Australian Government
Bureau of Meteorology

Automated Thunderstorm Alert Service (ATSAS) User Guide

November 2016

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1 ATSAS System

The Automated Thunderstorm Alert Service (ATSAS) is a graphical thunderstorm and lightning alerting system for the aviation industry.

ATSAS is a totally automated system based on the following instrumentation:

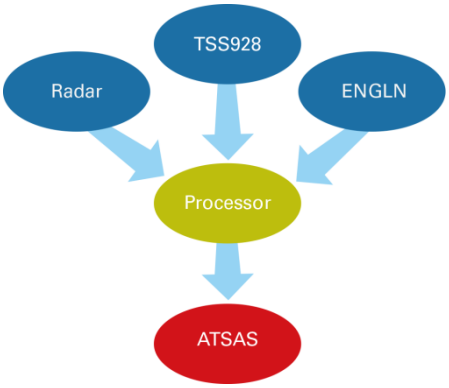
- Weather radar
- Vaisala TSS928 thunderstorm sensor, and
- Lightning data from the Earth Networks Global Lightning Network (ENGLN)

The radar performs a scan either every 6 minutes or every 10 minutes depending on the particular radar's configuration[1], feeding the captured data to a processor which interprets the data and identifies any thunderstorms via a number of classification techniques. The thunderstorm size, location, direction of movement and speed are calculated and then fed to the ATSAS display. The forecast position of a thunderstorm cell is calculated from the estimated cell movement. The processor requires three radar scans to establish a good estimate of cell movement. Prior to this, the processor estimates the movement of the new cell based on the average movement of other existing cells.

The TSS928 is an in situ sensor that detects lightning out to a range of 30nm at approximately 90-100% accuracy (depending on strength and distance of strike). This data is transmitted to the processor every minute.

The ENGLN lightning data is from a globally distributed network of lightning sensors transmitting lightning data to the Bureau every 15 seconds.

The processor integrates the data from the radar, the TSS928 and the Earth Networks Global Lightning Network to generate graphical and text based ATSAS products.



It is important to note that these three data sources are independent, and there may be a difference in the displayed location of storm cells compared to lightning strikes.

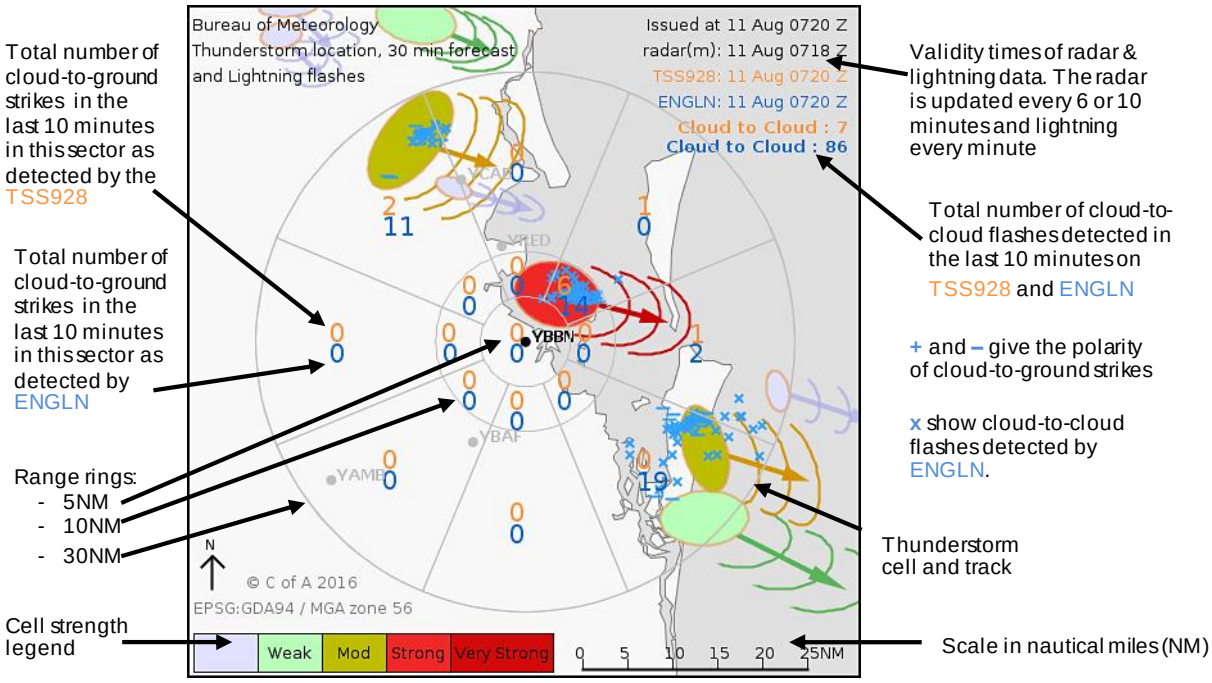
The thunderstorm location map shows:

