VIIRS-Land Validation Overview

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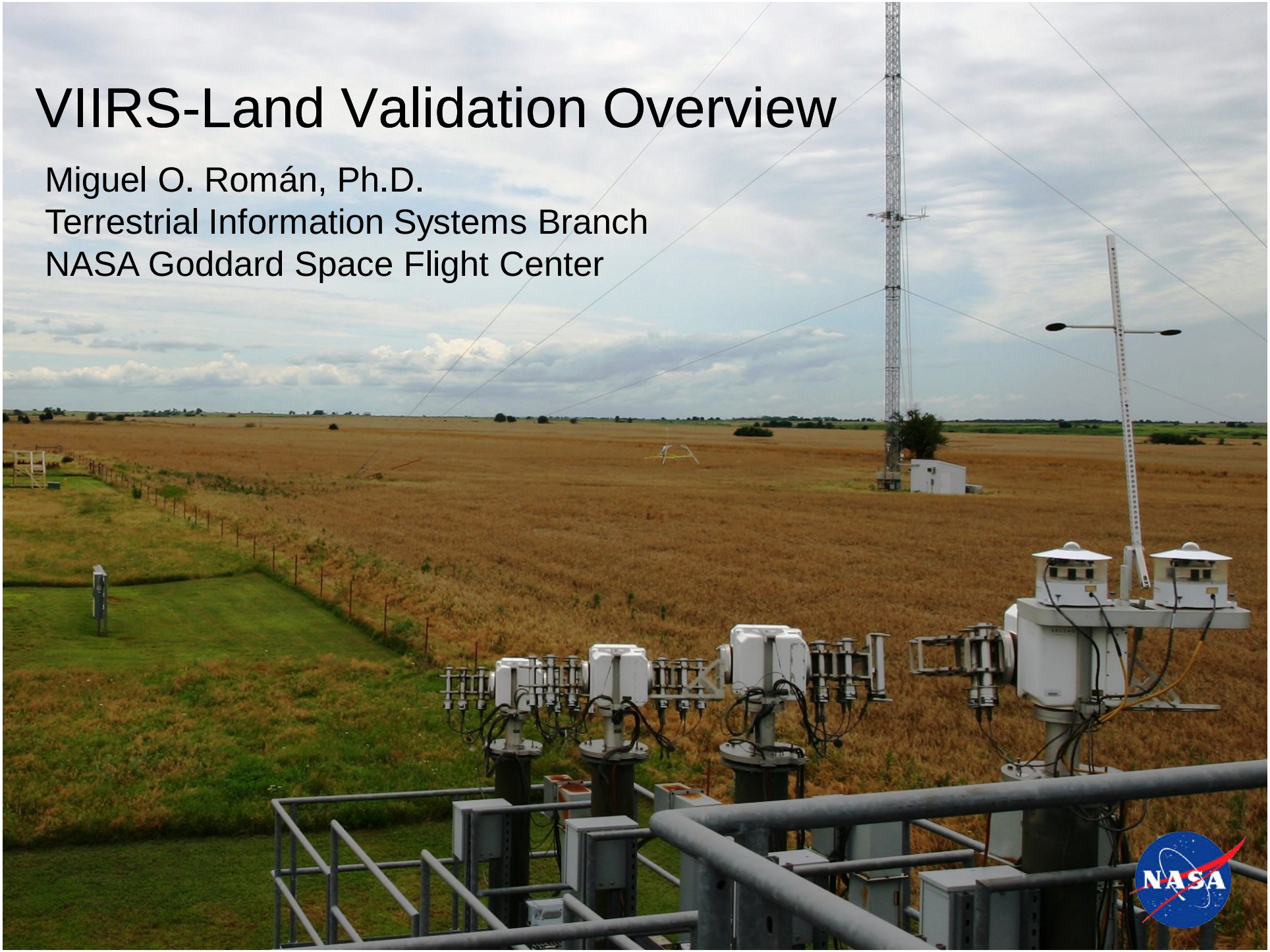

An Evaluation of the NPOESS Preparatory Project (NPP) Visible/Infrared Imager Radiometer Suite (VIIRS) and the Associated Environmental Data Records for Land Science

The VIIRS Land Team[#] with contributions from:
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Editors: *Miguel O. Román and Chris Justice*

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Land EDR Validation Team

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Joanne Nightingale	CEOS-WGCV LPV Liaison	Sigma Space Corporation (NASA GSFC)

- The Integrated Program Office (IPO) is currently supporting a Validation Team to help evaluate a total of 14 different products within nine general EDR product categories.
- This team includes Subject Manner Experts (SMEs) to provide guidance on several “upstream” algorithms critical to successful Land Products (e.g., Calibration, Geolocation, Aerosols, and Cloud Mask).

What does the Land Validation Team need to do to evaluate the EDRs?

