

Nauru Island Effect Study – Installation and Preliminary Data

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Abstract

A limited suite of instrumentation was installed on the windward side of Nauru to help in understanding the effect the island has on downwind development of clouds. This is of specific interest since the Atmospheric Radiation Measurement (ARM) Atmosphere Radiation and Cloud Station-2 (ARCS-2) site is on the leeward side of the island. This poster presents the instruments, data streams, and preliminary data from this study.

Background

During the first Department of Energy (DOE)/ARM Nauru99 Workshop held at Pacific Northwest National Laboratory (PNNL), various results were presented that indicated there indeed is an island effect on the measurements being made at the Nauru ARM site. Detection of an island effect was shown in many ways, including comparisons between ship and ARM site data, comparison of topside and ARM site measurements, and satellite images. The cause of this “island effect” is due to the ARM site being located on the leeward side of the island, a siting that proved necessary given the limited available choices for sites on Nauru. Of the results presented at the Workshop, some measurements, such as moisture amounts and wind speeds, do not appear to be significantly affected. Some measurements, such as wind direction and downwelling longwave radiation, appear to be slightly, but consistently, affected. Other measurements, such as downwelling shortwave radiation, cloud base height statistics, and cloud amounts appear to be significantly, though only periodically, affected.

Thus, the Tropical Western Pacific (TWP) Site Scientist Office proposed a Nauru Island Effect Study (NIES). The intent of the 1-year study is to quantify the island effect in the Nauru ARM site measurements. Figure 1 shows the location of the NIES site with respect to the ARM ARCS-2 site.

Installation

From October 31 to November 9, 2001, we installed the instrumentation and data system on Nauru just to the north of the Menen Hotel. The following instrumentation is currently installed:

- Vaisala ceilometer
- Yankee TSI-880 Total Sky Imager (TSI)
- Yankee Multi-filter Rotating Shadowband Radiometer (MFRSR)



Figure 1. Location of NIES and ARCS-2 sites.

- Eppley PSP, PIR, and B/W measuring downwelling radiation
- Kipp & Zonen Solar tracker
- Heinman Infrared Thermometer (IRT) measuring sky temperature
- Met station consisting of:
 - Temperature
 - Pressure
 - Humidity
 - Wind speed/wind direction
 - Optical rain gauge

Figure 2 shows a picture of the instruments and where they are installed with respect to the ocean. During high tide and westerly winds, significant amounts of salt spray are deposited on the instruments. Significant amounts of corrosion were noticed after 4 months of run-time. Examples of corrosion on the Normal Incidence Pyrheliometer (NIP) and TSI are shown in Figure 3.

A single fiber optic cable and single power cord was run from a second floor corner room in the hotel to the instrument field. This room houses the data collection computer, a frequency-converting uninterruptible power supply (UPS) for the outside equipment, another UPS for the inside equipment, the ceilometer computer, and a spare laptop that can serve as the data system. The data system includes a Global Positioning System (GPS) receiver and timeserver software to provide accurate time-stamping among all instruments.

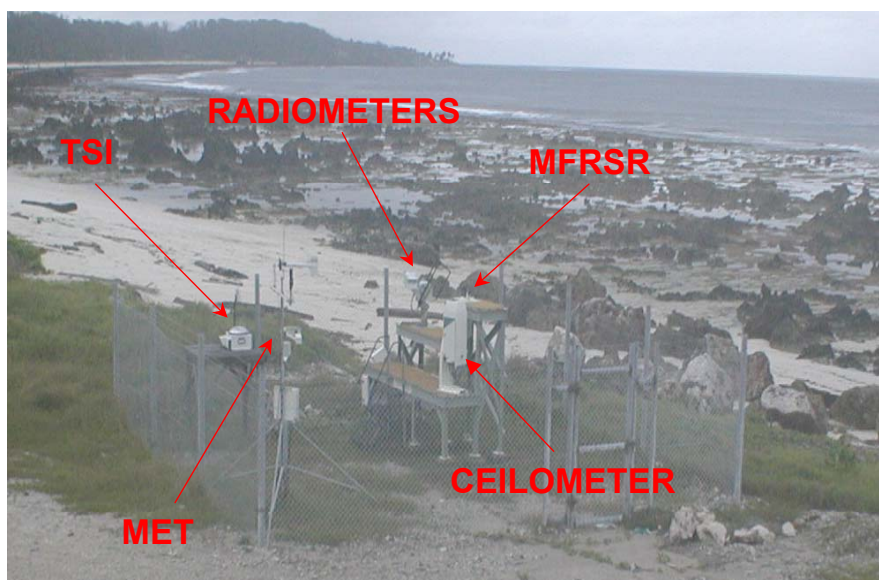


Figure 2. NIES site instrument field.



Figure 3. Examples of instrument corrosion.

During the NIES installation, a TSI-880 was also installed at the ARCS site. This is a permanent installation and data from this instrument is available from the ARM Archive.

Operations

The ARM observers from the ARCS site visit the NIES site at least once per day. During this time, they perform routine cleaning of the domes and mirrors, instrument operation, and data system operation. Once per week, the observers create a data CD and mail it to PNNL. The data are also permanently stored on the data collection computer's hard disk and a redundant external hard disk.

