

*Twenty Seventh Indian Antarctic Expedition 2007-2009*

*Ministry of Earth Sciences. Technical Publication No. 25, pp 191-201*

## **Meteorological Parameters and Ozone Hole Phenomenon at Schirmacher Oasis Antarctica during 2008**

**S. P. Sharma and K. C. Bhindwar**

India Meteorological Department, New Delhi

### **ABSTRACT**

India Meteorological Department (IMD) has been observing/ recording three hourly synoptic weather observations constantly since its association with Indian Antarctic Programme. It has covered various weather elements viz. surface temperature, surface pressure, surface wind speed with its direction, cloud details, precipitation (snowfall etc), blizzards and other atmospheric phenomenon like Auroras etc. During the 27th expedition, study of Ozone hole phenomenon was also undertaken, using the vertical profile of atmospheric ozone, recorded with the help of Ozonesonde flights. Surface weather observations, atmospheric Ozone profiles recorded with the help of Ozonesonde, Radiometersonde observations, direct and diffused solar radiations and various other Meteorological parameters observed/ recorded during the year 2008 are discussed in this report.

**Keywords:** Antarctica, Maitri, Year 2008, Met Observations, Ozone Measurements.

### **1.0 INTRODUCTION**

India Meteorological Department has been continuously participating in all Indian Scientific Expeditions to Antarctica from its commencement. IMD is dedicated to undertake Surface Observations, Upper Air Observations, Radiation Budget Studies, Atmospheric Ozone Profiles over Schirmacher Oasis, Atmospheric Turbidity etc. at Indian Antarctic Station, Maitri located in Schirmacher Oasis, Antarctica.

IMD is collecting/ recording/ logging various weather elements and analyzing the different meteorological parameters. Continuous recording of Surface Wind speed, Wind Direction, Surface Atmospheric Pressure, Temperature, Humidity, Surface Ozone, Diffuse Solar Radiation & Direct Solar Radiation using self recording instruments and their tabulation on hourly /10 minutes interval basis have also been done.

The data collection at Maitri is done as per the standards/ norms of World Meteorological Organization (WMO). The synoptic weather data

generated is also transmitted over Global Telecommunication System (GTS) on real time basis for the use of weather forecasting throughout the world.

## **2.0 SCIENTIFIC OBJECTIVES**

Scientific objectives for the Meteorological programme during the 27th expedition were to study the Atmospheric Ozone profile, its distribution and annual variation at different levels and Antarctic Meteorology in general. During the year 2008, following studies were carried out to fulfill above objectives:

- i) Daily, monthly and annual variation of atmospheric pressure, surface temperature, surface wind (speed and its direction), surface ozone, snowfall, and clouds etc.
- ii) The atmospheric changes with reference to specific synoptic weather systems.
- iii) The Radiation budget studies, including Total Global Solar Radiation.
- iv) Monitoring and archival of information received through weather satellites and facsimile regarding weather system affecting the Antarctic Continent.
- v) Atmospheric turbidity measurement using Microtops II Sun Photometer.
- vi) Balloon borne measurements of ozone for its vertical profile over Maitri, throughout the year at regular intervals, for the study of occurrence of Ozone Hole phenomenon over Antarctica during austral-spring months. Continuous recording of surface ozone at Maitri, Antarctica.
- vii) Providing weather reports, meteorological briefing etc for helicopter operations, scientific requirements and other activities at the station.

## **3.0 EXECUTION OF THE PROGRAMME**

During onward cruise by the ship, Emerald Sea, synoptic observations were taken eight times a day at three hourly intervals from the day of departure of ship from Mormugao until it reached India Bay, East Antarctica coast. At every six hours i.e. at 0000, 0600, 1200 and 1800 hrs UTC, these were transmitted to IMD, New Delhi for onward transmission to Global Telecommunication Network.