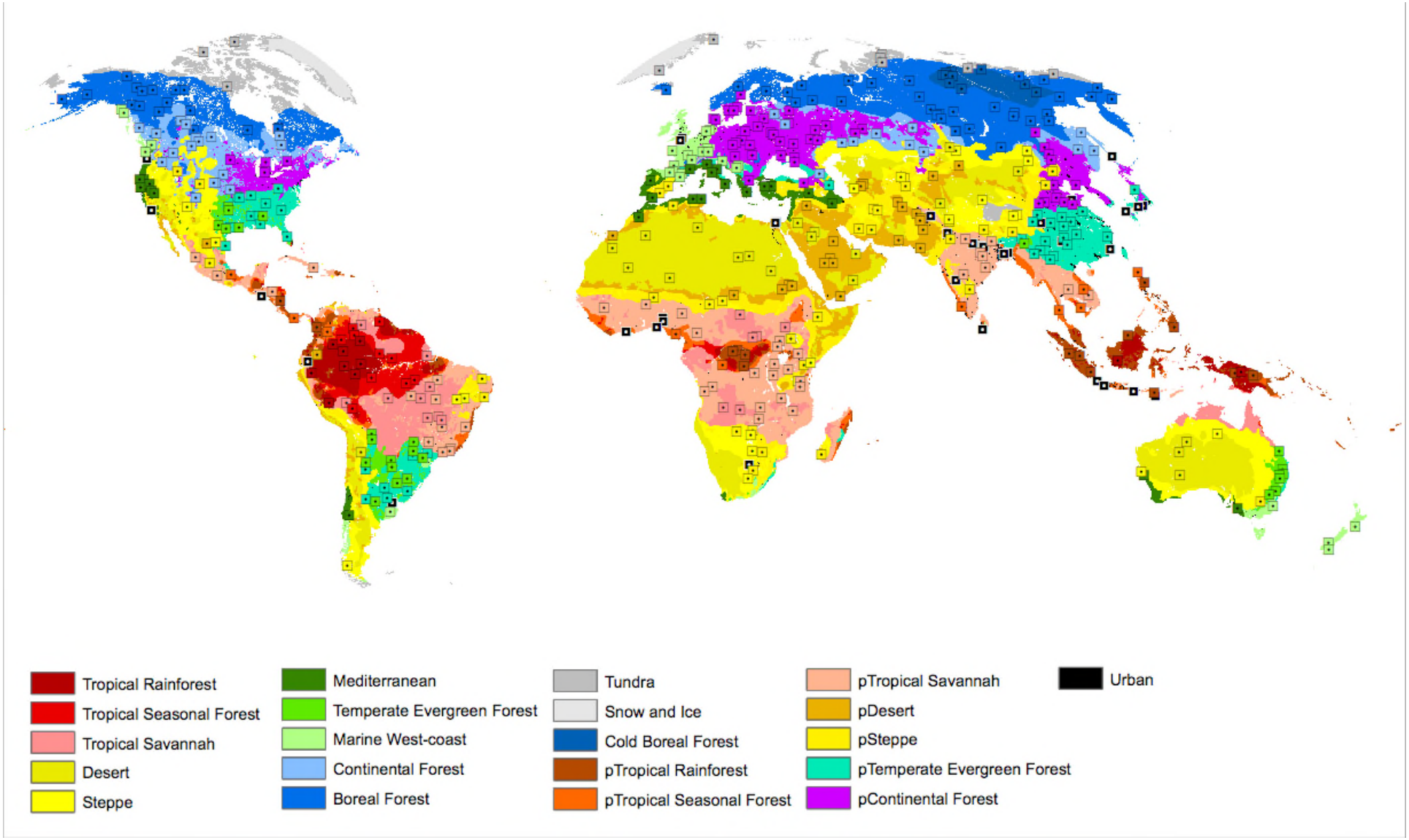
- Assess the operational viability and compliance of Land EDRs, IPs, and ARPs with: (1) VIIRS System Specification and (2) IORD2[#].
- Provide rigorous comparisons with independent datasets as well as estimated uncertainties for each comparison.
  - **Current Emphasis: Establish the infrastructure to validate the EDR's and, where possible, develop automated validation procedures.**
  - Immediate post-launch period: Emphasis will be given to product inter-comparison with validated MODIS data.
  - Short-Term Goal: Emphasis will be on Stage 1 Validation using a small number of well characterized targets of opportunity.
  - Long-Term Goal: To determine the quantitative uncertainties of EDR, IPs, and ARPs at CEOS Stage 3 Validation (statistically valid over comprehensive range of environmental conditions).

#Interagency Operational Requirements Document 2 (IORD2)
http://www.osd.noaa.gov/rpsi/IORDII_011402.pdf

