Bureau of Meteorology Submission to Senate Rural and Regional Affairs and Transport References Committee Inquiry into Aviation Accident Investigations

Note that all times referred to in this submission are Universal Time, Coordinated (UTC); local Norfolk Island time is UTC+11:30.

Aviation weather forecasting – a general overview

Aviation meteorological services are provided by the Bureau of Meteorology under the Convention for International Aviation, 1947 (the Chicago Convention) in accordance with Annex 3, "Meteorological Services for International Air Navigation". The Bureau provides its aviation forecasts and observations to Airservices Australia which is the designated Aeronautical Information Service (AIS) provider within the Australian Flight Information Region. The aviation industry, including pilots and airport staff, can access their briefing and weather information updates from the official AIS provider within the relevant Flight Information Region.

An aerodrome forecast (TAF) is a statement of meteorological conditions expected for a specific period of time, in the airspace within a radius of 5 nautical miles (9 km) of the aerodrome. The TAF provides predictions of wind, temperature, pressure, cloud height and amount, visibility and specific weather phenomena. To produce a TAF forecasters use information from various sources, including past and present in situ observations, radar and satellite imagery, climate information and weather forecasting models. Forecasting for a specific point and time is a continuous process that involves forecasters monitoring observations and forecast guidance, and updating forecasts according to standard criteria. Amendments to a TAF are issued in the event that one or more of the forecast elements described above varies by an amount that is significant to operations at the aerodrome.

TAFs are prepared by professional meteorologists in the Bureau's Regional Forecasting Centres, located in Capital Cities around the country. The TAF for Norfolk Island (YSNF) is routinely issued by the NSW Regional Office every 6 hours with each TAF valid for 18 hours i.e. from 1800 to 1200 UTC, 0000 to 1800 UTC, 0600 to 2400 UTC and 1200 to 0600 UTC respectively.

For many aerodromes, sets of meteorological observations called Meteorological Aerodrome Reports (METARs) are issued regularly – usually every thirty minutes at most airports with the appropriate instrumentation. Another type of observation report is a SPECIwhich is a special report of meteorological conditions, issued when one or more weather elements meet specified criteria significant to aviation and, in particular when cloud or visibility drops below the specified alternate minima conditions.

Alternate minima[1] are a set of cloud base and visibility conditions which is generated for each airfield that has a published instrument approach procedure. The alternate minima are based on the minimum descent altitude and minimum visibility of each of the available instrument approaches. When the forecast or actual conditions at an airfield decrease below the alternate minima, aircraft flying to that airfield must either carry fuel for flight to an alternate airfield or fuel to allow the aircraft to remain airborne until the weather improves sufficiently for a safe landing to be conducted.

[1] Extracted from: ATSB recommendation R20000040; 22 Feb 2000; Reliability of Norfolk Island Forecasts ; http://www.atsb.gov.au/publications/recommendations/2000/r20000040.aspx

(i) The reliability of weather forecasting for remote islands:

There are many factors which determine the accuracy and reliability of weather forecasts. These include the forecast location, observations from the forecast location, the observations in the surrounding area, the season, the complexity of the particular situation, the elements being forecast, the period of the forecast, the quality of the forecast models and systems available to forecasters, and the timeliness of updates to changing weather conditions (both forecasts and observations).

The Bureau provides TAFs for two remote Pacific Ocean islands, Norfolk Island and Lord Howe Island from the NSW Regional Office, and two Indian Ocean islands, Cocos Island and Christmas Island from the WA Regional Office.

Data from the Bureau's TAF verification system was used to assess the accuracy of forecasts for the two Pacific Ocean islands. Conditions which were forecast to be above the alternate minima, and therefore considered suitable for landing are shown in Table 1. The reliability of these forecasts was 97.3% and 97.7% for cloud base and 98.7% and 99.2%, for visibility at Norfolk Island and Lord Howe Island respectively. The probability of encountering un-forecast adverse weather conditions is therefore 2.7% and 2.3% respectively for cloud base and 1.3% and 0.8% respectively for visibility.