At Maitri, surface observational programme was as following:

- a) Surface observations of all weather parameters recorded at synoptic hours on all days. Four main synoptic observations (out of eight) were transmitted to IMD, New Delhi, India through Internet for real time use and for global exchange.
- b) Atmospheric pressure, wind speed, wind direction, surface ozone, global solar radiations were continuously recorded on autographic recorders and tabulated on hourly basis throughout the year.
- c) Sun-photometer observations were taken on all clear weather days for analysis of atmospheric turbidity.
- d) For the study of the Antarctic Ozone Hole phenomenon, a total of 71 Ozonesonde ascents were taken, using Indian Electro-chemical Ozonesonde. For study of Radiation budget, 20 numbers of Radiometersonde ascents were taken. The treatment of balloons using ATF was done to avoid premature burst of balloons at lower heights due to cold atmosphere.

Weather forecasting in Antarctica is a great challenging job with limited resources such as weather charts and network of observatories. Automatic Picture Transmission receiving equipment was found unserviceable since last one year at the time of takeover; this equipment was made operational at the earliest for the reception of cloud imageries. Reception of weather charts transmitted from the Pretoria was very irregular. Despite of above limitations, a very good weather forecast was provided to the team for convoys and field activities throughout the year, including flying operation during summer period of the 27<sup>th</sup> and 28<sup>th</sup> expeditions.

## **4.0 RESULTS AND DISCUSSION**

### **4.1. Meteorological and Climatological Studies:**

For the study of climatology of Schirmacher Oasis daily synoptic data was used for computation of daily and monthly mean of temperature, wind, pressure and cloud cover etc. The daily mean values were plotted and represented in a graphical form for comparative study. Annual weather summary for the year 2008 is given in the relevant discussion.

#### **4.1.1 Surface Temperature**

In the Maitri compound, a standard Stevenson Screen with a dry bulb thermometer, a maximum thermometer, a minimum thermometer and a

thermo linear thermister have been installed for the measurement of Surface Air Temperature, Maximum Temperature, Minimum temperature and continuous recording of surface air temperature respectively.

The lowest temperature value of -33.5 degree Celsius was recorded on 23<sup>rd</sup> June and the highest temperature value of +06.0 degree Celsius was recorded on 5<sup>th</sup> January during the year 2008.

Month of August with the mean temperature value at -20.5 degree Celsius was recorded as the coldest and January with the mean temperature value at -01.1 degree Celsius was recorded as the warmest month during the year 2008. Annual Mean temperature calculated for the year 2008 was -10.6 degree Celsius.

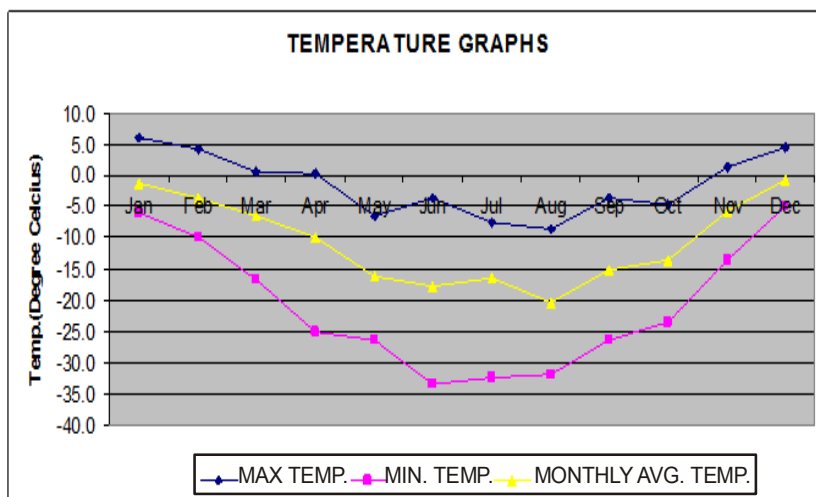


Fig. 1

#### 4.1.2 Surface Pressure

Precision Aneroid Barometer MKII was used to record station level pressure. Recorded value of pressure converted to Mean Sea Level Pressure after applying height and temperature correction for the station. Continuous recording of surface pressure was done with the help of Barograph MK III and the same was tabulated on hourly basis in the respective forms.

