

A Note on Snow Accumulation /Ablation on Ice Shelf and Secular Movement of Dakshin Gangotri Glacier Snout in Central Dronning Maud Land, East Antarctica

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Abstract

Snow accumulation and ablation studies are being carried out in Antarctica since 1982. The accumulation studies being done through monitoring of a stake net work positioned on the ice shelf near the Dakshin Gangotri station site has shown a **net** accumulation of 62.7 cm during 1999-2001 period. Besides this, polar ice sheet protruding into the Schirmacher Oasis and named as Dakshin Gangotri glacier is being monitored continuously since 1982. This polar ice sheet and land interface is considered sensitive to the ongoing global climate change. This glacier tongue is retreating continuously.

Introduction

Glaciological observations in Antarctica have attained importance and relevance in understanding the ongoing global climatic changes. The snow accumulation/ablation pattern on the ice shelf and the changes occurring at the land-polar ice sheet interface are considered sensitive to the ongoing climatic changes. The long term program for monitoring the snow accumulation pattern on the Ice shelf near Dakshin Gangotri station is proving to be fruitful in understanding the accumulation pattern. The second program of monitoring the changes occurring at the polar ice sheet-land interface is visibly dwindling and is reflecting the ongoing climate change.

Snow Accumulation/Ablation on Ice Shelf

Measurement of snow accumulation/ablation on ice shelf is an integral part of glaciological studies being carried out by GSI. The

observations were recorded using the network of stakes fixed on 24th February, 1999 during XVIII Antarctic Expedition. The present site 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. A total of 16 wooden stakes spaced at 50 m interval are fixed in a rectangular pattern and the stake network covers an area of 2250 sq. m.

During the 20th Indian Antarctic Expedition, observations i.e. the exposed height of the stakes were recorded on 27th February, 2001 (Table 1). Earlier studies have indicated a strong temporal (Seasonal) bias in accumulation / ablation with higher accumulation and precipitation of snow during polar summer (2.2 gm / sq cm / month) and lesser (0.89 gm / Sq cm / month) during winter. The average annual accumulation of snow was 18.71 gm / sq cm during March 1990-94 (Beg et al., 1997). A net yearly accumulation of 66.5 cm of snow was recorded during March 96 to March 97 amounting to a net rise of 2.2 cm in the shelf surface (Chaturvedi et al., 1999).

Table 1: Measurements recorded at each stake in the network during 20th IAE

Stake No.	24-Feb-99 Original	27-Feb-01 (20th expedition)	Accumulation (in cm)	Average annual accumulation (in cm)
1	269	149	120	60
2	251	127	124	62
3	268	146	122	61
4	264	132	132	66
5	263	139	124	62
6	249	111	138	69
7	267	133	134	67
8	248	108	140	70
9	254	133	121	60.5
10	242	128	114	57
11	250	121	129	64.5
12	253	140	113	56.5
13	251	132	119	59.5
14	250	124	126	63
15	256	133	123	61.5
16	248	121	127	63.5

On the basis of observations recorded during February 1999 and February 2001, the average annual accumulation is 62.7 cm for this period.

Secular Movement of Dakshin Gangotri Glacier Snout

The prominent feature of the icy continent is the 12 million sq km ice sheet. It is difficult to calculate the precise status of the mass balance of the Antarctic ice sheet because of its vastness, which restricts adequate number of observations. However, significant trends in the climate changes and their future implications can be made using local balance input. The polar ice sheet has a number of glacier tongues over-riding bedrock in Schirmacher Oasis. During the II Antarctic Expedition (1982-83), one such tongue was identified and was termed Dakshin Gangotri Glacier (Kaul et al., 1985). Since then the Geological Survey of India is monitoring the changes in the Dakshin Gangotri Glacier snout ($70^{\circ} 45' 20''$ S Latitude; $10^{\circ} 35' 05''$ E Longitude), over-riding Schirmacher Oasis from south. It is located 6 km west of the Indian Station Maitri. Morphologically the tongue has a lobate outline. (Fig. 1) The top surface of the glacier has a number of shallow channels, which become active during peak summer months only. This melt water feeds a small pro-glacial lake in front of the snout.



Fig. 1: An aerial view of DG glacier protruding tongue in Schirmacher Oasis, CDML, East Antarctica.

The glacier tongue has shown continuous recession since 1983 with maximum recession along the northern flank. The movement of the glacier varies in magnitude and direction with time. An overall recession of 7 m

has been observed (Ravindra et al., 1994) in the polar front during the decade 1983-1993. Correspondingly there is an increase of 550 sq m in the area of the pro-glacial lake (Asthana et al, 1996).

During the polar winter, the glacier advances northward due to accelerated flow regime. Due to the differential movement of the bottom and top layers, transverse cracks develop on the surface followed by calving / gravitational collapse of the ice blocks resulting in net retreat of the glacier front. During the summer months the recession is further enhanced due to melting.

During the 20th Expedition, the observations were recorded from 19 reference points that have been marked close to the periphery of the snout. A minimum retreat of 0.8 m to a maximum retreat of 7.84 m (w.r.t. February, 1996) at various reference points is observed (Table 2). The average retreat observed is 3.13 m.

Table 2: Measurement along the DG glacier protruding tongue recorded during 20th Indian Antarctic Expedition

Point No.	Latitude	Longitude	Feb-1996 (original position)	Feb-2001 (in 20 th expedition)	Retreat (in meter)
1	70 45.566	11 34.614	2.00	3.6	1.56
2	70 45.548	11 34.626	4.50	11.10	6.60
3	70 45.534	11 34.640	1.00	2.69	1.69
4	70 45.526	11 34.653	2.00	4.10	2.01
4-A	70 45.513	11 34.670	2.00	3.46	1.46
4-B	70 45.54	11 34.674	2.50	3.74	1.24
5	70 45.505	11 34.681	7.00	8.32	1.32
5-A	70 45.510	11 34.628	1.10	1.99	0.89
5-B	70 45.504	11 34.695	1.10	3.04	1.94
6	70 45.490	11 34.113	1.50	2.92	1.42
7	70 45.480	11 34.712	1.50	5.15	3.65
8	70 45.469	11 34.687	5.00	6.98	1.98
9	70 45.429	11 34.646	2.00	7.25	5.25
10	70 45.427	11 34.573	4.00	6.61	2.61
11	70 45.43	11 34.507	2.00	5.20	3.20
12	70 45.422	11 34.445	3.50	7.33	3.83
13	70 45.428	11 34.374	1.00	5.83	4.83
14	70 45.412	11 34.356	1.50	9.34	7.84

The observation zone along the margin of the ice cap has been extended by 9 line km. Starting from the westernmost point of Schirmacher

Range, 18 new markers have been fixed along the ice cap margin and the initial observation on the periphery has been recorded.

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