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Meteorological Observations : 1983-'84 Antarctic Summer

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ABSTRACT

Extensive meteorological observations of surface and upper air parameters were taken from ship platform during the voyage from Goa to Antarctica and back and also at Schirmacher hill station and at *Dakshin Gangotri.* The important meteorological events encountered during the expedition and the Antarctic weather have been discussed. Variations in observations taken at different locations and observational arrangements made by other countries have also been referred to.

INTRODUCTION

The Third Indian Scientific Expedition to Antarctica 1983-'84 left Marmugoa port on December 3, 1983 on board *M S Finnpolaris.* The team included two meteorological scientists from India Meteorological Department one meteorological officer from Indian Air Force and one meteorological and oceanographic officer from Indian Navy.

The main objective of the meteorological programme of the expedition was to set up a surface and upper air observatory at Indian permanent base station in Antarctica for continuous recording of meteorological parameters at the station. This was to facilitate, in the long run, obtaining meteorological record of the station. Besides, there were other specific objectives of the meteorological programme for the duration of the voyage and the stay in Antarctica as mentioned below.

1 To study synoptic weather systems that affect weather over Antarctica with special reference to their formation intensification movement and decay by collecting information about meteorological data net-work in Antarctica.

2 To study day-to-day changes in the structure of the Antarctic troposphere, tropopause and stratosphere by taking 401-MHz radiosonde and omegasonde ascents at regular time intervals.

3 To take and record synoptic weather observations during the voyage and the stay in Antarctica.

4 To provide weather forecasts for the purpose of planning and execution of the activities of the expedition in Antarctica.

5 To provide meteorological report and weather forecasts for helicopter operations in Antarctica.

6 To study sea-ice conditions and the details of sources and format of such information for Antarctic waters.

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EQUIPMENT

The meteorological equipment and stores were mainly provided by India Meteorological Depart merit and included the following

1 DR wind vane and anemometer with indicator panel
2 Temperature sensor and humicap with indicator panel
3 Surface ozone recorder
4 Muirhead weather facsimile recorder with RS 512 receiver
5 401-MHz Audiomodulated Radiosonde ground equipment (ECIL)
6 Omegasonde ground equipment without computer component (Vaishala)
7 Micro barograph aneroid barometer precision aneroid barometer whirling psychro meter and belfast hand anemometer cum wind vane
8 Optical theodolite fot pilot balloon ascent

In addition the meteorological instruments fitted on the bridge on board *M S Finnpolaris* for recording surface weather observations from the ship were also used during the expedition.

METEOROLOGICAL DATA

1 Weather observations made during the voyage

Routine weather observations at three hourly intervals were taken from the ship platform from 03 GMT of December 4, 1983 to 06 GMT of March 29, 1984 except during the period of stay of the ship in Port Louis Mauritius from12 GMT of December 10, to12 GMT of December 14, 1983 and from 12 GMT of March 18, to 12 GMT of March 22,1984. The complete surface weather data taken from ship platform for the period of stay of the ship south of 60°S at main synoptic hours are given in Table 3.

2 Weather observations at Schirmacher Oasis Field Camp (70°41 S, 11°46 E)

A field camp at Schirmacher Oasis was set up on January 13, 1984 at the same place where field camps were set up by the first and second expeditions. The field camp was about 15 km north-west of Novolazarevskaya a Russian station, and in a small valley surrounded by high rocky terrain. Three-hourly observations were taken from 12 GMT of January 16, to 00 GMT of February 5,1984. The data of the weather observations are given in Table 4.

3 Weather observations at Dakshin Gangotri (70°06'S, 12°00 E)

Weather observatory at base camp started functioning by taking three hourly surface observations from January 12, to February 20, 1984. The observatory was then moved to the nearby permanent station *(Dakshin Gangotri)* where surface and upper air parameters were to be monitored. Regular observations were started from February 24, 1984.

UPPER AIR OBSERVATIONS

Pilot balloon ascents

Pilot balloon ascents, using optical theodolite, were taken at base camp from January 31, to February 17,1984. During this period sixteen pilot balloon ascents were taken. Most of the flights lasted for less than 10 minutes as the balloon entered into low clouds which were invariably present for most of the time in the month of February. The highest ascent was tracked for 42 minutes.

Upper air soundings

The following gives the number of radiosonde and omegasonde ascents taken from ship during the voyage from Goa to Antarctica and back and during the stay in Antarctica

		Radiosonde	*Omegasonde*
1	Number of ascents taken during voyage from Goa to Antarctica	2	12
2	Number of ascents taken during ship s stay m Antarctica	-	10
3	Number of ascents taken during return voyage from Atarctica to Goa	-	10

Besides, 16 radiosonde ascents were taken at the base camp from January 12, to February 29,1984. The results of these ascents are being analysed by the India Meteorological Department. Upper air temperature and height are given in table 5.

IMPORTANT METEOROLOGICAL EVENTS

a. Storms and depressions

One severe cyclonic storm was encountered in the north Indian Ocean. It intensified into a severe tropical storm on December 8, 1983 centred at 11°S and 57°E; and crossed Azleza Island on the evening of December 8, 1983.

Due to the influence of an intense extra-tropical depression located approximately at 54°S and 24°E on December 20,1983, surface winds reached an all time high of 62 knots at 00 GMT of December 21. On this day *Finnpolaris* passed through the worst weather en route to Antarctica. This spell continued till 09 GMT of December 23, 1983.

b. Blizzards

Blizzards, which are associated with snow storms are the most troublesome meteorological events of Antarctic weather. On a few occasions, blizzards were observed during the third expedition.

The month of January was relatively calm with a few blizzards only. The occurrence and intensity of blizzards and their duration increased considerably during the month of February.

The details of blizzards during the months of January and February, 1984 are given in table 1.

TABLE 1

Details of blizzards in January and February 1984

	Time of commencement		*Time of ending*		*Max. wind speed observed from the ship platform (knots)*	*Max. wind speed observed at the base camp (knots)*
s/. No.	*Hour (GMT)*	*Date*	*Hour (GMT)*	*Date*		
1.	12	Jan. 06	15	Jan. 07	43	..
2.	12	Jan. 17	09	Jan. 19	50	..
3.	21	Feb. 08	18	Feb. 11	52	58
4.	21	Feb. 21	09	Feb. 24	50	70
5.	06	Feb. 26	15	Feb. 28	72	75

Besides these, there were seven occasions of snow fall and of drifting fog in January, and ten occasions of snow fall and one occasion of fog in February. Ground frost on ropes and metal surfaces was noticed on a couple of occasions.

Table 2 gives a few weather observations taken at the time of severe blizzards during January and February '84, when wind velocity was high and visibility was poor. This also indicates the variation in pressure and temperature during blizzards.

TABLE 2

Weather observations taken during severe blizzards in January and February, 1984

Date	Time of observations (GMT)	Surface wind		Temp. (°C)	Visibility (metres)	Pressure (mb)
		Direction (degrees)	Speed (knots)			
Jan. 07	06	095	53	-3.0	500	985.3
	12	130	38	-2.5	1000	983.8
18	06	100	36	-2.0	2000	1000.7
Feb. 09	06	100	33	-2.0	1000	976 0
	18	095	45	-1.0	3000	972.8
10	03	090	36	-2.0	1000	972.8
	06	100	40	-1.0	1000	973 3
	12	085	44	-1.0	1000	975.8
	18	090	40	-1.0	1500	977.3
22	12	100	30	-5.0	3000	973.8
23	03	100	42	-8.0	2000	975.8
26	18	100	60	-10.0	500	968.8
27	00	080	62	-7.5	500	968.7
	03	100	66	-11.0	100	966.8
	06	100	56	-10.0	300	969.0
	12	095	50	-7.0	300	972.0
	18	085	48	-8.0	300	972.8
28	00	095	48	-5.5	200	974.3
	03	100	40	-6.0	500	975.8
	06	110	40	-5.5	1000	976.3

COMPARISON OF OBSERVATIONS

1. Surface weather observations taken at permanent station were more or less identical with those taken from ship platform except in the case of ambient air temperature which was always lower by 5° to 10°C since this observational site was on the ice-shelf and away from the sea.

2. When the observations at the field camp and at the permanent station were compared, it was seen that the ambient air temperature at the Schirmacher Oasis field camp, due to the rocky terrain of the place, was 4° to 5°C higher than those recorded at the permanent station.

