551.575 (99)

FOG AT MAITRI, EAST ANTARCTICA

1. Fog-a mass of minute droplets of condensed water vapour suspended in the air, often greatly reduces visibility (less than 1000m). It is a common weather phenomenon in winter and poses a dangerous hazard to aviation. Reasons for fog occurrence are many. Fog occurring over the land is mainly caused by radiative cooling of the lower moist air. Clear skies leading to nocturnal radiation, and a low pressure system that is slowly advecting moist air from the sea to a shallow layer above the ground during the evening and early part of the night are the main conditions for the occurrence of fog. The slight turbulence that is necessary for the formation of fog is apparently brought about by a gentle katabatic flow from the hills to the east of the airfield (Santacruz airport) (Rangarajan, 1952). On all occasions of fog, the surface wind during the night preceding the occurrence of fog was generally calm or light. Fog also occurred in the wake of the passage of low pressure systems and associated rain (Swaminathan, 1961). Influence of horizontal convergence in the surface layers bounded by thermal inversion favours the formation of radiation fog at Palam, Santacruz and Begumpet airports during the winter (Natarajan, 1962). The processes of formation of fog and its dissipation have been well understood and explained in literature.

2. Though fog occurs mainly in the temperate regions, it has been observed in the Polar regions also. Bhukan Lal (1987) has reported that advection fog was very frequently observed at Dakshin Gangotri (70° S, 12° E) especially during the peak polar summer months (December – January) but not so frequently observed in other seasons. Koppar (1989) has observed fog on 13 days at Dakshin Gangotri in 1987. (Six events were observed in December and January, two events in June and October and one day of fog in March, May and July). He has stated that advection fog was most common although shallow

radiation (ground) fog occurs in the evening (1600 - 1800 hrs) in the summer months. The advection fog is generally thick and lasts for 3 - 6 hours. Joshi (1995) has observed fog frequently more over polynya than in the interior areas of the continent. Koppar (1995) has observed fog on two days in December at Maitri (70° 45′ S, 11° 44′ E)-Schirmacher Oasis in East Antarctica. Mc Murdo (77.51° S, 166.40° E), the USA Antarctic station reported the occurrence of fog in recent years (Lazzara, 2005). A good number of fog events were reported (7 event each in 2000 & 2003, 5 events each in 2001& 2002 and 4 events each in 2004 & 2005) between October and March. Using synoptic observations of Mc Murdo station from 1973 to 1998, University of Wisconsin, Madison has been studying the Polar fog events of Antarctica. Maitri, the permanent Indian Antarctic Scientific Research Station also reported fog twice during December - peak Polar summer month and once in May (winter month) during 2000 (19th Indian Antarctic Expedition). Occurrence of these three cases of fog events at Maitri is explained here.

3. *Fog during 30 April - 01 May 2000* – In the early hours on 30 April 2000, there was snowfall at Maitri accompanied with 'blizzard' mainly due the passage of low-pressure system north of the station. Sky was overcast with altostratus cloud and strong surface wind prevailed. Since the daylight was only few hours, at the end of the day the wind became calm and there was a fall of surface temperature by 7 degree from –7° C to –14° C. The sky became partly cloudy and calm wind continued till the mid-day on 01 May 2000. Haze was observed at 0730 UTC and became mist in the next 30 minutes. At 0830 UTC, the mist intensified into fog reducing the visibility from 2000 m to less than 500 m. The fog lasted about 3 hours and weakened as shallow fog at 1130 UTC and dissipated later around 1200UTC. During the fog the surface air temperature had further fallen to –19° C at 0900 UTC and rose steadily later. Based on synoptic observations, it may be concluded that the fog might have occurred due to the advection of warm and moist air (might have been brought by the low pressure system from lower latitudes) over cold surface. Surface wind was calm during the observation of fog and with increase in wind speed, the fog got dissipated (Fig. 1).

4. *Fog during 08 - 09 December 2000* – December is the peak summer month at Antarctica and the surface temperature goes above the freezing level depending upon the zenith angle of the sun. On 08 December 2000, the sky was clear in the early hours at Maitri and a few octa altocumulus clouds formed during later hours. The visibility was fine till 1900 UTC. Around 1930 UTC, the visibility reduced to 2000 m in mist in the