There have been some unanticipated operational challenges. Just before installation began, two of the island's power generators failed. This resulted in rolling power outages throughout the island. New generators were received in November but these new ones failed in February. This resulted in more power outages that last typically 4-5 hours per day, but have on occasion lasted for more than a day. The histogram in Figure 4 shows the data availability through February. Note that February data availability is horrendous. This is due solely to power outages. The ARCS site has back-up generators so data is uninterrupted there.

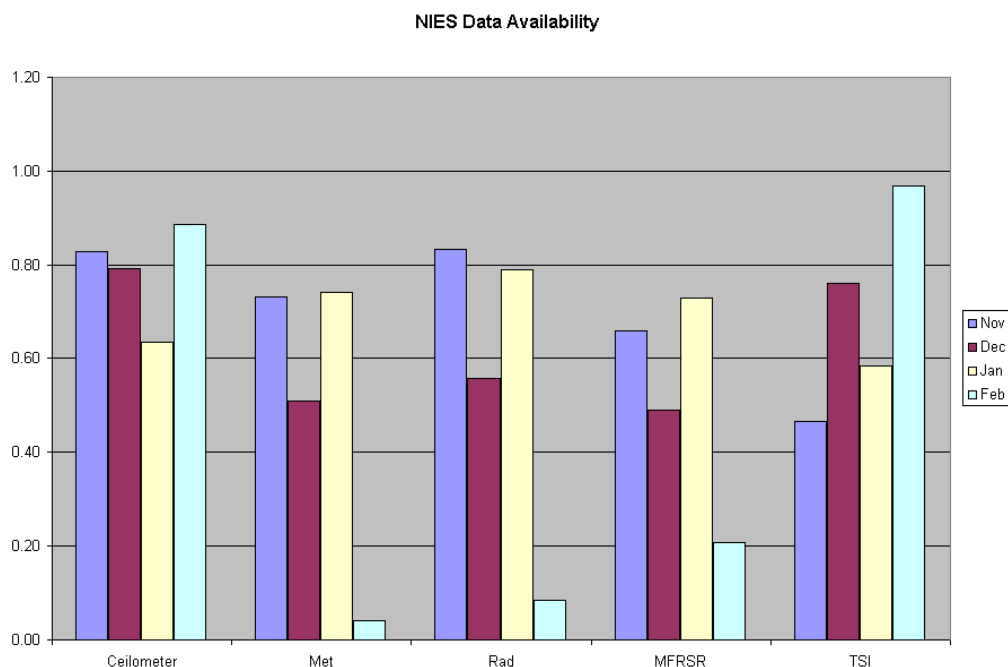


Figure 4. Data availability during November – February.

Preliminary Results

Figures 5 through 12 are plots of data from the NIES TSI, comparisons of NIES and ARCS-2 ceilometer, radiation, and meteorological instruments from January 16 and 17, 2002. Note that the data, especially from the radiometers and ceilometer, show a significant increase in the amounts of cloudiness at the ARCS-2 (leeward) site over the NIES site (windward). Radiometer data appear to have noise showing up during darkness hours. We believe this is due to a ground loop problem; we are currently investigating this.

Summary

The data are being collected. Early indications agree with data from Nauru 99 and from satellite imagery that ARM instruments at the ARCS-2 site are seeing the effect of the island. The complete data set will be analyzed in early 2003 to determine the extent of the effect that the island has on the ARCS site data.

