

RECEPTION AND USE OF TIROS OPERATIONAL  
VERTICAL SOUNDER DATA IN THE ANTARCTIC

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ABSTRACT

*This paper describes the increasing use being made of TOVS data for meteorological research in the British Antarctic Survey.*

*During the 1988/89 season we intend to install a VHF receiver at Halley (75.5°S, 26.9°W) to receive TOVS data from the operational NOAA satellites. The data acquired with this system will be used in the study of the occurrence, structure and development of meso-scale meteorological systems in the Weddell Sea.*

*A brief description is included of the interim results of a case study of a small, vigorous depression which developed, matured and declined in the south east corner of the Weddell Sea over seven days in January 1986. This system is being examined using surface and upper-air observations made at Halley, processed TOVS data and analyses provided by the British Meteorological Office.*

1. ANTARCTICA

There are only eleven upper-air stations in the Antarctic, a continent which covers an area one and a half times that of Europe (see Figure 1). As a result detailed studies of the structure of atmospheric systems in the region, even on synoptic scales, have not been possible using only data from the routine observational network.

The British Antarctic Survey (BAS) has three permanent bases in the Antarctic, two, Rothera (67.6°S, 68.1°W) and Faraday (65.5°S, 64.9°W), sited on the west side of the Antarctic Peninsula and one, Halley (75.5°S, 26.9°W), on the Brunt Ice Shelf. At each of these bases a programme of three hourly surface meteorological observations is carried out, and daily 12 GMT radio-sonde flights are launched from Halley.

2. DSB

Early last year (1987) it was decided to install equipment at Halley which would receive the Direct Sounder Broadcast (DSB) from the NOAA satellites, extract the TOVS data and pass it through the processing package we have obtained from the UK Meteorological Office to provide temperature profiles and thickness fields over Coats Land, the Weddell Sea and the Antarctic Peninsula (see Figure 1).

The receiver is being purchased from Mariner Radar Ltd. of Lowestoft, and is of a relatively inexpensive, simple and robust design which was originally developed to collect data from the ARGOS Data Collection System which is also contained in the DSB transmissions.

We estimate that, using an omni-directional whip antenna, the system's effective horizon will be at an elevation of 30 degrees which will mean that a satellite will be 'visible' over an area with a radius of approximately 1200 km. This means that data will be available from roughly a quarter of the Antarctic continent (see Figure 1).

### 3. THE RETRIEVAL SCHEME

Recently a MicroVAX II has been installed at Halley to handle communications with BAS HQ at Cambridge and to act as a general purpose computer for the base. This computer will be used to retrieve the temperature and humidity profiles from the raw TOVS information.

The retrieval package was obtained from the UK Meteorological Office and is identical to the scheme used operationally there (Eyre, 1984). However we will be restricted to using a climatological first guess, not having timely access to a forecast field. We have recently received a new cloud clearing scheme (Eyre & Watts, 1987), which we are now using in preference to the older N\* version, as well as a physical retrieval system which has not been installed yet.

In operational use, data from each satellite pass will be passed from the receiver to an IBM PC and stored on a 20 Mbyte Winchester disk. Once or twice a day all the collected sounder data will be transferred from the PC to the MicroVAX and passed through the retrieval package. The soundings or thickness fields will be plotted for use by the base meteorologists or, in instances of particular interest it will be possible to transfer either the original data or the products to Cambridge via a DECnet link over Inmarsat.

### 4. OPERATIONAL USE

We anticipate that some of the other data contained in the DSB will be useful. At the moment a group within BAS, in collaboration with the Scott Polar Research Institute, is investigating sea-ice dynamics in the Weddell Sea using several drifting buoys. It would be possible to compute the buoy

positions from the ARGOS system messages which are also contained in the TIP data-stream and to have them available in near real time.

#### 5. RESEARCH USE: AN EXAMPLE

Our first priority is research rather than operational meteorology. We have been studying the structure of meso-scale systems over the Weddell Sea using TOVS and AVHRR 4 km resolution data purchased from NOAA/NESDIS.

