LCLUC and High-resolution data update.

Chris Justice (UMD)

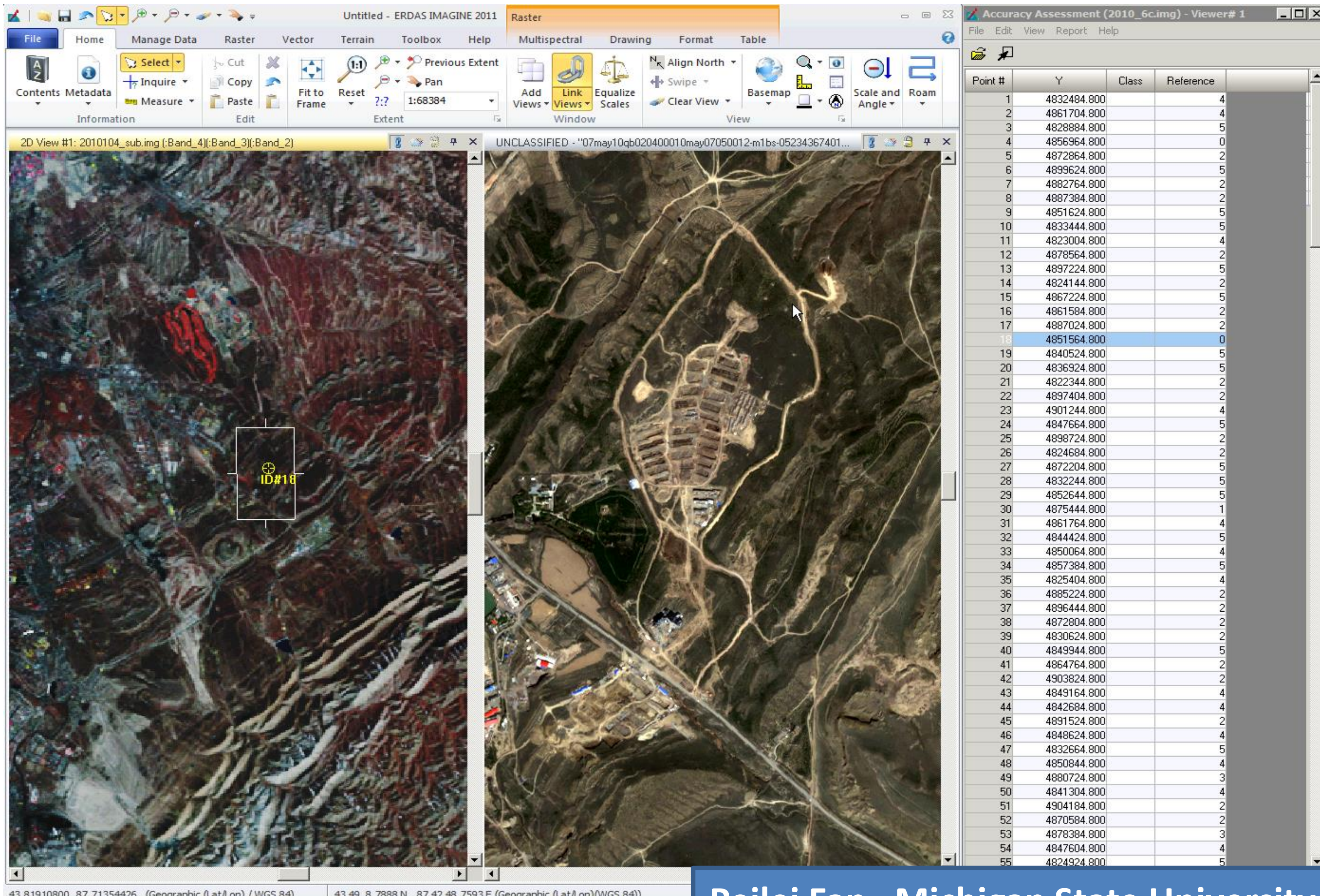
Very high-resolution commercial imagery available for NASA-funded research

