



# **Remote Sensing Product Verification and Validation at the NASA Stennis Space Center**

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# Verification & Validation

- Verification & Validation is critical to successful science research and applications development
  - Users of remote sensing products making policy, economic, or scientific decisions that require confidence in and an understanding of the product's characteristics to make informed decisions about its use.
  - NASA science and application activities that use “all source data” require the same level of data product characterization – whether it be commercial or government
- NASA data products are validated by NASA science teams
  - Coarse to moderate spatial resolution
- NASA SSC serves as the science validation team lead for commercial data products
  - Moderate to high spatial resolution

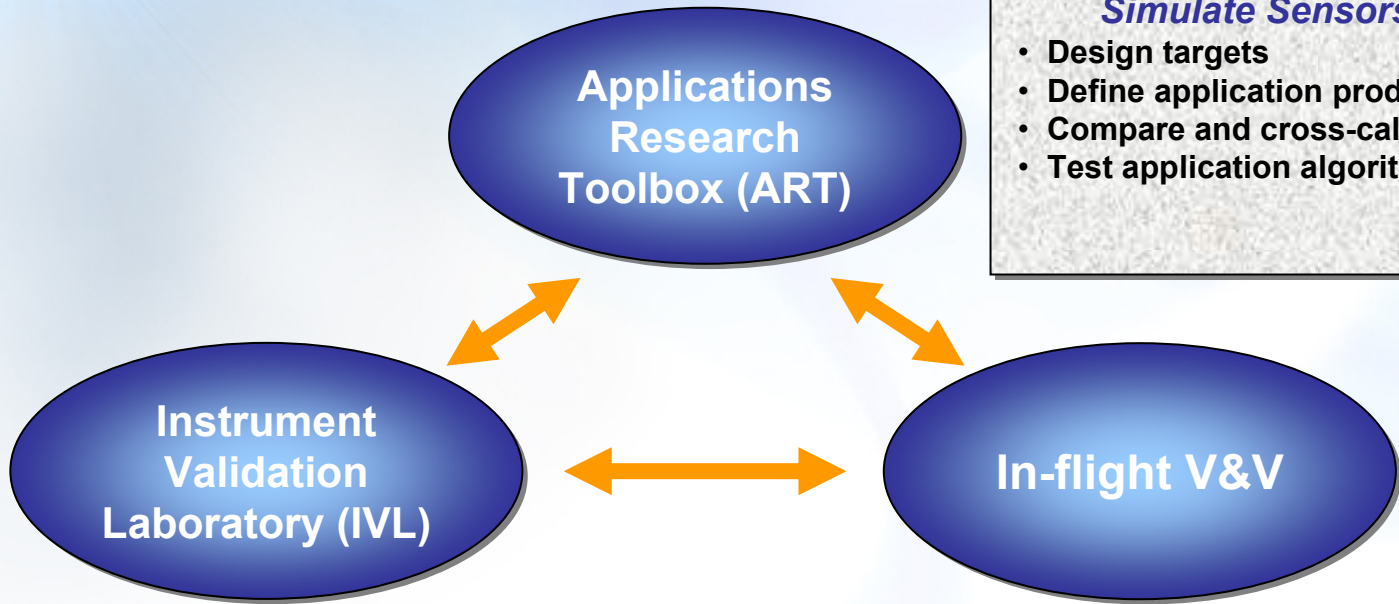


# SSC Verification & Validation Legacy

- Initiated during the Commercial Remote Sensing Program
  - Scientific Data Purchase Project data product verification
  - Facilitated the development of commercial products
- National Asset for characterization of high spatial resolution imagery
  - Intrinsic data characterization (radiometric, spatial, geospatial)
  - Focus on high to moderate spatial resolution commercial imagery products
  - Characterized site for complete system characterization
- SSC V&V characterizes commercial/non-NASA remote sensing data products used for both NASA Earth science research and applications studies



# SSC Verification & Validation: Three-Pronged Approach



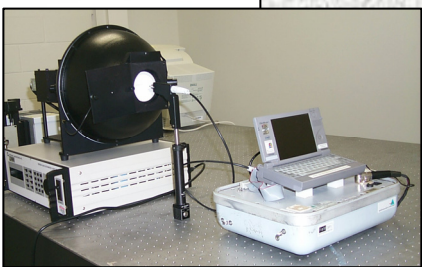
**APPLICATIONS RESEARCH TOOLBOX**  
*Simulate Sensors and Targets*

