

Queensland Flood Commission Report

By Anthony Cornelius
Meteorologist from Weatherwatch

I, Anthony Cornelius am writing to you as a meteorologist from Weatherwatch in regards to the devastating flood event that occurred in the Lockyer Valley on the 10th of January, 2011. In particular I would like to discuss:

1. *The lead-up, forecasts and warnings prior to the 10th of January, 2011 Lockyer Flash Flood.*
2. *The inability for private meteorologists to issue warnings/contradictory information to the Bureau of Meteorology*
3. *The warnings issued and their effectiveness*
4. *The ability to better predict and forecast extreme weather events in Queensland.*

In *Appendix A* I discuss more about myself and Weatherwatch. However I have worked with Weatherwatch since 2001 and have extensive experience in severe weather forecasting and forecast severe weather risks for many of our clients. Each year I volunteer my time to talk to schools, libraries and community groups on the risks and hazards of severe weather in Southeast Queensland. It's a great personal pursuit of mine and one I intend to continue. I hope that Queensland authorities and residents can learn from the events that have happened during this tragic event so that such huge loss of life is never repeated again in our history.

I have divided this report up into four sections (as listed above), and have included further information in the appendixes at the end of this report. More information is available and I will be happy to provide clarification (and can be contacted on the details found on the top of this page) if required. The information presented here has been provided in a non-technical standard for ease of understanding.

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Section 1: Forecasts and warnings leading up to the event, including warnings on the 10th of January, 2011

I was on duty on the 10th of January during the flood crisis. For several days prior we had been warning our clients in Southeast Queensland of the potential for flooding. An upper level low had moved over the region on the 6th and 7th of January, 2011 bringing locally heavy falls – including the Lockyer Valley with Mount Kynoch recording 60.1mm to 9am on the 6th of January, 2011 and Helidon receiving 54mm and Toowoomba Airport recorded 67.8mm both in the same time period. Locally heavier rainfall figures were unofficially reported but supported by the Warrego Hwy range crossing to Toowoomba being shut due to landslides (reference: <http://www.couriermail.com.au/news/cars-submerged-as-heavy-rains-turns-brisbane-city-and-fortitude-valley-streets-into-streams/story-e6freon6-1225982647414>). The same upper low moved northwards but there was consistently good forecast model guidance that the same upper low would drift southwards and bring even heavier rainfall over Southeast Queensland – of which much of it would be of high intensity.

Despite the northward progression (and consequently, the development of the Mary River flood for Gympie), moderate to heavy rainfall continued across parts of Southeast Queensland, including the Lockyer Valley. This was very significant as the catchments were all incredibly saturated and "primed" for a significant flood event. By the morning of the 10th of January, 2011 – only a small amount of heavy rain would have been more than sufficient to create further flash flooding let alone significant amounts of heavy rain.

Below is a table with rainfall figures for Toowoomba and the Lockyer Valley prior and during the main flood event:

	6 th Jan	7 th Jan	8 th Jan	9 th Jan	10 th Jan	Total	11 th Jan
Withcott 30		79.8	23.6	26.0	61.8	221.2	180.8
Mount Kynoch	60.8	102.3	37.8		12	104.2	225
Helidon 54		37	23	3	57	174	29*
Gatton 17.4		33.4	16	4.4	87.2	157	79.0
Toowoomba 68		17	23	5	84	197	123

Table 1: Rainfall figures for Toowoomba and the Lockyer Valley prior to the flood event. The total is the rainfall accumulation for the previous 5 days and does not include the rainfall which fell after 9am on the 10th of January (ie, the day of the main storm and flood scenario). * Helidon gauge likely to be erroneous due to failure of equipment due to the flood in this time period.

Of interest are the rainfall totals on the 6th and 7th and the 10th of January from two separate events which both caused flash flooding in the Lockyer Valley (particularly around Grantham). It is also significant to note that Gatton's January average is 111mm – of which was exceeded in just 5 days of January rainfall. Furthermore Toowoomba's average rainfall is 65mm – that figure was exceeded three-fold in just 5 days prior to the main flood event on the 10th of January. In fact, the prior wettest January on record was 198.7mm – meaning the five day total of 197mm was just shy of the Toowoomba Airport record. This demonstrates how much rain fell (and this came off the back of a very wet December – ie Gatton recorded 317mm in December 2010 – that was the wettest December on record and three times the average and

Toowoomba AP recorded 338.6mm in December 2010 – their wettest December on record also. Heavy rain also fell on the 9th of January with 104mm in Mount Kynoch and 87mm in Gatton. This led to further flooding in the region and by the morning of the 10th meant that many of the creeks and rivers were already in flood before the torrential rain occurred. (See Appendix D, figure 4.4). This graph shows the Lockyer Creek at Helidon peaking at moderate flood and only receding to minor flood levels prior to the January 10 flash flood event.

Radar images (Doppler accumulation totals) are presented in Appendix D figures 4.1 to 4.3 showing the rainfall over the region. These rainfall maps show a significant difference between the amount of rain that fell in prior flash flood events (notably the 6th of January), compared to the flash flood event of the 10th of January, 2011.

On **Friday the 7th of January, 2011**, the forecasts Weatherwatch issued for their clients in Southeast Queensland read:

0818hrs - *"The main concern will continue to be heavy rain and flooding (both river flooding and flash flooding). Isolated falls of 50-100 mm are possible today – though rain areas are likely to ease briefly tomorrow {Saturday} before red enveloping on Sunday and Monday with possibly even heavier falls developing in excess of 100-200mm."*

These forecasts were verified with Somerset Dam receiving 55mm during the 7th of January.

The passage of the upper low actually slowed down, and this was later revised to be Monday and Tuesday. On Monday morning, I was on duty and wrote the following information to our clients in Southeast Queensland on the **10th of January, 2011**. (Images of the upper level low can be seen in Appendix B, Figure 2.1 (forecast chart of upper level temperatures), and Appendix C, figures 3.1 & 3.2 for satellite images of the upper low.)

0956hrs - *"Upper low over central QLD is continuing to draw in very moist easterly winds from the Coral Sea across the entire lower, middle and upper atmosphere."*

"...the entire atmosphere is very wet and very unstable. Such conditions are conducive to very heavy rainfall and possible embedded thunderstorms..."

"Falls in excess of 100-150mm are expected to day in parts... ..of which some of this rain is expected to not only be consistent but also of high intensity at times.."

"This is still a very serious flooding situation for Southeast Queensland and it may not be until late tomorrow (Tuesday afternoon) when the rainfall situation is expected to significantly improve as the system weakens and moves inland."

Words to the effect of the last paragraph (very serious flooding situation for Southeast Queensland) are seldom used. It is our duty to ensure clients receive accurate weather information and also our duty to ensure clients take the threat seriously when required. Flash flooding is a common occurrence in the sub-tropical climate of Southeast Queensland, but occasionally some events appear far more significant than others and this was deemed to be such an event. The upper low had drawn in

moisture from the Coral Sea (*Appendix C, Figure 3.2*), and was bringing very unstable conditions. The high amount of moisture and unstable atmosphere meant that heavy rainfall was quite likely – unfortunately at the time (approximately 9:30-10am), it wasn't possible to ascertain exactly where this flooding was going to occur. However all forecast model data was forecasting heavy rain – even OCF (Operational Consensus Forecasts) and PME (Poor Man's Ensemble – a colloquial yet official name) were going for extremely high rainfall (approximately 100-200mm in 24 hours across a large portion of Southeast Queensland). These are both combinations of several forecast models that are averaged out and weighted towards the more accurate forecast models at the time. The overall process of forecast modelling is quite complex – but there are many different forecast models available for forecasters to use. ECWMF, GFS, ACCESS, UK-Met, JMA etc are all commonly used forecast models by meteorologists in Australia and many of these are included in the OCF and PME forecasts. Where OCF and PME are of particular use is to prevent "outliers" from being used in the forecasts. Occasionally, one of the models will be completely different to the other models. PME and OCF will help "smooth out" these outliers and therefore both are very good indicators of heavy rain. For instance, if one forecast model was forecasting 200mm of rain and all the other models were forecasting 10mm of rain, OCF and PME results would be quite low. I.e, if PME and OCF both suggest heavy rain, then generally that means that all forecast models are forecasting heavy rain. Operationally, we often see locally more intense pockets of even heavier rain than indicated by these ensembles in these events. *Please see Appendix B, figures 2.2, 2.3 & 2.4 for rainfall forecasts and information (all issued on Sunday the 9th of January for Monday the 10th of January).*

The following information is a discussion of the time line of the events that unfolded on the 10th of January, 2011.

At around 7:30am during the morning, a band of small, disorganised storms approached Moreton Island and moved W/SW over the Southeast Coast region. At 8:00am, the storm showed a small area of intensification on the northeast edge of the storm and attracted interest with the northern cell moving in a more westerly direction than the mean flow of all the other rain and cells. The storm system crossed land at approximately 9:30am. However more showers and storms developed to the north of the location in warmer, moister air with observations of 26/24 (temperature of 26 degrees with a dew point of 24 degrees) holding quite consistently over the region. Given the setup it would be reasonable to assume that the DP of 24 was well mixed (ie representative of the lower atmosphere), thus meaning observations of 26/24 produced a CAPE of around 2,500 – or very high instability (*see Appendix B, Figure 2.5*). It's important to note that typically storms that develop with a well mixed CAPE (Convective Available Potential Energy) in excess of 2000-2500 are nearly always severe over Southeast Queensland irrespective of other factors. The diagram in figure 2.5 also shows an incredibly moist atmosphere. Very high instability combined with a cool and very moist upper atmosphere is a sign of very heavy rainfall potential.

For some time, both storms ran concurrently beside each other but at around 11am both cells began to merge over the Esk-Somerset region. The slow moving nature of these storms and heavy rainfall reflectivities indicated the potential for flash flooding in the Esk region. Soon after this, the storm intensified to the northeast Toowoomba with particularly strong reflectivities experienced on the southeastern edge of the storm. Despite the upper level atmosphere being cold, the entire atmosphere was far

too moist for hail development. One of the issues with radar is that that hail reflects much stronger than rainfall (ie, 1L of hail would reflect back stronger than 1L of water). In these environments it's important that forecasters realise this so that they can determine an approximate rainfall rate. Also of interest is at around 11:48am was the strong inflow present on the Doppler radar. Doppler winds show winds approaching 90km/h in a broad area to the SE of the storm. There is no precipitation under this region which suggests a very large updraft, one capable of producing very high amounts of precipitation. During this time, the storm complex moved much slower which also suggests strong updraft enhancement (strong updrafts can often result in thunderstorm movement slowing down or even changing direction). The storm also showed some southward propagation which would also support strong updraft development on the southern side of the storm. Furthermore, visible satellite imagery on the day showed very strong and intense updrafts from this storm – again a sign of its intensity and strength.

For more information on radar and images of the radar on this day, please refer to Appendix C, figures 3.3 to 3.12.

As the storm moved across the Lockyer Valley and approached Toowoomba, I posted information on the Weatherzone Forums discussing the potential for Toowoomba, Grantham and Gatton. {Refer to section 2 about reasons why Weatherwatch was unable to contact media outlets or authorities on this matter – this was the only place I could put this information externally.} *Please see Appendix E for screen captures proving the time and validity of these reports, and for other comments some Weatherzone Forum users made on the event.*

1216 EST – *"Concerning for the Gatton-Grantham area right now with that very large storm/rain area moving towards it with no doubt, torrential rainfall! Sandy Creek (in Grantham) has caught quite a few people by surprise and I hope they're prepared for it, but sadly I think most won't know until the water starts lapping up at their homes due to our insufficient warning system."*

1434 EST – *"... there's going to be a near wall of water flowing down into the communities through there... ...The flooding in Toowoomba would be significant too with 60mm in the last hour."*

In summary, these extreme concerns were based on several factors (some of which have been mentioned previously)

- 1) Radar has been reported to underestimate rainfall over the region (both due to distance from the radar and due to the lack of hail likely on the day).
- 2) Rainfall was confined into the upper reaches of the Lockyer/Sandy Creek catchments, both of which are small creeks and rarely carry significant volumes of water (ie, a similar event closer to the coast on a large river system may have been less devastating due to the larger volume of water that they can carry).
- 3) Topography of the region with mountainous areas meaning water flow would carry great acceleration

4) Recent rainfall figures in the region (see page 2 for more information on the following table).

	6 th Jan	7 th Jan	8 th Jan	9 th Jan	10 th Jan	Total	11 th Jan
Withcott 30		79.8	23.6	26.0	61.8	221.2	180.8
Mount Kynoch	60.8	102.3	37.8		12	104.2	225
Helidon 54		37	23	3	57	174	29*
Gatton 17.4		33.4	16	4.4	87.2	157	79.0
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Table 1: Rainfall figures for Toowoomba and the Lockyer Valley prior to the flood event. The total is the rainfall accumulation for the previous 5 days and does not include the rainfall which fell after 9am on the 10th of January (ie, the day of the main storm and flood scenario) . * Helidon gauge likely to be erroneous due to failure of equipment due to the flood in this time period.

5) The very large geographical area that the storm covered with high intensity rainfall

6) The creek system was already in a minor to moderate flood levels prior to the 10th of January due to very recent (previous day) heavy rain. (See Appendix D, figure 4.4).

7) - Rainfall from less intense radar echoes already contributed to rapid flash flooding in the prior days (reference: <http://www.abc.net.au/news/stories/2011/01/07/3108058.htm>) please refer to Appendix F Figures 6.1 & 6.2 for radar imagery on the 6th of January (also a flood event but less severe).

Figure 6.2 from Appendix F has also been included here as it demonstrates a huge difference in rainfall intensity from prior flood events (ie the 6th of January, 2011) which also produced significant flash flooding to the 10th of January, 2011 which produced the devastating flash flood event. Ie, It's logical to expect significantly worse affects from the 10th of January compared to the 6th of January.



Figure 6.2: Comparison between the rainfall which produced the flooding on the 6th January, 2011 (left) and the flooding on the 10th January, 2011 (right). Both of these were under a generic severe weather warning for flash flooding.

Point numbers 4 and 7 were the most significant reasons for the extreme concerns and thoughts behind a wall of water approaching the Grantham and Lockyer Valley region. Record rain fall had fallen during recent weeks to the extent that light to moderate intensities were already producing flash flooding. As such – when such a large, intense thunderstorm moved over the same area I believed that the area was very likely to experience a very significant flash flood event (which later extended to Toowoomba – of which I made comments on this also).

The observations following the forecasts on Monday and Tuesday were soon devastatingly apparent. Reports of massive flash flooding came through from Toowoomba – again, a user on the Weatherzone Forums announced that ABC radio had gone live and we located their website online and listened to an audiostream.

But perhaps the most critical observation of all was at 1523, when the Helidon flood gauge recorded an 8m increase in water height in a period of tens of minutes before failing. (See Appendix D, Figure 4.4 for the flood gauge, or on the following page). Despite this occurring, the Bureau of Meteorology made no mention of this – and an hour later at 1616 issued a generic "moderate to major" flood warning for areas further downstream in Lockyer Creek (ie from previous days flooding) with no mention of the towns in the upper Lockyer Creek catchments. It wasn't until 1700 when a more urgent warning was issued in response to the extreme flash flooding in the upper Lockyer Creek region.

Comments on the "forecastability" of the Lockyer Valley Flash Flood Event

I've made mention earlier that during the morning of the 10th of January, 2011, it was nearly impossible to determine exactly where the heaviest rain would fall. Ie, at 10am it was impossible to determine that the Lockyer Valley was going to receive the rainfall. This was not able to be determined until later down the track when the radar showed the very large storm cell approaching the region. In my opinion, this should have been a fairly obvious flash flood threat at around its initiation. I was looking out for intense clusters of heavy rainfall or even storm activity throughout the day thanks to the high instability and high amounts of moisture present. As the storm slowed down and began to sit over the same catchment this in my opinion became a much more significant threat. There is limited rainfall data over the area, but the radar had very high intensity rainfall over a broad range. In my extensive storm experience (both theoretical and practical, ie "on the field"), I'm well accustomed to knowing what a certain level and area of reflectivity on the radar can produce at the ground. I've seen these events happen before in Southeast Queensland over other geographical areas though these regions (typically along the coast) are better built to cope with such incredible rainfall rates.

