

Continuous automatic measurement of an amount of sublimation in the summer season at the S17 base on the Antarctic ice sheet near Syowa station

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Introduction

It is thought that the vapor to make precipitation on the Antarctic ice sheet mainly enters from the open sea around Antarctica. However, amount of the vapor decreases as advance inside the continent. Therefore, vapor originated from the open sea is gradually relatively small for the source of the snowfall which is brought inside the continent. Meanwhile, vapor originated from the ice sheet surface by sublimation is relatively not so small and gradually large for the source of the snowfall into the continent. At first, we plan to make methods to measure the amount of vapor sublimation from the surface of the Antarctic ice sheet, continuously and automatically. Next, we show the result of time variation of the amount of sublimation from the ice sheet surface. For validation of the measured amount of sublimation, a vertical flux of the water vapor was also estimated from the vertical wind speed measured by ultrasonic anemometer and amount of water vapor measured by spectrometer simultaneously.

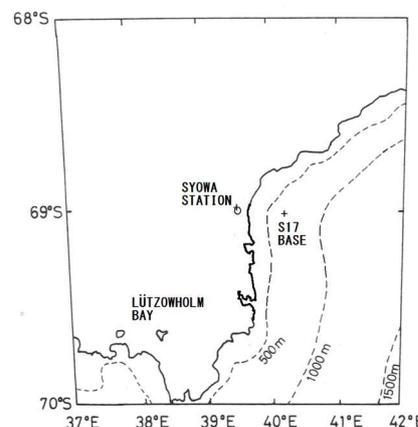


Figure 1. The location of an observation point, S17 base

Method

Authors participated in the 58th Japanese Antarctic Research Expedition (summer part) and did the following observation from December 31, 2016, to January 28, 2017, by S17 base on the Antarctic ice sheet near the Showa Station (figure 1). First, two holes were dug about 20 cm depth respectively according to the size of two electric balance on the snow surface as shown in figure 2. Next insulators were set in the bottom to keep warm the balances on the insulators and to avoid melting snow under the insulators. Then plywood, an electronic balance, and an insulator were put in turn, finally, a snow block was set on the top in each hole.

The snow block was thick enough so that in case of the water melted from the surface of the snow block to stop dropping to electric balance. The depth of the block was set at 13 cm of thickness to keep the snow surface height around the ice sheet. A gap of a snow block and the surrounding snow of the ice sheet was set to less than 1 cm as small as possible to make less influence of the amount of the sublimation from the side of the block. An electronic balance was connected through the interior PC by telecommunication cable and power cable from which it's 20 m away, and the weight data was sent every several seconds from the balance to PC and recorded in a PC. Two balances were used (large 46 x 43 cm and small 24 x 42 cm) to validate each other. 3-dimensional ultrasonic wind anemometer (USA-1) and open pass gas analyzer (LI-7500) was also installed in the location of the height 2 m and water vapor vertical flux was measured as for the validation as well as the direct method of measurement of the amount of the sublimation.

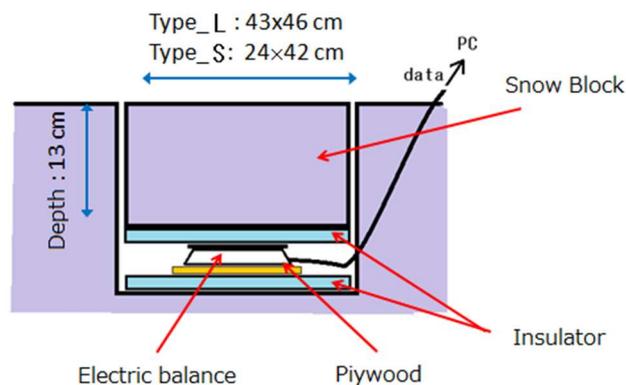


Figure 2. Schematic vertical section of the snow scale using an electronic balance.

Results

The amount of sublimation of each time (by a case, the amount of snowfall) was obtained by the following way from the time series of the weight data of the balance. First, the changing value of weight during every 30 minutes was obtained from the inclination of the regression line of a weight change calculated from the time series weight data divided every 30 minutes, and converted it into the decrease or increase increment per 1 hour per the unit area. The average value for each time during the observation period was shown in figure 3. It is clear that the main sublimation has occurred during from 9:00 to 18:00, however,

sublimation has occurred every time throughout the day. Sublimation exceeds in January because there is always sunshine when clearing up with almost no sunset. The maximum amount of sublimation by the hour was 0.07 mm/hr and the value of the amount of sublimation summed by day obtained from L size and S size balances were 0.59 mm/day and 0.69 mm/day respectively. when this sublimation value was summed for 30 days, the amount of sublimation was estimated about 18 mm in January. Because the annual amount of rainfall was said to be 400 mm at Antarctic coastal area around the Syowa station, it is found out that about 5 % of the annual amount of precipitation is returned by sublimation to the atmosphere.

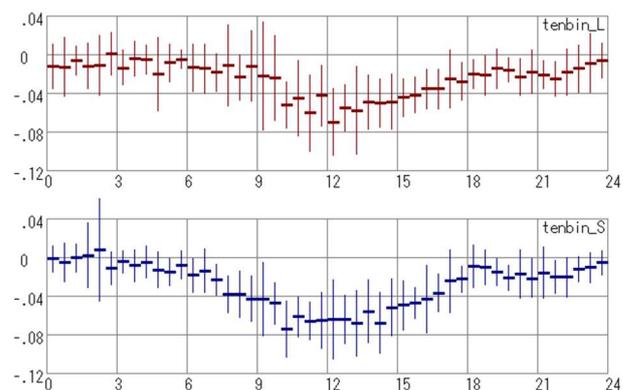


Figure 3. Day change in the amount of the sublimation (Jan. 2017 average)

Vertical axis: Hourly change (mm/hr) upper panel: In case of using the Large electric balance, lower panel: In case of using the Small electric balance.