- The National Geospatial-Intelligence Agency's extensive archive of commercial satellite data are available to you free of cost
- Licensed under NextView contract (can be shared with those supporting USG interests)
- 5 sensors available, MS and panchromatic (0.5 to 5 m resolution), NITF format, extensive global coverage
- Go to http://cad4nasa.gsfc.nasa.gov to register and submit requests (LCLUC grant number needed)
- See poster

Jaime Nickeson, : NASA-GSFC

Mapping Urbanization

- High resolution data is used as ground reference



Peilei Fan, Michigan State University

Mapping Urbanization: Urumqi

- Quantifying and understanding urban expansion
- Identify sinkhole areas that are not suitable for urban land use

Peilei Fan, Michigan State University

Use of high-resolution NGA-provided commercial datasets in LCLUC project: The Impact of Disappearing Tropical Andean Glaciers on Pastoral Agriculture

PI: Dan Slayback, SSAI/NASA Goddard
ROSES 2009, project period July 2011-June 2014

Access to cost-free high-resolution commercial imagery via NGA (and CIDR (USGS)) is improving the quality of the science returned by this project by:

1. Permitting much easier **validation of landcover changes** observed in Landsat in remote mountainous regions that are difficult, and expensive, to visit in person.
2. Providing detailed high-resolution landcover information for our 5 field sites, useful for planning field activities and **understanding landcover at the sub-Landsat pixel** scale (where small ponds are frequent)
3. Allowing us **to generate detailed DEMs for these sites from stereo imagery** (via CIDR requests), which greatly improve understanding of the local hydrology at the field sites. SRTM and GDEM (ASTER) are often the only available alternative, but are too coarse in spatial resolution to be useful.

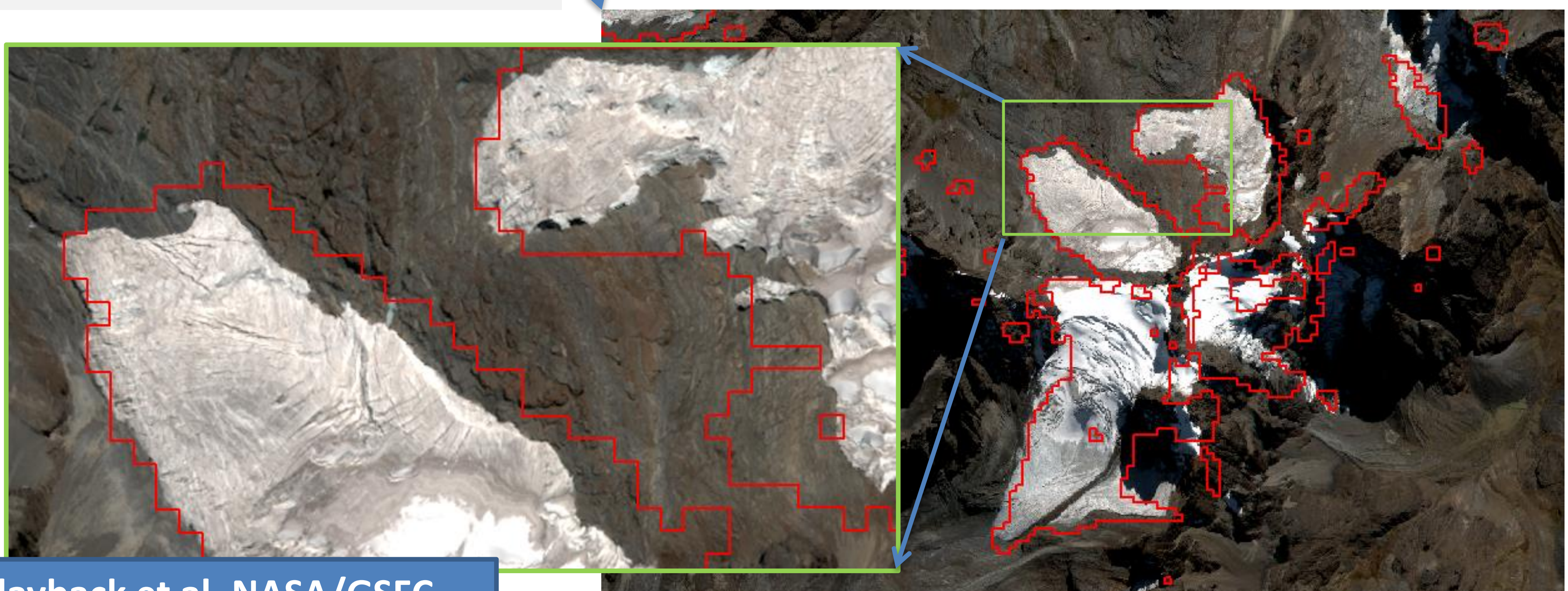
Obtaining the data we have used via commercial channels would have increased the budget for this project by a substantial margin – at least $100k, and possibly much more. Such costs would not have been within the budget limits of the original project proposal, and so were not included.