Nonetheless, the topography, the saturation of the catchments and the fact that the river system the storm was currently moving across was already in flood made me believe this to be a very concerning situation for the Lockyer Valley. So much so, I made specific references to towns (eg, Grantham) as seen above in the online Weatherzone Forums (and seen in Appendix E).

The difficulty in the above is that ultimately, it is the forecasters opinion and interpretation of the radar or situation and this will change from forecaster to

forecaster. But just after 3pm, the spike in the Helidon flood gauge was incredible. Over 8 metres increase in a very short period of time (see Figure 4.4 below and Appendix D). However this is only something I saw because I was looking out for it – I was expecting there to be a rapid increase in height at the Helidon flood gauge and was constantly refreshing the data throughout the afternoon to see what type of flood may be descending down the Lockyer Valley. If there was any doubt in the ability for a flash flood to occur – that observation should have been sufficient to dispel that doubt with emergency warnings issued immediately afterwards.

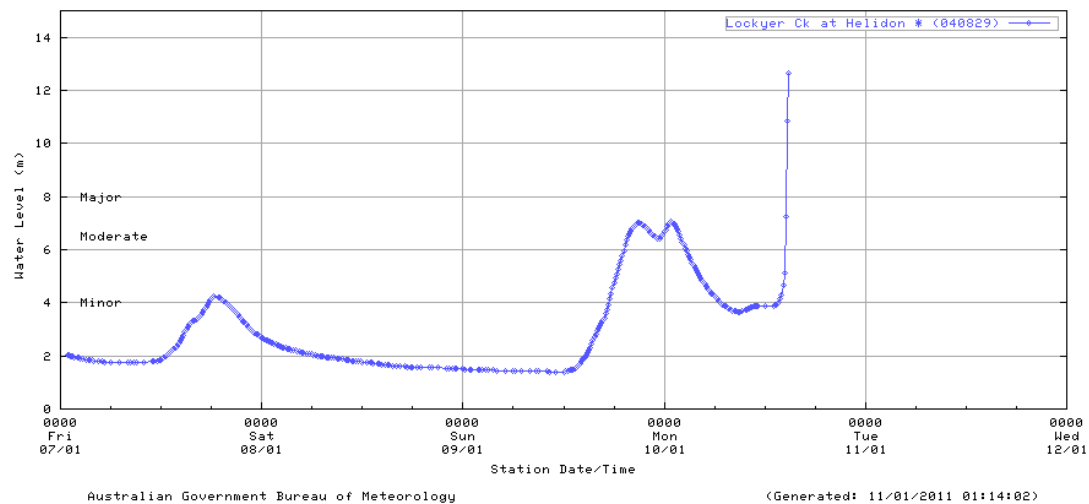


Figure 4.4: Helidon flood gauge – shows prior flooding from recent rainfall (moderate flood levels), then a huge 8m rapid spike before the gauge (presumably) failed.

Unfortunately the alerts that were issued were too late for the region – please refer to section 3 for further discussion on warnings.

In summary for section one:

- **Conditions were favourable for such an extreme event due to recent rainfall**
- **The storm size was very large and should have been viewed as a significant threat**
- **There was sufficient information to conclude that the areas downstream of the storm in the Lockyer Valley were in danger of significant flash flooding – far more intense than that of recent days.**

Section 2: The inability for private meteorological companies to issue warnings or publically contradict the Bureau of Meteorology.

Unfortunately in accordance to the Australian regulations, Weatherwatch was unable to contact a media outlet and issue warnings for such an event. Furthermore, there is no formalised way for private meteorological companies to contact the Bureau of Meteorology and discuss unfolding situations and alert them to a situation that is critical. Trying to contact Bureau of Meteorology forecasters is often extremely difficult and long-wait times are often experienced.

In addition, the Bureau of Meteorology regulations prevent private meteorologists providing forecasting information to media that contradicts the Bureau's official forecasts. This is despite many high risk operations being undertaken by private meteorological companies and the obvious experience they hold.

This brings out the first of the suggestions I would like to make and discuss.

- Private meteorological organisations should be allowed to issue their own forecasts to public and media outlets.

- Private meteorological organisations should be able to have emergency contact details for the Bureau of Meteorology and other emergency services so in these situations, have the ability to alert

Had such procedures been available – Weatherwatch could have contacted authorities or the Bureau of Meteorology to discuss the unfolding situation or even issued warnings to the relative media stations that a serious event was likely to unfold that had possibly been overlooked.

In summary for section two:

- **Private meteorological companies need a formal method to contact the Bureau of Meteorology and emergency services during weather emergencies.**

Section 3: The warnings issued

One of the issues on the day and for the entire event were the warnings. A severe weather warning had been in place for Southeast Queensland continuously since the 5th of January. Both flash flooding and river flooding occurred during the prior days – but there was nothing of the magnitude of what happened on the 10th of January, 2011. Methods **must** be derived to elevate warnings where required. For instance, severe weather warnings are also relatively common in Southeast Queensland and would occur a number of times a year. This makes it difficult for residents to understand which warnings are more urgent or dangerous than others. Therefore, severe weather (and thunderstorm) warnings should be tiered in according to their severity. For instance:

Level 1 Severe Thunderstorm/Weather Warning: Potential for damage on a local scale, potential for life threatening scenarios to occur (winds in excess of 90km/h, hail in excess of 2cm, flash flooding etc).

Level 2 Severe Thunderstorm/Weather Warning: Damage likely and imminent life threatening danger. May be widespread and affect a large number of people. (Winds in excess of 125km/h, hail in excess of 5cm, significant flash flooding etc).

Level 3 Severe Thunderstorm/Weather Warning: Widespread, potentially destructive damage. High potential for loss of life or injury. May be widespread but also used for locally destructive scenarios (eg, tornado, major flooding, major severe thunderstorm etc, winds in excess of 150km/h, hail in excess of 7-8cm, very significant flash flooding etc).

Such a method would allow for the public to determine the hazards available to them. Southeast Queensland is a very severe weather prone location – and severe thunderstorms often occur, especially in spring and summer. However it's important that major storms (eg, The Gap storm on November 16, 2008 or the Toowoomba-Lockyer Valley storm on January 10, 2011) are categorised appropriately so that the public realise the difference between an "ordinary" severe weather event and an "extraordinary" severe weather event.

It's important that the body responsible for warnings is also adequately trained and prepared for such a task. In the Lockyer Valley event, I believe that the warnings did not represent the gravity of the situation. Regardless of the severe weather warning issued – on the Bureau website it specifically states that a severe weather warning is not to be issued for thunderstorm activity, as seen below:

When is a Severe Weather Warning Issued?

- A Severe Weather Warning is issued when severe weather is expected to affect land-based communities within 6-24 hours; and
- it is not directly the result of severe thunderstorms; and
- it is not covered by tropical cyclone or fire weather warnings.

Reference:

http://www.bom.gov.au/catalogue/warnings/WarningsInformation_SW_SWW.shtml

The rain event that produced the devastating flood event was clearly a thunderstorm on the radar, but is also supported by lightning data (see Appendix C, Figure 3.13).

Thunderstorm rainfall is frequently more intense than ordinary non-thunderstorm rainfall and often the intensity can fluctuate significantly over a short time period. A severe thunderstorm warning for flash flooding may have been particularly useful in Toowoomba where residents (who had been under a generic severe weather warning for several days) may have been lulled into a false sense of security with the lack of significant flooding occurring until the 10th of January. An emergency warning was required for the Grantham and Lockyer Valley region and this was supported by the Helidon Flood Gauge graph just after 3pm. However warnings could have been issued earlier – especially given the past history of flash flooding from more minor and far less intense events in recent days.

Appendix G Warnings 1-4 are a sample of some of the warnings that were issued during this event. *Warning 1 and 2* show no difference in the wording used. *Warning 2* was the current warning at the time of the Lockyer Creek flash food on the 10th of January. It was the same warning that had been current since the 5th of January. There was no reasonable expectation by residents in the Lockyer Valley that a significantly more major flood was about to unfold than that of previous days

Furthermore, *Warning 3* shows that at after 4pm, there was still no direct mention of the region. This flood warning was for rainfall that had fallen on the previous day (ie. Lyons Bridge is well downstream of the Grantham-Helidon-Gatton area). It was n't until 5pm, when *Warning 4* was issued with an emergency warning and direct reference to the region.

Distribution of warnings is also important. It must be realised that not everyone will be in contact with media to hear warnings. In other countries, siren systems are used for extreme weather (or other) emergency situations. Such systems could be implemented in Queensland for future scenarios. Furthermore, the SMS systems should be examined for their effectiveness and efficiency. For instance, an SMS system was implemented across Australia after the Victorian bushfires in February, 2009. There are still obvious holes in the current SMS system (on a personal note both of my parents were affected and stranded by the floods. Both are with the same mobile carrier, both live at the same address yet only one of them received a text on their phones which suggests the system doesn't work well).

Perhaps the Queensland government needs to examine the potential to look at other carriers to better service this network. In particular, the body should ideally have meteorological background given most significant emergencies in Queensland are weather related.

In summary:

- **Warnings issued were insufficient and did not reflect the gravity of the situation.**
- **More urgent (emergency) warnings could have been issued prior – especially when the Helidon flood peak occurred**
- **A new warning system should be implemented, one that categorises warnings.**

- **Distribution methods of warnings should be examined further with the possibility of an audible siren system or further work on the current SMS network.**

Section 4: The ability to better predict and forecast extreme weather events in Queensland.

In section 1, I mentioned that during the morning (at around 9-10am), it was impossible to determine exactly where the heaviest rain would fall. There was strong consensus in the model information (*see Appendix B, figures 2.2 to 2.4 for rainfall forecast information*) that heavy rain was likely but no model was able to pin-point the exact location. This meant the event was difficult to forecast (but not difficult to warn for when the event unfolded). This is not an uncommon occurrence – the east coast of Australia often sees "short duration high intensity rainfall events." This is due to several factors:

- The most obvious is the ocean and ocean currents. Warm water often sits off the east Australian coastline and this helps produce the moisture and energy for such events to occur.
- The geographical nature of the east coast is for a large mountain range to be present within 100km of the coastline. In some cases, this mountain range is much closer (eg, Gold Coast Hinterland, Coffs Harbour Escarpment in Northern NSW or the Illawarra Escarpment in Wollongong). This results in orographic forcing of the air upwards and enhances the lift and rainfall potential.
- The presence of upper level cold pools of air that can rapidly enhance instability and at times, even induce a surface low or trough to develop close to the coast (which would enhance orographic lift with the acceleration of winds).

It is quite rare that the forecast models and tools used are able to detect this more than 3-6 hours ahead. This comes onto the final recommendations I would like to make.

The Bureau's direction in recent years has been to produce increased weather data to the public. However this information is still limited to the information that is available for these forecasts. I believe the Bureau's direction should be closer to research and development of forecast modelling to develop better forecast data. High resolution model data may be sufficient to detect these events far more accurately and therefore reduce the incidence of "false alarms" and increase the accuracy. Such implementation could require:

- Implementation of more Automatic Weather Stations (to gather surface observation data)
- Development of high-resolution models by a research team to try and detect "mesoscale events" that the broader national and global forecast models do not detect due to the coarser resolution.
- Better training of meteorologists – most training is theoretical, when in practice, weather forecasting is best learnt through experience
- Diversion of some of the Bureau's current resources into the above projects

Furthermore, nowcasting (ie, forecasting what's currently happening), could better be improved by:

- Extension of the Bureau' s current radar network (including Doppler radar installations).
- Implementation of m ore Autom atic W eather Stations (to gather surface observation data)
- Increased rain alerts to verify radar signatures.

The above suggestions would greatly increase the capability for more accurate weather forecasts. In particular, to provi de a m ore exact location of potential heavy rainfall. Currently, m odel guidance is ofte n su fficient to indicate the re'll be heav y rain but it's often difficult to determ ine exactly where tha t rainfall will occur. Loc al topographic effects which play a significant role in these events is smoothed out in the broader scale m odels which m eans locations may vary to those suggested by in the forecast models.

In summary:

- **Develop high-resolution models for rainfall in Queensland for both internal and external Bureau use.**
- **Diversion of current Bureau reso urces into research projects to develop better rainfall forecasting methods.**
- **Increase the data-collecting network.**

Section 5: Conclusion & Summary

It is of opinion that the events that contributed to the January 10, 2011 flash flood in the Lockyer Valley were events that any trained meteorologist should be able to determine as a highly significant flash flood threat beyond that of which is normally expected. Many reasons have been presented in this report, but the main reasons I believed this to be a more significant flash flood threat than prior events were:

- The intense, broad area of rainfall when compared with previous flash flood events prior indicated an obvious difference in flash flood potential. If light to moderate echoes produced flash flooding in previous days, then very intense echoes would logically produced increased rainfall and more significant flash flooding.
- The previous rainfall was very significant. December was the wettest on record for both Toowoomba and Gatton, and during the few days leading to the 10th, both locations had already exceeded their average monthly January rainfall. This meant the catchments were completely saturated and very prone to flash flooding from even light to moderate falls, let alone very heavy falls. Furthermore, minor to moderate flooding already existed in the creek and river systems.

Earlier and more urgent warnings could have been issued based on this information – but were eventually confirmed by the 8m spike in the Helidon flood gauge. However I am not in a position to determine whether or not earlier or more urgent warnings would have saved lives in this event.

In summary, my key recommendations are as follows:

- 1. Allow private meteorological companies access to Bureau of Meteorology and emergency personnel for contacts during weather emergencies**
- 2. Re-examine the current warning system with various levels of severe weather and/or thunderstorm warnings to be implemented**
- 3. Increased practical staff training in the Bureau**
- 4. Bureau of Meteorology resources to be better utilised to develop increased modelling data to better forecast these events and expand the data collection network**
- 5. More effective warnings (eg SMS/siren system) in emergencies**

Appendix A - Background

Background (Weatherwatch):

Weatherwatch is a private meteorological company which provides weather information, forecasts and data to clients across Australia and New Zealand. Weatherwatch is one of many private companies that work in Australia and throughout the world to better serve the needs of commercial clients with detailed, comprehensive and accurate weather information. Weatherwatch has been established since 1976 and is one of Australia's longest serving meteorological companies.

Weatherwatch employs meteorologists to provide information and data to its clients. Weatherwatch conducts rigorous training for all of its meteorologists and is very proud of the information it provides.

Background (Anthony Cornelius - meteorologist of Weatherwatch):

I commenced casual work with Weatherwatch in 2001. I graduated from my science degree (major in climatology) in 2004 from the University of Southern Queensland. I have spent many years researching and forecasting thunderstorm activity across Australia. I have conducted storm documentation in Queensland, NSW, Victoria and the Northern Territory. I am responsible for all the high-risk clients of Weatherwatch who require detailed severe weather and thunderstorm information and receive the highest commendations from clients for providing this data.

I have had a passion for educating the public to the risks of severe weather for some time. I frequently volunteer my spare time to raise community awareness and have worked with the Australian Severe Weather Association since 1999. Some of the duties under this role have included:

- ❖ Organising severe weather meetings for members
- ❖ Going to libraries and community groups to educate on severe weather and how to prepare for the annual 'storm season'
- ❖ Conducting radio and television interviews nearly annually (both as the capacity as a meteorologist and as a member of the Australian Severe Weather Association) to educate and inform people on the appropriate actions to take.

Background (Weatherzone Forums):

The Weatherzone internet forums are an online facility designed for people to discuss the weather. These forums have a wide range of contributors including professional meteorologists, researchers, hobbyists and amateurs. Discussions on these forums can include forecasting and advice, observations, discussions for research and post analysis of events. They have been a great learning tool for many people and is currently the most frequented Australian weather forum.