VIIRS Land Validation Plan: Current Emphasis

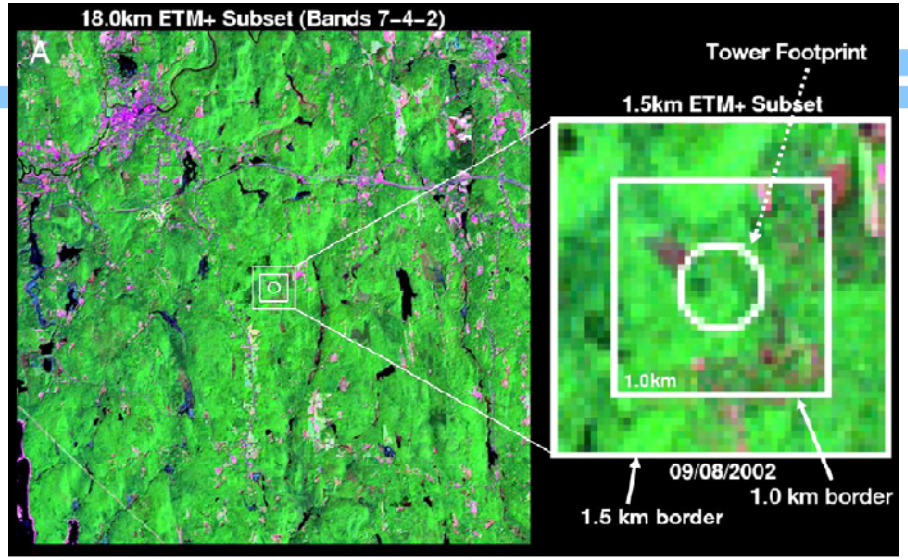
- Recent progress has been made on the implementation of a global sample design for surface type EDR validation as part of a larger effort to provide a global land cover validation dataset.
- The plan has been developed in coordination with a NASA-funded project that is a collaborative effort between GOFC/GOLD and CEOS WG Cal/Val that is led by Curtis Woodcock, Martin Herold, and Mark Friedl.
- The plan includes a global stratified sample, based on a combination of climate/vegetation biomes (modified from Koppen) and population data.
- Sample sites are 5km x 5km and the “ground truth” will be derived from very high resolution imagery with the assistance of local experts
- Preliminary analyses using MODIS and GlobCover datasets show that the sample design adequately captures the range and diversity of global land cover and land use types.

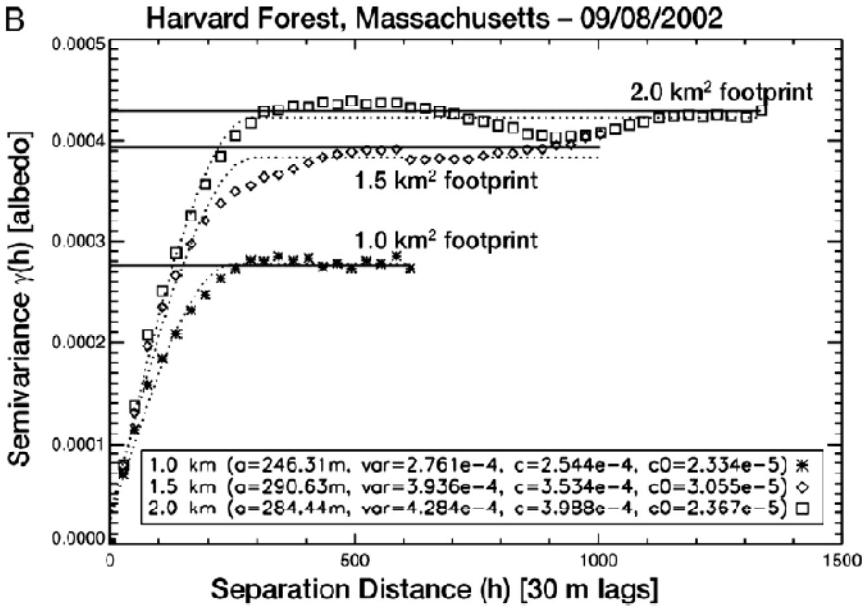
Global Land Cover Validation: Global Stratification and Sample Sites



