Meteorological observations on Soler Glacier

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Abstract. Meteorological observations were carried out on Soler Glacier in the Patagonia Northern Icefield, Chile. The observations were made for the period from December 12, 1983 to January 2, 1984. Items of observation were wind velocity, air temperature, global radiation, precipitation, humidity, amount of cloud, ablation of the glacier and albedo. The Föhn phenomenon sometimes occurred above Soler Glacier and contributed to ice melting.

1. Introduction

Meteorological observations were carried out on Soler Glacier in the Patagonia Northern Icefield, Chile. Soler Glacier is a valley glacier flowing eastward from the icefield. As seen in Figure 1, about 50 percent of the surface area of the glacier is covered by moraines, while the remainder consists of bare ice surface.

Only short-term data of mean ablation rate and air temperature were obtained in the past from March 21 to 26, 1967 (NARUSE and ENDO, 1967). Therefore, the purpose of this study was to obtain more meteorological data in this area which would be used to study the heat balance on the glacier.

2. Period of observations and instrumentation

The measurements were made on the lower part of the glacier at a height of 400 m (M_1, M_2) and on the old end moraine area at a height of 300 m (B.C.) shown in Figure 1, for the period from December 12, 1983 to January 2, 1984.

Instruments and observed quantities are listed in Table 1. Radiation measurements were initially made on the glacier, but were relocated to the base camp (B.C., see Fig. 1) because it was difficult to keep the instruments horizontal. Continuous temperature and wind speed measurements were maintained at two sites (M_1 and B.C.). Records of the wind speed profile and albedo were made on one occasion during the observation period at the glacier and the old end moraine surfaces. Although the ablation measurements were made with sixteen stakes in the ablation area with help by Naruse, Kohshima and Casassa, they were not read every day systematically. Three-hourly standard meteorological observations were also maintained throughout the period mainly at the base camp.

3. Meteorological conditions

The mean and extreme conditions observed during the period are shown in Table 2. The

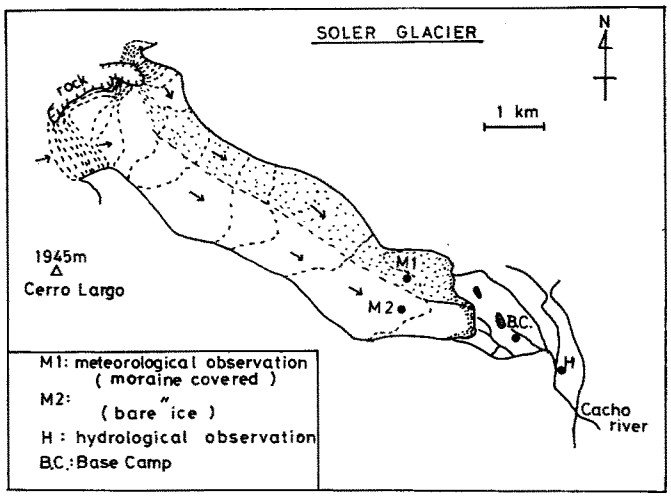

Fig. 1. Observation sites on Soler Glacier.

Table 1. Observed quantities and instruments.

Site	Item	Instrument
M1	Air temperature (1.0 m)	Thermistor thermometer
	Wind speed (1.5 m)	Three-cup anemometer
	Ablation amount	Snow stake
	Albedo	Albedo meter (EKO MR-21)
M2	Air temperature (0.5 m)	Thermistor thermometer
	Ablation amount	Snow stake
	Net radiation	Balance meter (EKO CN-11)
	Albedo	Albedo meter (EKO MR-21)
	Relative humidity	Assman psychrometer
	Wind speed profile	Three-cup anemometer (MAKINO)
B.C.	Air temperature (1.0 m)	Thermistor thermometer
	Wind speed (1.5 m)	Three-cup anemometer
	Global solar radiation	Pyranometer (EKO MS-42)
	Albedo	Albedo meter (EKO MS-42)
	Relative humidity	Assman psychrometer
	Precipitation	Rain gauge
	Wind speed profile	Three-cup anemometer (MAKINO)
	Net radiation	Balance meter (EKO CN-11)
	Cloud	8 mm interval camera

Table 2. Mean and extreme meteorological data on Soler Glacier, December 12, 1983-January 2, 1984.

