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Report on Meteorological Programme During Summer Period of Tenth Indian Expedition to Antarctica

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Introduction

The Antarctic weather influences the global climate to a great extent. In order to study meteorological features over Antarctica and correlate these with Indian weather, the meteorological observational programme of IMD has been a regular component of each Indian expedition to Antarctica. The programme has been augmented from time to time for obtaining various types of data.

Scientific Objectives

The major objectives of the meteorological programme during the summer of Tenth Expedition were as follows:

(i) Regular surface and upper-air observations during enroute cruises and at ice-shelf.

(ii) Continuance of on-going meteorological observational programme at Indian station 'Maitri' for building up climatology data-set and logistic support for various scientific activities of the Expedition.

(iii) Maintenance/calibration and checking of all meteorological instruments, replacement of unserviceable equipment etc.

(iv) Updating of inventory register of equipments/stores/tools etc.

Observational Programme

During cruises

Regular surface observations at 3 hrs interval for onward cruise (w.e.f. 0000 UTC of November 28,1990) and return cruise (w.e.f. 0000 UTC of March 3, 1991) were collected and recorded in the MET-96 registers. The main synoptic observations at 0000, 0600, 1200 & 1800 UTC were transmitted over telex to IMD HQ at New Delhi for onward transmission over Global Telecommunication Network

(GTN). Analysed isobaric facsimile (FAX) charts were received for surface and 500 hPa level from Molodezhanya and/or Pretoria. APT pictures were also received from NOAA 10 & 11 Polar Orbitting Satellites. Weather predictions/inferences were drawn from the aforesaid available data.

Radiosonde ascents for vertical profile of temperature, humidity and pressure were also taken during the enroute cruises whenever the ship encountered wind speed less than 20 knots. 26 radiosonde ascents could be taken in all during onward and return voyages of the ship.

At ice-shelf

Parallel surface observations, alongwith those at Maitri, were carried out till March 2, 1991. Three parallel radiosonde ascents were released at ice-shelf, alongwith ozonesonde/radiosonde ascents at Maitri for relative study of vertical profile of atmosphere.

At Maitri

The on-going meteorological programme at Maitri continued during the Expedition as schedule. This included regular surface observations, continuous recording of temperature, pressure, wind speed and direction, surface ozone and global solar radiation. The upper-air ascents such as ozonesonde/radiosonde, turbidity measurements, reception of fax charts and APT pictures were also taken.

Preliminary Findings from Analysis of Meteorological Data and Other Observations

In general, the weather was fair during onward and return voyages except for small period when ship negotiated rough sea weather. Though strong surface winds crossing 23 knots were experienced for more than 36 days at Maitri during the period January 1, 1991 to February 15, 1991 and for 26 days (with 9 days break in observations at Antarctica ice-shelf) during the period January 1, 1991 to March 1, 1991 at Antarctica ice-shelf; a strong blizzard was experienced on February 18, 1991 with heavy snow drift by surface winds crossing 45m/sec (at times gusting to 55-60 m/s) aboard *M.V. Thuleland* ship at Antarctic sea-shelf. This had caused damage to Hellical Antenna & Co-axial cable of Radiosonde Ground Equipment, laboratory container, rotors of one of the Naval Chetak helicopters and windvane, mounted atop of the ship.

The latitudinal variations of surface pressure in a narrow belt, 4-6 degrees latitudes width, around Forties/Fifties are almost sinusoidal in nature (Figs 1 & 2), apparently, due to the geostrophic winds attributable to sharp pressure gradients. A perusal of FAX charts dated 10th December, 1990, 12 UTC (Fig.3) alongwith Fig. 1, authenticates the rough weather/sea confronted during onward voyage. Similarly

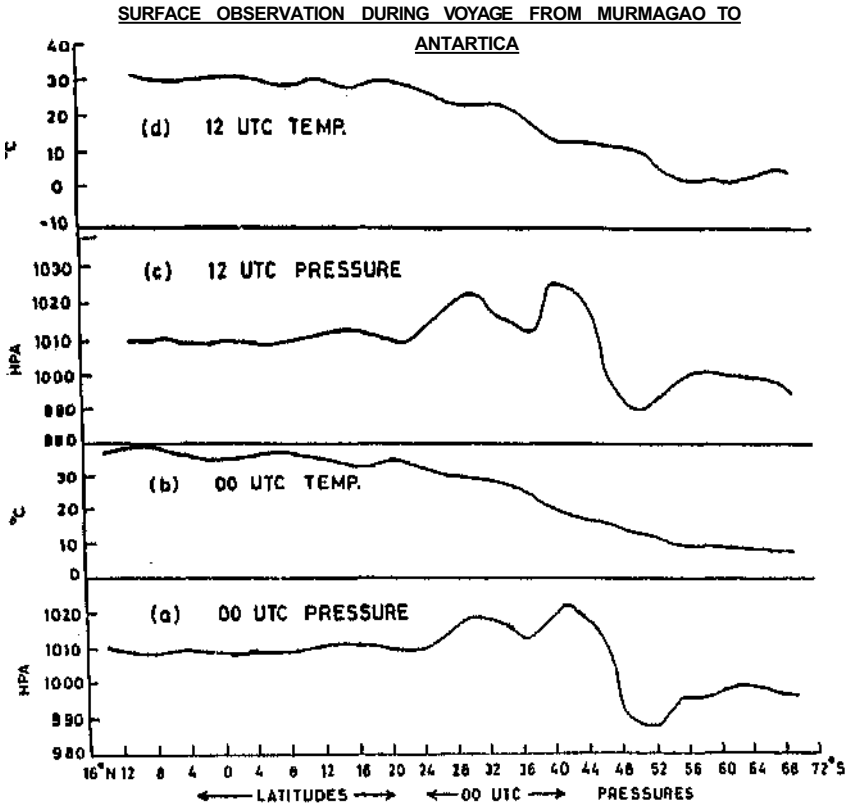


Fig. 1. Latitudinal variation of 12 UTC parameters/observations during onward voyage from Goa to Antarctica.

