Geostatistical Analysis of Ameriflux Validation Sites for the Assessment of Moderate Resolution Satellite-Derived Albedo Products

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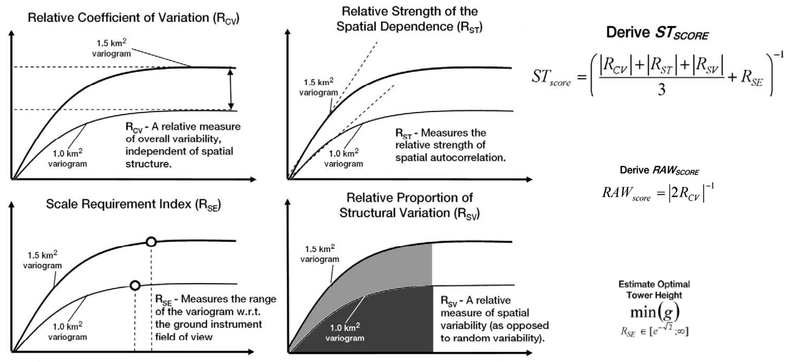
Establishing realistic ground truth validation data remains a perennial problem facing all producers of satellite products. The difference in spatial scale between what can be measured at the surface and what can be retrieved by satellite sensors is very difficult to reconcile. Tower mounted albedometers provide the best possible in situ measurements of land surface albedo and the albedometers deployed as part of the networks such as Ameriflux and the Baseline Surface Radiation Network are crucial for the ongoing evaluation of satellite derived surface albedo products. However many of these in situ albedometers are deployed on fairly short towers that monitor only limited fields of view.

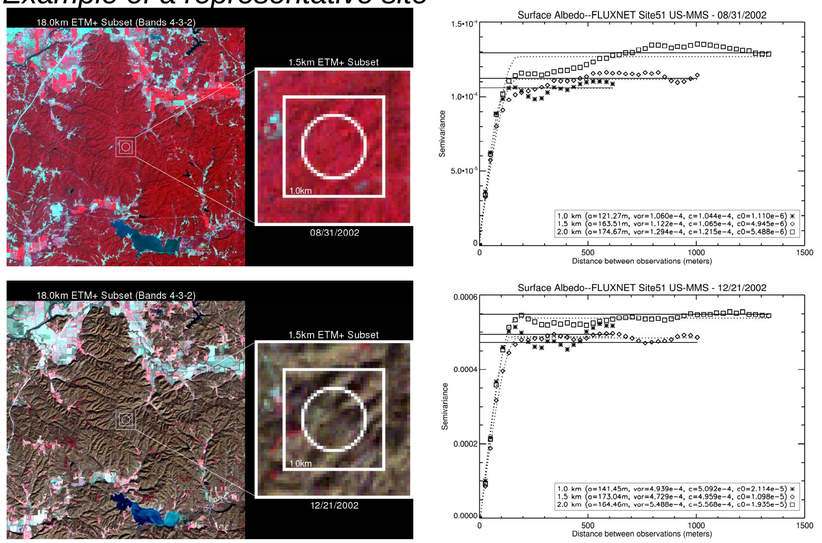
Therefore it is important to rely on tower sites that are truly representative of the much larger surrounding region so that the quantities being sensed from space at resolutions of 300m to 1km are similar to those being sensed from the tower. High resolution satellite data (such as from Landsat) can be used to provide interim geostatistical measures of the spatial heterogeneity of a locality and assess the representativeness of tower measurements.

The MODIS albedo product relies on multi-date, multi-spectral, multi-angular, cloud-free, atmospherically-corrected surface reflectance data from both Terra and Aqua to reconstruct the surface reflectance anisotropy of a location and thus derive intrinsic measures of surface albedo on a 500 m grid. With access to aerosol optical depth information, the actual clear sky albedos at a specific time can be estimated and compared with the in-situ measurements. The MODIS product has been routinely retrieved since 2000 and recent evaluation efforts have focused on albedos during both the growing season and the dormant season. A method to identify towers situated in spatially representative localities for each season has been devised (Román et al., 2009) and is being applied to locations contributing to the Fluxnet datasets. It must be noted that this evaluation of spatial representativeness does not merely identify surface types that are uniform and homogenous over large area. A location can still be quite patchy and heterogeneous as long as the tower measurement captures that variability as well. It should also be emphasized that this evaluation only applies to small field of view tower albedometers and the assessment of their usefulness in validating satellite albedo products and does not reflect on the importance of a particular site in providing crucial biogeochemical flux and meteorological information for the modeling community.