For these two island locations Norfolk Island had the highest incidence of observed low cloud base below alternate minima, being 10.2% of the time.

Table 1: Reliability of above landing minima forecasts over the ten year period 2002 – 2012

	Norfolk Is	Lord Howe Is
Cloud base (minima height)	97.3% (1189ft)	97.7% (1963ft)
Visibility (minima visibility)	98.7% (7000m)	99.2% (6000m)

Even with advancements in the science of weather forecasting guidance in recent years, weather forecasting for remote islands will continue to be a forecasting challenge. Given the highly localised influences which can impact on conditions, and the current level of scientific knowledge for forecasting low cloud and fog at specific locations, weather forecasts, for the foreseeable future, will not be 100% accurate. This is particularly so in remote locations where there is little surface data in the surrounding area to effectively monitor approaching weather systems.

(ii) The operational implications of forecast reliability for flights to and from remote islands:

The Bureau is not the appropriate authority to provide comment on the operational implications for aviators from using our forecasts. Operational considerations for the aviation industry are determined by CASA and Airservices regulations.

(iii) The particular circumstances of the weather forecasts for Norfolk Island on the day of the ditching incident:

The following summary provides an account of key weather observations and forecasts leading up to and during the time of the ditching of the aircraft on 18 November 2009.

Following some morning low cloud, weather conditions on Norfolk Island during the afternoon were good. There was no rain, visibility was greater than 10 kilometres and there was only scattered cloud.

The aerodrome forecast (TAF) issued at 04:37 (refer to Table 2) on the afternoon of 18 November 2009 was for these conditions to persist through the evening ahead of a southerly wind change and some light showers overnight associated with a weak front.

Forecasting experience shows that the aerodrome is particularly prone to low cloud when moist winds blowing from the northwest around to the east are lifted over the Island. As the front passed the island, winds were expected to turn to the west and then south overnight, lowering the moisture content of the atmosphere.

During the late afternoon the cloud base remained above the alternate minima and visibility was good. Indications that the front would be more significant than expected were first evident at 07:39 when a SPECI was issued indicating that the cloud base had lowered below the alternate minima to 1100 feet. Based on this report the TAF was amended at 08:03 to include a broken layer of cloud at 1000 feet.

Conditions deteriorated further after 09:00. The 09:30 SPECI indicated light precipitation, reduced visibility and mostly broken to overcast low cloud with a base of 200 feet. The TAF was amended at 09:58 to include a further lowering of the cloud base to 500 feet for periods of 30 – 60 minutes, with visibility reduced to 4000 metres in rain showers.

Weather conditions were poorest between 10:00 and 10:30, when overcast cloud with a base of 200 feet, and reduced visibility in showers to 3000 metres, were observed. This is the period when the aircraft made several attempts to land. From 11:00 an improvement of conditions was observed and by 11:32 the precipitation had ceased and visibility and cloud were above the airport minimum thresholds. There was no indication of any hazardous wind shear or severe turbulence at the aerodrome around the time of the incident.

Mean sea level pressure (MSL) charts on 18 November 2009 at 00:00 and 12:00 UTC (Attachment A) show the weak front that crossed Norfolk Island between these times. Satellite Images **(**Attachment B) show the cloud band associated with the front, to the south of Norfolk Island at 04:30 on 18 November 2009, and over the Island by 10:30. Norfolk Island radar images (Attachment C) show patches of precipitation to the southwest of Norfolk Island during the afternoon, then in the vicinity of the Island between 08:30 and 10:30. A total of 3 mm of rain was recorded in the 3 hours prior to 11:28.