Fig.2 helps draw inferences for rough sea/weather associated with pressure gradients during return voyage.

The Antarctic continent is surrounded with many low pressure systems, generally centred/moving in the latitudinal belt 50-60° around Antarctic continent, which subscribes to a typically unique climatology of the region.

Strangely, Maitri witnessed light rainfall in the evening of 17th January, 1991. The unusual rainfall in the frozen continent is attributable to the following parameters as will be seen from Figs 4 & 5 (analysed isobaric fax charts of 17th January 1991) and Fig.6 (12 UTC pressure and temperature graphs over Maitri and Antarctica ice-shelf for the period 1st January '91 to 15th February '91).

(i) There were four (4) low pressure systems stagnated by two (2) well worked high pressure systems. Three of the four low pressure systems were almost

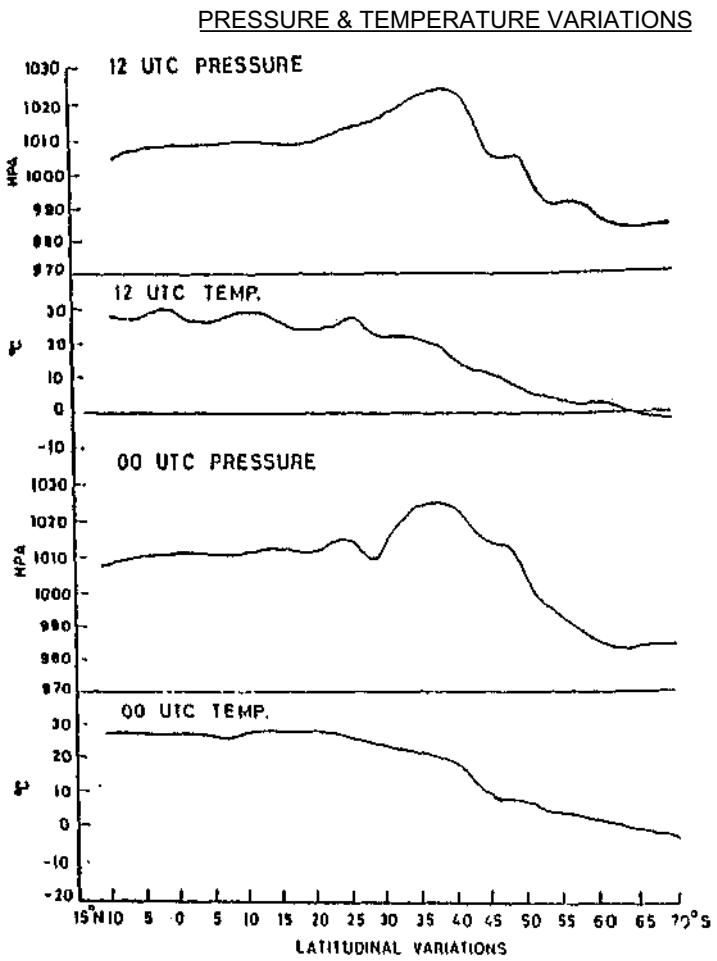


Fig. 2. Return voyage (Antarctica to Goa) latitudinal variations of 12 UTC pressures and temperatures.

rectilinear along 20°E (approx.) with centres at 68°S, 59°S & 44°S and the fourth centred at 54°S/17°W (Figs 4 & 5).

(ii) The surface pressure had dropped and was stagnant for some time (Fig.6).

(iii) The surface air temperatures had risen and became stagnant for about 3 days (Fig.6).

(iv) The sky was overcast with low and medium clouds.

(v) The atmosphere, in general, was warmer than other days facilitating rain drops to reach the ground without freezing enroute.