Appendix B – Weather Forecast Charts

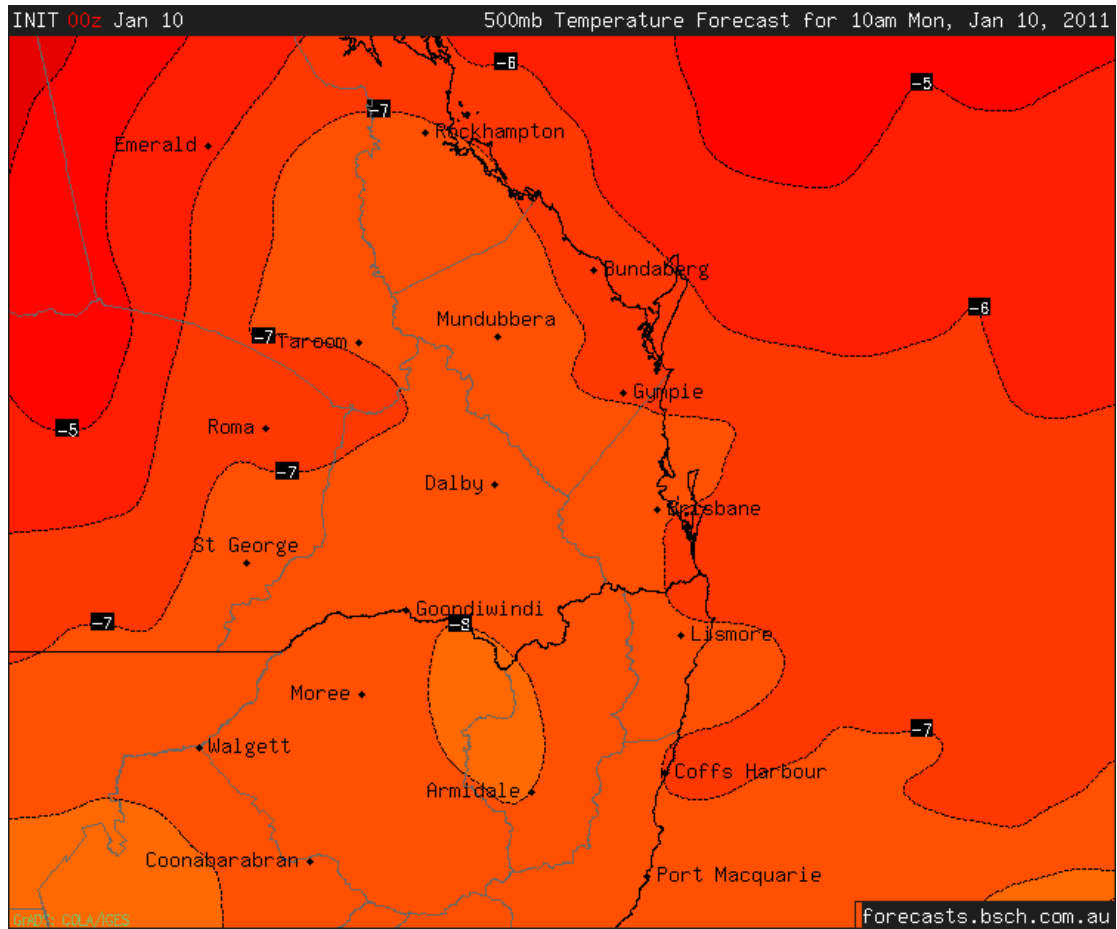


Figure 2.1: 500mb temperatures showing the cooler air across Southeast Queensland in the upper atmosphere. The region of -7 is shaded and signifies colder (more unstable air), than the surrounding environment where temperatures are warmer. Cooler air in the upper atmosphere in the right surface conditions is often associated with unsettled weather. (Source: Stormcast – forecasts.bsch.com.au)

Brisbane One Week Weather Forecast:

Day		Max (C)	Min (C)	Wind Dir.	Rain Forecast (mm)		
					OCF	PME	GFS
Today	Rain periods, possible thunder	27	22	ESE	78.0	84.9	?
Tomorrow	Rain periods, possible thunder	25	22	ESE	58.0	215.5	87.8
Tuesday	Rain periods, possible thunder	25	22	E	26.0	158.1	70.3
Wednesday	A few showers	27	22	ESE	2.2	2.1	3.8
Thursday	A shower or two	28	21	ESE	0.8	0.4	0.4
Friday	A shower or two	28	21	ESE	0.7	?	0.8
Saturday	Mostly fine, possible shower	29	20	E	3.0	?	1.1

Figure 2.2: OCF and PME forecasts along with another forecast model (GFS) rainfall predicts for Brisbane. Please note that due to model

resolution, these types of forecasts are more of an indication on what may fall over a broader geographical region rather than a pinpoint location (ie, somewhere within 50-100km may receive the forecast rainfall). (Source: Bureau of Meteorology PME & OCF output via Oz Forecast.)

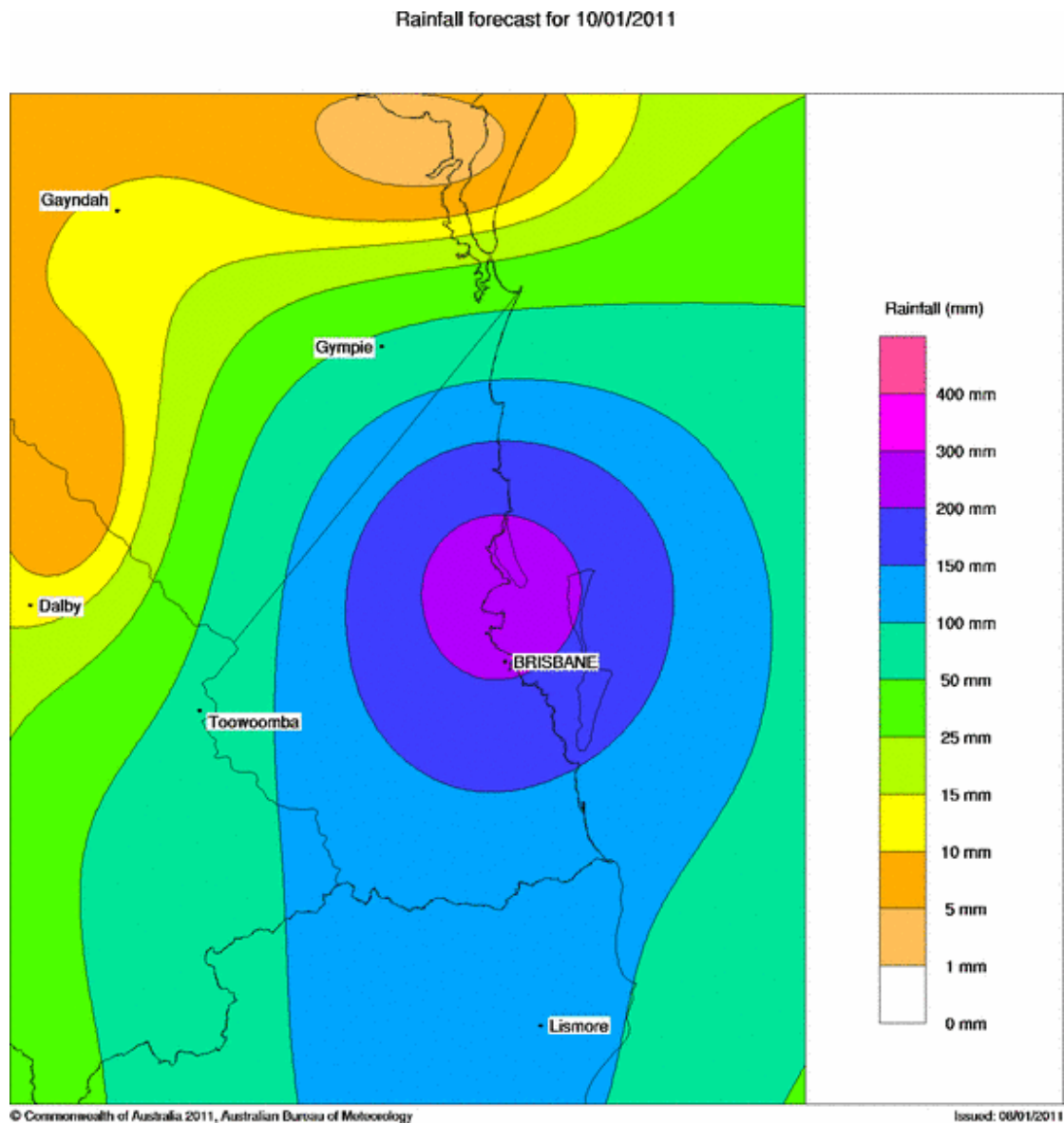


Figure 2.3: PME rainfall forecasts across Southeast Queensland. (Source: Bureau of Meteorology PME output – www.bom.gov.au)

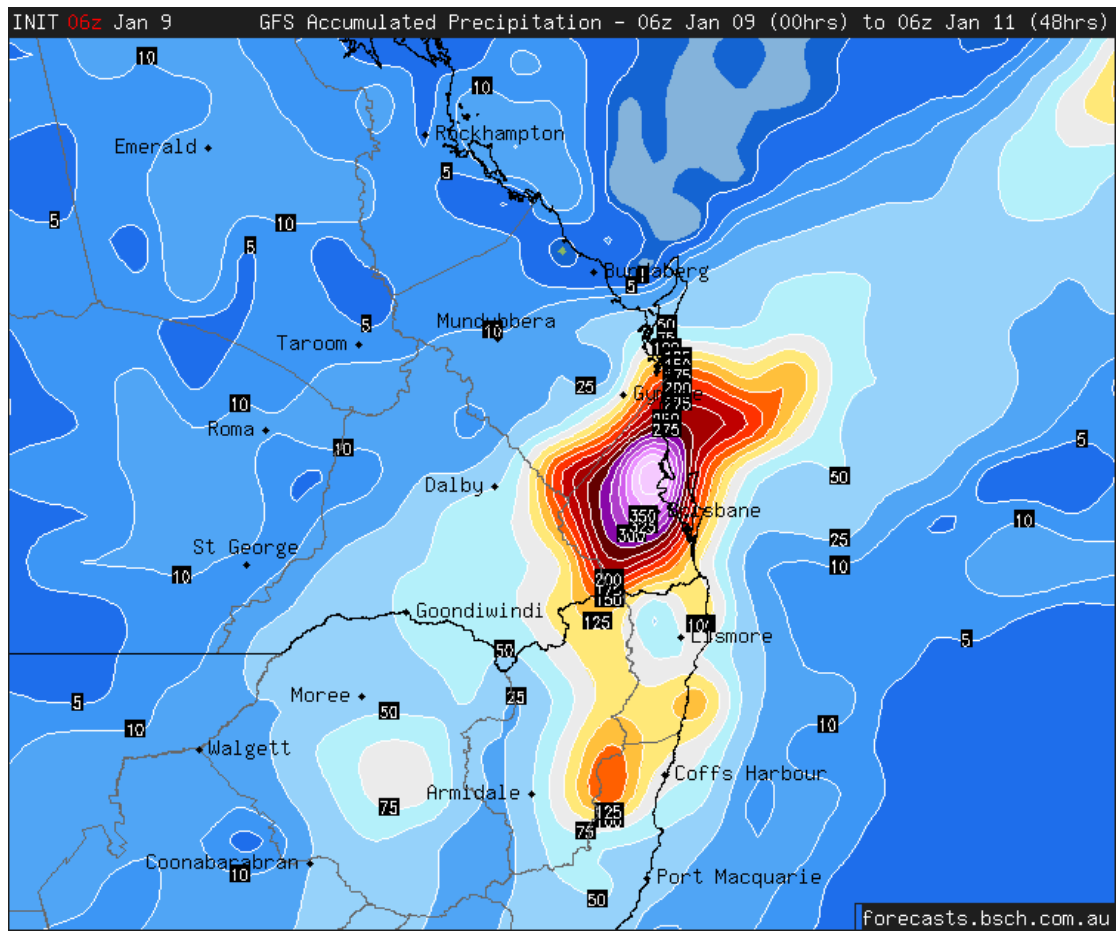


Figure 2.4: GFS rainfall forecasts across southeast Queensland suggesting very heavy rainfall over the next 48 hours (model run ran on Sunday afternoon, 9th of January, 2011). (Source: Stormcast – forecasts.bsch.com.au)

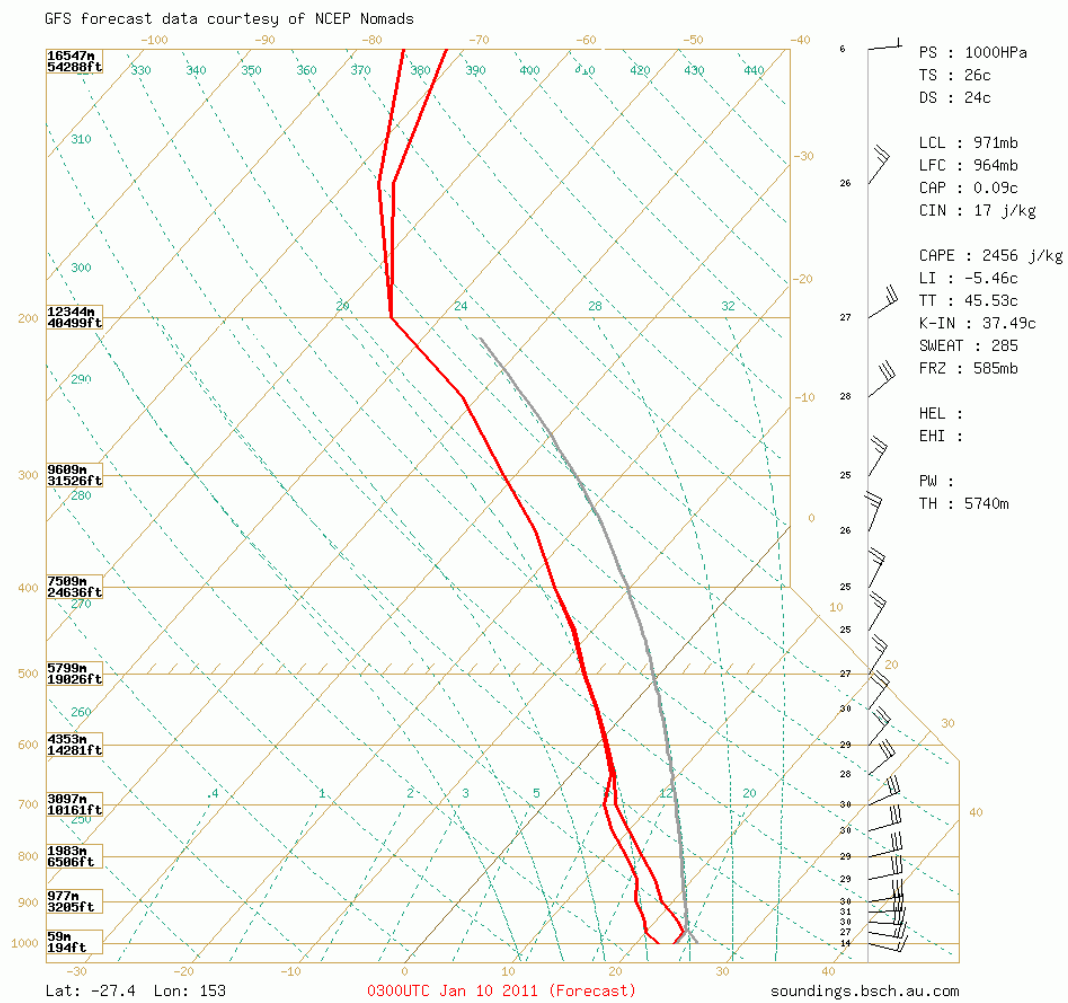


Figure 2.5: GFS 00Z analysis run (3hour forecast based on 00Z forecast run), for the Brisbane Valley/Lockyer Valley area at 1pm. Plot shows significant instability (CAPE 2456) and extremely saturated environment (left red line is the dew point, right red line is the dry adiabats). (Source: Stormcast – forecasts.bsch.com.au)