RESULTS AND DISCUSSION

1. Temperature

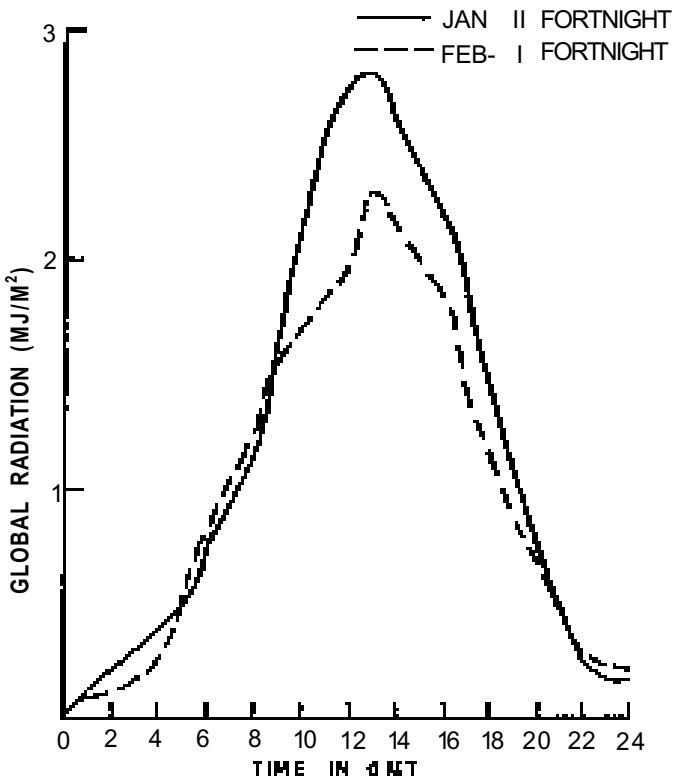
In Antarctica, air temperature is very low because of high latitude, greater reflectivity of ice surface and lack of thick cloud cover to block outgoing radiation. The data obtained in summer 1983-'84 indicated that the air temperature was generally below zero. On very few occasions, around local noon, above 0°C temperature has been recorded. The highest temperature of 4°C was recorded at the end of January and the lowest -22°C was recorded in the third week of February.

Variation in the wind speed significantly affects the diurnal temperature cycle. Strong winds associated with moving low pressure systems in the ocean surrounding Antarctica invariably raise the atmospheric temperature because they move humid maritime air southward in lower troposphere. Low temperatures are always associated with calm wind conditions.

2. Solar radiation

Continuous monitoring of incoming solar radiation was carried out with the help of pyranometer. In January 1984 30 33 MJ/m^2/ day (megajoules per Sq metre per day) of global radiation was received at *Dakshin Gangotri.* The hourly values of global radiation recorded in January were higher than in February. The mean noon maximum radiation was 3 08 MJ/m^2/hr and 2 82 MJ/m^2/hr for first and second fortnight of January respecti vely. During the first half of February the value reduced to 2 31 MJ/m^2/hr. There was marked diurnal variation in global radiation due to variation of solar angle. The local midnight minima recorded for the first and the second half of January were 0 22 and 0 10 MJ/m^2/hr respectively. Fig 1 gives the plot of diurnal variation of global radiation for January second fortnight and February first fortnight.

The average daily value of global radiation in the first half of January was 33 84 MJ/m^2/ day which decreased to 27 69 MJ/m^2/day during the second half. These are higher than the values of global radiation received at Indian latitudes in summer.



DIURNAL VARIATION OF GLOBAL RADIATION

Fig. 1

3. Wind and pressure

Antarctica is encircled by a belt of low pressure. Troughs can be seen on many occasions on surface charts with a number of low pressure systems embeded in them. These systems move in eastward direction. Fig 2 shows similar low pressure systems in the region.

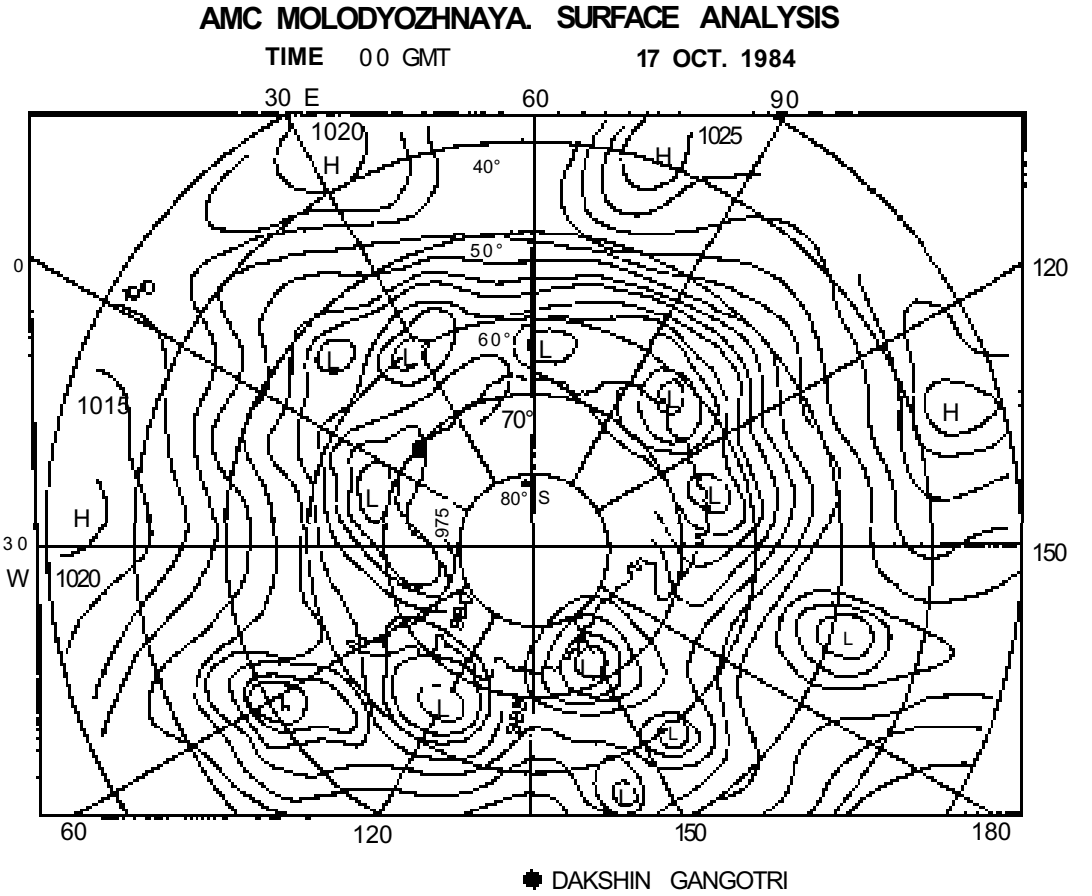


Fig. 2

Dakshin Gangotri on most occasions experienced light easterly winds. An analysis of wind data revealed that the direction of wind on majority of occasions varied from 67 5° to 112 5° and did not show any marked diurnal variation in wind direction. However frequency of occurrences of stronger winds was more during local noon. When a low pressure system passed over the station, winds were generally stronger and wind direction changed with northerly component replaced by a southerly component.

4. Relative humidity

Because of low temperature and supersaturated air humidity measurement techniques were not quite satisfactory. Both psychrometer and humicap sensors were used to determine relative humidity during the expedition. It is seen from analysis of relative humidity data that the percentage of relative humidity for most of the time was very high ranging from 60% to 100%. The actual water vapour content of the atmosphere however might be very low because of the low temperatures prevailing in Antarctica.

5. White-out

The term white out is used to describe an atmospheric condition in which there is a lack of contrast between sky and ice surface. There are four types of white-outs observed at *Dakshin Gangotri* Depending on the nature of weather they are called Overcast white out Fog white-out, Blowing snow white-out and Precipitation white out. Under these conditions the light reflected from the cloud is almost the same as reflected from surface. The intensity of light from all directions become same and there will be no shadow, no perception of depth or height above surface. There will be complete loss of horizon. However, any black object can be recognized very distinctly. This phenomenon which is very dangerous for aviation was very commonly observed at *Dakshin Gangotri.*

6. Mirage effects

Due to the differences in the refractive indices between the very cold air close to the ice-shelf and relatively warm air above, complicated mirage effects were observed. The far off objects like ice-bergs and peaks of mountains seemed to be very near. These objects appeared to be getting lifted when sun was at a low elevation. At sunset, some times, an image of sun was also seen.

FORECASTS AND METEOROLOGICAL REPORTS

Regular briefing was given onboard the ship to the flight commander and the pilots in the morning regarding the weather expected over the area and also the weather expected en route and at the destination for the planned flights. The local weather forecast included the state of sky surface wind upper winds upto 150 m above ground visibility and state of sea. Besides landing reports were given for all flights taking off/landing on the deck and at *Dakshin Gangotri*. The Leader of the expedition was briefed about the likely deterioration or improvement of weather throughout the stay.

RECEPTION OF FACSIMILE WEATHER CHARTS

Facsimile weather broadcast from New Delhi was received on December 5 1983 when the ship was at 07° 14 N 70° 14 E. After this no facsimile weather chart was available from New Delhi though the area of reception of New Delhi broadcast extends much south of this position. Facsimile weather charts from Nairobi were received when the ship was in southern Indian Ocean. The facsimile weather charts reception from Pretoria was clear and the weather charts were received regularly covering area from 50°W to 100°E and south of 10°S upto Antarctic boundary. The facsimile charts from Molodyozhnaya covering the entire southern hemisphere south of 30°S were received from December 23 1983 onwards till the ship crossed 30°S on her way back from Antarctica. Weather charts from Molodyozhnaya like those from Pretoria were received regularly and had high degree of clarity.