VIIRS Land Validation Plan: Current Emphasis

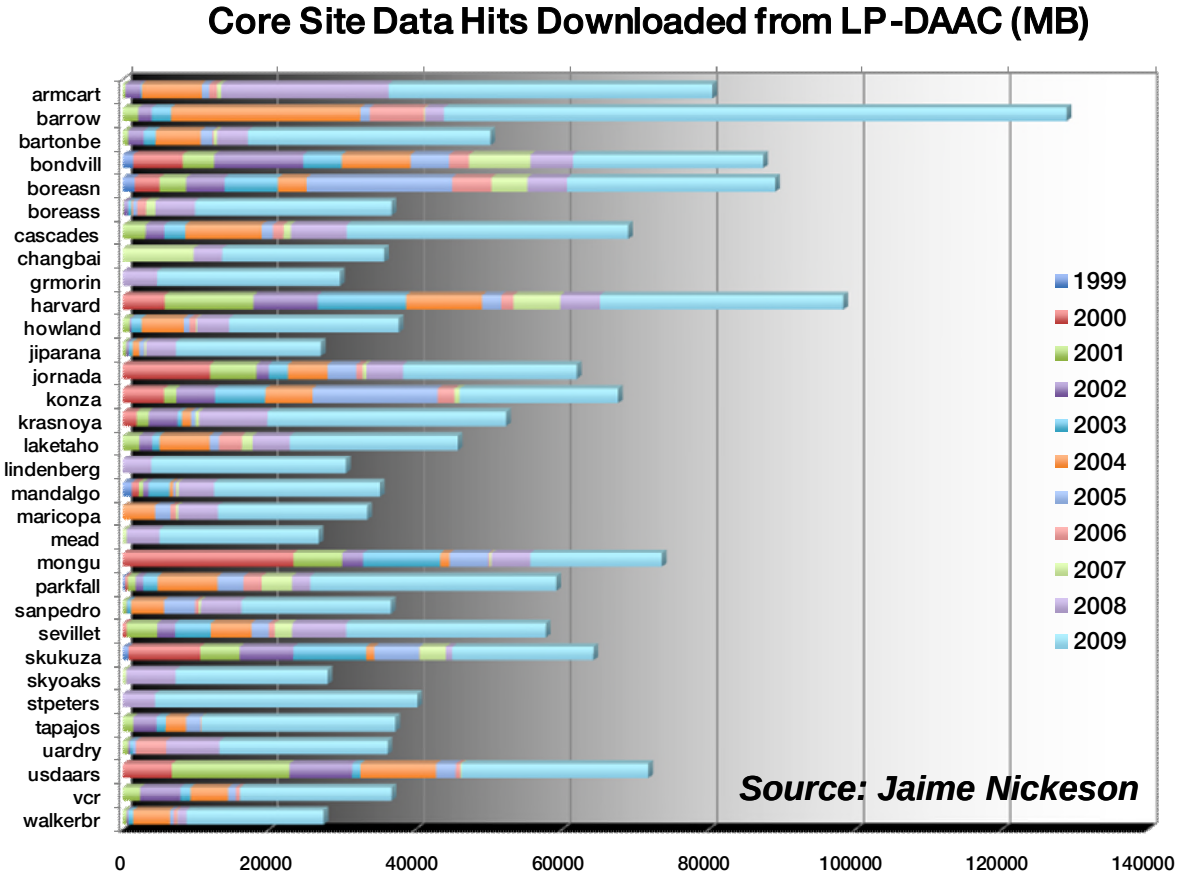
- Site-level characterizations of field network sites of potential interest.
- Objective statistical approach to identify best sites for validation assessments.
- Being systematically applied to:
  - FLUXNET
  - NOAA-CRN
  - SurfRad
  - DOE-ARM
  - BSRN





Source: Román et al., (2009)

VIIRS Land Validation Plan: Current Emphasis



By conducting these studies at the onset, the Land Validation Team can concentrate its post-launch activities on those sites for which success in scaling is likely.

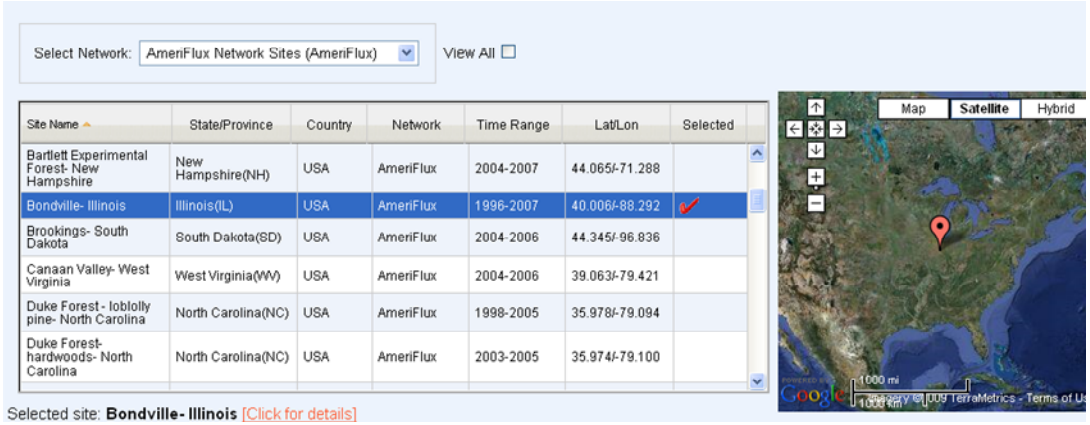
MODLAND Validation lessons learned:

- Core Site approach creates efficiency and focus.
- Spoon-feed data to users.
- On-line access, easy file format, common projection.
- Systematic method to incorporate user feedback.
- Utilize CEOS WGCV for sharing validation data and methods.
- Maintain archive and assess to independent-validation data sets so to validate multiple versions.
- Establish target accuracy and relay validation status in both stages and product accuracy.
- Plan field campaigns no sooner than ~6 months after launch.
- Utilize intermediate spatial-scale resolution imagery.