Appendix C – Radar, Satellite & Lightning Imagery of Storm

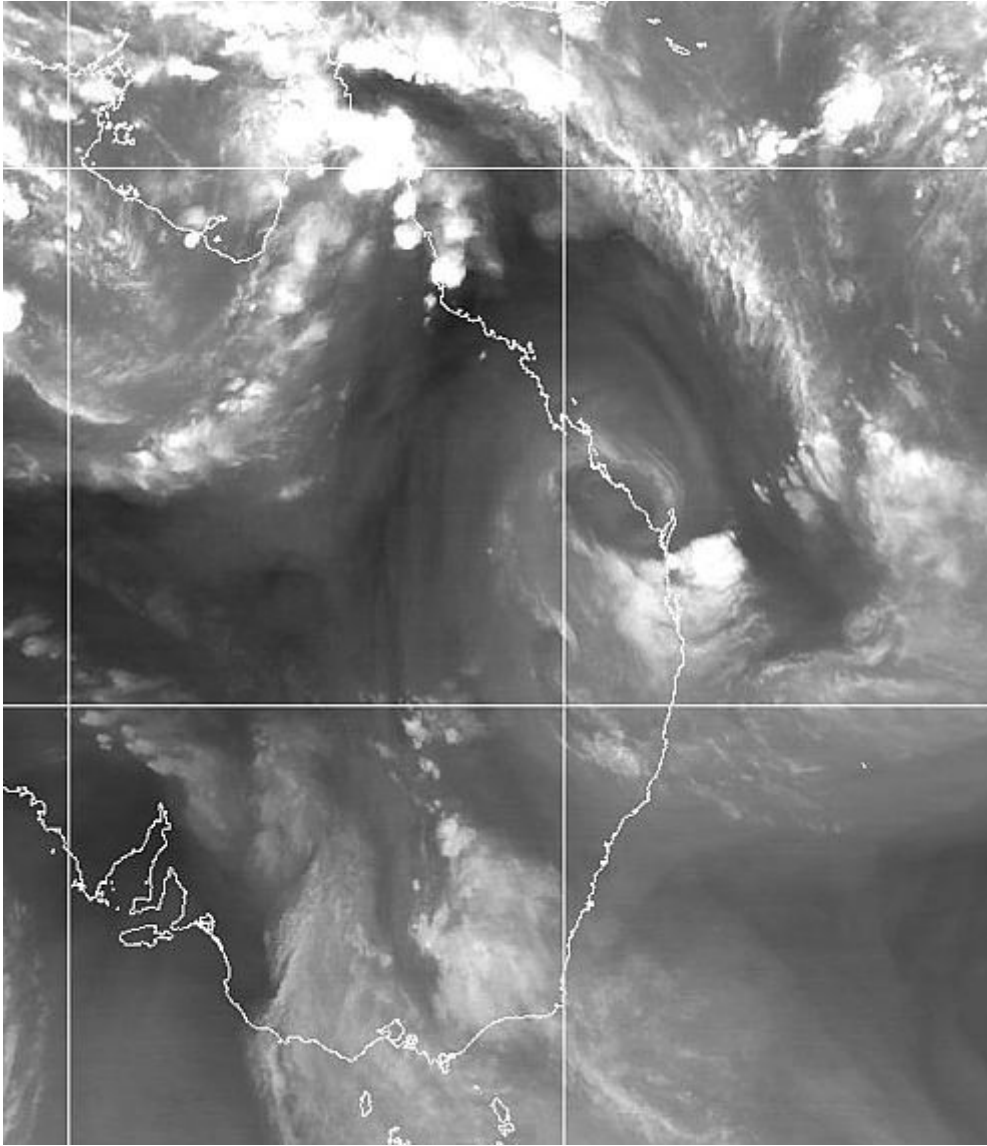


Figure 3.1: Upper level low situated to the west of Fraser Island taken at 19:30 local time, the 9th of January, 2011. (Source: *Naval Pacific Meteorology & Oceanography Centre*).

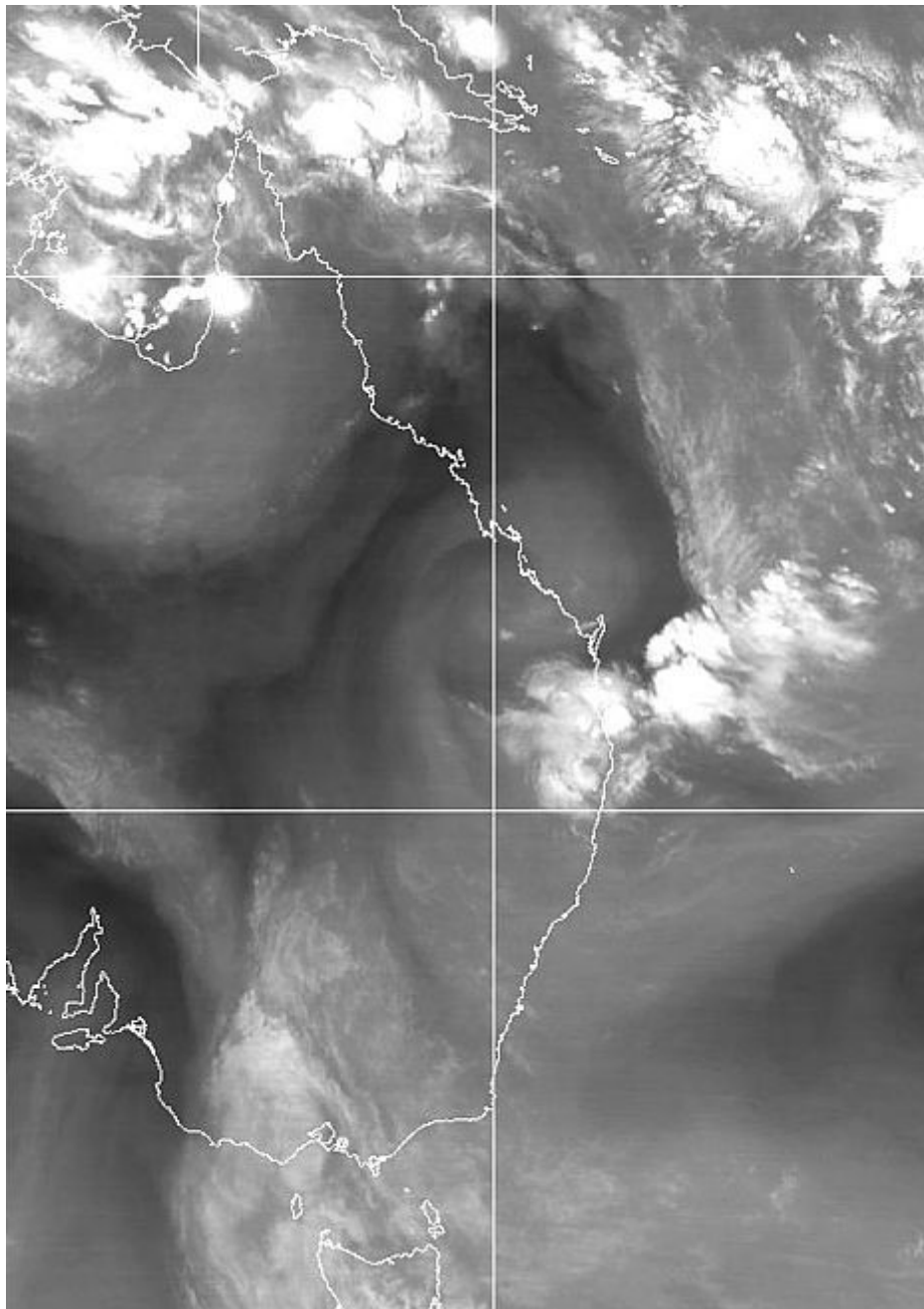


Figure 3.2: Upper level low situated just north of Brisbane, note the convergence line which extends NE out to sea that shows the long feed of moisture coming across from the central to northern Coral Sea (animations show this well). (Source: Naval Pacific Meteorology & Oceanography Centre).

The following radar images are all sourced from the Bureau of Meteorology.

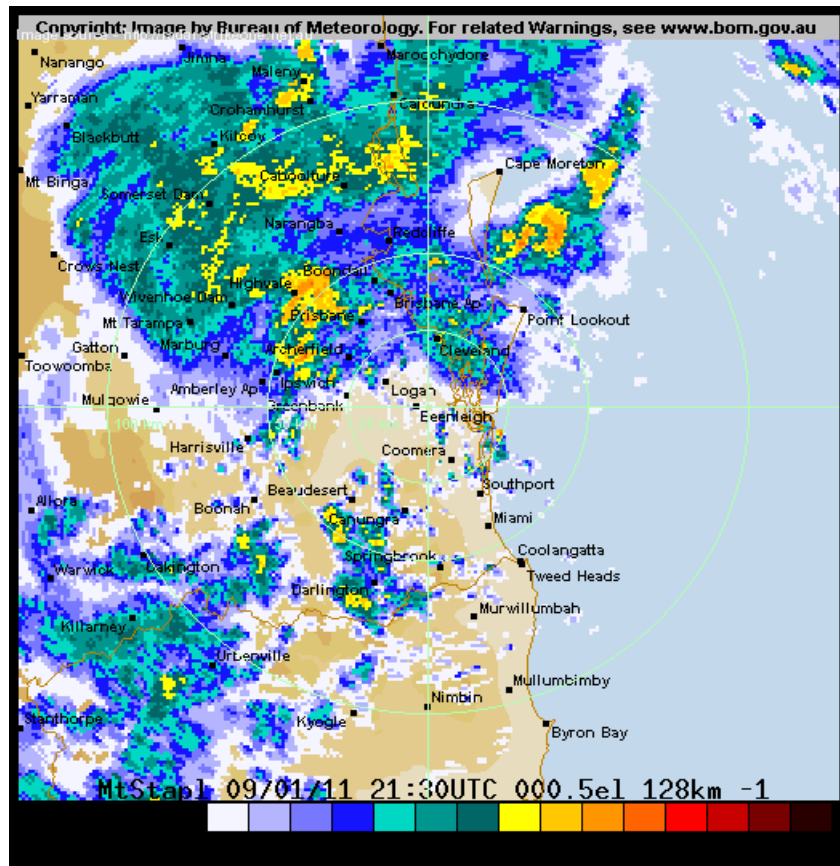


Figure 3.3: Storm currently situated E and SE of Cape Moreton at 7:30am.

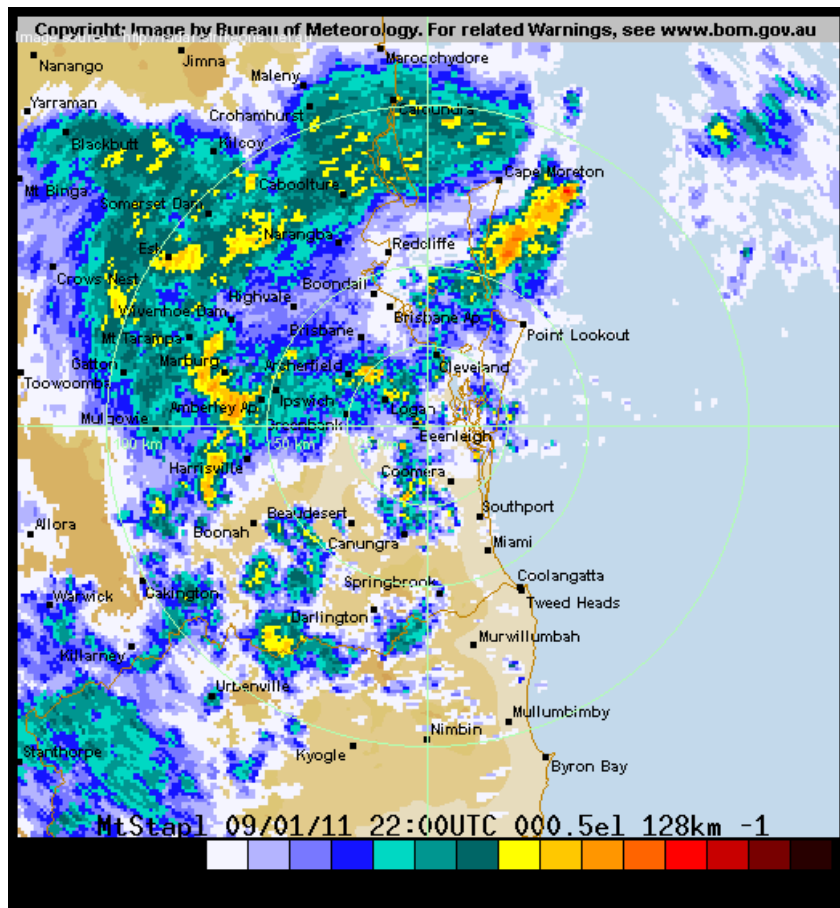


Figure 3.4: Storm approaching Cape Moreton and intensifying at 8am.

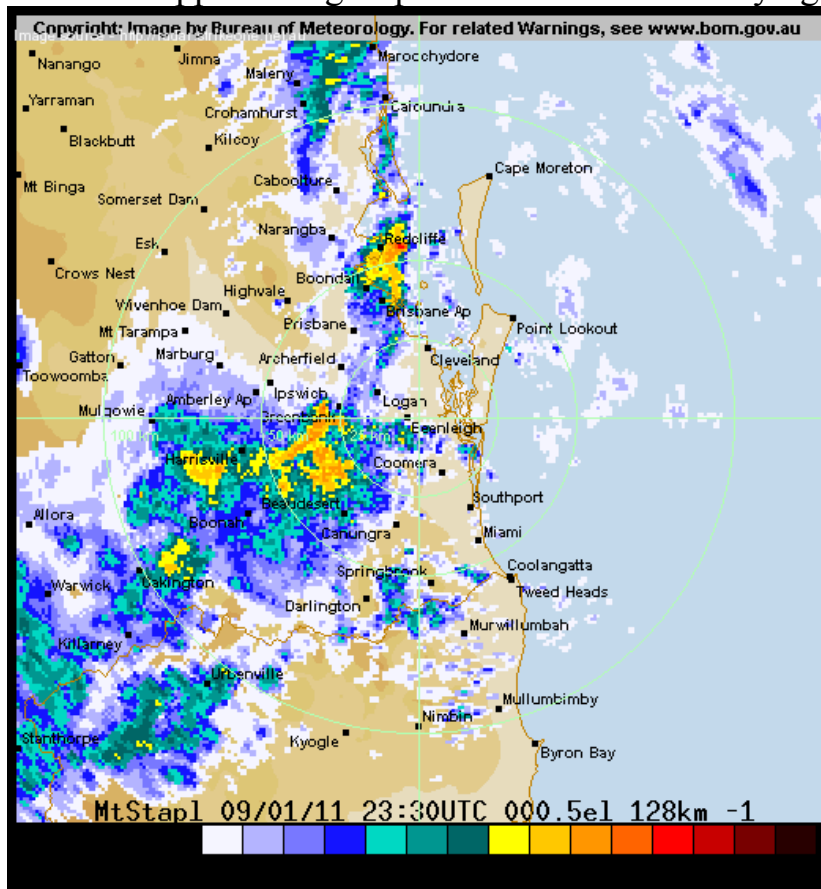


Figure 3.5: Storm approaching land at 9:30am.

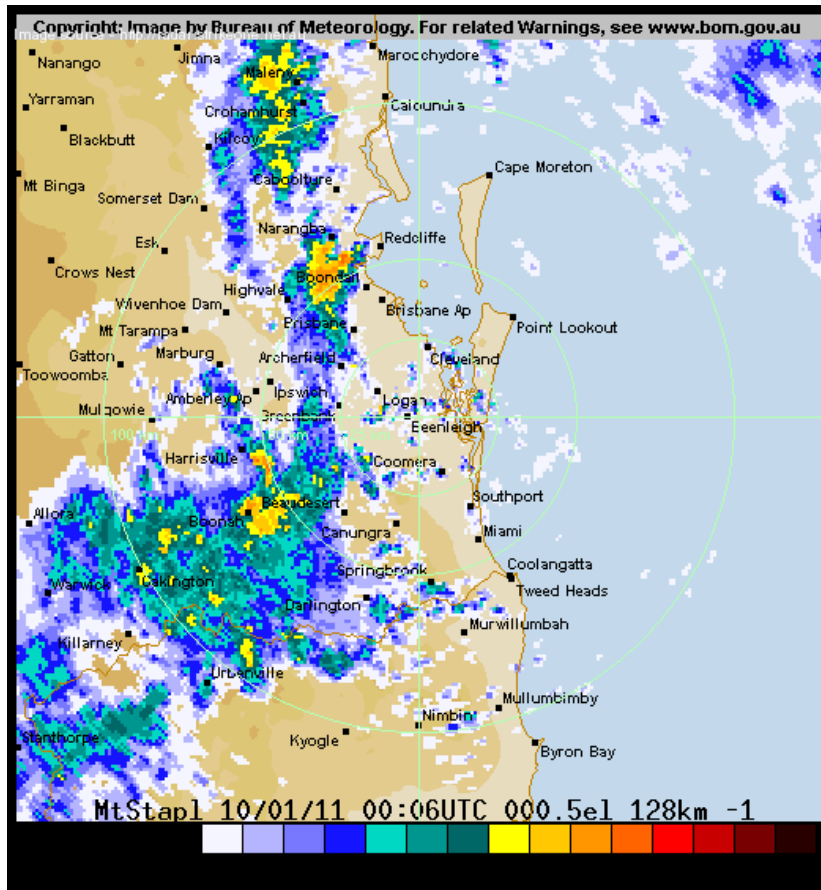


Figure 3.6: Storm over land with further cells developing to the north near Maleny and Croamhurst.