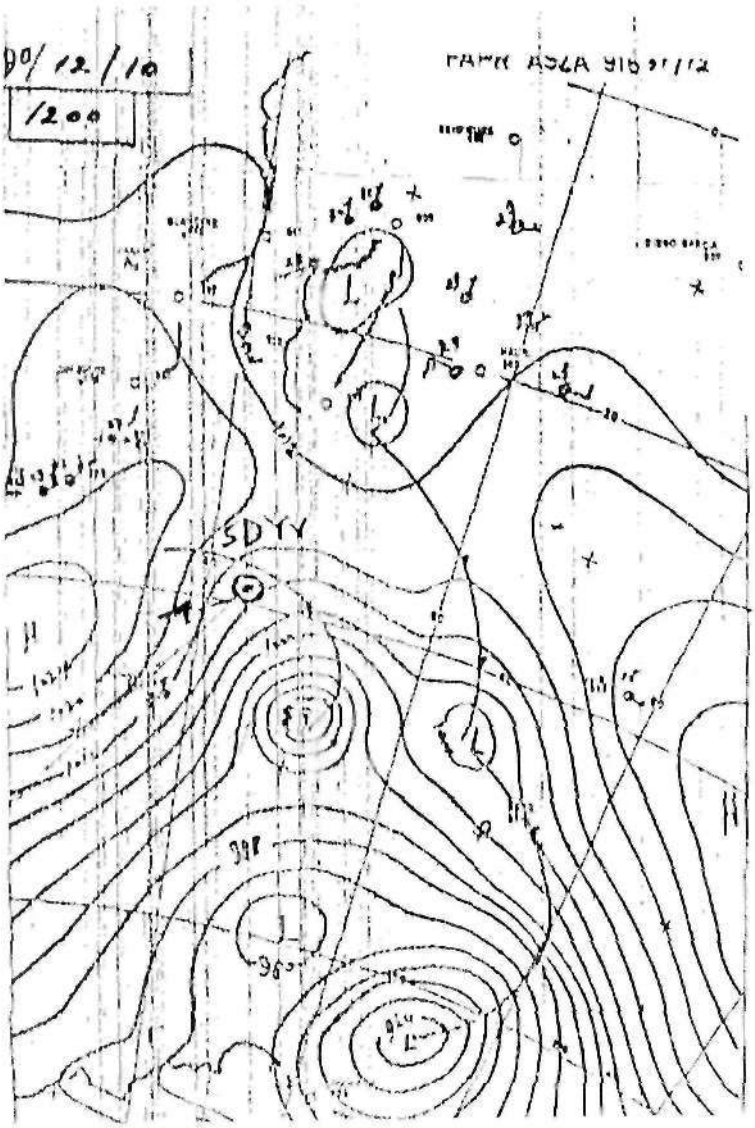


Fig. 3. Fax chart dated 10.12.90 (12 UTC) delineating rough weather enroute Antarctica (onward voyage)

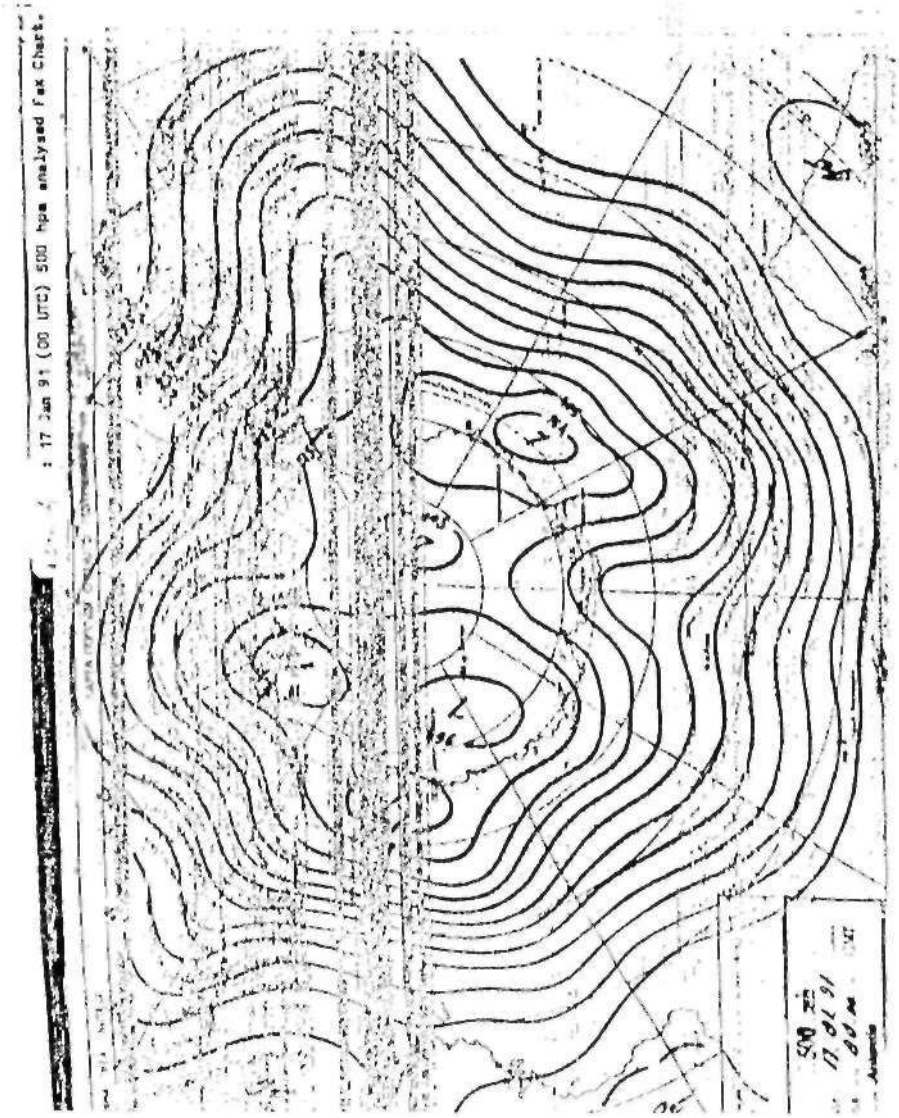


Fig. 4. 17 Jan 91 (00 UTC) 500 hPa analysed fax chart.