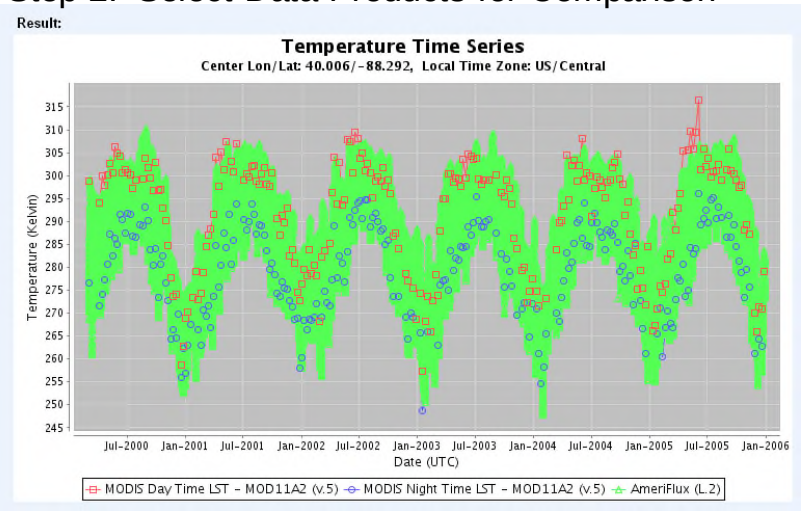
VIIRS Land Validation Plan: Current Emphasis

Satellite Product Evaluation Center (SPEC)

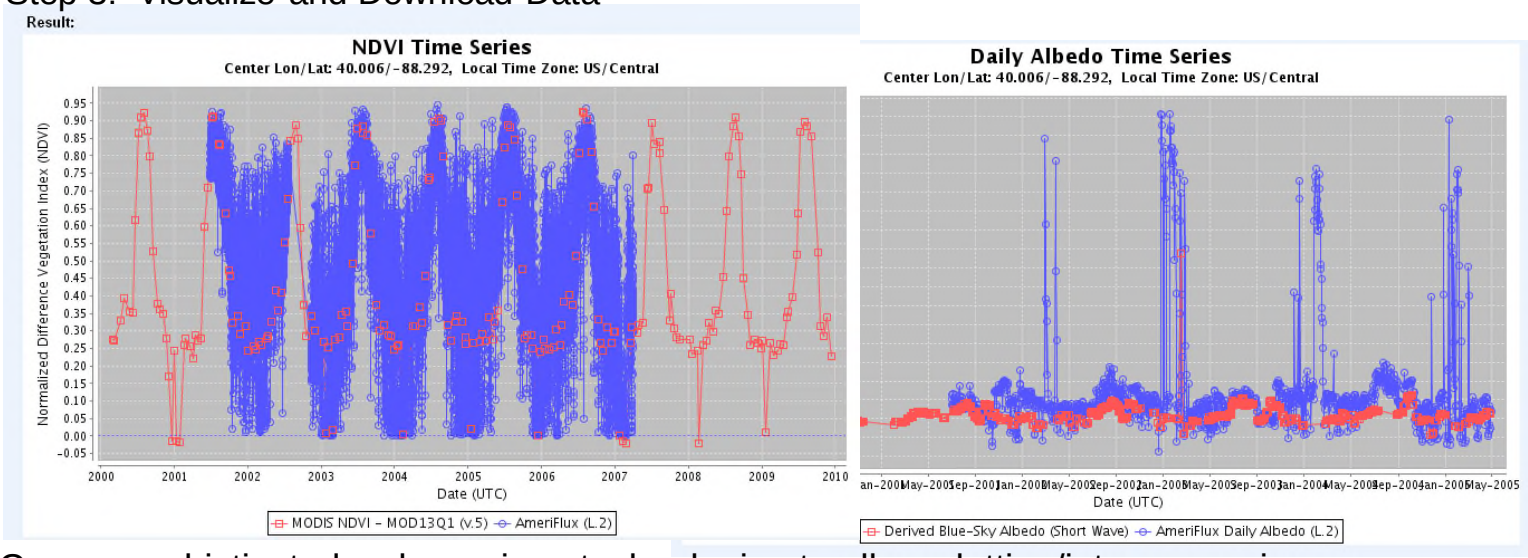
Step 1: Select a Site



Step 2: Select Data Products for Comparison



Step 3: Visualize and Download Data



SPEC uses sophisticated web-services technologies to allow plotting/intercomparison of point, swath, grid or radial (radar) data in a format-neutral way (OpenDAP).

Source: Robert B. Cook (See Meeting Poster)

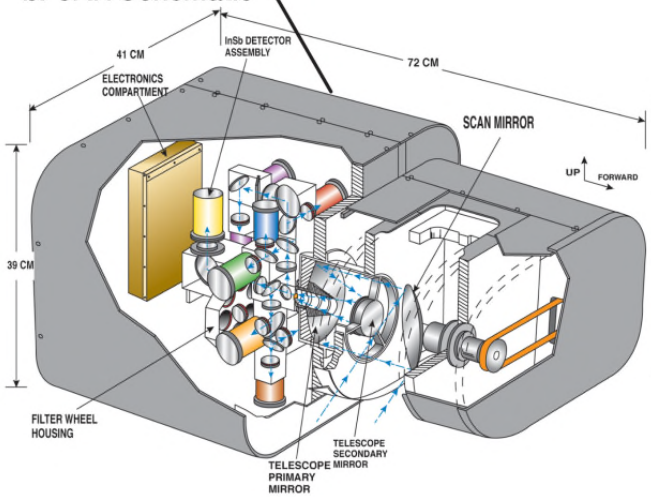
NASA's Role in Validation of VIIRS

- The NPP mission will provide an important benchmark to test the assumption that a VIIRS land product suite can be generated that is suitable for climate research applications and will provide continuity with the EOS MODIS instrument.
- This will require a more extensive set of activities and expertise including:
  - Assessments of consistency with long term data records (e.g. Surface Reflectance, NDVI), temporally smoothed and gap-filled land products (e.g. annual phenology, LAI/FPAR).
  - Evaluations of other EOS-era products (e.g. spectral surface albedo, burned area, and BRDF products).
  - Cal/Val analysis, coordination between dependent products, and **validation science activities** in support of the generation and refinement of VIIRS Land Science Products.