ICE-CHARTS AND DESCRIPTION OF ICE-CONDITION

Antarctic ice condition reports dated December 1 and December 8 1983 originated from *NOAA*. USA were received on board *MS Finnpolaris* on telefax from Finland. The information contained in these ice charts is satellite derived. There were no surface observations and as such ice information did not contain thickness of sea ice. Ice charts from Molodyozhnaya were regularly received on frequency 9280 KHz on 1st, 11th and 21st of each month on weather facsimile chart recorder at 0850 GMT. During the voyage the first ice berg was noticed when ship was in position 53º 53 S 32° 03 E on December 23 1983 at 0150 GMT. On December 26 1983 the ship encount ered large sea ice zone. The ship was secured to fast ice on December 27 1983 and finally secured for the first time along ice shelf on January 21 1984 in position 69° 57 S 11° 53 E.

VISIT TO NOVOLAZAREVSKAYA

Most of the members of the team visited the Russian and the nearby East German station at Novolazarevskaya (70° 46 S 11° 51 E). These are permanent stations situated in Schirmacher Oasis about 15 km southeast of Indian field camp and are built on rocky terrain which is completely free of ice or snow in Antarctic summer. There are beautiful fresh water lakes around the station.

Russian station has a modem meteorological observatory for taking surface observations and upper air soundings. These observations are passed on to Molodyozhnaya on Antarctic data net work. It has however no forecasting office of its own. The weather forecasts are received from Molodyozh¬ naya. In addition to these observations the following are also recorded at the Russian station.

1. Total incoming solar radiation

2. Total outgoing radiation

3. Insolation which is reflected back

East German Camp is about 500 metres away from the Russian station. It is completely a wooden structure on a slightly raised platform. There is no meteorological observatory at this station. There is, however, a weather satellite receiving ground equipment. The unit is capable of receiving APT pictures from both *METEOR* and *NOAA* series of polar orbiting weather satellites. The pictures are compiled and sent to Leningrad Institute of Antarctic Research.

SALVAGE OF METEOROLOGICAL EQUIPMENT

Meteorological instruments left behind by the second expedition in old base camp were retrieved. A precision aneroid barometer, DR wind vane and anemometer and Belford wind vane-cum-anemometer were a few important items. They were handed over to the meteorologist in the wintering team. The empty hydrogen cylinders were also salvaged.

RECOMMENDATIONS

In order to have better involvement in the study of Antarctic weather, the following recommendations are made.

1. It is beneficial to have meteorological data reception facility at the permanent station, so that synoptic weather data over Antarctica may be regularly received, plotted and analysed to understand the weather over the region. To achieve this, an RATT receiver with frequency convertor and teleprinter is required.

2. An Automatic Picture Transmission (APT) ground receiving equipment may also be provided to monitor cloud imageries from weather satellites.

3. The existing meteorological facility at the permanent station may be strengthened by providing additional equipment for upper wind study.

4. The team at the permanent station should consist of an experienced weather forecaster and a specialist in meteorological instruments.

CONCLUSION

The team has successfully achieved the aim laid down for the expedition by establishing a permanent full-fledged surface and upper air observatory in Antarctica. Valuable observational data have been collected during the voyage, at the field camp and at the permanent station. The weather data of these observations, and of those taken continuously over one year at the permanent station by wintering team are being analysed. The various meteorological research problems are being investigated and the findings would be published.

TABLE 3

Surface observations taken from ship

Latitude	Longitude	Date	Time of observations (GMT)	Wind		Visibility (km)	Temperature		Pressure (mb)	Cloud amount (Octas)		
				Direction (Degrees)	Speed (knots)		DB CC)	WB		Low	Medium	High
1	2	3	4	5	6	7	8	9	10	11	12	13
		1983										
58°54'S	25°33'E	Dec 24	00	330	12	8	1 5	1 0	973 1	4St	8As	
59°26'S	24°28'E	"	03	280	22	5	0 0		972 8	Sky	obscured	
59°57'S	23°27'E	"	06	280	20	5	0 0		973 8	"	"	
60°57'S	21°11'E	"	12	260	16	8	4 0	2 5	975 8		8As	
61°51'S	19°07'E	"	18	230	11	1	1 5	1 0	975 8	Sky	obscured	
62°39'S	17°15'E	Dec 25	00	130	23	8	1 5	1 0	975 2		8As	
63°12'S	16°04'E	"	03	100	23	10	2 5	1 5	976 3	2Sc	8As	
63°42'S	14°53'E	"	06	100	23	10	2 0	1 5	977 8	2Sc	8 As	
64°51'S	12°52'E	"	12	140	20	10	2 8	1 0	979 8	4Sc, Cu	6As	
66°14'S	12°33'E	"	18	185	14	10	—0 5	—2 0	980 3	4Sc, Cu	8As	
67°29'S	12°02'E	Dec 26	00	220	20	10	—0 5	—2 0	978 8	7Sc		
68°02'S	11°55'E	"	03	230	20	10	—1 5	—3 5	978 0	4Sc		
68°33'S	11°48'E	"	06	170	10	10	—2 5	—3 5	977 8			2Ci
69°03'S	11°38'E	"	12	120	10	10	+3 0	+2 0	982 0	1Sc		1Ci
69°54'S	12°39'E	"	18	130	15	10	—1 5	—2 5	936 0	1Sc		1Ci
69°58'S	12°49'E	Dec 27	00	130	08	10	0 0	—3 5	988 1			
69°57'S	"	"	03	120	08	10	—2 0	—4 5	987 8			1Ci
69°58'S	12°48'E	"	06	calm	00	10	—5 0	—7 0	986 0	1Sc		
"	"	"	12	VRB	05	10	0 0	—1 2	982 9	1Sc		
"	"	"	18	VRB	05	10	+0 5	—0 5	983 0	1Sc		

Ci = Cirrus, Cs = Cirrostratus, Cc = Cirrocumulus, As = Altostratus, Ac = Altocumulus,
Cu = Cumulus, Sc = Stratocumulus, St = Stratus, Tr = Trace, VRB = Variable

1	2	3	4	5	6	7	8	9	10	11	12	13
69°57 S	12°48 E	Dec 28	00	250	09	15	—4 5	—6 0	981 8	1Sc		
			03	260	08	15	—4 0	—6 0	980 0	1Sc		
			06	260	10	25	—3 0	—5 5	980 8	1Sc		
			12	240	15	25	+ 1 5	+ 0 3	980 7			1C
			18	230	12	25	0 0	—1 0	981 0			1Ci
69°58		Dec 29	00	180	10	28	—4 6	—5 4	980 6			1Ci
			03	calm	00	25	—6 5	—7 5	980 8			1C
			06	calm	00	25	—3 5	—4 5	981 0			1Ci
			12	090	05	25	+ 2 0	+ 0 5	981 0			
			18	VRB	05	25	—0 5	—2 0	981 2			
	12°49 E	Dec 30	00	VRB	05	25	—4 5	—5 7	977 8			
			03	VRB	05	25	—5 0	—6 0	975 8	1Sc cu		
			06	VRB	05	25	—3 5		975 5	1Sc cu		
			12	calm	00	25	+ 4 0		973 8			
			18	calm	00	25	0 0	—2 0	970 8		1Ac	
		Dec 31	00	135	08	25	—5 0	—6 0	970 3			4Ci
			03	120	15	25	—4 0		971 0			3Ci
			06	120	22	25	—1 0	—2 5	971 0			5Ci
			12	090	36	10	—1 6	—1 5	973 2	5Sc		4Ci
			18	100	16	10	—3 0	—4 0	977 6	5Sc	3Ac	
		1984										
69°58 S	12 49 E	Jan 1	00	140	10	25	—4 0	—5 0	981 6	2St Sc	7As	
			03	140	08	25	—4 0	—5 5	982 8	2Sc		1Ci
69°55 S	12 48 E		06	155	22	25	—2 0	—3 0	983 3	1Sc		1C
69°57 S	12°47 E		12	120	12	25	—1 0	—2 0	987 8			1Ci
69°54 S	12°48 E		18	140	10	25	—0 5	—1 5	988 0			1C
69 50 S	12 57 E	Jan 2	00	100	14	15	—6 0	—6 5	988 5			1Ci
			03	115	13	15	—5 5	—6 0	988 5			1C
69°46 S	12°49 E		06	115	12	25	—4 0	—4 5	988 5			1Ci
69°59 S	12°47 E		12	VRB	02	25	—1 0	—2 0	988 5			1Ci
69°57 S	12°45 E		18	VRB	02	25	+ 1 0	—0 5	988 5			1Ci