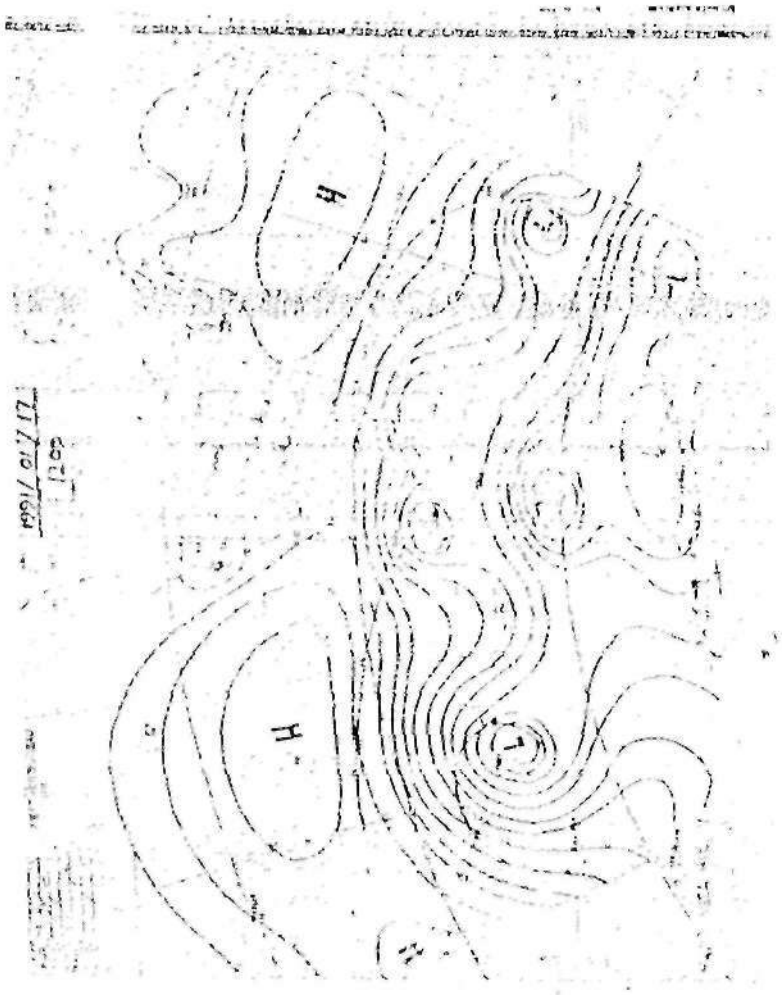


Fig. 5. 17 Jan 91 (12 UTC) analysed surface chart (isobaric).

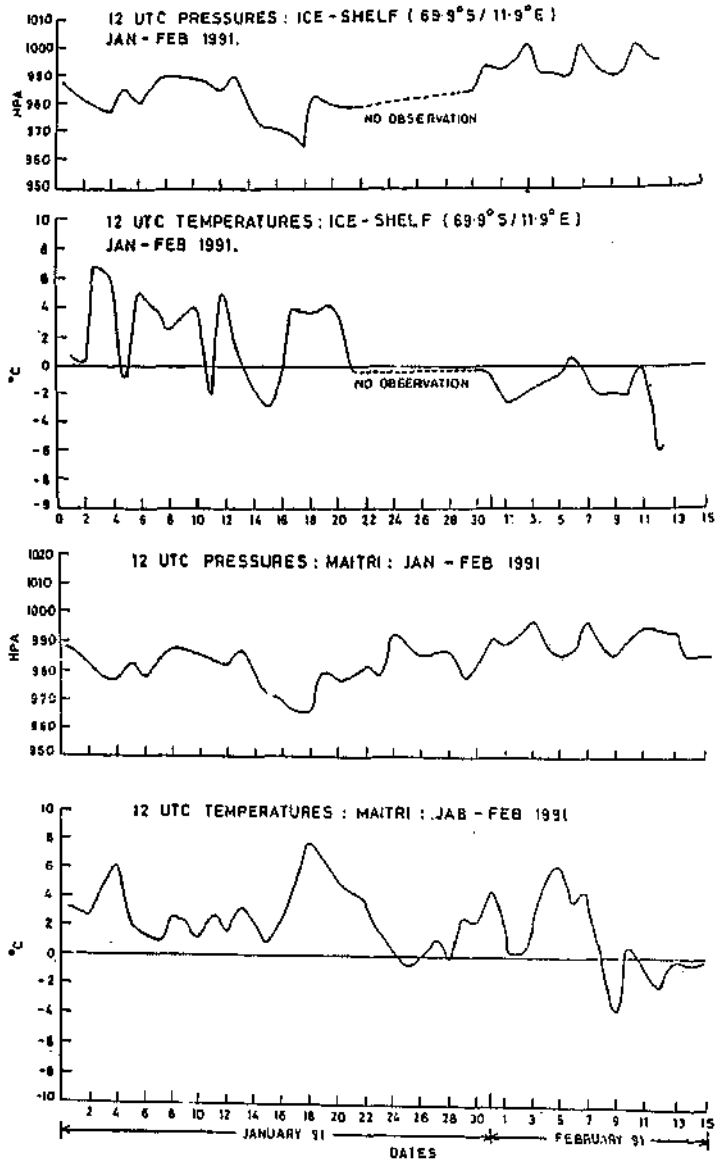


Fig. 6. Diurnal variations of 12 UTC pressure and temperature at Maitri (70.8°S, 11.7^{0}E, 117 m amsl) and ice-shelf (69.9°S, 11.9°E).