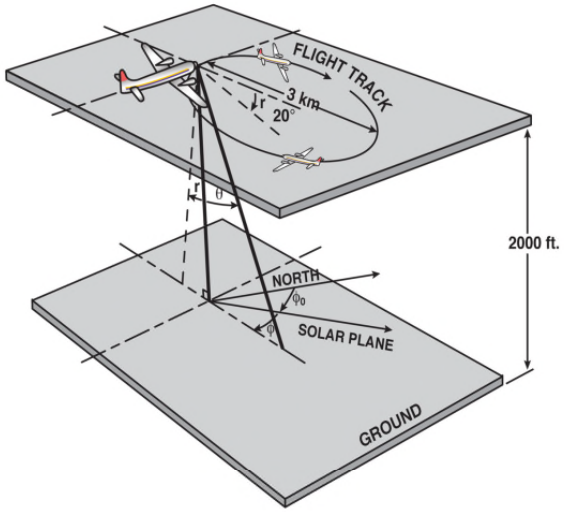
NASA's Cloud Absorption Radiometer (CAR)

a. Jetstream-31 Aircraft

b. CAR Schematic



c. BRDF Flight Track

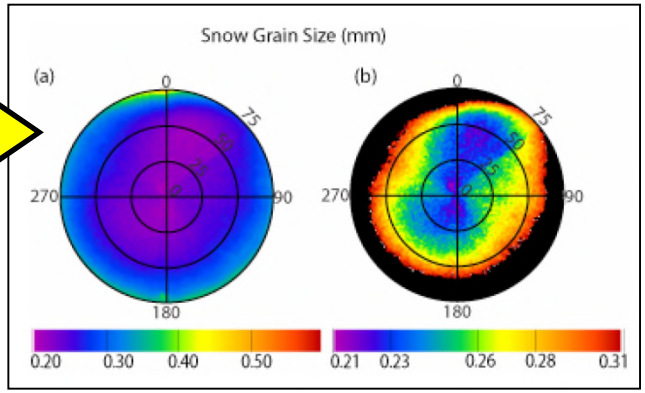


d. Cloud Absorption Radiometer (CAR) Parameters

Angular scan range	190°
Instantaneous field of view	17.5 mrad (1°)
Pixels per scan line	382
Scan rate	1.67 scan lines per second (100 rpm)
Spectral channels (μm; bandwidth (FWHM))	14 [a] (8 continuously sampled and last six in filter wheel): 0.340(0.009), 0.381(0.006), 0.472(0.021), 0.682(0.022), 0.870(0.022), 1.036(0.022), 1.219(0.022), 1.273(0.023), 1.556(0.032), 1.656(0.045), 1.737(0.040), 2.103(0.044), 2.205(0.042), 2.302(0.043)

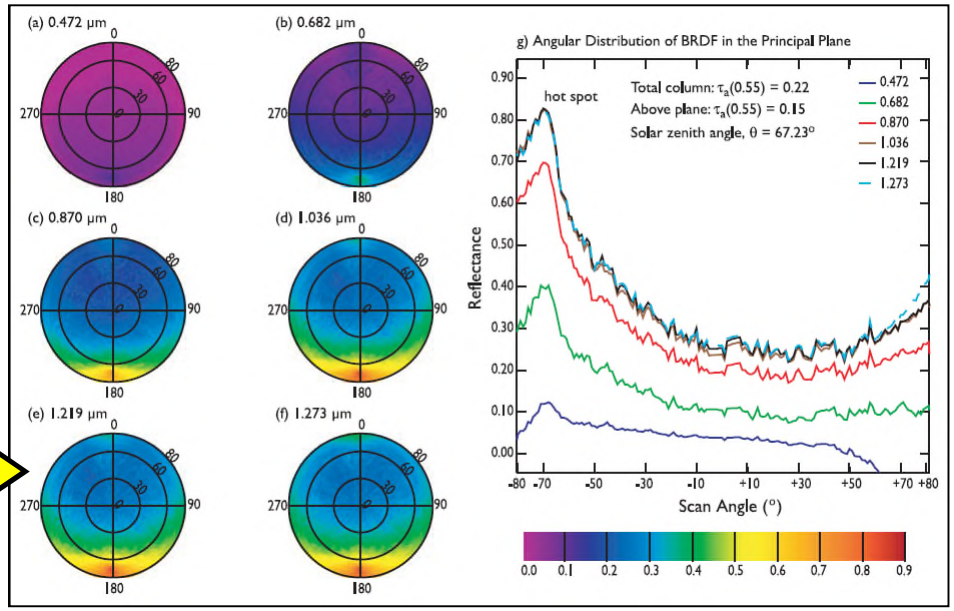
- A 14-channel airborne scanning radiometer with a spectral range from 0.331– 2.345μm.
- Considered as the most frequently used airborne instrument built in-house at NASA-GSFC.