Glacier change validation

Landsat 2006 with classified glacier area polygons

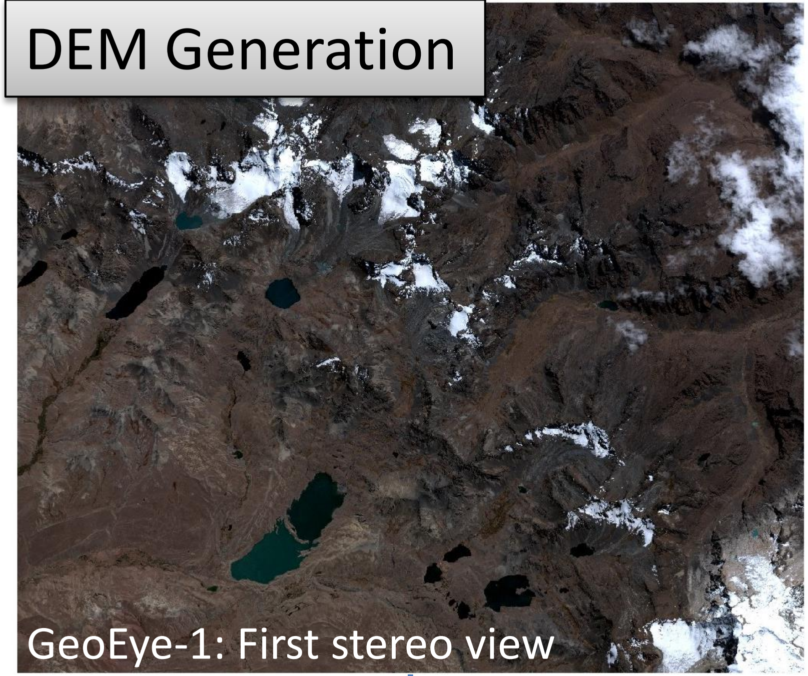
GeoEye 2010, displayed with a quick orthorectification, allows:

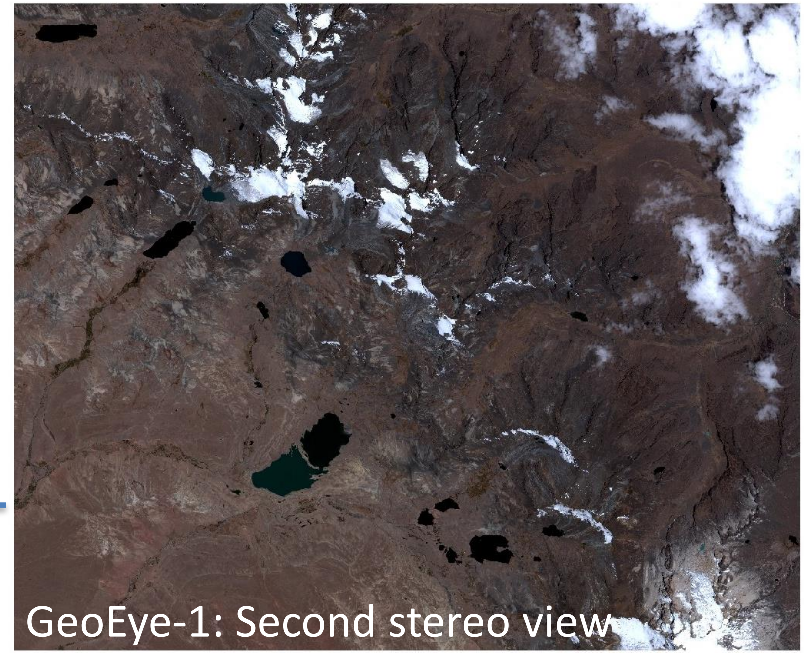
- Visual assessment of overall accuracy (despite further loss of glacier since 2006).
- Verification that glacier edges are clean, and not debris-covered.



