Surface Spectral Albedo Intensive Operational Period at the ARM SGP Site in August 2002: Results, Analysis, and Future Plans

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Introduction

A surface spectral albedo Intensive Operational Period (IOP) at the Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) site was conducted during August 14-19, 2002, to meet the ARM Program need in a detailed knowledge of surface boundary conditions for atmospheric radiation studies. We measured surface spectral albedos/reflectances for several representative surface types and made a survey of landcover types over an area of approximately 10 km x 10 km centered around the Central Facility (CF). Spectral measurements were taken using a GER-3700 spectroradiometer with a spectral coverage between 300 nm and 2500 nm. The survey of landcover classes was used in the classification of the landcover type distribution derived from Landsat ETM images. These data are available from the ARM IOP data archive (http://iop.archive.arm.gov/arm-iop/2002/sgp/sfcalb/).

Instrumentation and Observations

The GER-3700 spectrometer was designed by the Geophysical and Environmental Research Corporation (GER) (http://www.ger.com/ground.html). This is a high performance single-beam field spectroradiometer that measures shortwave radiation over the visible to infrared wavelength range. Specifications of the instrument are provided below:

Spectral Coverage:	300 - 2500 nm
Spectral Sampling:	1.5 nm over the range 300 - 1050 nm
	6.2 nm over the range 1050 - 1900 nm
	9.5 nm over the range 1900 - 2500 nm
Detectors:	Si/PbS/PbS, 3 Dispersion Gratings
Number of channels:	649
Field of View (FOV):	3°, 10°, 180° (diffusor)

This equipment (Figure 1) for ground measurements is portable and can be deployed quickly onsite; measurements at one point take around 30 minutes or less. This approach causes no damage to the crop or disturbance to the farmer's fieldwork, which is quite important for access to private land. The sky conditions for the first two days were clear-sky to scattered cloudiness; for the third day (August 16, 2002), sky conditions were overcast to mostly cloudy. Since the reflectance measurements are based on upward and downward measurements made by the same sensor, data for August 16 are less reliable due to the variability in downward flux over one cycle of measurements.

Figure 1. GER3700 setup used for surface reflectance measurements during the IOP.

On August 17 and 18, we visited several extended facilities (EF) to cover as much as possible the natural range of variability of surface reflective properties in the area; the EF included Ringwood, Byron, El Reno, Meeker, and Pawhuska. During the last day of the field campaign (August 19), we made a survey of the distribution of landcover types in the area to collect ground truth information necessary for classification of landcover types from satellite imagery.

Landcover from Satellite Data

We used the ground survey and Landsat data for September 1, 2002, to derive a landcover map over the 10 km x 10 km (6 mi x 6 mi) area centered at the ARM CF. The Landsat scene on this day was used to produce this map because the Landsat image for August 16 was not usable due to overcast cloudy conditions. A classification scheme KCLUS from the PCI software package was used to derive the

distribution of landcover classes. The total number of classes was then reduced to 10 by aggregating similar types according to the results of landcover survey conducted on August 19, 2002. It is possible that some changes in landcover were not properly captured due to agricultural activities practiced during the time since our survey. Results are presented in Table 1. Landcover map is available in netCDF format from the ARM IOP data archive at http://iop.archive.arm.gov/arm-iop/2002/sgp/sfcalb/.

Table 1. Statistics of dominant landcover types in the area 10x10km^2 around the ARM CF during late August.

Index	Land Cover Type	Percentage (%)
1	Water	0.48
2	Land-water mix	0.67
3	Deciduous trees/shrubs	3.96
4	Pasture/grassland	13.03
5	Corn/milo	11.40
6	Wheat stubbles/dry grass/ hay field	6.77
7	Bare soil with short grass	21.53
8	Bare soil dark/wet	17.02
9	Bare soil medium	21.76
10	Bare soil light	3.39
7-10	Bare soil total	63.71

The overall accuracy of the derived map is estimated to be better than 90%. The most dominant landcover type (at 64%) is bare soil in various conditions (wet, dry and partially vegetated), followed by pasture/grassland (13%) and corn/milo fields (11%).

