Land Product Validation (LPV)

Session on Validation Methods

Miguel Roman (NASA GSFC) – LPV Vice-chair

Validation Techniques

– *POINT LOCATION VALIDATION*: Albedo (Land), Land Surface Temperature, Vegetation Index, Surface Reflectance, Snow Cover/Depth, Phenology, LAI/FPAR, Soil Moisture.

- Validation data can be acquired using ground-based instruments in fixed locations, often as part of large field networks. Drifting buoys are included in this category. These data tend to be operationally quality-checked and archived using standard formats, metadata and documentation.

Validation Techniques

- *REMOTE SENSING VALIDATION*: Burned Area, Ice Surface Temperature, Albedo (Cryosphere), BRDF (case study to follow…)

- Validation data are typically acquired by research investigators using satellite data along with specialized sensors onboard manned and unmanned aircraft. The latter data tend to take more time and resources to be geolocated, quality-checked and archived, and may or may not adhere to standard formats, metadata and documentation. The aircraft operations are sometimes augmented by in-situ observations.

Validation Techniques

- *EPISODIC REMOTE SENSING VALIDATION:* Active Fires

- Validation data are typically acquired by operational agencies (e.g., national fire services) or research investigators using specialized aircraft sensors, or by tasked acquisition satellite systems. Depending on the source, these data can take a variable amount of time and resources to be geolocated, quality-checked and archived, and may or may not adhere to standard formats, metadata and documentation.

Validation Techniques

- – *CLASSIFIED REMOTE SENSING VALIDATION:* Land Cover, Sea Ice Characterization
- Validation data are typically acquired by tasked acquisition, fine resolution satellite systems. Images must be independently classified and validated before being useful for validation. The process can take a variable amount of time and resources, and may or may not adhere to standard formats, metadata and documentation.

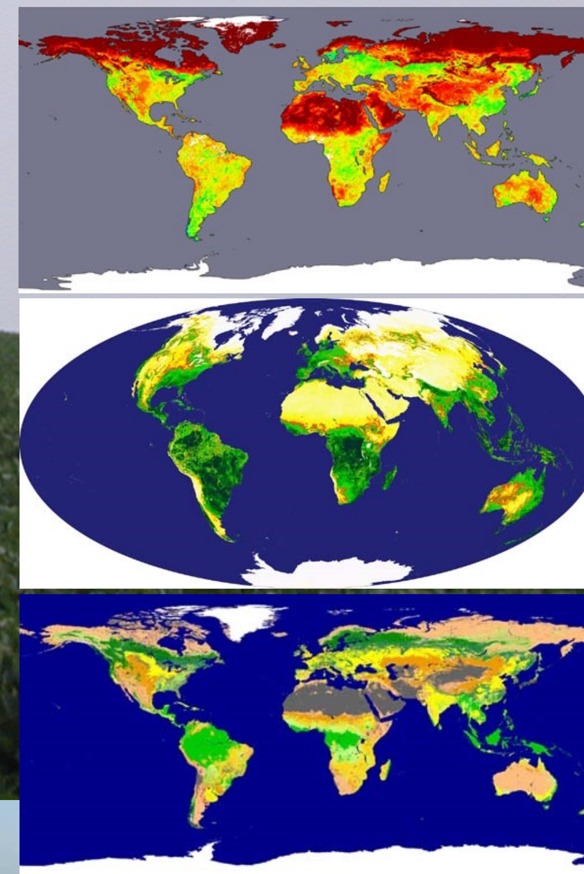
Objective: To directly map through measurement uncertainties from sensors to products.

