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Monthly Patterns of Advance and Retreat of Dakshin Gangotri Glacier Snout in Schirmacher Range

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Introduction

A glacial tongue in Schumacher Range was located in the Second Indian Antarctic Expedition in 1983 and it is being examined for the past two decades for observing the movement of this glacier snout. Most of the observations coincide with the peak polar summer, i.e. the first week of February. Thus, a clear understanding has been gained about the behaviour of the glacial tongue from year to year. It has been established that this glacier is receding at an average rate of 6.5 to 7 meters per decade.

However, only one study (Chaturvedi *et al,* 1999) is available to record as to what happens to the glacier snout within the cycle of one year. In that study, the same snout was studied during the entire year of 1996 and month-to-month variations at all the 19 peripheral points on this snout were observed. The general conclusions were that the glacial front advances during the winter months, bulges out due to faster movement of the upper layers, and then breaks off to result in a net retreat. This retreat is enhanced during the polar summer due to melting of the peripheral escarpments. This was also the first time that a forward movement of the glacial tongue was actually recorded.

Observations

In the present study, the same snout has been studied. The glacial front was observed every month during the entire year of 2000, along the same peripheral 19 points, shown in Fig. 1.

The actual readings are presented in Table-1. From these, calculated recession has been quantified, with reference to the original initial observations of February 1996. These are put in Table-2. The recession at each observation point is calculated in Table-3.

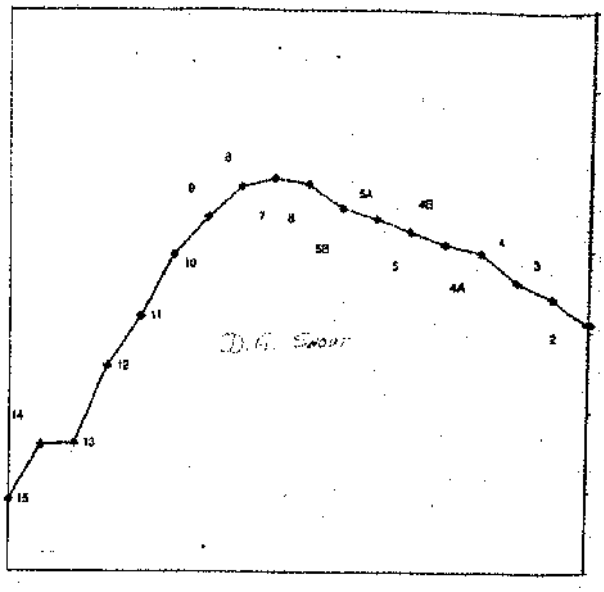


Fig. 1

It is seen that continuous records at all the points are not available in each and every month as some are interrupted by debris of fallen escarpments. Thus, out of the 19 peripheral points, only 13 have a continuous record of each month. These continuities have been plotted graphically, with reference to the original set of February 1996, from Fig. 2 to Fig. 14.