- Design targets
- Define application product requirements
- Compare and cross-calibrate sensors
- Test application algorithms



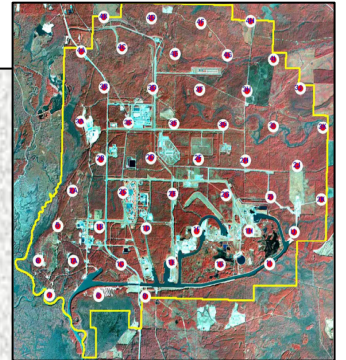
**INSTRUMENTATION VALIDATION LAB**  
*Validate Critical Sensors*

- Define sensor performance in controlled environment
- Calibrate ground truth equipment under expected operating conditions
- Provide NIST traceability



**IN-FLIGHT V&V**  
*Validate Installed Sensor Data Products*

- Validate ground measured truth set against imagery





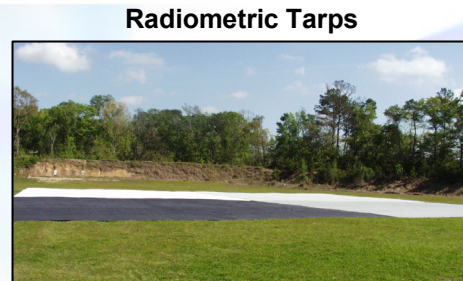
# SSC Verification & Validation Site



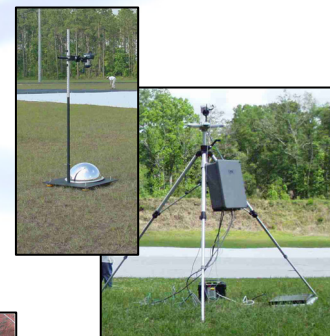
Sandmeier Field Goniometer for Bidirectional Reflectance Measurement



GPS, Spectroradiometer, and Upper Atmosphere Surveys



Radiometric Tarps



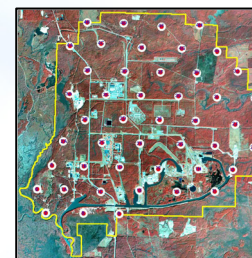
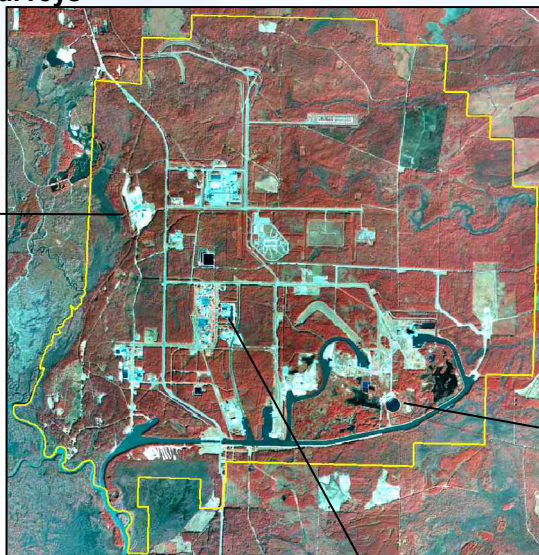
Field Atmospheric Measurements



40 m x 80 m Painted Concrete Edge Targets



Painted Concrete Radial Target



Network of Ground Control Points



Water Surface Temperature Sensor



Total Sky Imager



Surface Meteorology Stations



Multifilter Shadowband Radiometer



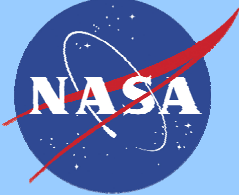
NASA GSFC AERONET Node

Atmospheric Measurement System



# JACIE Characterization Team: Joint Agency Commercial Imagery Evaluation

## JACIE TEAM



Multiple-agency team formed to

- Characterize commercial imagery to meet individual agency requirements
- Leverage each agency's expertise
- Foster improved relationship between industry and government
- Support science, civilian, and DoD applications
- Support Commercial Remote Sensing Space Policy

## Benefits:

- Cost efficiencies by both Government and industry – reduced duplication of effort
- Improved product characterizations
- Improved commercial products