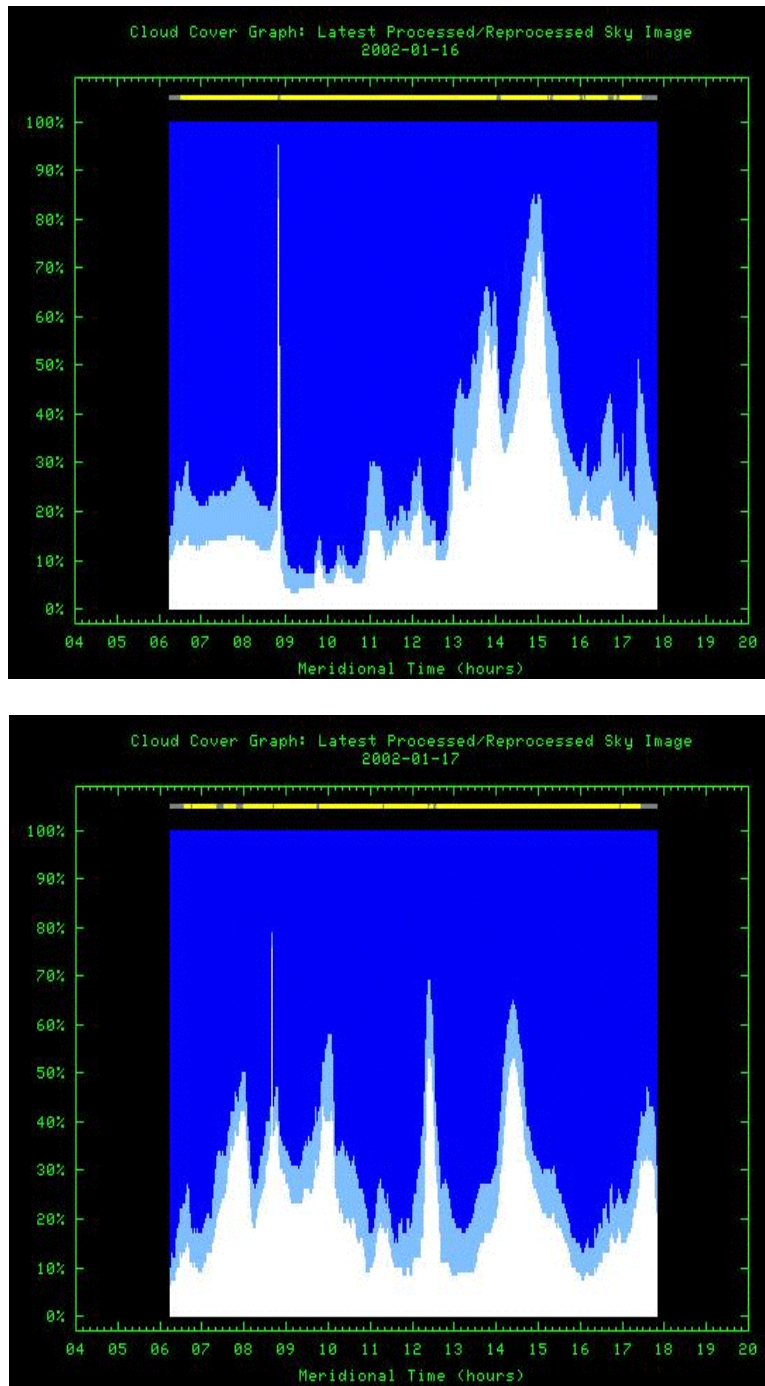


Figure 5. NIES TSI cloud cover for February 16 and 17, 2002.

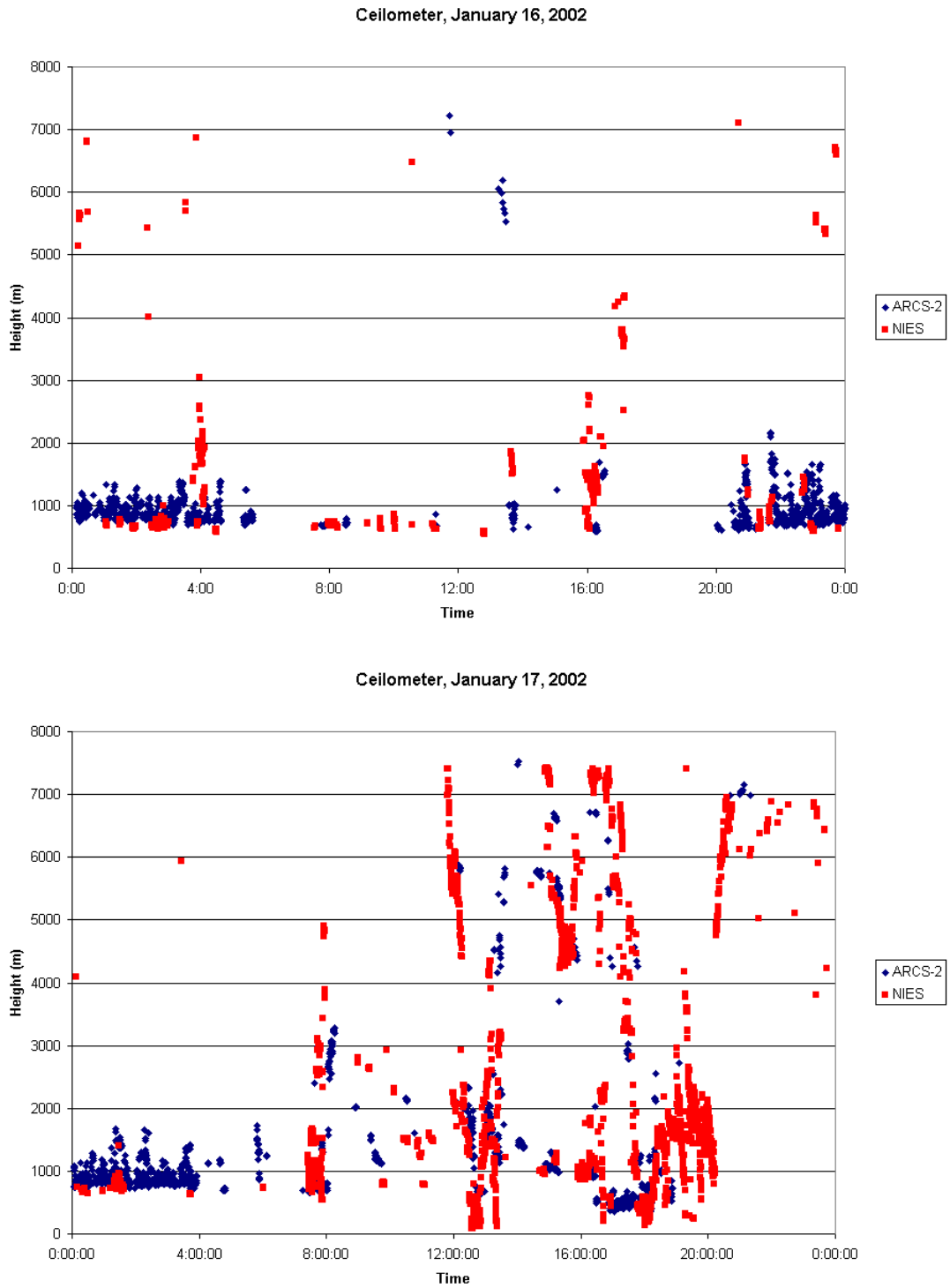


Figure 6. Comparison of NIES and ARCS-2 ceilometer data.