- The location of any radar-detected thunderstorm cell, and their forecast movement over the next thirty minutes.

[1] Note that some ATSAS products used merged radar data from 2 or more radars and these products are updated every ten minutes.

- The number of cloud-to-ground lightning strikes detected in the past 10 minutes in each range/azimuth sector. Both the ENGLN and the TSS928 data are displayed.
- The total number of cloud-to-cloud lightning flashes detected by the TSS928 and ENGLN in the past 10 minutes.
- The location of cloud-to-cloud lightning flashes detected by ENGLN (indicated by blue crosses).
- The polarity of strikes detected (+ve strikes are stronger than –ve strikes).

Thunderstorm Location Map



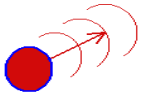
Note: NO DATA will be displayed in red in lieu of a current time stamp (in the top right-hand corner) when the radar or lightning sensor(s) is out of service. See Appendix 1 for an example of this and examples of other erroneous data.

1.1.1 Background Map

The background map includes range rings around the aerodrome at 5nm, 10nm and 30nm. Other reference points such as surrounding airports may be displayed. A distance scale is given in nautical miles (nm).

1.1.2 Thunderstorm Cell and Track

Thunderstorm cells are indicated by colour-filled shapes. The arrow extending from the cell is a vector representing the direction of movement and speed of the thunderstorm. The arrow points towards the direction the cell is moving whilst the semicircles indicate the position of the front edge of the cell at 10-minute intervals.



1.1.3 Legend

The colour coding on the legend is related to the thunderstorm intensity of the individual cells being tracked. Light green corresponds with weak, olive green with moderate, red with strong and dark red with very strong. Red and dark red are more likely to produce periods of severe weather.

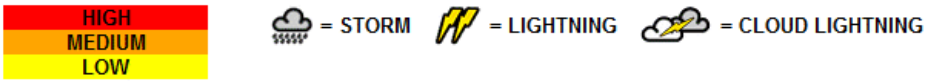
1.1.4 ATSAS Alerting System

The alerting system indicates the thunderstorm intensity on a scale of low, medium and high with an icon representing storm, lightning or cloud-to-cloud lightning or a combination of these.

Civil Airports
YBCS - Cairns uses Cairns radar (Saddle Mountain)
YBBN - Brisbane airport - merged radar
YBCG - Coolangatta (Gold Coast) - merged radar
YSCB - Canberra airport
YSSY - Sydney airport - merged radar
YMML - Melbourne airport uses Melbourne radar
YPAD - Adelaide airport - merged radar
YPPH - Perth uses Serpentine radar
YPDN - Darwin uses Berrimah radar
YBAS - Alice Springs Lightning sensor only

Defence Airports
YAMB - Amberley airport - merged radar
YBOK - Oakey airport - merged radar
YWLM - Williamtown airport - merged radar
YSRI - Richmond airport - merged radar
YPED - Edinburgh airport - merged radar
YMES - East Sale RAAF Base Airport uses Bairnsdale radar
YSNW - Nowra airport - merged radar
YPEA - Pearce RAAF Base Airport uses Serpentine radar
YPTN - Tindal uses Tindal radar
YBTL - Townsville uses Hervey Range radar
YSHW - Holsworthy airport - merged radar

Alert Levels and Symbols



The alert levels are defined as follows:

HIGH if:

- **Any** cloud-to-cloud lightning flashes within the 30nm range ring are reported by the TSS928 sensors Cloud-to-ground lightning strikes in the 5nm range ring
- Cells with VIL (Vertically Integrated Liquid) greater than 6 in the 5nm range ring

MEDIUM - if HIGH not satisfied and either of:

- Cloud-to-ground lightning strikes within the 10nm range ring
- Cells with VIL greater than 6 in 10nm range ring

LOW if HIGH or MED not satisfied and either of:

- Cloud-to-ground lightning strikes in 30nm range ring
- Cells with VIL greater than 6 in 30nm range ring

NONE if:

- All other normal conditions

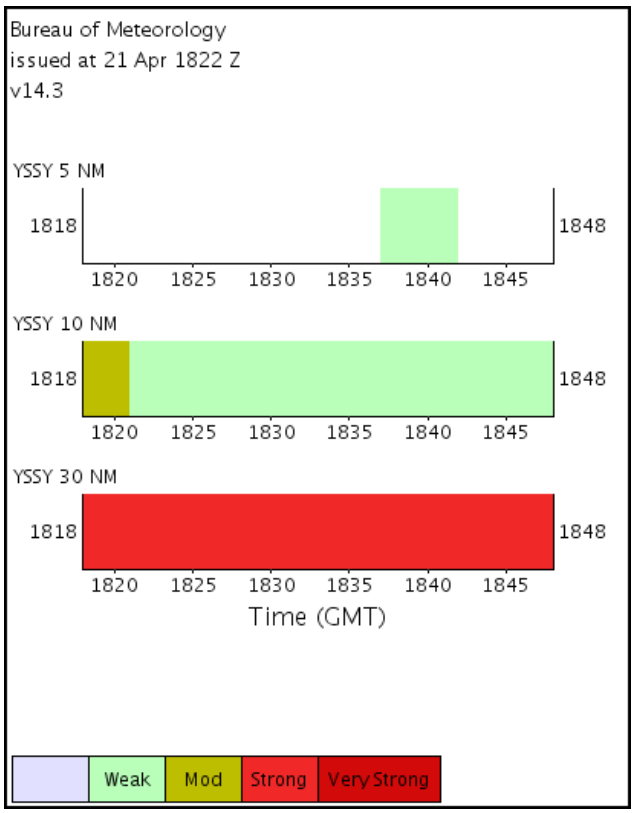
Note that the VIL value of 6 is the threshold value below which ATSAS doesn't consider a detected cell to be a thunderstorm.

1.2 Thunderstorm Time-of-Arrival Graph

The time-of-arrival graph shows a block of colour indicating when thunderstorms are expected to be within a certain range of the aerodrome reference point. The example below should be interpreted as follows:

- The 5nm graph indicates that weak thunderstorms are expected within 5nm of the YSSY aerodrome reference point between approximately 1837Z and 1842Z.
- The 10nm graph indicates that moderate thunderstorms are already within 10nm of the YSSY aerodrome reference point; and from 1821Z only weak thunderstorms are expected until at least 1848Z.
- The 30nm graph indicates that strong thunderstorms are already within 30nm of the YSSY aerodrome reference point and are expected to remain within 30nm until at least 1848Z.

This information must be used in conjunction with the thunderstorm location map.



1.3 Update Frequencies

The ATSAS graphical product is updated every minute, with the TTS928 data updating each minute, the ENGLN data updating every 15 seconds and the thunderstorm cell location and forecast normally updating every six or ten minutes, depending on the radar.

Note: Although the graphic will update every minute, the image may not change with each update since the thunderstorm cells and tracks normally only update every 6 or 10 minutes, and lightning activity detected by the lightning sensors may not change from one minute to the next.

1.4 The Vaisala TSS928 Lightning Sensor

The characteristics of the signal associated with a lightning strike are used to assign the strike to one of the three range intervals. Experience with the sensor has shown that the detection efficiency is a function of range and the maximum current associated with the strike. This may lead to intense lightning flashes at > 30 nm being reported in the 10-30 nm range, and weak lightning in the 10-30 nm range may not be detected. Experience has also shown the detection efficiency of cloud-to-cloud lightning decreases markedly beyond 20 nm.