There are particular, well-known problems associated with temperature sounding over the Antarctic continent. The surface lies at an average altitude of about 2000 m, for the most part it is permanently covered with ice or snow, and there are frequently strong temperature inversions in the lowest few hundred metres of the atmosphere. Despite these difficulties it is possible to obtain useful information from TOVS, largely by only using retrievals from over the sea or low lying coastal areas.

A good example of the value of TOVS soundings is provided by the study of a meso-scale depression which developed, matured and decayed between 1 - 8 January 1986, off the coast of Coats Land close to Halley. The surface observations and daily radio-sonde ascents from the base together with TOVS derived 1000 - 500 hPa thickness fields have lead to a self-consistent, qualitative understanding of the development of the system.

Figure 2 shows a sequence of TOVS derived 1000-500 hPa thickness fields from two days during the development of the system, whose position is indicated in the centre of the charts. The presence of a pool of warm air over the Ronne Ice sheet to the south and advection of cold air along the coast of Coats Land, to the north east, lead to the creation of a region of strong temperature gradients on the 3rd and 4th. The development took place towards the warmer side of this region, apparently as a result of the approach of a mid-level trough from the north east.

The retrievals were derived using a climatological first guess field and there are large differences between co-located TOVS and radio-sonde derived temperature profiles from Halley. However, as might be expected, the discrepancies between the height-integrated fields derived from the two systems are much smaller, and furthermore, warming or cooling trends at particular levels are well represented, qualitatively at least, by the TOVS retrievals. This gives us some confidence that the structure of larger scale features and their development can be reliably inferred from the TOVS data.

#### REFERENCES

Eyre, J. R., 1984, "High Resolution Temperature Retrievals at the UK Meteorological Office", Tech Proc 1st International TOVS Study Conference, Igls, Austria.

Eyre, J. R., & Watts, P. D., 1987, A Sequential Estimation Approach to Cloud Clearing for Satellite Temperature Soundings. *Q. J. R. Meteorol. Soc.*, 113, 1369-1376

