

TREND OF DEPOSITIONAL PATTERNS ON ICE SHELF NEAR DAKSHIN GANGOTRI STATION

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Abstract

Snow accumulation/ablation on the ice shelf is being monitored through a network of stakes near Dakshin Gangotri Station, since 1986. This study is aimed at finding the changes at the surface of the shelf ice. During the 15th expedition, it was found that all the old stakes were uprooted, possibly due to blizzards. Because of this, the continuity of the observation was broken and it was necessary to set up a new set of stakes for monitoring of ice shelf. A systematic network of 25 stakes has been installed in Feb 96 and ten sets of observations were taken by the wintering team of GSI, to study pre-winter and post-winter patterns of deposition.

Introduction

In the 5th expedition, Kaul *et al.* (1986) had fixed a network of 9 stakes on ice-shelf, about a km away from Dakshin Gangotri station. This network was upgraded during subsequent expeditions, as and when required, and a continuity of observations was maintained on the ice shelf, studying the various patterns of accumulation and ablation. In the summer of the 15th expedition, the GSI team found that each and every one of the old stakes was uprooted. This could be either due to human interference, or due an extraordinarily severe blizzard. Whatever the reason may be, it has broken the continuity of scientific observations on the shelf during the summer of 1996. During February 96, GSI team has fixed up a new set of 25 stakes, each separated by a distance of 50 m. Thus, a representative area of 200 m x 200 m has been marked out on the shelf. The pattern of stakes' fixation is given in **Fig.1**

Observations

The ten sets of observations between Feb 96 and Feb 97 are shown in **Table-1**. During these months, some of the stakes were broken and rendered useless by strong blizzards. The actual deductions of accumulation or ablation

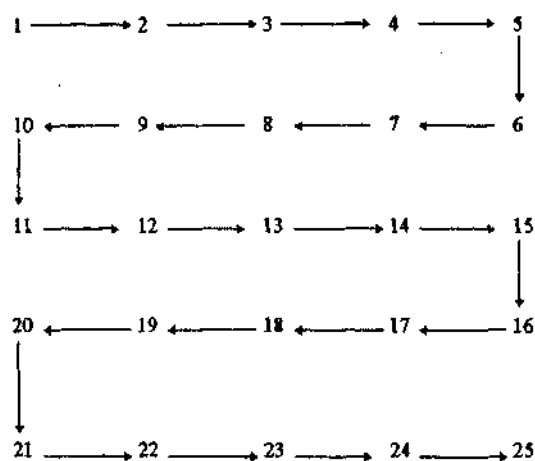


Fig 1: The pattern of stakes-fixation for the new set of 25 stakes.

are displayed in **Table-2**. From these observations, three dimensional representations have been drawn to find out the trends of deposition.

From **Table-2**, it is observed that the second set of readings within the same months, i.e. in March, April and October 96 are very close to the first readings for these months. Thus for the purposes of trends-deduction, these can be equated with the first set of values for those months. Further, the observations can be grouped into two blocks, the first containing 3 pre-winter months, i.e. March, April and May 96; while the second block contains two post-winter months, September-October 96, and one month of the next polar summer, i.e. February 97. Based on these groups, three dimensional representations have been drawn. Fig.2 shows the accumulation patterns for March-April-May 96. Fig.3 contains similar patterns for September-October 96 and February 97. A comparison of the values for the entire year, Feb 96 to Feb 97, is done in Fig.4 by plotting the patterns of March 96 - September 96 - February 97.

Discussion

From **Fig.2**, it is seen that the month of March in 1996 showed a slight ablation compared to the original surface of Feb 96. The overall average ablation is -1.6 cm. The month of April 96, conforms to this trend and shows a further depletion of the surface. The average ablation in April depresses the surface by -3.2 cm. By May 96, however, the deposition by blizzards has started and the result is a net gain for the surface of the shelf. The average rise in the surface is 6.4 cm.