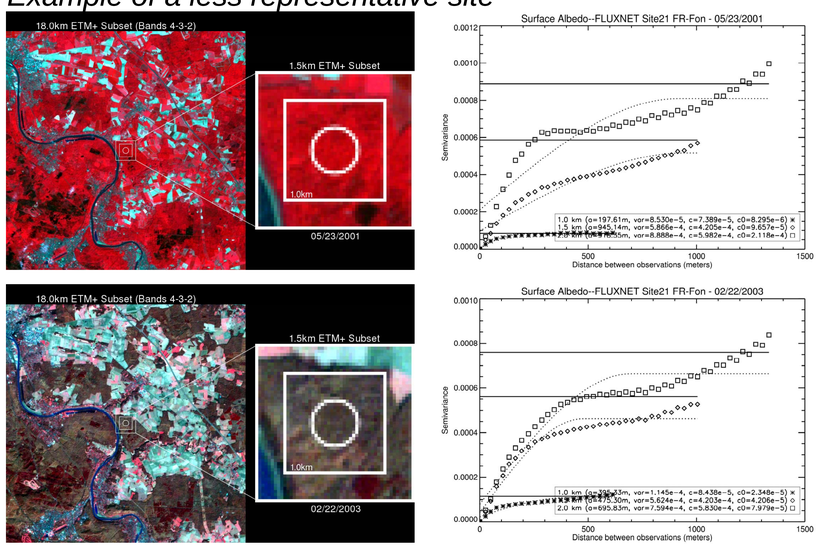
Román, M. O., C. B. Schaaf, C E. Woodcock, A. H. Strahler, et al., The MODIS (Collection V005) BRDF/albedo product: Assessment of spatial representativeness over forested landscapes, Remote Sensing of Environment, 113, 2476-2498,2009.

Example of a representative site



Top-of-Atmosphere (TOA) shortwave reflectance composite (ETM+ Bands 4-3-2) and corresponding semivariogram functions, variogram estimator (points), spherical model (dotted curves), and sample variance (solid straight lines) using regions of 1.0 km (asterisks), 1.5 km (diamonds), and 2.0 km (squares), centered over Morgan Monroe State Forest, IN USA (**US-MMS**) on 08/31/2002 (leaf-on) and 12/21/2002 (leaf-off). The circle stands for the tower footprint.

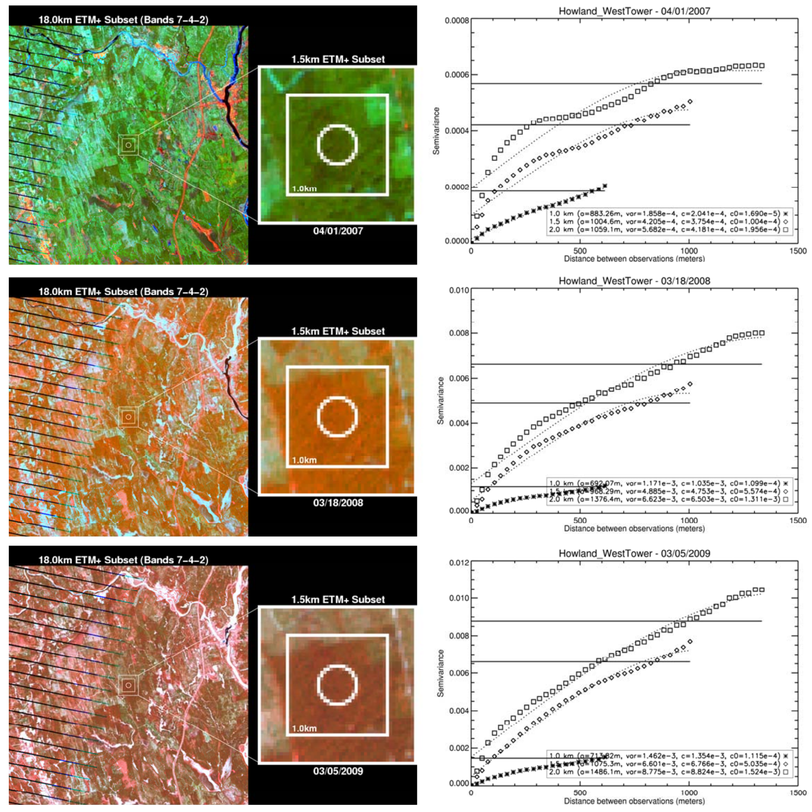
Example of a less representative site



Top-of-Atmosphere (TOA) shortwave reflectance composite (ETM+ Bands 4-3-2) and corresponding semivariogram functions, variogram estimator (points), spherical model (dotted curves), and sample variance (solid straight lines) using regions of 1.0 km (asterisks), 1.5 km (diamonds), and 2.0 km (squares), centered over Fontainebleau, France (**FR-Fon**) on 05/23/2001 (leaf-on) and 02/22/2003 (leaf-off). The circle stands for the tower footprint. While representative at higher spatial resolutions, this site is less representative at lower resolutions due to the influence of the nearby river and surrounding agricultural fields.

Site	Height (m)	PFT	Date	Rcv	Rse	Rsv	Rst	ST score
US-MMS	48	DBF	8/31/2002	3.94%	0.20%	8.30%	-21.45%	8.750
			12/21/2002	-4.24%	0.39%	14.51%	-23.74%	1.147
FR-Fon	35	DBF	5/23/2001	171.26%	10.18%	342.88%	46.02%	0.508
			2/22/2003	119.03%	23.36%	12.54%	265.58%	0.642

Temporal change



Top-of-Atmosphere (TOA) shortwave reflectance composite (ETM+ Bands 7-4-2) and corresponding semivariogram functions, variogram estimator (points), spherical model (dotted curves), and sample variance (solid straight lines) using regions of 1.0 km (asterisks), 1.5 km (diamonds), and 2.0 km (squares), centered over Howland Forest (West Tower), ME USA (**US-Ho2**) on 4/01/2007, 03/18/2008 and 3/05/2009. The circle stands for the tower footprint and the black strips are caused by SLC-off. This site has become less representative over time due to harvesting to the north.