Atmospheric Pressure was recorded to be highest as 1012.1 hPa on 24<sup>th</sup> April and lowest value as 953.0 hPa on 26<sup>th</sup> June during the year 2008. The annual Mean Pressure value was 985.0 hPa for the year 2008.

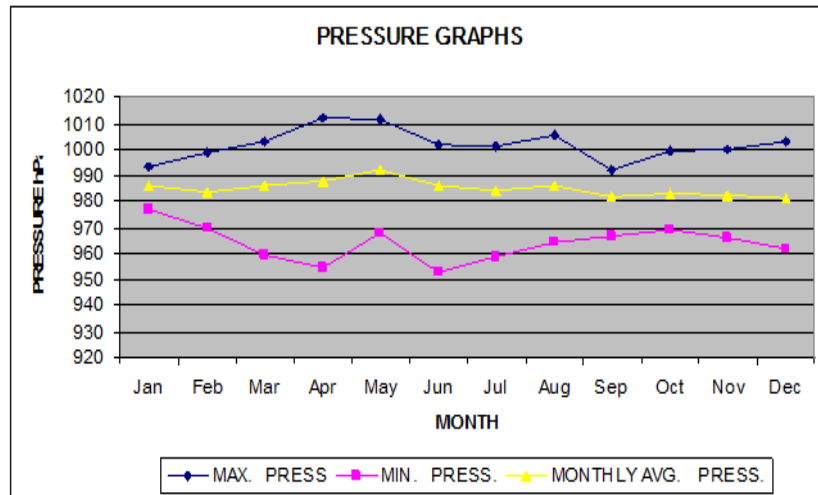


Fig. 2

### 4.1.3 Wind Speed and Direction

Continuous recording of wind speed and its direction using a Distant Indicator Wind Equipment (DIWE), comprising of one Cup Generator Anemometer (CGA) and Selsyn Windvane system was done and tabulated on hourly basis for the year.

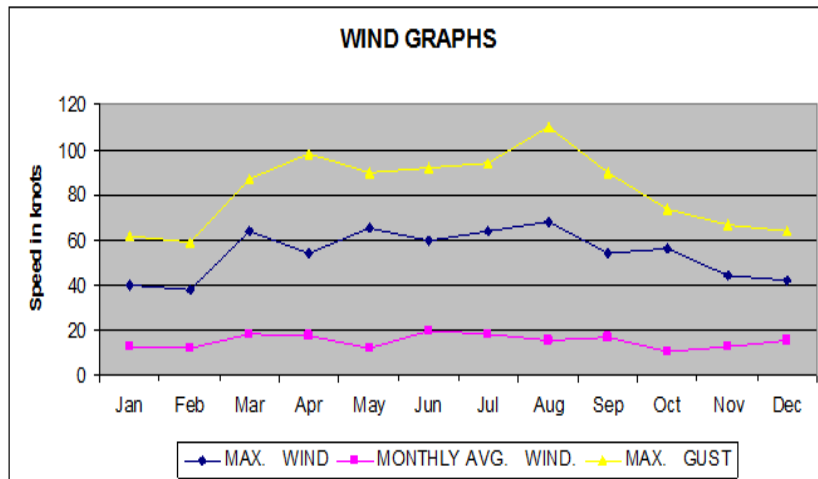


Fig. 3

The maximum wind speed of 68 knots, gusting to 110 knots, was recorded on 14th August during one of the strongest blizzards of the year

2008. The month of June was the windiest month with the average wind 20 knots followed by the months of March, April and July with average wind speed of 18 knots respectively. The monthly average wind during the month of October was 11 knots which was lowest during the year.

#### **4.1.4 Precipitation/ Snowfall**

Precipitation in Antarctica normally occurs in the form of snowfall only. Weather observatory at Maitri is equipped with Snow Gauge to measure the quantity of the snowfall. However, the same could not be measured/ estimated correctly at most of the times, as snowfall is usually accompanied by strong winds/ blizzards.

