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Meteorological measurements at Soler Glacier, Patagonia, in 1985

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Abstract

Detailed meteorological conditions were observed at Soler Glacier on the eastern side of the Northern Patagonia Icefield during October 19 to December 8, 1985. Measurements were made both on the moraine field and on the glacier surface near the glacier snout. General conditions of fine or rainy weather lasted about two weeks and changed almost periodically. The rise in air temperature and drop of humidty during the strong downslope wind were recognized. It is possibly a Föhn phenomenon.

1. Introduction

Soler Glacier is located at the eastern side of the Northern Patagonia Icefield. The ablation area of the glacier has the form of a valley-type glacier about 7 km in length and 1.5 km in mean width. The glacier is fed by icefalls and ice avalanches from the icefield. as well as from the southern slope of Mt. Hyades (Aniya and Naruse, 1987).

Meteorological observations were first made from the middle of December 1983 to early January 1984 (Kobayashi and Saito, 1985). Although short-term data were obtained, some characteristic features of meteorological conditions in this region including the occurrence of Föhn phenomenon were given. For studies of the heat balance for glacier ablation, hydrological features, and glacier dynamics, it is necessary to collect more meteorological data in detail and over a longer period.

From October 19 to December 8, 1985, meteorological meaturements were carried out at the moraine field in the vicinity of the terminus of Soler Glacier and also at the lower reach of the glacier ablation area.

2. Method of measurements

Measurements were made at the Base Camp (BC) in the endmoraine field about 1 km downstream from the glacier terminus, and also at the Glacier Camp (GL) 1.7 km upglacier from the terminus. A map showing the locations of these stations are given by Fukami and Naruse (1987). Elevations are 277 m a.s.l. at BC and 378 m at GL. The surface condition of meteorological station at BC is a flat field of small pebbles and sand with short grass in a depression of moraine hills; that at GL is clean ice without debris on an undulating glacier surface.

Items, instruments and observation periods are summarized in Table 1. Air temperature and relative humidity were measured in a shelter set up 1.5 m above the surface at BC and 1.35 m at GL. Records of dry- and wet-bulb air temperature and relative humidity were collected every 3 to 6 hours with an Assmann psychrometer. Wind velocity was measured at a height of 1.5 m at both stations. Also, vertical profiles of wind speed were measured at GL in two weeks for the heat balance study.

Recorders were installed in the camping tents; all power was supplied by dry-cell batteries.

Table 1. Meteorological elements observed at Base Camp and Glacier Camp in Soler Glacier.

[Note] Period of observation

L: October 20 to December 7, 1985

S: October 31 to November 6, and November 24 to 30, 1985

Frequency of measurements

C: Continuous recording

3: Every 3 hours

A: Arbitrary occasion

Site: Base Camp (BC). Observation period: October 19-December 8, 1985

Item	Instrument	Frequency	Period
Atmospheric pressure	aneroid barometer	C	
Air temperature (dry-bulb)	bimetal thermometer	C	
(wet-bulb)	Assmann psychrometer	3	
Relative humidity	hair hygrograph	C	
Wind velocity	3-cup anemometer	C	
Wind direction		3	
Precipitation	tipping bucket raingauge	C	
Global radiation	pyranometer	C	
Albedo	pyranometer type albedometer	A	
Downward all-wave radiation	net radiometer with adapter	C	
Cloud amount		3	

Site: Glacier Camp (GL).

Item	Instrument	Frequency	Period
Air temperature (dry-bulb)	thermistor thermometer	C	L
(wet-bulb)	thermistor thermometer	C	L
Relative humidity	Assmann phychrometer	A	L
Wind velocity	3-cup anemometer	C	L
Wind direction		3	S
Global (solar) radiation	pyranometer	C	S
Reflected solar radiation	pyranometer	C	S
Net radiation	net radiometer	C	S
Cloud amount		3	S
Ablation	ablation stake	A	L
		3	S

3. Results of measurements

Variations in meteorological elements measured at Base Camp (BC) are shown in Fig. 1, and some basic data at Glacier Camp (GL) are shown in Fig. 2. Atmospheric pressure, air temperature and relative humidity indicate instantaneous values for every 3 hours; wind velocity the 1-hour mean value for every 3 hours; precipitation the 3-hour total amount; global radiation the 1-day total amount.

It is noted from the figures of atmospheric pressure and precipitation in Fig. 1 that the general condition of fine or rainy weather lasted for about two weeks and changed with a cycle of this period. Daily mean air temperature showed slight increase after the end of the 2-week rainy period, namely from November 17 through early December.