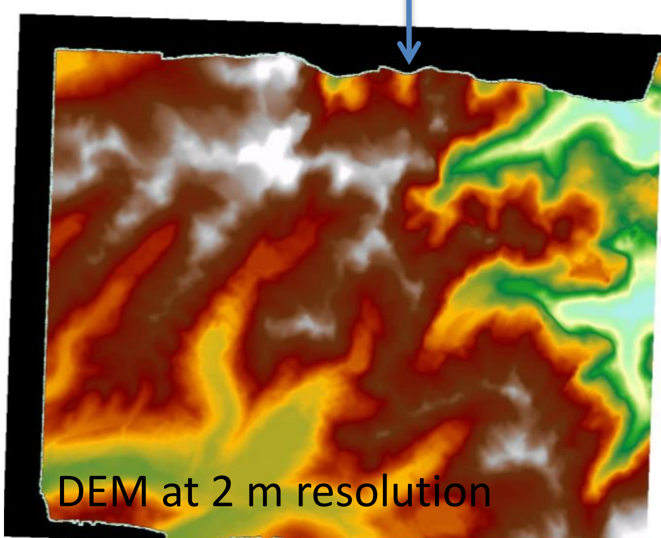
Slayback et al. NASA/GSFC

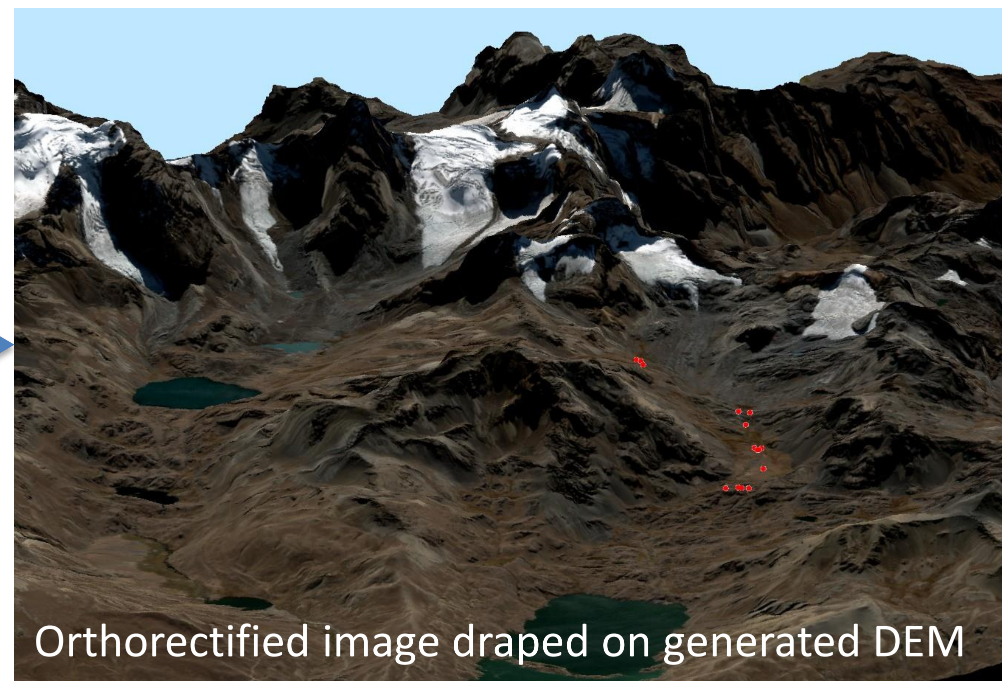
DEM Generation





DEM Generation



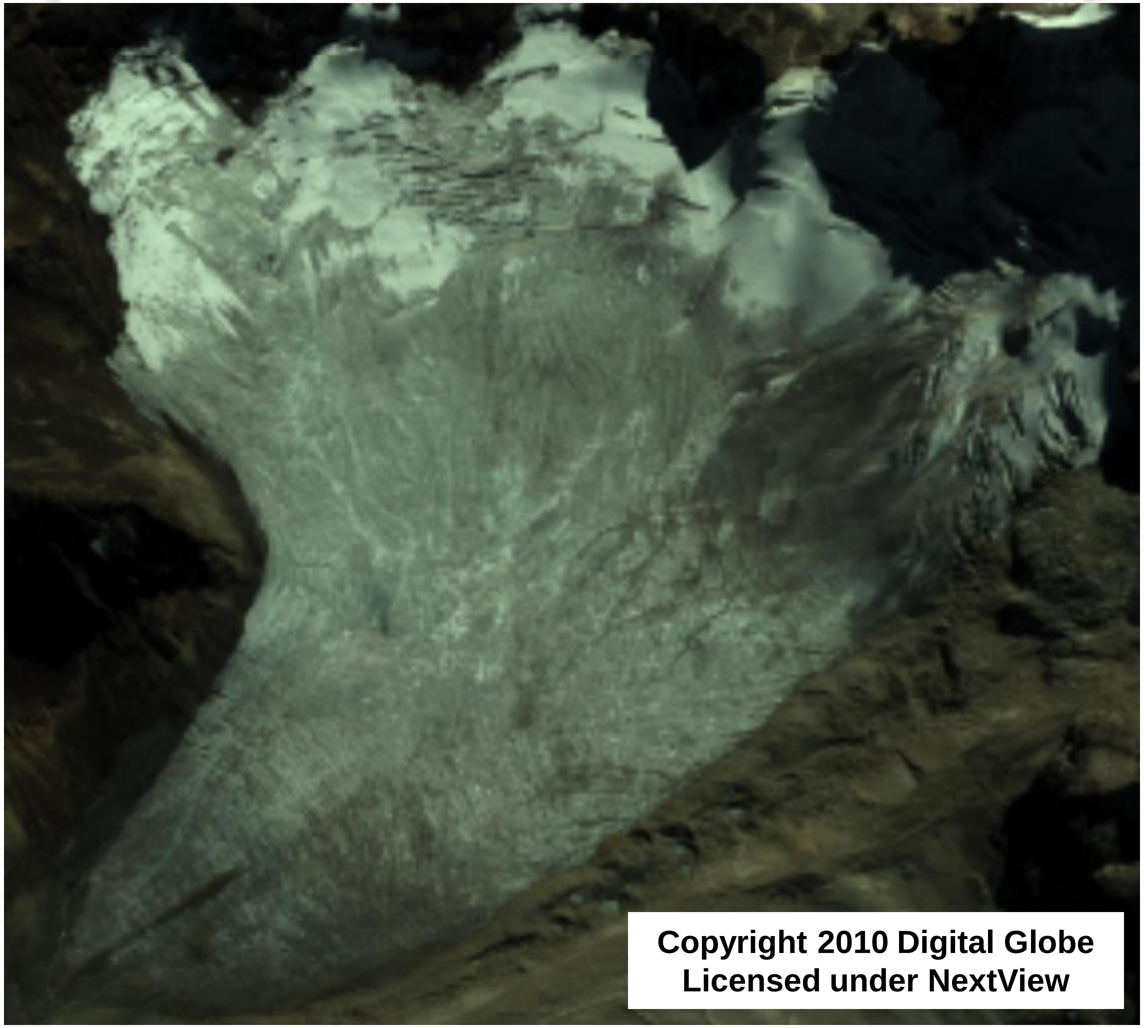


Slayback et al. NASA/GSFC