More detailed information on the weather conditions in aviation coded format (METARs and SPECIs), can be found at Appendix B in the ATSB final report into the incident. Observations for Norfolk Island aerodrome are provided by an Automatic Weather Station that also has a ceilometer (to measure cloud base) and a visibility meter. Supplementary input is provided by qualified observers when on duty. A chronology of key observations and forecasts issued on 18 November 2009 are shown in Table 2.

Table 2: Chronology of key weather observations and forecasts at Norfolk Island for the period 0430-1130 UTC 18 November 2009

Time (UTC)	**Observed Weather** (from METAR/SPECIs)	**Forecast Weather** (from TAF)
04:30-06:30	Main cloud base 2500 feet, few lower patches	
04:37		Routine TAF issued; valid 0600-2400, scattered cloud at 2000 feet, light showers from 1500.
07:39	SPECI report - cloud base lowers below alternate minima - broken cloud 1100 feet	
08:03		TAF amended; valid 0800 - 2400 to indicate below alternate minima cloud conditions - broken cloud at 1000 feet.
09:25-09:30	SPECI reports - cloud base lowers further, visibility reduces due showers. Broken cloud 200-300 feet, visibility 4500m in showers	
09:58		TAF amended; valid 1000 - 2400 to indicate further deterioration in conditions, broken cloud at 500 feet, visibility 4000 metres in showers for periods of 30-60minutes.
10:00-10:30	SPECI reports - overcast cloud at 200 feet, visibility 3000m in showers. Conditions poorest.	
11:00	SPECI report - conditions improve slightly. Cloud base 500 feet and visibility 5000m	
11:28	METAR report - conditions improve further, rain stops and cloud base lifts above alternate minima, broken cloud at 1200 feet, visibility 7000m.	

