Dynamics of the Surface Albedo Over the ARM SGP Area During Spring 2003 Aerosol IOP

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Introduction

The systematic measurements of surface albedo properties were conducted over an extended area around the Atmospheric Radiation Measurement (ARM) Program Southern Great Plains (SGP) site as a part of the ARM Aerosol Intensive Observational Period (IOP) organized in May 2003. Albedo is required as surface boundary condition for assessment of aerosol radiative forcing and aerosol satellite retrievals, modeling of radiative transfer, atmospheric dynamics and clouds. Ground and satellite observations of the surface spectral and angular properties were collected. Preliminary intercomparison was made between multiplatform measurements available from the ground, satellite and aircraft observations. Results in general showed good consistency.

Albedo mapping from satellites

Special moderate-resolution imaging spectroradiometer (MODIS) data product at 500 m spatial resolution and 10-day intervals was generated from both Terra and Aqua satellites. The details of method are described in Luo et al. (2004). Method used MOD09A1/MYD09A1 500 m clear-sky composite datasets as input and generated the bi-directional reflectance distribution function (BRDF) and albedo maps using a landcover-based fitting algorithm. Spectral albedo maps over the area (32N-40N; 92W-102W) were produced. Maps of directional surface albedo computed at local solar noon for three consecutive 10-day intervals are presented in Figure 1 for three spectral bands. Figure 2 presents the entire seasonal cycle of albedo for red and near infrared (NIR) channels and for normalized difference vegetation index (NDVI) for 2003 at the 500x500 m^2 pixel, which covers the Central Facility. Some noticeable changes can be observed during the Aerosol IOP period in May. This month is a time of intensive ripening of the wheat. The harvesting begins at the end of May and early June. The ripening of the wheat fields in the vicinity of Central Facility (CF) is clearly observed on the time sequence of maps as slight increase of the red channel reflectance and significant decrease of NIR channel reflectance. The NIR albedo drops from 0.35 to 0.27, i.e. by about 25% during the month. The NDVI decreases from 0.75 to 0.52, as a result of ripening and associated changes in the biophysical and reflective properties of the plants.

Ground measurements

Ground observations of surface spectral albedo were conducted using an analytical spectral device (ASD) FieldSpecPro instrument similar to that described by Trishchenko et al. (2003). A total of 37 spectra for various surfaces were determined and transferred to the ARM IOP archive. The ground measurements were collected during the period of May 11 - May 16, 2003. An example of the instrument setup and view of various surface types in the area is presented in Figure 3. The differences in the color of wheat fields in the various stages of maturity are clearly seen. An example of those spectra measured by the ASD FieldSpecPro is shown in Figure 4. Several sets of BRDF measurements over the wheat and young corn field were acquired. An example of BRDF measurements and model fit is presented in Figure 5. Figure 5 shows data points in the principal plain. They were fitted with the RossThick-LiSparse model (Wanner et al., 1997).

In addition to surface spectral albedo measurements, a survey of landcover types distribution in the area over 18x18 km2 around SGP CF was conducted. It complements the survey we conducted earlier in August 2002 (Trishchenko et al., 2003). The landcover map at a 30-meter spatial resolution was produced based on results of ground survey and Landsat-7 ETM imagery for Spring 2003 (Trishchenko et al., 2004). Classification and ground survey show that the area surrounding the ARM SGP CF is dominated by agricultural land with 65% being wheat fields (Figure 6).

Data intercomparison

Preliminary results of intercomparison among ground, aircraft and satellite observations of surface spectral albedo properties are presented in Figure 4. The aircraft spectral albedo data are available from solar spectral flux radiometer (SSFR) instrument (Pilewski et al., 2003) collected during low altitude aircraft flights during the Aerosol IOP. Preliminary comparison shows reasonable agreement between various sources of data.

Conclusions

Surface spectral albedo was characterized during the Spring 2003 ARM Aerosol IOP using various sources: ground observations, satellite data and aircraft measurements. Ground survey and high-resolution satellite imagery were used to produce a landcover map distribution. Generated datasets are available from the ARM IOP Archive and CCRS ftp site ftp://ftp.ccrs.nrcan.gc.ca/ad/CCRS_ARM. Preliminary comparison shows good agreement between various sources of observations. High-temporal resolution observations (10 day intervals or shorter) are required to represent rapid changes of surface albedo properties over the ARM SGP Cloud and Radiation Testbed (CART) site area during the springtime.