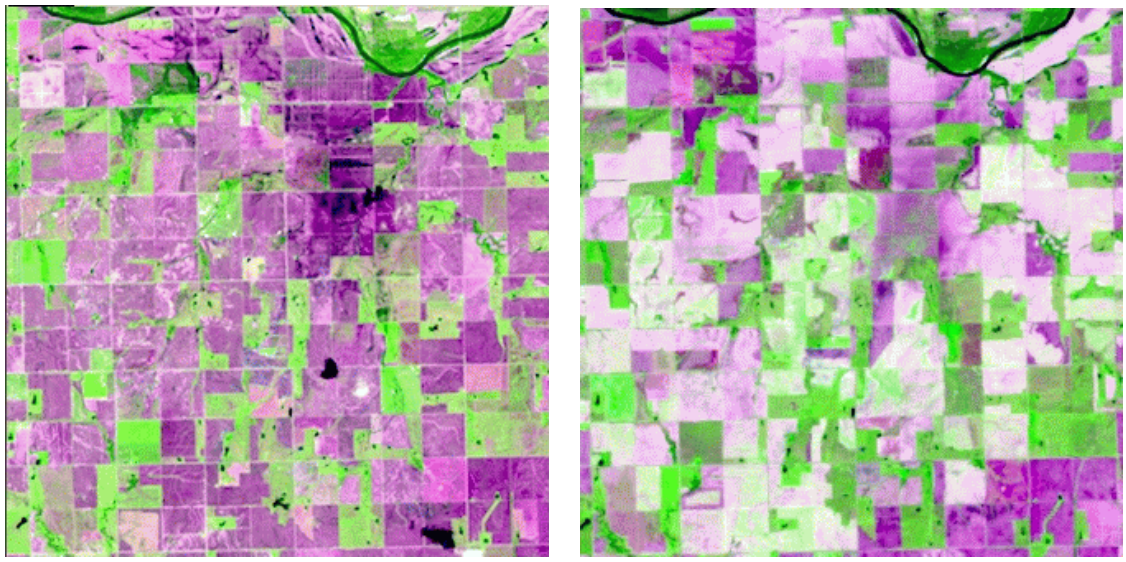
Two Landsat images for July 31, 2002 and September 1, 2002 and the derived landcover map are presented in Figure 2, illustrating the surface conditions in the area in late August.

Examples of Results

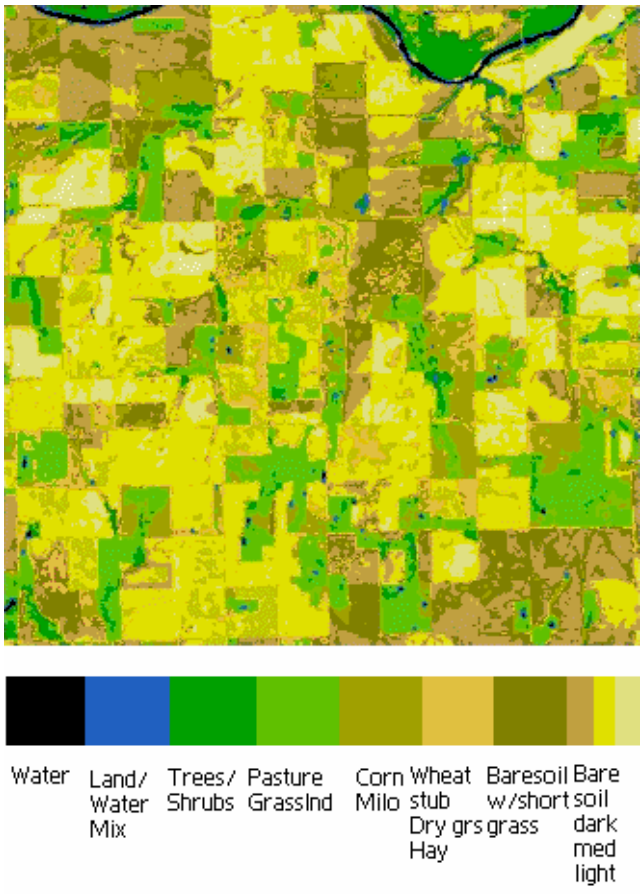
Examples of observed surface albedo spectra are shown in Figure 3 for bare soil, Figure 4 for grassland, and Figure 5 for matured milo. Red and green lines correspond to Multi-filter Radiometer measurements taken around noontime on August 14, 2002. More spectral samples are available from the ARM IOP data archive at http://iop.archive.arm.gov/arm-iop/2002/sgp/sfcalb/.

Conclusions

Systematic mapping of surface albedo by means of regular ground observations together with satellite measurements is a necessary step towards addressing one of the knowledge gaps as identified by the ARM Vision 2000 report. To this end, we conducted the first Surface Spectral Albedo IOP in August



(a) July 31, 2002 (b) September 1, 2002



(c) Landcover map derived from Landsat image on September 1, 2002.

Figure 2. Landsat images and landcover map for the 10 km x10 km area around the ARM CF.

