# Current and Future Plans for Satellite Data Reception and Utilisation at the Australian Bureau of Meteorology

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***Introduction***

The Bureau of Meteorology (Bureau) acquires a range of satellite data, from both local and indirect reception, in support of its services to the Australian public. These data are used in a range of applications including forecasting and warnings, climate studies, research and numerical weather prediction. In terms of local reception, the Bureau receives data from both polar-orbiting and geostationary satellites using a network of reception stations deployed across the continent.

Satellite data reception is supported by the Space-based Observations Section, comprising approximately 15 staff located in the Bureau's Head Office in Melbourne. The section has developed in-house hardware and software for the reception and processing of L-band satellite data and maintains a critical mass of satellite and remote-sensing expertise within the Bureau.

***Geostationary Satellite Data***

The Bureau directly receives data from Japan's MTSAT-1R and China's Fengyun-2C, both of which are used in operations, and for the generation of derived products such as atmospheric motion vectors (Le Marshall et al., 2000) and daily insolation (Weymouth and Le Marshall, 1999). For the purposes of redundancy and to reduce communications costs, geostationary reception systems are located in Darwin, Perth, Sydney and Melbourne. These stations all receive data from MTSAT-1R and it is also planned to implement Fengyun-2C reception in Perth within the next year. Due to its position at 105° East, Fengyun-2C is very useful for forecasts and warnings in Western Australia.

***Polar-Orbiting Satellite Data***

The Bureau continues to acquire data with national coverage from the polar orbiting NOAA satellites, distributing both imagery and derived products from the AVHRR and the ATOVS sensor suite for atmospheric sounding. Data from China's Fengyun-1 is also received routinely.

NOAA and Fengyun-1 data is received via a network of L-band receiving stations across the continent and in Antarctica. Data received on the mainland is transmitted to head office (Melbourne) immediately after reception of the pass is completed. Transfers are conducted using the Bureau's dedicated communications network, WeatherNet. Once the full pass is received in Melbourne, it is processed into products for use in operations.

***Crib Point Satellite Earth Station***

The Bureau's primary satellite data reception facility is located near Melbourne at Crib Point on a 10 hectare radio-quiet site. The site is adjacent to the HMAS Cerberus Naval Training Base on Westernport Bay, about an hour and a half's drive from Melbourne.

Built in 1992, the station houses antennae and reception equipment required for a number of meteorological satellites including MTSAT-1R, the Fengyun-1 series, Fengyun-2C, and the NOAA series. It also incorporates a Turn Around Ranging Stations (TARS) for the Fengyun-2C satellite which is used for positioning the spacecraft. The station was designed to operate autonomously and is normally unmanned, with critical monitoring functions being carried out in Melbourne.

The received data is sent to the Bureau's Head Office over a high speed data communications link, for distribution to Bureau forecasting centres and other users throughout Australia.

***Reception and Processing Systems***

On site ingest of L-band data from geostationary and polar-orbiting satellites is carried out using Bureau-designed satellite ingestors. Each of these consists of a HP 700-series workstation, running the Bureau's own ingest software and interfacing with the antenna through an ISA-bus receiver card. The card handles data reception, demodulation and formatting. Data may be sent back to head office either by ftp once the pass or image has been completed, or in real-time on a line-by-line basis. In both cases, the same ingest software is used to assemble the data into McIDAS AREA and Australian Satellite Data Archive (ASDA) formats for use in Bureau operations and further processing.

Centralised processing is carried out on an HP RP8400 Server with 8 CPUs and 8 Gb of memory, located in the purpose-built Central Computing Facility at the Bureau's Head Office in Melbourne. This server is one of a pair, with the second server always available to take over in case of a failure in the first. Numerous data products are generated including level-1c and 1d ATOVS data from AAPP. Raw data is archived to the Bureau's dual StorageTek 9310 Automated Cartridge System (ACS) Libraries running SAM-FS software.

***X-band***

The Bureau is currently rolling out a network of X-band receiving stations to complement the existing Australian stations in preparation for the new generation of sensors on the NPP, NPOESS and METOP satellites. The first station, which is partially owned by the Bureau as part of the Western Australian Satellite Technology and Applications Consortium (WASTAC), is already operating in Perth. Stations in Darwin and Crib Point are planned for the coming year with a fourth station to be installed at Casey Station, Antarctica, the following year.