1	2	3	4	5	6	7	8	9	10	11	12	13
69°53'S	12°51'E	Jan.3	00	210	09	25	—3.0	—4.5	984 6	Sc Tr	..	..
69°50'S	12°52'E	"	03	205	05	25	—1.5	—3 0	983.8	.	..	..
69°55'S	12°54'E	"	06	210	05	25	—4.0	—5.0	981.8	..	..	..
69°56'S	12°48'E	"	12	VRB	02	25	+ 0.5	—1.8	980 7	..	..	.
69°53'S	12°49'E	"	18	calm	00	25	—0.5	—2.0	982.8	1Sc	.	..
69°52'S	12°53'E	Jan.4	00	115	08	25	—4.5	—5.5	983.7	.	1Ac	1Ci
69°48'S	13°12'E	"	03	130	10	25	—5.0	—6.0	984.7	..	1Ac	1Ci
70°00'S	12°52'E	"	06	100	12	25	—2.5	—3.5	986.0	..	..	1Ci
69°59'S	12°49'E	"	12	calm	00	25	—1.5	—3 2	987.5	.	..	..
"	12°44'E	"	18	calm	00	25	—0.5	—2.5	987.8	..	..	1Ci
69°56'S	12°47'E	Jan.5	00	calm	00	25	—2.0	—2.5	988.1	.	1Ac	.
69°55'S	12°47'E	"	03	130	10	25	—3.0	—4.0	987.0	.	..	..
70°01'S	12°50'E	"	06	115	14	25	—2.5	—5.0	986.0	1Sc	..	..
70°02'S	12°43'E	"	12	095	15	10	—4.0	5.0	984.2	7Sc, St	..	.
69°50'S	12°21'E	"	18	070	10	8	—3.5	—4.0	981.5	8Sc, St	.	..
69°53'S	12°58'E	Jan.6	00	070	14	10	—5.0	—5.5	979.6	7Sc, St	6As	..
69°55'S	12°49'E	"	03	070	17	10	—6.0	—6.5	978.8	6Sc, St	6As	..
69°51'S	12°54'E	"	06	090	20	10	—5.5	—6.0	978.6	6St	6As	..
70°01'S	12°45'E	"	12	110	32	10	—2.5	—3.0	979.8	5St, Sc	..	..
69°46'S	12°57'E	"	18	095	32	10	—1.0	—1.5	981.0	4St, St	5As	..
69°49'S	12°56'E	Jan.7	00	100	34	1	—3.0	—3.5	982.8	..	..	6Ci
69°54'S	12°49'E	"	03	090	28	8	—3.0	—4.0	983.6	2Sc	8As	..
70°01'S	12°44'E	"	06	095	33	0 5	—3.0	—4.0	985.3	3St	8As	..
69°49'S	12°58'E	"	12	130	38	1	—2.5		983.8	3Sc	6Ac, As	..
70°04'S	12°40'E	"	18	115	26	15	0 0	—1.0	983 3	2Sc	2Ac	5Ci
69°40'S	13°12'E	Jan.8	00	100	20	15	—4.5	—5.5	980 1	.	2Ac	3Ci
69°56'S	12°47'E	"	03	120	20	15	—3.5	—4.0	979.2	..	5Ac	4Ci
69°54'S	12°41'E	"	06	090	26	15	—3.0	—4.0	976.8	2Sc	4Ac	3Ci
70°02'S	12°34'E	"	12	110	18	15	+ 0.6	—1 0	975.5	1Sc	4Ac	3Ci
69°57'S	12°41'E	"	18	100	16	15	—0.5	—2.0	972.9	3Sc	2Ac	3Ci
69°53'S	12°44'E	Jan.9	00	120	20	15	—4.3	—6.0	972.6	2Sc	3Ac	2Ci

1	2	3	4	5	6	7	8	9	10	11	12	13
69°51'S	12°51'E	Jan.9	03	120	20	15	—3.0	—4.5	973.8	2Sc	--	3Ci
69°55'S	12°44'E	"	06	100	30	15	—2.0	—3.5	975.3	"	3Ac	"
70°03'S	12°41'E	"	12	080	22	8	—0.8		979.0	2Sc	3Ac	3Ci
70°01'S	12°41'E	"	18	115	20	15	—1.0	—1.0	982.6	2Sc	6As	"
69°48'S	13°00'E	Jan.10	00	130	08	10	—1.5	—3.0	986.6	3Sc	6As	"
69°49'S	13°03'E	"	03	VRB	03	10	—3.0	—5.0	987.8	3St, Sc	6As	"
69°58'S	12°50'E	"	06	110	10	5	0.0	—0.5	988.5	5St, Sc	6As	"
70°03'S	12°36'E	"	12	090	20	3	+ 2.0	—0.5	990.0	"	8As	"
"	12°37'E	"	18	090	14	5	+ 1.0	0.0	990.3	2Sc	6As	"
69°58'S	13°02'E	Jan.11	00	110	08	10	—1.8	—2.5	989.4	2Sc	5As	"
70°00'S	12°47'E	"	03	VRB	05	10	—2.0	—3.5	988.8	3St, Sc	4Ac	"
70°00'S	12°40'E	"	06	VRB	03	10	—0.5	—1.0	987.8	3Sc	5Ac	"
70°01'S	12°36'E	"	12	Calm	00	10	—0.5	—1.0	987.8	4Sc	5Ac	"
70°00'S	12°35'E	"	18	Calm	00	10	+ 0.5	—0.5	986.6	3Sc	5Ac	"
69°51'S	12°44'E	Jan.12	00	Calm	00	10	0.0	—1.0	986.8	2Sc	2Ac	"
69°52'S	12°47'S	"	03	Calm	00	4	+ 2.0	0.0	987.8	2Sc	"	"
69°50'S	12°45'E	"	06	Calm	00	0.5	—1.0	—1.5	987.8	3Sc	1Ac	"
70°01'S	12°40'E	"	12	VRB	05	15	+ 2.0	0.0	992.0	2Sc	"	"
70°02'S	12°48'E	"	18	250	08	15	—0.8	—1.2	996.2	3Sc	"	3Ci
69°51'S	12°43'E	Jan.13	00	250	15	15	—1.0	—2.0	999.0	"	1Ac	2Ci
69°53'S	12°51'E	"	03	240	15	15	—2.0	—3.0	998.8	1Sc	"	2Ci
69°57'S	12°50'E	"	06	130	10	15	—2.2	—3.1	998.4	1Sc	"	1Ci
70°03'S	12°32'E	"	12	150	12	15	+ 3.0	+ 1.0	996.5	"	"	1Ci
"	12°33'E	"	18	140	26	15	+ 4.0	+ 0.5	991.5	"	"	1Ci
69°47'S	12°45'E	Jan.14	00	100	16	15	—1.0	—2.0	989.6	"	"	1Ci
69°53'S	12°35'E	"	03	100	24	15	—1.0	—1.5	988.8	"	"	2Ci
69°46'S	12°40'E	"	06	100	26	15	—1.0	—3.0	988.0	"	"	1Ci
70°02'S	12°39'E	"	12	100	24	15	+ 3.0	+ 1.0	987.6	"	"	"
70°03'S	12°36'E	"	18	120	20	"	+ 3.0	+ 1.0	984.6	"	"	"
69°37'S	12°51'E	Jan.15	00	120	16	15	—0.5	—1.5	991.8	"	"	"
"	12°49'E	"	03	130	15	15	—1.0	—2.0	980.8	"	"	"

1	2	3	4	5	6	7	8	9	10	11	12	13
69°53 S	12°31 E		06	100	16	15	+ 0 5	—0 5	980 6			
70°03 S	12°30 E		12	075	18	15	+ 1 0	—1 5	979 9			1Ci
70°04 S	12°30 E		18	090	14	15	+ 0 5	—1 0	980 8	1Sc		1Ci
69°42 S	12°43 E	Jan 16	00	080	14	8	—2 0	—3 0	984 4		7As	
69°40 S	12°55 E		03	070	16	10	—3 0	—3 5	984 8	1Sc	6As	
69°40 S	12°28 E		06	060	12	10	—2 5		985 0	2Sc	6As	
70°01 S	12°41 E		12	100	08	10	0 0	—2 0	985 8	3Sc	6As	
70°04 S	12°36 E		18	100	06	10	+ 2 0		987 6	5Sc	2Ac	
69°40 S	12°50 E	Jan 17	00	170	17	10	0 0	—2 0	990 5		3Ac	2Ci
69°37 S	12°42 E		03	050	20	10	—2 0	—3 5	991 8	2Sc		5Ci
69°45 S	12°43 E		06	085	22	10	—0 5	—2 0	991 8		3Ac	5Ci
69°33 S	11°53 E		12	090	30	10	+ 1 0		993 0	5Sc St		4Ci
69°56 S	11°40 E		18	085	32	8	—0 5		992 0	1Sc	8As	
69°52 S	12°54 E	Jan 18	00	100	37	4	—2 0	—3 0	997 0	2St	8As	
69°57 S	12°36 E		03	080	40	8	—3 0	—3 5	998 8	2St Sc	8As	
69°58 S	12°30 E		06	100	36	2	—3 0	—3 5	1000 7	1Sc	8As	
69°59 S	12°49 E		12	085	38	6	—2 0		1004 7	4Sc St	8As	
69°52 S	12°34 E		18	080	36	10	—2 0		1006 3	1Sc	5As	3Cs
69°51 S	12°56 E	Jan 19	00	085	32	10	—4 0	—5 0	1008 0	2Sc	4As	4Cs
69°57 S	12°48 E		03	090	34	10	—4 0	—5 0	1008 8	1Sc	5As	3Cs
69°58 S	12°31 E		06	080	36	15	—2 0	—2 5	1000 3		3Ac	5Cs
70°01 S	12°33 E		12	140	15	10	+ 2 0	+ 0 5	1008 6	1Sc	3Ac	7Cs
69°57 S	11°53 E		18			15	+ 2 0	+ 0 5	1005 0	1Sc	2Ac	6Cs
69°58 S	12°09 E	Jan 20	00	100	16	15	—1 0	—3 0	1000 6		4Ac	3Ci
69°55 S	12°57 E		03	110	16	15	+ 1 0	—1 0	999 8		5Ac	1Ci
69°51 E	12°11 E		06	120	12	15	+ 2 5	+ 0 5	998 0		5Ac	2Ci
69°56 E	11°56 E		12	100	10	15	+ 4 0	—2 5	997 0		1Ac	3Ci
69°58 E	11°56 E		18	140	20	15	—1 5	0 0	995 6		1Ac	1Ci
69°56 E	12°32 E	Jan 21	00	130	30	15	—3 5	—4 0	996 8		1Ac	1Ci
69°49 E	12°36 E		03	110	32	15	—3 0	—4 0	999 6	6Sc		1Ci
69°44 E	12°29 E		06	080	30	15	—3 0	—4 5	1000 8	4Sc	3As	