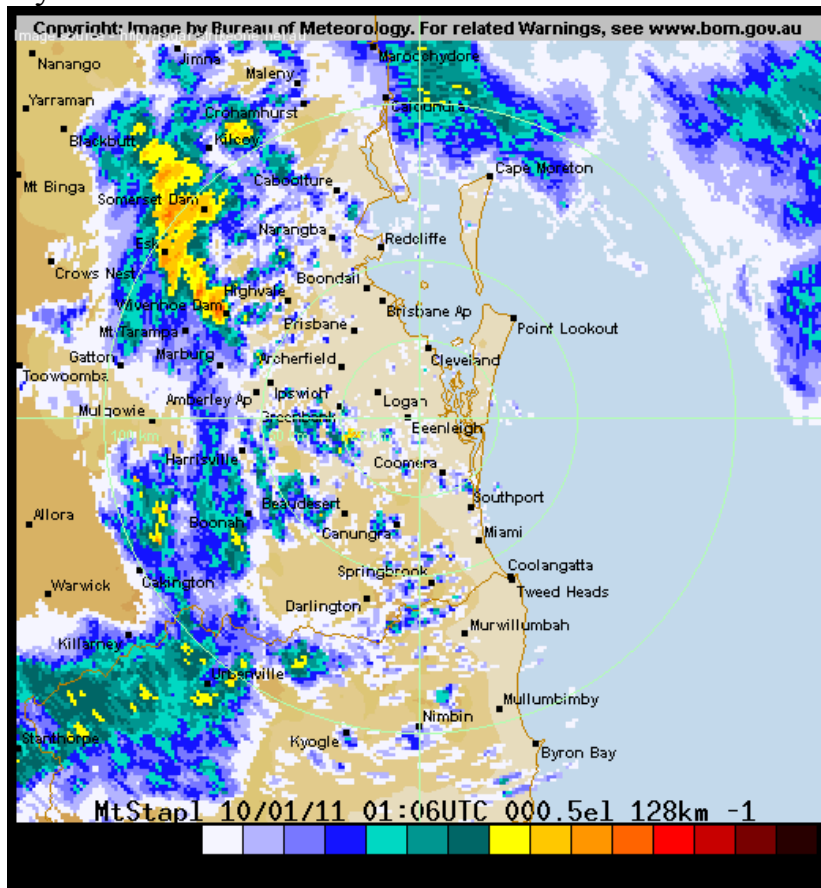


Figure 3.6: Storm systems merge over the Brisbane Valley at 11:06am.

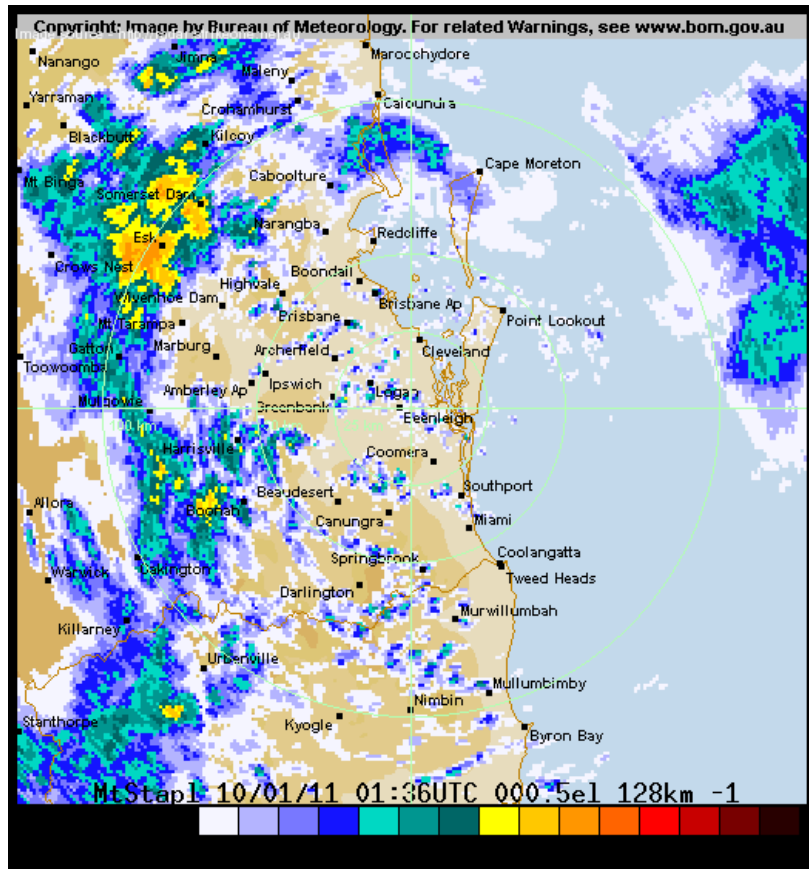


Figure 3.8: Broad region of heavy rain and storm echoes approach the Lockyer Valley.

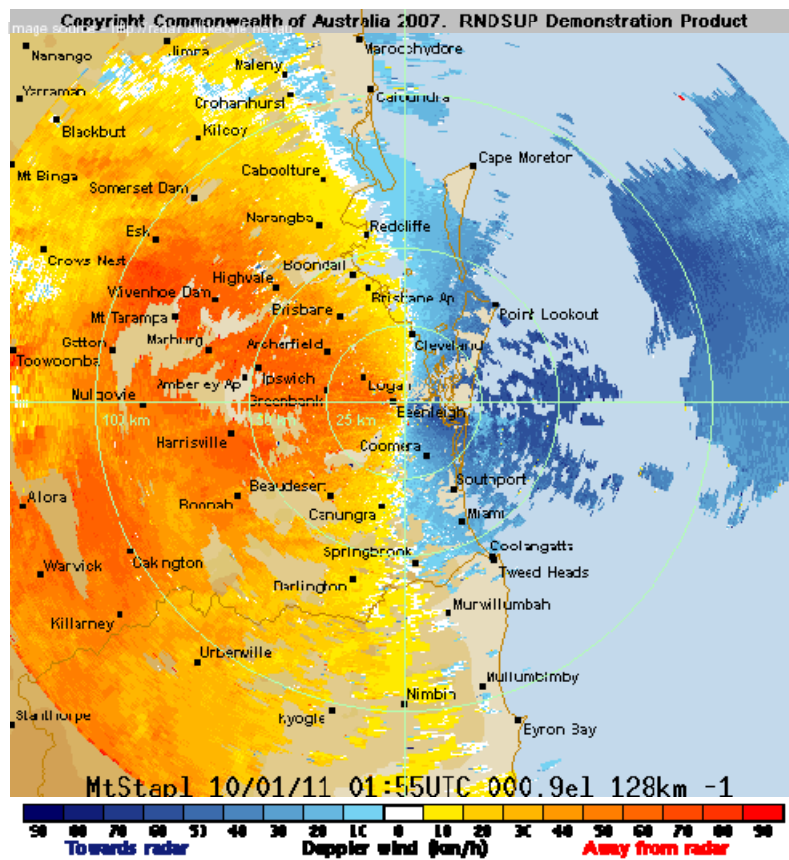
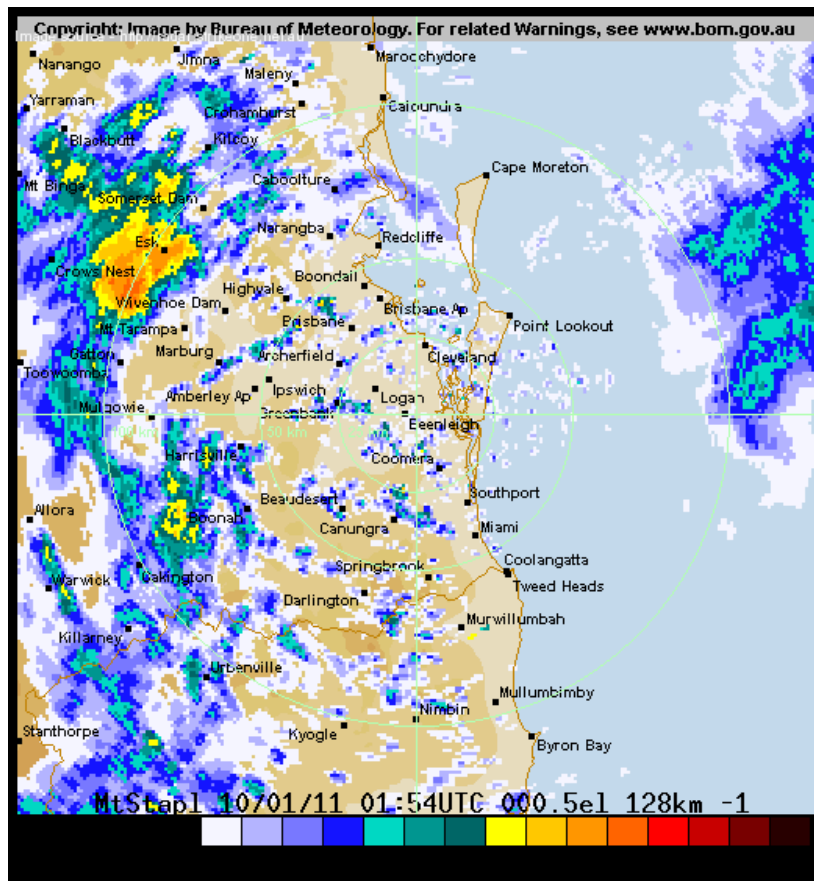


Figure 3.9: Above, radar imagery showing intensification on the southern edge. Below, radar imagery showing wind speeds, the orange to

red shows strong winds (70-80km/h) approaching on the southern side of the storm (inflow).

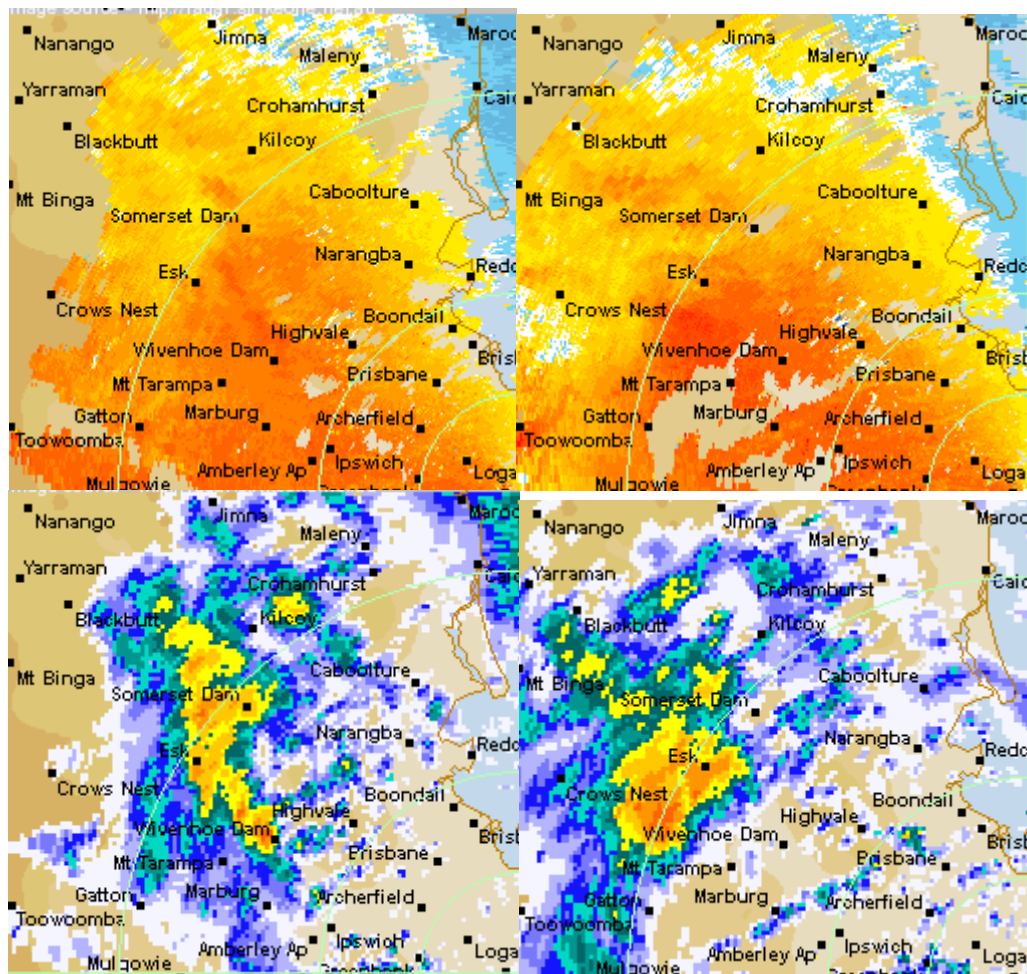


Figure 3.10: Zoomed in images of the winds (above) and rainfall rates (below), at 11:06am (left) and 11:54am (right), shows the intensification (ie more intense rainfall rates and increased storm organisation) on the bottom right (later radar image), than prior. The above winds show broad but weaker inflow (30-50km/h) at 11:06am (above left), compared to the intense inflow (70-80km/h) at 11:54am which also coincided with the storm intensification. For wind scales in the above images please see figure 3.9.

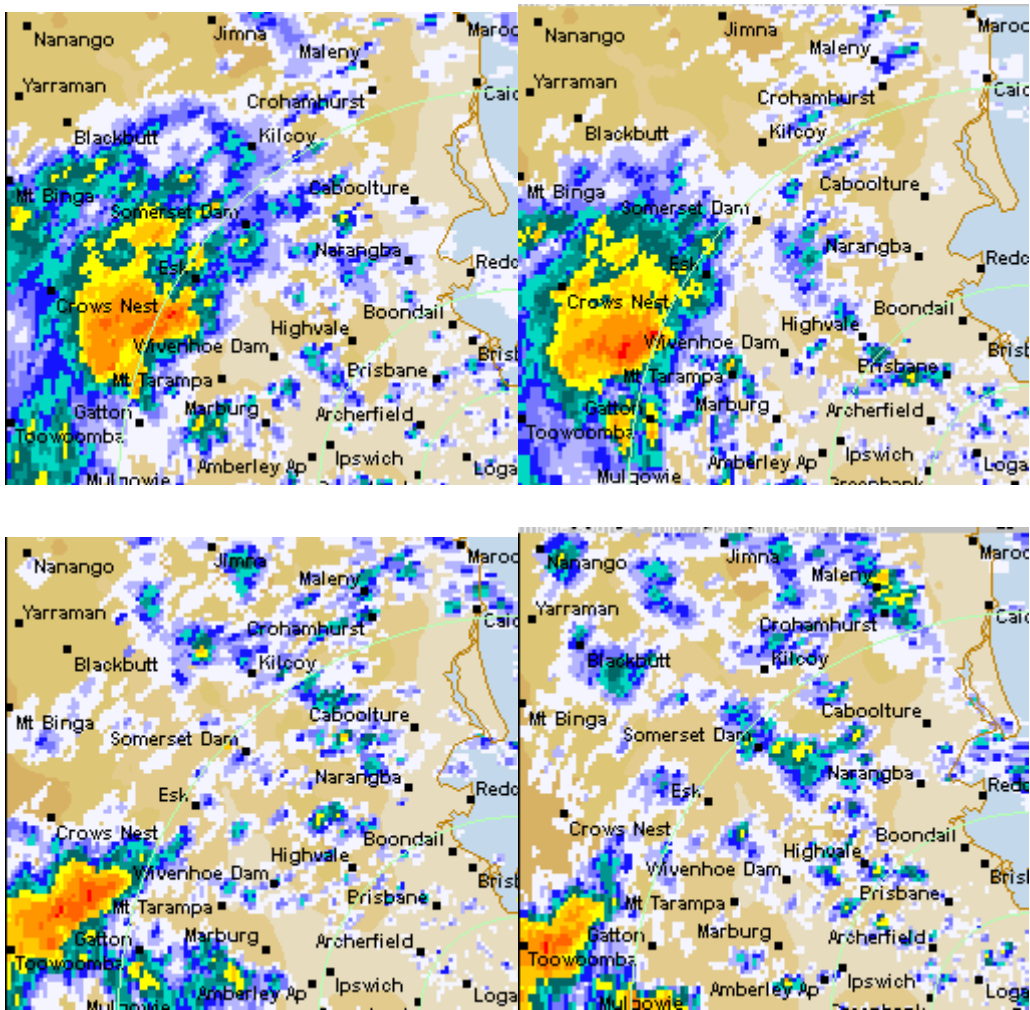


Figure 3.11: Zoomed in images of the storm cell taken at 12: 12pm, 12:30pm, 1:24pm and 1:48pm. It's important to note the slow movement of which this storm took over approximately 2 hours.