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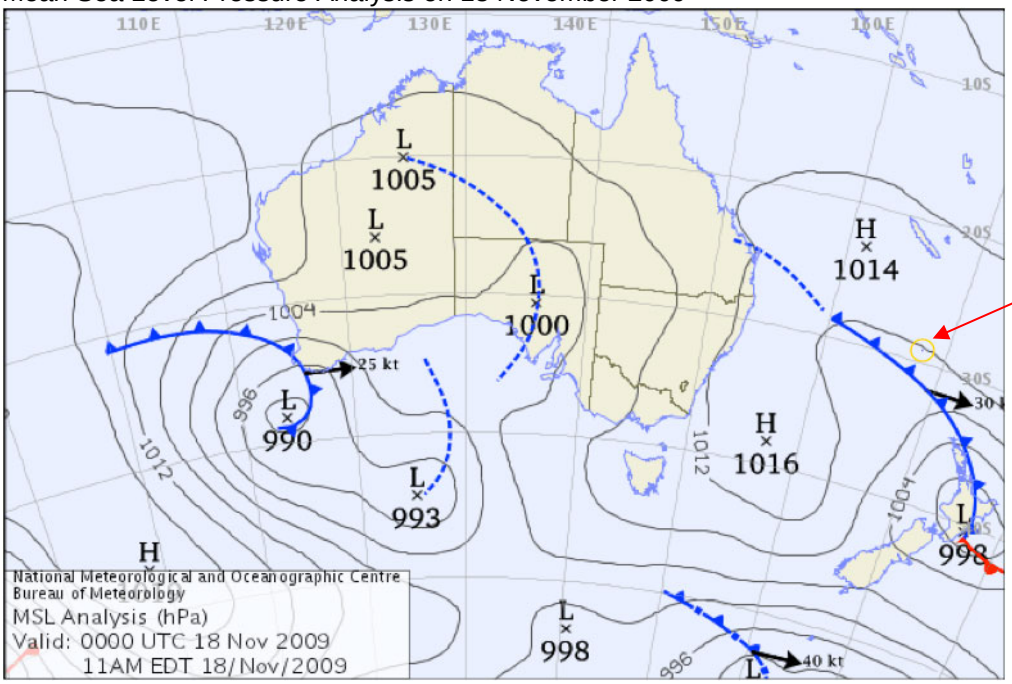
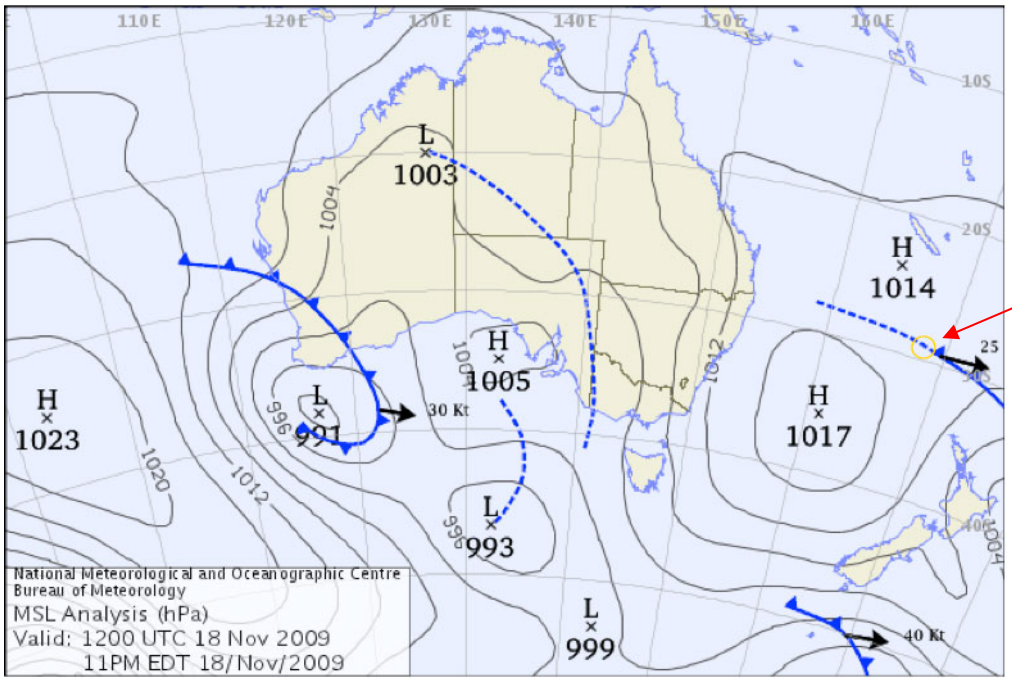
Attachment A