1	2	3	4	5	6	7	8	9	10	11	12	13
69°57 E	11°53 E	Jan 21	12	080	23	15	—1 5	—2 0	1002 4	5St Sc	5As	
69 57 E	11 53 E		18	070	11	15	—2 0	—3 0	1002 8	4Sc	5As	
		Jan 22	00	100	15	15	—4 0	—6 0	1002 0	3St Sc	5As	
			03	110	10	15	—3 0	—4 5	1000 8	3Sc		5Cs
			06	110	10	15	—2 0	—4 0	1000 0		1Ac	1Ci
			12	080	12	15	+ 2 0	+ 0 5	998 6	1Sc	1Ac	1Ci
			18	075	18	15	—2 0	—3 5	996 3	1Sc	4Ac	
		Jan 23	00	085	13	15	—4 0	—6 0	995 0		5Ac	2C
			03	075	12	10	—4 0	—5 5	993 8	2Sc	3Ac	2Ci
			06	VRB	03	10	—2 2	—3 5	991 8	7St Sc		
			12	Calm	00	15	+ 3 0	+ 0 5	989 3			7Cs
			18	250	05	15	+ 0 5	—1 0	985 3			5Ci
		Jan 24	00	VRB	05	15	—4 0	—5 5	984 8			4Ci
			03	100	18	15	—3 0	—5 0	984 8			4Ci
			06	100	18	15	—1 0	—3 0	986 3	1Sc		3Ci
			12	070	13	15	+ 0 8	—0 8	987 3	6Sc		1Ci
			18	VRB	03	15	0 0	—1 0	985 0	1Sc		1Ci
		Jan 25	00	VRB	03	15	—5 0	—6 0	983 8			3Ci
			03	Calm	00	15	—4 0	—6 0	982 8	1Sc		2Ci
			06	VRB	03	15	—4 0	—5 5	984 0			2Ci
			12	090	16	15	+ 3 0	+ 1 0	987 0	1Sc		2Ci
			18	035	18	8	—0 5	—2 0	989 2	7Sc St	5As	
69 54 S	12°07 E	Jan 26	00	090	18	8	—3 0	—4 0	991 0	5Sc	6As	
69°53 S	12°50 E		03	130	15	2	—2 5	—3 5	989 7	5St	8As	
69°57 S	12°30 E		06	170	10	8	—2 2	—3 5	989 3	3Sc	7As	
69°55 S	11°49 E		12	Calm	00	8	+ 1 5	—0 5	989 5	3Sc	1Ac	
69°57 E	11°53 E		18	Calm	00	10	+ 1 0	—1 0	988 5	2Sc		1Ci
69°56 S	12°50 E	Jan 27	00	VRB	04	10	—1 5	—3 5	989 3	6St Sc	5As	
			03	100	07	10	—3 0	—4 5	989 7	6St Sc	6As	
69°51 S	12°38 E		06	060	06	10	—2 5	—3 5	991 5	7Sc St	6As	
69°57 S	11°53 E		12	080	07	10	—1 0	—2 0	992 0	5Sc	5As	

1	2	3	4	5	6	7	8	9	10	11	12	13
69°57'S	11°53'E	Jan.27	18	Calm	00	10	—2.5	—4.0	991.0	4Sc	3Ac	.
"	"	Jan.28	00	190	04	15	—5.0	—6.0	993.2	4Sc	--	..
"	"	"	03	130	06	15	—4.5	—5.5	994.1	1Sc	2Ac	--
"	"	"	06	050	16	15	—2.0	—3.0	995.0	1Sc	..	--
"	"	"	12	065	12	15	—1.5	—2.5	997.0	2Sc	1As	1Ci
69°56'S	12°09'E	"	18	100	12	15	—3.0	—4.5	997.6	2Sc	--	1Ci
69°57'S	12°50'E	Jan.29	00	130	06	15	—5.0	—6.0	999.4	1Sc	1Ac	--
69°53'S	"	"	03	100	09	15	—6.0	—7.0	998.6	1Sc	-.	1Ci
69°56'S	11°53'E	"	06	100	14	15	—4.0	—5.5	998.8	1Sc	..	..
69°57'S	"	"	12	080	20	15	—1.0	—3.2	997.8	1Sc	..	..
"	"	"	18	060	12	15	—4.0	—4.5	996.4	7Sc	..	..
"	"	Jan.30	00	120	05	4	—5.5	—6.0	995.8	7St	..	..
"	"	"	03	100	06	8	—6.0	—6.5	994.8	7St, Sc	5As	..
"	"	"	06	150	10	10	—2.5	—4.0	995.0	5St, Sc	5As	..
"	"	"	12	200	03	10	—0.5	—2.0	994.0	6St, Sc	6As	..
"	"	"	18	210	06	10	—2.5	—3.0	994.8	6St, Sc	..	..
"	"	Jan.31	00	VRB	04	15	—6.0	—6.5	996.5	..	1Ac	..
"	"	"	03	VRB	05	15	—6.0	—7.0	996.8	1Sc	1Ac	-.
"	"	"	06	110	05	15	—5.8	—7.0	998.7	3Sc	..	1Ci
"	"	"	12	140	05	15	—2.0	—2.8	1002.0	1Sc	..	2Ci
"	"	"	18	200	03	15	—0.5	—1.5	1001.3	..	.	2Ci
"	"	Feb.1	00	100	12	10	—4 0	—5.0	1003.0	..	2Ac	..
"	"	"	03	110	10	10	—6.0	—7.0	1002.8	1Sc	--	2Ci
"	"	"	06	090	10	10	—4.0	—5.8	1002.8	2St	..	2Ci
"	"	"	12	070	15	10	—1.5	—2.6	1002.6	1St	--	1Ci
"	"	"	18	070	05	10	—1.5	—3.0	1001.0	7Sc, St	..	..
"	"	Feb.2	00	Calm	00	10	—4.0	—5.0	999.4	2St	5As	..
"	"	"	03	190	06	3	—6.0	—7.0	997.8	6St	3As	..
"	"	"	06	150	05	8	—5.5	—6.0	997.3	7St, Sc	3As	..
"	"	"	12	Calm	00	15	—2.0	—2.8	996.2	8St, Sc	4As	..
"	"	"	18	VRB	03	15	—3.0	—4.0	994.1	3St, Sc	..	..

1	2	3	4	5	6	7	8	9	10	11	12	13
69°57 S	11°53 E	Feb 3	00	200	08	10	—8 0		994 8	2Sc	3Ac	
			03	160	08	10	—9 6		995 8	1Sc	3Ac	
			06	060	16	10	—4 5	—5 0	997 2	3Sc	4Ac	
			12	100	12	10	—1 2	—2 6	997 2	8St Sc		
			18	085	18	10	—1 5	—3 2	995 0	7St Sc	1Ac	
		Feb 4	00	090	12	10	—4 8		995 3	7St Sc		
			03	090	16	10	—4 0		995 8	7St Sc		
			06	085	16	10	—3 8	—4 5	994 8	7St Sc		2Ci
			12	090	16	10	—1 0	—1 8	993 9	8St Sc		
			18	VRB	02	10	0 0	—1 5	991 7	2Sc	4Ac As	2Ci
		Feb 5	00	150	12	10	—5 8		990 0	1Sc	3Ac	3Ci
			03	100	16	10	—6 0		990 8	3Sc		5Ci
			06	140	10	10	—5 5		991 8	2Sc		5Ci
			12	100	10	10	+ 0 2	—1 5	992 4	3Sc St		4Ci
			18	100	03	10	—3 2	—3 2	994 2	6St Sc	2Ac	1Ci
		Feb 6	00	100	05	10	—4 0		997 4	8St Sc	6As	
			03	090	14	10	—4 0		998 8	6St Sc	4As	
			06	130	10	10	—2 5	—4 5	1001 0	6Sc St	3Ac	
			12	085	10	10	—1 0		1003 2	7Sc St	3As	2Ci
			18	085	12	10	—2 0		1004 0	5Sc St	2Ac	2Ci
69°56 S	12°13 E	Feb 7	00	090	26	10	—3 8		1000 5	8Sc St	2Ac	1Ci
69 53 S	12 47 E		03	100	18	10	—3 5		1000 0	5Sc St		5Ci
69°58 S	12°49 E		06	100	22	10	—1 8		999 5	2Sc		3Ci
69°57 S	12 38 E		12	120	16	10	—2 0		995 3	2Sc	6Ac	2Ci
69 54 S	12 23 E		18	160	12	10	—1 5	—2 5	991 0	2Sc	3As	5Cs
69 46 S	12 50 E	Feb 8	00	160	16	10	—2 0		987 8		6As	5Cs
69°47 S	12°32 E		03	110	26	10	—3 0		984 8	2Sc	6As	
69°56 S	12 08 E		06	100	16	10	—1 0		984 6		8As	6Cs
69 57 S	11°54 E		12	100	23	10	—0 5		981 6		6As	3Cs
69 57 S	11°54 E		18	080	22	10	—1 2		980 0		6As	2Cs
70°01 S	12°34 E	Feb 9	00	110	20	10	—4 5		977 0	1St	7As	