***Digital Receiver***

In support of its satellite reception activities, the Bureau has recently developed the DigRX 6000 Satellite Receiver. This is a highly configurable USB-connected digital receiver able to handle data rates up to 8 Mbps. The receiver is designed to support the following satellite data formats: MTSAT HRIT, MTSAT LRIT, GOES LRIT, NOAA HRPT, SeaWIFS, Fengyun-1 CHRPT, Fengyun-2 SVISSR and METOP AHRPT. For Bureau operations, the DigRX 6000 is interfaced to an ingestor, a linux PC running ingestor code which has also been developed in-house. The ingestors deliver data in both McIDAS AREA and Australian Satellite Data Archive (ASDA) format, essentially the raw data with an ASCII header containing metadata. The linux ingestors are currently being rolled out to replace the ageing HP ingestors, some of which are 10 years old.

***Use of AAPP***

After NOAA HRPT data is received in the Bureau's Head Office in Melbourne, it is processed using AAPP to produce level-1c and level-1d data. The level-1d data is then converted to BUFR format and loaded to the operational MARS database for use by the assimilation system. The transfer from Darwin to Melbourne takes 15 minutes, on average, with 90% of passes received within 16 minutes. From Perth, the average transfer time is 13 minutes, with 90% of passes received within 17 minutes. Queuing and AAPP processing typically take another five minutes. This information is displayed graphically in figures 2 and 3.

As part of the roll-out of the DigRX 6000, the processing computers in Darwin, Perth and Casey Station will be upgraded. This increase in processing power will allow AAPP to be run on-site, and the level-1c data files returned to Melbourne, prior to the raw data, for assimilation into NWP. This change is expected to improve data timeliness by at least five minutes for Darwin and Perth. Data from Casey is not currently received in Melbourne in real time.

***Data Exchange***

There is a global trend toward rapid exchange of regional data for assimilation into numerical weather forecasting systems. The Bureau has been an early participant in trials of the Regional ATOVS Retransmission Service (RARS), which enables routine rapid exchange over the internet of ATOVS atmospheric sounding information between centres in the Asia-Pacific region. Since early June 2006, data from Darwin, Perth and Crib Point has been routinely sent to Japan and successfully assimilated into NWP models. Data originating from China (data from three stations merged in Beijing), Japan (Kiyose) and Korea has been received via the GTS from Japan.

***Future Plans***

Over the next two years, as the Bureau upgrades its NWP systems under the Australian Community Climate and Earth System Simulator (ACCESS) project (Puri, 2005), there will be a requirement for more satellite data, both from local reception and indirect sources. From local reception, it is planned to make available data from AIRS on Aqua and IASI on METOP. These data streams will follow the in-situ processing model outlined above.

***References***

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Puri, K. (2005), "The Australian community climate earth-system simulator (ACCESS)", BMRC Research Report No 111, 2005, 19

Weymouth, G. and Le Marshall, J. (1999), "An operational system to estimate global solar exposure over the Australian region from satellite observations. I. Method and the initial climatology." Australian Meteorological Magazine, 48, 181-193.