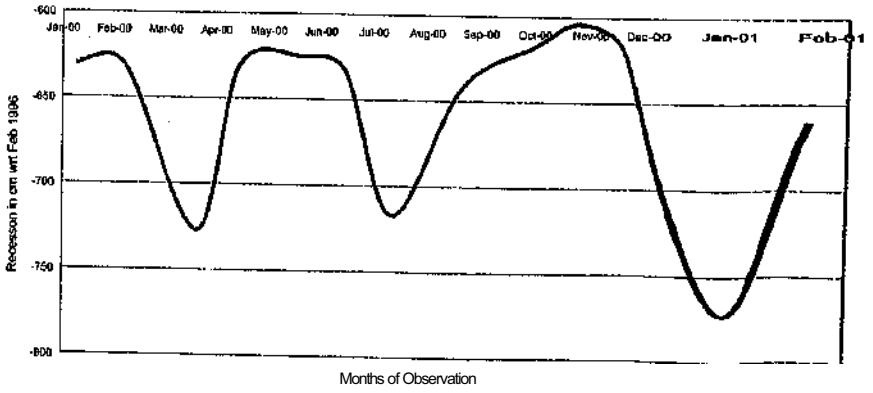


Fig. 2: Monthly Recession Pattern at Point-2

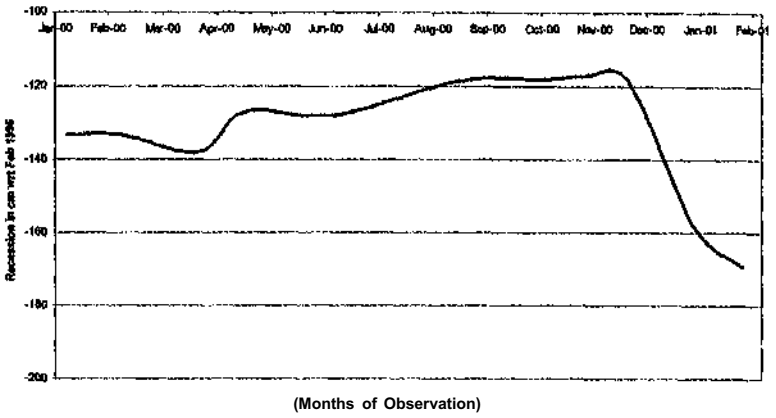


Fig. 3: Monthly Recession Pattern at Point-3

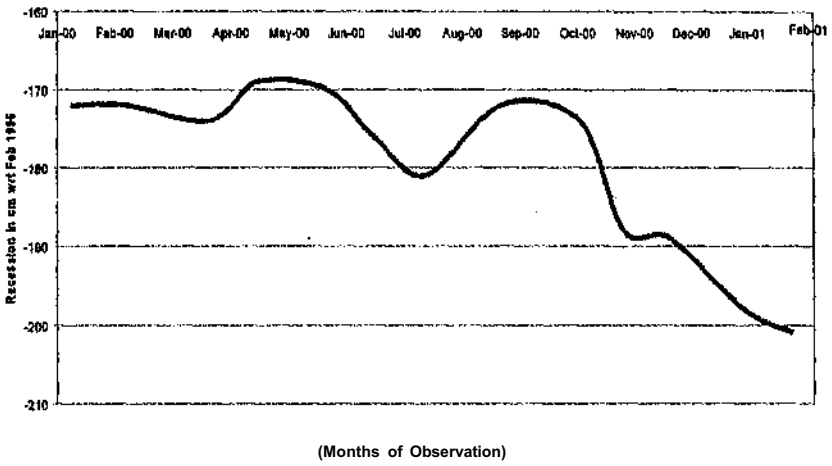
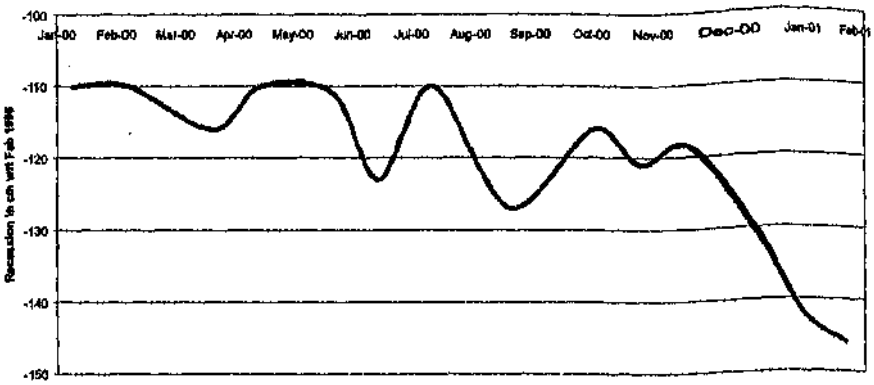


Fig. 4: Monthly Recession Pattern at Point-4

Discussion and Conclusions

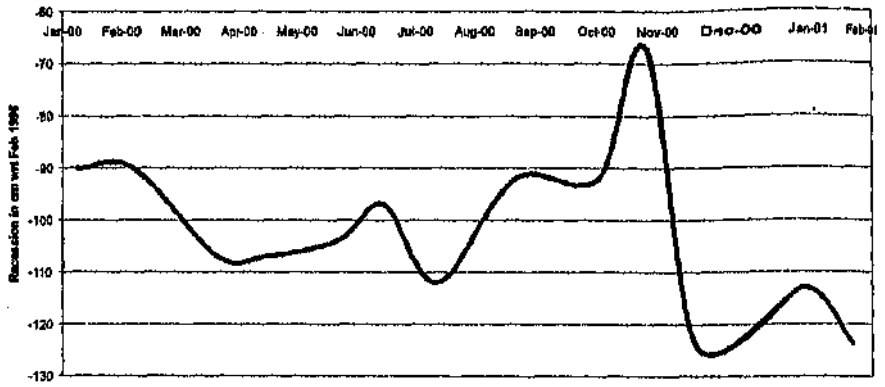
From the plots of Fig. 2 to Fig. 14, it is seen that most of the points show multiple advance and retreat cycles and generally one of the advances is a pronounced peak. Even in the situation of a single advance pattern, there is one marked peak. In most of these cases, the peak coincides with September-October period, sometimes stretching up to November. Thus, the period of September-October represents the culmination of polar winter during which the glacial front advances to its maximal limits.