1	2	3	4	5	6	7	8	9	10	11	12	13
69°53 S	12°50 E	Feb 9	03	100	24	3	—2 0		976 8		Sky obscured	
69°57 S	12°35 E		06	100	33	1	—2 0		976 0		-do-	
69°53 S	12°12 E		12	105	44	3	—0 5		972 8		-do-	
70°01 S	12°46 E		18	095	45	3	—1 0		972 8		-do-	
69°52 S	12°15 E	Feb 10	00	085	42	3	—1 0		973 0		-do-	
69°55 S	12°30 E		03	090	36		—2 0		972 8		-do-	
69°54 S	11°44 E		06	100	40		—1 0		973 3		-do-	
69°55 S	11°58 E		12	085	44		—1 0		975 8	6St	8As	
69°59 S	12°22 E		18	090	40	1	—1 0	—1 5	977 3		Sky obscured	
69°53 S	11°59 E	Feb 11	00	090	33	1 5	—3 0		979 2		do	
69°59 S	12°37 E		03	090	28	5	—3 0		980 8	3Sc	5As	
69°58 S	11°25 E		06	080	28	8	—1 8		980 8	6St Sc	7As	
69°56 S	12°27 E		12	090	36	2	—2 5		980 8	5St	6As	
69-57 S	11°48 E		18	085	26	10	—3 0		980 8	6Sc	6As	3Cs
	11°53 E	Feb 12	00	075	20	10	—2 5		980 8	5St	6Ac As	
			03	090	18	10	—5 0		980 8	3Sc	6As	
			06	100	16	10	—3 2		980 8	4Sc	4As Ac	
			12	095	17	10	—2 5		980 8	3Sc	4As	
			18	085	13	10	—2 0		980 8	1St	8Ac As	
69°57 S	11°53 E	Feb 13	00	085	12	10	—3 0		980 8	4Sc	5As	
			03	100	16	10	—4 0		980 8	2Sc	4As	6Cs
			06	075	18	10	—3 8		981 2	3Sc		
			12	085	16	10	—2 5		982 6	2Sc	7Ac	6Cs
			18	090	24	10	—2 2		981 8	1Sc	4Ac	
69°54 S	11°57 E	Feb 14	00	090	26	10	—3 0		981 4	5St Sc		2Cs
69°58 S	12°25 E		03	090	26	10	—5 0		981 8	3Sc		2Cs
69°56 S	11°43 E		06	120	25	10	—3 0		981 0	4Sc		2Cs
69°57 S	12°43 E		12	110	30	10	—2 5		980 0	3Sc		
69°58 S	12°00 E		18	070	16		—2 5		979 2	4Sc		
69°57 S	11°53 E	Feb 15	00	150	15	10	—8 0		976 9	1Sc		
			03	140	20	10	—9 0		975 8	1Sc		

1	2	3	4	5	6	7	8	9	10	11	12	13
69°57 S	11°53 E	Feb 15	06	150	18	10	—3 5		975 8	1Sc		
			12	200	18	10	—3 5		974 8	2Sc		
			18	255	26	10	—3 5		972 8	1Sc		
69°51 S	12°45 E	Feb 16	00	250	24	10	—4 2		973 0	1Sc		
69°57 S	12°02 E		03	270	24	10	—6 0		972 8	2Sc		
69°56 S	11°34 E		06	240	12	10	—7 5		974 0	4Sc Cu		
69°57 S	11°53 E		12	VRB	03	10	—3 0		978 9	2Cu		
			18	210	16	10	—3 5		981 6	2Sc Cu	3Ac	
69°54 S	12°44 E	Feb 17	00	200	16	10	—7 0		981 6	2Cu	2Ac	
69°59 S	11°47 E		03	210	14	10	—8 0		982 8	2Sc	2Ac	
69°56 S	11°45 E		06	190	10	10	—6 8		982 8	3Sc	3Ac	
69°57 S	11°53 E		12	110	05	10	—4 5		984 0	2St	7Ac As	
			18	110	05	10	—4 2		982 8	2Sc		4Cs
		Feb 18	00	110	04	10	—9 5		982 0	1Sc		5Cs
			03	150	16	10	—11 0		980 8		2Ac	3Cs
			06	095	05	10	—6 0		979 3	2Sc	3Ac	4Cs
			12	075	24	4	—4 5		978 6	8St Sc	2Ac	
			18	095	28	0 2	—6 5		976 8	Sky Obscured		
		Feb 19	00	100	30	0 1	—8 0		976 8		-do-	
			03	100	32	0 2	—8 0		976 8		-do-	
			06	085	30	0 5	—7 5		978 3	2Sc	7As	1Cs
69°59 S	12°16 E		12	100	28	6	—5 5		979 3	5Sc	6As	
69°55 S	12°01 E		18	085	22	10	—6 2		979 3	8Sc	5As	2Cs
69°54 S	12°15 E	Feb 20	00	090	28	10	—7 0		979 8	8Sc	6As	2Cs
			03	090	28	10	—7 0		979 8	2Sc	7As	1Cs
69°46 S	12°18 E		06	100	20	10	—6 0		979 3	3St Sc	5As	2Cs
69°57 S	12°13 E		12	095	31	8	—6 0		978 6	7Sc St	7As	
	12°11 E		18	110	30	8	—5 0		976 6	5Sc	7As	
69°55 S	11°49 E	Feb 21	00	100	22	10	—6 5		976 8	8St Sc	3Ac	
69°53 S	11°53 E		03	090	16	10	—7 0		975 8	2Sc	5Ac	
69°54 S	11°29 E		06	100	20	10	—6 5		973 8	4Sc	5Ac	

1	2	3	4	5	6	7	8	9	10	11	12	13
69°59 S	11°46 E	Feb 21	12	110	22	8	— 5 0		972 8	6St Sc	6As	2Cs
69°51 S	12°02 E		18	085	25	10	— 5 0		971 3	6St Sc	4As	
69°54 S	11°52E	Feb 22	00	095	35	4	— 6 0		972 4	8St Sc		
69 55 S	11 45 E		03	090	36	6	— 7 0		972 8	4St Sc	5As	
69 57 S	12°46 E		06	090	35	6	— 7 0		972 8	3Sc	7As	
69°55 S	11°50 E		12	100	30	3	— 5 0		973 8	3Sc	8As	
69°56 S	12°14 E		18	100	30	15	— 7 0		975 8	3Sc		
69 53 S	11 39 E	Feb 23	00	090	38	3	— 8 0		975 5	8Sc St		
69°58 S	12°28 E		03	100	42	2	— 8 0		973 8	Sky obscured		
69 55 S	12 09 E		06	090	34	4	— 8 0		977 8		do	
69°57 S	12°26 E		12	087	28	6	— 7 0		981 8	3Sc	3As	2Cs
69 57 S	12°08 E		18	100	41	8	— 8 5		983 6	2Sc	6As	
69 50 S	12°06 E	Feb 24	00	087	40	15	— 8 0		987 5	1Sc	3Ac	
69 58 S	12°42 E		03	090	39	15	—10 0		988 0		2Ac	
69°49 S	11°32 E		06	090	28	15	— 8 0		989 6	2Sc	2Ac	
69°57 S	11 53 E		12	100	22	15	— 9 0		991 3		4As	6Cs
			18	150	22	15	—10 0		991 4	2Sc	2Ac	1Ci
		Feb 25	00	155	12	15	—15 0		991 1	1Sc		
			03	150	18	15	—18 0		990 8			2Ci
			06	150	16	15	—12 5		989 3	1Sc		
			12	180	10	15	— 7 0		988 3			
			18	210	08	15	—10 0		985 2			
		Feb 26	00	087	16	15	—12 0		984 0			
			03	095	28	15	—13 0		982 8			
			06	095	42	15	—14 0		979 3			4Ci
	12°06 E		12	090	45	6	— 7 0		974 0		4Ac	6Cs
69°58 S	12 28 E		18	100	60	0 5	—10 0		968 8		Sky obscured	
70°00 S	12°46 E	Feb 27	00	080	62	0 5	— 7 5		968 7		do-	
69°46 S	13 10 E		03	100	66	0 1	—11 0		966 8		do	
69°52 S	12°57 E		06	100	56	0 3	—10 0		969 0		do	
69°46 S	13 02 E		12	095	50	0 3	— 7 0		972 0		do	