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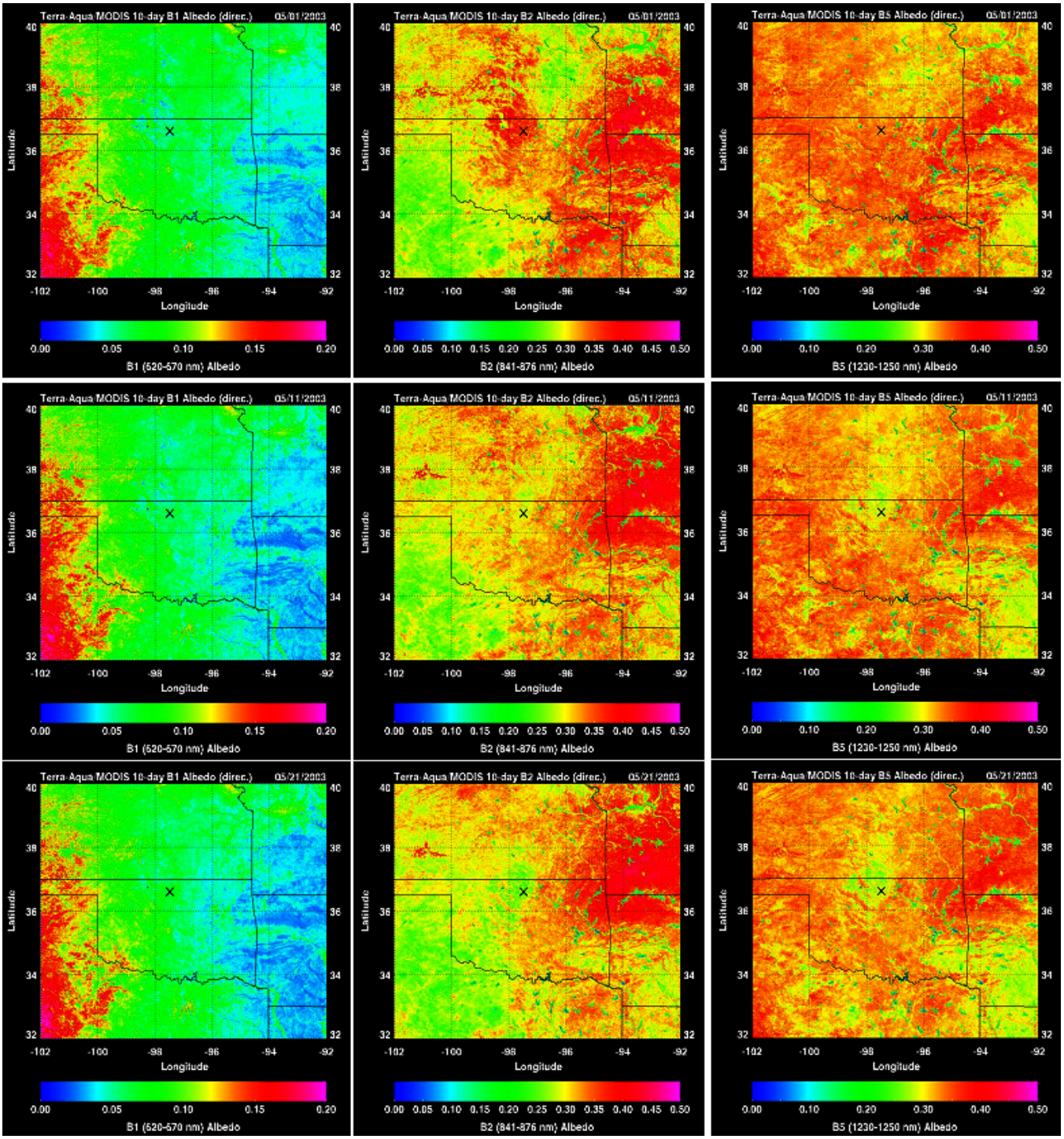

Figure 1. The distribution of surface albedo over the ARM SGP area during May, 2003. Three 10-day intervals are shown: May 1-10, May 11-20, May 21-31. Left column corresponds to red spectral band (0.62-0.67 μm), central column corresponds to NIR band (0.841-0.876 μm), right column corresponds to SWIR band (1.23-1.25 μm). The location of the ARM SGP CF is marked by cross (X).