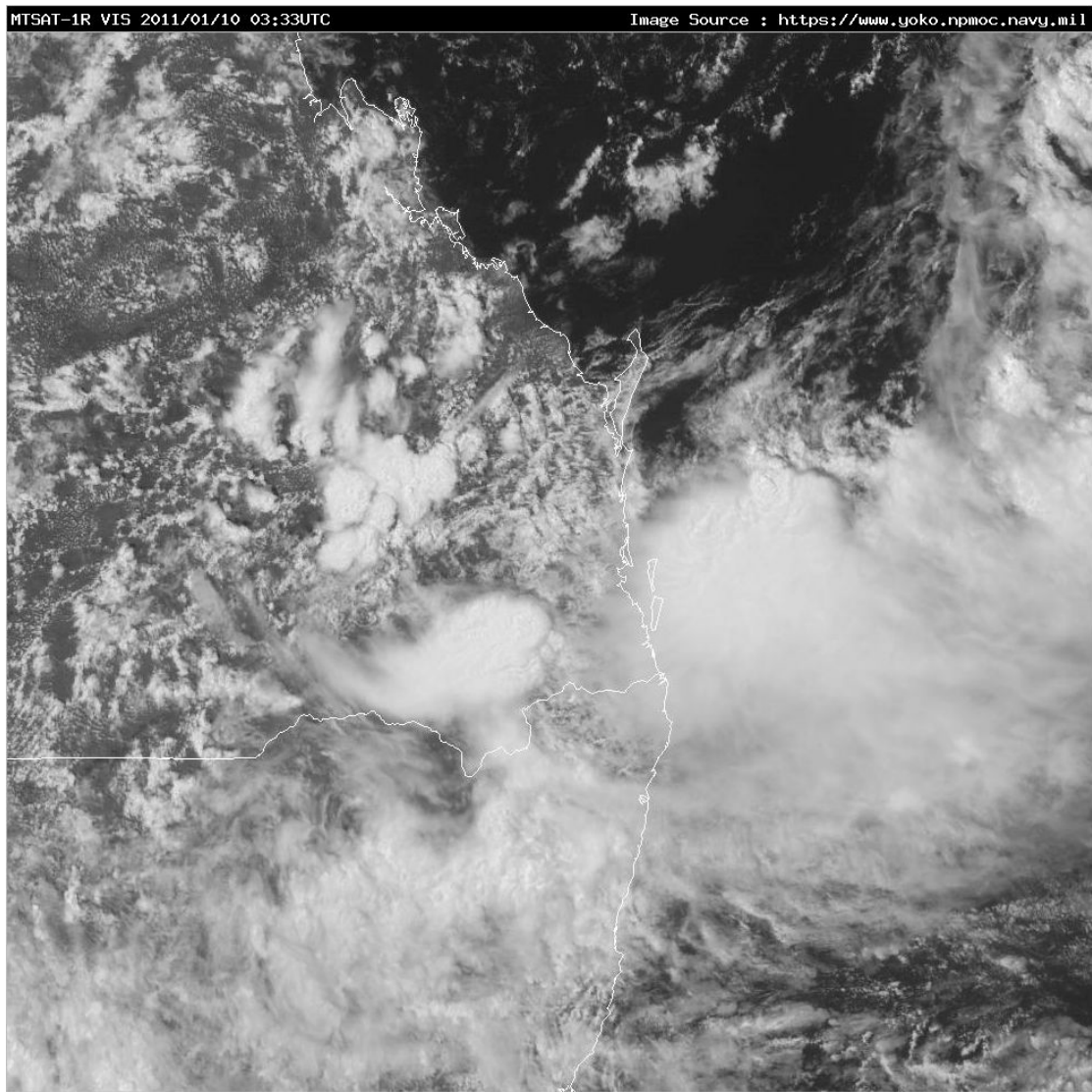


Figure 3.12: Visible satellite imagery of the storm west of Brisbane over the Toowoomba & Lockyer Valley region. (Source: Naval Pacific Meteorology & Oceanography Centre).

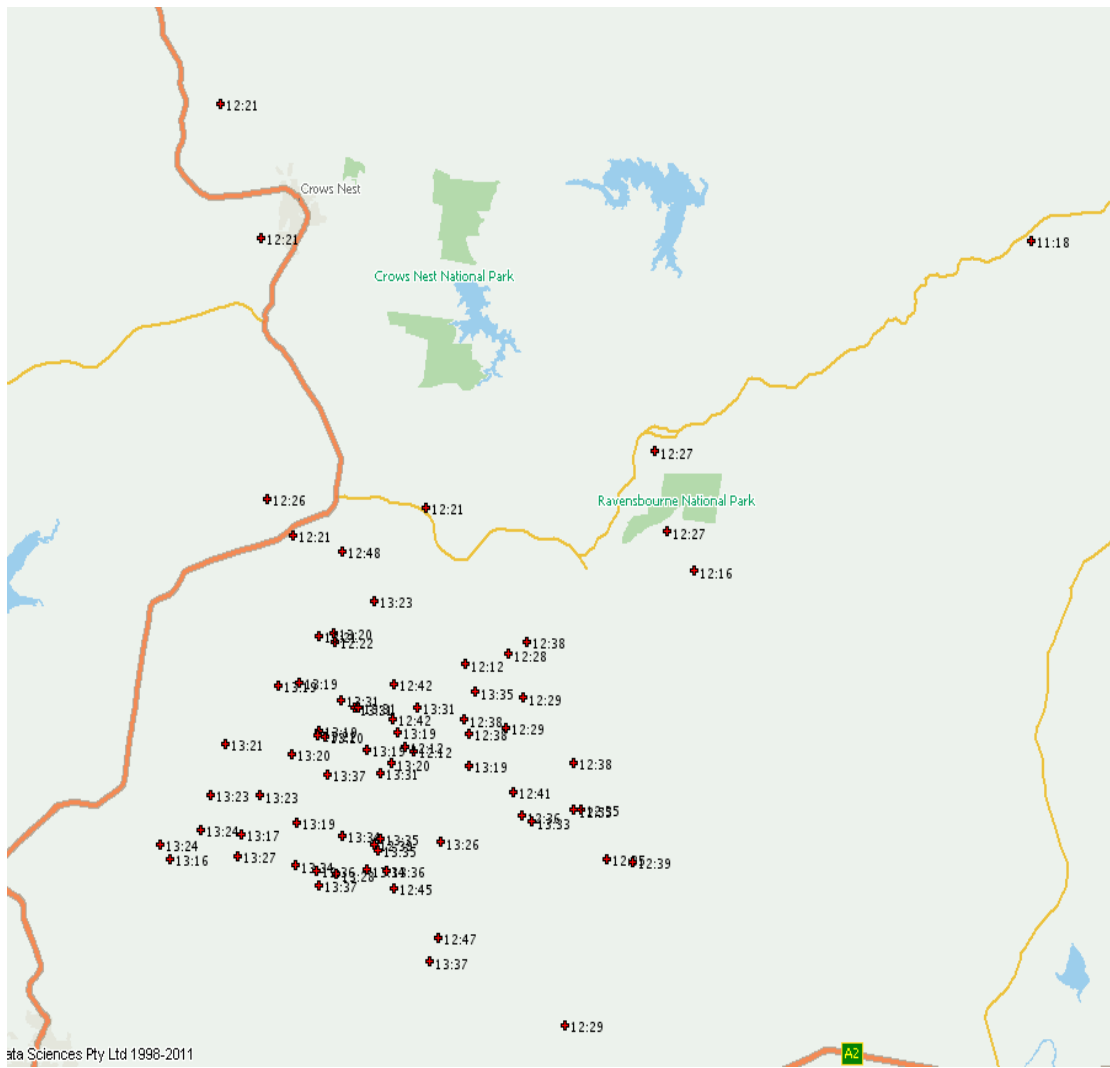


Figure 3.13: Lightning tracker data from the 10th of January. This shows the times (in local time) that strikes occurred. It's important to note the low frequency of strikes prior to 12pm, but then the sharp increase between 12 and 2pm when the storm intensified as supported by radar imagery in previous figures. (Source: Weatherzone – Storm Query)

Appendix D – Rainfall accumulation & River Heights

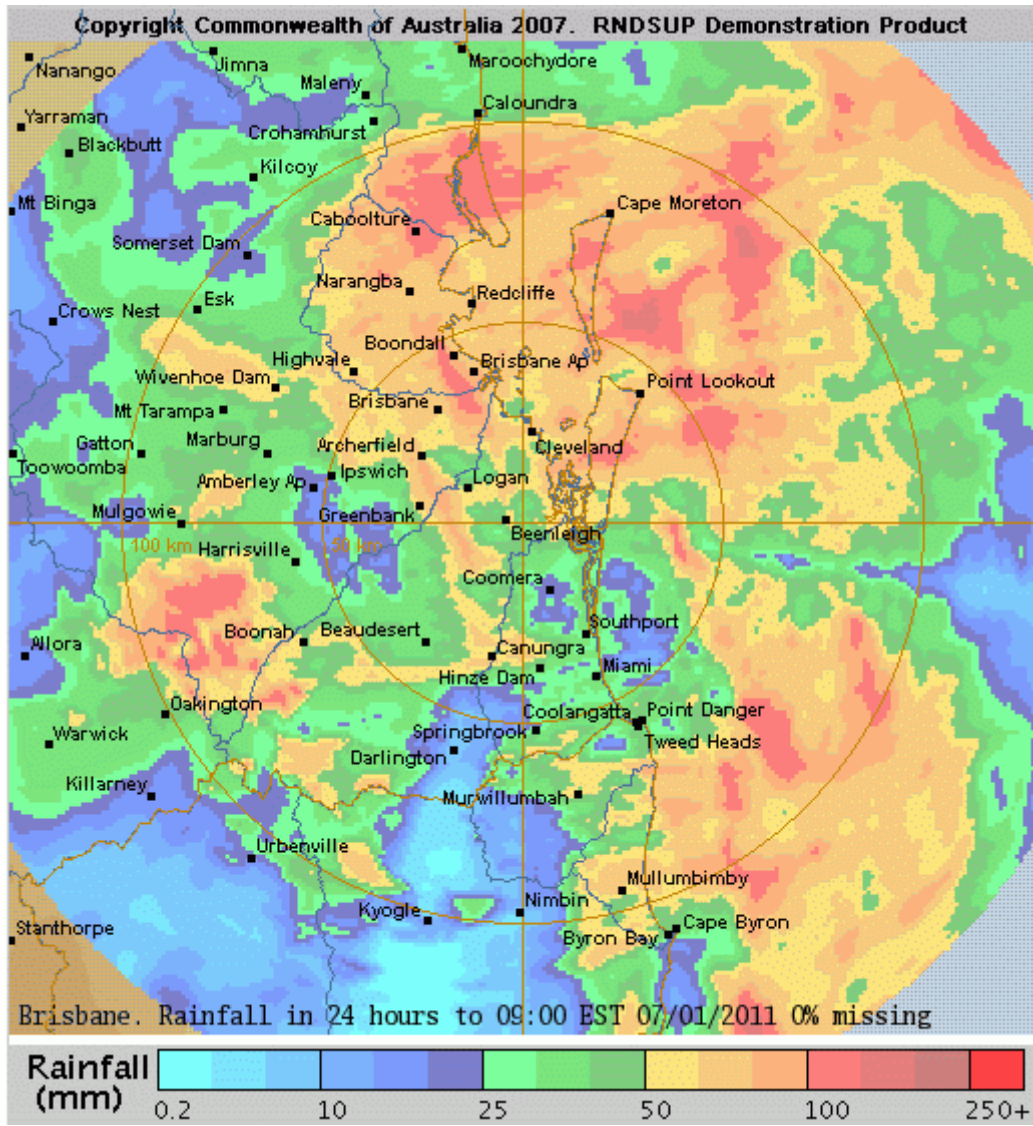


Figure 4.1: Accumulated rainfall from 9am the 6th of January 2011, to 9am the 7th of January, 2011. Moderate falls produced flash flooding over the region. This is significant when compared to the following two radar images. (Source: Bureau of Meteorology)

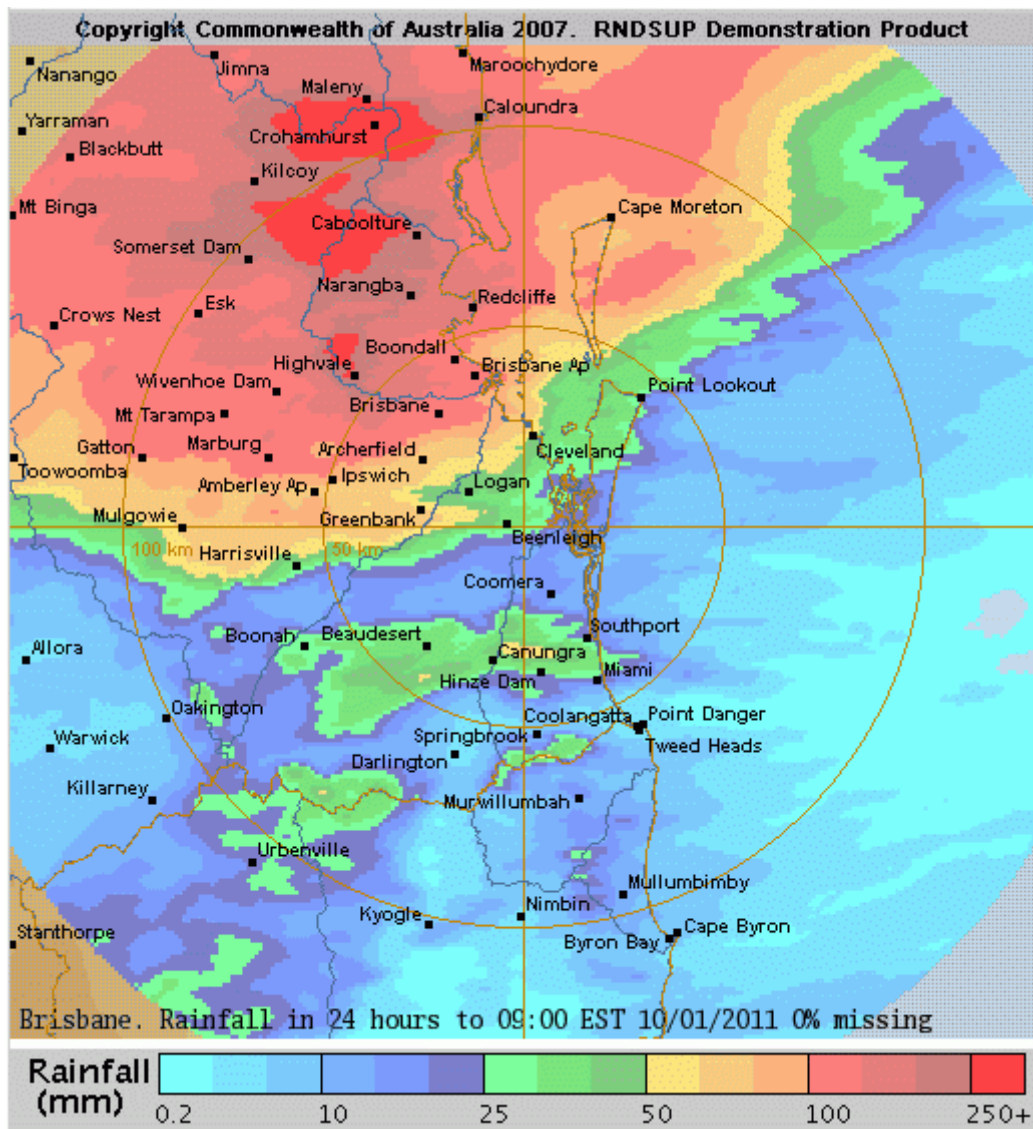


Figure 4.2: Accumulated rainfall from 9am the 9th of January 2011, to 9am the 10th of January, 2011. Heavy rain can be seen falling over the catchments (in particular north of Gatton) with falls of over 100mm **prior** to 9am of the major flood. (Source: Bureau of Meteorology)