A total of 74 days were with snowfall during the year. December was having the most 16 days with snowfall followed by July with 11 days. Total quantity of snowfall was measured to be 100.7\* mm.

#### **4.1.5 Blizzards**

It is almost unpredictable in Antarctica, when blowing/ drifting snow may take the form of a Blizzard. Blizzards may have a life of a few hours, extending to a few days, sometimes may continue for a week or so. During the Year 2008, 31 blizzards have occurred, varying in intensity and duration. The maximum number of blizzards occurred in June (total 07), followed by July (total 06), and August & December (total 05 each). Approx 46 days were with blizzard. Maximum gust of approx. 110 knots was measured/ estimated on 14th of August during a blizzard. At a number of occasions, blizzards have continued for more than two days and some of them re-occurred after a break of just few hours.

#### **4.1.6 Clouds**

Cloud imageries through Polar orbiting satellites, and analyzed-weather-charts from Pretoria, South Africa, were received through facsimile. These were utilized for forecasting daily weather conditions around Maitri, Antarctica. This also helped in Helicopters operation, especially during the construction of Satellite Earth Station during the summers of 2008.

The weather forecasts were also given to convoys going to the ice shelf and to other outdoor field parties of various participating

---

*\*Total quantity measured may not be taken as the total precipitation, because most of the snowfall days are accompanied by strong winds/ blizzards.*

organizations like Geological Survey of India, Indian Institute of Geomagnetism, Snow & Avalanche Study Establishment etc.

Some labs like National Geophysical Research Institute and National Physical Laboratory have also utilized the met-data for scientific purposes.

**Table 1— History of blizzards: (Wind Speed > 23 Kts)**

S.N.	Date/Time		Extreme Values (with Date/Time)				
			MSL Pressure (hPa)		Temperature (°C)		Wind (Knots)
	Commencement	Cessation	Max.	Min.	Max.	Min.	Max.
1.	03.03.08/ 0630	03.03.08/ 0905	988.5 02.03.08/ 0000	970.3/ 03.03.08 0900	-1.1 03.03.08/	-6.4 03.03.08/	35/G64 03.03.08/ 1800
2.	15.03.08/ 2130	17.03.08/ 0330	992.4 15.03.08/ 0000	972.0 17.03.08 1200	-5.5 15.03.08/	-11.6 15.03.08/	64/G87 17.03.08/ 0300
3.	17.03.08/ 0830	17.03.08/ 1530	992.4 15.03.08/ 0000	972.0 17.03.08 1200	-5.5 17.03.08/	-9.1 16.03.08/	50/G86 17.03.08/ 1200
4.	01.05.08 / 1320	01.05.08 / 2140	999.7/ 28.04.08 / 1500	987.6 / 01.05.08/ 1200	-6.5 / 01.05.08 / 1200	-10.2 / 01.05.08 / 1800	60 /G86 / 01.05.08 / 1800
5.	30.05.08 / 2240	01.06.08 / 0145	997.0/ 30.05.08 / 1200	976.1 / 31.05.08 / 0600	-12.5 / 01.06.08 / 0300	-21.1 / 30.05.08 / 0900	65 /G90 / 31.05.08 / 0600
6.	01.06.08 / 0000	01.06.08 / 0145	997.0/ 30.05.08 / 1200	976.1 / 31.05.08 / 0600	-12.5 / 01.06.08 / 0300	-21.1 / 30.05.08 / 0900	65 /G90 / 31.05.08 / 0600
7.	01.06.08 / 1730	02.06.08 / 0820	990.3/ 1800/ 01.06.08	984.1/ 0300/ 02.06.08	-12.0/ 0600/ 02.06.08	-14.5/ 1200/ 02.06.08	42/G62/ 02.06.08
8.	02.06.08 / 1820	03.06.08 / 0830	991.5/ 1200/ 02.06.08	979.4/ 0000/ 03.06.08	-13.2/ 1800/ 02.06.08	-25.2/ 1500/ 04.06.08	46/G67/ 03.06.08
9.	05.06.08 / 1300	06.06.08 / 1100	1001.7/ 0000/ 05.06.08	993.1/ 0900/ 06.06.08	-7.5/ 2100/ 06.06.08	-22.0/ 0000/ 05.06.08	50/G85/ 06.06.08
10.	06.06.08 / 2335	07.06.08 / 0500	989.8/ 0600/ 07.06.08	987.6/ 0300/ 06.06.08	-7.7/ 0300/ 07.06.08	-8.2/ 0600/ 07.06.08	60/G92/ 07.06.08
11.	07.06.08 / 0810	07.06.08 / 2030	984.8/ 1500/ 07.06.08	983.3/ 2100/ 07.06.08	-8.6/ 0900/ 07.06.08	-17.7/ 0600/ 08.06.08	40/G70/ 08.06.08