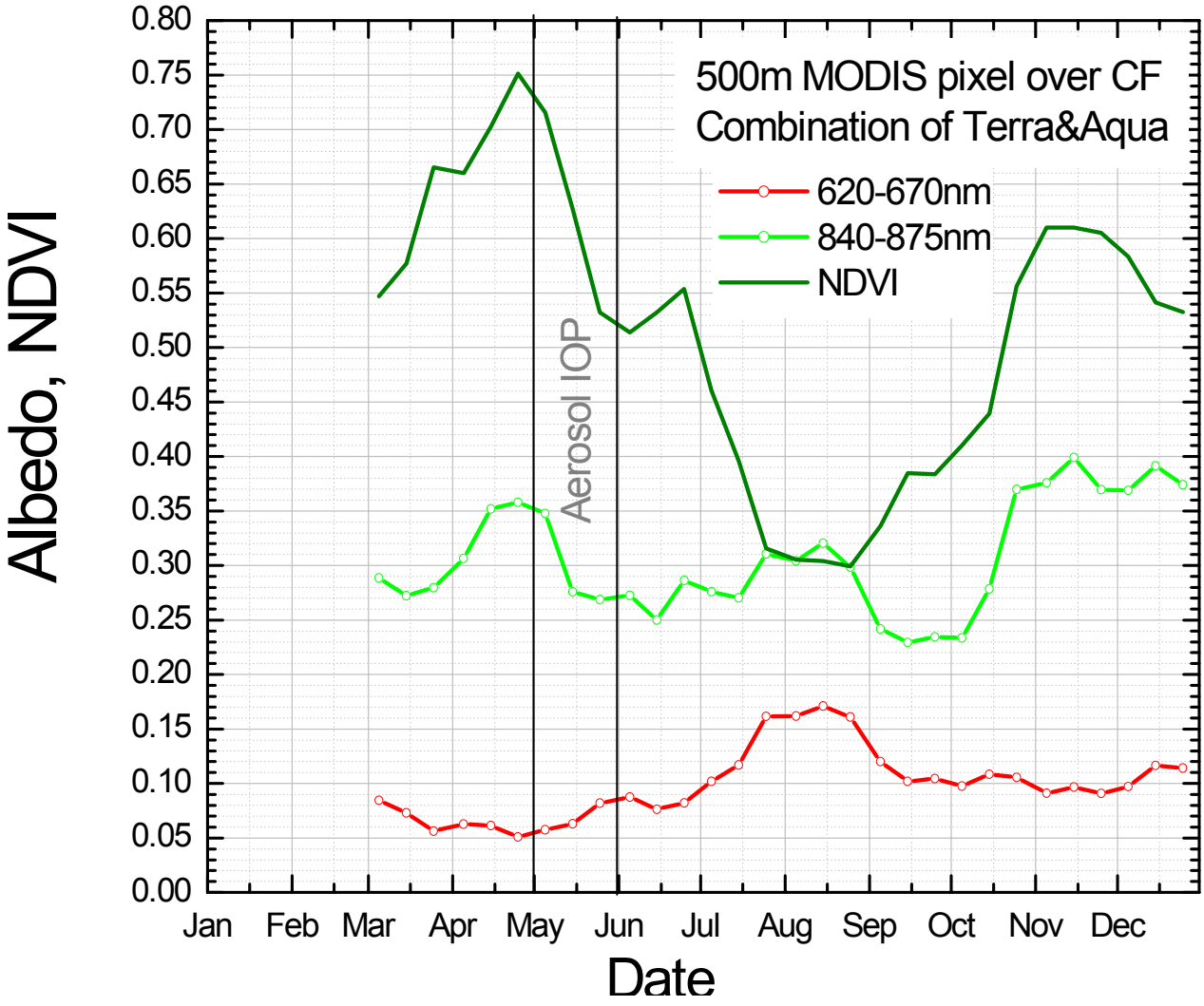

Figure 2. The seasonal cycle of surface albedo for the red and NIR bands and of NDVI over the ARM SGP area during May, 2003.

