height (backing). Such a profile is associated with large scale ascent and produces rain areas with embedded thunderstorms. Studies by Bonell, Callaghan and Connor (2005), Callaghan and Bonell (2005) and Bonell and Callaghan have revealed that intense rainfall in Queensland is typically associated with a vertical wind profile that sees winds turning anti-clockwise with height with the highest rainfalls recorded from events where winds were mostly in the north-east quadrant.

The backing wind with height profile can be depicted by plotting the 700hPa winds with a vector calculated by subtracting the 850hPa wind vector from the 500hPa wind vector (850/500hPa shear). This is shown in Figure 4 and the solid black circles marked at the end of the 700hPa wind plots indicate ascent. This occurs in a region where the air flows from high to low thickness and is equivalent to warm moist air being lifted as it passes over a cooler denser air mass. In Fig 4 the available hourly rainfall intensities are plotted and the heaviest rainfall over the 24 hours up to 2300UTC 13 January was 353mm at Proserpine (location marked on the lower panel Figure 4) where northeast winds are lifted as they approach the coast. Heavy rain was also occurring further up the

coast around Townsville at 1200UTC 13 January (top panel). At 0000UTC 14 January the low can be seen approaching from the west.
In Figure 5 (top frame) the low is northeast of Townsville with heavy rain showers also wrapping around its western flank. These showers formed in the ascent region east of Townsville and then circulated around the centre of the low. This is very much like what happens near the centre of a tropical cyclone. In a tropical cyclone in such a sheared environment the eye wall convection is initiated in the ascent region and reaches maximum strength downwind and to the right (southern Hemisphere) of the 850 to 500hPa shear vector (Black et al. 2002). Convective cells then circulate right around the eyewall except in strong shear where they dissipate upshear. Black et al. (2002) found this using airborne radar data and in situ observations of the intense hurricanes *Jimena* (1991) and *Olivia* (1994). As the low came ashore (lower frame Fig. 5) very heavy rainfall intensities of up to 55mm/hour are evident southeast of the centre in the ascent region. Nevertheless the heaviest 24 hour totals occurred further down the coast where Crystal Brook recorded 245mm in the 24 hours to 2300UTC 14 January 2008.

Wind structure and moisture associated with heavy rainfall near over Central Queensland
The 24 hour rainfall totals covered by the period in Fig. 6 are marked in red in the centre panel. Totals in inland Queensland reached 313mm with the heavy rain over a vast area where the winds and thickness contours indicated strong and widespread ascent. This also continued over the following 24 hours (Fig. 7) with totals inland to 219mm.

Exceptional Rainfall
The rainfall over Central Queensland was analysed the Bureau of Meteorology Hydrology as having a very large Average Recurrence Interval (ARI) from the Belyando to the Warrego River catchments as follows:-.

Bogantungan	329mm in 24h ARI ~500 years
	453mm in 48h ARI ~500-1000 years
	604mm in 72h ARI~ 2000years
Anakie	313mm 24h ARI~ 200-500years
	386mm 48h ARI 200-500 years
	463mm 72h RI 500-1000 years

Flooding
The most significant flooding, in terms of damages and rarity, was in the Nogoa, Belyando and Warrego rivers.
Heavy rainfall occurred on the Central Coast of Queensland between Townsville and Mackay starting Sunday 13th January and continuing until Saturday 19th January. This caused a record major flood in the Haughton River at Giru on Tuesday the 15th and minor to moderate flooding in the Don, Pioneer and lower Burdekin Rivers. Intense rainfall of 143mm fell on Giru over 2 hours, whilst the heaviest daily rainfall totals exceeded 300mm causing flash flooding in the Proserpine and Airlie Beach area. As the low moved inland from Townsville very heavy rainfall and flash flooding occurred in the Charters Towers area during the afternoon of the 15th January.
Emergency Services evacuated many houses in and around the city of Emerald on about the 20th of January as floodwaters from the Nogoa River surrounded and isolated the city, and some evacuations also occurred a week later on the Fitzroy River around the city of Rockhampton on about the 28th of January.
Major flooding occurred on the Thompson/Barcoo Rivers Cooper Creek, Paroo River, Bulloo River, Warrego River, Dumaresq/Macintyre Rivers, and the Condamine/Balonne Rivers.
Emergency Services erected temporary levee banks where the Warrego River passed through Charleville Township; however the major flood level reached 6.02m on 22nd of January (lapping at

the foot of the temporary levee). Major flooding downstream of Charleville affected Cunnamulla until 29th of January.
Some of the higher flood levels included:-