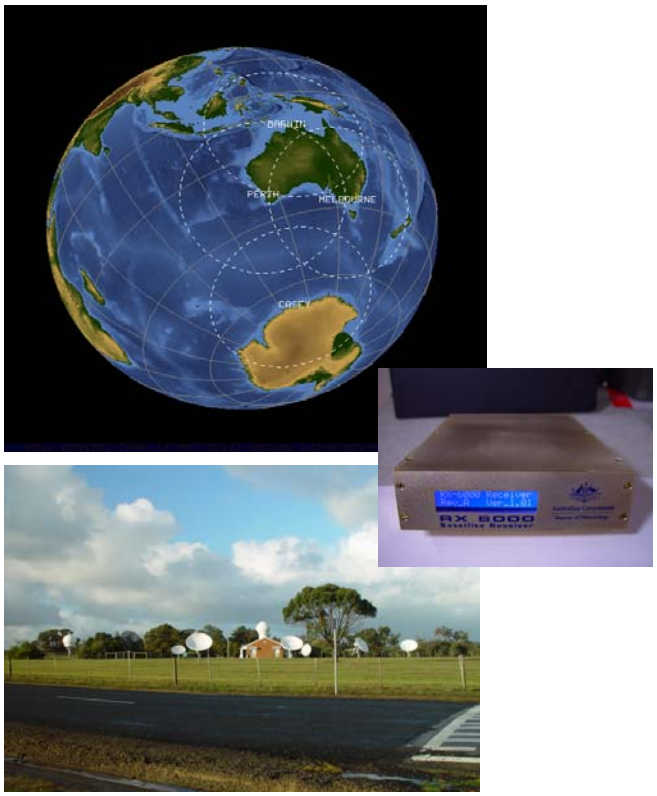


***Figure 1 – The combined coverage from the Bureau of Meteorology L-band reception network and planned X-band network (top); the Bureau of Meteorology's Satellite Earth Station at Crib Pont, Victoria (bottom); and the Bureau-developed Digi RX6000 Satellite Receiver (inset).***

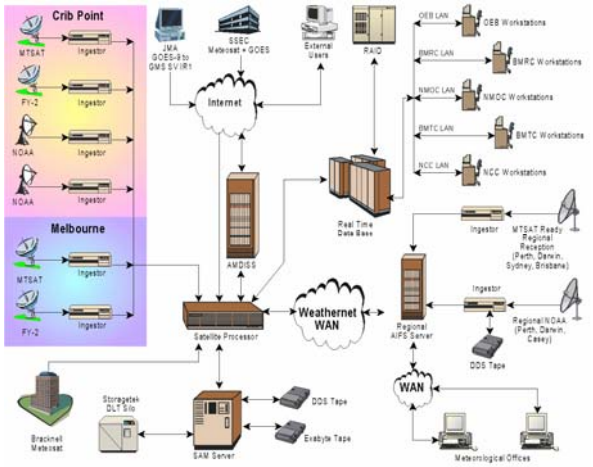


***Figure 2 – The Bureau of Meteorology's satellite data reception and processing network.***

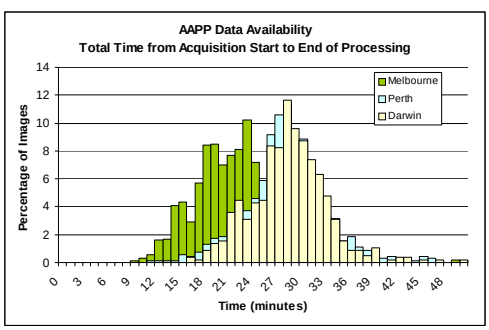


***Figure 3 – Frequency histogram showing total lag time for data processed through AAPP in Melbourne. This includes transmission time, file transfer, queuing and processing time and is measured from the start of acquisition.***

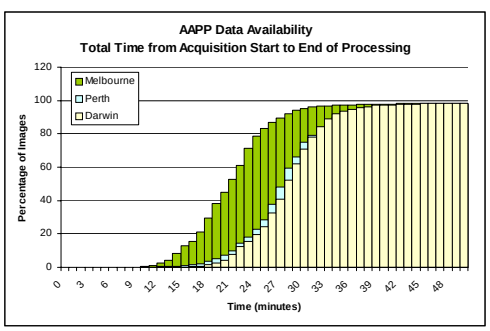


***Figure 4 – Frequency histogram showing percentage availability of data processed through AAPP in Melbourne. This includes transmission time, file transfer, queuing and processing time and is measured from the start of acquisition.***

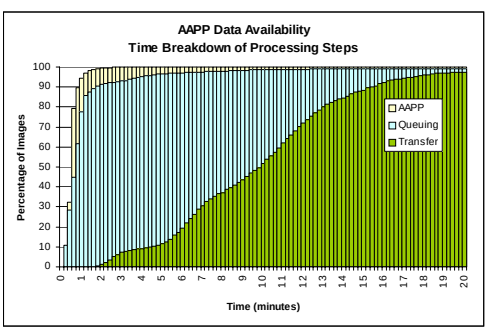


***Figure 5 – Frequency histogram showing distribution of completion times for each step as data is processed through AAPP in Melbourne. This includes transmission time, queuing and processing time (AAPP).***