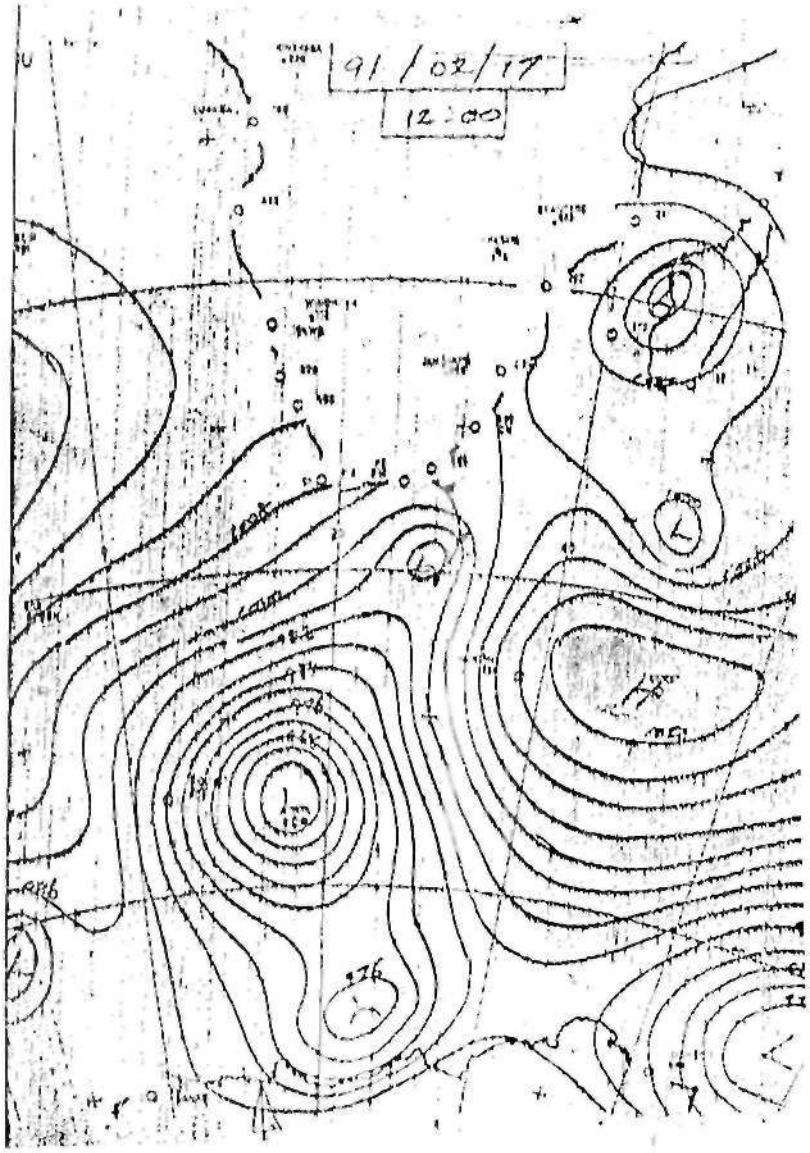


Fig. 7. Fax chart dated 17.02.91 (12 UTC) giving probability of blizzard.