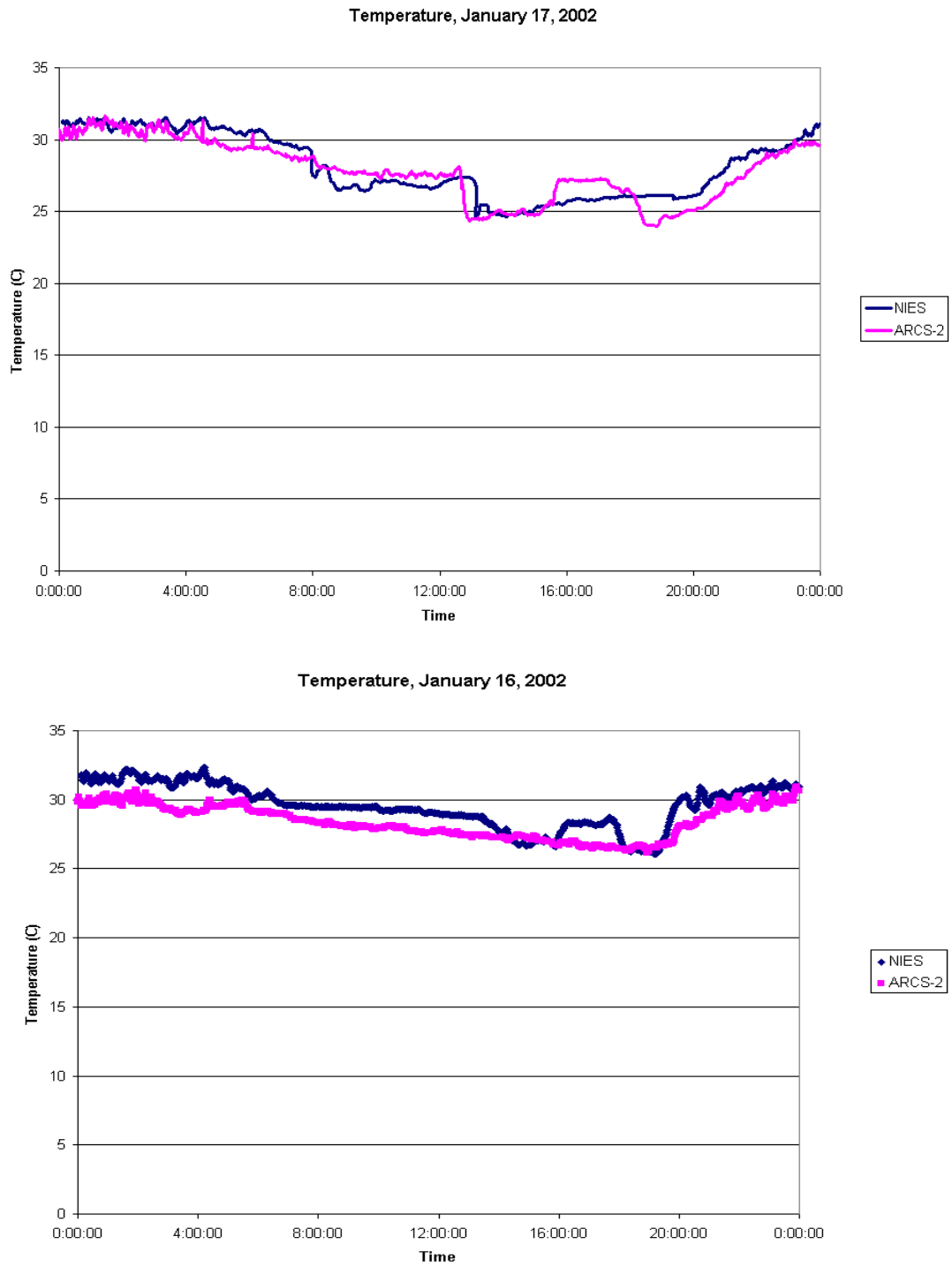


Figure 7. Comparison of NIES and ARCS-2 temperature data.