Mean, minimum and maximum values of meteorological elements obtained at BC and GL are listed in Table 2. By using the mean air temperatures at BC and GL, the lapse rate of temperature was estimated as 3°C/100m. The result should mainly be caused by the cold air mass formed on the glacier. Relative humidity showed the same values at both stations. Wind velocity at GL was about 1.5 times stronger than that at BC. This may be due to that BC was located in a slight depression of moraine hills.

We can notice from Fig. 2 that the wind speed on Soler Glacier sometimes became as strong as about 10 m/s, for example on October 24, November 3-4, 12, 16 and 21. To see this phenomenon more clearly, hourly variations in air temperature, relative humidity, water vapor pressure and wind velocity at BC and GL during November 14 to 16 are illustrated in Fig. 3 . Dotted lines indicate values at BC; solid lines at GL. Wind velocity gradually increased from the early morning

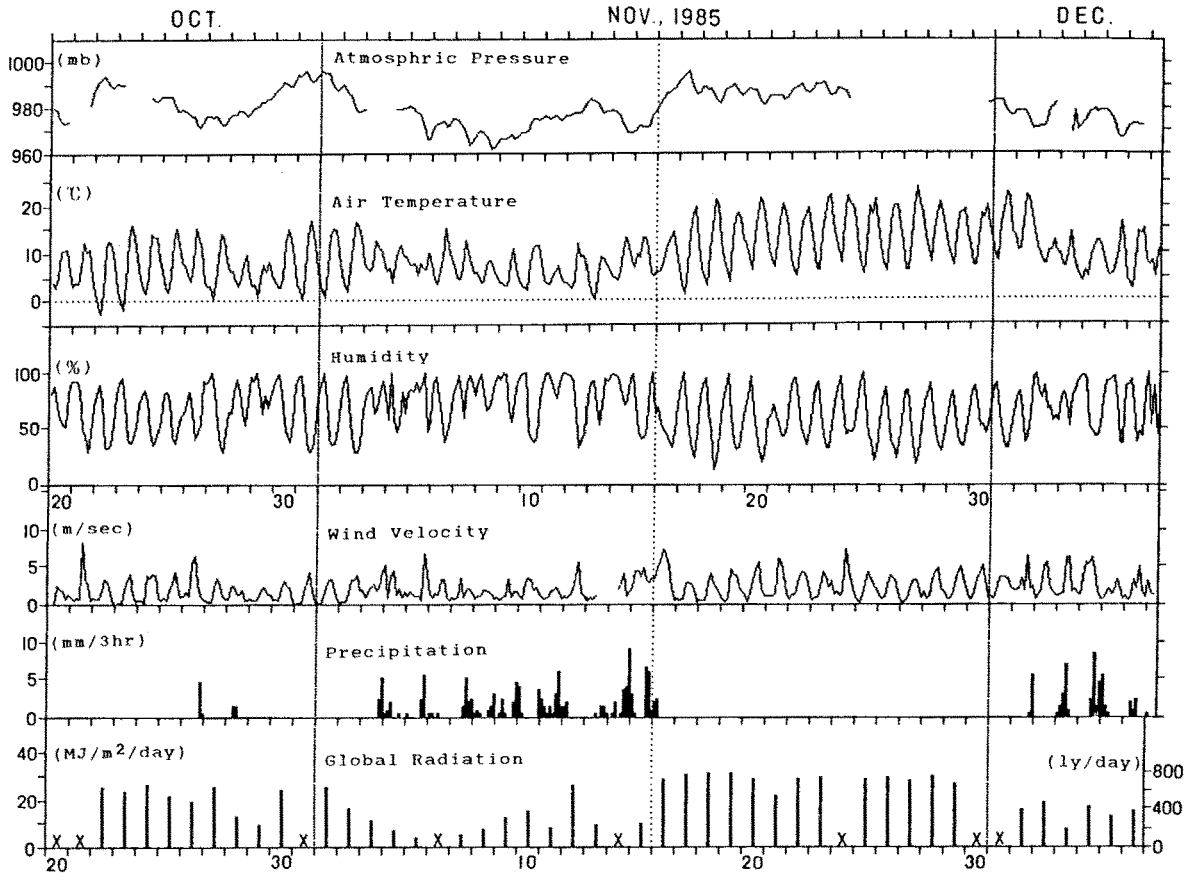

Fig. 1. Variations in meteorological elements observed at Base Camp (BC) near the terminus of Soler Glacier from October to December 1985.

Table 2. Mean and extreme values of meteorological elements obtained at Base Camp and Glacier Camp on Soler Glacier during October 20 to December 8, 1985.