WorldView2 enables detailed glacier margin mapping

Slayback et al. NASA/GSFC

1.5 km



Worldview-2 June 16, 2010 <1 m

Huayna-Potosi Glacier Bolivia

1.5 km

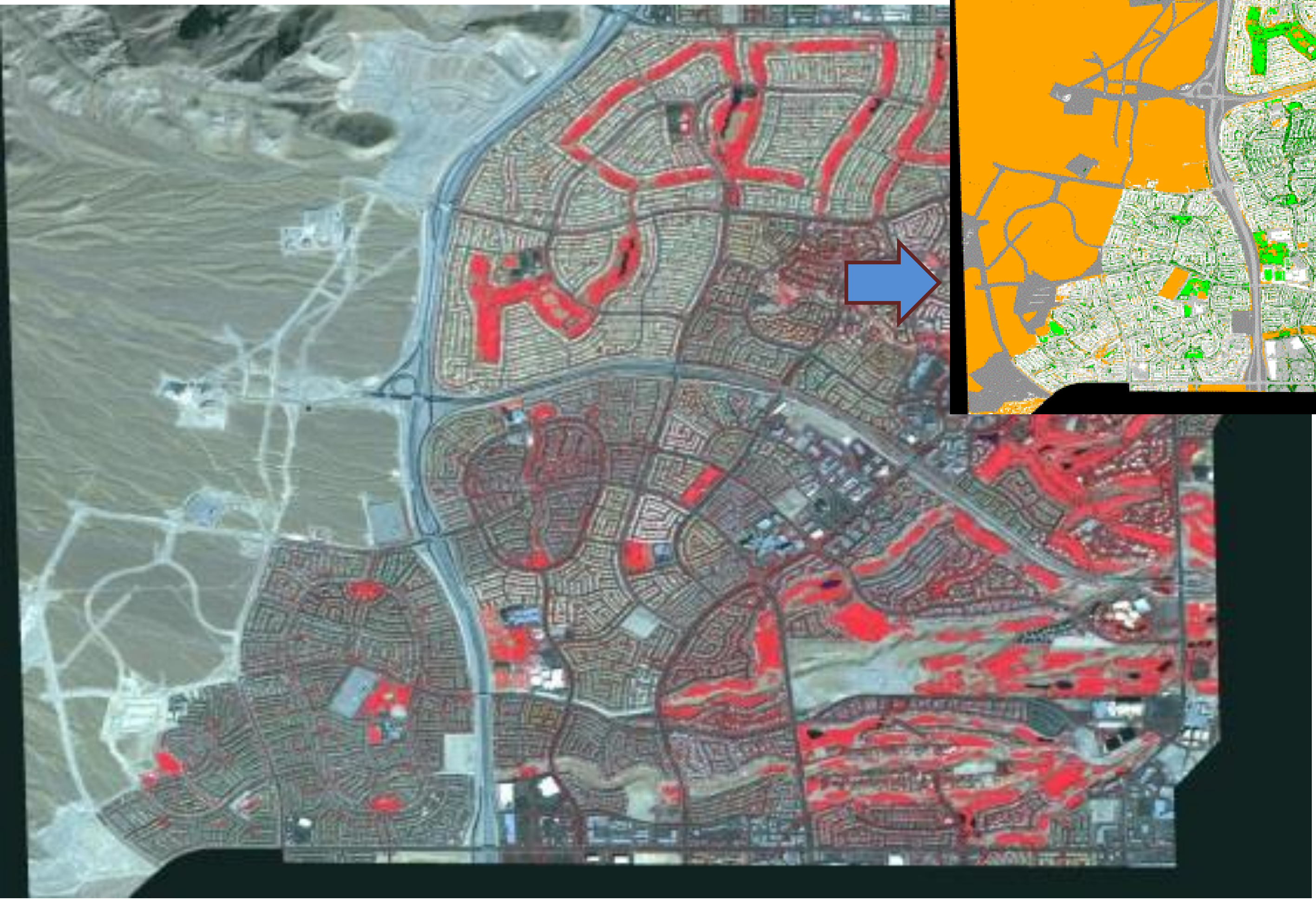
Landsat 5 TM August 17, 2010 30 m