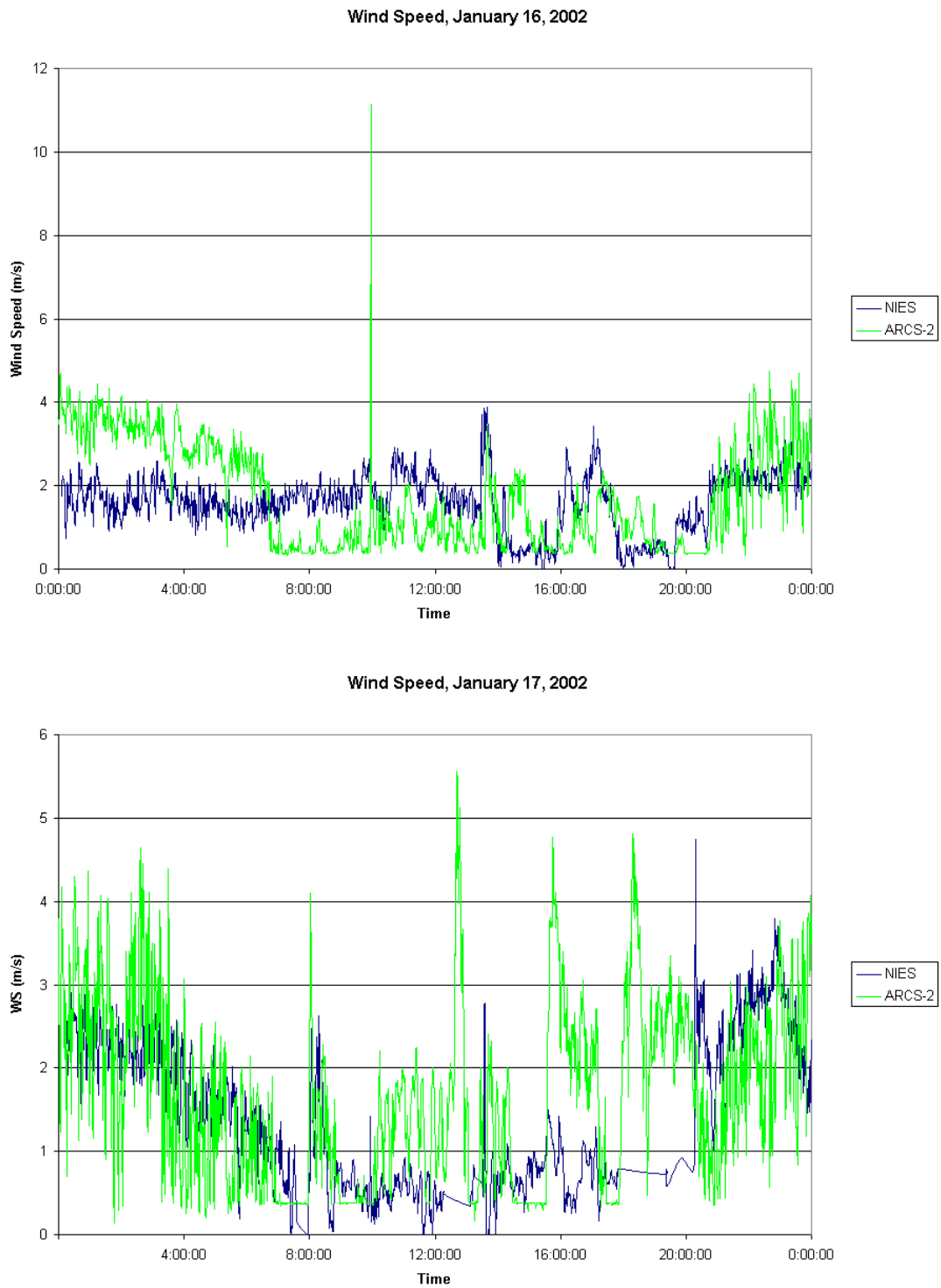


Figure 8. Comparison of NIES and ARCS-2 wind speed data.

