Data Quality Display Modules - Assessment of Instrument Performance at the Southern Great Plains Cloud and Radiation Testbed Site

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Introduction

Graphical displays of geophysical data plotted against expectations are useful in identifying instrument malfunction. Such displays are being incorporated into modules for utilization by Site Operations staff (primarily), the Site Scientist Team, and Instrument Mentors, for quick detection of instrument malfunction and a first-level data quality check (i.e., are the data streams within reasonable bounds?).

Displays Under Development

The display modules are currently in a development and testing mode designed to create displays that provide utility for the operation of the Southern Great Plains (SGP) Site. Since standard time series displays of individual data streams often do not provide sufficient context to evaluate the operating status of an instrument, creation of displays that provide proper background to data streams from the instrument are important. Display modules currently in the development stage include (but will not be limited to) the following:

- comparison of Solar and Infrared Observation Station (SIROS) hemispheric broadband solar observations at Atmospheric Radiation Measurement (ARM) SGP Extended Facilities (EFs) to modeled clear sky estimates
- comparison of shortwave albedo estimates (from SIROS data) from multiple EFs
- comparison of broadband longwave observations (both upwelling and downwelling) from multiple EFs
- plots of the logarithm of the direct irradiance from the six Multi-Frequency Rotating Shadowband Radiometer (MFRSR) channels versus the airmass depth viewed (from multiple EFs).

The test display being used to compare SIROS-based estimates of the hemispheric broadband solar irradiance makes use of SIROS data and modeled estimates of the broadband solar flux at each EF. The flux based on the SIROS unshaded pyranometer is plotted as well as that derived by adding the diffuse component from the shaded pyranometer to the direct component (multiplied by the cosine of the zenith angle) obtained from the pyrheliometer. The difference between these two estimates is also plotted. The clear sky model estimates of the broadband flux are based on a model by Meyers and Dale (1983) and are plotted for additional context. Six model estimates are used with each estimate based on a different amount of precipitable water. The various model estimates provide a range of expectations for a clear sky day. An example of the display is shown in Figure 1 for the Cyril EF. In this case, a discrepancy in the unshaded pyranometer data may indicate that maintenance is necessary (e.g., cleaning the radiometer dome).

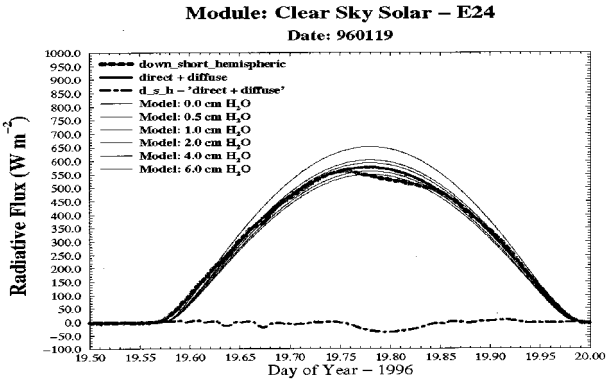

Figure 1. Display of SIROS derived estimates of the hemispheric broadband and modeled estimates for the Cyril, OK Extended Facility on January 19, 1996. 40 W m^{-2} differences between the unshaded pyranometer (down_short_hemispheric) and that calculated from the direct and diffuse components are noted during mid-day.

Estimates of albedo based on SIROS upwelling and downwelling broadband hemispheric fluxes provide an alternative method for evaluating broadband radiation data. Figure 2 depicts the albedo from a variety of extended facilities on January 8, 1996. The albedos during the afternoon range between 0.2 and 0.3 for most of the sites. However, one facility, Ashton (E8), departs from the others, which may have been an indicator of improper sensor performance. It was found, after further investigation, that E8 was experiencing melting snow cover. The data from E8 compared well to the other EFs after the snow-melt.

The display of quantities from multiple EFs onto one graph has been extended to the SIROS upwelling and downwelling broadband longwave fluxes. Though not shown, this has proven to be helpful in identifying SIROS components experiencing excessive noise in the longwave. Similar extension of the idea of overlaying time-series from several EFs to the MFRSR data has been shown to provide utility. Figure 3 depicts the natural logarithm of MFRSR Channel 4 direct irradiance data from several EFs as a function of the depth of air mass on January 13, 1996. The skies were generally clear across the SGP Cloud and Radiation Testbed (CART) Site, resulting in the expected nearly straight line plots of data for the given facilities. Improper calibrations explain the wide separation between facilities, though they do not affect the linear relationship between the natural logarithms of the direct radiation and the airmass depth. Non-conformance to the linear profile on a clear sky day could lead to identification of sensor problems not related to calibration.