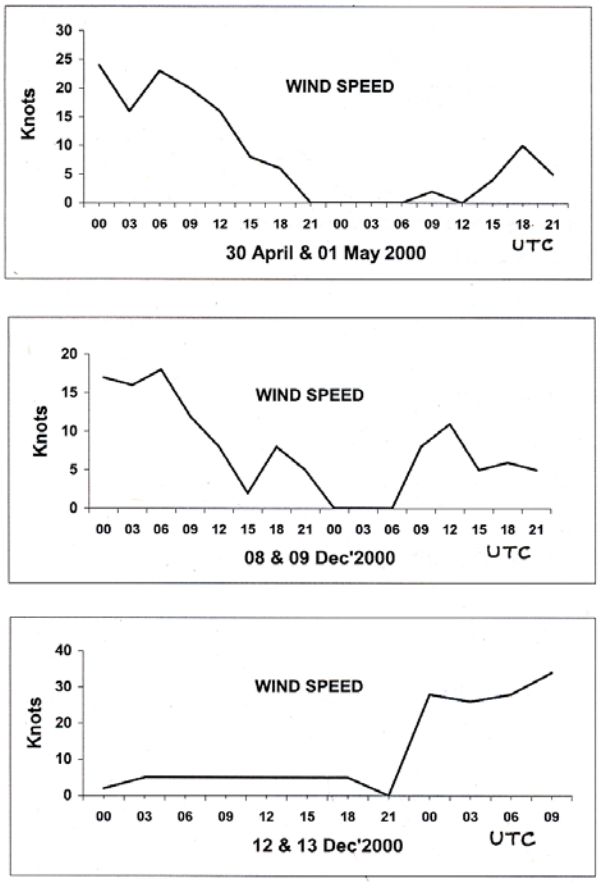

Fig. 1. Variation of wind speed during fog at Maitri

northern side of Maitri. At 2200 UTC the visibility improved to 4000m in haze and continued to the next day. On 09 December, at 0030 UTC the visibility once again deteriorated to less than 1000m due the local advection of shallow fog from the 'shelf ice'. Few octa stratus clouds also appeared over the land area and continued till 0800 UTC. During this shallow fog, the surface air temperature had fallen by 8° C from –1° C to –9° C. This fog later became haze and dissipated at 0930 UTC mainly due to the strong surface wind from NE direction. The pressure showed increasing tendency on 8th as well as 9th December 2000 after passage of the low-pressure system towards east. In this case also calm wind was observed during foggy condition which got dissipated when the wind speed increased to 8 kts (Fig. 1).

5. *Fog during 12 December 2000* – Thick fog occurred at Maitri on 12 December 2000, three days after the previous fog event on 09 December. The visibility was 10 km till 0700 UTC on 12th and the sky was covered with

one or two octa of low and medium clouds till 1200 UTC. Light surface wind prevailed from east and later backed north. Just after 0800 UTC, haze appeared over the exposed land area and low stratus clouds moved towards Maitri from northern side. Haze became mist at 0830 UTC and the visibility reduced to less than 1000m. Around 1500 UTC the visibility further deteriorated to 150m and a rapid passage of very low stratus could be seen. Since Maitri is 117m above sea level the advection of 6 or more octa of low stratus cloud with base150m from 'shelf ice' (north of Maitri) appeared as thick fog when it entered over the exposed land area that reduced the visibility to less than 200m. At 2300 UTC, strong southerly 'katabatic wind' rushed from the elevated 'ice plateau' inclining towards south of the station and cleared all the stratus clouds and the sky became cloud free at once (Fig. 1). This thick fog lasted about eight (1500 – 2300) hours. During this fog, a light surface wind of five knots had been observed from north. The sudden strong katabatic flow from south could explain the sudden dissipation of thick fog. The pressure was falling continuously on 12th and 13th.

6. Peak summer months (December - January) are favourable for the formation of fog at Maitri and rare in winter months. Advection fog is more common than the radiation fog. Three events of fog, of which two are during peak summer, suggest that occurrence of fog, though rare, could be possible in summer months. Advection of sea fog over shelf ice and the exposed land area in 'Schirmacher Oasis' and the very low stratus clouds entering from north are the main reason for the occurrence of fog at Maitri. Orographic condition very close to shelf ice generally prevents advection of dense fog. Further study can be attempted with more data base provided fog phenomenon is reported positively by the meteorologists participating in every Indian Antarctic Expedition.

7. The authors express their sincere thanks to Dr. R. Suresh, Director, Meteorological Office, Airport, Chennai for examining the manuscript and offering his valuable comments and suggestions. The authors also acknowledge Dr. A. L. Koppar, Dy. Director General of Meteorology, Pune for providing more information about fog over Dakshin Gangotri and Maitri and thanks to the referee for his valuable suggestions and comments to enhance the quality of this paper.

References

Joshi, S.C., 1995, "Weather forecasting in Frigid Desert of Antarctica", Scientific report of 11th Indian Expedition to Antarctica, Technical Publication No.9, Dept. of Ocean Development, New Delhi.

Koppar, A. L., 1989, "Scientific report on the Meteorological Programme of IMD carried out during the IV Wintering at Antarctica 1987-88", (submitted to IMD).

Koppar, A. L., 1995, "Report on the Meteorological Programme carried out during Eleventh Indian Expedition to Antarctica", Technical Publication No. 9, Dept. of Ocean Development, New Delhi.

Lal, Bhukan, 1987, "Report of the Indian wintering team (4th IAE) in Antarctica (1985-86)", Dept. of Ocean Development, New Delhi.

Lazzara, M. A., 2005, "8th Conference of Polar Meteorology and Oceanography – Mc Murdo station, Antarctica Fog Climatology", Antarctic Meteorological Research Center, University of Wisconsin, Madison, WI.

Natarajan, K. K., 1962, "Horizontal convergence as a factor for forecasting fog or stratus", *Indian J. Met. & Geophysics*, **13**, 3, 367-370.

Rangarajan, S., 1952, "Fog at Santacruz airport", *Indian J. Met. & Geophysics*, **3**, 186-196.

Swaminathan, D. R., 1961, "Fog over Nagpur (Sonegaon) Airfield", *Indian J. Met. & Geophysics*, **12**, 4, 673-676.

E. KULANDAIVELU
M. J. NARASIMHALU
M. V. GUHAN*

Meteorological Office, Airport, Chennai, India
**Regional Meteorological Centre, Chennai, India*
(*4 May 2006, Modified 26 October 2006*)