Haughton River at Giru	**3.0metres highest on record.**
Nogoa River at Craigmore	16.25metres Record at the time
Nogoa River at Duckponds	14.52metres Record at the time
Nogoa River at Fairbairn Dam	4.44metres record at the time.
Nogoa River at Emerald	15.36metre (highest at the time).
Belyando River at Mt Douglas	9.90metres 3rd highest
Fitzroy River at Rockhampton	7.5metres.
Warrego at Lochinvar	85metres (2nd highest)
Augathella	6.5metres (2nd highest)
Charleville	6.02metres
Cunnamulla Bridge	9.91metres
Paroo River at Humeburn	6.3metres (3rd highest).
Bulloo River at Adavale	5.4metres (2nd highest)
Quilpie	6.2metres
Thomson, Barcoo Rivers and Cooper Creek basin- Muttaburra	5.78metres (5th highest)
Longreach	5.28metres (5th highest)
Isisford	8.68metres (2nd highest).

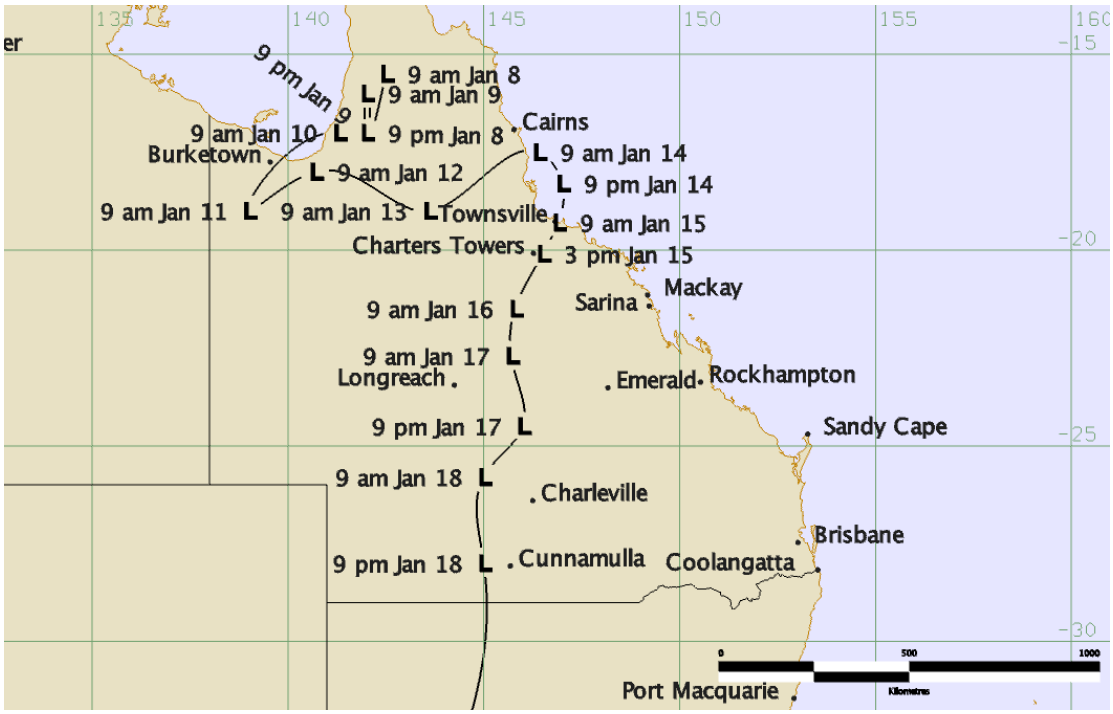

Figure 1. Track of tropical low pressure system associated with the Queensland floods of January 2008.