[Note] * indicates daily extremes, while others indicate hourly extremems.
( ) shows the total amount in the whole period.

site	Item	mean	maximum	minimum
Base Camp	Atmospheric pressure (mb)	979.9	995.8	961.4
	Air temperature (°C)	9.5	24.9	−2.7
	Relative humidity (%)	67	100	11
	Vapor pressure (mb)	7.53	15.14	2.94
	Wind velocity (m/sec)	2.1	9.0	0.0
	Precipitation (mm)*	(180.5)	19.5	0
	Global radiation (MJ/m^2)*	19.7	32.2	3.6
	Cloud amount (10th)	5.0	10	0
Glacier Camp	Air temperature (°C)	6.5	17.4	0.3
	Relative humidity (%)	65	100	16
	Vapor pressure (mb)	6.09	10.64	2.94
	Wind velocity (m/sec)	3.0	14.0	0.4

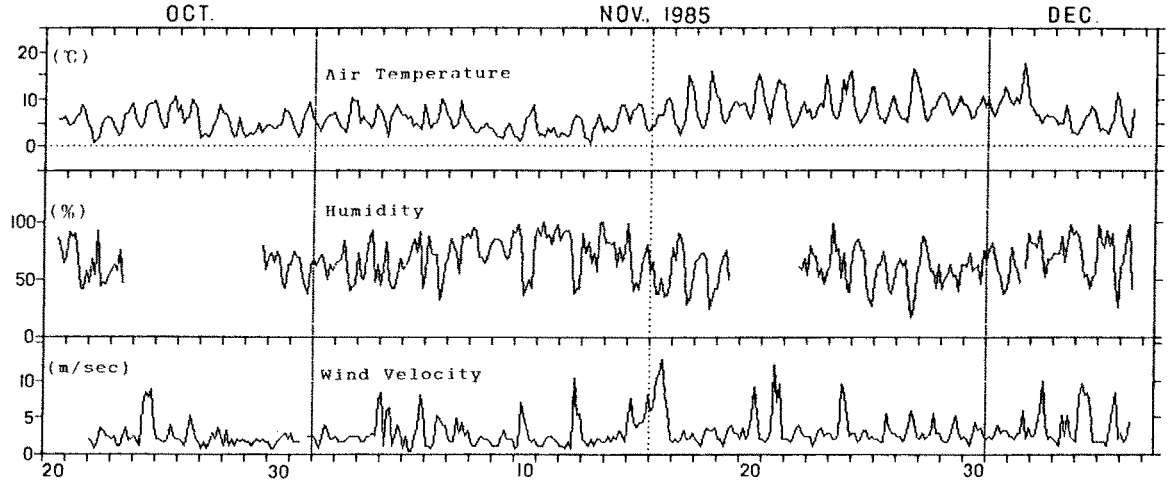

Fig. 2. Variations in meteorological elements observed at Glacier Camp (GL) in the lower reach of Soler Glacier during October to December 1985.

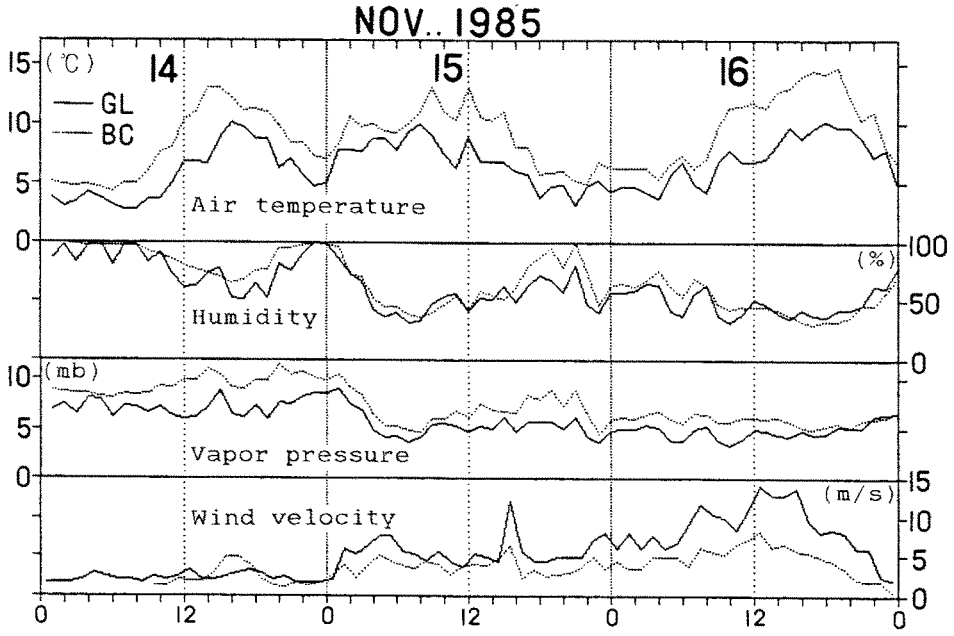

Fig. 3. Hourly variations in meteorological elements observed at BC and GL of Soler Glacier during November 14 to 16, 1985.