Relating point measurements…

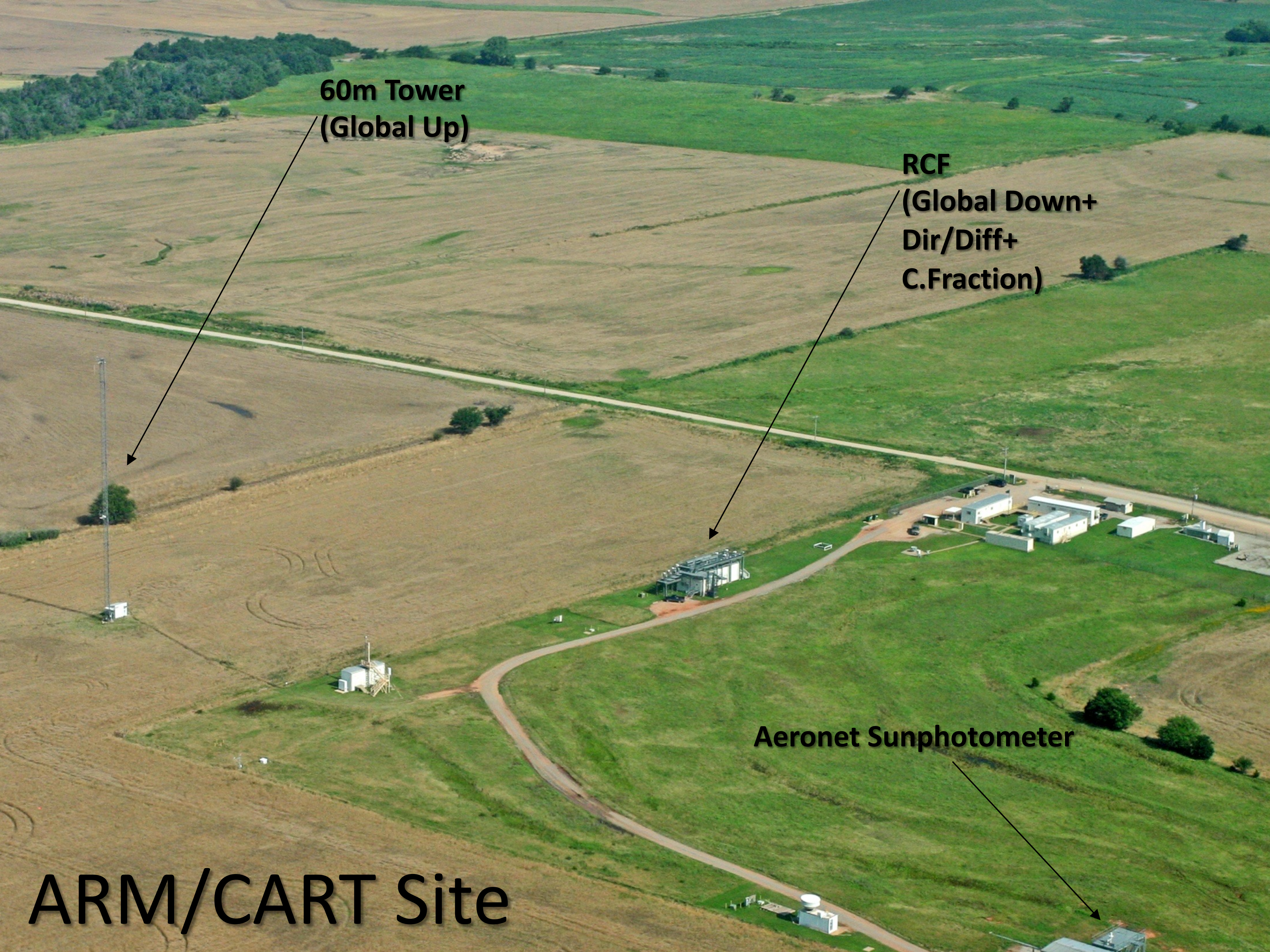
tower measurements…

and/or airborne measurements…

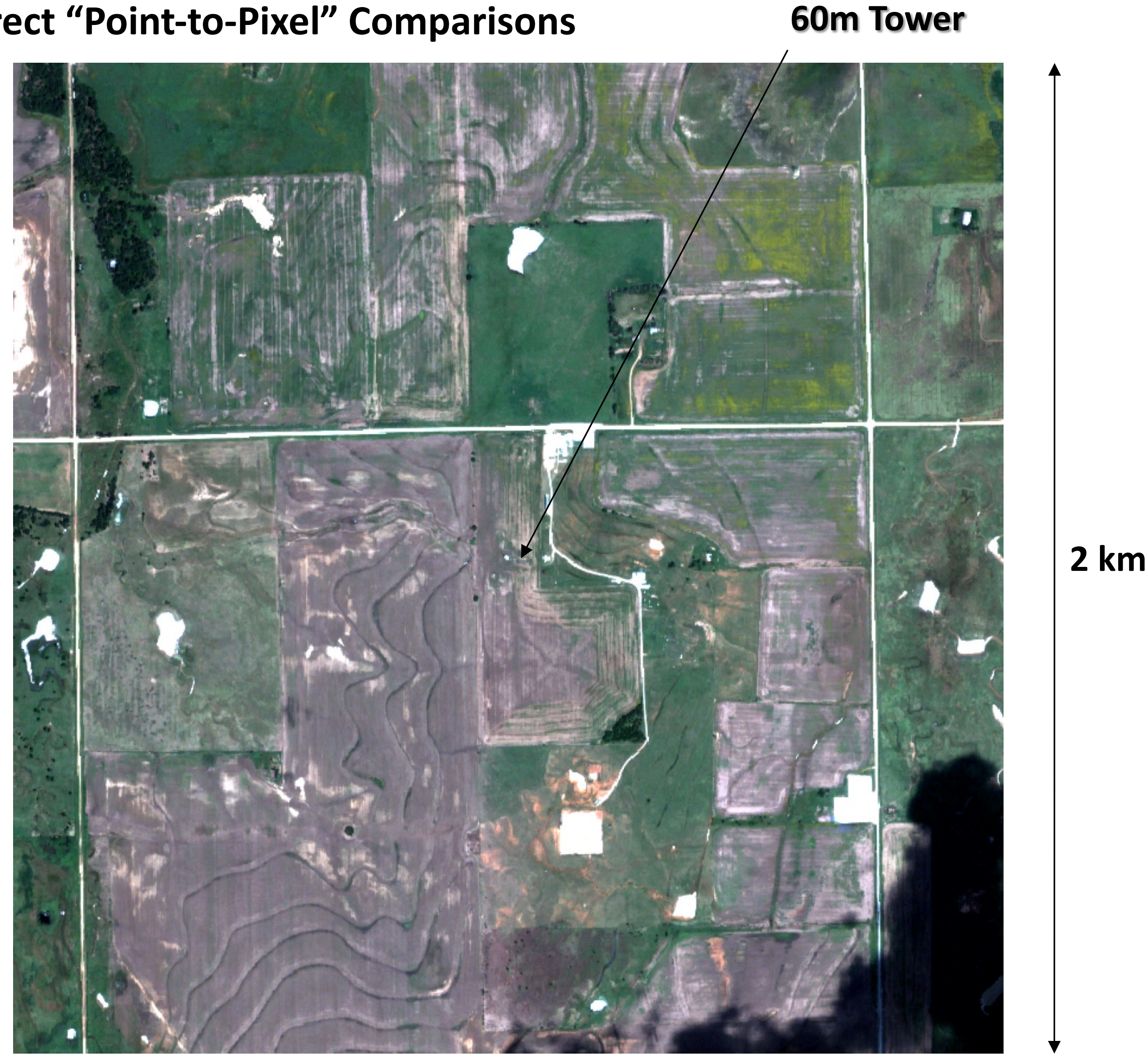
…to global land products.



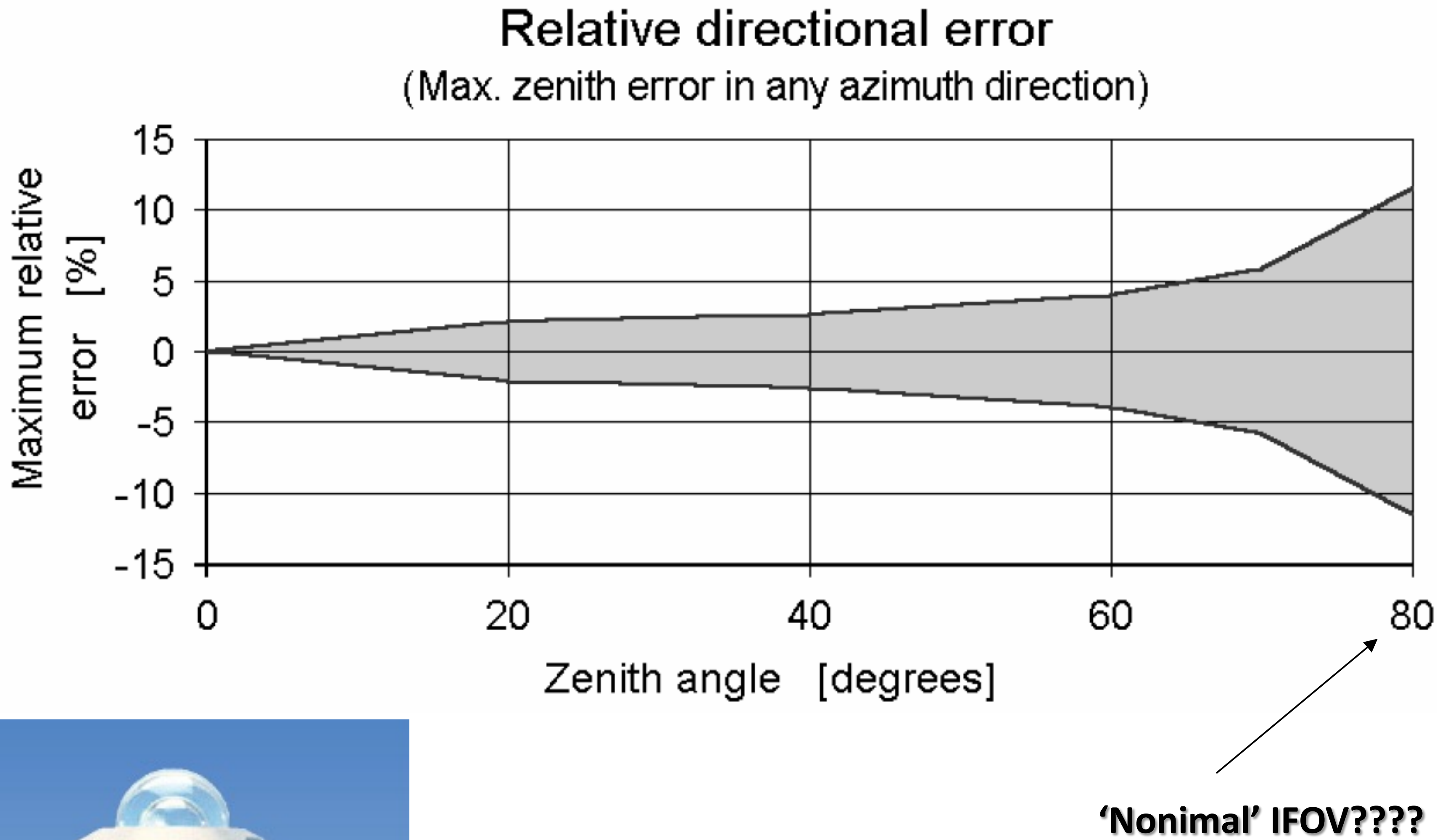
Bondville, IL


60m Tower
(Global Up)
RCF
(Global Down+
Dir/Diff+
C.Fraction)
Aeronet Sunphotometer
ARM/CART Site

Improving Direct "Point-to-Pixel" Comparisons



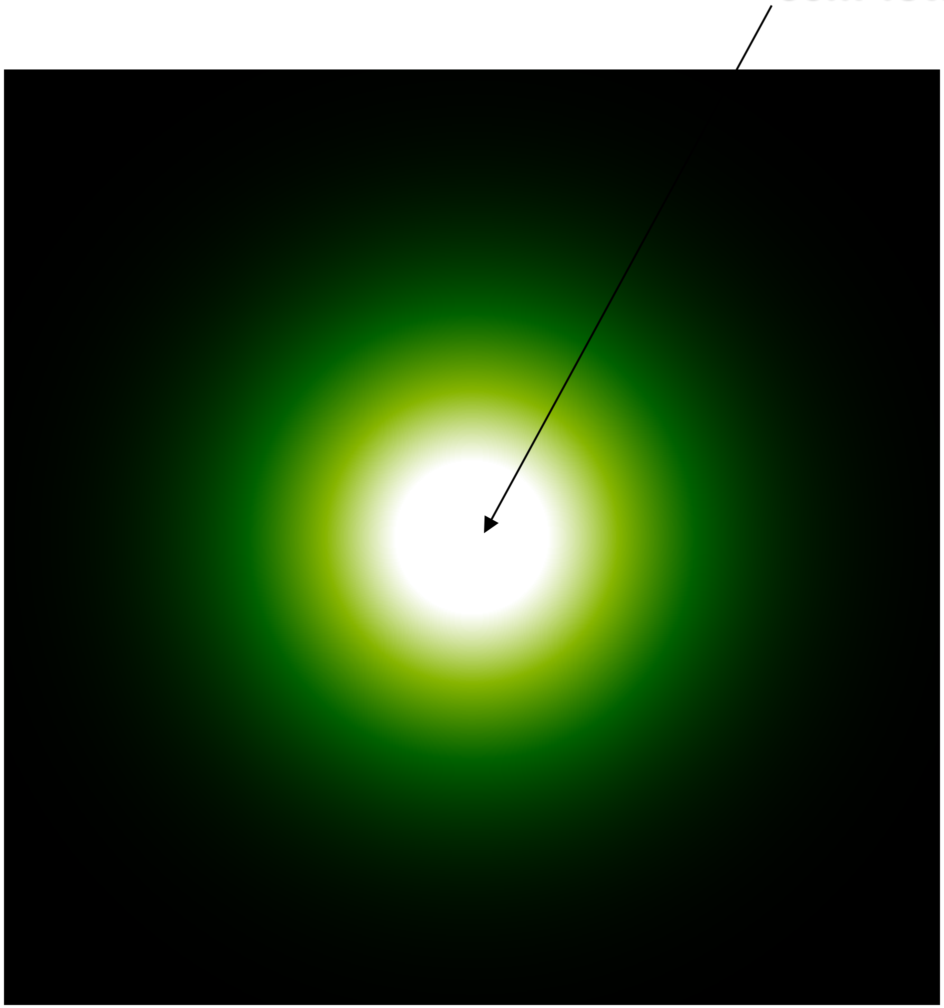
Improving Direct “Point-to-Pixel” Comparisons