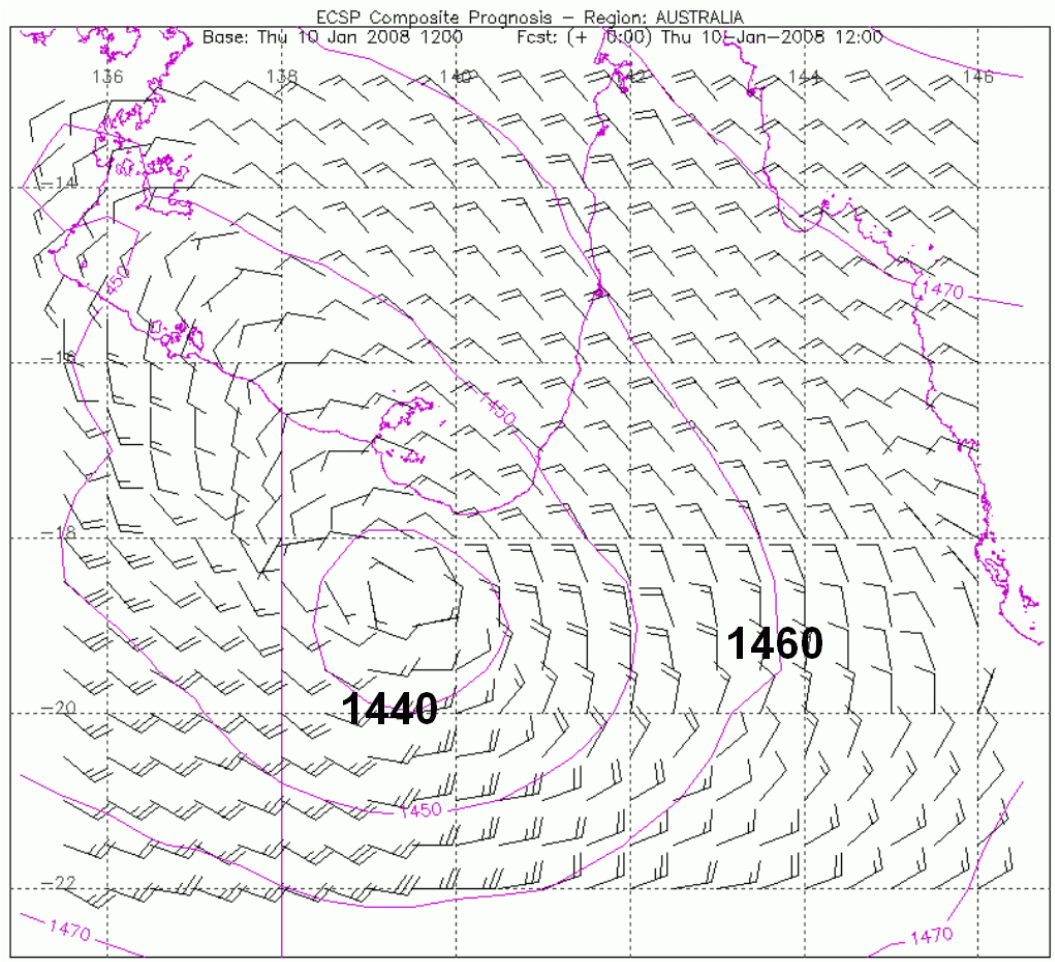

Figure 2. EC analysis of winds and geopotential height in metres at 850hPa at 1200UTC 10 January 2008 (9pm EST)