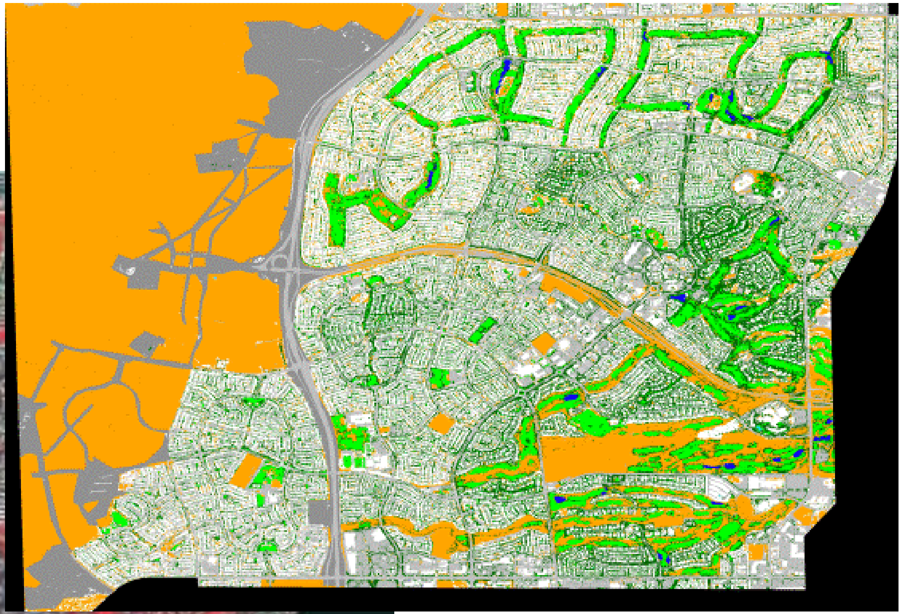
Slayback et al. NASA/GSFC

Relationship between spatial patterns of land cover types and surface temperatures (Soe Myint, NASA funded Project: 11-IDS11-4).

- Spatial arrangement and LC type
