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Glaciological Studies During 24th Indian Antarctic Expedition

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ABSTRACT

Dakshin Gangotri Glacier was identified in Schirmacher Range in 1983 by the Second Indian Scientific Expedition to Antarctica. Since then, its snout is being monitored every year. It was observed that the snout is persistently receding at an average rate of 65 to 70 cm per annum. With the quantification of data, now it is possible to decipher the behavior of the glacier at each point separately. Most of the points showed a marked recession. The overall average annual recession within these years attained 71 cm per annum. The western polar ice margins showed greater recession than the actual snout. Snow accumulation/ablation observations showed that there is marked ablation of snow at some locations. The iceberg monitoring during the onward journey to Antarctica exhibits variety of icebergs having different shapes and sizes.

Keywords: DG Glacier, Recession, Schirmacher Oasis, Accumulation, Ablation.

INTRODUCTION

Dakshin Gangotri (DG) Glacier, a prominent ice tongue forms a part of the continental ice sheet that occupies a small valley in the western part of Schirmacher Oasis, East Antarctica **(Fig. 1)**. This glacier was first identified and named in 1983. Since then this snout was monitored regularly with reference to fixed observation point(s). It was observed from the very beginning that the snout is persistently receding (Asthana et al., 1996 and Chaturvedi et al., 1999a & b, Chaturvedi et al., 2003, Chaurvedi et al., 2005, Krishnamurthy et al., 1999, Singh and Jayaram, 1989). The glacier snout has been monitored regularly by GSI teams during successive Indian Antarctic Expeditions. The measurement of snow accumulation/ablation on the ice shelf near Dakshin Gangotri Station, Central Dronning Maud Land, East Antarctica was started in February 1994 during the thirteenth

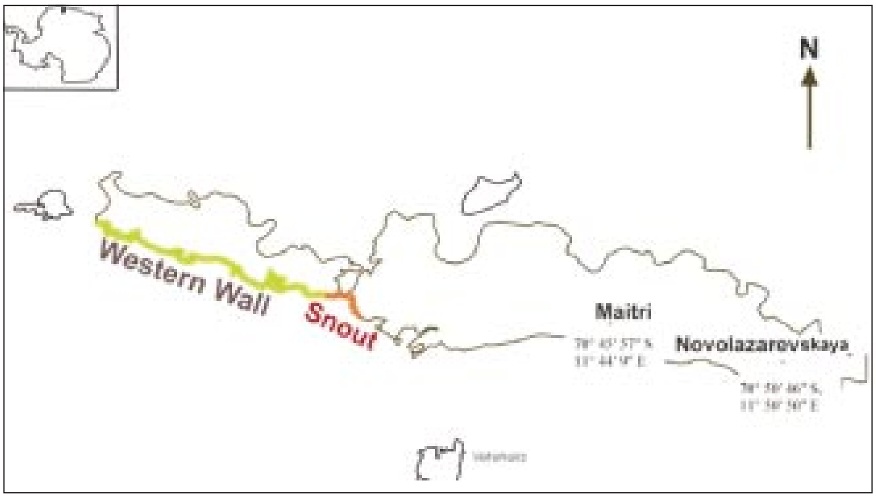

Fig. 1: Location map of Dakshin Gangotri glacier and Western wall in Schirmacher Oasis, East Antarctica

Antarctica expedition as part of an ongoing programme of GSI. The studies were initiated in 1983 during the second expedition (Kaul *et al.,* 1985) but, regular monitoring for the behavior of the snow surface in terms of level variation due to accumulation/ablation studies started only during the fifth expedition (Singh et al., 1988). The present site with a network of 16 stakes, is located about 1 km ESE of Dakshin Gangotri station on the ice shelf. It is 20 km away from the coastline in Indian Bay region of Lazarev Iceshelf area. An attempt of small drilling in Polar Ice (south of Maitri) has also been carried out successfully to test the drilling machine for future scientific work. This work has resulted in 3m long ice core with almost 100% recovery. The location of drill site is at 70^{0}51'55.7" and longitude 11^{0}30'44.6" having has an elevation of 659 m above MSL.

OBSERVATION AND DISCUSSIONS

The monitoring the snout points of Dakshin Gangotri (DG) glacier snout show is being carried out since last several years. The trend of annual retreat of Dakshin Gangotri snout, from 1996 to 2005, shows marked recession **(Fig. 2)**. At Points-2, 7, 13, 14 and 15, maximum average annual recession of 1.24 m, 1.05 m, 1.02 m, 1.62 m and 1.46 m has been recorded, respectively. These points also show large net-recession of 11.15 m, 9.45 m, 9.15 m, 14.60 m and 13.14 m, respectively. Such a magnitude of glacial recession may be an indicator of the effect of global warming, widely postulated these days. As compared with the previous year, average annual

