Note on air temperature measurement by automatic weather stations in Antarctica

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1. Introduction

Many automatic weather stations (AWSs) are currently installed on the Antarctic ice sheet. The Japanese Antarctic Research Expedition (JARE) has also set up AWSs for meteorological observation; however, it is necessary to exercise caution when using this observational data. Here, we report on temperature data in particular.

2. AWS at H128, MD364, and NDF

Since 2016, we have collected Antarctic weather observational data in Japan via the Argos system (AWS-JP). The AWSs were installed at the coastal H128 site (69°24'S, 41°34'E, 1380 m a.s.l.), inland MD364 site (74°00'S, 43°04'E, 3353 m a.s.l.), and NDF site (77°47'S, 39°03'E, 3754 m a.s.l.) in the JARE observational area. They observe air temperature obtained by a forced ventilated solar shelter, snow depth changes, short and long wave upward and downward radiation, and snow temperature in addition to general air temperature gathered using solar radiation shelter, humidity, wind speed, wind direction, and air pressure. This meteorological data is observed at intervals of ten minutes; snow temperatures are observed at one-hour intervals. Four Argos-type AWSs-US, provided in cooperation with the University of Wisconsin, are also set up in the JARE observational area.

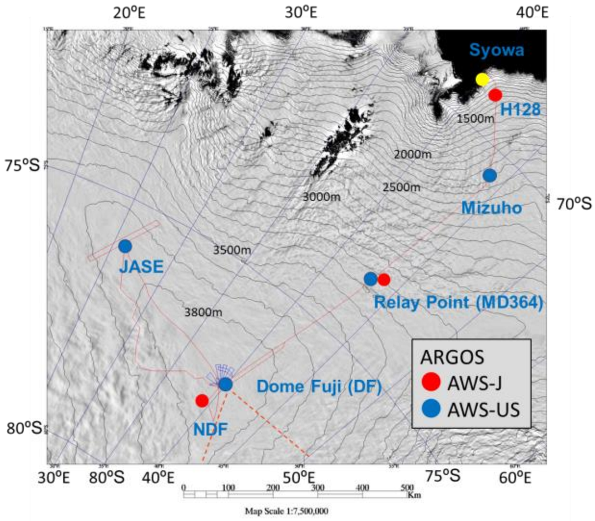

Fig.1. Map of AWS sites.

3. Air temperature using solar radiation shelter and a combination of shelter/ventilation

There was a significant difference between air temperature measurements taken with solar radiation shelter only (T1) and a solar radiation shelter with a forced ventilator operated by a solar cell (T2) at the NDF site from November to February. When solar radiation was strong and wind speed was low, the temperature difference between the two measurements exceeded 10 °C. Therefore, multiple regression analysis was performed using downward solar radiation (w/m^2) and wind speed (m/s). This analysis was carried out using ten-minute, one-hour, and one-day averages. However, similar relational expressions with a determination coefficient of approximately 0.80 were obtained.

$$T2 = T1 - 2.35 - 0.00921 SR\downarrow + 0.591 WS \quad (\text{hourly}, r^2 = 0.81)$$

The average value of the difference between T2 and T1 from November to February was -3.4 °C for the NDF site, -1.4 °C for the MD364 site, and -0.1 °C for the H128 site. If there is data on solar radiation, wind speed, and air temperature by forced ventilated solar shelter, T2 can be accurately estimated from T1. However, it is difficult to observe solar radiation at AWS sites. Thus, care should be taken when using air temperature data from the Antarctic summer season, when the solar radiation intensity is high and the wind speed is weak. In contrast, the difference between T1 and T2 at the H128 site was small and the results of multiple regression analyses were highly variable.

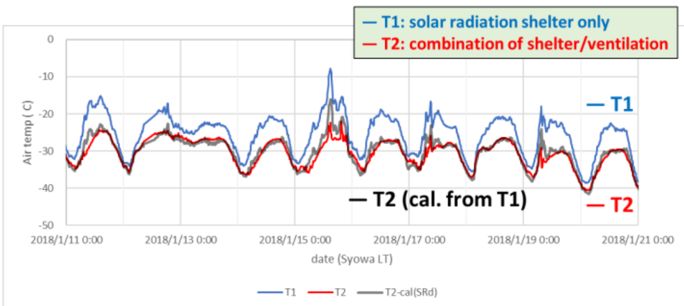

Fig.2. Estimated T2 by T1, SR↓ and WS.

At the inland MD364 site, although there was a large difference between T1 and T2 during the summer, multiple regression analyses could not be performed because there was no solar radiation data. Therefore, we used NDF solar radiation data for the MD364 site instead. The one-hour average determination coefficient r2 is 0.474, but the daily average can reach as high as 0.723. There is a possibility that the T2 temperature can be estimated using T1 data.

Solar radiation and wind speed measurements are very important for measuring summer air temperature in inland Antarctica.