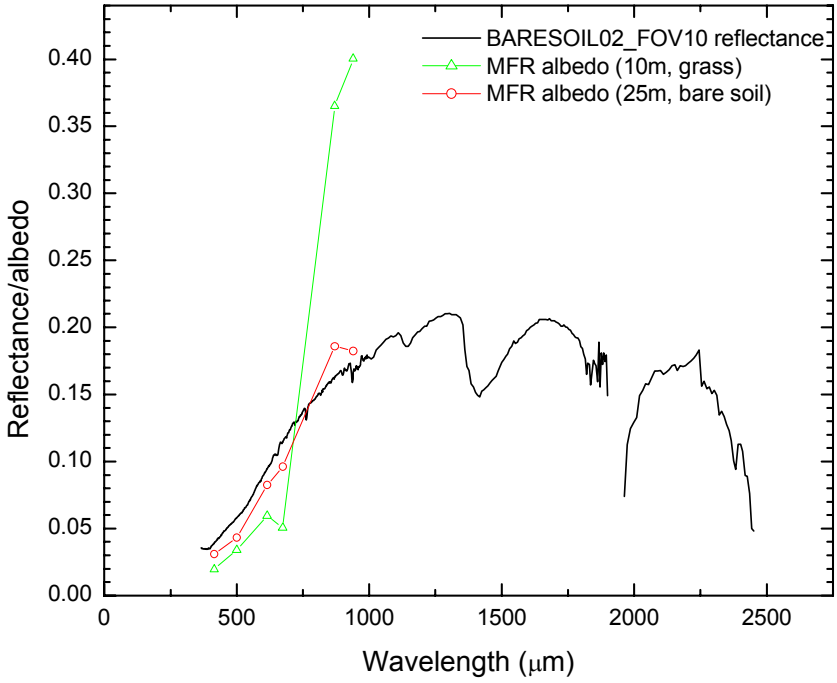


Figure 3. Spectral reflectance for dark (wet) bare soil in the vicinity of the CF.

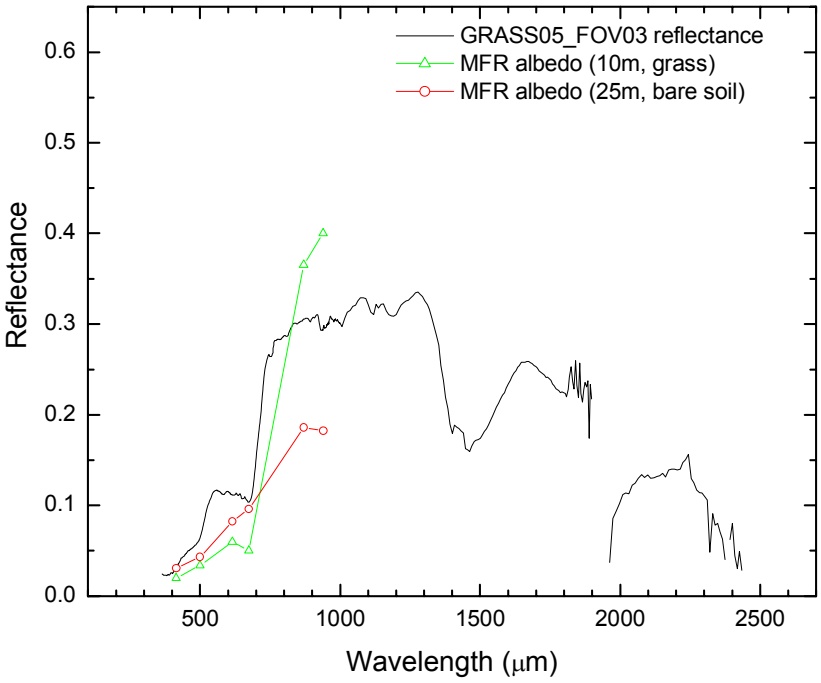
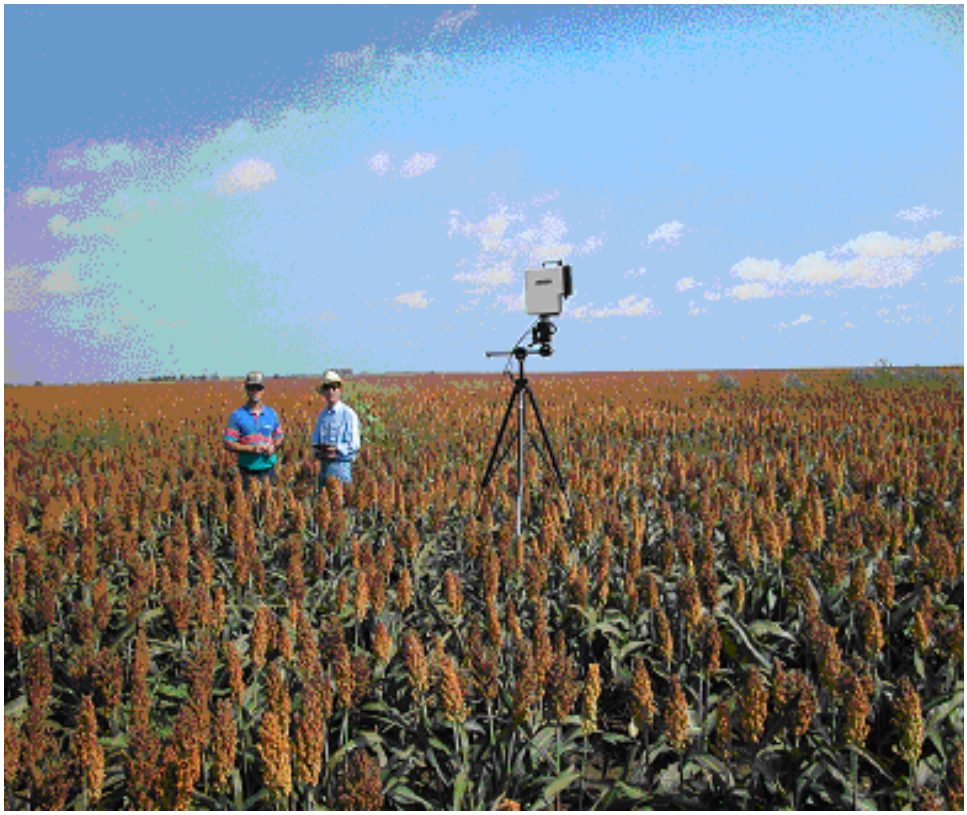