of November 15, and showed a maximum value of about 14 m/s at GL in the early afternoon of November 16, then gradually decreased through the evening. Air temperature was raised and relative humidity decreased in the same manner. Absolute vapor pressure lowered also slightly from the early morning of November 15. Winds were blowing toward down-glacier. Based on these results, we may consider it similar to a Föhn phenomenon. Inoue *et al.* (1987) also suggested that the wind on Soler Glacier during the sunny period showed the nature of a Föhn by summarizing the data from November 17 to December 1. We cannot, however, conclude that the Föhn occurred frequently in this Soler Glacier region, because of the lack of meteorological data in the upper atmosphere around the region.

4. Concluding remarks

Detailed meteorological data were obtained from the middle of October to early December 1985 in the Soler Glacier region. Periodical changes of general weather conditions were found with a cycle of about two weeks in this season. The observational period could be divided into two sub-periods, namely relatively low air temperature in the first half period (*i.e.* late spring) and relatively high temperature in the second half (early summer). This difference clearly caused different heat balance for glacier ablation (Fukami and Naruse, 1987), and resulted in a different amount of water runoff from the glacier (Fukami and Escobar, 1987).

A Föhn-like phenomenon was observed, as previously suggested by Kobayashi and Saito (1985). More data and analyses are necessary to clarify the phenomenon. Comparison of the observed meteorological conditions with those at the western side of the Northern Icefield, *i.e.* the San Rafael region, is presented by Inoue *et al.* (1987).

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Resumen

Mediciones meteorológicas en el Glaciar Soler, Patagonia, en 1985

Desde Octubre 19 a Diciembre 8, 1985, se realizó observaciones meteorológicas detalladas en el Glaciar Soler, en el lado oriental del Hielo Patagónico Norte. Las mediciones se llevaron a cabo en el Campamento Base (BC) ubicado en la zona de morrenas terminales, aproximadamente 1 km aguas abajo del frente del glaciar, y también en el Campamento Glaciar (GL), 1,7 km aguas arriba del frente. BC y GL tienen una cota de 277 m y 378 m.s.n.m. respectivamente.

Las siguientes observaciones se llevaron a cabo: presión atmosférica, temperatura del aire, humedad relativa, velocidad del viento, dirección del viento, precipitación, radiación solar de onda corta, radiación global neta, nubosidad, albedo de la superficie del glaciar y ablación (derretimiento y sublimación) de hielo.

La variación de los elementos meteorológicos medidos en BC y GL se muestran en la Fig. 1 y Fig. 2, respectivamente. En la Fig. 1, a partir de la variación de la presión atmosférica y la precipitación, se observó que la condición general de buen tiempo o mal tiempo tenía una duración de unas dos semanas y variaba cíclicamente. La temperatura media del aire mostró un aumento leve después del término de las dos semanas de mal tiempo, vale decir entre el 17 de Noviembre y principios de Diciembre. Los valores medios y extremos de los elementos meteorológicos obtenidos en BC y GL se muestran en la Tabla 2.

La Fig. 3 muestra la variación horaria de temperatura del aire, humedad relativa, presión de vapor y velocidad del viento en BC y GL desde el 14 al 16 de Noviembre. La línea punteada indica los valores en GL. La velocidad del viento aumentó gradualmante desde temprano en la mañana del 15 de Noviembre, y alcanzó un valor máximo de unos 14 m/s en GL temprano por la tarde del 16 de Noviembre, para luego disminuir hacia la noche. De la misma manera la temperatura del aire aumentó y la humedad relativa disminuyó. La presión absoluta de vapor también disminuyó ligeramente en este período. El viento tenía

una dirección hacia aguas abajo del glaciar. Basándose en estos resultados, podemos considerar que se trata de un fenómeno similar a Föhn. Sin embargo no podemos caracterizar en detalle el mecanismo de este fenómeno, debido a una falta de información meteorológica en la región alrededor del Glaciar Soler y la alta atmósfera.