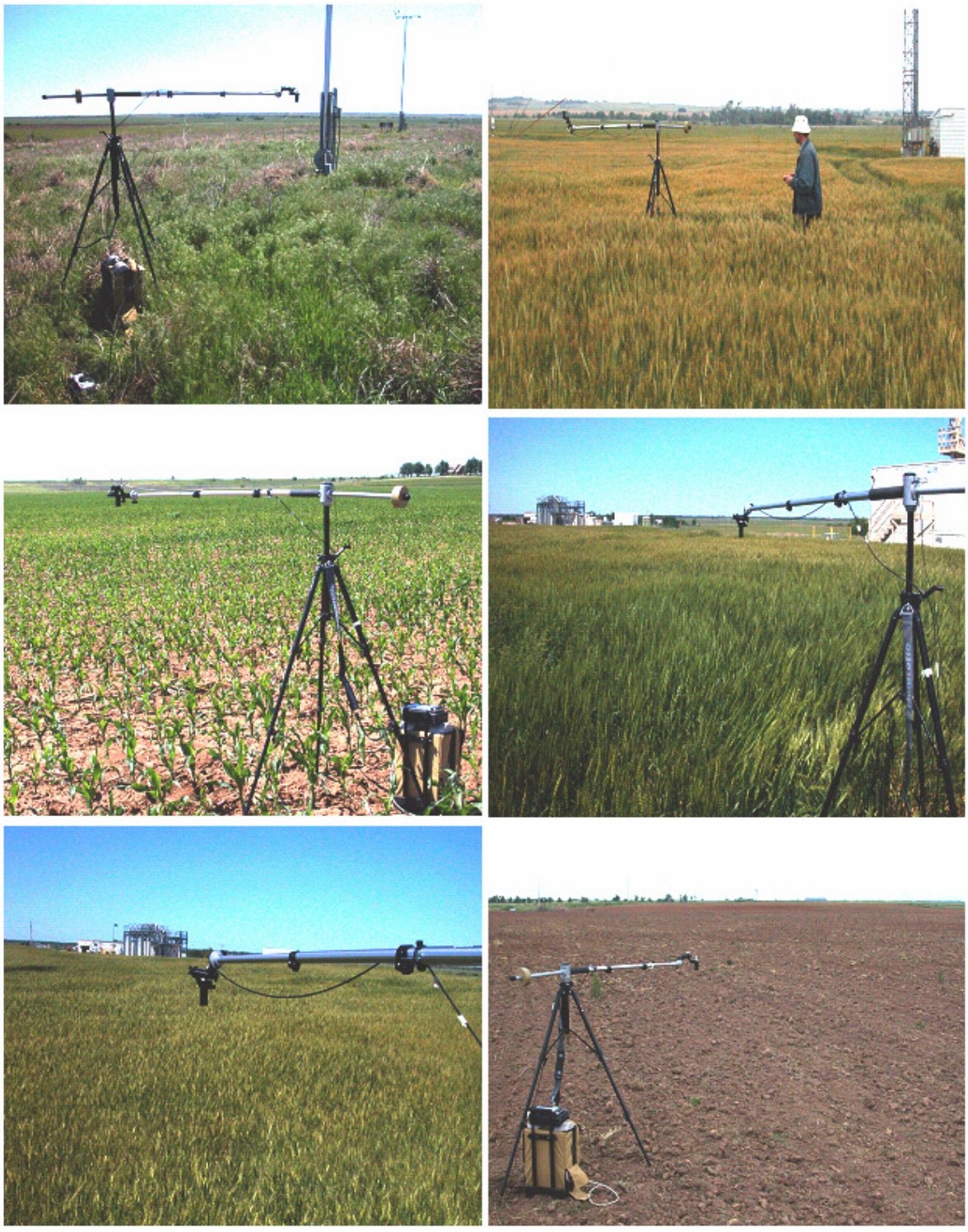

Figure 3. Ground measurements of surface spectral albedo with ASD spectroradometer during May, 2003 over several typical surfaces: grassland/pasture, wheat, young corn and baresoil.

