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# Meteorological Studies During Summer Part of 14th Indian Antarctic Expedition

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## Abstract

Meteorological Programme of IMD in Antarctica and its implementation during summer are explained. Based on the observations undertaken during onward and return voyages of Fourteenth Indian Antarctic Expedition and at Maitri during Jan and Feb'95 latitudinal variation of meteorological parameters; summary of weather at Maitri; Comparison of extreme values of meteorological parameters; Ozone data and comparison with Syowa values and services being provided by IMD for the activities of the Expedition are discussed. Highest maximum air temperatures at Maitri are reaching positive values in January at Maitri every year and temperatures falling in February. Occurrence of drifting/blowing snow is not frequent at Maitri during January and February months. Maitri and Syowa ozonesonde ascent values are tallying and comparable.

## Introduction

India Meteorological Department is having a longterm scientific programme and implementing it continuously in all summer and winter components of Indian Antarctic expeditions starting from first expedition. The aim of this meteorological programme is to study and understand Antarctic weather in general and its relations to global weather systems with special emphasis on weather systems which influence Indian sub-continent like southwest monsoon.India Meteorological Department is also showing keen interest on the recent thoughts of concern like ozone depletion over Antarctica and continuing its ozone monitoring programme by releasing ozonesondes.

In addition to the main programme at Maitri; IMD is also having programme during both outward and return voyages. Three hourly monitoring of weather parameters during voyage not only gives latitudinal variation of meteorological parameters, but also it is an invaluable tool for weather forecasting all over the world on sea where the observational network is very poor. From 13th expedition IMD introduced ozonesonde programmes during voyage for study of vertical profile of atmospheric ozone in the sub-tropical zone which

will be useful to study the latitudinal variation and mixing of ozone between low and high latitudes. But due to practical problems like non-availability of suitable laboratory space, no facility for filling and releasing of ozonesonde balloons onboard the ship, the ascents during voyage were not successful.

## Meteorological Programme

Scientific objectives for meteorological programme during 14th expedition are the study of Antarctica meteorology in general and the following in particular:

a. The daily, seasonal and annual variations of atmospheric pressure, surface wind, surface air temperature and cloud cover.

b. The Radiation Budget Studies, diffuse radiation observations in addition to direct solar radiation observations as well as radiometersonde ascents.

c. Balloon borne measurements of ozone for its vertical profile over Maitri,Antarctica for the study of the occurrence of ozone-hole over Antarctica during spring months. In addition ozonesonde ascents on board the ship during onward and return voyages of expedition for study of vertical profile of atmospheric ozone in the sub-tropical zone.

d. Monitoring and archival of information through weather satellites and HF radio sets regarding weather systems affecting the antarctic continent.

e. Monitoring of hourly surface meteorological parameters on real time basis through INSAT by DCP system.

## Implementation of Programmes During Summer Part of the Expedition

### A. While on cruise

*(1) Onward voyage:*

*Surface observations:* Three hourly Surface observations of following parameters were taken starting from 18th Dec'94 after leaving India till reaching Antarctica and continued upto 20th Jan '95.

Wind speed and direction

Visibility

Surface pressure

Air temperature

Humidity

Clouds

Sea surface temperature and weather

The observations were entered in log book and every six hourly observations were passed to IMD Head Quarters.

*(2) Return voyage:*

Three hourly surface observations of the above mentioned meteorological parameters were taken starting from 0000 hrs UTC of 7th Mar'95 (from leaving Antarctica) to 0000hrs UTC of 29th Mar' 95(till approaching India) and entered in log book. Main synoptic hour observations(00,06,12 and 18 UTC) were passed to IMD Head Quarters on real time.

**B. In Antarctica at Maitri**

The following observations and studies were continued:

*(1) Surface observations:* Continuous recording of windspeed, wind direction,prcssure,temperature,total solar radiation(Direct and Diffuse) on self recording instruments. Three hourly synoptic observations were recorded and six hourly observations at main synoptic hours were transmitted to the IMD Delhi on real time.

(2) *Atmospheric turbidity observations:* Turbidity observations were taken on clear sunny days.

(3) *Data collection platform:* Transmission of hourly surface met parameters(pressure,air temperature,wind speed and direction) on real time basis through INSAT was continued.