Our Mission: *To promote efficient use of NASA sensor resources and technical capabilities.*



Lyapustin et al. (2009): Retrieved snow grain diameter from CAR BRF data.

Gatebe et al., (2003): Spectral BRDF for selected CAR channels obtained over Skukuza, South Africa.



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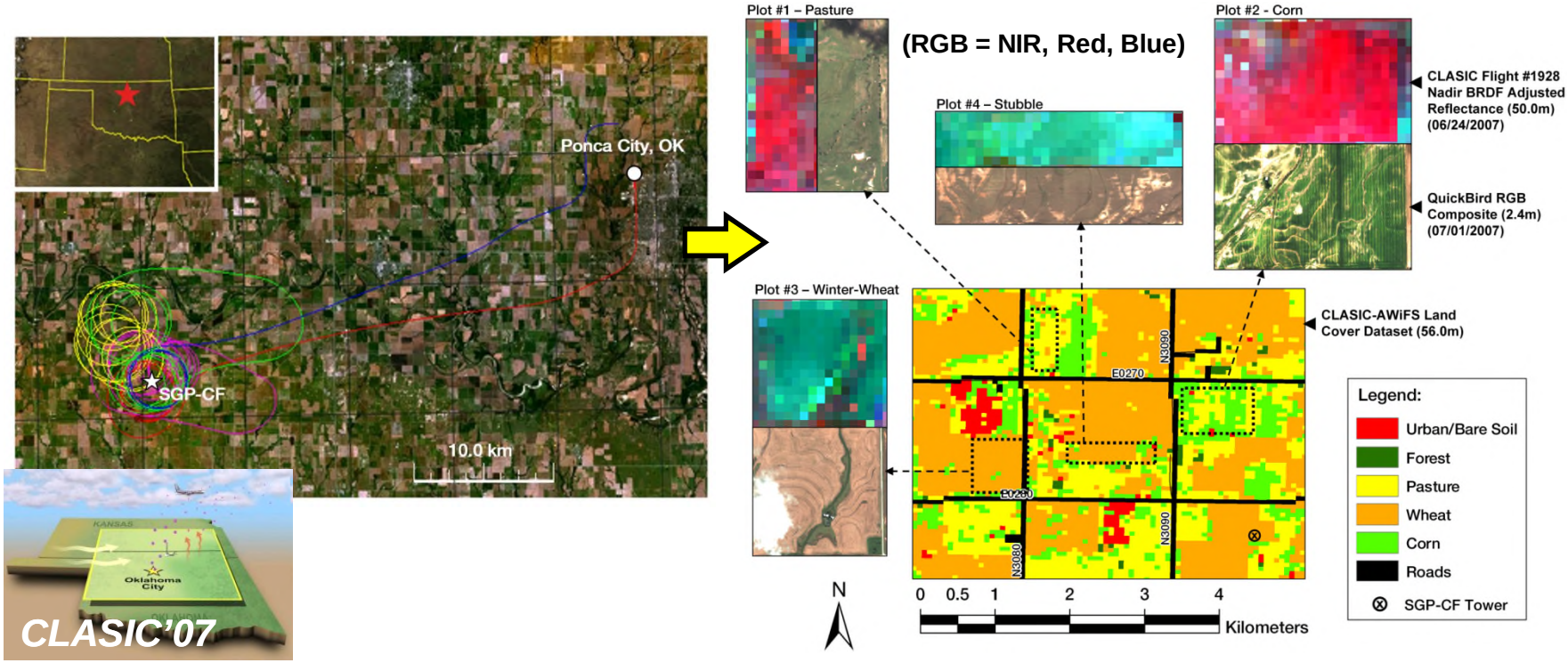
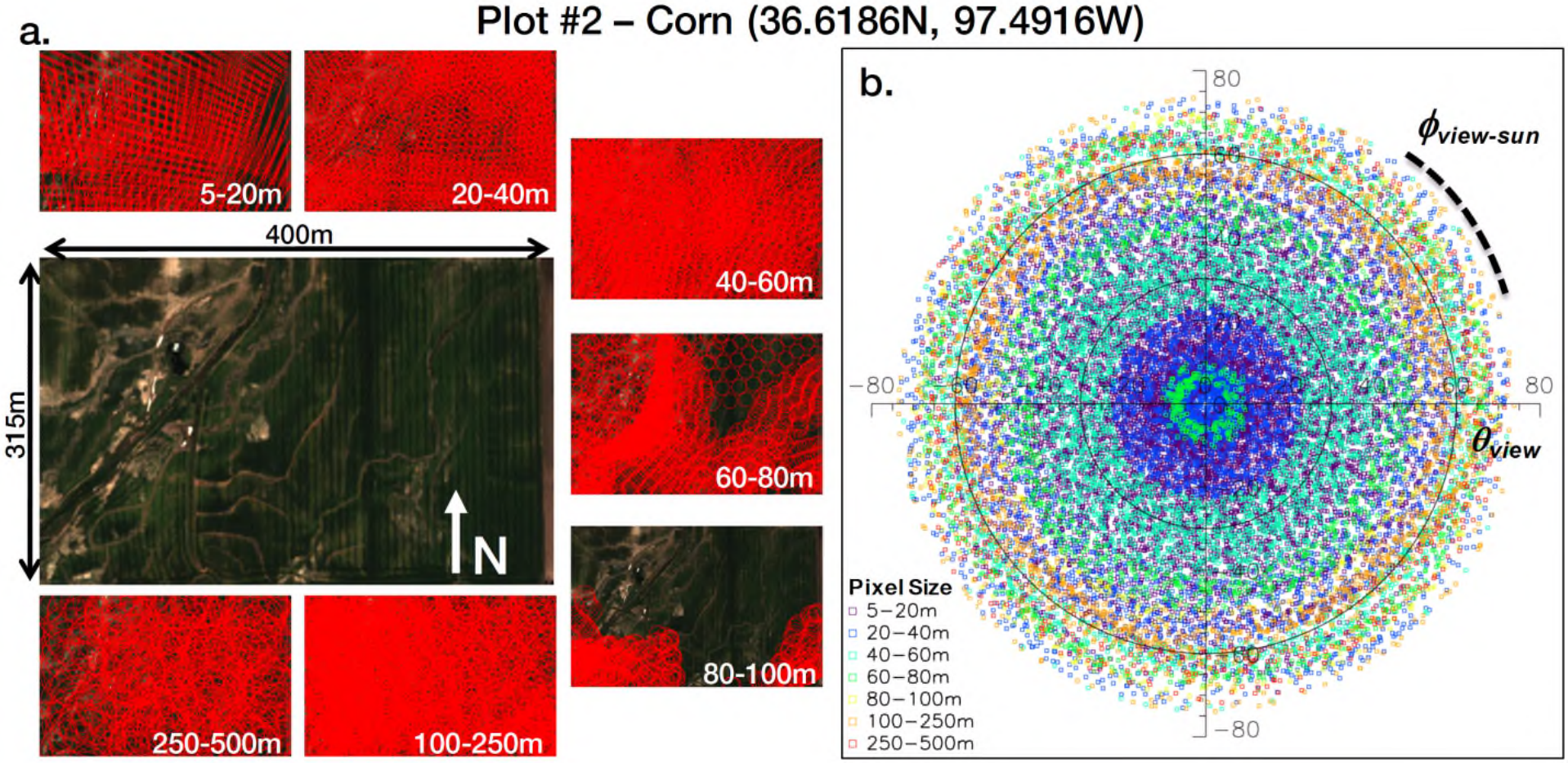