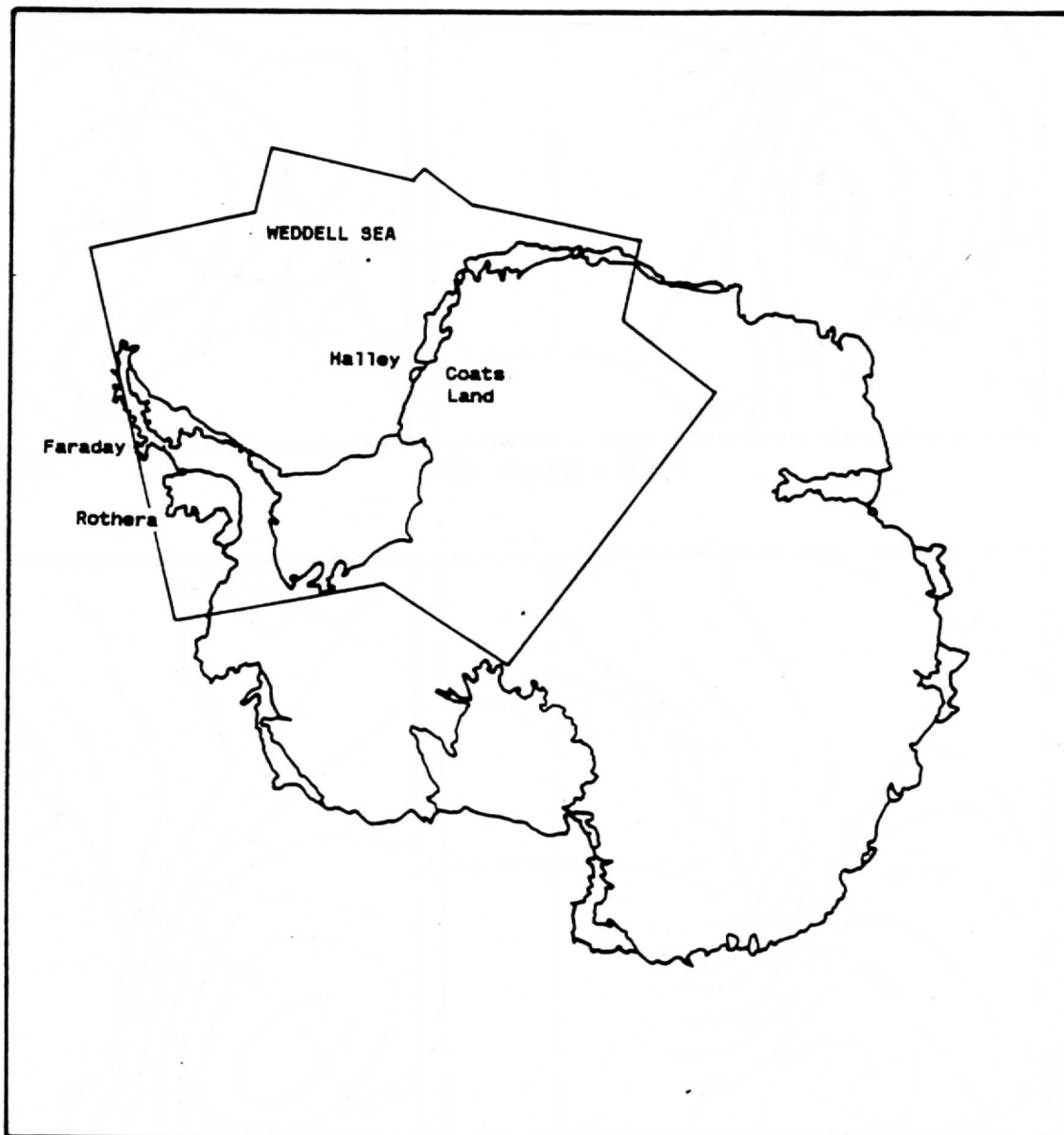
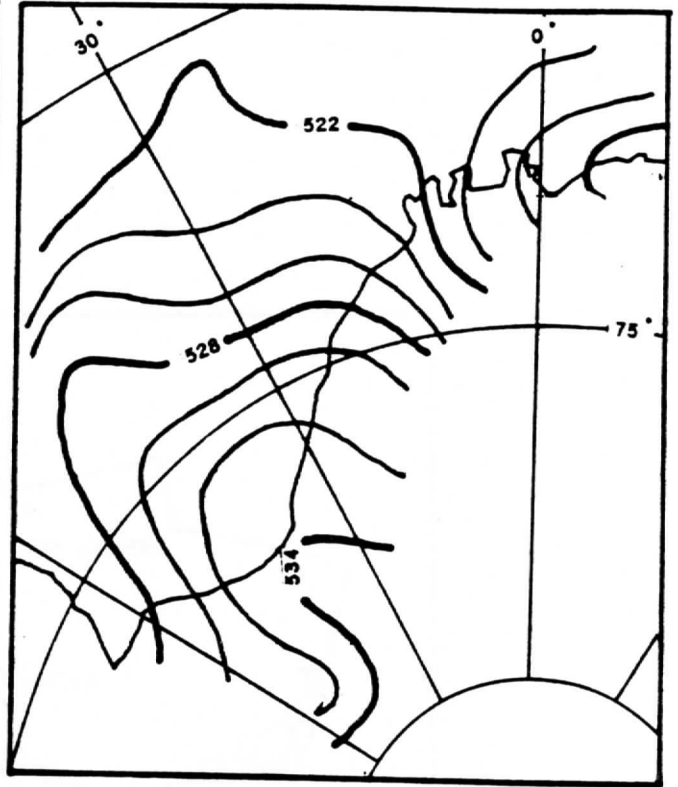