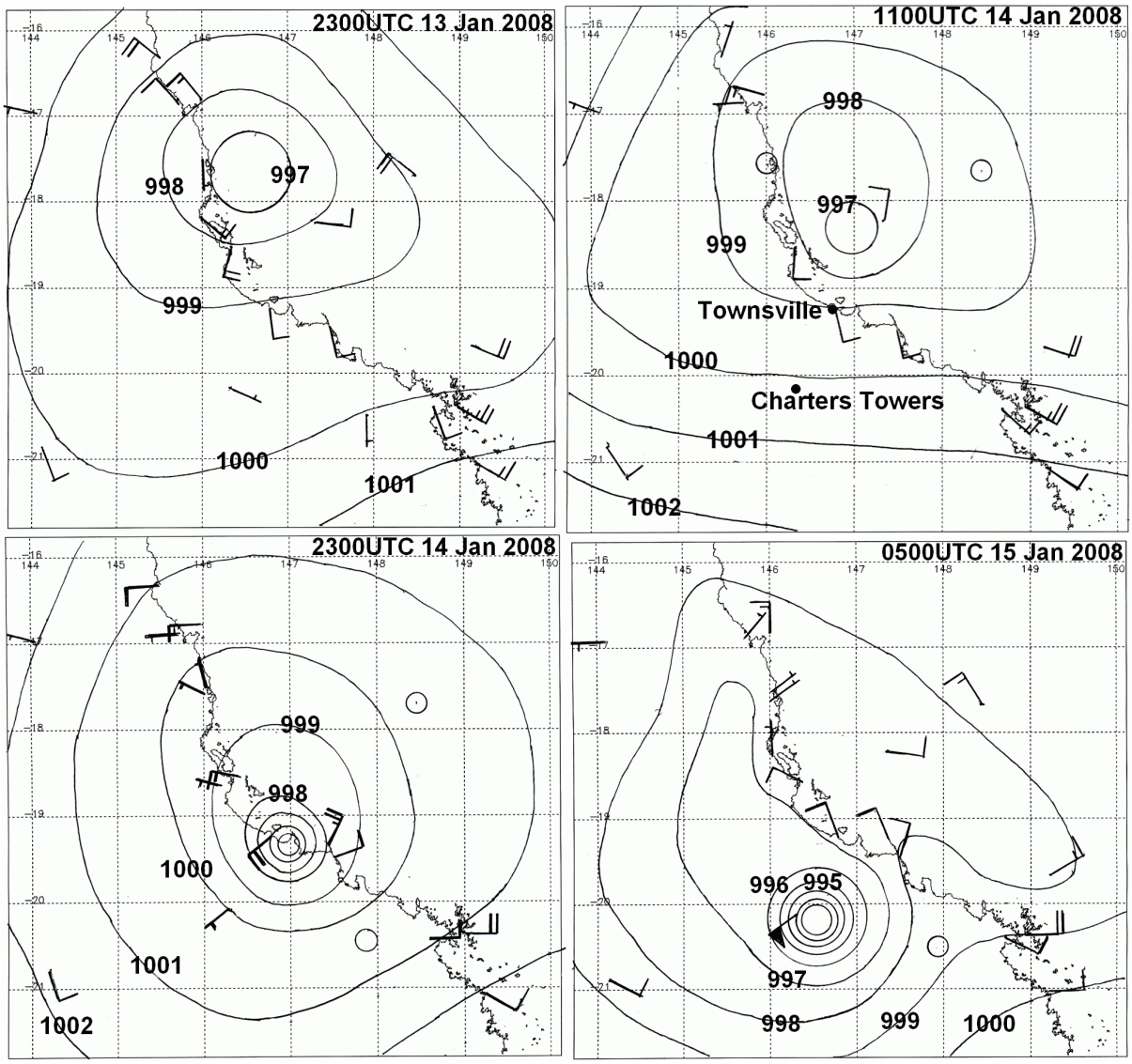

Figure 3. Pressure distribution (hPa) at mean sea level with wind observations from 2300UTC 13 January 2008 (9am 14th EST) to 0500UTC 15 January 2008 (3pm 15th EST)