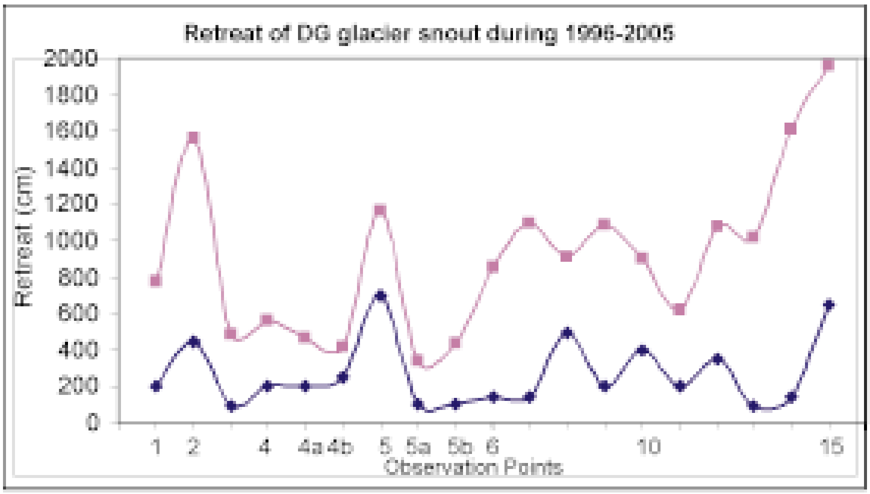

Fig. 2: Recession of Dakshin Gangotri snout between 1996 and 2005

Fig. 3: Deformed layers in Dakshin Gangotri glacier snout

recession of DG snout was 87cm with cumulative average recession 6.42m since 1996 **(Table 1)**. The western wall has shown an average annual retreat of 98cm between 2001 and 2005 **(Table 2)**.The cross section wall of the western wall and snout show deformed layers **(Fig. 3)** which may have been formed by vertical load and/or topography. The movement of continental glaciers around Schirmacher Oasis has also been studied in collaboration with Indian Institute of Geomagnetism, using a GPS.

Table 1—Annual recession of the snout of Dakshin Gangotri glacier

Obs. Points	Latitude	Longitude	1996-97	2003-04	2004-05	Avg retreat (in cm)	Net Retreat (in cm)
1	70º45.566'	11º34.614'	66	89	301	64.556	581
2	70º45.548'	11º34.626'	43	175	171	123.89	1115
3	70º45.534'	11º34.64'	28	50	66	42.889	386
4	70º45.526'	11º34.653'	-20	67	30	40.333	363
5	70º45.513'	11º34.67'	19	18	20	29.444	265
5a	70º45.514'	11º34.674'	20	-10	-18	18.333	165
5b	70º45.505'	11º34.681'	16	319	-10	51.667	465
6	70º45.51'	11º34.628'	39	-1	27	25	225
6a	70º45.504'	11º34.695'	32	29	2	36.556	329
6b	70º45.49'	11º34.113'	-14	191	158	78.333	705
7	70º45.48'	11º34.712'	22	130	151	105	945
8	70º45.469'	11º34.687'	9	-71	115	46.111	415
9	70º45.429'	11º34.646'	149	-51	91	99.111	892
10	70º45.427'	11º34.573'	10	13	60	56.111	505
11	70º45.434'	11º34.507'	9	84	-5	47.222	425
12	70º45.422'	11º34.445'	151	94	91	81	729
13	70º45.428'	11º34.374'	84	-13	229	101.67	915
14	70º45.412'	11º34.356'	72	258	20	162.22	1460
15	70º45.406'	11º34.289'	191	132	154	146	1314

Table 2—Annual recession of Western wall of Dakshin Gangotri glacier

	Latitude	Longitude	2001	2004	Recession	2005	Recession
XX1			0.94			104.75 (?)	
XX2	70º 44.603'	11º 26.390'	1.06			46.15 (?)	
XX3	70º 44.621'	11º 26.529'	0.95	72.50 (?)			
XX4	70º 44.729'	11º 27.660'	0.78	18.65 (?)		21.65 (?)	
XX5	70º 44.797'	11º 28.147'	1.53				
XX6	70º 44.874'	11º 28.562'	2.67	15.0 (?)			
XX7	70º 44.932'	11º 28.905'	2.53	6.80	1.56		
XX8	70º 45.225'	11º 31.120'	2.50	8.28	1.76		
XX9	70º 45.268'	11º 31.401'	1.72	3.00			
XX10	70º 45.300'	11º 31.614'	3.30	17.63 (?)		17 (?)	-0.63
XX11	70º 45.417'	11º 33.135'	1.84	5.92	0.65	7.10	1.18
XX12	70º 45.428'	11º 33.289'	1.08			2.80	
XX13	70º 45.407'	11º 33.478'	1.58	3.10	0.14	4.70	1.60
XX14	70º 45.403'	11º 33.619'	1.02	3.80	1.14	5.65	1.85
XX15	70º 45.424'	11º 33.733'	4.06	4.80	0.38	4.37	-0.43
XX16	70º 45.436'	11º 34.022'	0.53	0.01	0.01	1.55	1.54
XX17	70º 45.631'	11º 34.739'	0.94			20.05 (?)	
XX18			2.87				