(Contd....)

Table 1-(Contd....)

12.	11.06.08 / 1115	11.06.08 / 2210	995.4/ 0000/ 11.06.08	990.6/ 1500/ 11.06.08	-4.1/ 0000/ 13.06.08	-14.2/ 0300/ 11.06.08	58/G78/ 11.06.08
13.	07.07.08 / 0000	07.07.08 / 0400	984.8/ 06.07.08/ 2100	963.8 / 08.07.08/ 0300	-12.4 / 08.07.08 / 0300	-27.5 / 06.07.08 / 1500	28 /G51 / 07.07.08 / 0300
14.	11.07.08 / 0030	13.07.08 / 1130	996.5/ 11.07.08/ 1800	965.3 / 13.07.08/ 0600	-09.4 / 12.07.08 / 1500	-16.0 / 11.07.08 / 0300	64 /G94 / 12.07.08 / 1800
15.	19.07.08 / 1030	19.07.08 / 1720	1001.0/ 19.07.08/ 1200	958.9 / 20.07.08/ 1800	-07.7 / 20.07.08 / 1800	-22.3 / 21.07.08 / 0000	61 /G91 / 21.07.08 / 0000
16.	19.07.08 / 1925	21.07.08 / 0400	1001.0/ 19.07.08/ 1200	958.9 / 20.07.08/ 1800	-07.7 / 20.07.08 / 1800	-22.3 / 21.07.08 / 0000	61 /G91 / 21.07.08 / 0000
17.	24.07.08 / 1645	24.07.08 / 2030	986.5/ 24.07.08/ 1800	962.8 / 26.07.08/ 1200	-10.5 / 25.07.08 / 1200	-13.8 / 24.07.08 / 1500	32 /G49 / 25.07.08 / 0000
18.	26.07.08 / 2335	27.07.08 / 0630	992.0/ 28.07.08/ 1200	962.8 / 26.07.08/ 1200	-09.8 / 26.07.08 / 2100	-14.9 / 25.07.08 / 0300	36 /G50 / 26.07.08 / 0000
19.	14.08.08 / 1220	15.08.08 / 0130	990.6/ 13.08.08/ 1800	964.0 / 16.08.08/ 0900	-14.7 / 15.08.08 / 0000	-21.5 / 14.08.08 / 0300	68 /G110 / 15.08.08 / 0000
20.	16.08.08 / 1430	17.08.08 / 0830	966.8/ 16.08.08/ 1500	965.5 / 17.08.08/ 0000	-13.3 / 17.08.08 / 0300	-15.0 / 16.08.08 / 1800	42 /G68 / 17.08.08 / 0000
21.	24.08.08 / 1530	24.08.08 / 2015	999.7/ 24.08.08/ 0000	986.9 / 24.08.08/ 1800	-16.7 / 24.08.08 / 2100	-21.5 / 25.08.08 / 0900	35 /G55 / 24.08.08 / 1800
22.	28.08.08 / 2110	31.08.08 / 0400	1000.6/ 29.08.08/ 2100	978.7 / 31.08.08/ 0600	-13.8 / 31.08.08 / 0300	-24.7 / 28.08.08 / 2100	50 /G78 / 29.08.08 / 0900
23.	31.08.08 / 0730	02.09.08 / 2200	983.7/ 31.08.08/ 2100	969.7 / 02.09.08/ 1200	-05.4 / 02.09.08 / 0900	-14.9 / 31.08.08 / 0900	54 /G90 / 01.09.08 / 1200
24.	18.09.08 / 1615	18.09.08 / 1850	991.8/ 17.09.08/ 0000	975.9 / 18.09.08/ 1800	-08.9 / 19.09.08 / 0300	-21.5 / 17.09.08 / 1800	48 /G78 / 19.09.08 / 0000
25.	08.10.08 / 0115	08.10.08 / 1100	982.9/ 08.10.08/ 0600	977.9 / 08.10.08/ 2100	-12.2 / 08.10.08 / 1200	-15.0 / 08.10.08 / 0000	39 /G54 / 08.10.08 / 0000
26.	04.11.08 / 1320	04.11.08 / 1430	997.8/ 05.11.08/ 1500	983.5 / 04.11.08/ 0600	-02.7 / 03.11.08 / 2100	-08.1 / 04.11.08 / 1500	35 /G59 / 04.11.08 / 1200
27.	11.12.08/ 0050	11.12.08/ 0745	978.6/ 11.12.08/ 2100	962.0 / 10.12.08/ 0900	+03.1 / 11.12.08 / 0000	-03.5 / 11.12.08 / 1200	27 /G33 / 11.12.08 / 1200