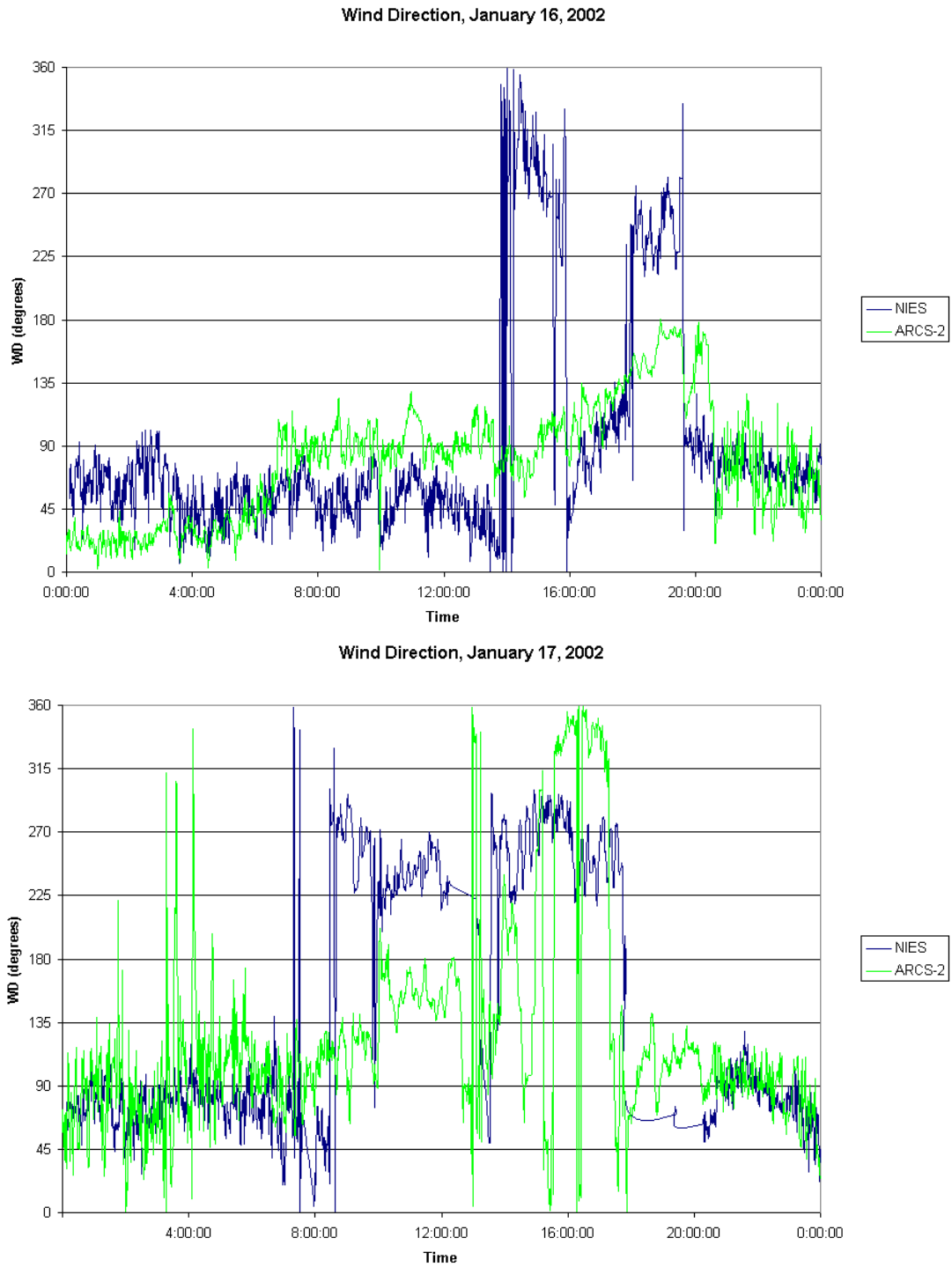


Figure 9. Comparison of NIES and ARCS-2 wind direction data.