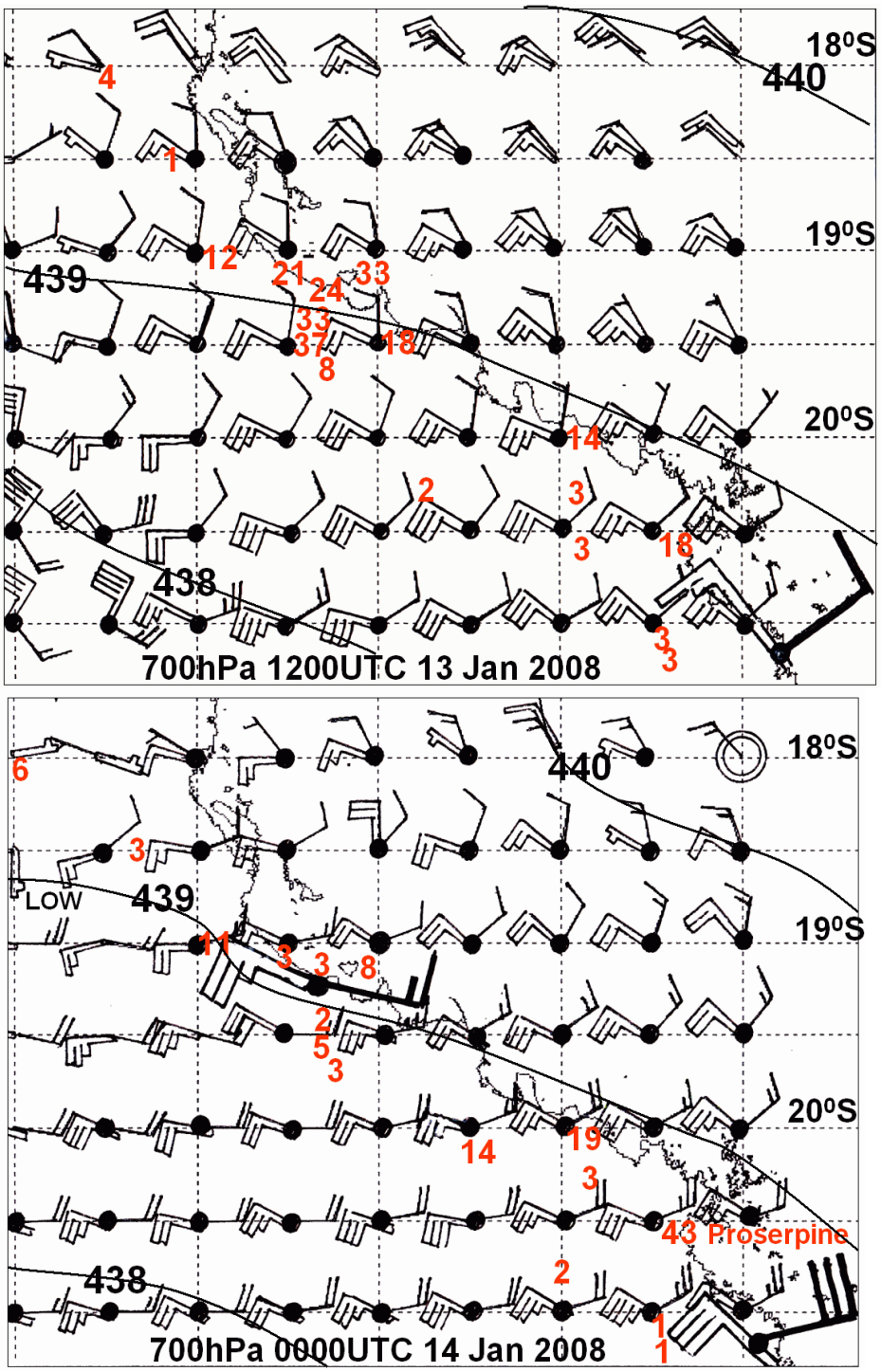

Figure 4. EC 700hPa wind plots and 850hPa to 500hPa shears (unfilled plots) with 850hPa to 500hPa thickness contours. Red numerals are hourly rainfall intensities at locations on the map within one hour of the analysis. Maximum 24 hour rainfall to 2300UTC 13 January 2008 was 353mm at Proserpine. Large plots are actual observations.