(Contd....)



**Table 1- (Contd....)**

28.	17.12.08 / 2140	17.12.08 / 2210	986.7/ 18.12.08 / 0600	978.7/ 16.12.08/15 00	+03.6/ 19.12.08/ 0000	-04.5/ 19.12.08/ 1200	24/ G40/ 18.12.08/ 0000
29.	17.12.08 / 2250	18.12.08 / 0245	986.7/ 18.12.08 / 0600	978.7/ 16.12.08/15 00	+03.6/ 19.12.08/ 0000	-04.5/ 19.12.08/ 1200	24/ G40/ 18.12.08/ 0000
30.	28.12.08 / 1530	30.12.08 / 1045	1003.3/ 27.12.08 / 1800	992.9/ 29.12.08/03 00	+03.9/ 31.12.08/ 1200	-04.5/ 28.12.08/ 1200	40/ G64/ 29.12.08/ 0000
31.	31.12.08 / 1630	01.01.09 / 0840	999.4/ 30.12.08 / 1500	982.5/ 01.01.09/ 0900	+03.9/ 31.12.08/ 1200	-03.6/ 02.01.09/ 0000	48/ G68/ 01.01.09/ 0600

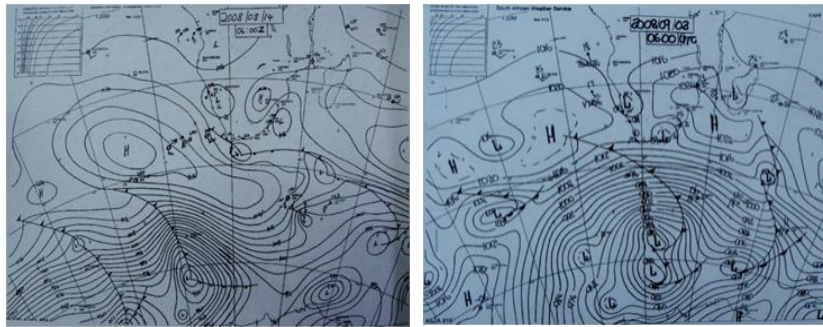


Fig. 4a

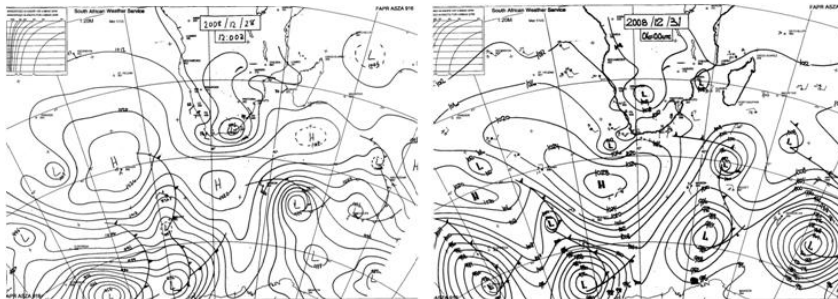


Fig. 4b

**4.1.7 Radiation Budget Studies**

The total global solar radiations were observed/ recorded on all Solar days with the help of two Thermo-electric Pyranometers; one for measuring direct solar radiations and other equipped with a shadow ring to measure diffused solar radiations.

Table 2—Yearly Statistics

MONTH	Temperature			Pressure			Wind		
	MAX. TEMP.	MIN. TEMP.	Monthly AVG. TEMP.	MAX. PRESS	MIN. PRESS	Monthly AVG. PRESS.	MAX. WIND	Monthly AVG. WIND.	MAX. GUST
Jan	6	-6	-1.1	993.4	976.9	985.8	40	13	62
Feb	4.3	-10	-3.5	998.9	969.7	983.7	38	12	59
Mar	0.5	-16.7	-6.5	1002.9	959.1	985.8	64	18	87
Apr	0.3	-25	-9.8	1012.1	954.8	988	54	18	98
May	-6.5	-26.4	-16.1	1011.3	967.9	992.3	65	12	90
Jun	-3.5	-33.5	-17.8	1001.7	953	986	60	20	92
Jul	-7.5	-32.3	-16.3	1001	958.9	984.3	64	18	94
Aug	-8.5	-31.9	-20.5	1005.4	964	985.9	68	16	110
Sep	-3.5	-26.4	-15.1	991.9	966.5	982.1	54	17	90
Oct	-4.6	-23.5	-13.4	999.6	969	982.9	56	11	74
Nov	1.4	-13.6	-5.7	999.9	966	982.2	44	13	67