Element	Maximum	Minimum	Mean
Air temperature at 1.0 m (°C)	17.1	3.5	8.6
Wind speed at 1.5 m (m/s)	16.7	1.6	4.1
Water vapor pressure (mb)	11.8*	5.6*	9.6*
Dialy ice ablation (cm)	16	2	9.8
Cloudiness (10ths)	10*	1*	5.8*
Global radiation (ly/day)	794*	138*	539*
Global radiation ($MJ/m^2 \cdot day$)	33.3*	5.8*	22.6*

*These values are daily extremes, while for the other climatic elements hourly extremes are given.

Table 3. Ice ablation in cm.

	Day	Night	Day and night
Mean value at lower part of glacier	10.7	2.4	13.1
Mean value at upper part of glacier	5.4	1.0	6.4
Averaged	8.1	1.7	9.8

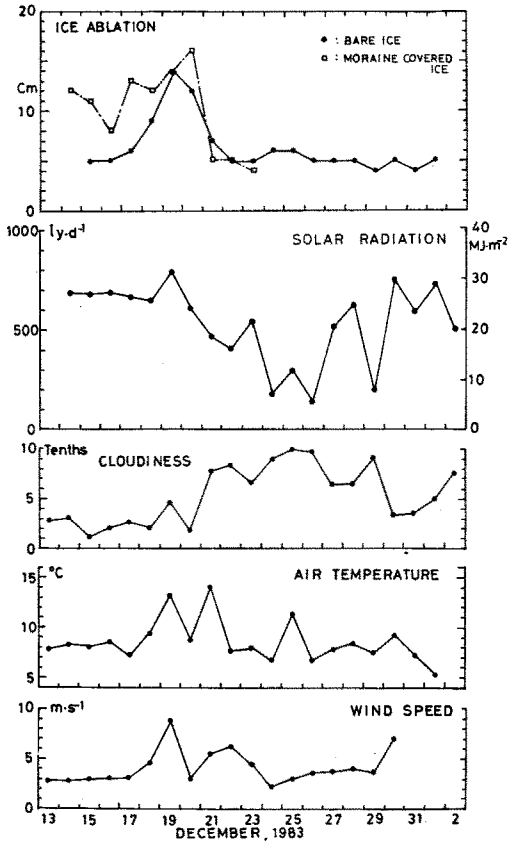

Fig. 2. Variations in mean daily values of meteorological elements, Soler Glacier, 1983.

hourly average wind speed ranged between 1.6 and 16.7 m/s, and the hourly average value was 4.1 m/s. Air temperature changed between 3.5 and 17.1°C, and the hourly average value was 8.6°C throughout the observational period.

The total precipitation was 131.2 mm for the 22-day period. The daily variation of the precipitation is reported in Report 9. The mean amounts of ablation measured by the sixteen stakes in the ablation area are given for day, night, and 24 hour periods in Table 3.

Daily mean values of meteorological elements are shown in Figure 2. According to Figure 2, the air temperature above the glacier increased with increasing the wind speed, for instance December 19, 21, and 30 in 1983. This is the well known "Föhn" phenomenon. The phenomenon can be seen in Figure 3 from 14:00 to 20:00 LT on December 15, 1983. The maximum daily average wind speed under the Föhn condition was 8.9 m/s; on that day the

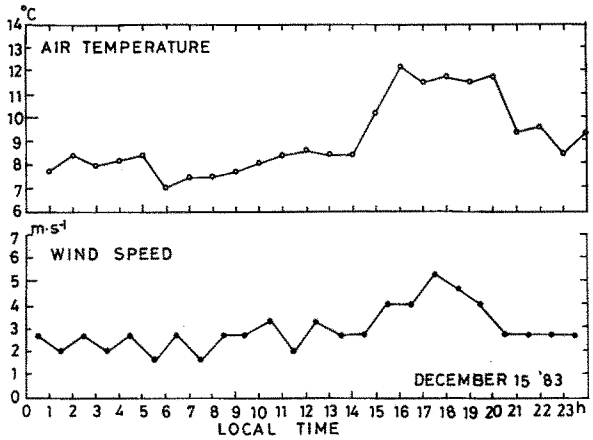

Fig. 3. Variations in hourly values of air temperature and wind speed, Soler Glacier, December 15, 1983.