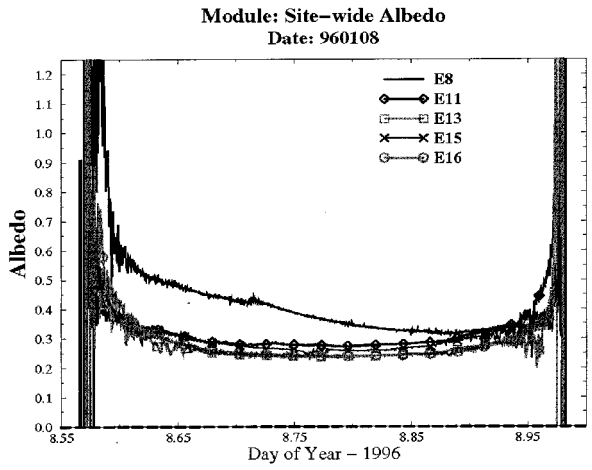

Figure 2. Albedo estimates displayed from across the Site reveal different behavior at one of the Extended Facilities, E8 (Ashton, KS). The data from E8 was found to be associated with melting snow-cover, while the other facilities had none.

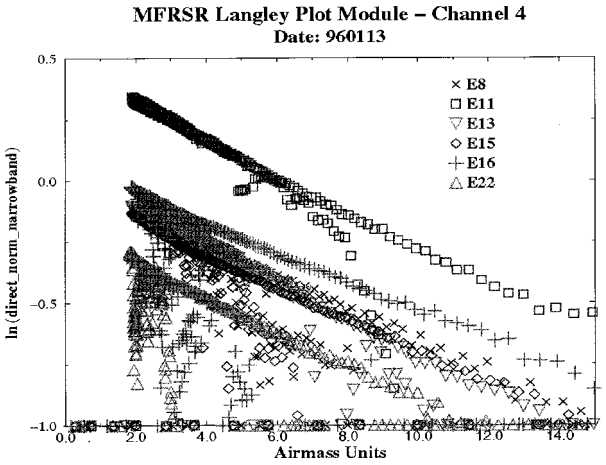

Figure 3. MFRSR Channel 4 natural logarithm (direct radiation) plotted as a function of airmass reveals the expected linearity for a given EF as a function of nearly clear sky conditions across the SGP Site. Values near -1 for the irradiance indicate "missing" data points.

Incorporation into Site Operations Activities

The displays are currently created and housed on the Site Scientist's workstation and are available to Site Operations and others via a World Wide Web interface. Data for the displays are transferred to the workstation from the Site Data System (SDS) at the Central Facility on a daily basis. Due to the logistics of the data transfer, the most recent data for a display is from two days previous. Transfer of the display modules from the Site Scientist's Workstation to the SDS may allow for more real-time data to be examined. The display modules are not just comprised of the graphical displays of data, but will also include guidance instructions for Site Operations staff on use of the modules to detect instrument malfunction as well as a reporting mechanism to report results of data inspections. Reports issued by Site Operations staff that indicate a potential problem with a data stream are planned to be reviewed by the Site Scientist Team to determine the required action (e.g., maintenance action, Instrument Mentor notification, etc.).

Module development will be focused in the future on incorporating an expanding number of data streams, especially including the use of multiple data platforms within a display. Use of modeled expectations of data streams will also be pursued when reasonable. Interaction with Site Operations will be essential in tailoring the modules to their needs.

The modules are anticipated to help Site Operations in the daily evaluation of instrument performance, which will aid in maintenance efforts and improve the overall quality of data from the SGP Site, especially as the Site approaches the physical completion of its full array of instrumentation.

Reference

Meyers, T.P., and R.F. Dale, 1983: Predicting daily insolation with hourly cloud height and coverage. *J. Appl. Climate and Meteor.*, **2**:537-545.