Mean Sea Level Pressure Analysis on 18 November 2009



Norfolk Island

Mean Sea Level Pressure Analysis, 0000 UTC 18 November 2009

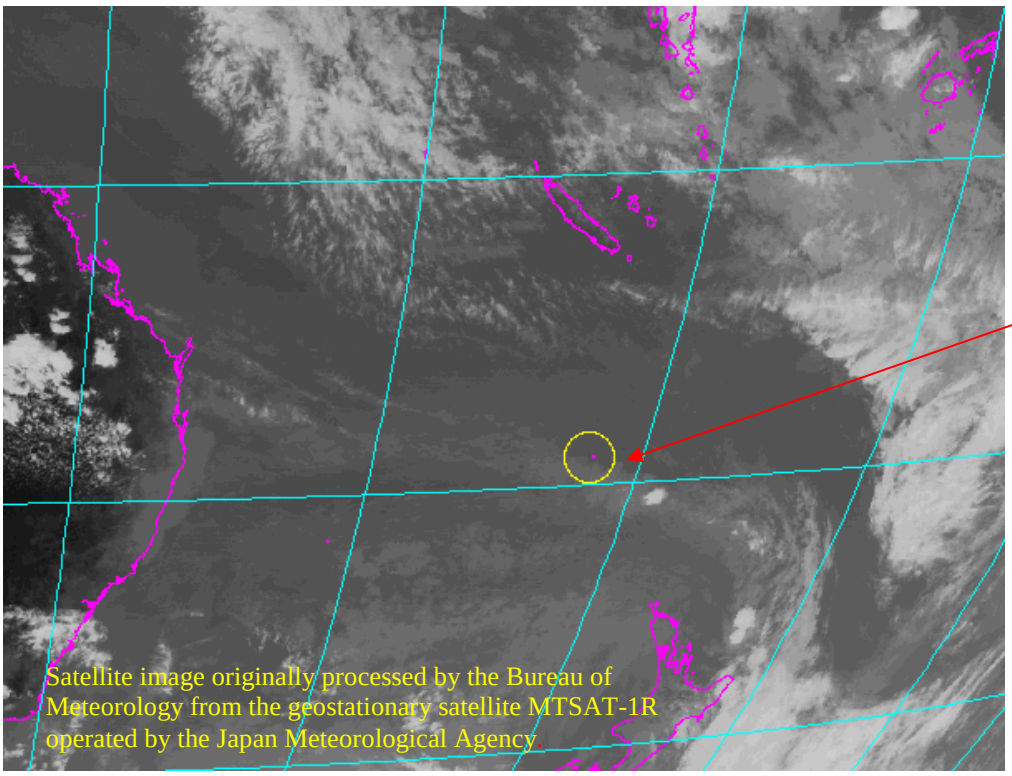


Norfolk Island

Mean Sea Level Pressure Analysis, 1200 UTC 18 November 2009

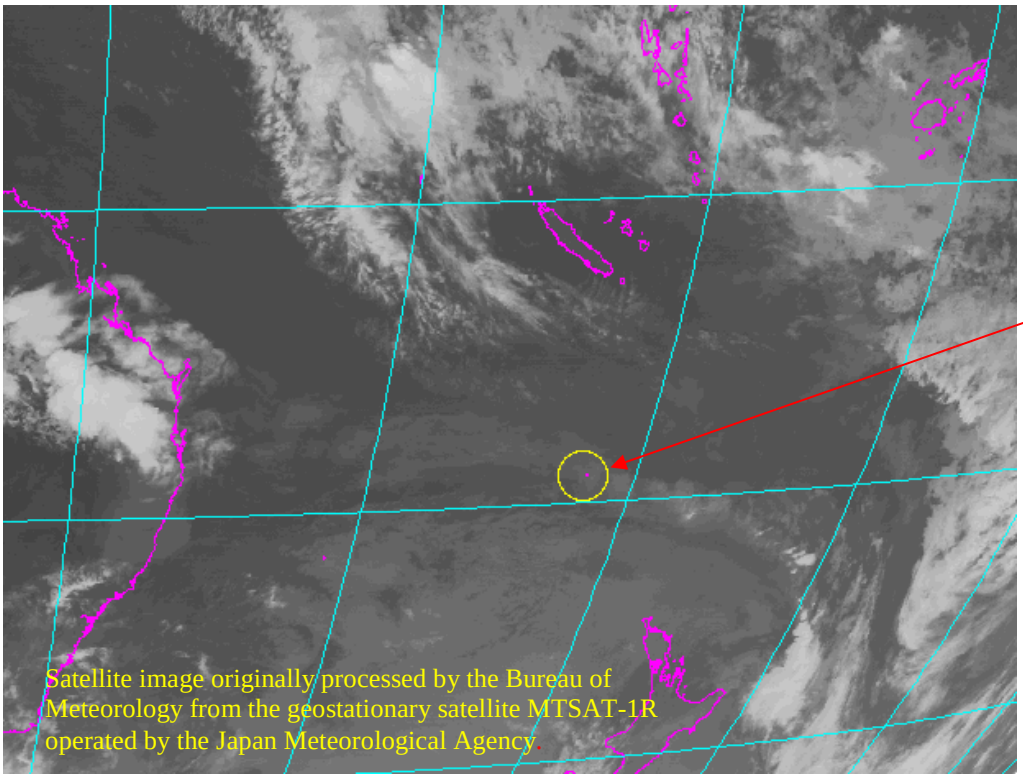