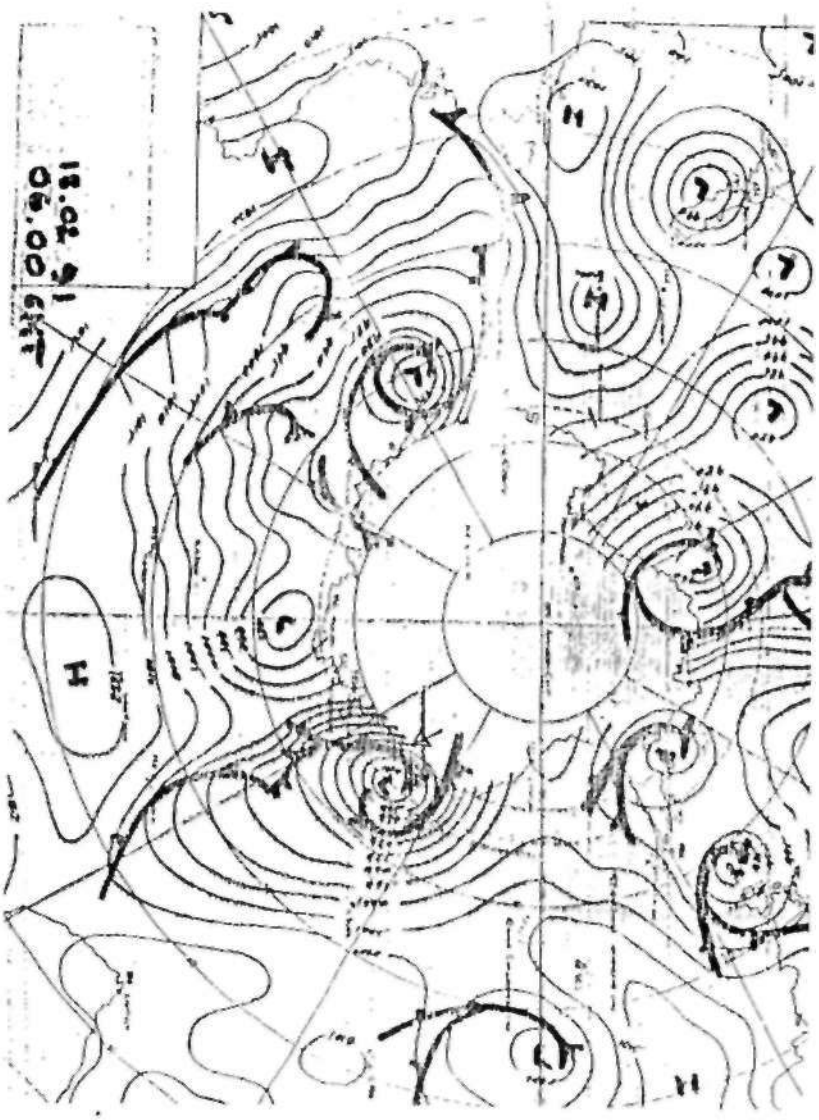


Fig. 8. Fax chart dated 18.02.91 (06 UTC) delineating stagnation of low pressure systems which caused blizzard with speeds of 45 m/s gusting to 55.60 m/s.

The warmest day at Maitri (Table 1) during January '91 was 18th January 1991 (8.2°C) immediately after the rains of 17th January 1991 (Fig.6) attributable to the systems discussed in above para. The lowest temperature recorded in January 1991 was -5.6°C on 11th January 1-991.

The 18th February, 1991 blizzard is attributable to such a typical configuration of low pressure systems, stagnated by high pressure systems, as is evident from fax charts of 17th & 18th February, 1991 (Figs. 7,8). Despite the fact that it is very difficult to predict blizzards well in advance yet efforts were made with the help of officers of IAF and IN to predict the weather and blizzard (of 18th February). On the basis of available data/information, likewise many strong surface winds with speeds exceeding 23 knots were confronted with appropriate prediction based on the available meteorological data fax charts and APT pictures. Tables (2 & 3) will give the briefs about the blizzards/strong surface winds faced at Antarctica during January 1, 1991 to February 15, 1991..

Out of 26 radiosonde ascents taken on board the ship, 6 could cross tropopause level and rest suffered pre-matured termination on account of signal discontinuation. Fig.9 gives the latitudinal variations of tropopause, 700 hPa and 500 hPa

Table 1: Weather Summary : Maitri: January 1991

Surface. Pressure (hPa)	
1. Average	981.8 hPa
2. Highest recorded with date	994.6 hPa / 24 Jan. 1991
3. Lowest recorded with date	960.0hPa/18Jan. 1991
Air Temperature ^{O}C)	
I. Average 0.9	
2. Highest recorded with date	8.2/18 Jan. 1991
3. Lowest recorded with date	-5.6/11 Jan. 1991
4. Average of maxima temperature	3.7
5. Average of minima temperature	-2.9
Winds (Knots)	
1. Average wind speed	14.8
2. Highest wind speed	62
3. Blizzards	Nil
Sky Conditions	
1. No. of days - Clear sky	2
2. No. of days - Overcast sky	6
3. No. of days with precipitation	8

Table 2: Blizzards

S.N.	Month of Blizzard	Ice-shelf Days	Remarks	Maitri Days	Remarks
1.	Jan. 1991	03	Snow-drift	07	No Snow-drift
2.	Feb. 1991	11	Snow-drift	05	- do - (Upto 15.02.91)

Table 3: Surface Winds of 23 Knots & More Speed

S.N.	Month of Winds	Ice-shelf Days	Remarks	Maitri Days	Remarks
1.	Jan. 1991	10	No Snow-drift	21	No Snow-drift
2.	Feb. 1991	19	-do-	15	- do - (Upto 15.02,'Jl)

Ice-shelf data upto 01,03.91, while the Maitri data upto 15.02.91

parameters. A perusal of Figs.9(i) to (iii) gives the following inferences/observations:

(i) The gpm height of tropopause falls with increase of latitudes.

(ii) The gpm height of 700 hPa & 500 hPa levels remains, almost, constant upto 40°S and, thereafter, starts decreasing polewards.

