Operation of Atmospheric Radiation Measurement Radiation Instruments in Fairbanks to Evaluate Performance in a Cold Environment

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Introduction

The North Slope of Alaska (NSA) is an area with an adverse and severe climatological environment. Harsh weather conditions in the Arctic offer unique challenges for data collection. ifficulties associated with working in a remote locale will further complicate taking the standard radiation measurements at the NSA/AAO Cloud and Radiation Testbed (CART) site. Equipment must survive low temperatures and extended periods during which maintenance will be difficult. Since the temperature in Fairbanks often drops below -40ºF during the fall and winter, these conditions have a close resemblance to those encountered at the NSA site. The purpose of this operation of selected instruments in Fairbanks prior to deployment at the ARM/NSA/AAO site, is to test their performance and gain operational experience under cold conditions. This will teach us how to deal with and solve the practical problems that we will be facing in routine operation of and data acquisition from these instruments, and it will allow us to formulate sound procedures regarding their future implementation and deployment at the NSA/AAO CART site.

Operational Aspects

The performance of a few radiation instruments to be operated at the NSA/AAO site, are being evaluated under cold environment. In the summer of 1993 the Multi-Filter Rotating Shadowband Radiometer (MFRSR) (Harrison et. al. 1994) was deployed on the roof of the Geophysical Institute (GI) in Fairbanks. The data were downloaded to the Pacific Northwest National Laboratory (PNNL) until April 1995, and to the Geophysical Institute since then.

We had adopted the Shortwave Infrared Observing Station (SIROS) concept from the Southern Great Plains (SGP) ARM site, where the MFRSR also serves as the primary data logging station for a suite of other sensors. This allows us to implement the same data processing program for a set of solar and IR radiation instruments. In late summer 1994 an Eppley Precision Infrared Radiometer (PIR) on loan from the ARM Program equipped with a ventilator with a better fan (EG&G ROTRON, Px3BT115AC N763ZH) to alleviate the frost and moisture accumulation on PIR's dome was added. Both instruments have been installed on a new mount.

Since the MFRSR is called twice a day and after a power failure is restarted automatically at this time, the power outages result only in some loss of data during the warm period of the year. At low temperatures a power outage of a few hours duration may cause damage to the MFRSR detector head. In late November 1994 when the temperature dropped to -30ºF the unit had lost the power due to an electronics fault in the logger board. In February 1995 the detector head of the MFRSR unit was replaced.

Suggestion: To ensure the AC power during the power outages consider the use of a commercially available uninterrupted power supply unit.

In December 1995, when the temperature dropped to -30ºF, the built-in modem stopped answering resulting in loss of data from the PIR and MFRSR instruments, although the remaining part of the data acquisition system remained in operation. In January 1996 we got a spare modem from PNNL, replaced the broken one, and resumed data collection. Because of the difficulties associated with working at low temperatures it seems highly desirable to limit the maintenance activity in the field.

Suggestion: Although the electrical specifications of the data acquisition systems manufactured by Yankee Environmental Systems Inc. are guaranteed over the complete -50ºC to +50ºC environmental temperature range, we propose to install all electronics into a thermally insulated enclosure with a fan type electric heater where some minimum amount of spares and supplies could also be stored. A replacement of failed sub-units could safely be done inside the enclosure which also would provide necessary protection from wind and mosquitoes.

Data Samples

Solar irradiances measured by the MFRSR under clear-sky (November 5) and overcast cloudy (October 20) conditions are shown in Figure 1. Due to a noise problem in the data it appeared impossible to obtain Langley regressions by means of the objective algorithm of Harrison and Michalsky (1994) where strict fitting constraints are applied. Using a least-squares regression technique, the following values of the atmospheric optical depths were retrieved based on 11 selected days of observation: 0.401, 0.228, 0.178, 0.123, and 0.07 at 414, 499, 608, 662, and 859 nm, respectively. Based on these limited data, the atmosphere over Fairbanks appears to be slightly more turbid in the morning as compared to the afternoon.