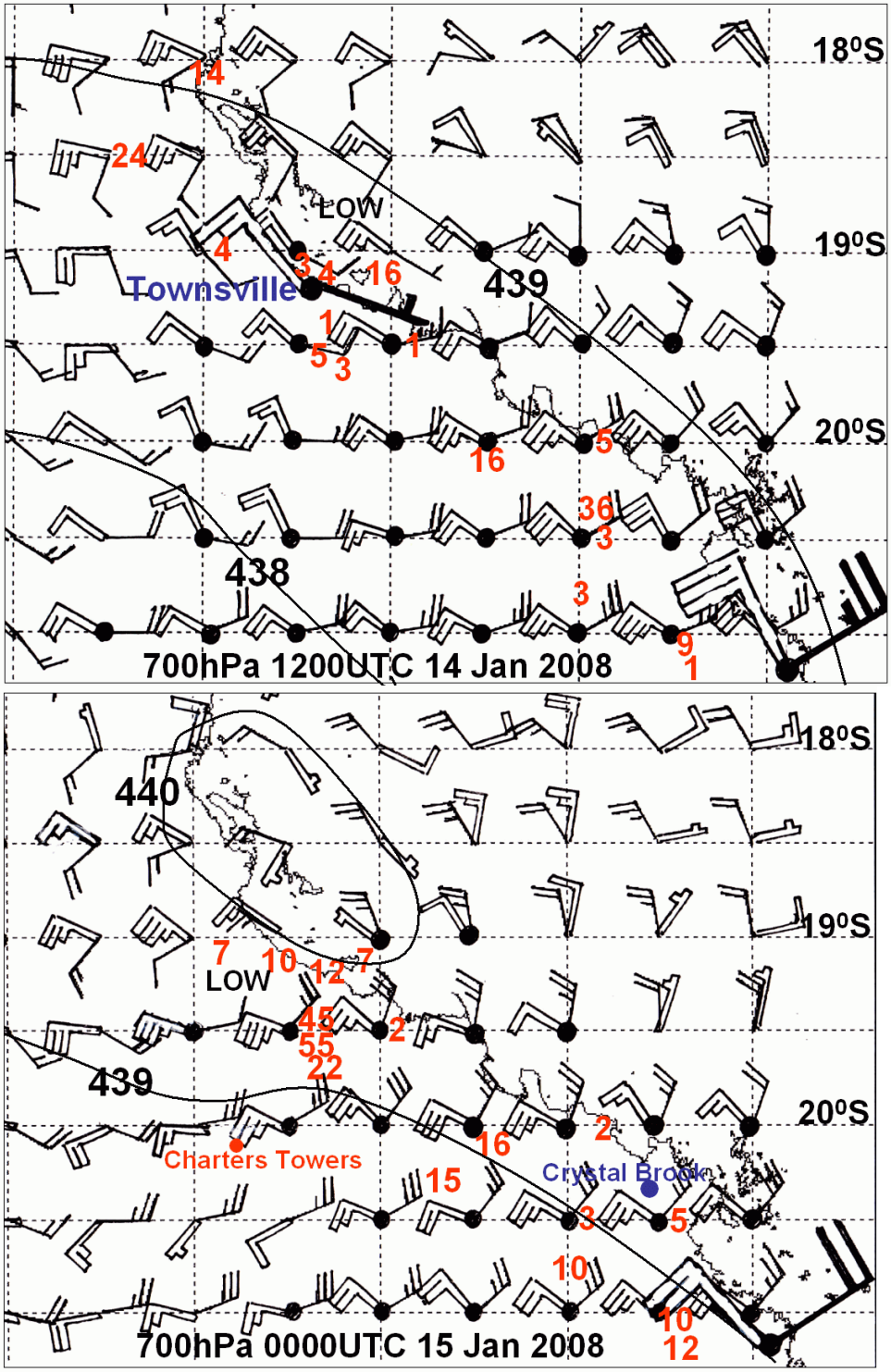

Figure 5. EC 700hPa wind plots and 850hPa to 500hPa shears (unfilled plots) with 850hPa to 500hPa thickness contours. Red numerals are hourly rainfall intensities at locations on the map within one hour of the analysis. Maximum 24 hour rainfall to 2300UTC 14 January 2008 was 245mm at Crystal Brook. Large plots are actual observations.