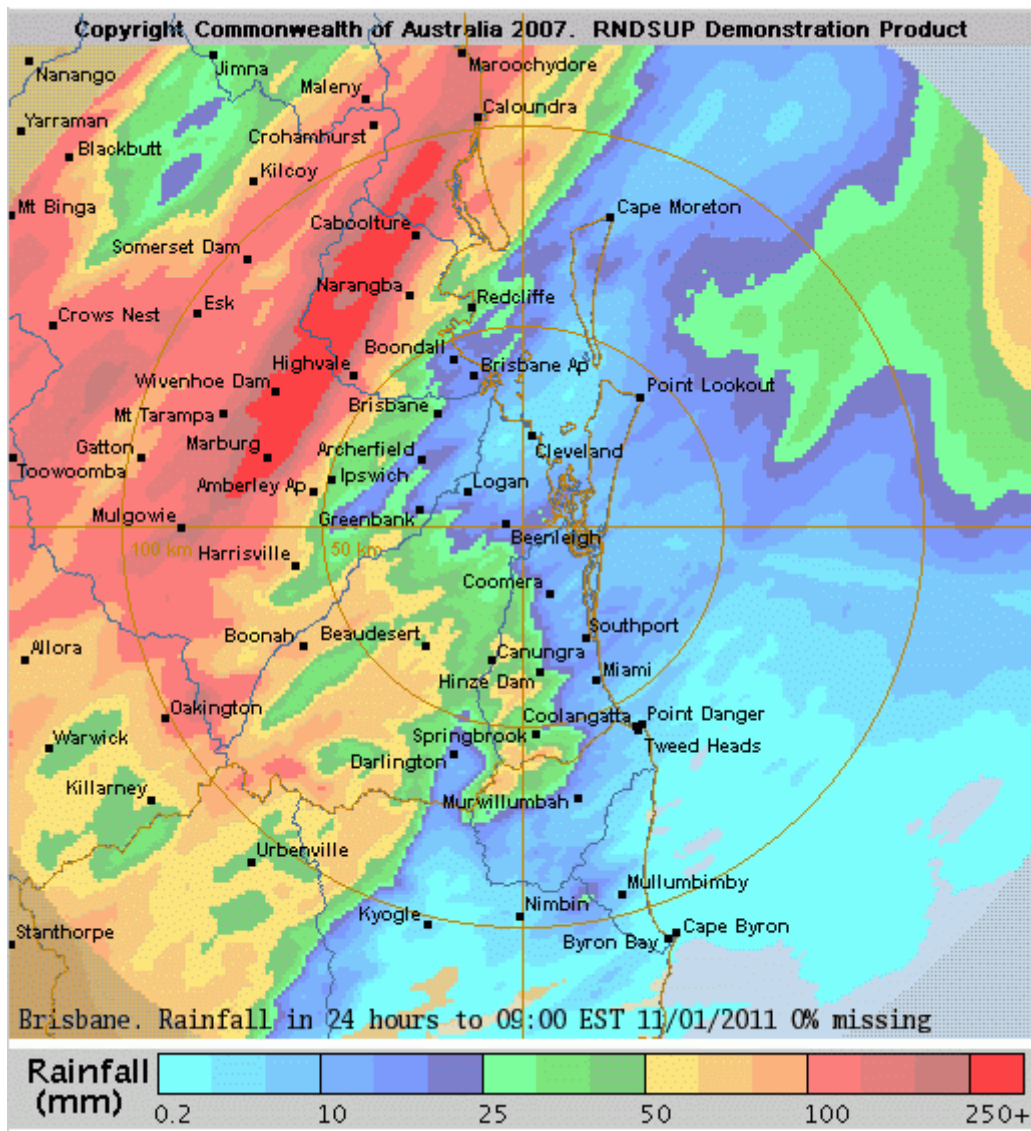


Figure 4.3: Accumulated rainfall from 9am the 10th of January 2011, to 9am the 11th of January, 2011 showing far more significant rain than the previous two flash flood events. Note the area of approximately 200mm (colour shade below 250mm+) to the N/NW of Gatton. (Source: Bureau of Meteorology)

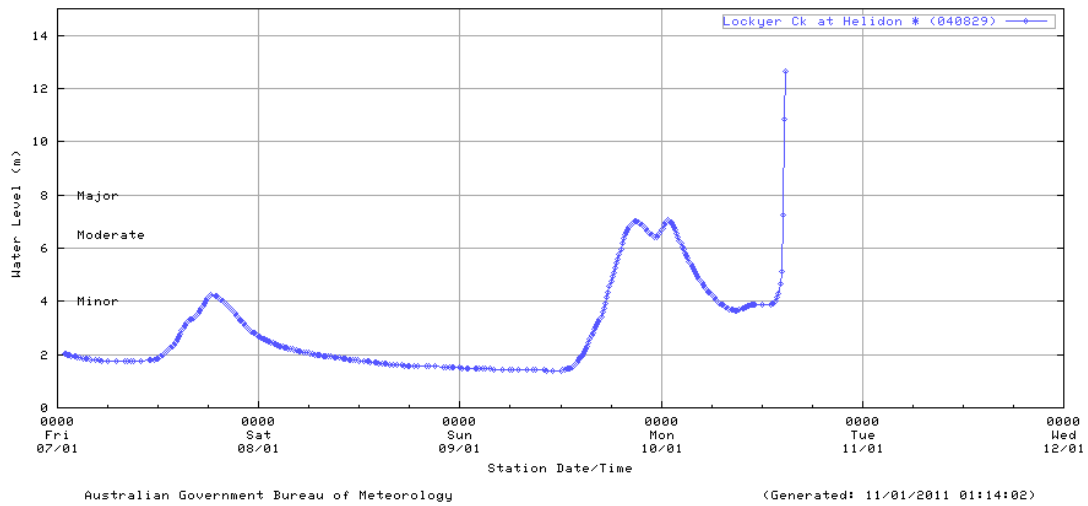





Figure 4.4: Helidon flood gauge – shows prior flooding from recent rainfall (moderate flood levels), then a huge 8m rapid spike before the gauge (presumably) failed.


Appendix E – Screen Captures of Weatherzone Forum comments

The below screen captures are from various Weatherzone Forum users (including myself). The date and time (in EST) is clearly marked on the top right hand corner of each post. (Source: www.weatherzone.com.au)







#925017 - 10-01-2011 12:16	
Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: Bryan]	
 Anthony Cornelius <small>Meteorologist</small> <small>Registered: 22-05-2001</small> <small>Loc: Heritage Park, Brisbane</small>	<p>Concerning for the Gatton-Grantham area right now with that very large storm/rain area moving towards it with no doubt, torrential rainfall! Sandy Creek (in Grantham) has caught quite a few people by surprise and I hope they're prepared for it, but sadly I think most won't know until the water starts lapping up at their homes due to our insufficient warning system.</p> <p>Event is definitely not over - the dry slot is there, but the moist air in front of it is the danger zone which is what's passing through/moving towards Southeast Queensland right now! Not to mention the instability - and radar is certainly showing a clear picture of the instability right now.</p> <p>AC</p> <p>Downunder Chasing www.downunderchase.com</p>

#925146 - 10-01-2011 14:34	
Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: buster]	
 Anthony Cornelius <small>Meteorologist</small> <small>Registered: 22-05-2001</small> <small>Loc: Heritage Park, Brisbane</small>	<p>Originally Posted By: buster</p> <p>Anthony, do you think the BOM's on the case with that cell. If not you probably know who should be told about it. Those rain rates between Esk, Crows Nest and Toowoomba are truly frightening. I fear that there could be a dangerous flash flood very soon, particularly in Grantham. Am I overreacting?</p> <p>This is my concern too - that there's going to be a near wall of water flowing down into the communities through there...</p> <p>The flooding in Toowoomba would be significant too with 60mm in the last hour.</p> <p>The satellite images seem to be hooking the cloud more westerly now which if that's the case, would begin to drag the rain and storms offshore back onto the coast.</p> <p>AC</p> <p>Downunder Chasing www.downunderchase.com</p>

#925225 - 10-01-2011 15:23	
Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: Loopy Radar]	
 Dave Wx <small>Weatherzone Addict</small> <small>Registered: 27-08-2001</small> <small>Loc: Heritage Park, Brisbane, QLD</small>	<p>I have just spotted a 12.68m reading at Helidon...INCREDIBLE flooding there if so!</p> <p>http://www.bom.gov.au/fwo/IDQ65389/IDQ65389.540143.pit.shtml</p>

#925328 - 10-01-2011 16:27	
Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: maf101]	
 Dave Wx <small>Weatherzone Addict</small> <small>Registered: 27-08-2001</small> <small>Loc: Heritage Park, Brisbane, QLD</small>	<p>I wonder if anybody at the Bureau is awake at the moment?</p> <p>This is the latest warning for Lockyer Ck, issued a couple of minutes ago:</p> <p>(note, an hour after Helidon flood gauge recorded ridiculous flooding, and countless scary flooding and landslide reports from the Toowoomba area)</p> <div style="border: 1px solid gray; padding: 5px; margin: 10px 0;"> <p>Quote:</p> <p>FLOOD WARNING FOR THE LOCKYER, BREMER, WARRILL AND Brisbane RIVER BELOW WIVENHOE INCLUDING Brisbane CITY Issued at 4:16 PM on Monday the 10th of January 2011 by the Bureau of Meteorology, Brisbane.</p> <p>Stream level rises causing moderate to major flooding are being recorded in Lockyer Creek, Warrill Creek and along the Bremer River. Major flood levels are likely at Ipswich during Tuesday.</p> <p>LOCKYER CREEK: Further rainfall during Monday has led to renewed rises in the Lockyer Creek catchment. Rainfall is forecast to continue this evening and a return to moderate to major flood levels is expected overnight and during Tuesday. Major flood levels are expected to continue at Lyons Bridge with rises above 15 metres likely during Tuesday.</p> </div>

These are four posts referred to in the main text above. The following are some further posts from the Weatherzone forums that provide further information on the Lockyer Valley flood event.

<p>Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: CivEngSean] #924838 - 10-01-2011 08:51</p>	
<p>Anthony Cornelius  Meteorologist Registered: 22-06-2001 Loc: Heritage Park, Brisbane</p>	<p>I've noticed the DP/temp increases too. And it's actually a big concern...it means that we're getting air dragged from further northwards now which has much more moisture and energy... le the potential for a lot more rain to come!</p> <p>DPs are now 23-24 rather than 21-22, there's a BIG energy difference between the two, especially given the upper atmosphere...CAPE values have nearly doubled in the last 1-2 hours from the DP increase alone. Storm rainfall would be horrible right now if it occurs!</p> <p>AC</p> <p>Downunder Chasing www.downunderchase.com</p>
<p>Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: shama] #924911 - 10-01-2011 09:59</p>	
<p>Ken Kato  Cloud Gazer Registered: 15-11-2008 Loc: Brisbane</p>	<p>Could be a fair bit more to go into those dams, Shama. The ACCESS-C model suggests isolated pockets of peak rainfall rates up to 321mm/3hrs in some places overnight.</p>
<p>Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: Cyclonic Nikko] #925005 - 10-01-2011 12:01</p>	
<p>Hinezy  Weatherzone Addict Registered: 28-06-2007 Loc: Arane Hills SE QLD</p>	<p>Amazing how high the Dew Points are at the moment! This morning's sounding looks extremely unstable and moisture loaded as well! That could well be a recipe for some very heavy flash flooding type storms to pop up at any time around the place... especially within this break in the rain bands we're seeing at the moment. If the sun comes out that might not necessarily be a good thing because it could make way for some explosive convective activity which would have the potential to unleash torrential amounts of rain in a short amount of time.</p> <p>It feels so muggy when it's not raining. The next couple of hours could be interesting while this next rainband is making its way to the coast. It will be interesting to see what fires up in between!</p> <p><i>Edited by Hinezy (10-01-2011 12:02)</i></p>
<p>Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: Anthony Cornelius] #925065 - 10-01-2011 13:10</p>	
<p>buster  Weather Freak Registered: 25-09-2006 Loc: Kalbar (near Boonah) SEQ</p>	<p>Originally Posted By: Anthony Cornelius</p> <p>Concerning for the Gatton-Grantham area right now with that very large storm/rain area moving towards it with no doubt, torrential rainfall! Sandy Creek (in Grantham) has caught quite a few people by surprise and I hope they're prepared for it, but sadly I think most won't know until the water starts lapping up at their homes due to our insufficient warning system.</p> <p>Event is definitely not over - the dry slot is there, but the moist air in front of it is the danger zone which is what's passing through/moving towards Southeast Queensland right now! Not to mention the instability - and radar is certainly showing a clear picture of the instability right now.</p> <p>AC</p> <p>Anthony, do you think the BOM's on the case with that cell. If not you probably know who should be told about it. Those rain rates between Esk, Crows Nest and Toowoomba are truly frightening. I fear that there could be a dangerous flash flood very soon, particularly in Grantham. Am I overreacting?</p>
<p>Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: buster] #925077 - 10-01-2011 13:22</p>	
<p>Dave-WX  Weatherzone Addict Registered: 27-08-2001 Loc: Heritage Park, Brisbane, QLD</p>	<p>Originally Posted By: buster</p> <p>Anthony, do you think the BOM's on the case with that cell. If not you probably know who should be told about it. Those rain rates between Esk, Crows Nest and Toowoomba are truly frightening. I fear that there could be a dangerous flash flood very soon, particularly in Grantham. Am I overreacting?</p> <p>No you're not overreacting Neil!!! We've just been chatting about it here...111mm at Redbank Creek alert (1/3 of the way between Esk and Toowoomba, under that stormy blob) since 9am now!</p>
<p>Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: snowmad] #925095 - 10-01-2011 13:41</p>	
<p>Adam Ant  Weather Freak Registered: 28-10-2003 Loc: Withcott...on the eastern side...</p>	<p>Originally Posted By: snowmad</p> <p>Those falls around Redbank creek and other areas in the Lockyer and Esk valleys are insane 111mm most of that in last hour. Falls like that are going to send huge surge down to the Brisbane river and flows in below the Wivenhoe dam so no flood mitigation possible. Mt Crosby weir approaching 14m and still rising watch it shoot up later tonight when water releases from Wivenhoe increase from overflow.</p> <p>It has absolutely bucketed down in the last 30 minutes in toowoomba. I wouldnt be surprised if we got 50mm. Keep a close eye on the lockyer creek at Helidon and now cressbrook creek. There will be a wall of water coming down it</p> <p>Lockyer creek at Helidon Cressbrook creek</p> <p><i>Edited by Adam Ant (10-01-2011 13:43)</i></p>

Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: Dave-Wx] #925097 - 10-01-2011 13:42

buster Weather Freak
Registered: 25-09-2006
Loc: Kalbar (near Boonah) SEQ

Originally Posted By: Dave-Wx

Originally Posted By: buster

Anthony, do you think the BOM's on the case with that cell. If not you probably know who should be told about it. Those rain rates between Esk, Crows Nest and Toowoomba are truly frightening. I fear that there could be a dangerous flash flood very soon, particularly in Grantham. Am I overreacting?

No you're not overreacting Neil!!! We've just been chatting about it here...111mm at Redbank Creek alert (1/3 of the way between Esk and Toowoomba, under that stormy blob) since 9am now!

Dave, I live in an area that is equally not used to being so saturated and equally not used to falls of that nature (as opposed to say Springbrook). I just know that 56mm in an hour right now here would produce a flood of frightening proportions and one likely to put lives at risk. Falls higher than this in the immediate area are likely. I repeat my question....Does someone in Esk, Grantham, Toogoolawah need to know what's possible. Who do we tell?

Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: buster] #925102 - 10-01-2011 13:49

Dave-Wx Weatherzone Addict
Registered: 27-08-2001
Loc: Heritage Park, Brisbane, QLD

Originally Posted By: buster

Dave, I live in an area that is equally not used to being so saturated and equally not used to falls of that nature (as opposed to say Springbrook). I just know that 56mm in an hour right now here would produce a flood of frightening proportions and one likely to put lives at risk. Falls higher than this in the immediate area are likely. I repeat my question....Does someone in Esk, Grantham, Toogoolawah need to know what's possible. Who do we tell?