1	2	3	4	5	6	7	8	9	10	11	12	13
69°45 S	13°03 E	Feb 27	18	085	45	0 3	—8 0		972 8		Sky obscured	
69°57 S	12°41 E	Feb 28	00	095	48	0 2	—5 5		974 3		-do-	
69°51 S	12°54 E		03	100	40	0 5	—6 0		975 8		-do-	
69°47 S	13°05 E		06	110	40	1 0	—5 5		976 3		-do-	
69°60 S	12°42 E		12	090	40	6	—4 0		978 4	2St Sc	3Ac	4Cs
70°00 S	11°50 E		18	085	25	15	—4 5		976 8	2Sc	4Ac	4Cs
69°57 S	11°53 E	Feb 29	00	150	12	15	—9 0		973 0	2Sc		1Ci
			03	200	20	15	—7 0		969 8	1Sc		
69°52 S	12°23 E		06	100	13	15	—9 5		967 6	1Sc		
69°56 S	12°52 E		12	080	10	15	—9 1		965 8	1Sc		
69°41 S	12°35 E		18	075	08	15	—6 0		965 3			
69°37 S	13°24 E	March 1	00	VRB	03	15	—8 5		966 0	1Sc		
69°36 S	13°25 E		03	110	10	15	—10 0		965 8			
69°37 S	13°34 E		06	160	13	15	—7 0		968 3	1Sc		2Cs
70°08 S	11°56 E		12	110	08	15	—4 6		972 0	2Sc		
69°40 S	13°14 E		18	VRB	03	15	—5 2		976 1	2Sc		
69°19 S	13°27 E	March 2	00	050	08	15	—3 8		980 7	2Sc		
69°04 S	13°25 E		03	340	09	15	—2 0		982 8	2Sc		6Cs
69°49 S	13°37 E		06	320	12	15	—1 5		985 6	1Sc	5As	8Cs
68°26 S	14°59 E		12	280	08	15	—0 5		989 8	3Sc	6Ac	8As
68°30 S	15°32 E		18	300	10	15	—0 5		991 6	4Sc	4Ac	6Cs
68°31 S	17°15 E	March 3	00	280	08	15	—1 0		991 0	4Sc	3Ac	5Cs
68°31 S	18°15 E		03	260	06	15	—2 0		990 8	3Sc		6Cs
	19°21 E		06	290	07	15	—1 0		983 6	5Sc		7Cs
68°29 S	20°03 E		12	210	10	15	—0 8		987 2	5Sc	8As	
68°20 S	20°00 E		18	220	07	15	—1 0		986 0	6Sc Cu	8As	
68°00 S	16°57 E	March 4	00	200	12	10	—1 0		984 1	5Sc	8As	
	16°00 E		03	150	06	10	—2 5		983 0	4Sc	8As	
	15°16 E		06	150	12	15	—5 5		983 0	6Sc	8As	
67°50 S	13°56 E		12	145	08	15	—5 8		981 1	5Sc	6Ac	
67°31 S	15°28 E		18	130	18	15	—7 0		982 6	3Sc	4Ac	

1	2	3	4	5	6	7	8	9	10	11	12	13
67 30 S	17 55 E	March 5	00	080	05	15	—5 5		982 5	6Sc		
67°30 S	18°53 E		03	080	16	10	—7 0		983 8		8As	
67°30 S	20 00 E		06	105	24	10	—8 0		986 3	6Sc	8As	
67°18 S	20 58 E		12	120	25	10	—5 7		989 0	5Sc	7As	
66 25 S	23°11 E		18	150	23	10	—6 0		990 3	3Sc	7As	5Cs
65°29 S	25 26 E	March 6	00	130	22	4	—3 5		991 0	5Sc	6As	
65°02 S	26 41 E		03	100	24	2	—3 5		990 0	4Sc	6Ac As	
64°42 S	27 30 E		06	110	25	3	0 0		991 0	4Sc	6As	
64°16 S	28 30 E		12	120	20	10	—0 5		994 4	6Sc St	6As	
63°22 S	30 33 E		18	VRB	03	10	+ 2 0		997 6	3Sc	5Ac	
63°24 S	32 48 E	March 7	00	220	12	6	0 0		1001 6	3Sc	5As	
61 56 S	33°39 E		03	210	10	10	+ 0 5		1002 8	4Sc	5Ac	
61°32 S	34 27 E		06	240	08	15	+ 3 0		1004 8	3Sc	5Ac	
61°31 S	34 39 E		12	250	13	15	+ 2 8		1007 3	5Sc		
60°53 S	36°00 E		18	300	15	15	+ 2 0		1009 0	4Sc		

Ci = Cirrus Cs = Cirrostratus Cc = Cirrocumulus As = Altostratus Ac = Altocumulus
Cu = Cumulus Sc = Stratocumulus St = Stratus Tr = Trace VRB = Variable

TABLE 4

Surface observations taken at Schumacher Oasis Field Camp (70°41 S 11°4E)

Date	Time (GMT)	Wind (Degrees)	Wind Speed (knots)	Visibility (km)	Temperature DB (°C)	Temperature WB (°C)	Pressure (mb)	Cloud amount (octas) Medium	Cloud amount (octas) High
1	2	3	4	5	6	7	8	9	10	11
1984									2Ac	1Ci
Jan 16	12	100	05	10	6 5	3 0	978 5		1Ac	1Ci
	15	110	03	10	4 0	1 5	979 0	2Sc	2As	2Ci
	18	100	10	10	1 5	—1 0	979 5	4Sc	1Ac	3Ci
	21	110	12	10	—1 0	—1 5	981 0	4Sc		
Jan 17	00	120	16	10	—2 0	—3 0	983 0	4Sc	1Ac	3Ci
	06	110	09	10	1 0	—0 5	985 0	4Sc	2Ac	2Ci
	09	090	15	10	4 0	1 0	985 5		2Ac	2Ci
	21	110	15	10	1 5	—0 5	988 0		3Ac	1Ci
Jan 18	00	100	16	10	1 5	0 0	988 5	2Sc	2Ac	3Ci
	06	100	20	10	1 0	—0 5	991 5	4Sc		2Ci
	09	110	20	10	3 5	—0 5	994 0	6Sc	2Ac	2Ci
	12	115	16	8	3 0	—0 5	995 5	3St 5Sc	3Ac	
	15	115	20	8	4 0	0 5	997 0	3St 6Sc	2Ac	
	18	110	20	8	4 0	0 0	998 0	5Sc	3Ac	3Ci
	21	110	20	8	3 0	—0 5	999 0	5Sc	3Ac	3Ci
Jan 19		110	20	8	1 0	—1 5	999 5	4Sc	4Ac	2Ci
		110	25	8	2 0	—0 5	999 5	2Sc	4Ac	2Ci
	09	115	08	10	6 0	2 0	999 5	2Sc	4Ac	4Ci
	12	080	11	10	7 5	1 5	998 5	1St	4Ac	
	15	120	13	10	7 0	1 0	997 0		2As 2Ac	5Ci
	18	120	06	10	6 0	0 5	994 3		6As	2Ci
	21	080	03	10	4 5	—0 5	993 0		7As	2Ci
Jan 20	00	120	02	10	4 5	0 0	992 5		5As	2Ci
	06	120	12	10	6 5	1 0	989 0		4As	
	09	060	04	10	6 5	2 0	988 2		3As 1Ac	

1	2	3	4	5	6	7	8	9	10	11
Jan.20	12	110	08	10	6.5	1.5	988.1	..	3As	1Ci
	15	110	10	10	5.5	1.5	988.0	..	2Ac	1Ci
	18	060	10	10	4.5	1.0	988.5	3Sc	..	..
	21	110	08	10	2.5	—1.5	989.5	3Sc	..	1Ci
Jan.21	00	130	12	10	2.0	—1.5	989.9	..	4As	2Ci
	06	090	15	10	3.0	—1.5	992.0	..	3As	1Ci
	09	090	15	10	3.5	—1.5	992.8	..	2As	3Ci
	18	110	05	10	2.0	—1.0	991.0	..	3As	2Ci
	21	110	05	10	1.0	—2.0	991.0	..	..	4Ci
Jan.22	00	120	07	10	—0.5	—3.5	991.5	..	..	3Ci
	06	120	17	10	2.0	—2.0	990.5	..	..	1Ci
	09	160	17	10	2.5	—0.5	990.0	..	..	1Ci
	12	070	12	10	4.0	0.0	989.0	..	1Ac	1Ci
	15	070	11	10	2.5	—0.5	980.4	1Sc	..	1Ci
	18	060	11	10	1.5	—1.0	989.1	..	1Ac	2Ci
	21	Calm	00	10	—1.0	—3.0	987.0	..	1Ac	5Ci
Jan.23	00	090	03	10	—0.5	—3.0		..	..	3Ci
	06	030	05	10	1.0	—2.0		..	1Ac	5Ci
	09	320	03	10	3.0	0.0		..	..	5Ci
	12	050	06	10	6.0	2.0		..	..	5Ci
	15	100	11	10	6.5	1.5		..	..	3Ci
	18	130	13	10	6.5	1.5		..	..	2Ci
	21	130	07	10	3.5	—0.7			..	4Ci
Jan.24	00	160	12	10	1.7	—2.5		..	..	2Ci
	03	170	16	10	1.0	—3.0		..	..	1Ci
	06	130	15	10	3.5	—0.2		..	..	1Ci
	09	120	18	10	4.5	—0.5		..	..	2Ci
	12	085	12	10	6.5	1.5		1Sc	..	1Ci
	15	030	04	10	3.8	0.0		..	..	1Ci
	18	Calm	00	10	5.0	0.5		..	..	1Ci
	21	070	07	10	2.0	—0.5		..	..	1Ci