Román et al., (2010) In Prep.

Innovative approach uses CAR airborne datasets to come up with reflectance-based products that recreate the measurement methodology, spatial coverage, and data processing protocols employed by VIIRS Land Science Products.

Case Study: 2007 CLASIC Campaign (Flight #1928)



(a.) Instantaneous retrievals of surface directional reflectance acquired by the CAR instrument during CLASIC Flight #1928 over a plot of corn located outside of Lamont, Oklahoma. Retrievals have been partitioned into seven spatial intervals (from 5.0-250 m^2). (b.) Polar plot showing the angular distribution of the CAR retrievals using the same spatial intervals as (a.)

Case Study: 2007 CLASIC Campaign (Flight #1928)

- Results show how BRDF normalization of surface directional reflectances improves the consistency of CAR retrievals by an average of 11.98%, 5.93%, and 9.00% (relative units) for CAR Bands #3 (0.472 µm), #4 (0.682 µm), and #5 (0.870 µm); and by an average of 7.65% and 9.00% for NDVI and EVI (respectively).
- The variability between CAR retrievals increases from one spatial interval to the other (mainly as a function of pixel size and scan angle). However, as landscape heterogeneity increases, multiple underlying scales of variation will undercut this trend and introduce residual spatial patterns that are intrinsic to a specific location.
- The influence of random sensor noise on CAR retrievals was examined by calculating the proportion of structural variation at multiple spatial intervals. Results indicate that systematic and random variations in CAR reflectance data are somewhat enhanced by spatial sampling effects.
- Due to the spectrally different spectral bandpass between the CAR instrument and MODIS sensor, the adoption of MODIS-EVI coefficients resulted in additional retrieval uncertainties of ~5.15% relative to NDVI.

What type of support should NASA provide?

- Provide expedited access to site-level ancillary information and high resolution imagery over the EOS Core Sites as well as future additional NPP validation sites (e.g. NOAA-CRN, DOE-ARM, SurfRad/BSRN).
- Establish partnerships with other agencies that are setting up long-term field experiments and major campaigns (e.g. DOE-ARM and NSF-NEON).
- Ensure continued access to ongoing platforms and NASA sensor resources for which dedicated airborne campaigns or campaigns of opportunity are available.
- Contribute to the definition and implementation of internationally accepted validation protocols as defined by the CEOS Land Product Validation Working Group (LPV WG) which is part of the CEOS Cal/Val program.