Table I: Measurements of stakes in cm between Feb 96 and Feb 97

STK No.	Feb-96	7-Mar-96	28-Mar-96	9-Apr-96	24-Apr-96	1-May-96	7-Sep-96	2-Oct-96	6-Oct-96	18-Feb-97
1	249	249	250	251	236	236	182	161	165	168
2	242	245	245	246	233	231	181	163	168	176
3	258	260	262	262	261	259	208	205	207	217
4	237	239	240	240	-	-	-	-	-	-
5	252	255	255	256	243	245	203	189	186	182
6	235	237	239	238	231	230	193	174	177	181
7	246	247	248	251	236	234	193	186	191	187
8	236	236	236	240	235	230	174	163	167	168
9	240	241	241	244	-	-	-	-	-	-
10	238	240	238	242	236	238	198	169	174	176
11	240	241	240	243	-	-	-	-	-	-
12	241	241	242	240	236	237	192	179	182	167
13	236	238	237	229	226	226	193	156	161	167
14	239	242	243	246	222	223	184	171	173	164
15	266	267	270	270	262	262	-	-	-	-
16	245	247	249	249	244	242	188	185	187	179
17	222	223	223	225	216	217	161	149	151	141
18	235	235	237	238	-	-	-	-	-	-
19	248	250	251	251	241	242	-	-	-	-
20	242	246	245	246	245	243	205	181	178	182
21	217	218	220	221	214	215	176	168	162	156
22	242	243	244	246	234	235	-	-	-	-
23	235	238	237	238	216	217	180	163	175	155
24	233	233	235	237	220	220	182	162	167	167
25	245	248	248	249	247	250	196	170	174	182

- (stake uprooted/broken by blizzards, subsequently)

Table 2: The actual values, in cm, computed from Table-1 for accumulation/ablation at stake-points

STK No.	7-Mar-96	28-Mar-96	9-Apr-96	24-Apr-96	1-May-96	7-Sep-96	2-Oct-96	6-Oct-96	18-Feb-97
1	0	-1	-2	13	13	67	88	84	81
2	-3	-3	-4	9	11	61	79	74	66
3	-2	-4	-4	-3	-1	50	53	51	41
4	-2	-3	-3	-	-	-	-	-	-
5	-3	-3	-4	9	7	49	63	66	70
6	-2	-4	-3	4	5	42	61	58	54
7	-1	-2	-5	10	12	53	60	55	59
8	0	0	-4	1	6	62	73	69	68
9	-1	-1	-4	-	-	-	-	-	-
10	-2	0	-4	2	0	40	69	64	62
11	-1	0	-3	-	-	-	-	-	-
12	0	-1	1	5	4	49	62	59	74
13	-2	-1	7	10	10	43	80	75	69
14	-3	-4	-7	17	16	55	68	66	75
15	-1	-4	-4	4	4	-	-	-	-
16	-2	-4	-4	1	3	57	60	58	66
17	-1	-1	-3	6	5	61	73	71	81
18	0	-2	-3	-	-	-	-	-	-
19	-2	-3	-3	7	6	-	-	-	-
20	-4	-3	-4	-3	-1	37	61	64	60
21	-1	-3	-4	3	2	41	49	55	61
22	-1	-2	-4	8	7	-	-	-	-
23	-3	-2	-3	19	18	55	72	60	80
24	0	-2	-4	13	13	51	71	66	66
25	-3	-3	-4	-2	-5	49	75	71	63

- (stake uprooted/broken by blizzards, subsequently)

