Clear Sky Broadband Surface Albedo From CERES and MODIS Instruments on Board Terra Satellite, Direct Comparisons

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Goal: Compare CERES/CRS Ed2b Land Surface Albedo to MODIS MOD43C2 v004 Surface Albedo.

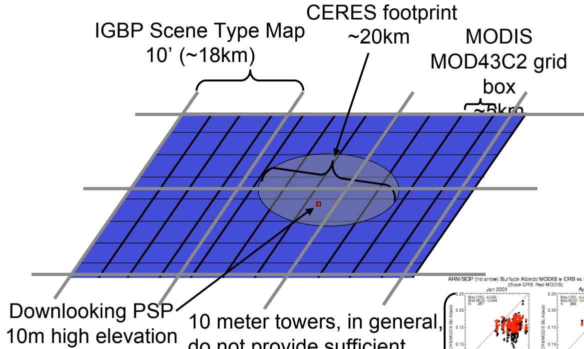
CERES Broadband Surface Albedo

To run a radiation transfer calculation globally we require an estimate of spectral and broadband surface albedo beneath each CERES footprint.

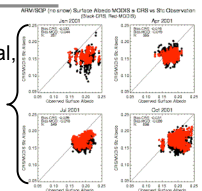
For footprints identified as clear, a TOA to surface parameterization (or Look Up Table LUT) is run to give a first estimate of surface albedo. (See below for details.)

Clear sky values are used for initial albedo in model runs and saved for use under cloudy skies.

Results shown here are based on radiation transfer model runs below CERES observations. Broadband albedo is defined as the ratio of upward to downward shortwave fluxes at the surface.



10 meter towers, in general, do not provide sufficient spatial representation for validation of albedo from satellite products.



MODIS BRDF Based Broadband Surface Albedo

The MODIS land surface group developed an algorithm to invert MODIS shortwave radiances to spectral albedos using a sparsely filled estimate of the Bi-directional Reflectance Distribution Function (BRDF) of land surfaces viewed by the MODIS instrument.

MODIS observations are collected over 16-day periods, filtered for cloud and snow then a model is used to derive an empirical estimate of the spectral BRDF for a 0.05degree region.

Once BRDFS are calculated, spectral weights for the MODIS shortwave channels are used to estimate broadband albedo.

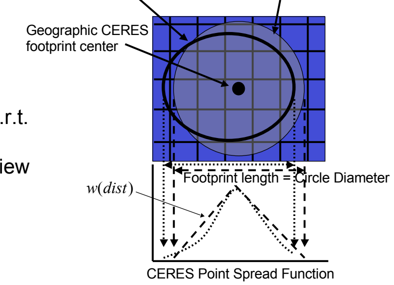
Problem: Validation of surface albedo, derived from TOA observations, is tricky because surface observations are not spatially representative.

Solution: Compare independently derived clear sky broadband surface albedo matched in space and time from CERES and MODIS.

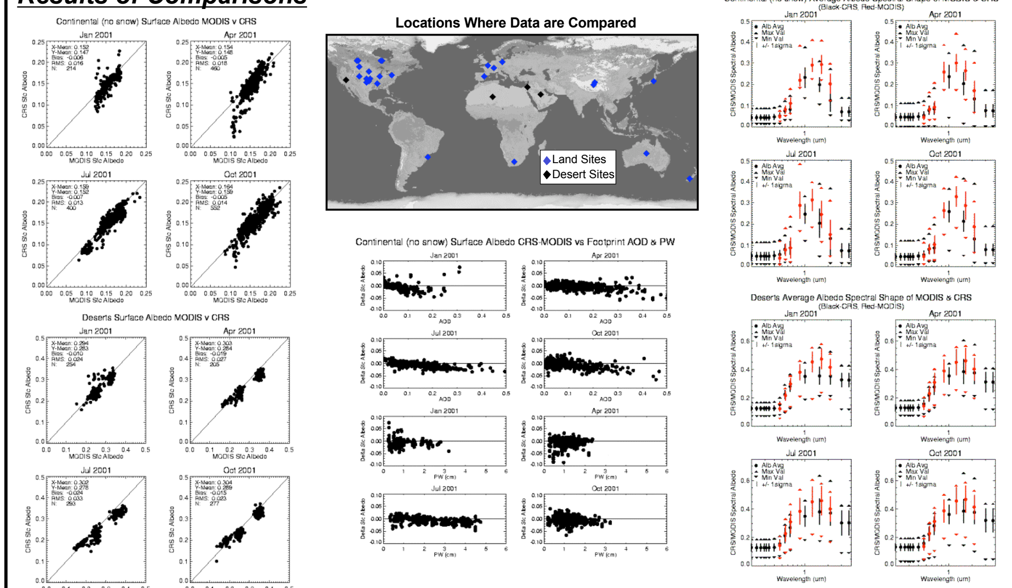
To insure a good match between products, we integrate MODIS 0.05degree "pixels" within the CERES ~20km "footprint".

$$\alpha_{est} = \iint_{xy} \alpha_{MODIS}(x,y)\,w(dist)\,dxdy$$

- Isolate clear sky CERES footprints within 16 day windows of MODIS BRDF estimation for 4 months (Jan, Apr, Jul, Oct 2001.)
- Approximate CERES footprint as a circle.
- Weight MODIS results within CERES footprint with a linear function decreasing w.r.t. geographic center of footprint (to simulate energy distribution observed by the larger view of the CERES instrument.



Results of Comparisons



CERES Initial Clear Sky Spectral Surface Albedo (Methodology)

$\alpha_{clr} = LUT\{\mu, \tau_{aot}, pw, O_3, \ln(vis/nir)\}$ — 1st For clear sky, estimate broadband surface albedo using a LUT

$\alpha_{fp}(\upsilon) = \sum_{i=1}^{n-scenes} \alpha_i(\upsilon) w_i$ — 2nd Estimate spectral albedo based on linking spectral shapes to IGBP types identified within CERES footprint.

$\{w_i \equiv$ %scene in a footprint $\}$ $\{\alpha_i(\upsilon) \equiv$ spectral albedo for i-th IGBP scene type in footprint $\}$

$\alpha_{initial}(\upsilon) = \alpha_{fp}(\upsilon) * (\alpha_{clr} / \int_{\upsilon} \alpha_{fp}(\upsilon))$ — 3rd Normalize spectral albedo so that integrated value equals clear sky estimate from the LUT.

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