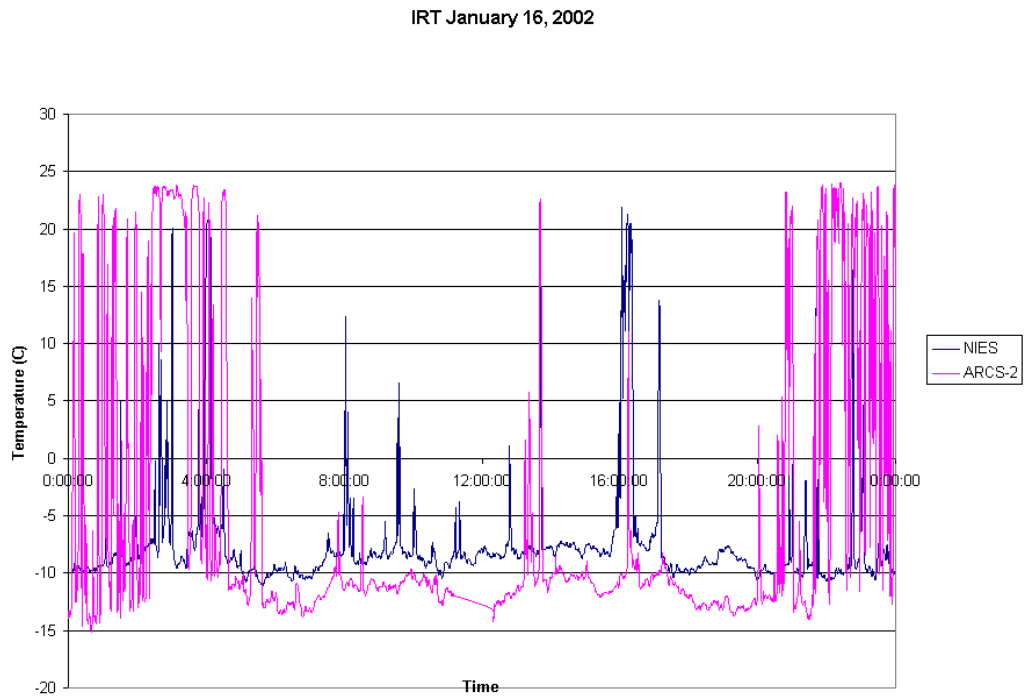
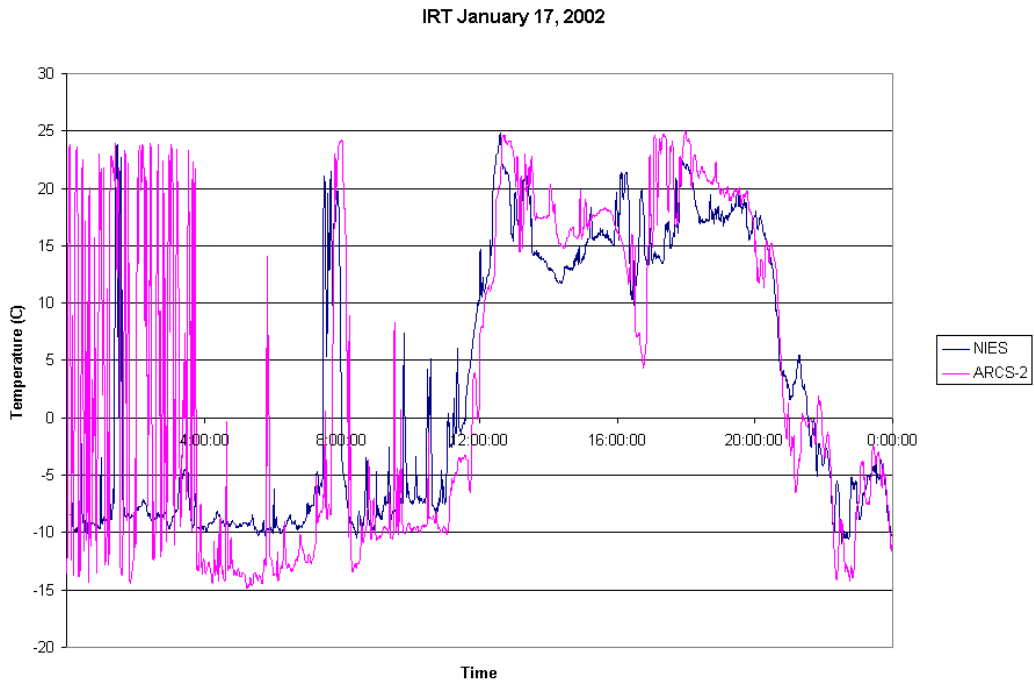
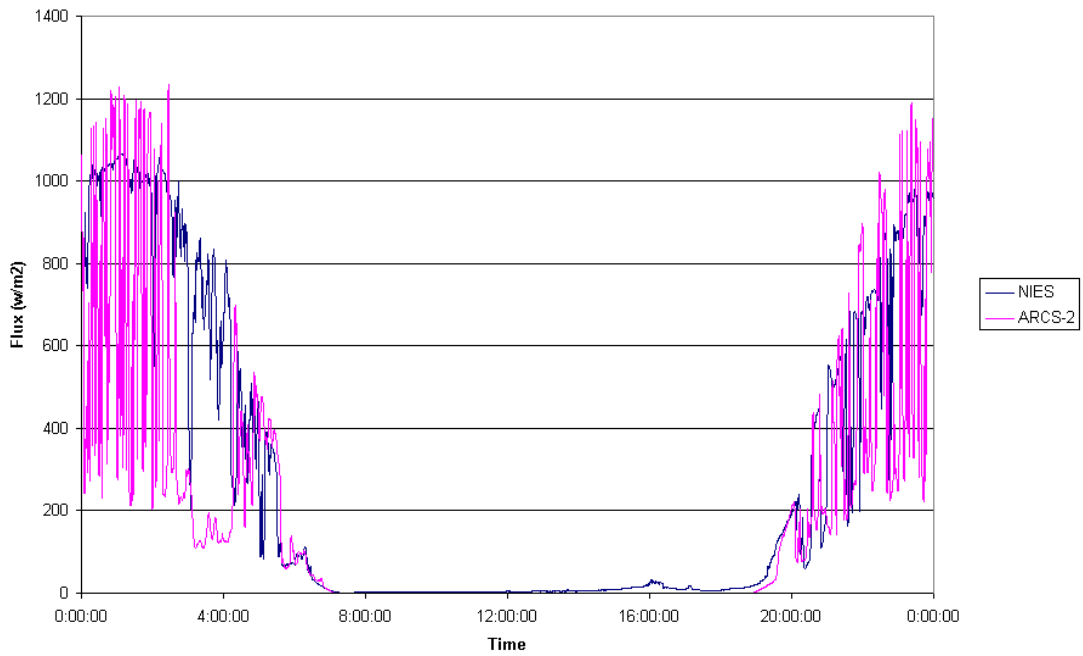


Figure 10. Comparison of NIES and ARCS-2 IRT data.