There are many corresponding cycles of retreat, most of these are minor, except when there is a breaking off of the escarpment. In every



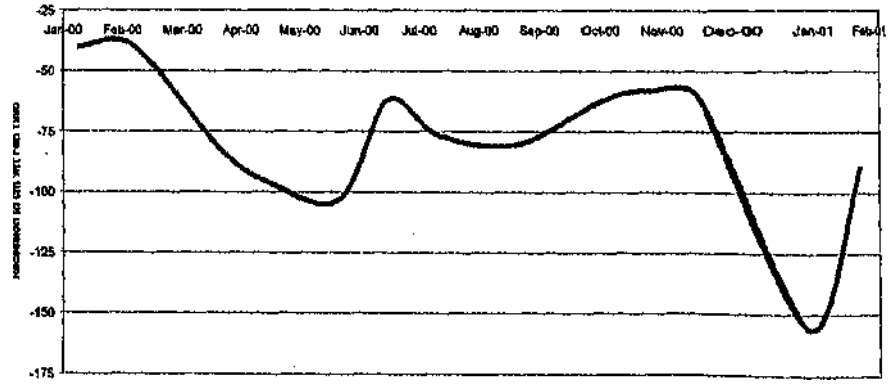
(Months of Observation)

Fig. 5: Monthly Recession Pattern at Point-4A



(Months of Observation)

Fig. 6: Monthly Recession Pattern at Point-4B



(Months of Observation)