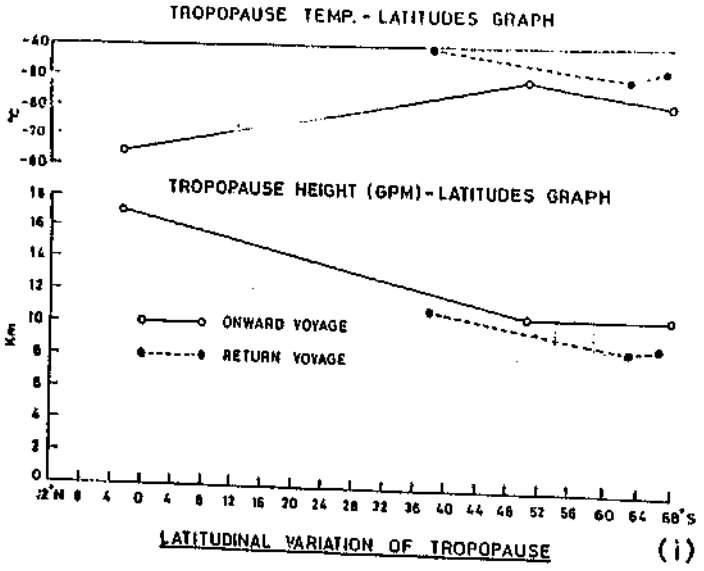
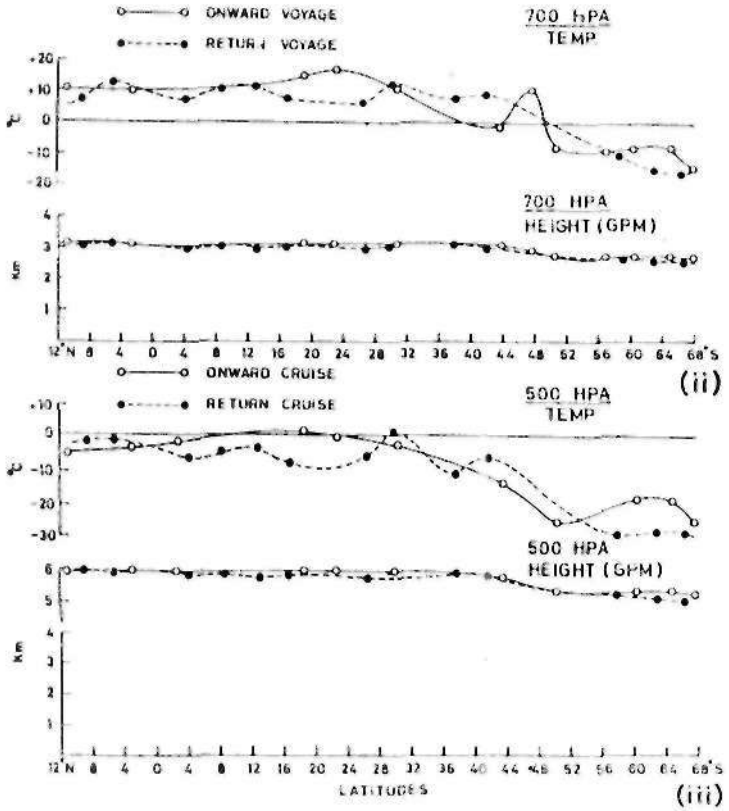


Fig. 9(i). Latitudinal Variation of Tropopause



LATITUDINAL VARIATIONS OF HEIGHT (GPM) AND TEMPERATURES, 700 & 500 HPA.

Fig. 9(ii & iii). Latitudinal variations of tropopause, 700 hPa and 500 hPa parameters

Table 4: RS Ascents at Ice-shelf (Detail of Tropopause)

S.N.	Date of Ascent	Pressure hPa	Height gpm	Temp. ºC
1.	13.02.91	331	8000	-47.5
2.	15.02.91	297	8620	-54.5
3.	23.02.91	319	8310	-45.9

Fig.9(i) can only be called illustrative and not exhaustive for the obvious reasons of discontinuity in tropopause data.

The observations cited in above para lead to understand that atmosphere is elliptical in shape with its minor axis across poles and major axis across equator.

Tables 4 & 5 give the details of the radiosonde ascents taken at Antarctica ice-shelf (69.9°S and 11.9°E).

A total of six ozonesonde ascents were taken at Maitri during January & February, 1991 (Figs 10, 11 & 12). The ozone maxims are tabulated in Table 6. Some of the ascents had reached upto 3 hPa and above levels.

Table 5: Last Level Reached at Ice-shelf

S.N.	Date of Ascent	Last Pressure hPa	Last HT in gpm	Temp °C
1.	13.02.91	34	23450	- 40.5
2.	15.02.91	10	31580	-35.3
3.	23.02.91	49	21110	-36.3

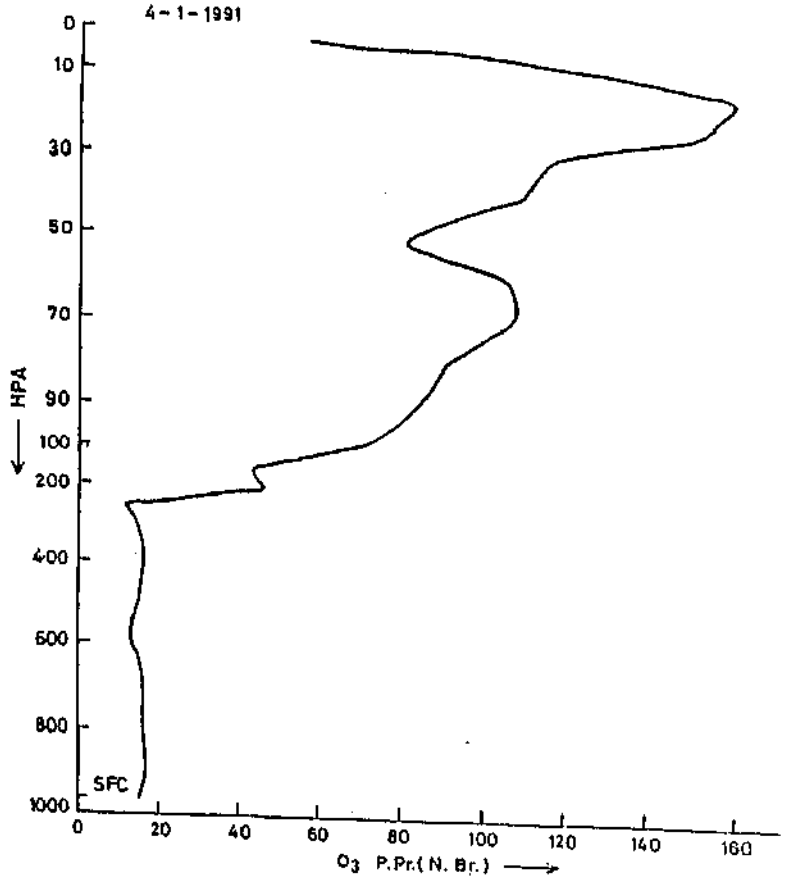


Fig. 10. Ozone ascent data of 4.01.91 (Maitri).