Attachment B

Infrared Satellite Images on 18 November 2009



Norfolk Island

Infrared Satellite Image, 0430 UTC 18 November 2009

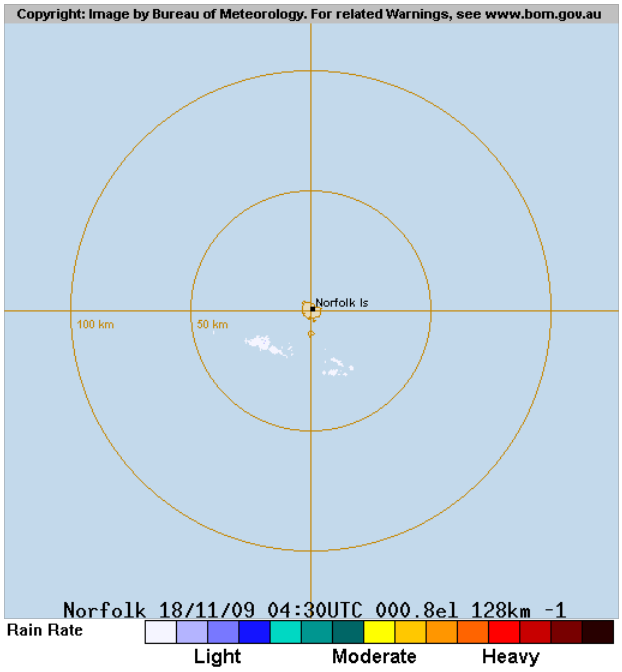


Norfolk Island

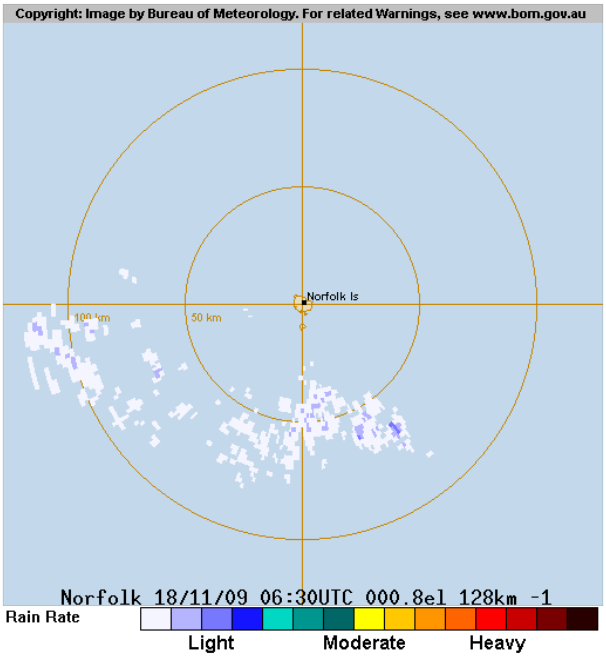
Infrared Satellite Image, 1030 UTC 18 November 2009