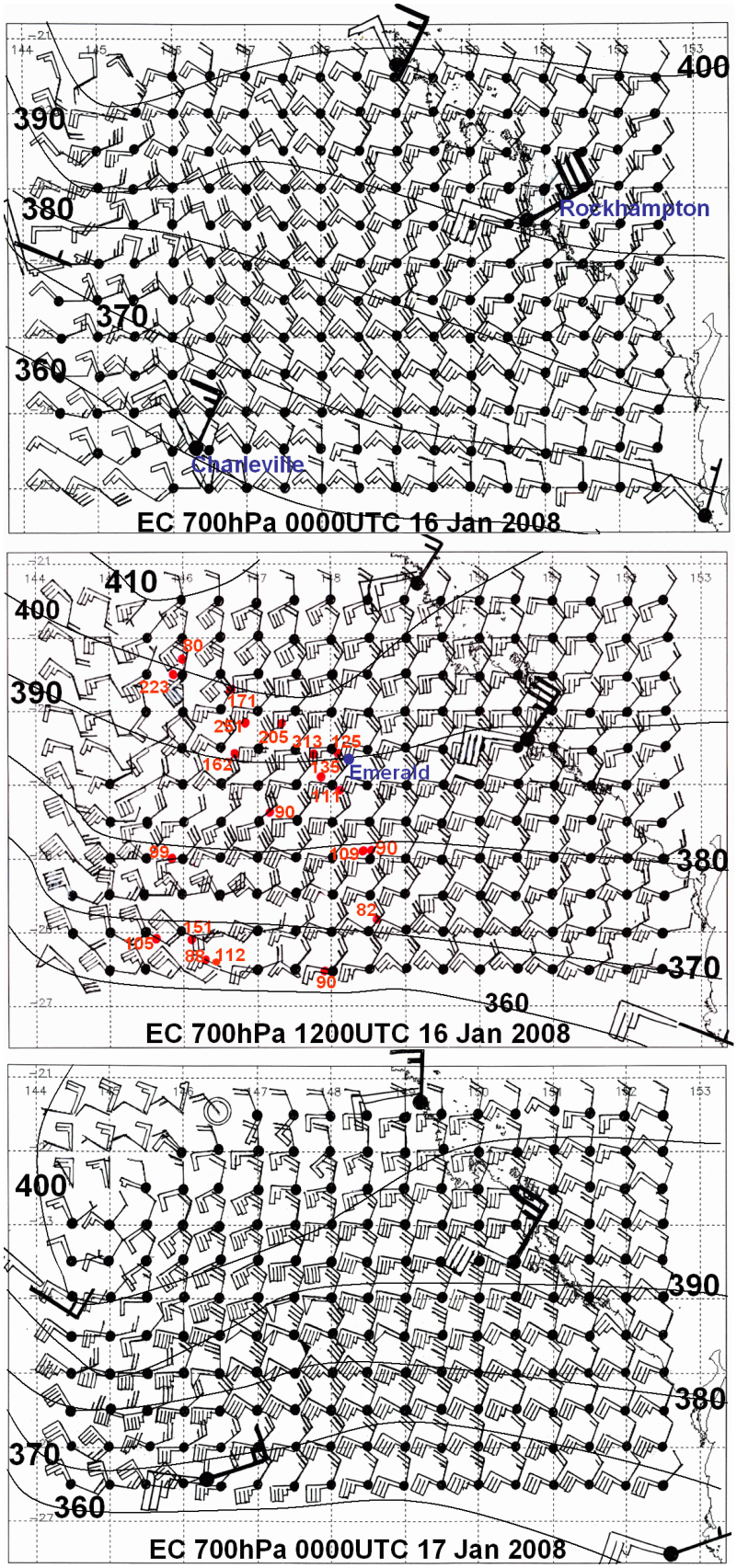

Figure 6. EC 700hPa wind plots and 850hPa to 500hPa shears (unfilled plots) with 850hPa to 500hPa thickness contours. Red numerals are 24 hour rainfall totals to 2300UTC 16 January 2008. Large plots are actual observations.