There is nothing really that we can do is there ☹️

This is why I wanted to see some sort of heads up for **everyone** in SEQ a few days ago, because it is hard to justify sounding the SEWS just for that part of Lockyer Ck (for example) when they have no telemetry telling them just yet that there is a huge wall of water coming down the creek in that area. It is also very hard to warn people quickly in specific areas like this when there is stuff happening everywhere.

Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: Matt@dstorms] #925283 - 10-01-2011 16:49

buster Weather Freak
Registered: 25-09-2006
Loc: Kalbar (near Boonah) SEQ

That cell has caused more than problems at Toowoomba. I hope and pray that this is a mistake or the whole Lockyer valley is heading for an unmitigated disaster. If I lived near Lockyer creek further down the valley from Helidon I would be heading for high ground....now.
<http://www.bom.gov.au/fo/IDQ65389/IDQ65389.540143.pit.shtml>

Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: james1977] #925285 - 10-01-2011 15:50

Anthony Cornelius Meteorologist
Registered: 22-05-2001
Loc: Heritage Park, Brisbane

I hope some one is warning Gatton of what's coming down their way...don't want a wall of water to sweep through the town...

Both Helidon stations recorded the peak, they're very real and believable! I've contacted my rels in the Lockyer and told them all to get home and stay there.

AC

Downunder Chasing www.downunderchase.com

Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: maf101] #925328 - 10-01-2011 16:27

Dave-Wx Weatherzone Addict
Registered: 27-08-2001
Loc: Heritage Park, Brisbane, QLD

I wonder if anybody at the Bureau is awake at the moment?

This is the latest warning for Lockyer Ck, issued a couple of minutes ago:

(note, an hour after Helidon flood gauge recorded ridiculous flooding, and countless scary flooding and landslide reports from the Toowoomba area)

Quote:

FLOOD WARNING FOR THE LOCKYER, BREMER, WARRILL AND Brisbane RIVER BELOW WIVENHOE INCLUDING Brisbane CITY
Issued at 4:16 PM on Monday the 10th of January 2011
by the Bureau of Meteorology, Brisbane.

Stream level rises causing moderate to major flooding are being recorded in Lockyer Creek, Warrill Creek and along the Bremer River. Major flood levels are likely at Ipswich during Tuesday.

LOCKYER CREEK:
Further rainfall during Monday has led to renewed rises in the Lockyer Creek catchment. Rainfall is forecast to continue this evening and a return to moderate to major flood levels is expected overnight and during Tuesday. Major flood levels are expected to continue at Lyons Bridge with rises above 15 metres likely during Tuesday.

Re: SE QLD /NE NSW FLOOD DISASTER 5-12 JANUARY 2011 [Re: Steve G] #925383 - 10-01-2011 17:04

Dave-Wx Weatherzone Addict
Registered: 27-08-2001
Loc: Heritage Park, Brisbane, QLD

Just heard a report from Grantham on the ABC radio stream that **a house has been washed away** and the family got out and they are wandering along the trainline, waiting for help...though the radio stream just died for me.

mickyd
Weather Freak
Registered: 18-04-2008
Loc: Mitchelton

Broadcasters are directed to use the SEWS for this warning.

TOP PRIORITY
FLASH FLOOD WARNING FOR LOCKYER CREEK
Issued at 5:00 PM on Monday the 10th of January 2011
by the Bureau of Meteorology, Brisbane.

Very heavy rainfalls have been recorded in the Toowoomba area and caused extreme flash flooding. This rainfall is also causing extreme rises in the upper Lockyer Creek at Helidon with very fast and dangerous rises possible downstream at Gatton in the next few hours. Rises will extend downstream of Gatton during tonight.

Heavy rain areas and thunderstorms are expected to continue through the Southeast Coast district, far southern parts of the Wide Bay and Burnett District and eastern parts of the Darling Downs and Granite Belt district. Heavy falls may lead to localised flash flooding and/or worsen existing river flooding.

Further rises and flash flooding are likely in the creeks and streams around Brisbane and Ipswich associated with the heaviest rainfall.

Flood warnings are current for the Mary River, Sunshine Coast streams and the Upper Brisbane and Lower Brisbane rivers. A severe weather warning is also current for this region.

Appendix F – Miscellaneous data

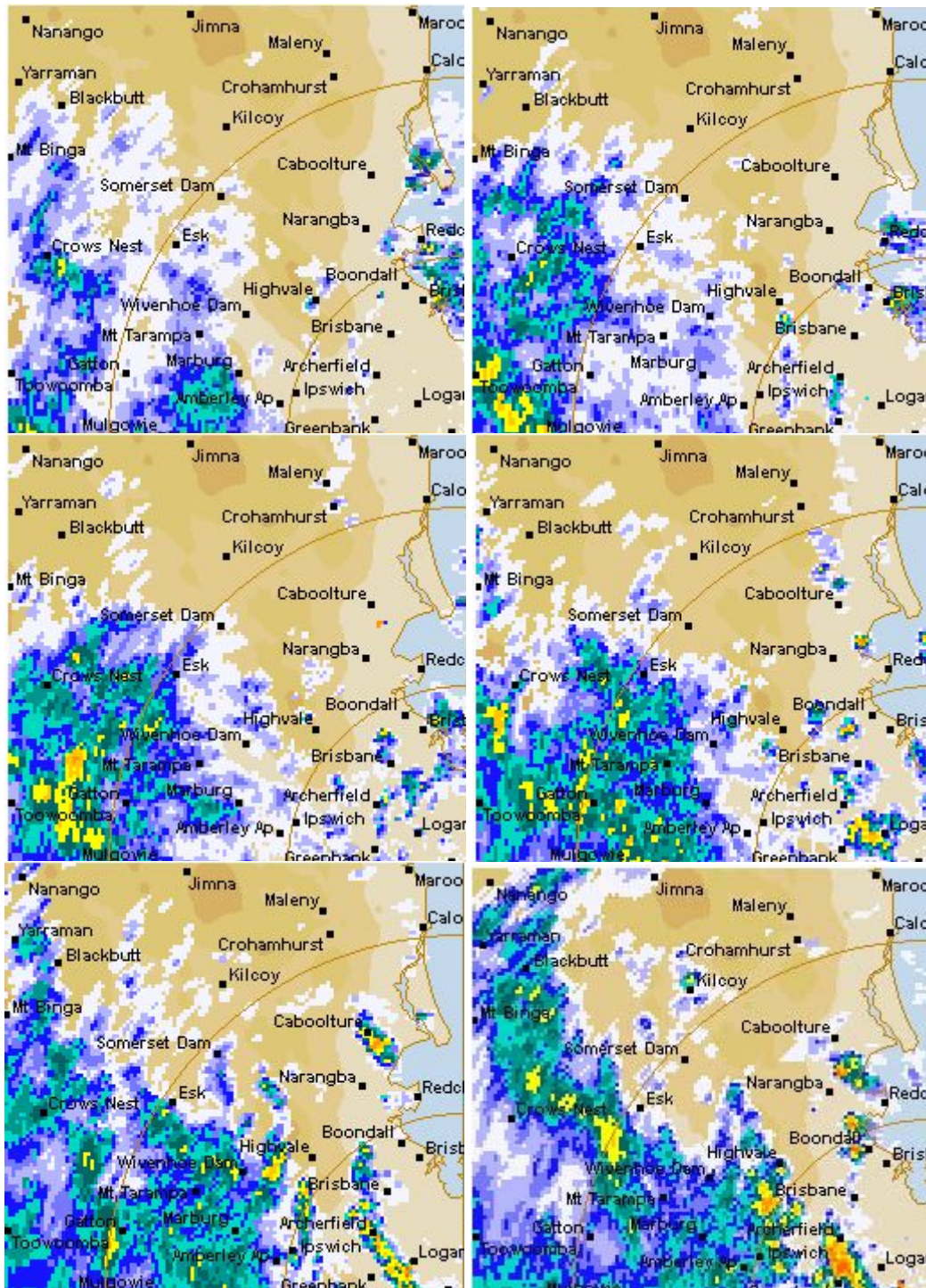


Figure 6.1: 30 minute radar images (8:30am , 9am , 9:30am, 10am, 10:30am & 11am from left to right) of the rainfall which produced flooding to Grantham, Toowoomba and the Lockyer Valley on the 6th of January. (Source: Bureau of Meteorology– www.bom.gov.au)

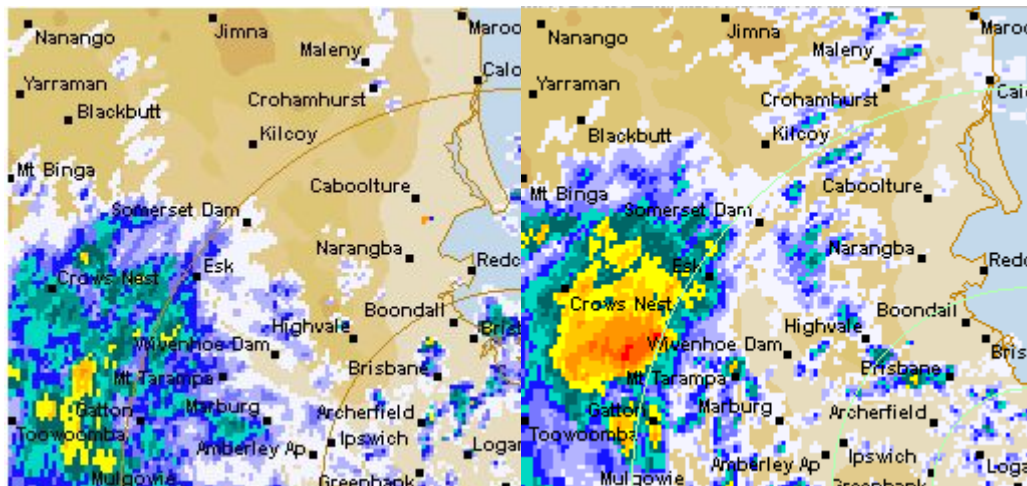


Figure 6.2: Comparison between the rainfall which produced the flooding on the 6th January, 2011 (left) and the flooding on the 10th January, 2011 (right). Both of these were under a generic severe weather warning for flash flooding. (Source: Bureau of Meteorology– www.bom.gov.au)

Appendix G – Bureau of Meteorology Warnings

Warning One

IDQ20032

Australian Government Bureau of Meteorology
Queensland

TOP PRIORITY FOR IMMEDIATE BROADCAST

SEVERE WEATHER WARNING

for heavy rainfall leading to localised flash flooding and potentially worsening the existing river flood situation

For people in the Maranoa, Darling Downs and Granite Belt, Southeast Coast, Wide Bay and Burnett and southern parts of the Central Highlands and Coalfields and Capricornia forecast districts.

Issued at 10:55 am on Wednesday 5 January 2011

Synoptic Situation: At 10am EST, a trough extended from northwestern Queensland into the southern Maranoa. The trough is expected to intensify as it moves slowly east over the next 24 hours.

Thundery rain areas with some heavy falls are expected to develop this evening and overnight over the Maranoa, Darling Downs and Granite Belt, Southeast Coast districts and southern parts of the Wide Bay and Burnett district. This heavy rain is expected to extend to the Capricornia districts and remaining parts of the Wide Bay and Burnett district during Thursday. The rain will ease over the Maranoa and western Darling Downs during Thursday.

Heavy rainfall may lead to localised flash flooding and/or worsen current river flooding.

Flood warnings are current for various rivers and streams in these districts; refer to these products [www.bom.gov.au/qld] for further information.

The State Emergency Service advises that people in the affected area should:

- avoid driving, walking or riding through flood waters
- take care on the roads, especially in heavy downpours
- avoid swimming in swollen rivers and creeks

Contact the SES on 132 500 for emergency assistance if required.

The next warning is due to be issued by 5:00 pm Wednesday

This warning is also available through TV and Radio broadcasts; the Bureau's website at www.bom.gov.au or call 1300 659 219. The Bureau and State Emergency Service would appreciate this warning being broadcast regularly.

Warning Two

IDQ20032

Australian Government Bureau of Meteorology
Queensland

TOP PRIORITY FOR IMMEDIATE BROADCAST

SEVERE WEATHER WARNING

for heavy rainfall leading to localised flash flooding and potentially worsening the existing river flood situation

For people in the Southeast Coast district, southern parts of the Wide Bay and Burnett district and eastern parts of the Darling Downs and Granite Belt district.

Issued at 11:05 am on Monday 10 January 2011

Synoptic Situation: At 10am EST, an upper level low was located over the southwest of the Capricornia District. A surface trough was located off the southeast coast. Both of these systems are moving slowly west.

Heavy rain areas and thunderstorms are expected to continue through the Southeast Coast district, far southern parts of the Wide Bay and Burnett District and eastern parts of the Darling Downs and Granite Belt district. Heavy falls may lead to localised flash flooding and/or worsen existing river flooding.

The heavy rain areas and thunderstorms are expected to contract southwards into the Southeast Coast district and southeast parts of the Darling Downs and Granite Belt district during Tuesday.

Recent events: In the 24 hours to 9am EST Monday morning, Maleny received 321mm, West Bellthorpe 310 mm and Peachester 298 mm.

Flood warnings are current for various rivers and streams in these districts; refer to these products [www.bom.gov.au/qld] for further information.

The State Emergency Service advises that people in the affected area should:

- avoid driving, walking or riding through flood waters
- take care on the roads, especially in heavy downpours
- avoid swimming in swollen rivers and creeks

Contact the SES on 132 500 for emergency assistance if required.

The next warning is due to be issued by 5 pm Monday.

This warning is also available through TV and Radio broadcasts; the Bureau's website at www.bom.gov.au or call 1300 659 219. The Bureau and State Emergency Service would appreciate this warning being broadcast regularly.

Warning Three

IDQ20805

Australian Government Bureau of Meteorology
Queensland

PRIORITY

**FLOOD WARNING FOR THE LOCKYER, BREMER, WARRILL AND
BRISBANE RIVER BELOW WIVENHOE
INCLUDING BRISBANE CITY**

Issued at 4:16 PM on Monday the 10th of January 2011
by the Bureau of Meteorology, Brisbane.

Stream level rises causing moderate to major flooding are being recorded in Lockyer Creek, Warrill Creek and along the Bremer River. Major flood levels are likely at Ipswich during Tuesday.

Wivenhoe dam is providing significant mitigation of upper Brisbane floods. River flows from the Bremer and Lockyer catchments combined with releases from Wivenhoe dam are expected to increase levels in Brisbane overnight and through Tuesday.

At the Brisbane City Gauge, a river levels of about 2.1 metres is expected with the afternoon high tide on Tuesday and about 3 metres is expected with the high tides on Wednesday causing moderate flooding.

(3 metres at the Brisbane City gauge is about 1.5 metres higher than the highest tide of the year at this location).

LOCKYER CREEK:

Further rainfall during Monday has led to renewed rises in the Lockyer Creek catchment. Rainfall is forecast to continue this evening and a return to moderate to major flood levels is expected overnight and during Tuesday. Major flood levels are expected to continue at Lyons Bridge with rises above 15 metres likely during Tuesday.

Warning Four

IDQ20780

Australian Government Bureau of Meteorology
Queensland

Broadcasters are directed to use the SEWS for this warning.

TOP PRIORITY

FLASH FLOOD WARNING FOR LOCKYER CREEK

Issued at 5:00 PM on Monday the 10th of January 2011
by the Bureau of Meteorology, Brisbane.

Very heavy rainfalls have been recorded in the Toowoomba area and caused extreme flash flooding. This rainfall is also causing extreme rises in the upper Lockyer Creek at Helidon with very fast and dangerous rises possible downstream at Gatton in the next few hours. Rises will extend downstream of Gatton during tonight.

Heavy rain areas and thunderstorms are expected to continue through the Southeast Coast district, far southern parts of the Wide Bay and Burnett District and eastern parts of the Darling Downs and Granite Belt district. Heavy falls may lead to localised flash flooding and/or worsen existing river flooding.

Further rises and flash flooding are likely in the creeks and streams around Brisbane and Ipswich associated with the heaviest rainfall.

Flood warnings are current for the Mary River, Sunshine Coast streams and the Upper Brisbane and Lower Brisbane rivers. A severe weather warning is also current for this region.

Next Issue:

The next warning will be issued at about 8:30pm Monday.

Latest River Heights:

nil.

Warnings and River Height Bulletins are available at <http://www.bom.gov.au/qld/flood/>. Flood Warnings are also available on telephone 1300 659 219 at a low call cost of 27.5 cents, more from mobile, public and satellite phones.