Current Funded Applied Science Program



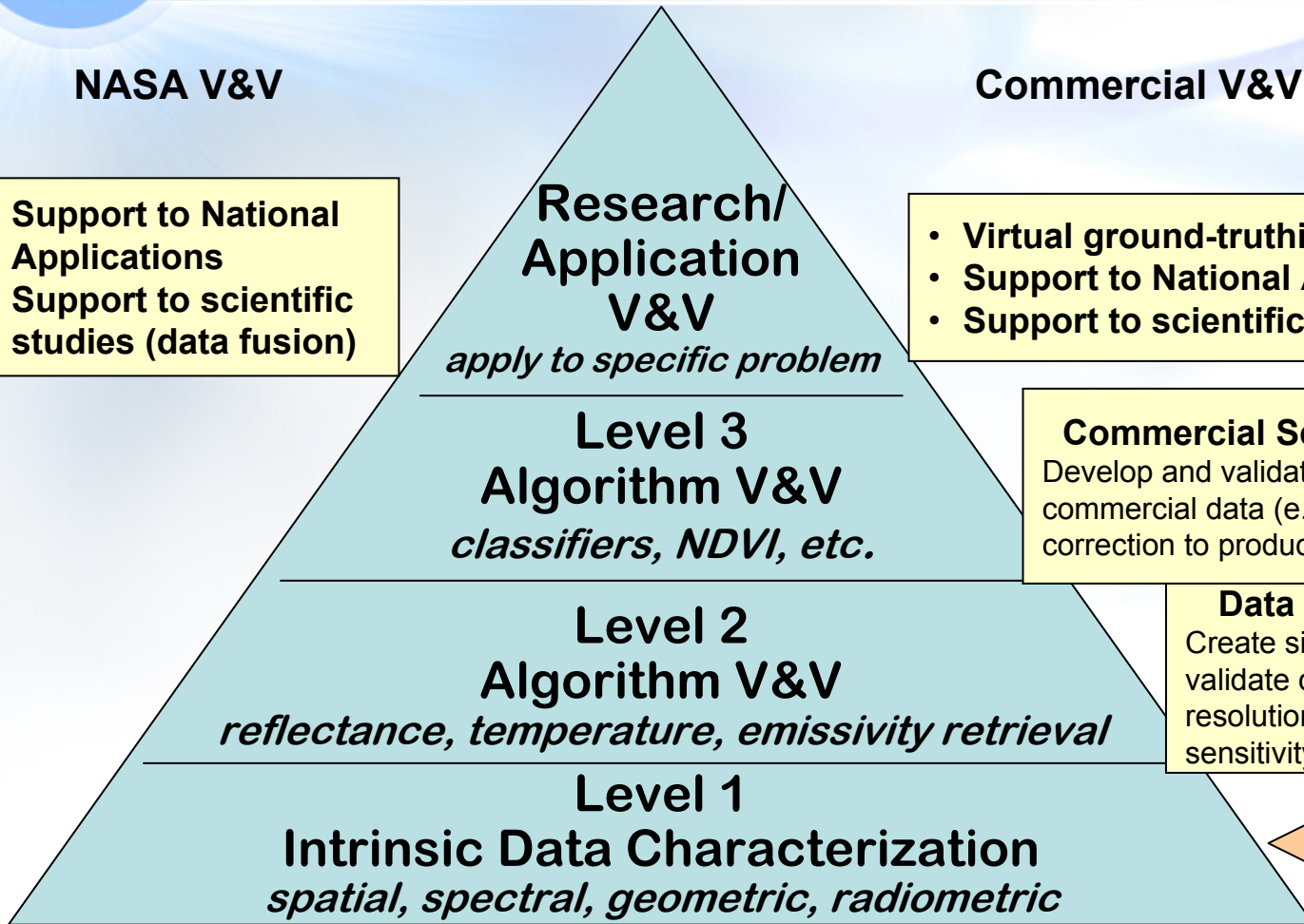
# Verification & Validation Pyramid

## NASA V&V

- Support to National Applications
- Support to scientific studies (data fusion)

## Commercial V&V Opportunities

- Virtual ground-truthing tool
- Support to National Applications
- Support to scientific studies (data fusion)



**Commercial Science-quality Products**  
Develop and validate science products using commercial data (e.g., apply atmospheric correction to produce surface reflectance)