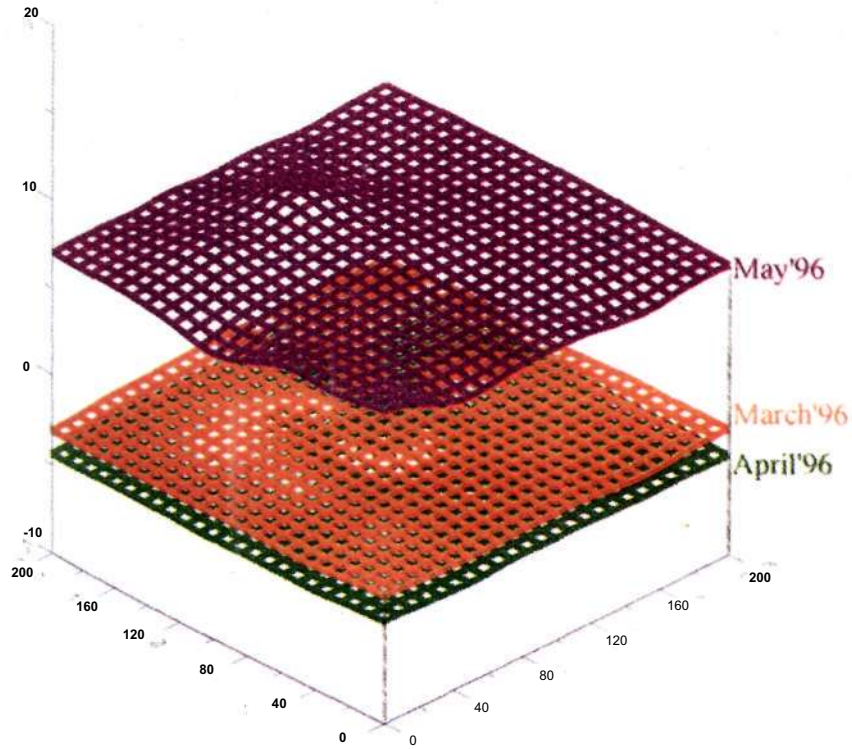


Fig. 2 : Accumulation patterns on shelf for the pre-winter months of March-April-May, 1996

Fig.3 shows that the post-winter months have a significant accumulation. The average gain in the surface for September 96 is 51.2 cm. In the month of October 96, this trend continues and the surface has registered further gain. The total average accumulation reaches 64.8 cm. Normally it is seen, that the values for the month of October represent the peak deposition for any year and after that the surface is ablated due to the onset of polar summer, till the next winter-cycle starts. But this year, we find that the surface for February 97 has risen higher than the surface of October 96.

Fig.4 displays the total pattern of the yearly deposition, comparing the plots of March 96 with September 96 and February 97. The average accumulation, as compared to the original surface of February 96, is 66.5 cm. This value is higher than the yearly pattern of accumulation as seen in the preceding years. It has been observed that every year the total average accumulation on the shelf is between 50 to 55 cm of snow (Asthana *et al*, 1996, Beg *et al*, 1997); so the