For further information about the sensor, refer to the manufacturer's website: http://www.vaisala.com/en/products/thunderstormandlightningdetectionsystems/Pages/TSS928.aspx

1.5 Earth Networks Global Lightning Network (ENGLN)

The ENGLIN lightning data is merged data from three sources: the WeatherZone Total Lightning Network (WZTLN) made up of sensors located on mainland Australia and Tasmania, the World Wide Lightning Location Network (WWLLN) with sensors distributed globally, and other networks and sensors operated by EarthNetworks. Coverage over oceanic areas of the Melbourne and Brisbane FIRS is provided mainly by the WWLLN, whereas the data over the Australian continent is predominantly from the WZTLN. EarthNetworks uses the time difference of arrival method to detect and locate lightning, however these sensors detect a portion of the higher frequency RF energy produced by cloud-to-cloud lightning, thereby providing higher cloud-to-cloud lightning detection efficiency.

1.6 ATSAS Limitations

In using ATSAS, the user has acknowledged and signed the *ATSAS Terms of Use* document. By signing the document, the user has acknowledged that ATSAS has the following limitations:

- It is subject to the uncertainties of scientific research and technical limitations.
- The radar interpretation software, which determines whether radar echoes are strong enough to be classified as thunderstorms, will not identify all thunderstorms particularly small thunderstorms, high-based thunderstorms and

thunderstorms with a short life cycle. This may result in the ATSAS graphic indicating lightning strikes without any cells being displayed. On the other hand, the software may not filter out all non-thunderstorm echoes, resulting in the graphic displaying cells that are not thunderstorms, and hence there will no accompanying lightning strikes shown.

- To predict a thunderstorm track, the software interpolates the movement from the location history. Fast-moving and small thunderstorms, typically cold air winter thunderstorms and thunderstorms embedded in fast-moving middle-level cloud may not be identified or tracked accurately. The impact of these types of situations is a lack of predictability, in which case users will be required to be more reliant on the lightning information.

- ATSAS does not forecast the development of new thunderstorms, and hence is unable to provide adequate lead times for thunderstorms that develop very close to, or over, the airport itself.

- ATSAS does not forecast lighting.

- The location of lightning strikes on the graphic may not correspond precisely with the analysed and forecast location of thunderstorms (as identified by radar) because thunderstorms have the potential to produce lightning that strikes the ground at a considerable distance from the thunderstorm cells.

- ENGLN has a theoretical detection efficiency of between 90% and 95% for cloud-to-ground lightning and between 40% and 70% for cloud-to-cloud lightning, and a location error for cloud-to-ground strikes of less than 500m.

- The Bureau's radar network is configured to provide radar information at least every 10 minutes for some radars and 6 minutes for others, but if for some reason radar information is not available, the product update rate and tracking accuracy will be degraded.

- The Alice Springs radar is a part-time windfinding radar which has routine periods when coverage is not available. See Appendix 2 for details.

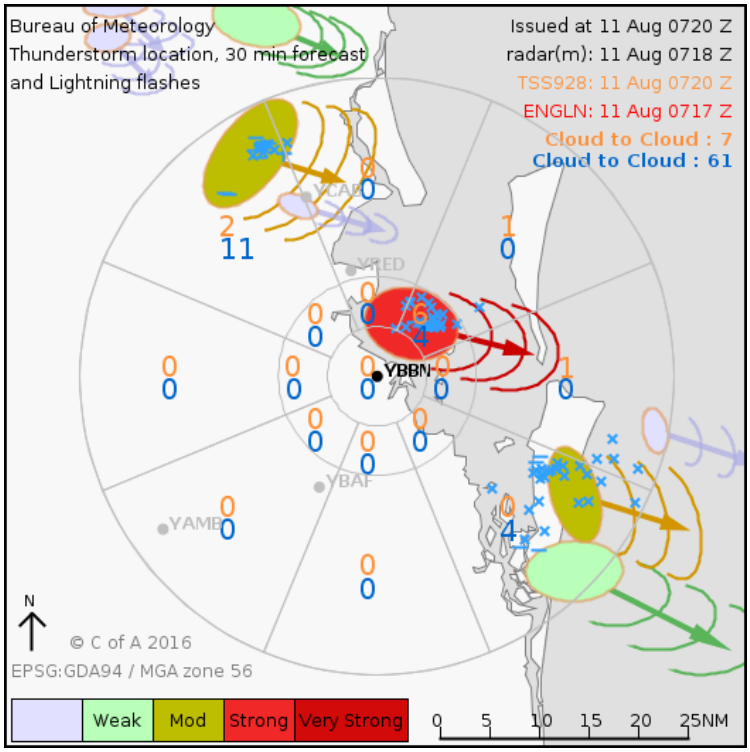
- ATSAS does not provide Occupational Health and Safety advice to users.

