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# Analysis of Meteorological and Oceanological Situations Encountered during Summer Months of 1993 - 94 in Antarctica

**M SARANGAPANI**

**Indian Navy**

## Abstract

**The Antarctica is known to be the coldest, stormiest, windiest and least known continent. It is almost completely covered by ice. Inspite of these inhospitable conditions, it is attracting world wide attention because of its strong influence on weather, the global heat balance and its hidden economic potential.**

**This paper presents an analysis of different weather systems encountered and experienced during the passage and stay at Antarctica of the XIII Antarctica expedition. The expedition team sailed from Marmagao onboard M V Stepan Krashanennikov on 08 Dec 93. The team included two Meteorological scientists from India Met Dept and one Meteorological and Oceanographic Officer from the Indian Navy.**

**The summer of 1993 - 94 had one of the severest blizzards during Feb 94 which damaged the ship's rudder control system. This led to an unavoidable extended stay at Antarctica.**

## Objectives

**The objectives of the Meteorological and Oceanographic programme during the voyage and our stay at Antarctica are mentioned below :**

**(a) Study synoptic systems that affect weather over Antarctica by collecting information from the met. data network**

**(b) Collect and record synoptic weather observations during the passage to and from Antarctica**

**(c) Collect ship / surface meteorological observations during the stay at Antarctica**

**(d) Provide weather briefings and forecasts for ship's routing**

**(e) Provide general weather and aviation forecasts during the expedition**

**(f) Receive and interpret cloud imageries from NOAA satellites for the purpose of planning and execution of expedition activities**

(g) Collect Oceanographic observations during the passage to and from Antarctica

(h) Study the movement of water masses, their origin and sea ice conditions

## Meteorological Inputs during the Expedition

The following inputs were received and used for meeting the above objectives:

(a) Surface and upper air analyses by facsimile from Pretoria, South Africa

(b) Satellite imageries received onboard the ship

(c) Current weather observations of the ship and Maitri

(d) Air borne Meteorological reports from helicopters

(e) South African Weather bulletins

(f) Weather bulletins for the high seas from South Africa

(g) Meteo - France Re-Union Weather bulletins

(h) Weather bulletins from Met. Mauritius

(i) Indian Ocean Fleet Forecasts from India

## Weather Systems encountered during the onward passage — Tropical Storms

One tropical storm was observed over the South Indian Ocean during the onward journey. It intensified into a severe cyclonic storm on 19 Dec 93 and moved in a SW to WSW direction and crossed Mauritius. This system followed the track of the ship for the next 36 hours and became unimportant thereafter. Under its influence the ship experienced a NE swell of 4 to 5 m height.

## Sea-Ice conditions

During the onward passage, the following types of sea-ice conditions were experienced. The facsimile chart received onboard the ship is given in Figure 1. Beyond 68 S, the conditions remained as fast unbroken ice which took nearly three days to cross and reach the India Bay at Antarctica.

