Notes on observational data from automatic weather stations in Antarctica

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1. Introduction

Many automatic weather stations (AWS) are installed on the Antarctic ice sheet. The Japanese Antarctic Research Expedition (JARE) has also established several AWS that conduct continuous observation. We need to be careful when using public AWS data. Hence, we report them.

2. AWS at H128 and NDF sites

The JARE installed its 57th AWS at the coastal H128 site (69°24′S, 41°34′E, 1380 m a.s.l.) in January 2016, and its 59th AWS at an inland NDF site (77°47′S, 39°03′E, 3754 m a.s.l.) in January 2018.

The observational items at the H128 site are air temperature and relative humidity (3 sets), wind speed and wind direction (2 sets), surface height change (snow depth), atmospheric pressure, shortwave radiation (downward and upward), longwave radiation (downward and upward), and ice temperature (13 different depths). The observational items at the NDF site are air temperature and relative humidity (2 sets), wind speed and wind direction, surface height change (snow depth), atmospheric pressure, shortwave radiation (downward and upward), longwave radiation (downward and upward), and ice temperature (10 different depths).

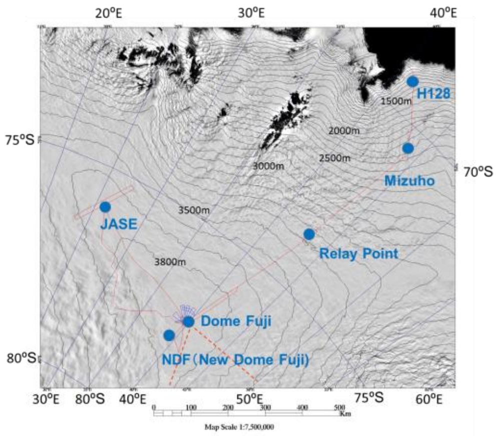

Figure 1. Location of AWS

The ground weather is observed every 10 minutes and the ice temperature is measured at 1-hour intervals. Observational data can be acquired remotely via the Argos satellite system with a time lag of up to one day. However, at times problems with adjusting the power supply voltage and correcting the program make it difficult to successfully acquire data in Japan.

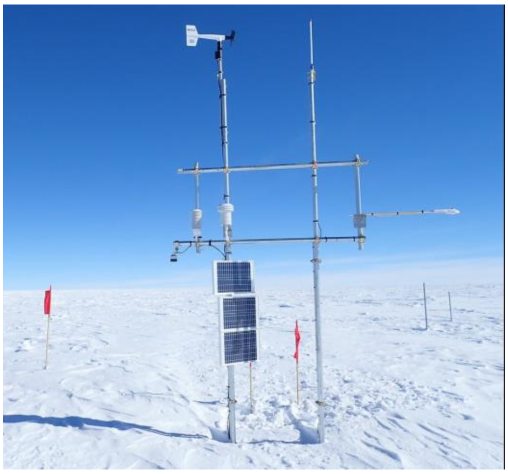

Figure 2. AWS at NDF

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

There was a significant difference in air temperature measurements between T1 (solar radiation shelter only) and T2 (solar radiation shelter with forced ventilator operated by a solar cell). When solar radiation was strong and wind speed was weak, the temperature difference between the two measurements exceeded 10 °C. Therefore, through multiple regression analysis of downward solar radiation (SRdown (w/m^2)) and wind speed (WS (m/s)), a good relational expression was obtained with a determination coefficient of 0.83.

$$T2 - T1 = -2.16 - 0.0114\ SRdown + 1.03\ WS\ (r^2 = 0.825)$$

When air temperature was recorded using only the solar shelter, its value was found to greatly depend on solar radiation and wind speed. However, at the H128 site the difference between T1 and T2 was small and the results of multiple regression analysis were highly variable. Thus, care must be taken when using and interpreting the published air temperature data.