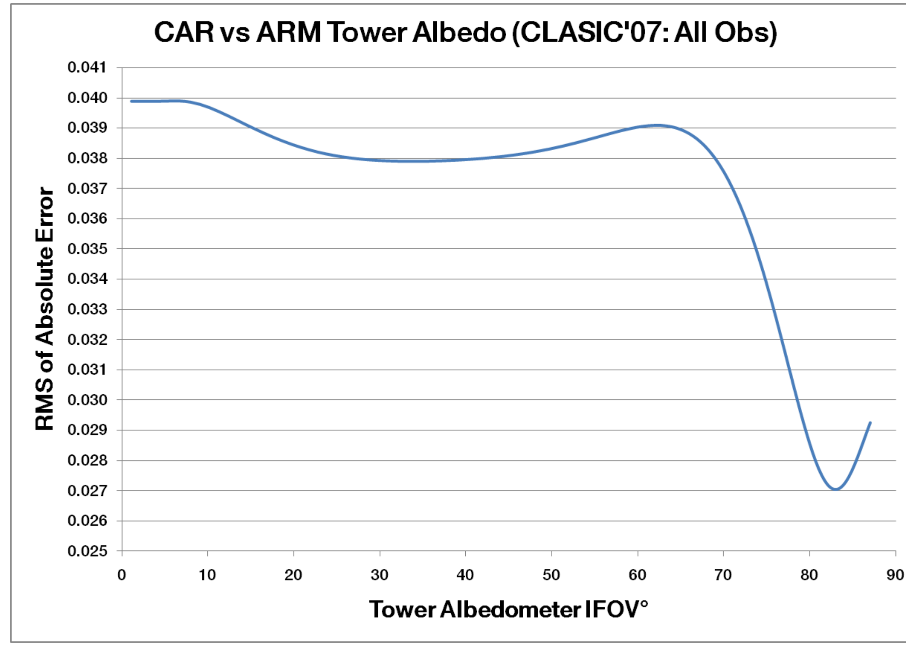
From CM 6B Pyranometer Kipp-Zenon Manual

Improving Direct "Point-to-Pixel" Comparisons

60m Tower



Total(psf) = 1



'Nominal' IFOV: 80˚

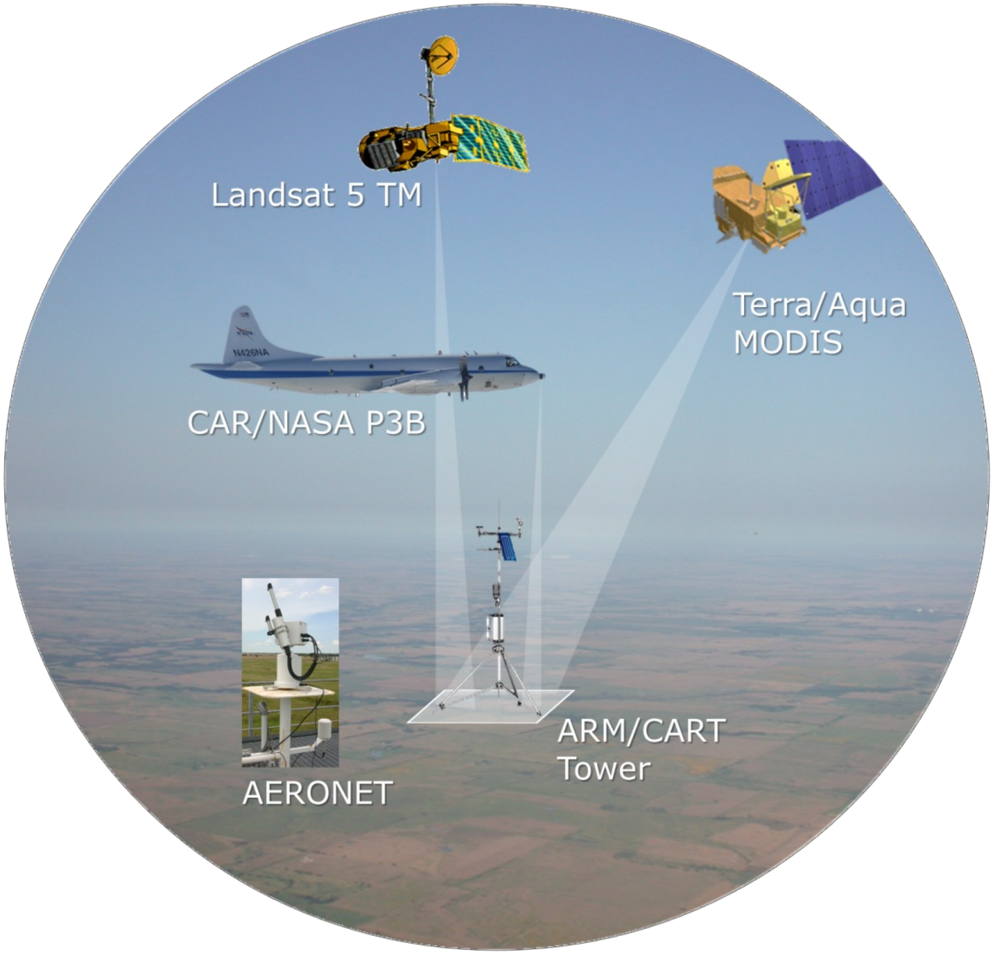
'True' IFOV: 82.3˚ (FWHM = 763m)

Error due to Scale Mismatch: **~2.53%**

So what???

What is the accuracy of a ‘mixed’ BRDF/albedo pixel????

Use of in situ and airborne multiangle data to assess MODIS- and Landsat-based estimates of directional reflectance and albedo (Román et a., 2013 – TGRS)



Measurement configuration for multiscale assessment of MODIS- and Landsat-albedos.

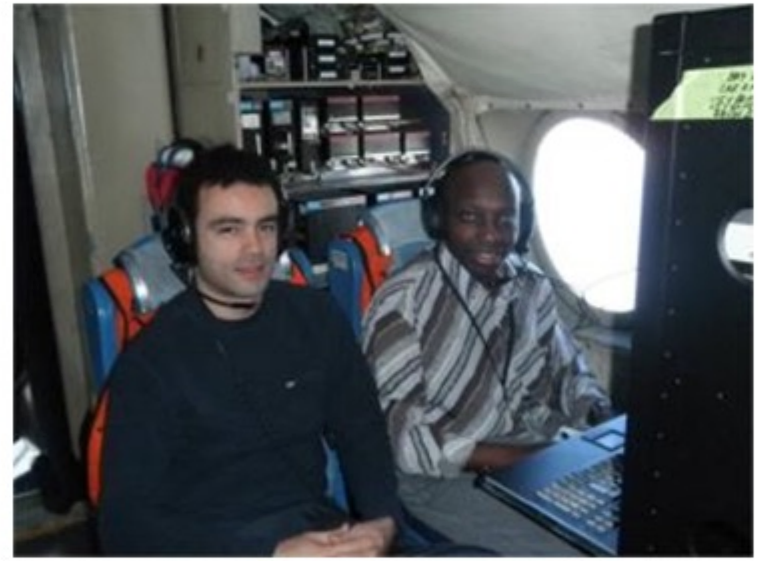
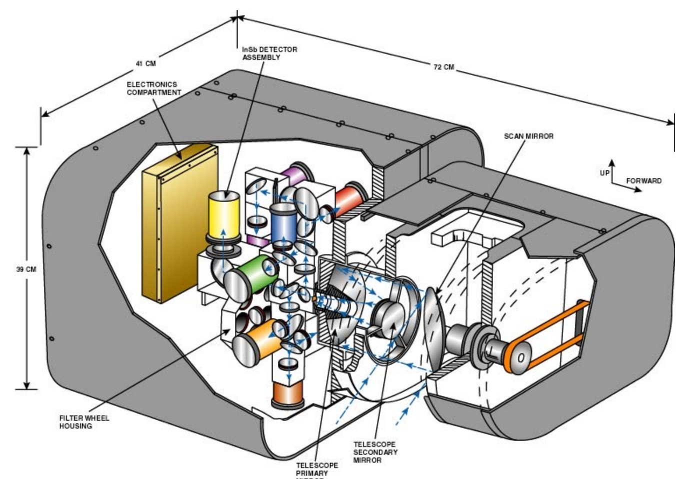


Fig. 1: Román and Gatebe on P3B during Eco/3D campaign Flight #2035.