1	2	3	4	5	6	7	8	9	10	11
Jan 25	00	190	10	10	1 5	—2 5	976 3			1Ci
	06	130	15	10	4 0	1 0	977 0			1Ci
	09	125	12	10	6 0	1 5	979 4			3Ci
	12	070	10	10	6 5	3 0	980 2			3Ci
	15	090	12	10	6 0	3 0	981 8	2Sc		2Ci
	18	090	13	10	3 5	2 0	983 0	3Sc		1Ci
	21	100	07	10	3 0	1 0	983 2	3Sc		1Ci
Jan 26	00	120	06	10	1 5	—1 2	982 4	2Sc	1Ac	
	03	Calm	00	10	—0 5	—2 5				1Ci
	06	350	05	10	3 0	1 8	981 3			1Ci
	09	VRB	03	10	5 8	3 0	981 3			1Ci
	12	095	15	10	7 0	2 5	982 0			
	15	070	08	10	6 5	2 0	981 4			
	18	075	06	10	3 5	1 0	981 0			2Ci
	21	Calm	00	10	1 0	—1 0	981 0			
Jan 27	00	080	10	10	—0 5	—1 5	980 0			
	03	110	12	10	—0 9	—2 5	983 0			1Ci
	06	110	14	10	4 5	0 5	983 5			
	09	085	10	10	5 3	1 5	984 0	1Sc		
	12	070	12	10	5 8	2 8	984 0	1Sc		3Cl
	15	050	08	10	5 8	2 0	983 5	1Sc		2Ci
	18	060	06	10	2 5	—0 5	983 0	1Sc		
	21	060	05	10		—1 0	983 0	1Sc		2Ci
Jan 28	00	090	08	10	0 0	—2 0	984 0			2Ci
	03	120	12	10	0 5	—3 0	985 2	1Sc		
	06	130	15	10	2 8	—1 4	987 1	1Sc		1Ci
	09	120	17	10	4 3	—0 6	988 2			1Ci
	12	075		10	5 8	1 2	988 8	1Sc		1Cl
	15	100	07	10	4 0	0 0	988 6			2Cl
	18	080	15	10	2 2	—0 8	989 0			1Ci
	21	080	03	10	0 8	—2 0	989 2			1Ci
Jan 29	00	100	14	10	0 0	—0 5	989 0			2Ci

1	2	3	4	5	6	7	8	9	10	11
Jan.29	03	140	16	10	—0.5	—3.5	989.2	1Sc	..	1Ci
	06	130	17	10	1.5	—2.0	989.2	..	..	1Ci
	09	140	16	10	3.5	—0.5	989.0	..	..	1Ci
	12	150	12	10	5.0	1.0	989.0	2Sc	3Ac	..
	15	080	15	10	4.5	0.5	989.0	2Sc	4Ac	..
	18	130	13	10	2.0	—0.5	989.0	No cloud data		..
	21	110	05	10	0.0	—1.5	986.9	..	..	..
Jan.30	00	130	05	5	—3.0	—5.0	985.5	..	..	..
	03	Calm	00	6	—3.0	—4.0	981.1	..	..	..
	06	Calm	00	10	—2.0	—2.5	985.0	..	..	..
	09	Calm	00	10	—0.7	—1.0	985.5	..	..	..
	12	Calm	00	10	..	..	985.0	..	..	..
	15	Calm	00	10	3.7	0.5	984.8	..	..	..
	18	080	05	8	0.7	—1.4	985.2	..	..	..
	21	Calm	00	8	—2.5	..	986.0	..	..	..
Jan.31	06	110	15	10	1.0	—1.0	989.0	..	..	..
	09	110	10	10	3.5	—1.0	990.0	..	..	..
	12	110	03	10	4.0	0.0	986.0	..	..	..
	15	110	04	10	4.0	1.0	986.0	..	..	..
	18	110	05	10	3.0	0.0	985.0	..	..	..
	21	130	04	10	1.0	—1.0	985.0	..	..	..
Feb.1	00	145	05	5	0.0	—2.0	992.0	..	..	..
	09	140	15	10	3.5	1.0	992.6	..	..	..
	12	060	08	5	3.0	0.8	992.5	..	..	..
	15	080	10	10	3.5	1.0	992.5	..	..	..
	18	Calm	00	10	1.5	—0.5	991.0	..	..	..
	21	080	05	10	0.5	—1.5	990.0	..	..	..
Feb.2	00	040	05	10	—2.0	—4.5	990.2	..	..	..
	03	080	05	10	—3.0	—5.0	990.0	..	..	..
	06	040	10	10	—1.0	—2.5	992.0	..	..	..
	09	140	04	10	1.0	0.0	986.0	..	..	..
	12	140	04	10	1.0	0.0	982.0	..	..	..

1	2	3	4	5	6	7	8	9	10	11
Feb.2	15	120	04	10	—1.0	—2.0	982.0	..	..	..
	18	020	03	10	—1.0	—2.0	985.5	..	..	..
	21	080	03	10	—3.5	—4.0	985.0	..	..	..
Feb.3	00	110	07	10	—4.0	—7.0	982.0	..	..	..
	03	120	02	10	—5.0	—9.0	985.0	..	..	..
	06	290	03	3	—2.0	—3.5	987.0	..	..	..
	12	120	02	5	1.2	—1.0	988.5	..	..	..
	15	070	12	3	1.5	—1.0	988.0		..	..
	18	280	02	5	0.5	—1.5	983.0	..	..	..
	21	130	02	6	—2.0	—3.0	987.0	..	..	..
Feb.4	00	120	05	6	—3.0	—4.0	986.0	..	..	..
	06	110	04	10	1.5	—1.0	988.0	..	..	..
	09	110	02	10	0.0	—1.0	986.0	..	..	..
	12	080	05	10	2.5	0.0	988.0	..	..	..
	15	100	04	10	1.0	0.0	984.0	..	..	-
	18	130	03	10	1.0	—1.0	984.0	..	..	..
	21	110	03	10	0.0	—2.0	982.0	..	..	..
Feb.5	00	260	02	5	1.5	—1.0	983.0	..	..	..

TABLE 5

Upper air temperature and height in geopotential metres at standard Isobaric levels at Dakshin Gangotri during January and February 1984

Date	Time of observation	Isobaric levels (mb) 850 m	850 °C	700 m	700 °C	500 m	500 °C	400 m	400 °C	300 m	300 °C
25-1-84	16	1196	-12.1	2664	-18.9	5105	-32.9	6644	-43.1	8506	-56.1
26-1-84	15	1206	- 7.1	2678	-15.7	5163	-30.3	6723	-40.7	8633	-53.1
31-1-84	14	.	. .	2652	-20.5	5052	-33.9	6557	-45.1	8407	-56.7
4-2-84	18	1219	- 8.1	2704	-18.3	5136	-34.9	6665	-45.5	8570	-49.5
6-2-84	13	1293	-11.7	2759	-20.5	5159	-37.3	6680	-45.1	8574	-46.1
8-2-84	13	1138	-11.7	2602	-18.9	5057	-30.3	6619	-38.9	8529	-52.7
12-2-84	17	1129	-10.5	2602	-17.9	5032	-30.1	6592	-39.9	8514	-50.3
13-2-84	12	1121	-11.1	2592	-19.9	5027	-32.7	6571	-40.7	8489	-52.5

TABLE 5 *(Continued)*

Date	(Isobaric levels (mb) 200 m	200 °C	150 m	150 °C	125 m	125 °C	100 m	100 °C	80 m	80 °C
25-1-84	11086	-48 1								
26-1-84	11299	-44 3	13219	-44 1						
31-1-84	11042	-45 1								
4-2-84	11269	-44 3	13186	-44 1	14406	-43 9	15896	-42 3	16416	-40 7
6-2-84										
8-2-84	11179	-44 3	13092	-44 5						
12-2-84	11209	-42 9	13130	-41 9						
13-2-84	11154	-43 1	13100	-41 5	14335	-41 5				