Dec	4.6	-5	-0.8	1003.3	962	981.1	42	16	64
YEAR 2008	6	-33.5	-10.6	1012.1	953	985	68	15	110

A total number of 21 Radiometersonde ascents were taken during the year, except polar nights, to study the radiation budget in Schirmacher Oasis, Antarctica.

#### 4.1.8 Annual Statistics

The highlights of the yearly observations are given in Table-2.

### 5.0 CONCLUSIONS

**Table 3—Annual Met Summary**

a.	Maximum Temp.	+06.0°C	on 05.01.2008
b.	Minimum Temp.	-33.5°C	on 23.06.2008
c.	Warmest Month	-01.1°C ( <i>Avg. Temp</i> )	January
d.	Coldest Month	-20.5°C ( <i>Avg. Temp</i> )	August
e.	Windiest Month	20 knots ( <i>Avg. Wind</i> )	June
f.	Max. Pressure	1012.1 hPa	on 24.04.2008
g.	Min. Pressure	953.0 hPa	on 26.06.2008
h.	Total no. of Blizzards	31	during 2008
i.	Max no. of Blizzards (in a month)	7	during June
j.	Max. Wind (Gust)	110 knots	on 14.08.2008

#### Acknowledgements

We express our sincere thanks to AVM (Dr) Ajit Tyagi, Director General of Meteorology and Sh R. C. Bhatia, former DGM for giving us the opportunity to participate in the Indian Antarctic Expedition. We are thankful to various wings of IMD situated at New Delhi and Pune for imparting us intense training, guidance, encouragement and support. We also express our gratitude to Sh Arun Chaturvedi, Leader & Stn Cdr of the 27<sup>th</sup> expedition for his continuous guidance and extreme support throughout the expedition. We are grateful to all the members of the 27<sup>th</sup> expedition team for their esteemed support and help to achieve our objective/ programme. In particular, we are thankful to Sh Parmatma Choubey, Vehicle Mechanic, Border Roads Organization, for his assistance on most of the occasions in taking balloon borne ascents and in other tasks.

---