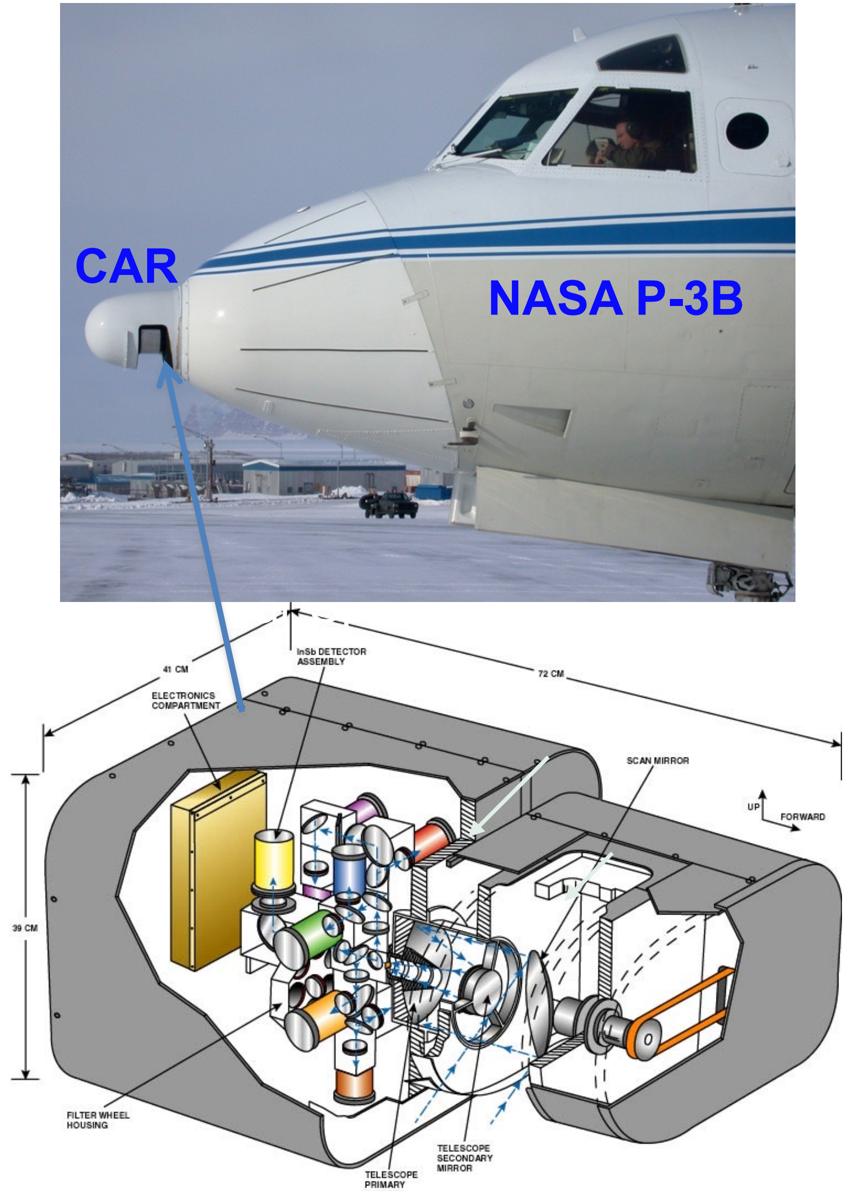


CAR Instrument

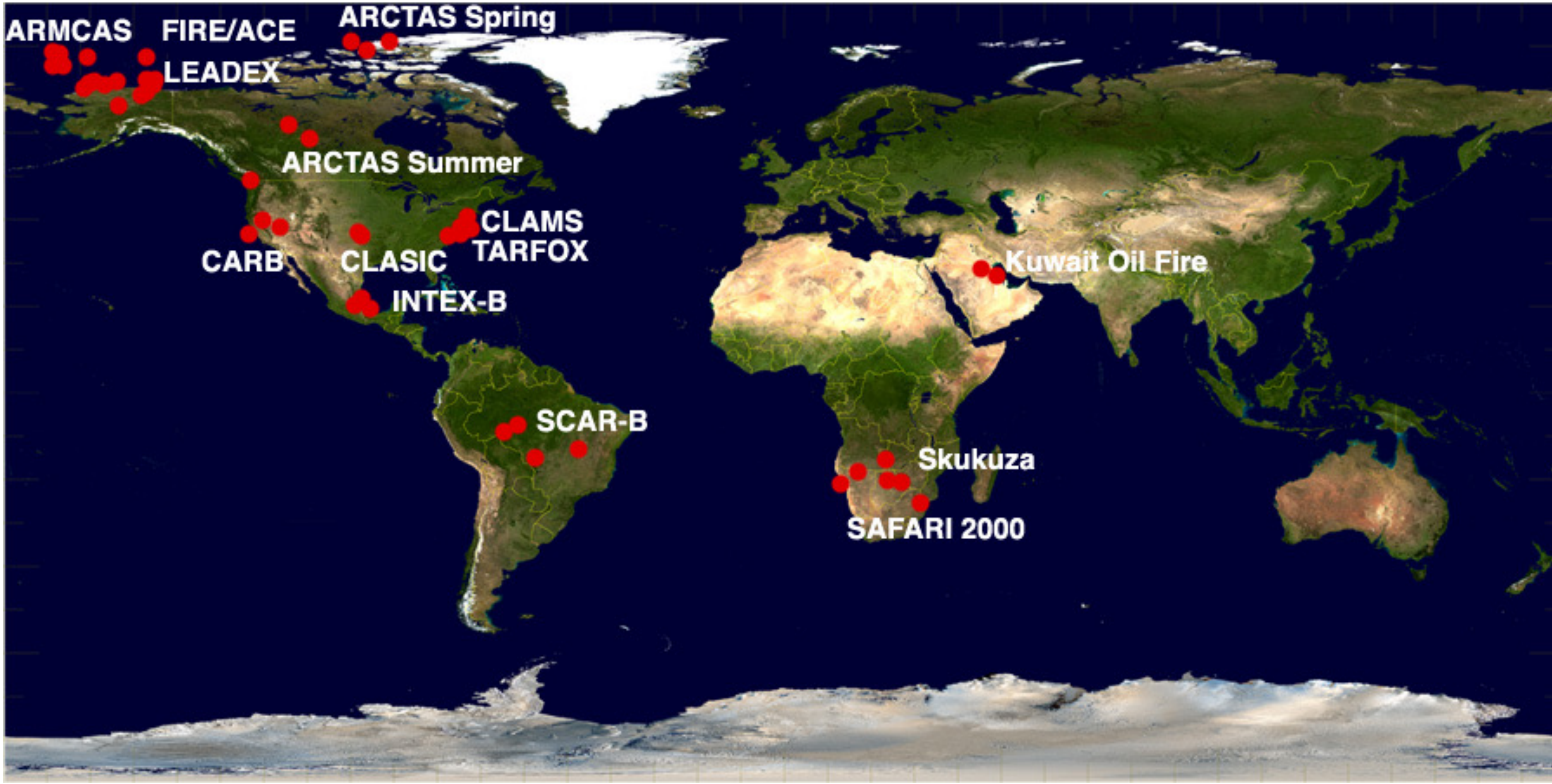
Overview of the CAR Instrument

Sensor Characteristics:

- 14 spectral bands (0.34 to 2.29 µm)
- scan ±95° from horizon on right-hand side of aircraft or image 190° horizon-to-horizon
- field of view 17.5 mrad (1°)
- scan rate 1.67 Hz (100 rpm)
- data system 9 channels @ 16 bit
- 395 pixels in scan line
- Platform: NASA P-3B