Fig. 7: Monthly Recession Pattern at Point-5A

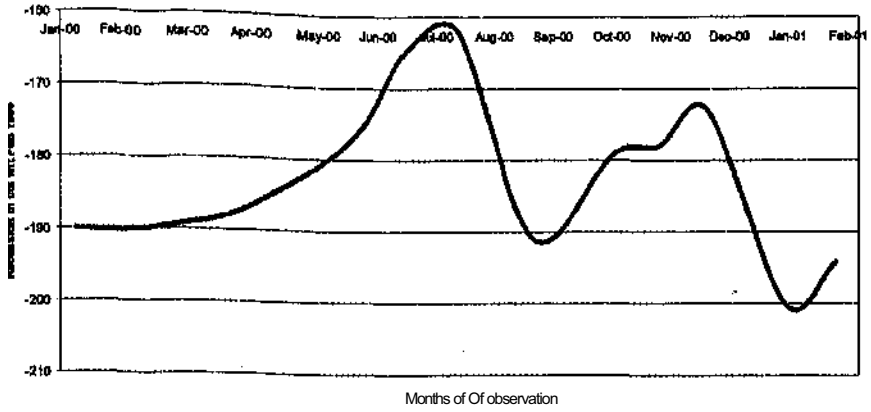


Fig. 8: Monthly Recession Pattern at Point -5B

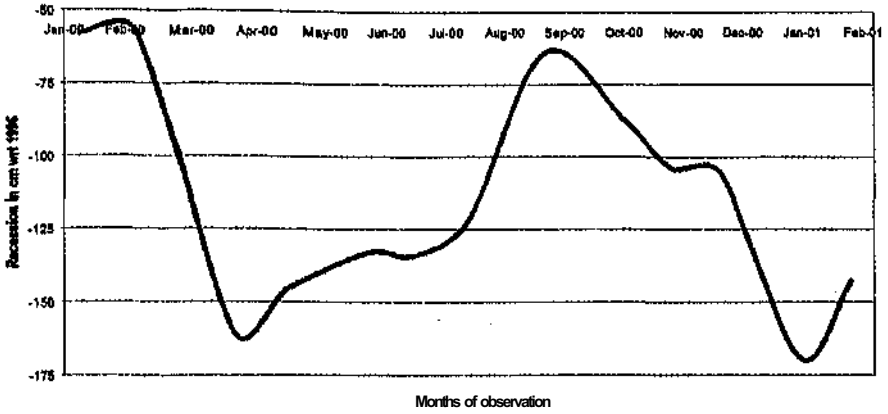


Fig. 9: Monthly Recession Pattern at Point-6

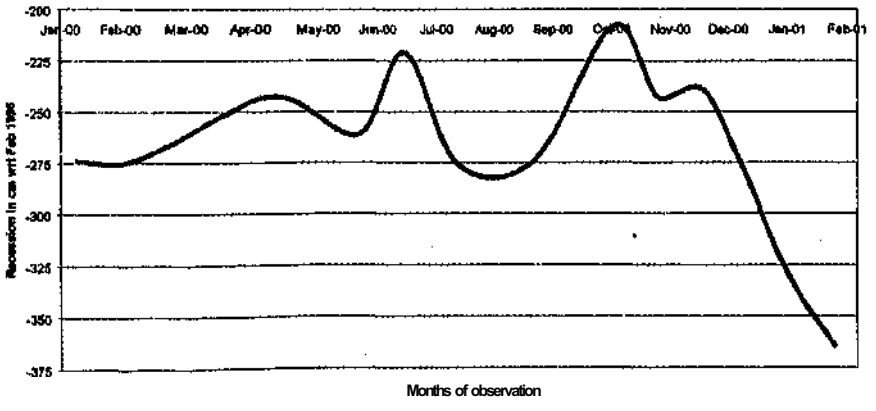


Fig. 10: Monthly Recession Pattern at Point-7

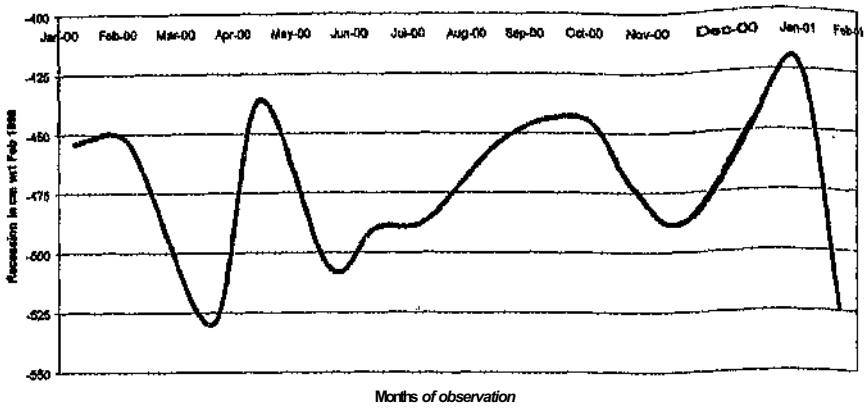


Fig. 11: Monthly Recession Pattern at Point-9

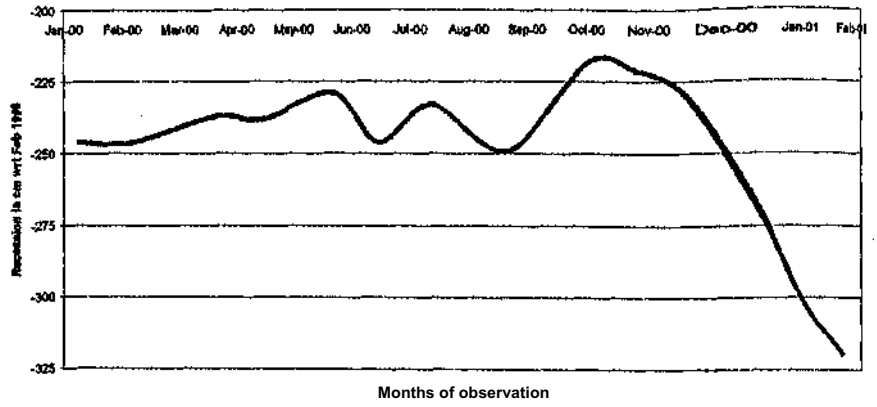


Fig. 12: Monthly Recession Pattern at Point-11

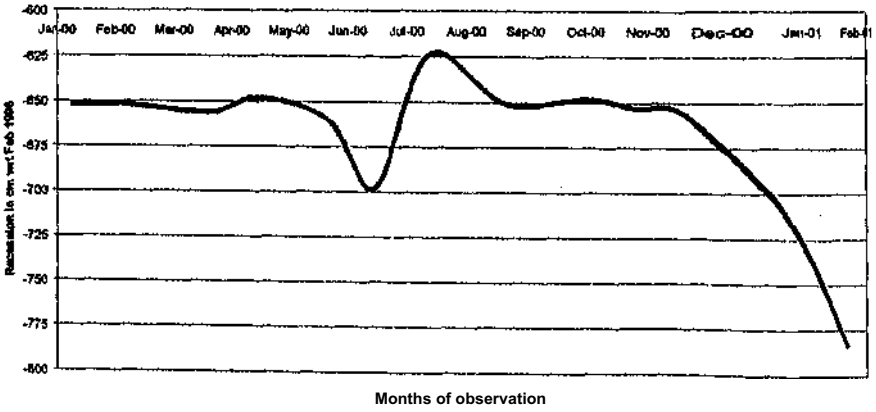


Fig. 13: Monthly Recession Pattern at Point-14

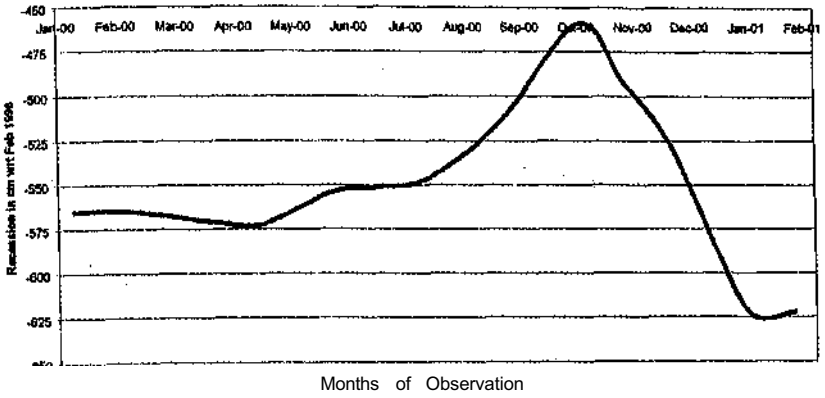


Fig. 14: Monthly Recession Pattern at Point-15

case, the peak recession is seen in the next polar summer period of January-February. And again, in each and every case without any exception, all the observation points display a net overall retreat compared to the values of the previous polar summer. Thus, the glacial front is conclusively retreating at all the observed points.

In the previous study of year 1996, Observation Points 6 and 7 were classified as the "spearhead zone" of the advancing glacial tongue. In the year 2000, large chunks of glacial escarpment broke off during April-May from these points, resulting in a prominent retreat, but after that these points continued to advance with the usual culmination in September-October. Point-6 displayed a consistent advance of almost 96 cm within 5 months from April to September. Therefore, once again it is a confirmation of the inference that in the entire periphery of the glacier, the zone near Point-6-7 is the focal point of the glacial advance.