Attachment C

Norfolk Island radar images during the period, 0430 – 1030 UTC 18 November 2009



0430 UTC 18 November 2009



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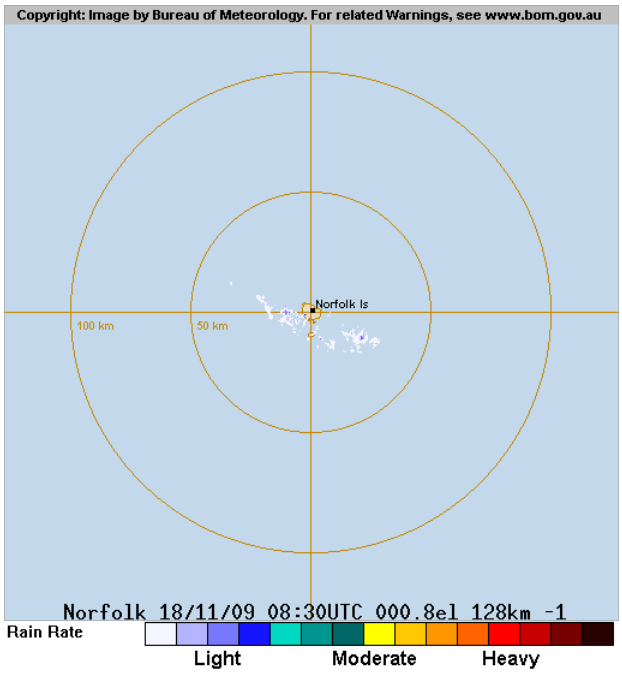
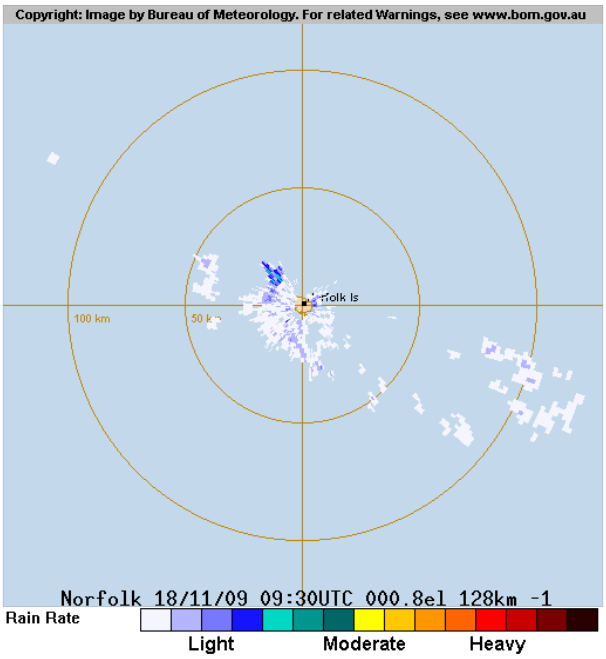
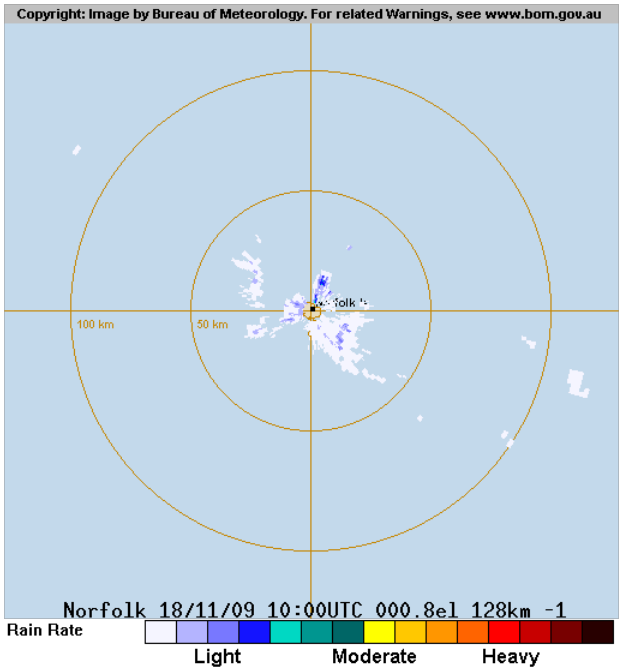