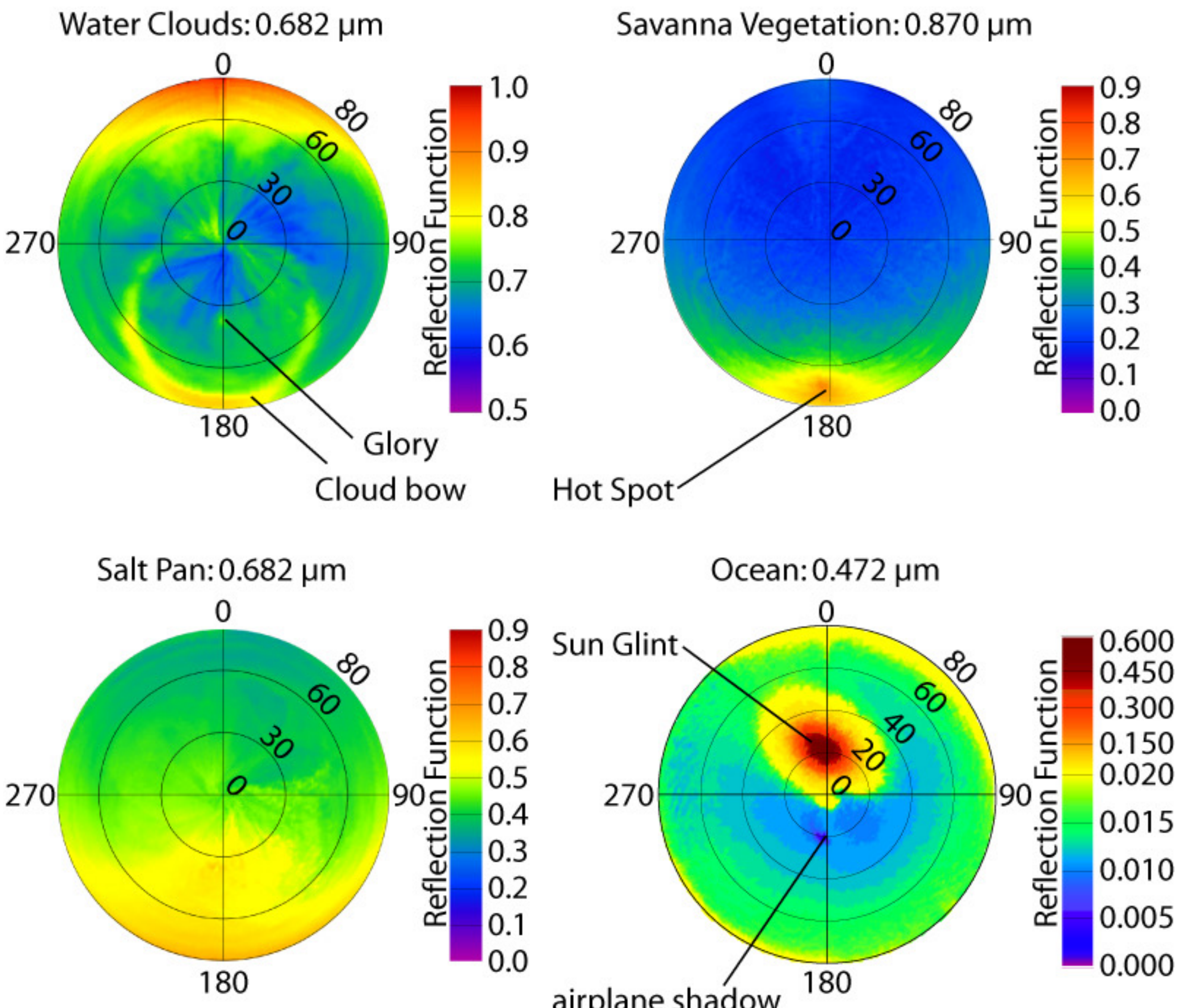


CAR BRDF Data Sets 1991-2008



Multi-spectral Surface Bidirectional Reflectance (BRF) for: snow & sea ice, ocean, clouds, smoke plumes, salt pan (i.e., calibration sites), vegetation (grass, savanna, forests, etc), urban.

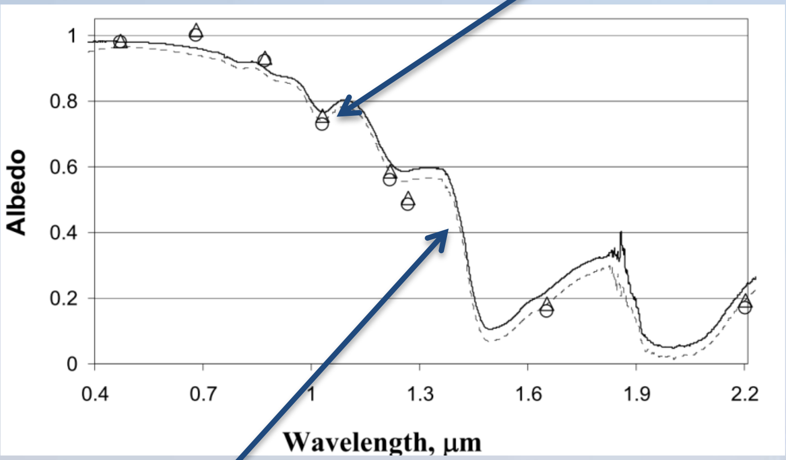
BRDF: Different Surfaces



High angular and spatial resolution (1° IFOV) coupled with a high SNR and dynamic range provides unmatched details of the radiance field above clouds and various surfaces.

ARCTAS 2008

CAR-measured Albedo



Surface-Measured Albedo

Mission Highlights:

- ***Best ever*** in-situ measurements for accuracy analysis of analytical snow BRDF models.
- ***Developed, tested, and evaluated*** new models of macroscopic surface roughness that adjust the plane-parallel radiative transfer solution to experimental snow BRF.

Lyapustin et al. (2010)

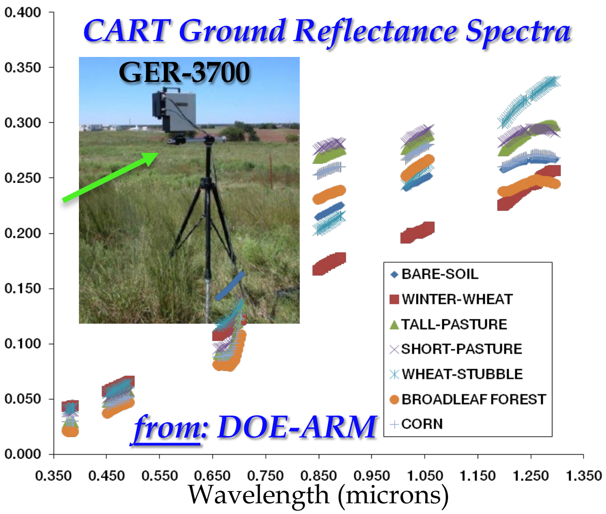
CLASIC'07: ARM Southern Great Plains (SGP) CART

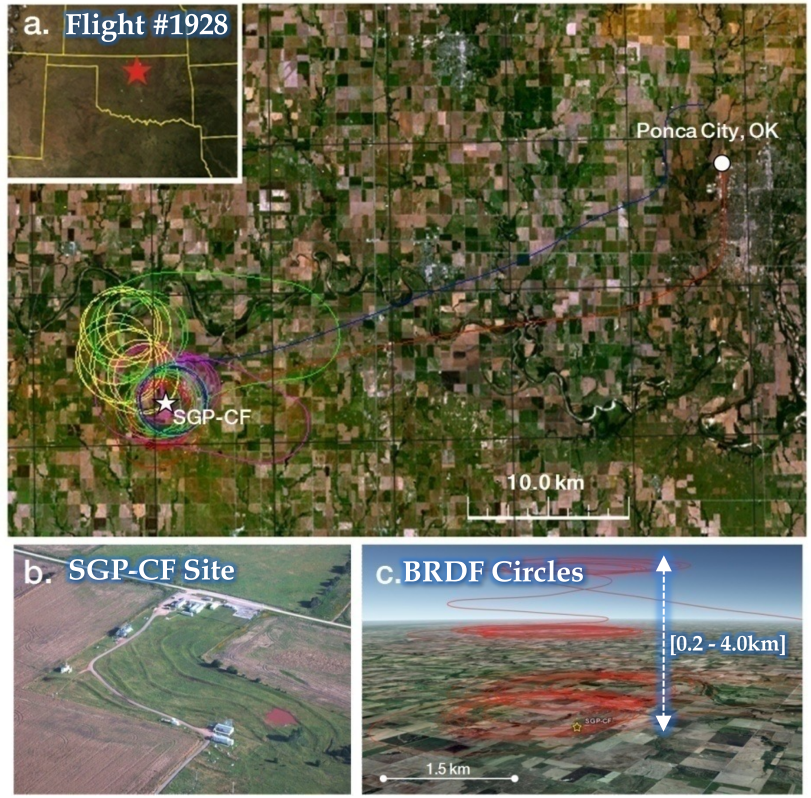
Coincident

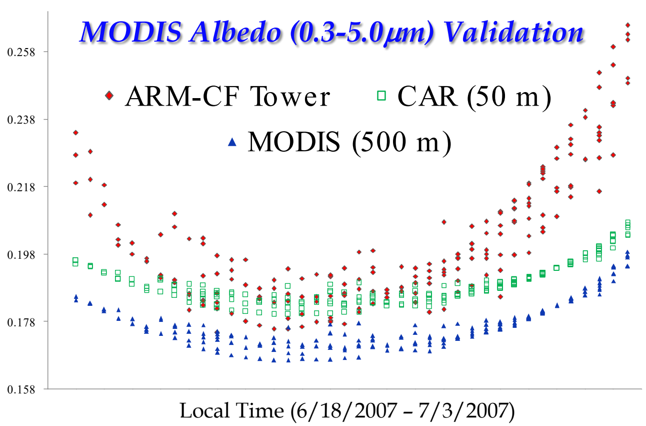
Surface BRDF and Albedo from Ground, Aircraft, and Satellite.

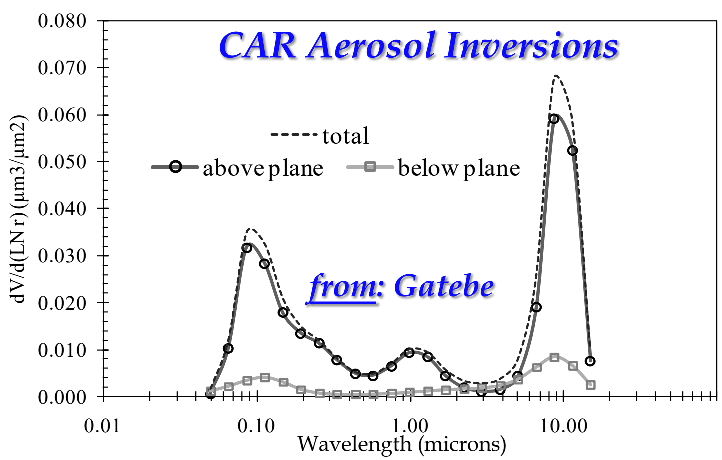
Best ever

Multi-scale observations of the CART Site.