Figure 4. Spectral reflectance for a grassland surface in the vicinity of the CF.



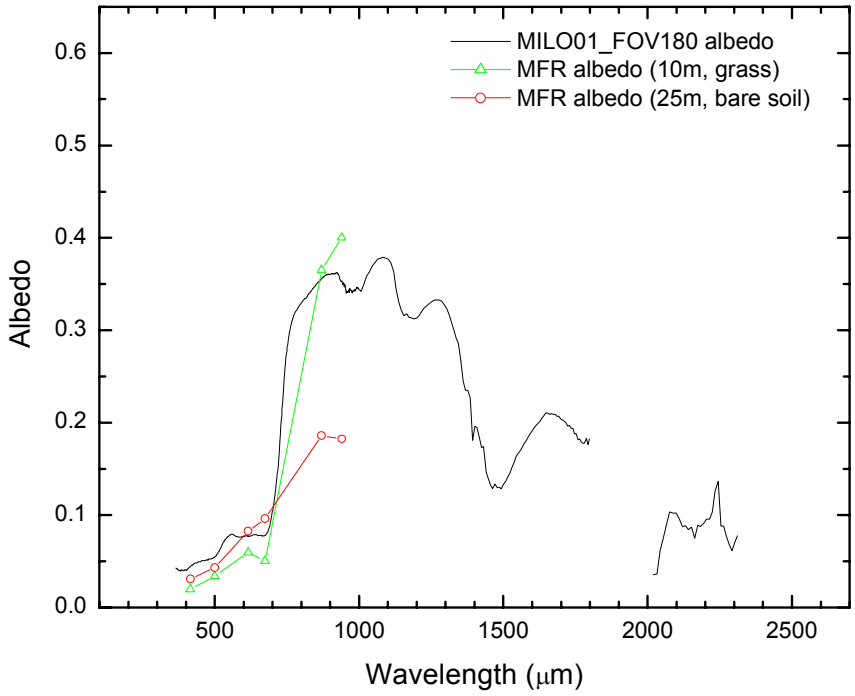


Figure 5. Spectral reflectance for mature milo.

2002 over the ARM SGP Cloud and Radiation Testbed area. Sets of representative surface albedo spectra in the solar spectral region were collected for the major surface types in the area. The next Surface Spectral Albedo IOP is planned for May 11-16, 2003, as part of the Aerosol IOP.

Satellite observations and our land survey showed that bare soil in various conditions (dry and wet) was the most dominant landcover class over the SGP area in August-September. Bare soil remains without vegetation for several weeks and its reflectivity varies with soil moisture.

Comparisons with operational albedo measurements made from the 10-m tower at the SGP CF site may not be representative for the entire area since these measurements are made over a vegetated surface. Use of observations from the 25-m tower also warrants a special attention regarding its spatial representativeness (Li et al. 2002).

Satellite data with high (Landsat, ASTER, etc.) and moderate spatial resolution (MISR, VGT, MODIS, AVHRR) spatial resolution in combination with ground survey data, are suitable for generating comprehensive surface albedo maps that may be used as boundary conditions in radiative transfer simulations (Trishchenko et al. 2002).

Processed IOP data are available from the ARM archive: http://iop.archive.arm.gov/arm-iop/2002/sgp/sfcalb/ and the Canada Centre for Remote Sensing ftp site: //ftp.ccrs.nrcan.gc.ca/ad/EMS/ALEX.TR/

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