0830 UTC 18 November 2009

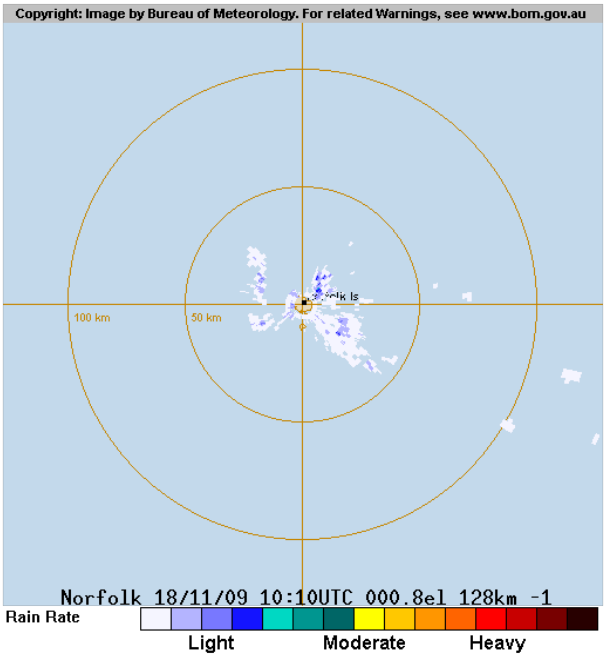


0930 UTC 18 November 2009

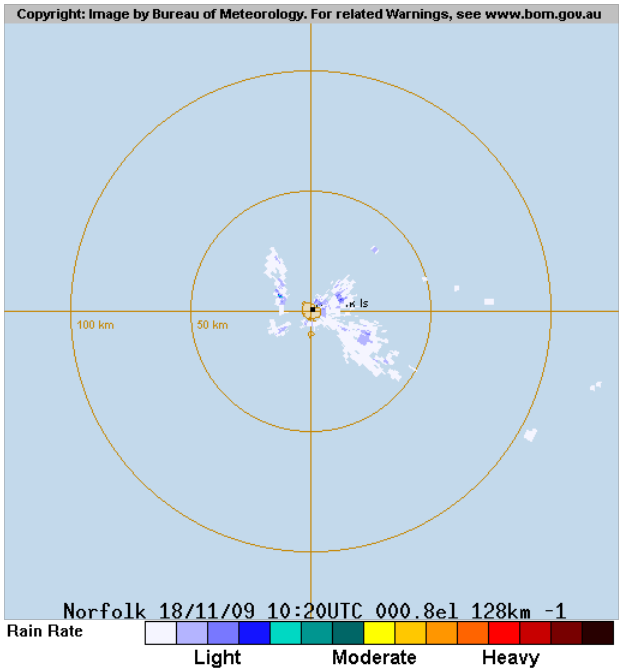
Attachment C



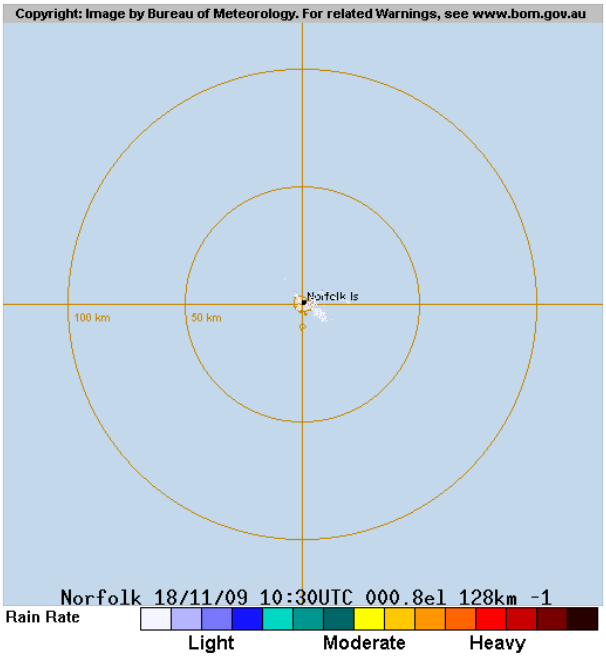
1000 UTC 18 November 2009



1010 UTC 18 November 2009



1020 UTC 18 November 2009



1030 UTC 18 November 2009