PSP January 16, 2002



PSP January 17, 2002

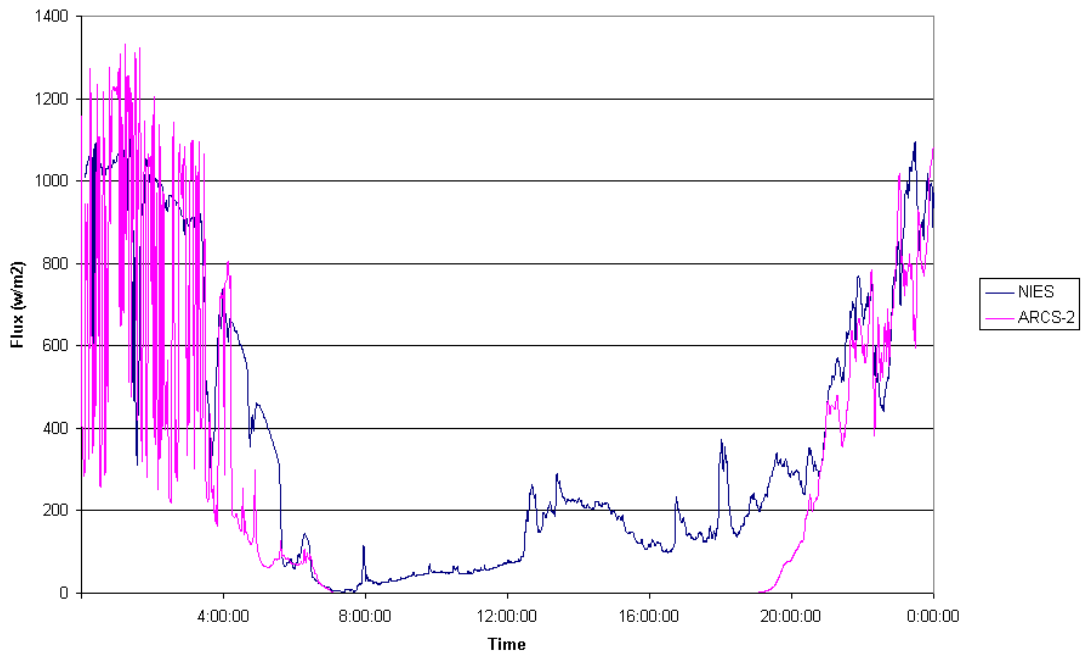


Figure 11. Comparison of NIES and ARCS-2 PSP data.

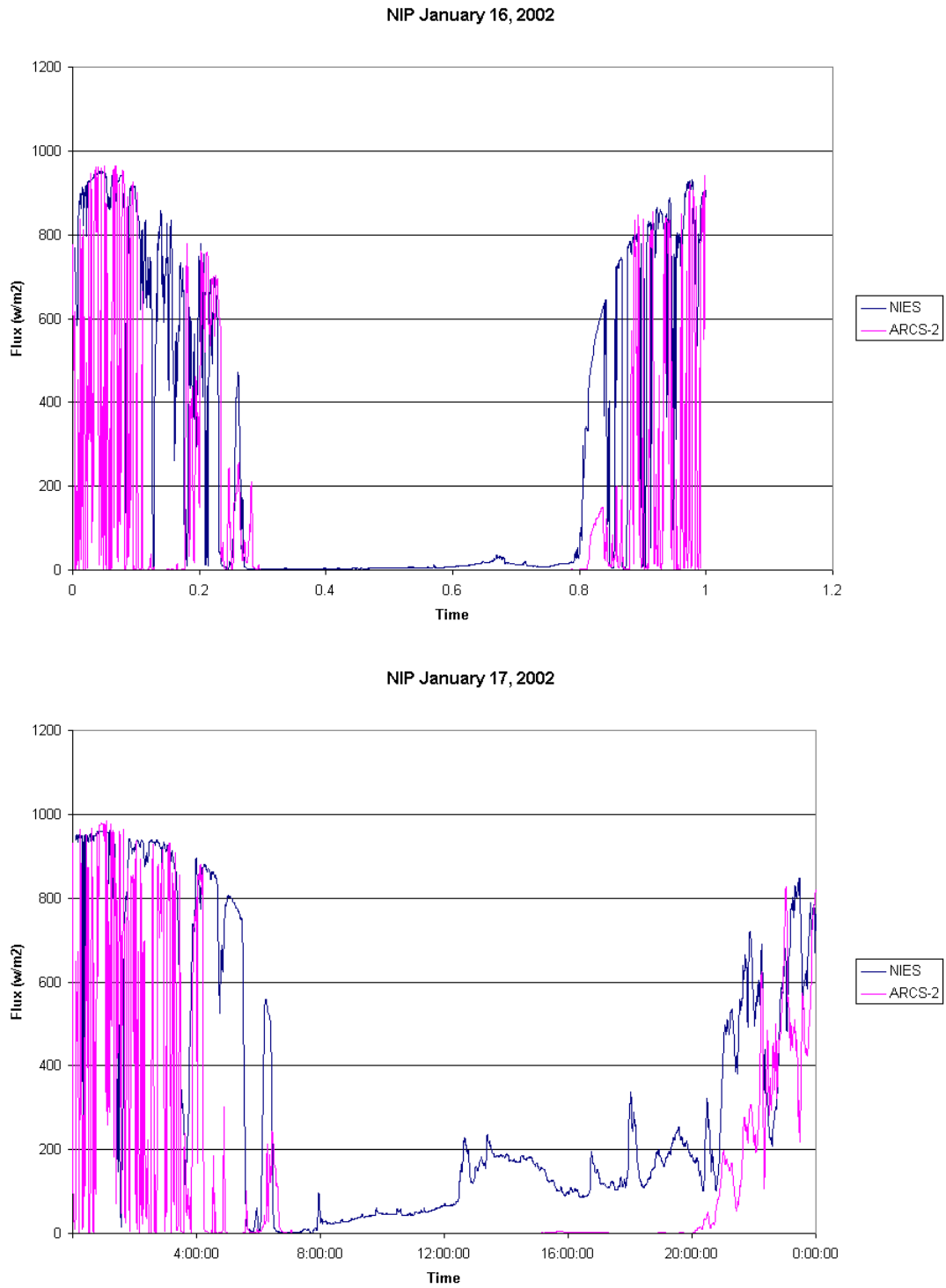


Figure 12. Comparison of NIES and ARCS-2 NIP data.