(a) 28 Dec 93: Drift ice of 5 / 10 cover near 61 S / 16 E

(b) 29 Dec 93: Pack ice of 10 /10 cover near 67 S / 15 E

(c) 30 Dec 93: Fast unbroken ice of 1.5 m from 68 S onwards

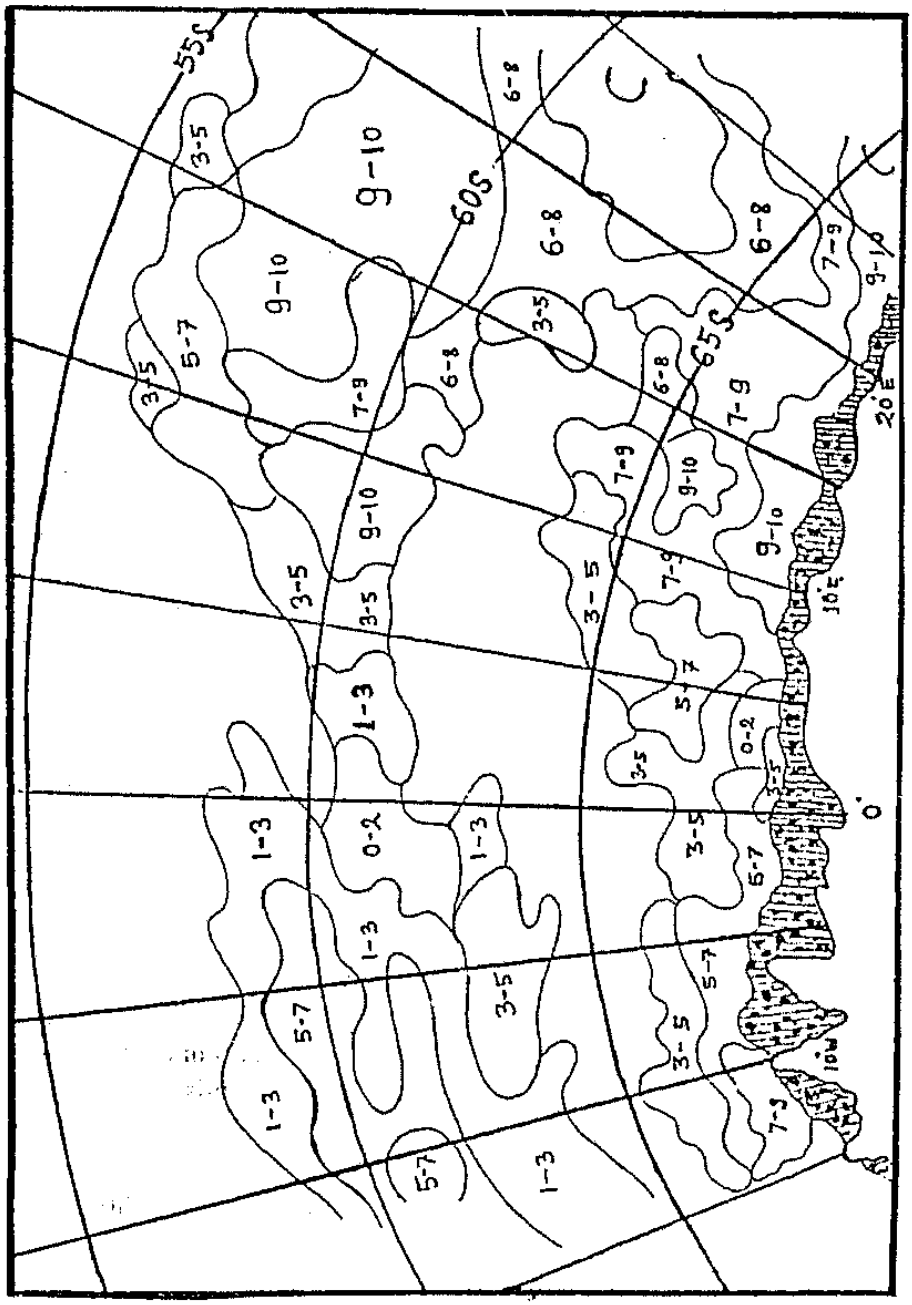


*Fig. 1: Facsimile chart of Northern Limit of Sea-Ice conditions (Ice concentration in tenths)*

## Meteorological Events Observed at Antarctica

**The following meteorological events were observed at Antarctica during the summer of 1993 - 94:**

**(a) Blizzards**

**(b) Strong surface winds**

**(c) Movement of clouds**

**(d) White-out conditions**

**(e) Change in upper wind pattern before meteorological systems**

**(f) Turbulence**

**(g) Mirages and**

**(h) Aurora australis**

### Blizzards

**Blizzards are special weather phenomena over Antarctica. They are associated with the winds and blowing snow thus reducing the horizontal as well as the vertical visibility. There were only two low intensity blizzards during Jan 94. However the intensity and duration considerably increased during the month of Feb 94. There were four blizzards during Feb 94 of which one was a severe blizzard with strong surface winds of 80 to 90 Kts and swell of 4 to 6 m height. The details of this blizzard is given in the next paragraph. In addition on many occasions there was snow fall and the sudden appearance of dense drifting fog. This reduced the visibility.**

**An intense low pressure system was observed on 19 Feb 94 on a facsimile chart. The approaching bad weather was identified by a change in wind direction from the ESE to the SSW and S. The system was on the edge of a cold front extending from 60° to 70° S. There was a time gap of 6 hrs between the change in the wind direction and the appearance of low clouds . The blizzard continued to blow constantly up to 23 Feb 94. The wind speed was 50 to 60 kts at times reaching to 80 - 90 kts, throughout the period. This caused a swell of 4 to 6 m height. We observed heavy swings of the berthing ropes. This forced the ship to cast off from the shelf which ultimately resulted in the failure of the rudder control system and drifting of ice for the next few days.**

### Strong surface winds

**Surface winds from E to ESE of the order of 25 to 30 kts were frequently experienced under the influence of passing low pressure systems. In addition, on many occasions katabatic winds of cold dense air from the slopes of a nearly**

plateau under gravity caused an icy blast of 25 to 30 kts. At times winds reaching to 40 kts were also experienced.