(4) *Fax reception:* Analysed charts of surface weather were received from Pretoria(South Africa) on H/F.

(5) *APT pictures:* Cloud pictures through NOVA SATELLITES were received daily.

(6) *Ozone observations:*

a. Surface ozone was being recorded continuously.

b. Ozonesonde ascents were taken at the rate of about once in a week.

## Results and Discussion

(a) Latitudinal variation of meteorological parameters observed between India and Antarctica during both onward and return voyages of the expedition:

Fig.(l) gives the approximate course of MV Polar Bird, the ship chartered for Fourteenth Indian Antarctic Expedition followed during both onward and return voyages. The following discussion is based on the meteorological

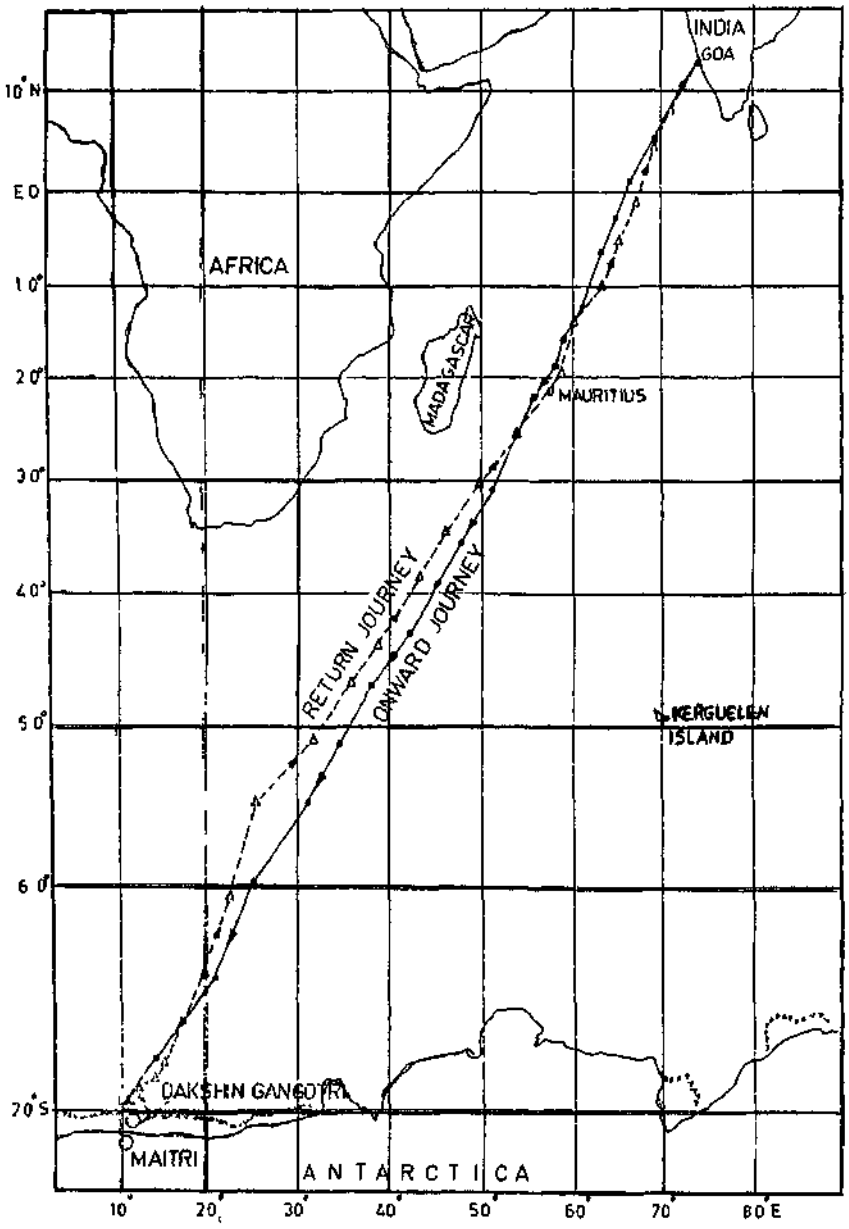


*Fig. 1— Course Of the ship chartered for XIV Indian Antarctica Expedition in both on-ward and return voyages along which continuous 3 hourly meteorological studies were undertaken.*

observations undertaken during onward and return voyages of the expedition. In the figures (2) to (5) mainly the 1200 UTC observations are plotted to overcome the crowding of the points. Observations recorded at other hours are also in conformity with the values plotted.