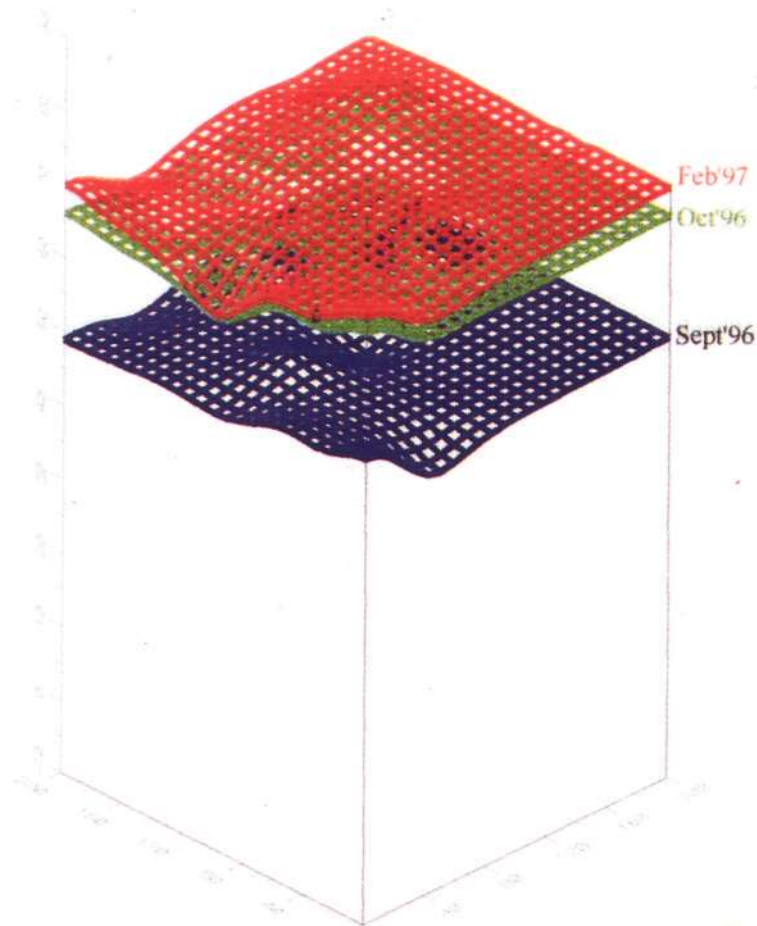


Fig. 3 : Accumulation patterns on shelf for the post-winter months of September-October 1996 and February 1997.

deposition this year of 66.5 cm of snow is much higher than the yearly averages. The reason for this could be a very mild polar summer in 1997, eliminating the ablation part of the total cycle that occurs during the summer.

Conclusions

The net yearly accumulation in February 1997 was 66.5 cm of snow, which was higher than the average yearly trends of 50-55 cm of deposition seen in preceding years. This could be due to a mild polar summer in 1997. Since on consolidation, the density of snow changes from the original 0.3 g/cc to about 0.9 g/cc; this will be compacted to a rise of about 22 cm of ice on the shelf.

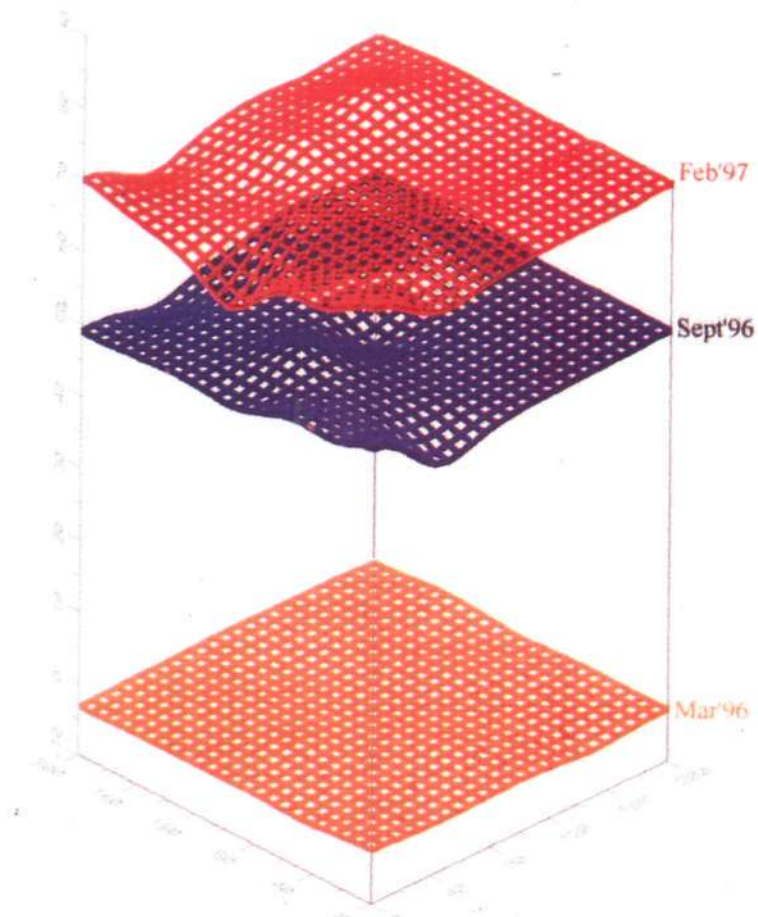


Fig. 4 : A comparison of the accumulation patterns for the entire year, displaying surfaces for March '96, September '96 and February '97.

Again, since the nine-tenth of the shelf is submerged in ocean to maintain the equilibrium of the floating shelf, the final net gain on the surface, due to the deposition this year, will be about 2.2 cm.

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