ECV T08

ALBEDO AND REFLECTANCE ANISOTROPY

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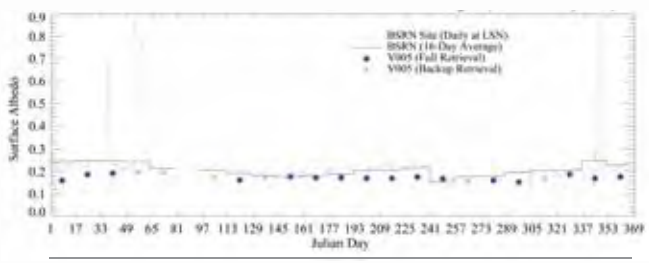
OBSERVATIONAL IMPORTANCE

Land surface albedo, or the ratio of the radiant flux reflected from the Earth's surface to the incident flux, is a key land physical parameter controlling the planetary radiative energy budget. Variations in the extent of snow cover and flooding, and in the phenology of natural vegetation and agricultural crops are all accompanied by significant changes in land albedo. Therefore, long-term surface albedos with absolute accuracies of 0.02-0.05 are required by climate, biogeochemical, hydrological and weather forecast models at a range of resolutions, both spatial (from a few hundred metres to 5 to 30 km) and temporal (from daily to monthly).

CURRENT OBSERVATIONS

Snow cover, hydrological processes and vegetation structure and phenological state all play an enormous role in the seasonal variation of land surface albedo.

Furthermore, the albedo at any given time depends both on the unique reflective anisotropy of the surface (related to the intrinsic composition and structure of the land cover) and the atmospheric condition. Therefore tower-based field measurements of surface albedo are required to support local and regional determination of the surface radiation, while remote sensing provides a way to measure and monitor the global heterogeneity of land surface albedo.



Comparison of the MODIS 500-m albedo product with field measurements at the ARM/SGP Central Facility #C01 (2003)

REMOTELY SENSED ALBEDO PRODUCTS

Directional satellite observations are currently being utilized from a number of instruments (e.g. MODIS, MISR, CERES, POLDER, MERIS and MSG) to provide various routine regional and global operational albedo products at a variety of spatial and temporal resolutions. While data quality assessments and field validation exercises are routinely carried out by the respective science teams, data set intercomparisons are being facilitated through the Land Product Validation Subgroup of the Committee on Earth Observing Satellites/Working Group on Calibration and Validation (CEOS/WGCV).

TOWER-BASED FIELD MEASUREMENTS OF ALBEDO

Long-term, high-quality, calibrated field measures of direct and diffuse land surface incident and reflected radiation are being collected from tower-mounted pyranometers at a limited number of sites by the Baseline Surface Radiation Network (BSRN). The BSRN, with its standardized measurement protocols, has already been designated by the World Climate Research Programme (WCRP) as the global baseline network for surface radiation for the Global Climate Observing System (GCOS). The BSRN archive (currently maintained by ETH, Zurich, Switzerland) will be transferred in 2008 to the Alfred Wegener Institute, Bremerhaven, Germany. Reflected radiation measurements are also frequently collected by International Long Term Ecological Research (ILTER) sites and regional flux tower networks (such as Ameriflux, Asiaflux, Fluxnet- Canada, CarboEurope, etc.). Guidelines for data collection protocols and standardization across the flux networks are being developed under the auspices of the Terrestrial Carbon Observation (TCO) effort. Additional vital atmospheric state measurements are collected at these sites by regional or global networks, such as the AErosol RObotic NETwork (AERONET).

The reflective character of a sunlit earth governs the energy absorbed at the surface

ARM/SGP Central Facility #C01

REQUIREMENT FOR EXPANDED TOWER-BASED MEASUREMENTS

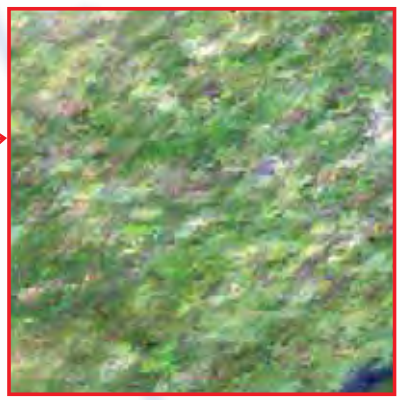
At present, only a dozen or so BSRN sites worldwide provide the calibrated tower-based reflected radiation measurements necessary for albedo monitoring. In addition to localized monitoring and modelling of surface albedo, these data are also used for validation efforts by all of the operational satellite producers. However, field measurements are needed from a greater diversity of land covers and ecological regions. Therefore, upgrading the instrumentation and data collection protocols to BSRN standards at pre-existing flux and ecological towers remains a priority. Such improvements, however, do require a significant financial commitment.

An instrumentation package recently suggested to upgrade Ameriflux measurements of both direct and diffuse shortwave and longwave radiation was priced at US$20 000. Increased human maintenance and calibration requirements, site accessibility and power needs preclude implementation of BSRN standards at all tall towers. However, for those sites with sufficient pre-existing infrastructure, only a modest capital outlay would be needed to greatly expand access to BSRN-calibre field measurements of surface albedo.

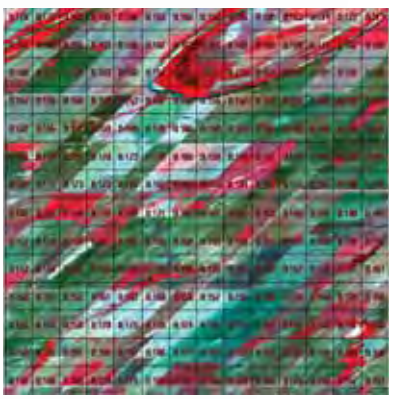
RECOMMENDATION

Official recognition is required of the need for long-term, high-quality field measurements of land surface albedo to monitor local climatic changes, model surface energy variations and validate regional and global albedo products. A modest increase in financial support for those field sites already equipped with sufficient personnel to maintain and monitor equipment to BSRN standards would enormously increase our ability to monitor surface albedo fluctuations worldwide.

MODIS 500-m white-sky albedo (isotropic bi-hemispherical reflectance) of the Southern Great Plains, USA. Nominal date 23 May 2006, true-color image in sinusoidal projection



MODIS 500-m white-sky albedo from the Atmospheric Radiation Measurement (ARM)/ Southern Great Plains (SGP) Central Facility #C01 (subset from figure to left)



ASTER scene of the ARM/SGP Central Facility #C01 on 23 May 2006 superimposed with 500-m MODIS shortwave albedo values (bi-hemispherical reflectance)

RELATED LINKS:

Baseline Surface Radiation Network: www.gewex.org/bsrn.html | **Aeronet:** http://aeronet.gsfc.nasa.gov/index.html
Terrestrial Carbon Observations: www.fao.org/gtos/TCO.html | **CEOS/WGCV/Land Product Validation:** http://lpvs.gsfc.nasa.gov
NASA ESDR White Papers with References: http://lcluc.umd.edu/Documents/land-esdr.asp