Fig.(2) shows the latitudinal variation of surface air temperature. The profiles for both onward and return voyages are nicely matching and the seasonal variation of air temperatures are clearly seen. The month of December during which the onward voyage was undertaken is winter in Northern Hemisphere and summer in Southern Hemisphere, where as the month of March during which the return voyage was undertaken was setting of summer in Northern Hemisphere and setting of winter in Southern Hemisphere. It is clear

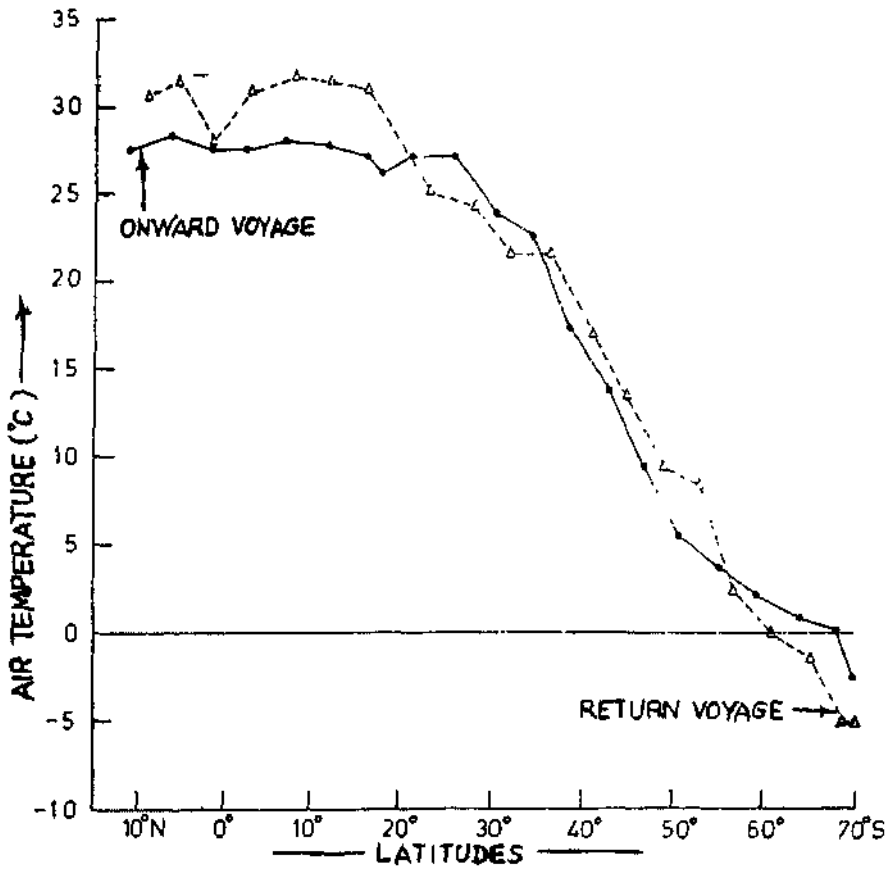


*Fig.* 2 — *Latitudinal variations of surface air temperature*

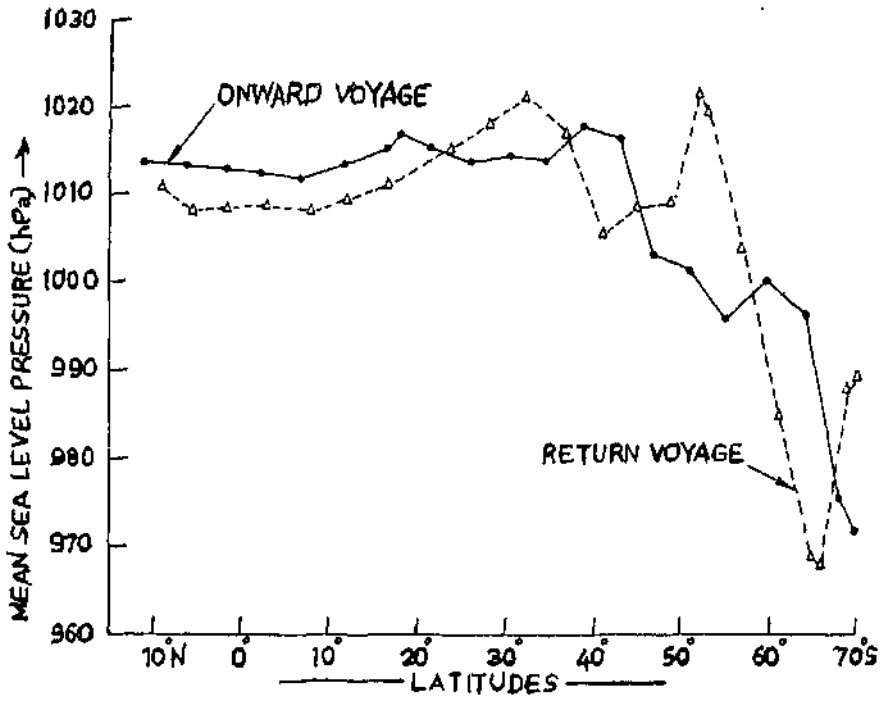


*Fig. 3 — Latitudinal variation of MSL pressure*

from the figure that in December the tropical airmass is cooler than during March and Polar airmass beyond about 57 Deg South latitude is reverse. There is little up and down variation in the temperatures in-between. However the cyclonic storms travelling around Antarctica influence very much the day to day temperatures on the periphery of Antarctic continent. It is clear that the temperatures gradually fall beyond 25 Deg S latitude and reach near zero and sub-zero values over oceans after crossing Antarctic circle.

Fig.(3) shows the latitudinal variation of Mean Sea Level air pressure. In the tropics pressures were higher during onward voyage, may be because of the Northern winter. As expected the pressures during both voyages are higher around 30° S latitude, the Sub-tropical High region. Beyond the Sub-tropical High belt upto the periphery of Antarctica, the day to day variation of pressures are highly variable depending on the presence of the pressure systems and fronts.

Fig.(4) shows the latitudinal variation of wind speed. Wind was stronger during return voyage from Antarctica till about 20 Deg S latitude. In these latitudes, wind is generally stronger and highly variable from day to day