Now data on monthly advance and retreat patterns are available for the entire years of 1996 and 2000. Comparative study of these patterns for each of the 19 observation points would reveal farther insight into the movement of this snout; but that, being quite a detailed discussion in itself, could be the subject matter of another scientific paper.

Acknowledgements

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Table 1: Original observations along all the peripheral points from Feb-2000 to Feb-2001

Point No.	96 Original	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	Feb-01
1	200	470	470	500?	500?	7	7	?	?	9	?	?	490	656
2	450	1080	1080	1177	1080	1075	1083	1167	1092	1067	1054	1070	1222	1110
3	100	233	233	238	227	228	227	223	218	218	217	218	259	269
4	200	372	372	374	369	370	376	381	372	374	388	389	398	401
4-A	200	310	310	316	310	311	323	310	327	316	321	319	341	346
4-B	250	340	340	357	357	354	347	362	342	342	317	374	363	374
5	700	930	930	868	?	1055	811	818	798	794	835	853	854	832
5-A	110	150	150	192	206	213	172	187	190	172	168	172	266	199
5-B	110	300	300	298	294	286	275	272	301	289	288	283	310	304
6	150	208	208	310	295	283	284	272	214	238	254	256	319	292
7	150	424	424	401	393	411	371	426	424	358	393	391	475	515
8	500	698	698	700?	?	767	?	?	?	?	?	7	627	*69S*
9	200	654	654	730	636	706	690	686	652	644	673	686	620	725
10	400	604	604	693	585	587	561	588	?	548	541	554	610	661
11	200	446	446	437	438	429	446	433	449	418	421	432	497	520
12	350	721	?	?	?	?	?	662	651	654	646	639	722	*733*
13	100	515	515	486	451	487	415	434	?	?	?	375	524	583
14	150	802	802	806	798	810	848	774	801	798	803	808	873	934
15	650	1215	1215	1221	1222	1204	1201	1196	1163	1109	1141	1178	1271	1272