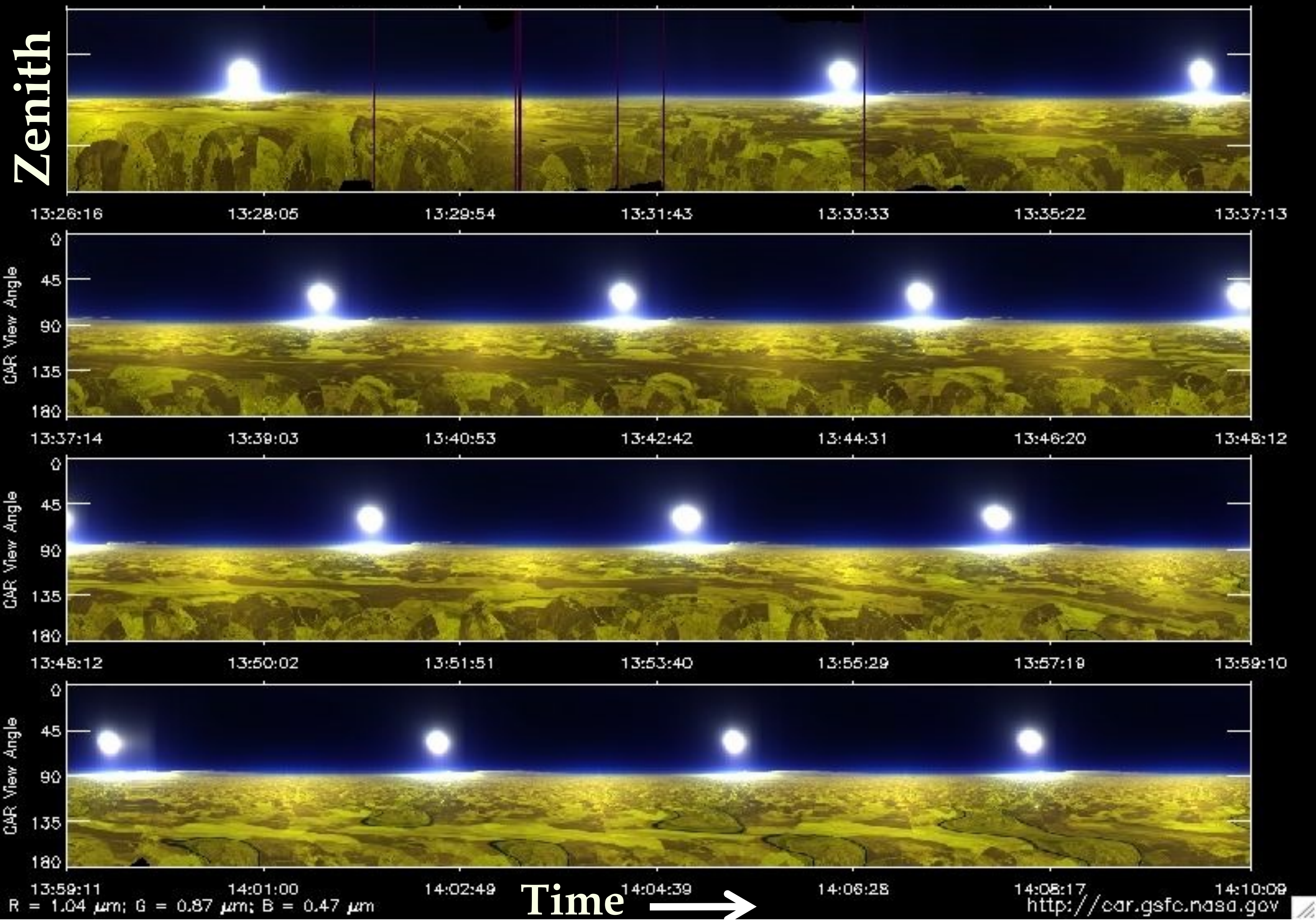




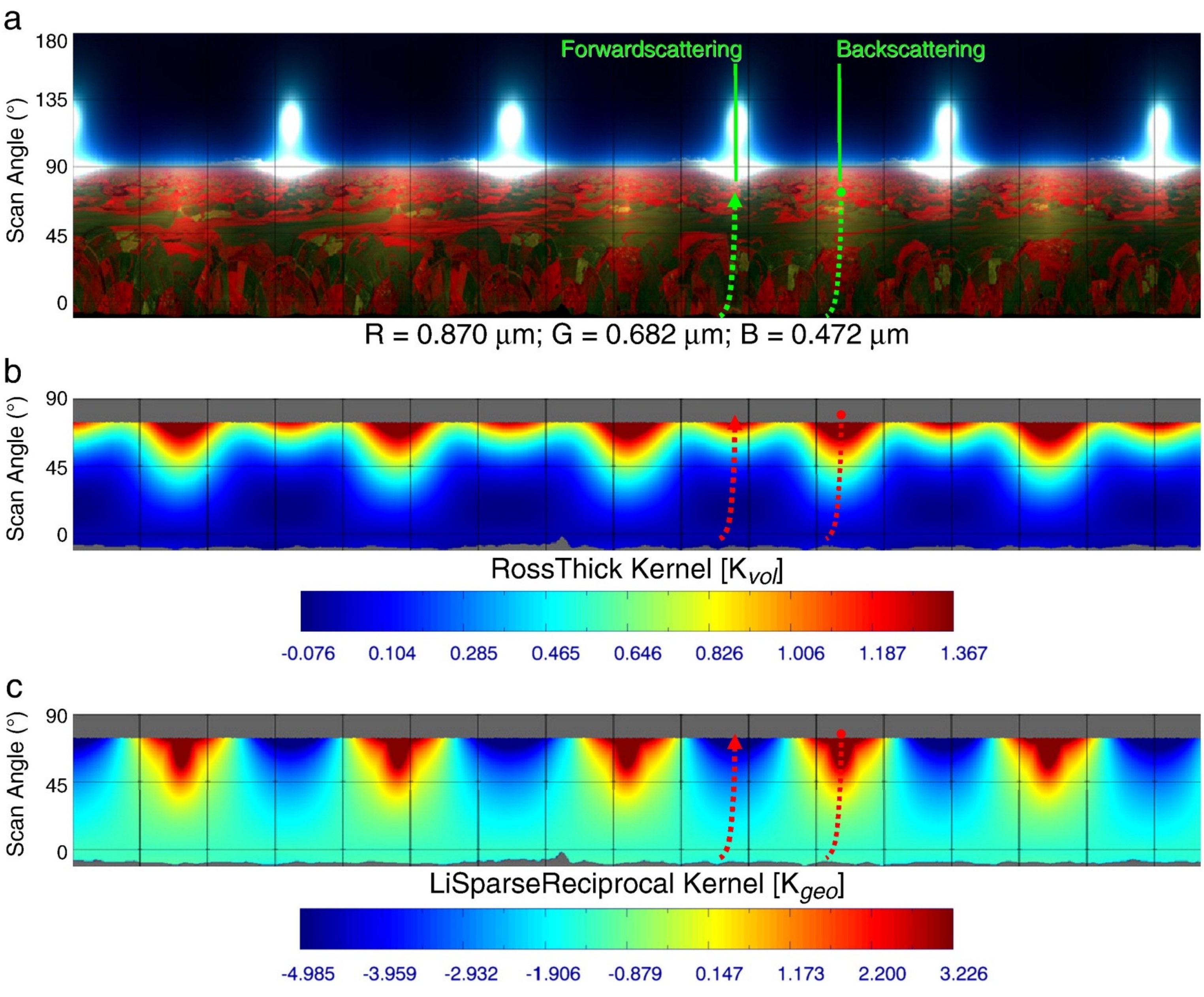
CLASIC Flight #1928:

1.6 million BRFs, from nadir to 75° off-nadir, at spatial resolutions ranging from 3.0 m to 400 m.

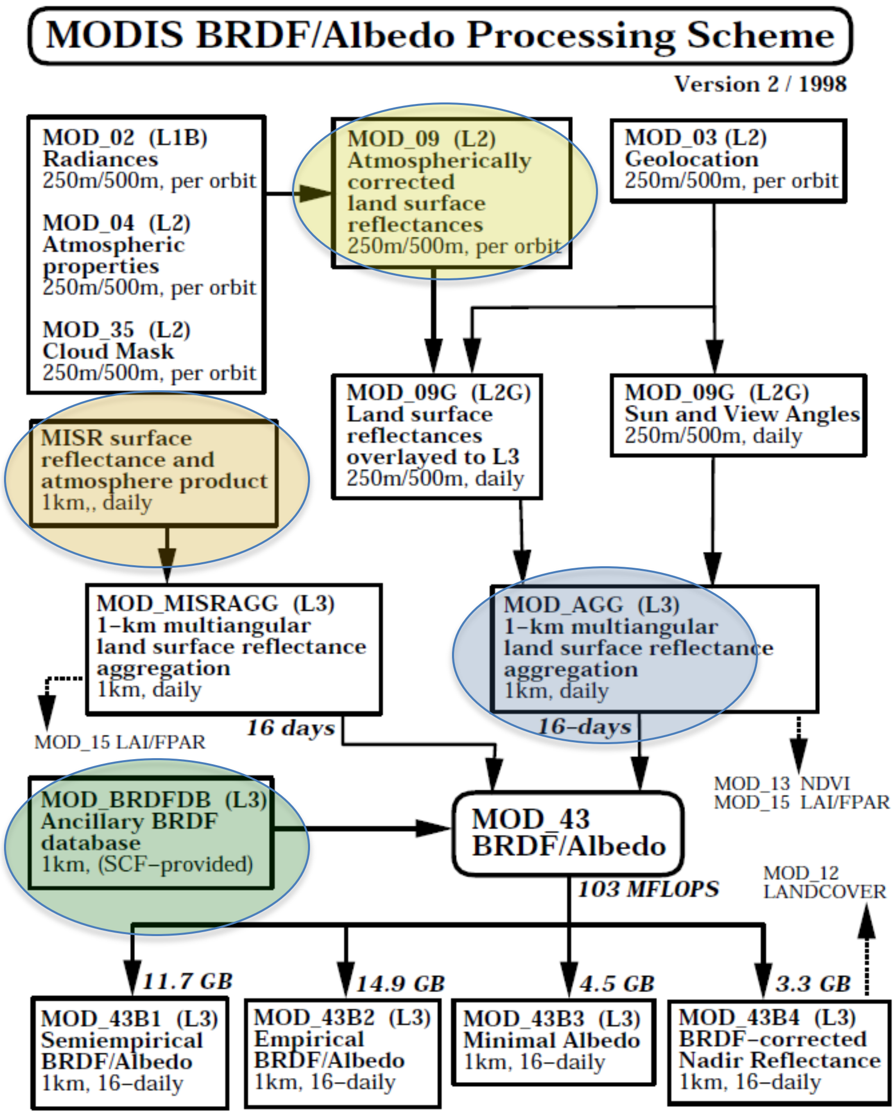
CAR Quick-Look Image: CLASIC Flight #1928



Flight #1928 (12-min segment at 2km AGL).