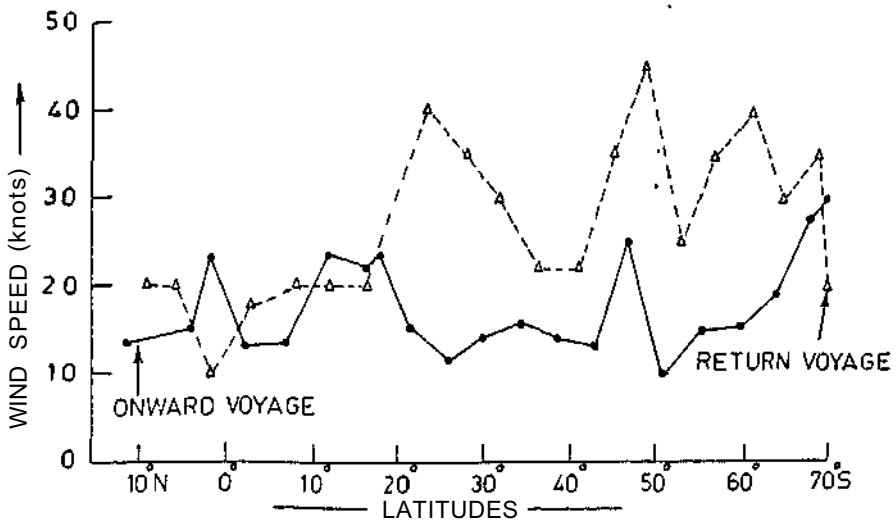


*Fig. 4 — Latitudinal variation of wind speed*

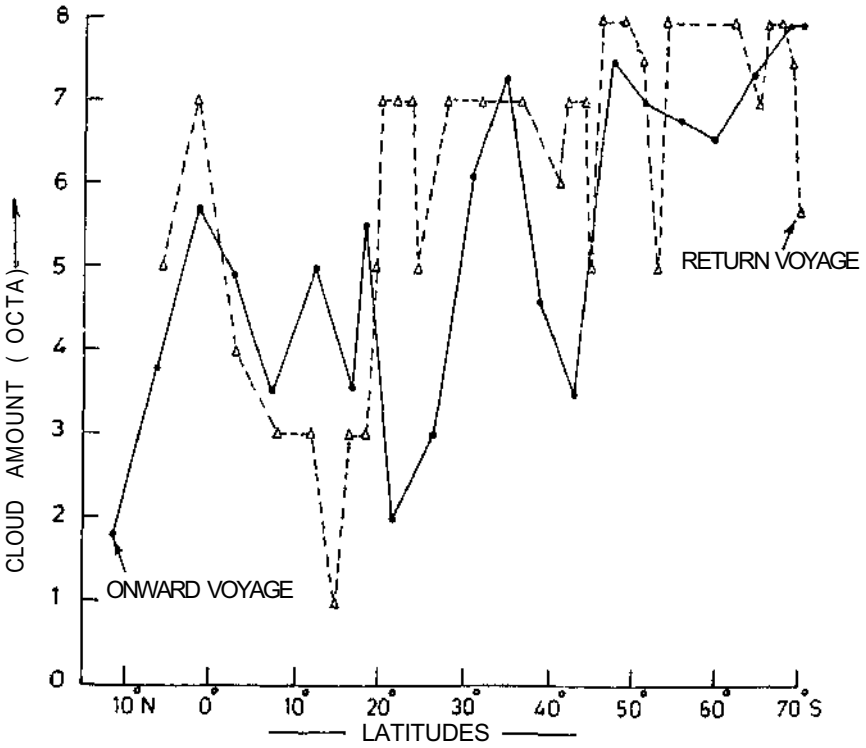


*Fig. 5 — Latitudinal variation of cloud amount*

depending on the position of the passing weather systems. Within the tropics, wind was almost same with little fluctuations during both voyages.

Fig.(5) shows the latitudinal variation of cloud amount. It is highly variable from day during both voyages but during return voyage it persistently higher from Antarctica till about 20 Deg S latitude because of the encounter with pressure systems. This is nicely matching with the wind speed which is discussed above. Near Sub-tropical High region, the cloud amount is lowest. As expected near equator around the equatorial trough region the cloud amount is high during both voyages due to the convective clouds.

(b) Weather summary at Maitri during January and February 1995:

| Parameter | Jan'95 | Feb'95 |
|---|---|---|
| 1. PRESSURE (hPa) | | |
| Average | 984.3 | 985.5 |
| highest/date | 1001.2/30th | 996.9/20th |
| lowest/date | 971.5/12th | 968.2/22nd |
| 2. TEMPERATURE (Deg Cent) | | |
| Average | -00.4 | -02.6 |
| highest/date | +05.0/13th | +05.2/03rd |
| lowest/date | -06.7/31st | -11.6/16th |
| 3. WIND SPEED (Knots) | | |
| Average | 12.4 | 17.6 |
| highest/date | 35/10th | 42/27 & 28th |
| 4. BLIZZARD | | |
| No, of days with drifting/ blowing snow | 00 | 02 |
| 5. SKY CONDITION | | |
| No. of days with | | |
| - clear sky | 03 | 02 |
| - partly cloudy sky | 13 | 04 |
| - mainly cloudy sky | 07 | 13 |
| - overcast sky | 08 | 09 |
| - mean cloud amount | 4.9 octa | 5.6 octa |
| 6. WEATHER | | |
| No. of days with snow | 01 | 08 |
| No. of days with fog | 04 | 00 |

(c) Comparison of some interesting weather parameters recorded at Maitri in the months Jan & Feb for 6 years(from 1990 to 1995): These values will give an idea for advance planning of the summer activities at Maitri.

In all the years, highest maximum temperatures are reaching positive values in January and February is cooler than January. There is no systematic

variation in other parameters. Number of days with drifting/blowing is not common at Maitri during both January and February.