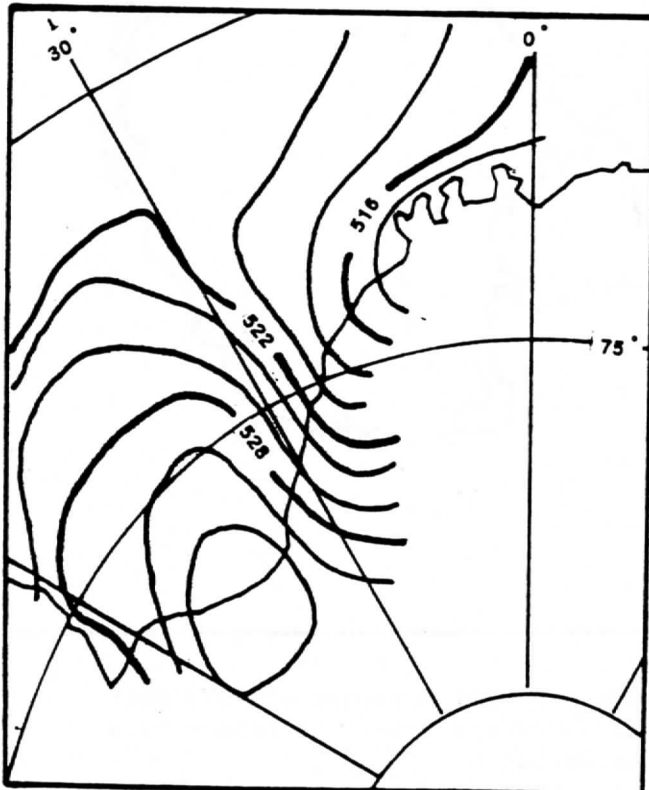
Figure 1. The Antarctic, showing expected coverage of TOVS data acquired from three consecutive satellite passes by a VHF receiver sited at Halley.



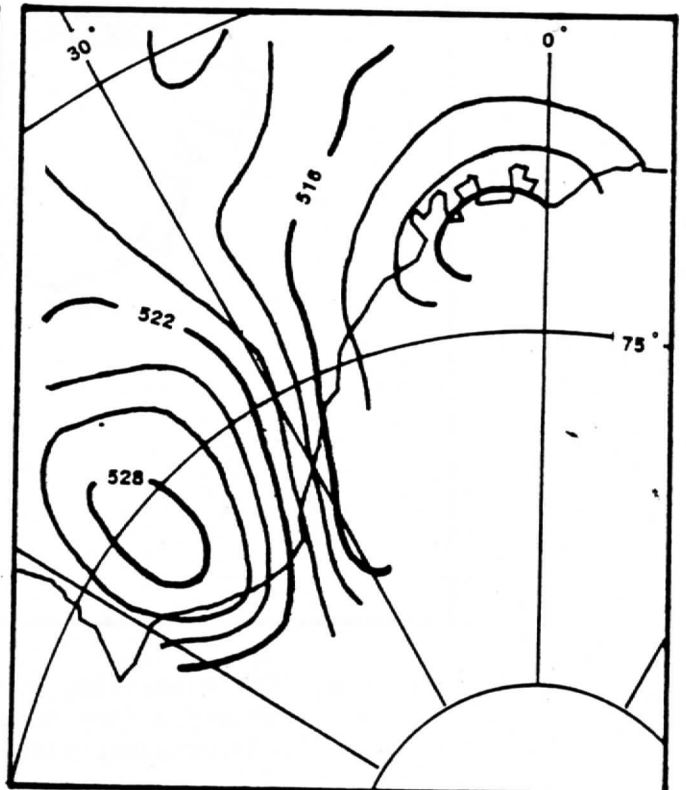
01 GMT 3 January 1986



18 GMT 3 January 1986



01 GMT 4 January 1986



18 GMT 4 January 1986

Figure 2. 1000-500 hPa thickness field derived from TOVS data from four passes on 3 January and 4 January 1986. Contours are drawn at intervals of 2 gpm.

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