MODIS BRDF/Albedo ATBD (1999)



Strahler et al., 1999

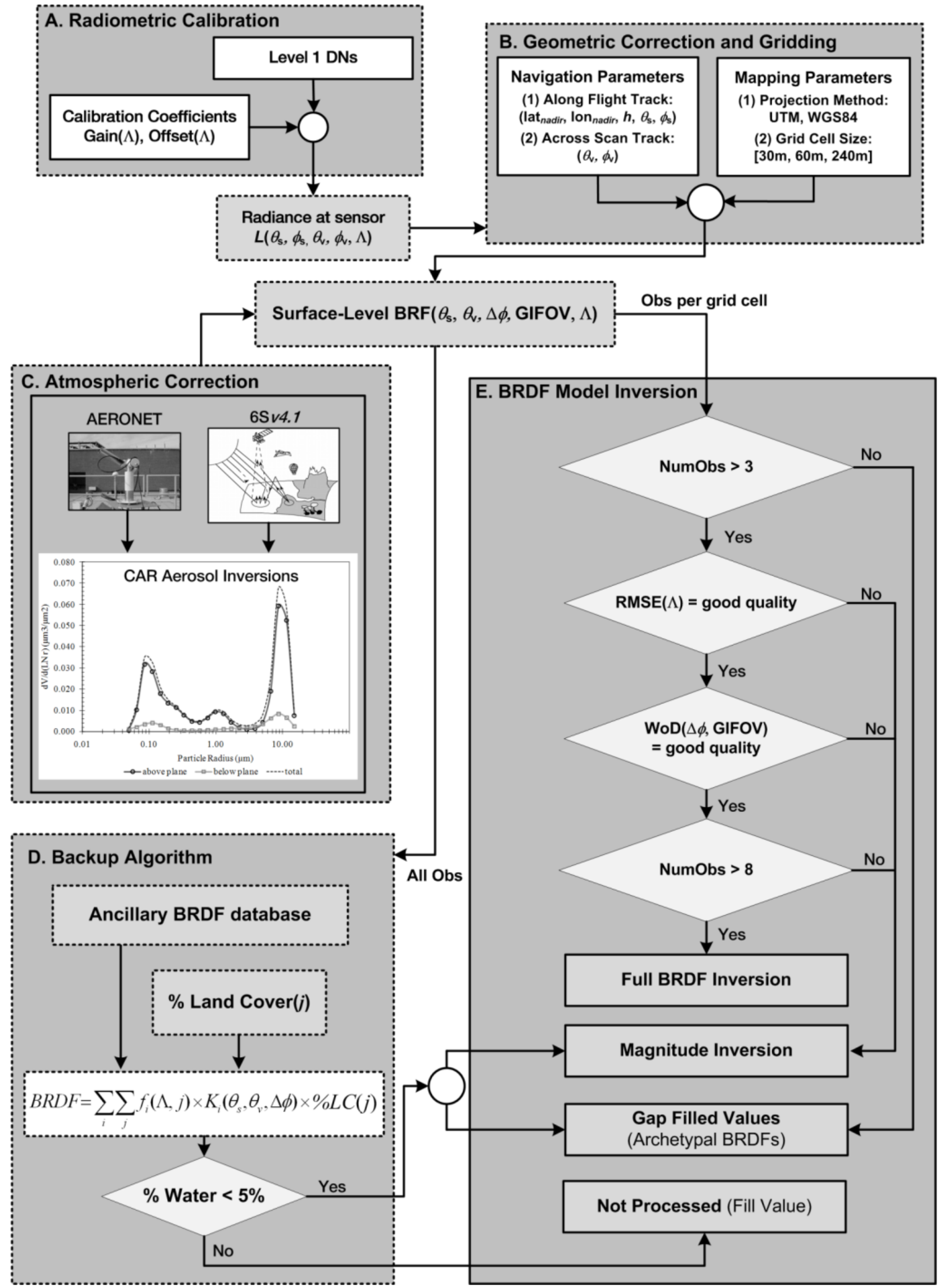
MODIS and VIIRS Algorithm Challenges:

- Temporal (restricted to 8-16 days).
- Spatial-scale (>500m).
- Atmos. Correction
- "A priori" knowledge required.
- Multi-sensor approach (e.g., MODIS+Landsat).

Solutions:

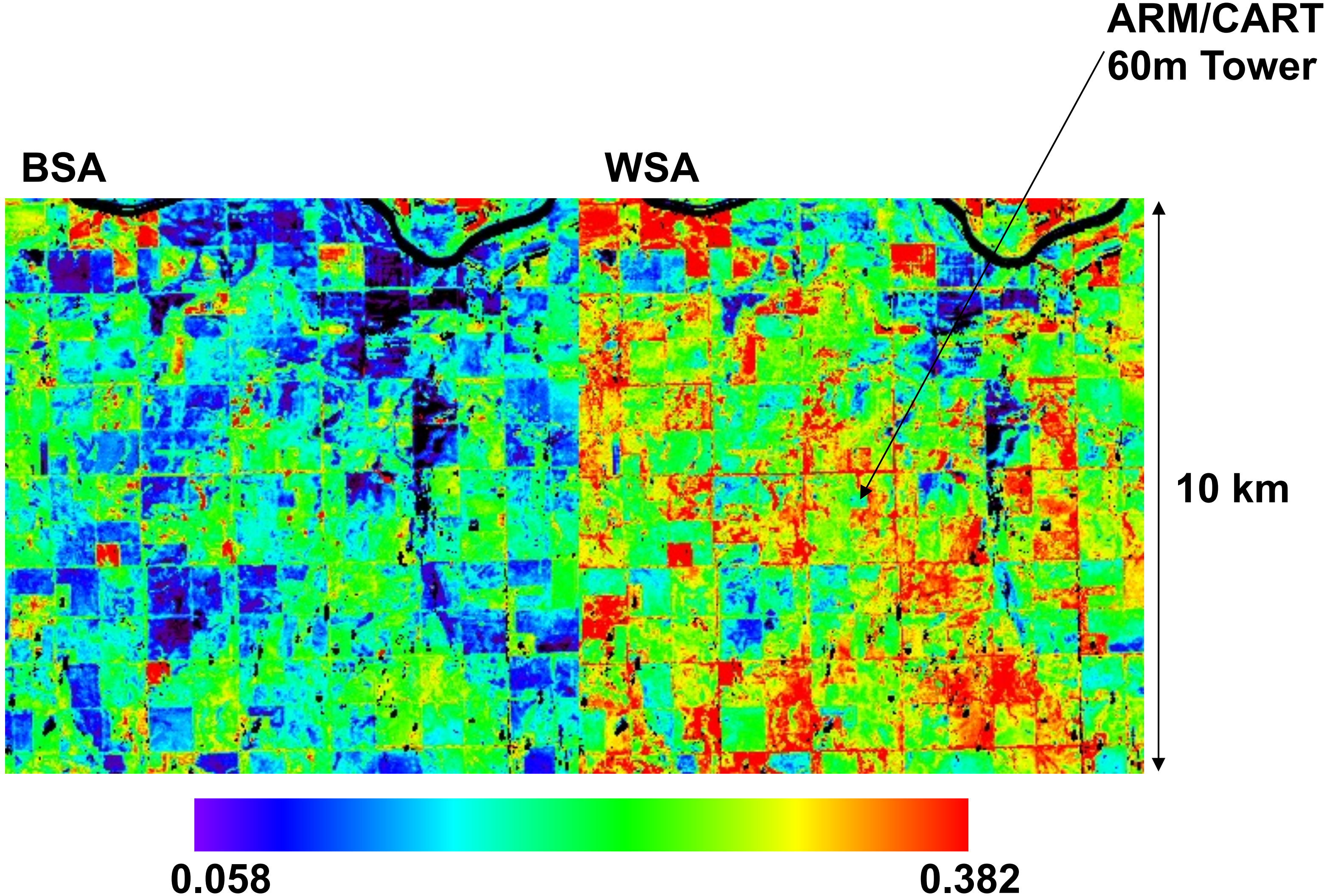
- Temporal (reduced to minutes).
- Multi-scale BRDF (4.0m to 500m).
- Atmos. correction – BRF/aerosol inversion.
- Standard processing (PGE), QA.