## Movement of clouds

The appearance or drifting low clouds over the shelf near India Bay is very frequent. On many occasions, these clouds appeared as broken, isolated and distant stratiform clouds in E to ESE direction. Within no time, these clouds drifted overhead leading to overcast and whiteout conditions with zero visibility.

## Upper winds

The low level winds below 3000 ft were observed to be E to ESE of the order of 15 - 20 kts (as obtained from helicopters). Backing of low level upper winds with increase in speed gave advance warning of an approaching low pressure system. Backing of winds were noticed at least 12 hr before the approach of a system.

## Turbulence

Moderate to severe turbulence was observed near mountain regions, particularly near Maitri. Turbulence was observed under the following conditions:

(a) Behind or immediately after the passage of low pressure systems, and

(b) Strong wind shears in low level upper winds

## Mirages

On many occasions when the sun was closer to the horizon polar mirages were observed. They were seen generally during the early morning or late evening hours. They occurred when a layer of cold air near the surface lay under a layer of warm air above. During such occasions,distant features, such as, mountains, ice bergs seem to be looming above the horizon or appeared to be very near with very good visibility.

## Aurora australis

Beautiful aurora lights, aurora australis with its colourful draperies were observed on three consecutive days from 06 Mar 94, during extended stay at Antarctica. They are magnificent atmospheric phenomenon which are sometimes called, "heavenly lights" or "atmospheric dancing lights". They appeared in one part of the sky and started moving at very slow speed from the North to South.They used to continuously change its colours in a wave like pattern.

direction and crossed Madagascar. On crossing Madagascar it further intensified and crossed the Muzambique channel and hit South Africa. The facsimile chart showing the relative positions of the ship and storms is shown at Figure 3.

## Satellite Imageries

A weather Satellite Receiver 525 was installed onboard the ship by the Naval Met officer. With the help of this unit, cloud imageries were received on a routine basis from NOAA weather satellites. These imageries helped in identifying the cloud and ice covers and in monitoring different weather systems over and around Antarctica. These imageries also served as an important tool for the study of weather systems. They helped us to give correct and timely forecasts for the successful operation of aerial surveillance and various other expedition activities.

## Oceanographic Observations

Continuous three hourly observations of sea surface temperature, Sea state , swell (direction, height and period) were recorded. In addition, during the onward journey, six hourly XBT probes were launched for recording the temperature profiles. A total of 45 observations were recorded. A study on the data revealed different Southern oceanic processes, such as, Antarctic current convergence, divergence and upwelling. A study of bathy observations indicated the following:

(a) Fluctuation of sea surface temperature from 14 to 20°C near 35° to 40°S. This indicated the movement of water masses associated with Antarctic current convergence and divergence.

(b) MUD extending upto a depth of 200 to 300 m near 45 S

## Met Data (extreme values) recorded during the expedition

During the ship's stay at India Bay and near Antarctica from 30 Dec 93 to 16 Mar 94, the following extreme values of Meteorological data were recorded:

(a) Maximum surface wind: 90 kts on 21 Feb 94

(b) Temperature: Maximum: 05°C on 09 and 11 Jan 94

Minimum: -18°C on 21 Feb 94

(c) Minimum Atmospheric pressure: 947 hPa on 17 Mar 94 at 63 S /11 E

(d) Aurora australis : 06, 07 and 08 Mar 94 near 69 S / 06 E

(e) Swell: Height of 08 M on 19 Mar 94 near 62 S /11 E

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## Conclusions

**During the 13 th Antarctica expedition, typical Meteorological and oceanological situations were encountered and experienced by the Indian Naval Meteorological officer have been described. The detailed experience and study is given with a view to act as a guide line for the future expeditions . The critical situations dealt with by the Leader, Captain of the ship and Meteorological staff were of total professionalism and aptness. For further detailed study on the variations of Antarctic weather, it's effect on global heat exchange and in particular the Indian monsoon, a continuous time series of meteorological and oceanological observations from number of stations may therefore be necessary and is recommended.**