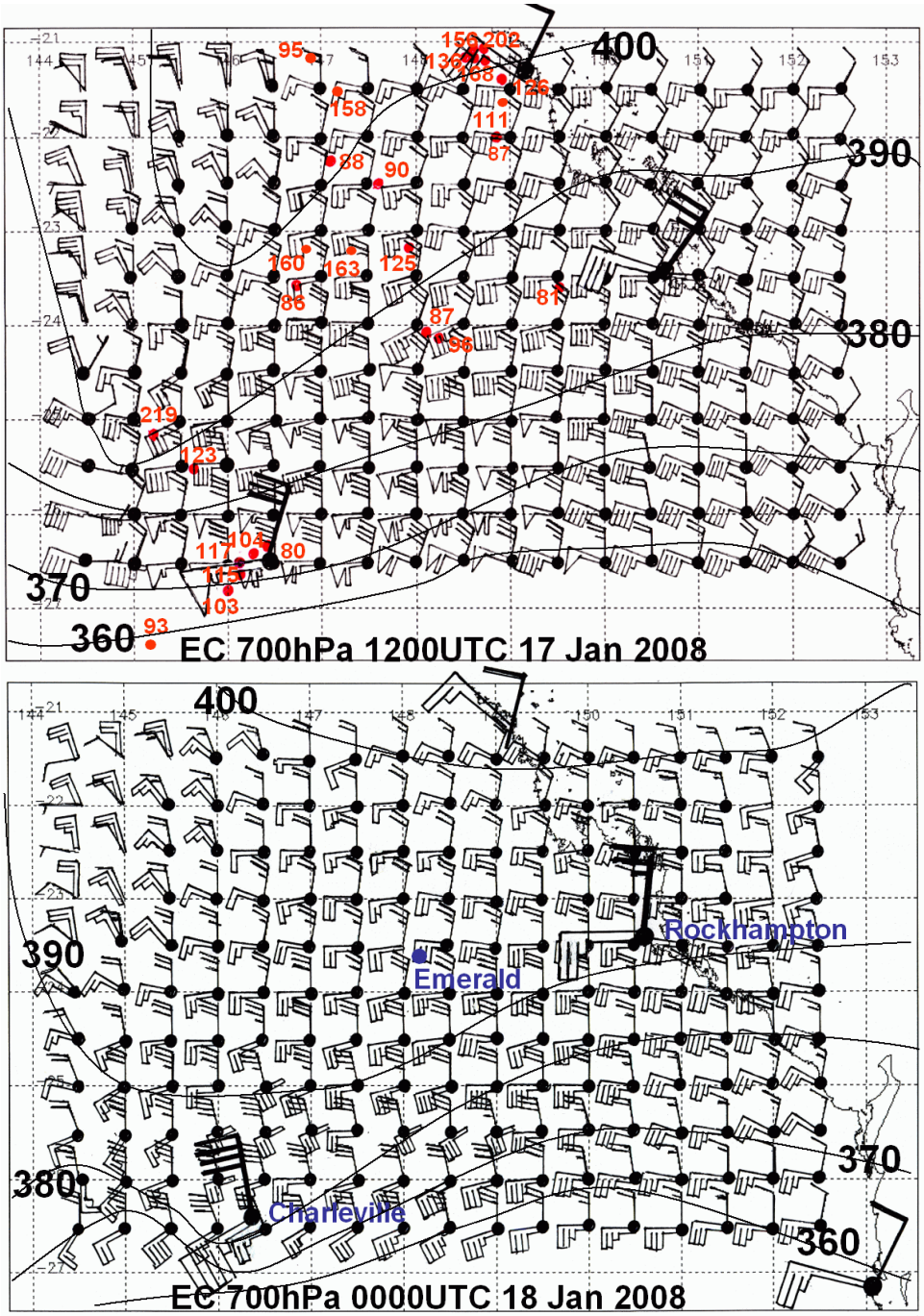

Figure 7. EC 700hPa wind plots and 850hPa to 500hPa shears (unfilled plots) with 850hPa to 500hPa thickness contours. Red numerals are 24 hour rainfall totals to 2300UTC 17 January 2008. Large plots are actual observations