- ATSAS may be disrupted by equipment or communication faults. In the event that ATSAS, or any part thereof, becomes temporarily unavailable, other sources that indicate observed or expected thunderstorm activity should be used. These may include:

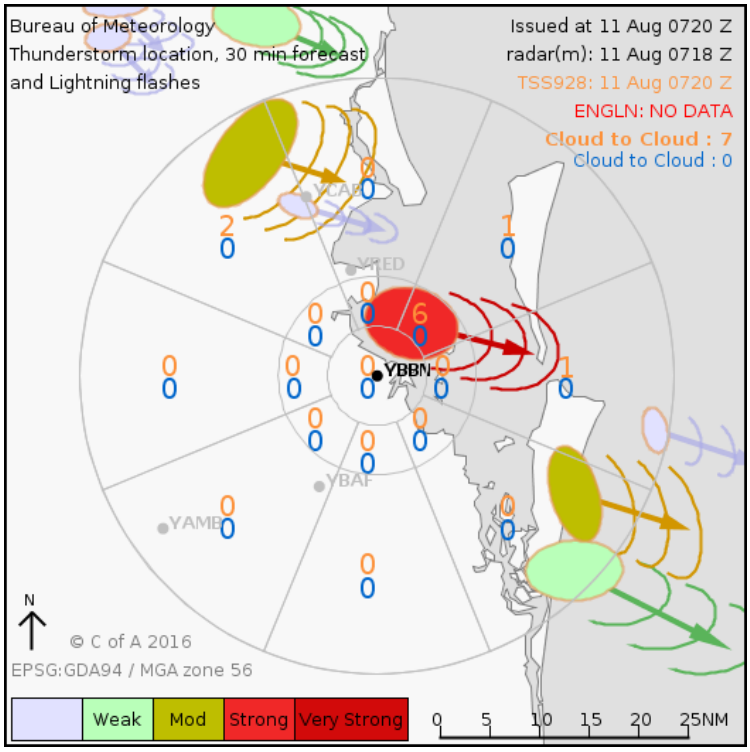
    - Visual reports
    - Consultation with aviation forecasters
    - Weather radar displays
    - Lightning data displays
    - Automatic Terminal Information Service (ATIS)
    - Meteorological Reports (METAR/SPECI)
    - Trend Type Forecasts (TTF)
    - Aerodrome Forecasts (TAF)
    - Severe Thunderstorm Warnings
    - Aerodrome Warnings

APPENDIX 1: Examples of erroneous ATSAS images

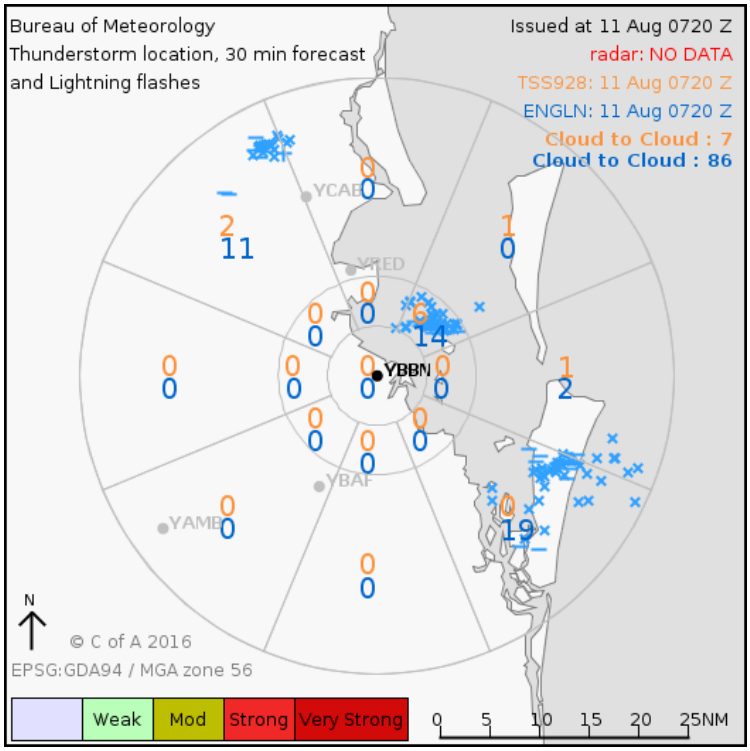
1. There is a minor fault with ENGLN. Valid data is available, but there is some missing data:



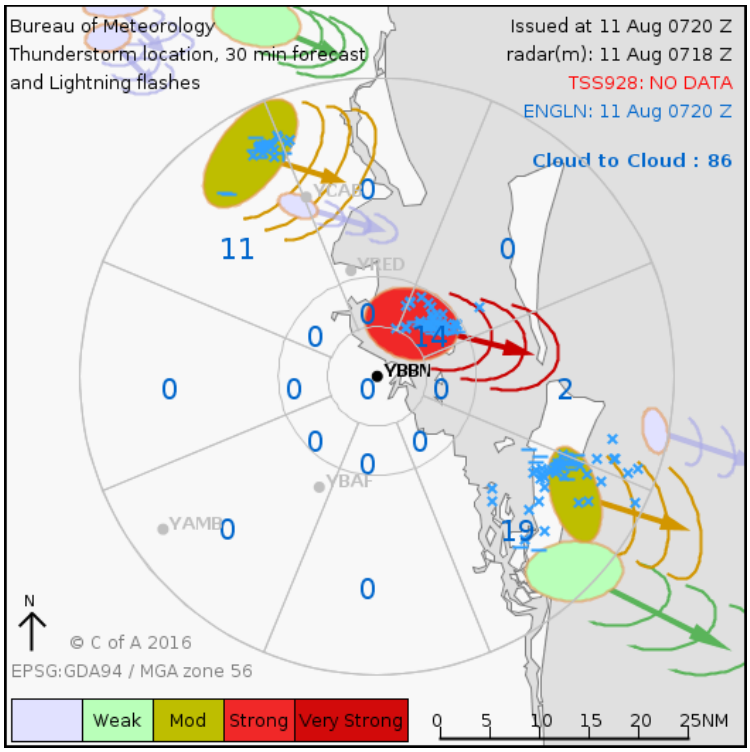
2. There is a fault with the ENGLN network. No data is available:



3. There is a fault with the upstream radar and storm detection system. No storm track information available:



4. There is a fault with the TSS928 sensor at this site. No TSS928 lightning information is available:



APPENDIX 2: Part Time Radar Availability

Part-time Windfinding Radars have routine periods when weather watch coverage is not available. This normally occurs, up to 4 times a day, for approximately 1.5 hours as shown in the table below. During these periods these radars will be engaged in tracking of high-level balloons for the measurement of winds in the upper atmosphere.

UTC / GMT	05:15 — 06:45	11:15 — 12:45	17:15* — 18:45	23:15 — 00:45
Eastern Daylight Time	04:15 — 05:45pm	10:15 — 11:45pm	04:15 — 05:45am	10:15 — 11:45am
Eastern Standard Time	03:15 — 04:45pm	09:15 — 10:45pm	03:15 — 04:45am	09:15 — 10:45am
Central Daylight Time	03:45 — 05:15pm	09:45 — 11:15pm	03:45 — 05:15am	09:45 — 11:15am
Central Standard Time	02:45 — 04:15pm	08:45 — 10:15pm	02:45 — 04:15am	08:45 — 10:15am
Western Standard Time	01:15 — 02:45pm	07:15 — 08:45pm	*12:15 — 01:45am	07:15 — 08:45am