**JANUARY:**

| Parameter | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|
| AIR TEMPERATURE: | | | | | | |
| Highest | 7.8 | 8.2 | 7.8 | 8.2 | 6.6 | 5.0 |
| Lowest | -7.6 | -5.6 | -6.4 | -5.5 | -6.2 | -6.7 |
| Mean | 0.9 | 0.9 | 1.3 | 0.7 | -0.1 | -0.4 |
| MSL AIR PRESSURE: | | | | | | |
| Highest | 1009.8 | 994.6 | 1001.4 | 1006.1 | 995.6 | 1001.2 |
| Lowest | 967.3 | 960.0 | 978.5 | 979.3 | 979.0 | 971.5 |
| Mean | 991.1 | 981.8 | 989.4 | 994.0 | 987.7 | 984.3 |
| WIND SPEED: | | | | | | |
| Max | 40 | 62 | 70 | 44 | 30 | 35 |
| Mean | 9.4 | 14.8 | 14.0 | 11.3 | 13.5 | 12.4 |
| WEATHER: | | | | | | |
| No. of Pptn days | 10 | 8 | 6 | 7 | 7 | 1 |
| No. of Drift/blow days | 0 | 0 | 0 | 0 | 0 | 0 |

**FEBRUARY:**

| Parameter | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|
| AIR TEMPERATURE: | | | | | | |
| Highest | 3.7 | 7.6 | 5.3 | 5.4 | 4.8 | 5.2 |
| Lowest | -9.2 | -8.5 | -8.4 | -13.8 | -9.7 | -11.6 |
| Mean | -2.9 | -0.9 | -1.8 | -3.5 | -3.9 | -2.6 |
| MSL AIR PRESSURE: | | | | | | |
| Highest | 999.6 | 999.3 | 1003.5 | 996.0 | 995.9 | 996.9 |
| Lowest | 968.7 | 963.3 | 971.9 | 965.6 | 973.1 | 968.2 |
| Mean | 981.6 | 994.9 | 989.2 | 983.0 | 985.0 | 985.5 |
| WIND SPEED: | | | | | | |
| Max | 62 | 68 | 68 | 42 | 35 | 42 |
| Mean | 15.9 | 20.7 | 14.0 | 17.0 | 14.3 | 17.6 |
| WEATHER: | | | | | | |
| No. of Pptn days | 1 | 10 | 4 | 8 | 1 | 8 |
| No. of Drift/blow days | 0 | 0 | 0 | 0 | 0 | 2 |

NOTE:
Pptn = Precipitation;
Drift/blow= Drifting/blowing snow

(d) Information about successful ozone sonde ascents taken at Maitri during January,1995 and comparison with the ozone data received from Syowa station

| S No | Date | Time (UTC) | Terminate Pressure (mb) | Ozone Max Level (mb) | Ozone Maximum Partial Pressure (nb) |
|---|---|---|---|---|---|
| 1 | 05 195 | 2145 | 05 | 64 6 | 164 |
| | | | | 102 0 | 116 |
| 2 | 21 195 | 2027 | 12 | 69 5 | 116 |
| 3 | 28 195 | 2134 | 05 | 82 0 | 148 |
| Syowa | 04 195 | 0715 | 06 | 618 | 155 |

Total Ozone data of Syowa in January,1995 Date(amount in Dobson Units)

01(305), 02(312), 03(296), 04(307), 05(305), 06(309), 07(309)

The above ozonesonde data indicate that Maitri and Syowa recordings are tallying and comparable

## Weather Service

Weather service in the form of present condition of weather and likely variations of weather in a day or two was being provided from day to day, for planning and execution of flying operations, Convoy movements, station maintenance, scientific and other logistic activities Some of the data collected by IMD scientists was utilized by many organisations who were the part of the expedition like NEERI, AIIMS, NPL, SOI, Indian Navy etc

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1. Technical Publication Numbers 6 and 8 of Indian Scientific Expeditions to Antarctica.
2. Scientific Reports on Meteorological Studies of XI and XII Indian Antarctic Expeditions, submitted to India Meteorological Department by Dr A L Koppar and Shri S Venkateswarlu respectively.
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