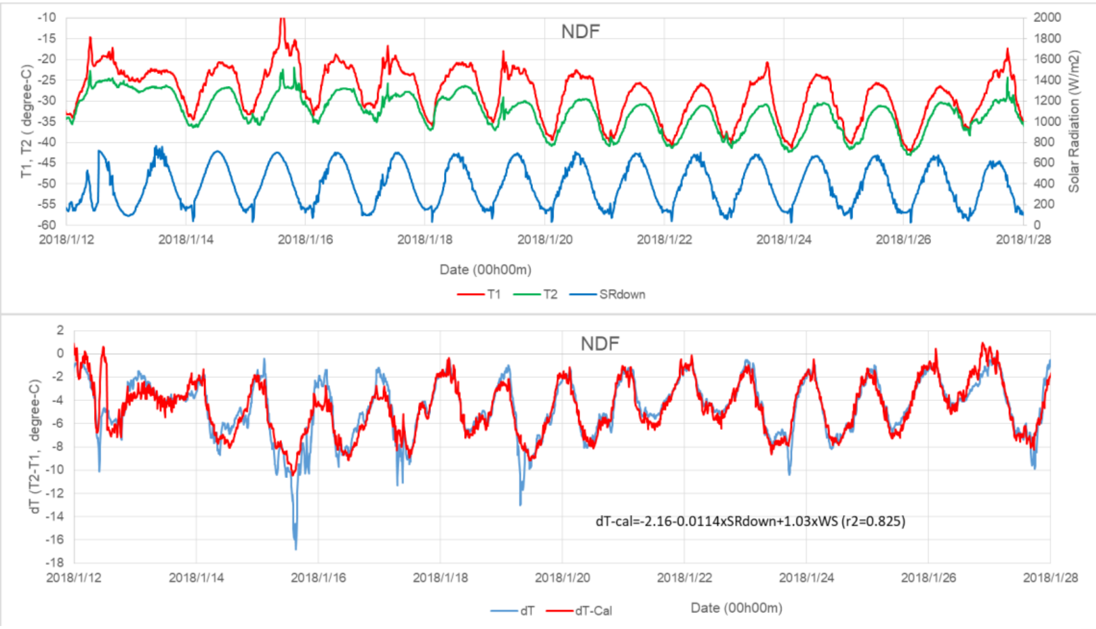

Figure 3. Significant difference in air temperature measurements using solar radiation shelter and a combination of shelter/ventilation.

4. Snow surface fluctuation

When snow surface fluctuation is observed with an ultrasonic snow depth meter, it sometimes records large fluctuations in value. This represents a small-scale version of the moving dunes phenomenon. At a certain trigger point, drift is formed on the snow surface and moves downwind. As this moving dune passes under the snow depth meter, a large value is registered. When it passes by, the reading returns to the initial value. Additionally, it has been observed that the snow depth at the base of the AWS tower gradually decreases due to densification if new snow cover is not received for a certain period of time.

5. Shortwave and longwave radiation

During downward shortwave radiation measurements, frost can stick to the filter and snowfall can accumulate on the instrument. Under these conditions, the albedo value exceeds 1. Sometimes, the snow surface used to observe upward shortwave radiation may be inclined. When this occurs, the peaks of upward and downward radiation shift and albedo values may change unexpectedly. Downward longwave radiation is also affected by frost and snow. However, it is easier to determine whether an upward longwave radiation value is abnormal once it is converted to surface temperature.

6. Long-term observation

In cooperation with the University of Wisconsin, the AWS-US has been operating for a long time at the Dome Fuji, Relay Point, Mizuho, and JASE. Our duties have been to raise the observation tower, renew the instruments, exchange the loggers and transmitters, update programs, and replace batteries, among various other tasks. At the AWS-US installed at Dome Fuji, simultaneous observation of temperature and wind speed was conducted with the data-logger-type AWS-JP. Also, the observation data were compared with data from the NDF installed in 2018.

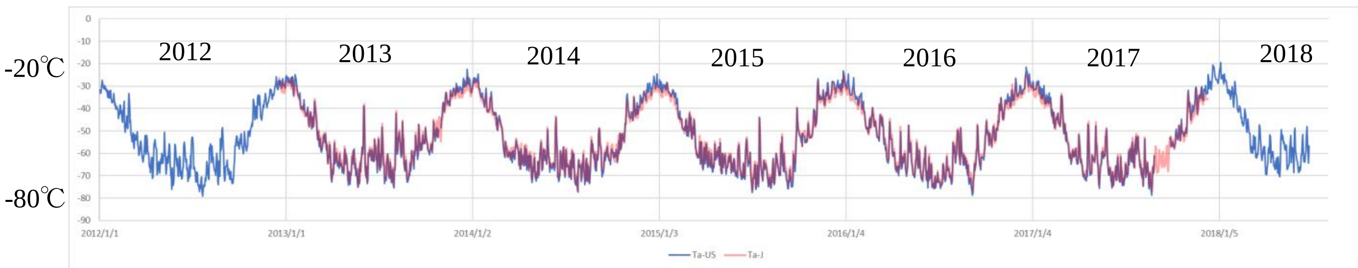

Figure 4. Daily mean air temperature at Dome Fuji. blue line: AWS-US, red line: AWS-JP.