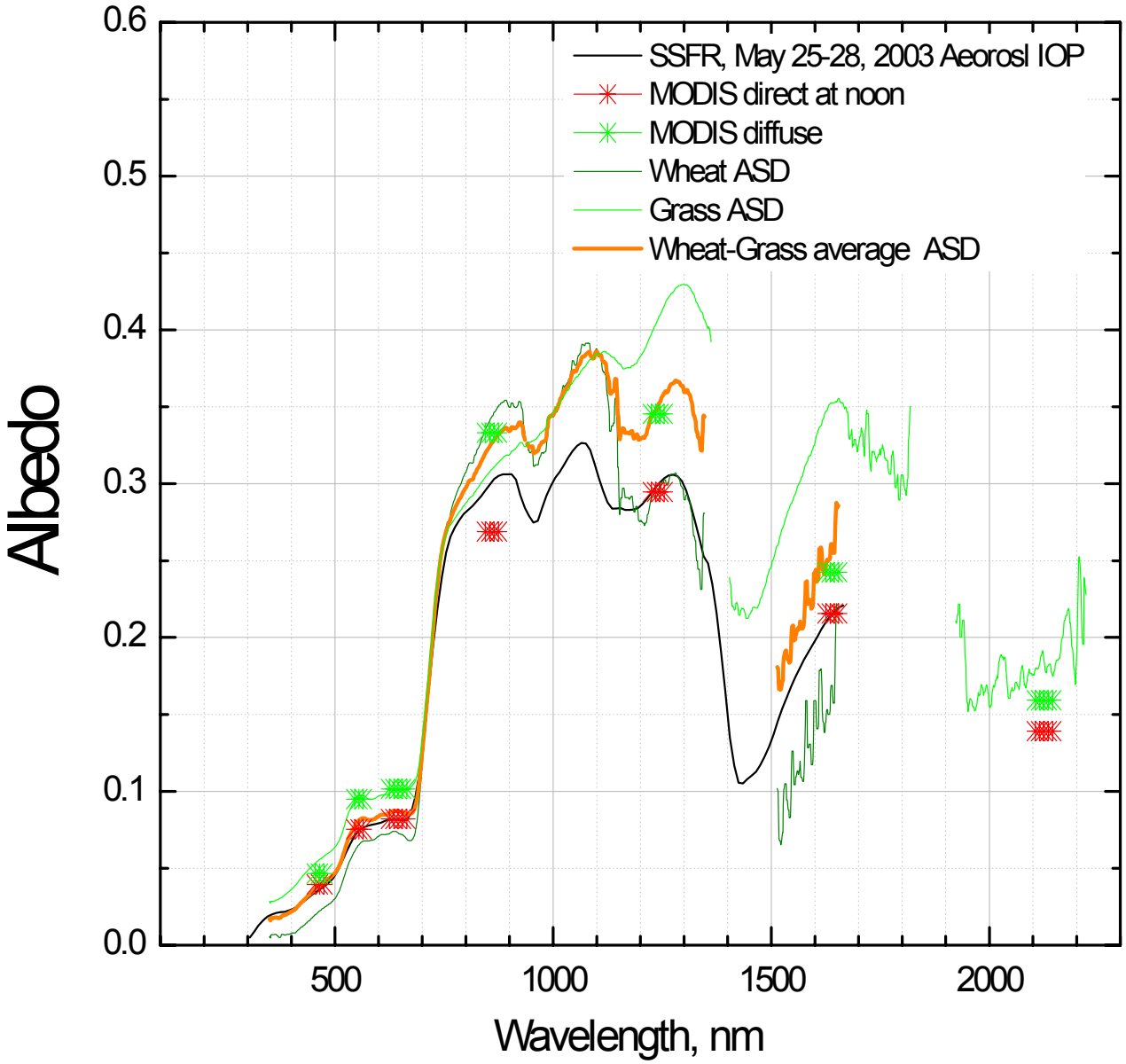

Figure 4. Comparison of ground and aircraft spectral measurements of surface albedo with MODIS data (Luo et.al, 2004).