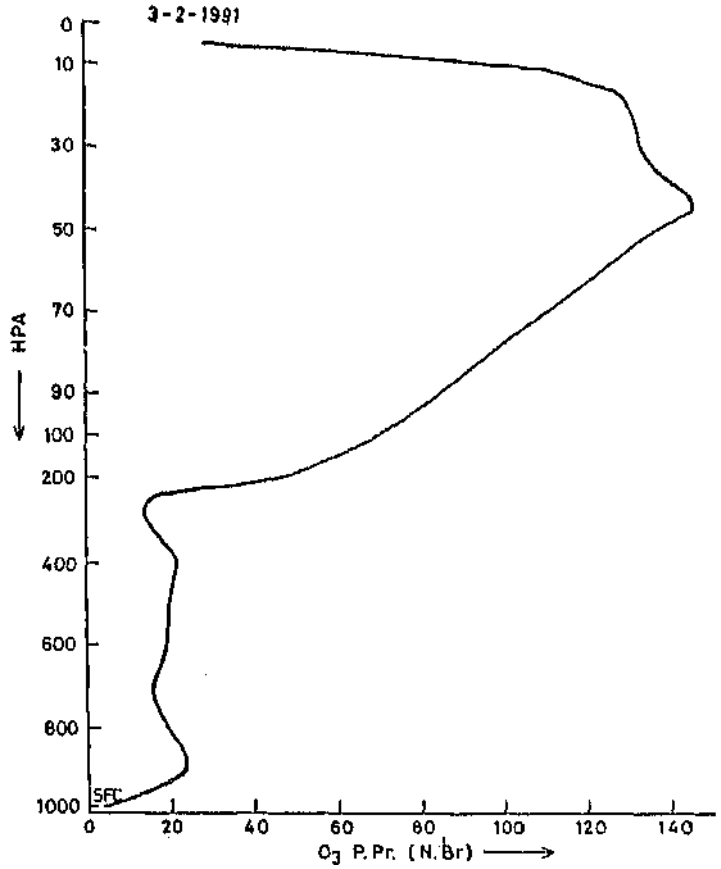


Fig. 11. Ozone ascent data of 3.02.91 (Maitri)

Table 6: Ozonesonde Data (Maitri)

S.N.	Date of Ascent	Pressure level at which Ozone Maxima	Ozone (Partial Pressure) NBR
1.	04.01.91	18.7 hPa	160.59
2.	13.01.91	28.0 hPa	118.12
3.	23.01.91	45.8 hPa	103.00
4.	03.02.91	43.4 hPa	145.15
5.	13.02.91	52.0 hPa	136.38
6.	24.02.91	44.0 hPa	146.30
Total		231.9 hPa	809.54
Mean		38.65 hPa	134.92

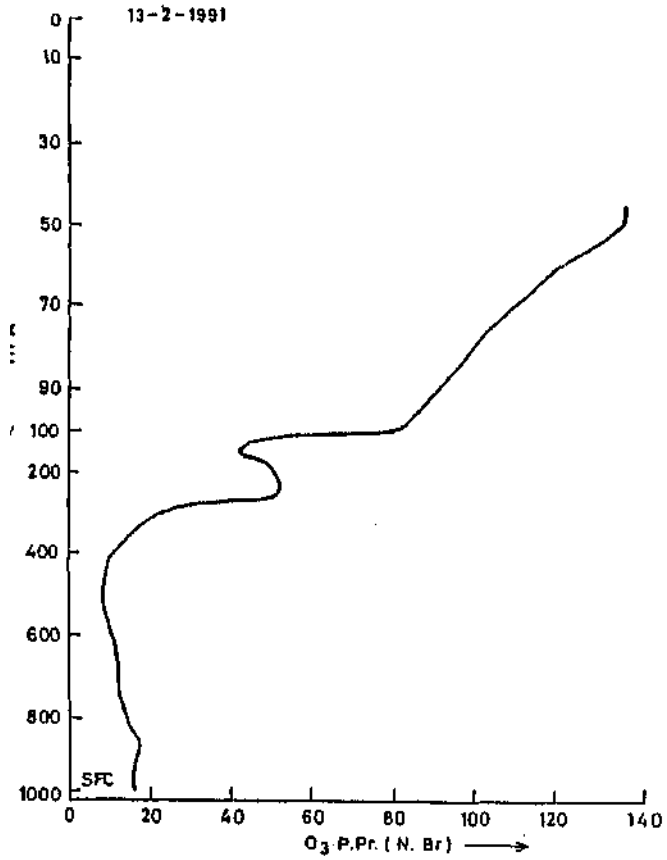


Fig. 12. Ozone ascent data of 13.02.91 (Maitri).

Conclusion

By and large the team has collected the data and completed its task as per the observational programme assigned.

Acknowledgement

I would like to express my sincere gratitude and thanks to the Director General of Meteorology and the Department of Ocean Development for giving me an opportunity to participate in the Tenth Indian Scientific Expedition to Antarctica (as its summer member). I would also like to thank Dr. A.K. Hanjura (Leader of the Expedition) and other met. officers of IAF, Indian Navy and of my department for the help and support extended to me in accomplishment of the task.