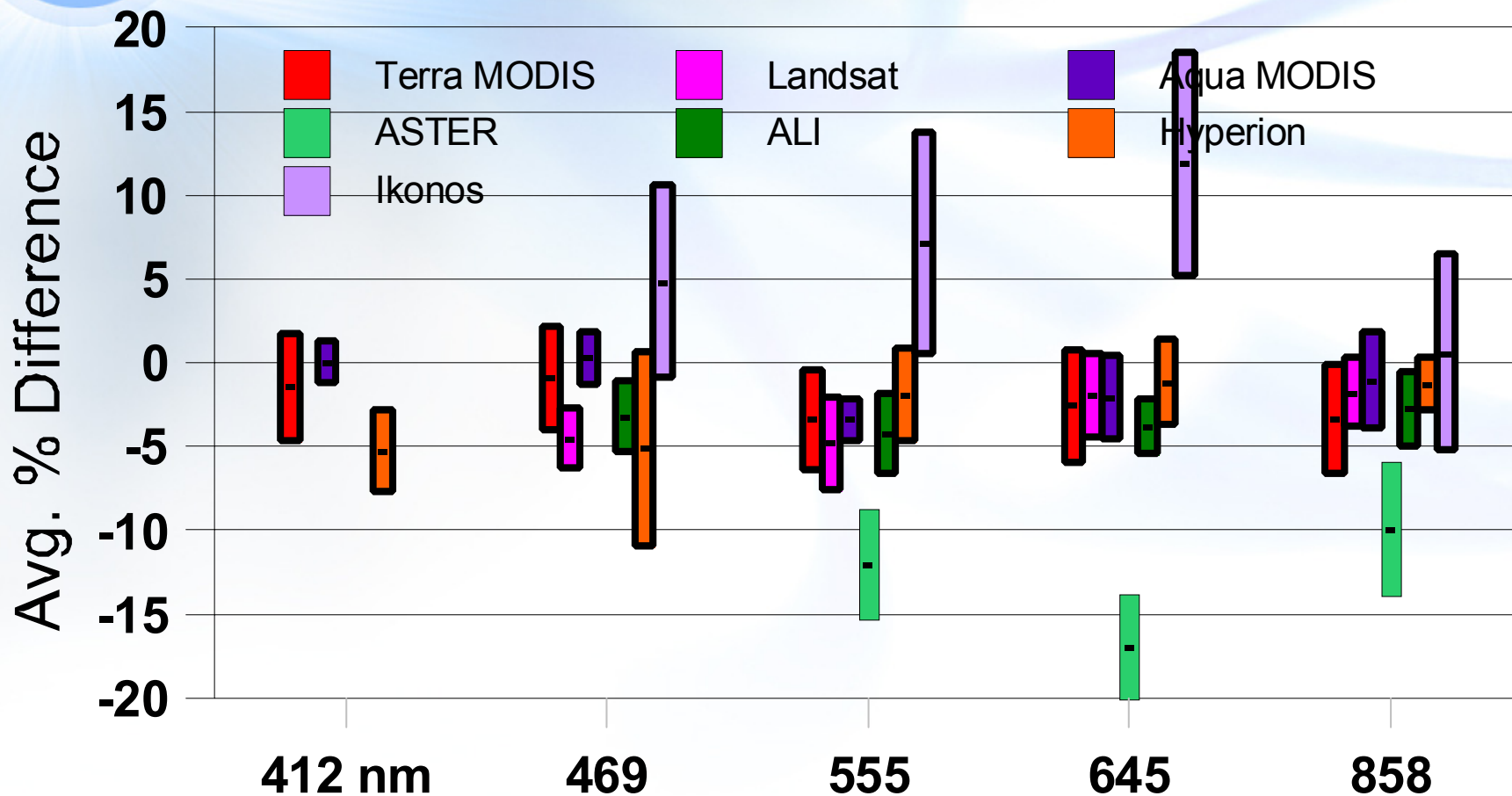
**Data requirements validation**  
Create simulated data and products to validate data specifications, to validate resolution requirements, and to perform sensitivity analysis

**Traditional V&V role**

SSC performs these V&V characterizations for commercial products.  
NASA Science Validation teams perform these V&V characterizations for NASA products.



# Radiometric Accuracy Comparisons: All Source Data Example



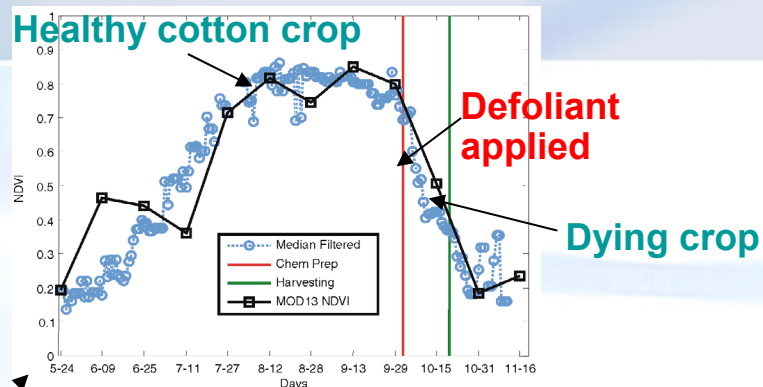
Understanding imaging system performance is critical to use of data products from different systems.