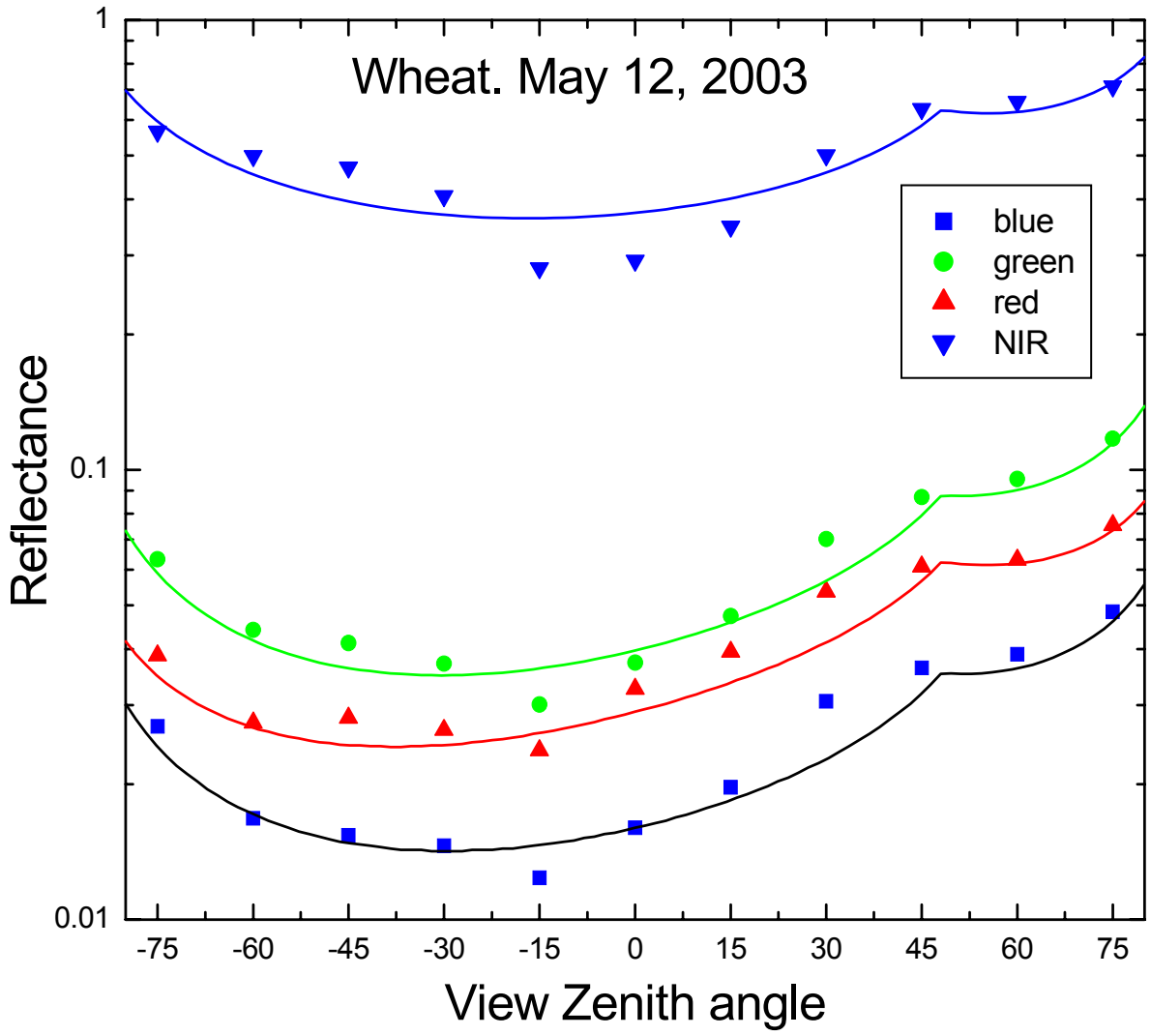

Figure 5. BRDF observations and model fit for reflectance of the wheat field measured on May 12, 2003.