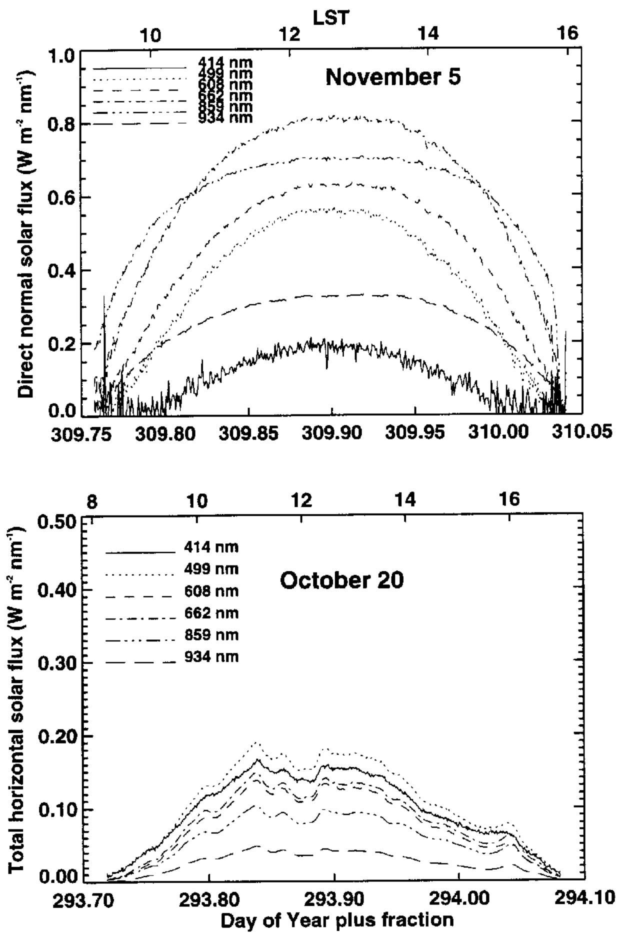

Figure 1. Solar fluxes measured by the MFRSR in Fairbanks.

Our observations made by the PIR during winter indicate that the ventilator indeed works very efficiently and prevents snow accumulation on the PIR's dome. The IR fluxes measured on the same two days are presented in Figure 2. The IR fluxes measured on November 5, 1994, have been compared with model estimations based on radiosonde sounding data obtained from the National Weather Service in Fairbanks. Figure 2 (upper panel) indicates good agreement between measured and modeled values.

Progress

In September 1995 the radiometer equipment funded by the NSF grant G95-36 (SHEBA Tethered Balloon Project) to the GI UAF was ordered. An Eppley Precision Spectral Pyranometer (PSP) with ventilator and a Yankee Environmental Systems (YES) Total Solar Pyranometer (TSP-1) arrived in late 1995. In February 1996, after testing of both units at PNNL these pyranometers have been deployed on the roof of the GI next to the Eppley PIR and became a part of SIROS.

The purpose of the Eppley and Yankee pyranometers that are part of the SHEBA Thethered Balloon project is to test more compact units that are suitable for deployment on a Balloon platform. Thus, two such instruments are being acquired for the SHEBA Balloon project: a Double-Sided Total (solar and thermal) Hemispherical Radiometer with ventilator for measuring incoming total hemispherical irradiance, outgoing total hemispherical irradiance and net irradiance simultaneously; and a Double-Sided Pyranometer with ventilator for measuring the same three solar components. The instruments are produced by Radiation and Energy Balance Systems Inc. (REBS). A Campbell 21XL Data logger will collect the data from these radiometers.

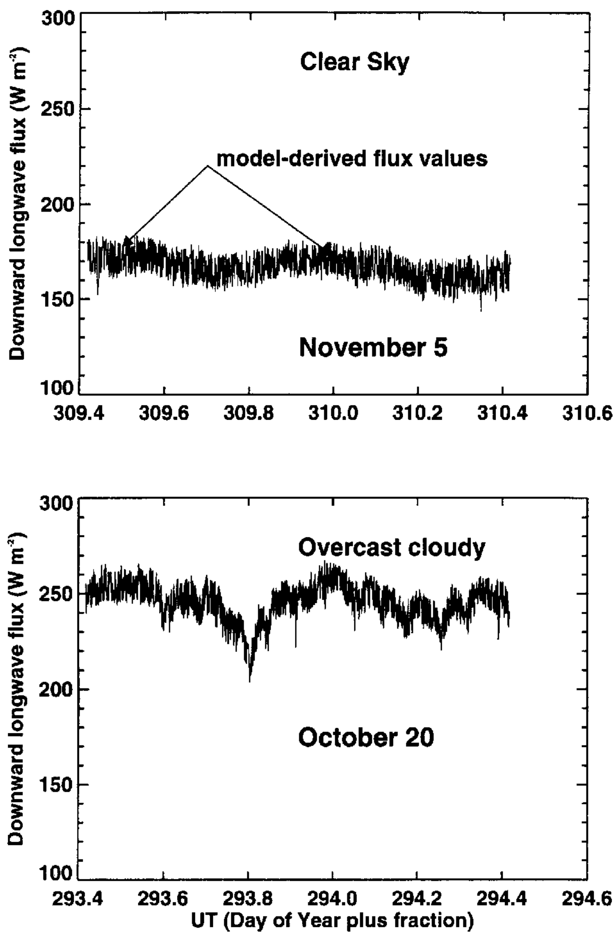

Figure 2. Downward IR flux measured by Eppley PIR in Fairbanks.

A zenith-viewing microwave radiometer has been installed at the GI by J. Liljegren of PNNL for testing during the 1995-96 winter season. It appears that the radiometer works well.

Future Plans

The REBS radiometers should be mounted on a platform that resembles the balloon mount to simulate the conditions of the balloon environment in the future radiation measurements from the tethered-balloon system at the SHEBA ICE Camp. The ultimate goal is to test the performance of the REBS radiometers in a variety of conditions, especially during very cold winter periods against the Eppley PSP, PIR, and Yankee TSP-1.

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