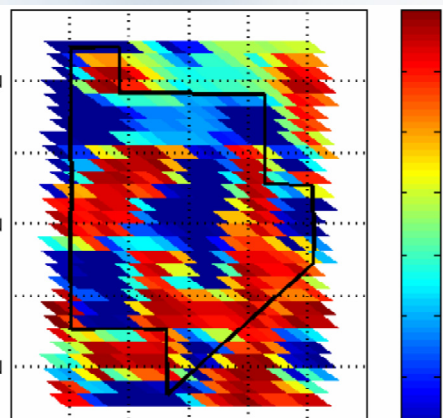
# Crop Security (All Source Example)

## Objectives/Approach

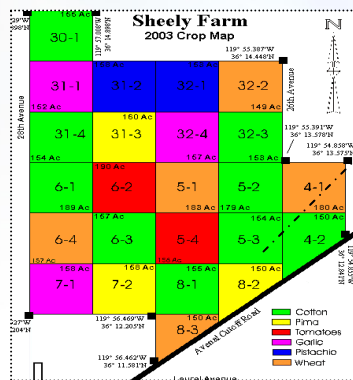
- Examine utility of MODIS and other NASA products for wide area crop security surveillance (Near daily time series analysis at 250 m scale)
- Develop and validate commercial equivalent products for high spatial resolution zooms for virtual ground truthing (Targeted acquisitions based on anomaly detection)



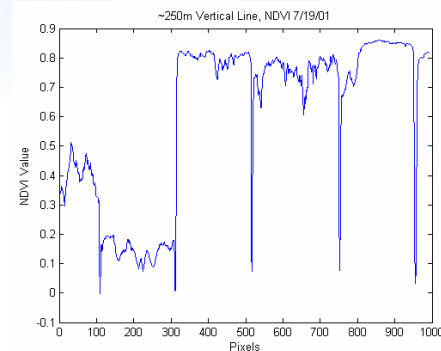
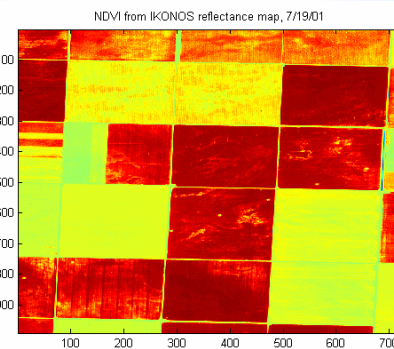
Near-daily (single field) MODIS vegetation index time series (blue curve) and Science validation team 16-day product (black curve)



Wide area 250 m GSD MODIS derived vegetation index (crop health) map (Science validation team derived product)



Application V&V data: Crop shapefile and growing season data by field



High spatial resolution (4 m) commercial system derived vegetation index using NASA satellite derived atmospheric data and JACIE radiometric characterization

NASA products used to create interoperable science-grade commercial products

**REPORT DOCUMENTATION PAGE**

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<b>14. ABSTRACT</b> Remote sensing data product verification and validation (V&V) is critical to successful science research and applications development. People who use remote sensing products to make policy, economic, or scientific decisions require confidence in and an understanding of the products' characteristics to make informed decisions about the products' use. NASA data products of coarse to moderate spatial resolution are validated by NASA science teams. NASA's Stennis Space Center (SSC) serves as the science validation team lead for validating commercial data products of moderate to high spatial resolution. At SSC, the Applications Research Toolbox simulates sensors and targets, and the Instrument Validation Laboratory validates critical sensors. The SSC V&V Site consists of radiometric tarps, a network of ground control points, a water surface temperature sensor, an atmospheric measurement system, painted concrete radial target and edge targets, and other instrumentation. NASA's Applied Sciences Directorate participates in the Joint Agency Commercial Imagery Evaluation (JACIE) team formed by NASA, the U.S. Geological Survey, and the National Geospatial-Intelligence Agency to characterize commercial systems and imagery.					
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