CAR BRDF/Albedo Retrieval Strategy (2011)



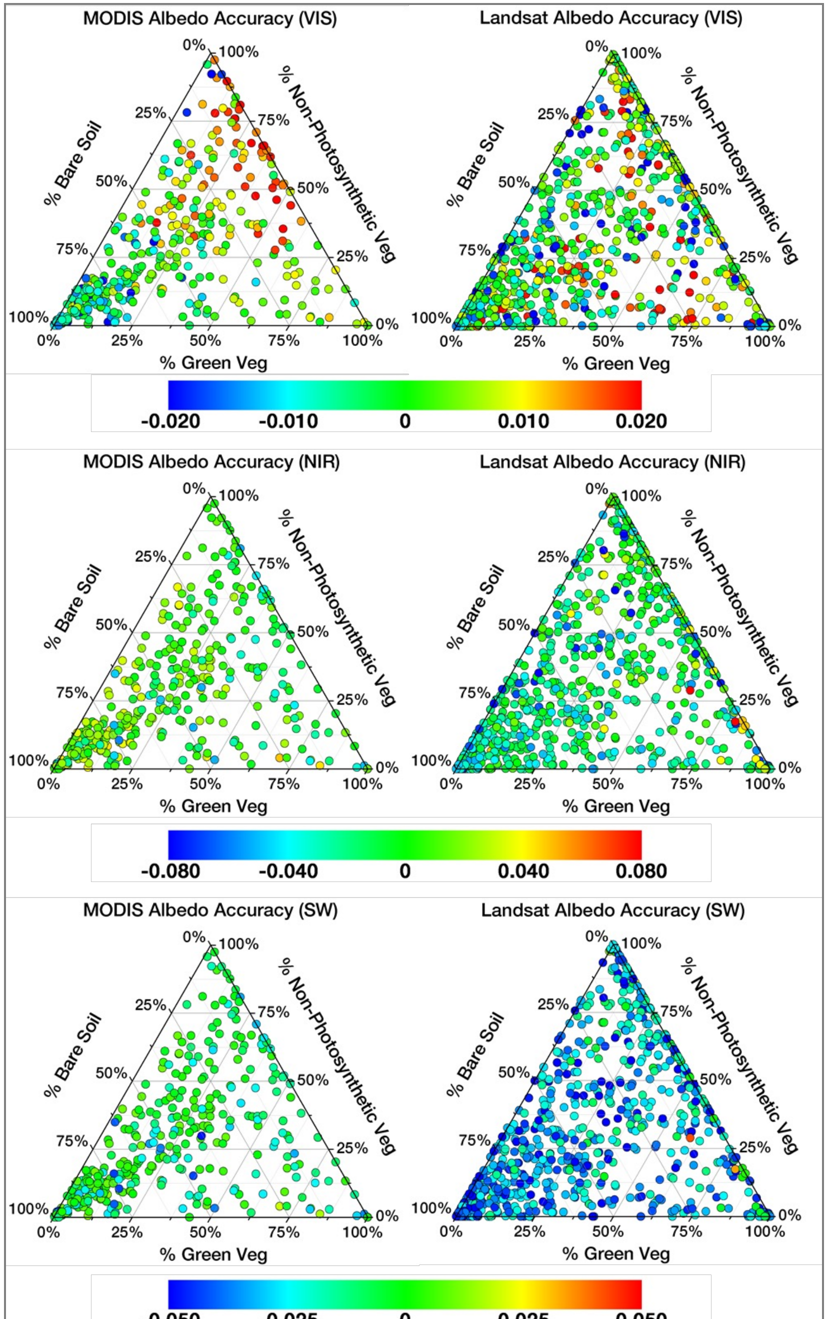
Román et al., 2011

Landsat SW albedo based on CAR-derived Albedo-to-Nadir-reflectance ratios



L5028035_03520070603; SZA = 23.4

Assessing MODIS & Landsat Albedo Retrieval Accuracy at the Pixel-Level



Findings:

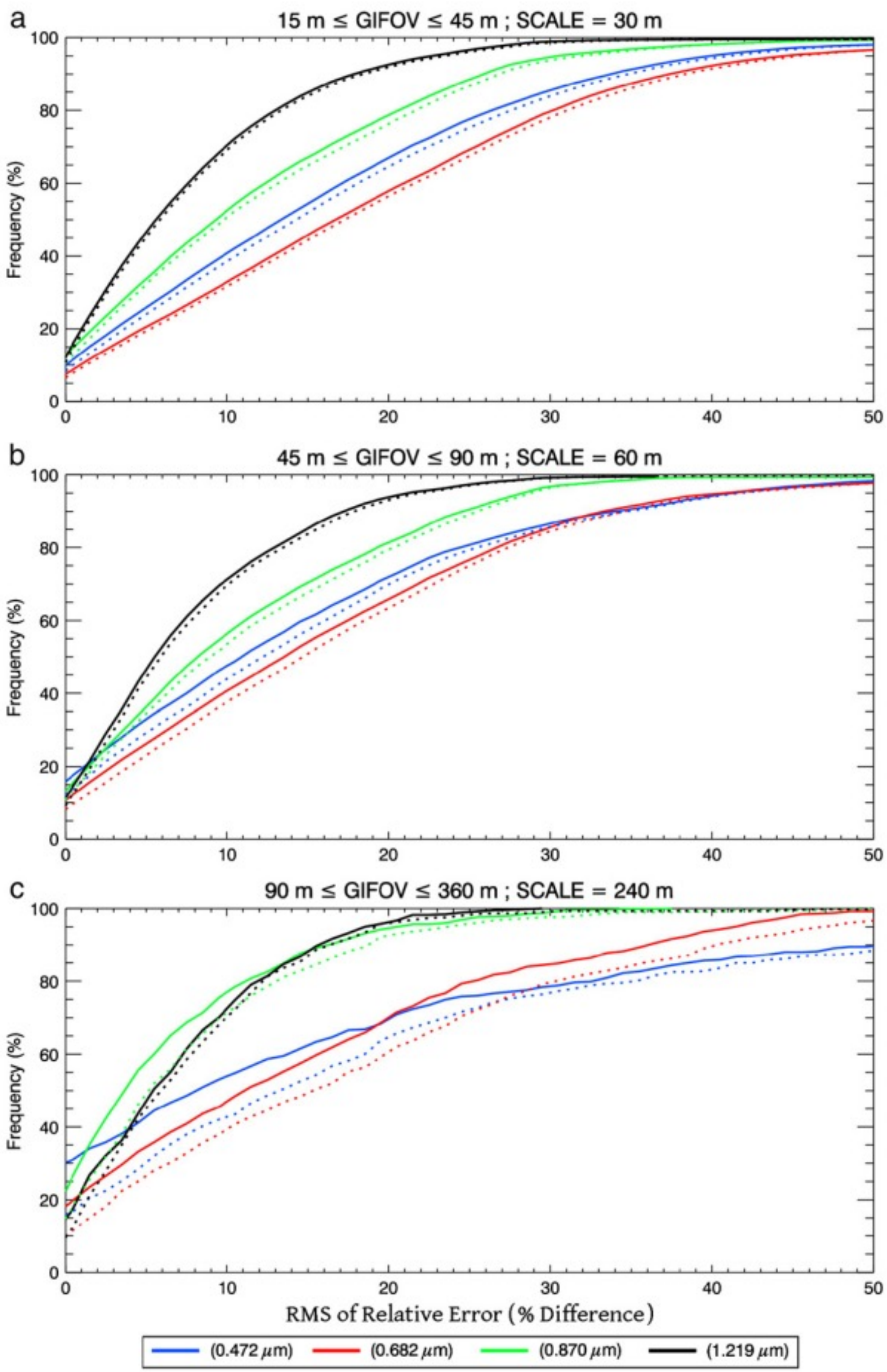
- MODIS VIS albedos captured bare-soil albedo variability (i.e., wet vs. dry soils) with high accuracy (-0.008); but biases are moderately larger over mixed landscapes (+0.012) and regions dominated by 'brown' vegetation (+0.019).
- At the scale of Landsat albedos, uncertainties in the VIS broadband are more likely to affect the SW domain.

Sources of Uncertainty:

- The assumption of temporal stability in the retrieval of 500 m MODIS BRDF values over extended periods of cloud-contaminated observations.
- The assumption of spatial and structural uniformity at the Landsat (30 m) pixel scale.

Román et al., 2013

M.O. Román et al. / Remote Sensing of Environment 115 (2011) 2184–2203



Sources of Uncertainty (*cont.*):

- The use of dominant archetypal BRDF shapes leads to errors on the order of 0.5% – 6.5% in the retrieved BRF.
- This will particularly affect retrievals where heterogeneous conditions are being lumped into a single land cover class.
- These situations can be addressed by breaking “pure” land cover clusters into multiple sub-clusters representing different surface conditions.

◀ **(Cumulative distribution of differences in Relative RMSE %)**

ΔRMSE% of linear-mixture BRDFs (solid lines)

ΔRMSE% of dominant BRDF (dotted lines)