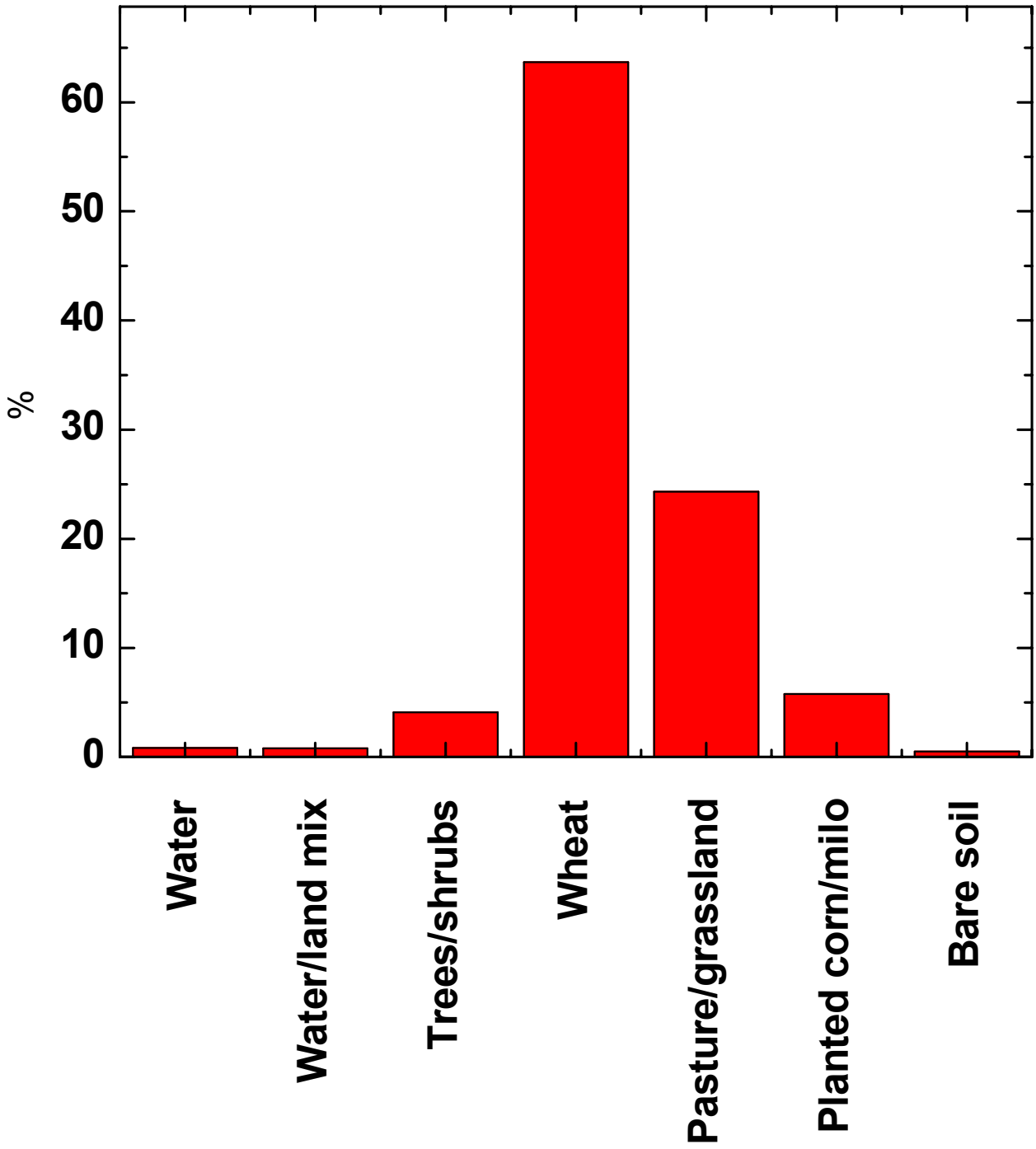

Figure 6. The distribution of landcover types in the area of 15 x 15 km^2 around the ARM SGP Central Facility.