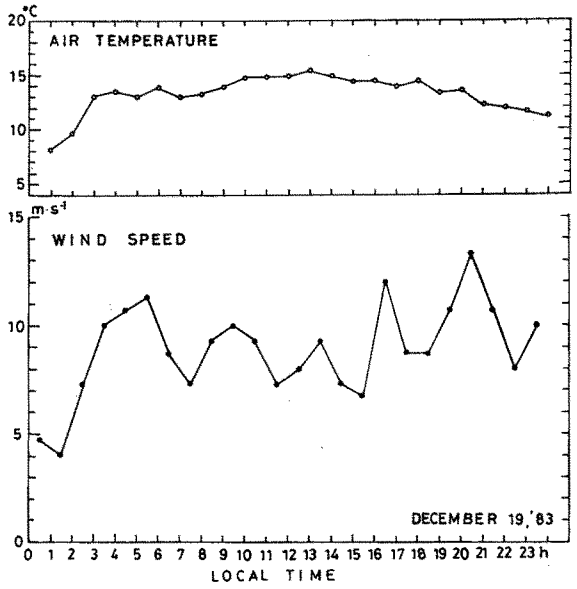

Fig. 4. Variations in hourly values of air temperature and wind speed during Föhn, Soler Glacier, December 19, 1983.

air temperature increased from 8.2°C at 01:00 LT to 15.4°C at 13:00 LT on December 19, 1983 as shown in Figure 4. During a Föhn, the sensible heat flux toward the ice surface was large.

Finally, Figure 5 shows the variations of cloudiness and relative humidity obtained from three-hourly standard meteorological observations.

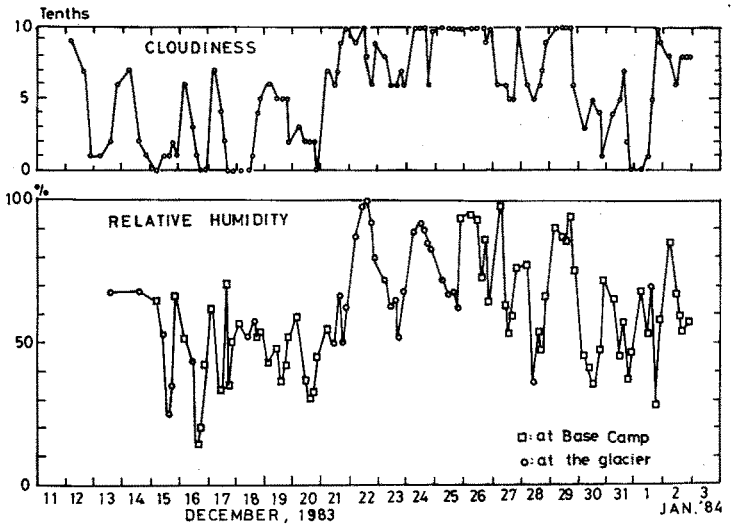

Fig. 5. Variations of cloudiness and relative humidity, Soler Glacier, 1983.

Acknowledgments

Dr. A. Akitaya, Institute of Low Temperature Science, Hokkaido University, made the wind speed and temperature recorders available to us, for which we are grateful.

Reference

NARUSE, R. and ENDO, T. (1967): Glaciological investigations of northern Patagonian glaciers, Chile. Seppyo, **29**, (6), 167–176 (in Japanese with English abstract).

Resumen. Observaciones meteorológicas en el Glaciar Soler

Se efectuó observaciones micrometeorológicas en el Glaciar Soler en el Hielo Patagónico Norte, Chile. Se hizo las observaciones en el período entre Diciembre 12, 1983 y Enero 2, 1984. Las mediciones fueron hechas en el frente del glaciar a nua cota de 400 m (M1, M2) y sobre un frente morrénico antiguo a una cota de 300 m (B.C.), tal como se muestra en la Fig. 1. Las variables observadas fueron la velocidad del viento, temperatura del aire, radiación global, precipitación, humedad, nubosidad, ablación del glaciar y albedo.

La velocidad media horaria del viento varió entre 1,6 y 16,7 m/s y el promedio horario fue de 4,1 m/s. La temperatura del aire varió entre 3,5 y 17,1°C, y el valor medio fue 8,6°C a lo largo del período de observación. En general, la velocidad del viento sobre el Glaciar Soler aumentó con la temperatura. Este fenómeno es bien conocido como "Föhn". Entonces, en caso de Föhn, el flujo de calor sensible hacia la superficie de hielo mostró valores elevados. La velocidad diaria promedio máxima bajo condiciones de Föhn fue de 8,9 m/s, y ese día la temperatura del aire subió de 8,2°C a las 01 :00 hora local a 15,4°C a las 13:00 hora local el 19 de Diciembre de 1983.

La precipitación total fue de 131,2 mm, en forma de lluvia, para el período comprendido entre el 12 de Diciembre de 1983 y el 1 de Enero de 1984.

Todos los datos meteorológicos serán usados para estudiar el balance energético del glaciar.