Observation of snow accumulation/ablation in ice shelf in India Bay region indicates very less amount of accumulation as compared to the previous year. Along with this, some locations have also shown ablation **(Table 3)**. The average annual accumulation or ablation has been plotted in the form of contour map **(Fig. 4)**. Accumulation is shown by +ve values and ablation by –ve values. Locations 9 and 14 showed ablation, while other locations showed little accumulation of snow. The high variability in

Table 3—Snow accumulation / ablation on ice shelf in India Bay region

Stake	Latitude deg.min.sec	Longitude deg.min.sec	29-Jan 2003 in cm.	12-Mar 2004 in cm.	Net Accumu-lation in cm	6-Feb 2005 in cm.	Net accumu-lation in m.
1	70 04 34.6	12 01 27	302	235	67	227	8
2	70 04 34.9	12 01 49.5	304	264	40	243	21
3	70 04 35.1	12 02 09	291	235	56	227	8
4	70 04 30.2	12 02 10.3	340	264	76	241	23
5	70 04 24.8	12 02 11.8	306	251	55	237	14
6	70 04 24.1	12 01 51.3	296	271	25	269	2
7	70 04 23.6	12 01 32.4	306	257	49	226	31
8	70 04 28.7	12 01 29.1	293	258	35	223	37
9	70 04 29.5	12 01 48.8	287	243	44	247	-4
10	70 04 18.9	12 01 34.5	306	259	47	225	34
11	70 04 18	12 01 52.1	309	258	51	239	19
12	70 04 17.1	12 02 13.7	317			240	
13	70 04 16.1	12 02 30.1	297	228	69	219	9
14	70 04 25.5	12 02 30.9	310	256	54	258	-2
15	70 04 30.2	12 02 31.1	310	247	63	244	3
16	70 04 35.4	12 02 31.6	303	252	51	244	8

snow mass balance is mainly due to ablation processes driven by katabatic winds (wind-driven sublimation). A few strong wind events can greatly decrease the mass through snowdrift sublimation, especially during summer. The drift snow playing an important role in altering the surface profile of the shelf ice as reported earlier (Mukerji et al., 1995). It is evident from the study that the rate of snow deposition is controlled strongly by the temporal variations in that region (Beg et al., 1997). Iceberg monitoring was carried out during the onward journey. The first iceberg was noticed at 49°11.7’ S latitude and 24°12.2’ E longitude. Between location 49°11.7’ S & 24°12.2’ E and 57°31.57’ S & 20°35.85’ E, a total of 177 icebergs were noticed **(Fig.3)**.

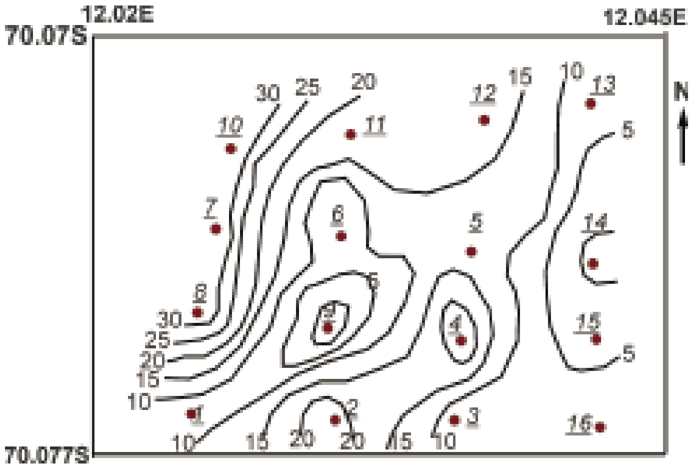

Fig. 4: Accumulation/Ablation of snow recorded in 2005 on ice shelf in India Bay region

Out of these icebergs, 31.51% were smaller than 50 m length, 31.07% were between 50 and 100 m length, 31.63% were between 100 and 500 m length and 6.78% were larger than 500 m length. After this, pack ice and many other smaller icebergs were noticed before entering into the Polynya water. Here ice floes and tabular icebergs were present.

CONCLUSIONS

During the period of nine years between 1996 and 2005, the cumulative average recession of the snout was 6.42m, while average annual recession recorded was 87 cm. The rate of average annual recession was highly fluctuating. Different points of the snout varied greatly in magnitude of recession. The western wall has receded more than the actual snout. On the ice shelf the average annual accumulation of snow was much low as compared to the previous year. Some points in the stake network, have also recorded ablation of snow.

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