Table 2: Transposed table for plots of peripheral points

	pt-1	pt-2	pt-3	pt-4	pt-4A	pt-4B	pt-5	pt-5A	pt-5B	pt-6	pt-7	pt-8	pt-9	pt-10	pt-11	pt-12	pt-13	pt-14	pt-15
Feb-00	470	1080	233	372	310	340	930	150	300	208	424	698	654	604	446	721	515	802	1215
Mar-00	470	1080	233	372	310	340	930	150	300	208	424	698	654	604	446	?	515	802	1215
Apr-00	500?	1177	238	374	316	357	868	192	298	310	401	700?	730	693	437	?	486	806	1221
May-00	500?	1080	227	369	310	357	7	206	294	295	393	?	636	585	438	?	451	798	1222
Jun-00	?	1075	228	370	311	354	1055	213	286	283	411	767	706	587	429	?	487	810	1204
Jul-00	?	1083	227	376	323	347	811	172	275	284	371	?	690	561	446	?	415	848	1201
Aug-00	?	1167	223	381	310	362	818	187	272	272	426	?	686	588	433	662	434	774	1196
Sep-00	?	1092	218	372	327	342	798	190	301	214	424	?	652	?	449	651	?	801	1163
Oct-00	?	1067	218	374	316	342	794	172	289	238	358	?	644	548	418	654	?	798	1109
Nov-00	?	1054	217	388	321	317	835	168	288	254	393	?	673	541	421	646	?	803	1141
Dec-00	?	1070	218	389	319	374	853	172	283	256	391	?	686	554	432	639	375	808	1178
Jan-01	490	1222	259	398	341	363	854	266	310	319	475	627	620	610	497	722	524	873	1271
Feb-01	656	1110	269	401	346	374	832	199	304	292	515	698	725	661	520	733	583	934	1272

Table 3: Calculated recession in cm for each peripheral point

	pt-1	pt-2	pt-3	pt-4	pt-4A	pt-4B	pt-5	pt-5A	pt-5B	pt-6	pt-7	pt-8	pt-9	pt-10	pt-11	pt-12	pt-13	pt-14	pt-15
Feb-00	-270	-630	-133	-172	-110	-90	-230	*-40*	-190	-58	-274	-198	-454	-204	-246	-371	415	-652	-565
Mar-00	-270	-630	-133	-172	-110	-90	-230	*-40*	-190	-58	-274	-198	-454	-204	-246	?	-415	-652	-565
Apr-00	?	-727	-138	-174	-116	-107	-168	-82	-188	-160	-251	-200	-530	-293	-237	?	-386	-656	-571
May-00	?	-630	-127	-169	-110	-107	?	-96	-184	-145	-243	**?**	-436	-185	-238	?	-351	-648	-572
Jun-00	?	-625	-128	-170	-111	-104	-355	-103	-176	-133	-261	-267	-506	-187	-229	?	-387	-660	-554
Jul-00	**?**	-633	-127	-176	-123	-97	-111	-62	-165	-134	-221	?	-490	-161	-246	?	-315	-698	-551
Aug-00	?	-717	-123	-181	-110	-112	-118	-77	-162	-122	-276	?	-486	-188	-233	-312	-334	-624	-546
Sep-00	**?**	-642	-118	-172	-127	-92	-98	-80	-191	-64	-274	?	452	?	-249	-301	?	-651	-513
Oct-00	**?**	-617	-118	-174	-116	-92	-94	-62	-179	-88	-208	?	-444	-148	-218	-304	?	-648	-459
Nov-00	?	-604	-117	-188	-121	-67	-135	-58	-178	-104	-243	?	-473	-141	-221	-296	?	-653	-491
Dec-00	?	-620	-118	-189	-119	-124	-153	-62	-173	-106	-241	?	-486	-154	-232	-289	-275	-658	-528
Jan-01	-290	-772	-159	-198	-141	-113	-154	-156	-200	-169	-325	-127	-420	-210	-297	-372	-424	-723	-621
Feb-01	-456	-660	-169	-201	-146	-124	-132	-89	-194	-142	-365	-198	-525	-261	-320	-383	-483	-784	-622

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Reference

Arun Chaturvedi, Amar Singh, M.P. Gaur, K.V. Krishnamurthy and M.J. Beg (1999): "A Confirmation of Polar Glacial Recession by Monitoring the Snout of Dakshin Gangotri Glacier in Schirmacher Range". Scientific Report, Fif teenth Indian Expedition to Antarctica, Department of Ocean Development, Technical Publication No. 13, New Delhi, pp 321-335.