- Impact on Surface and Air Temperature

Worldview 2 (NGA)



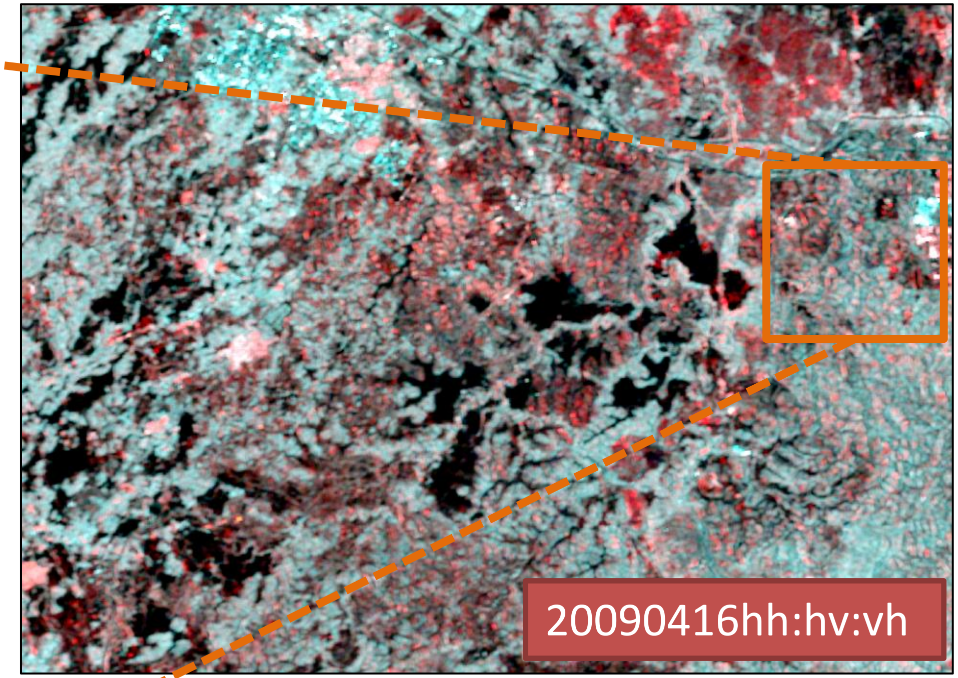


Classified Output
(Ecognition)

Las Vegas. Nevada

Soe W. Myint, ASU

Mapping agricultural expansion across Monsoon Asia



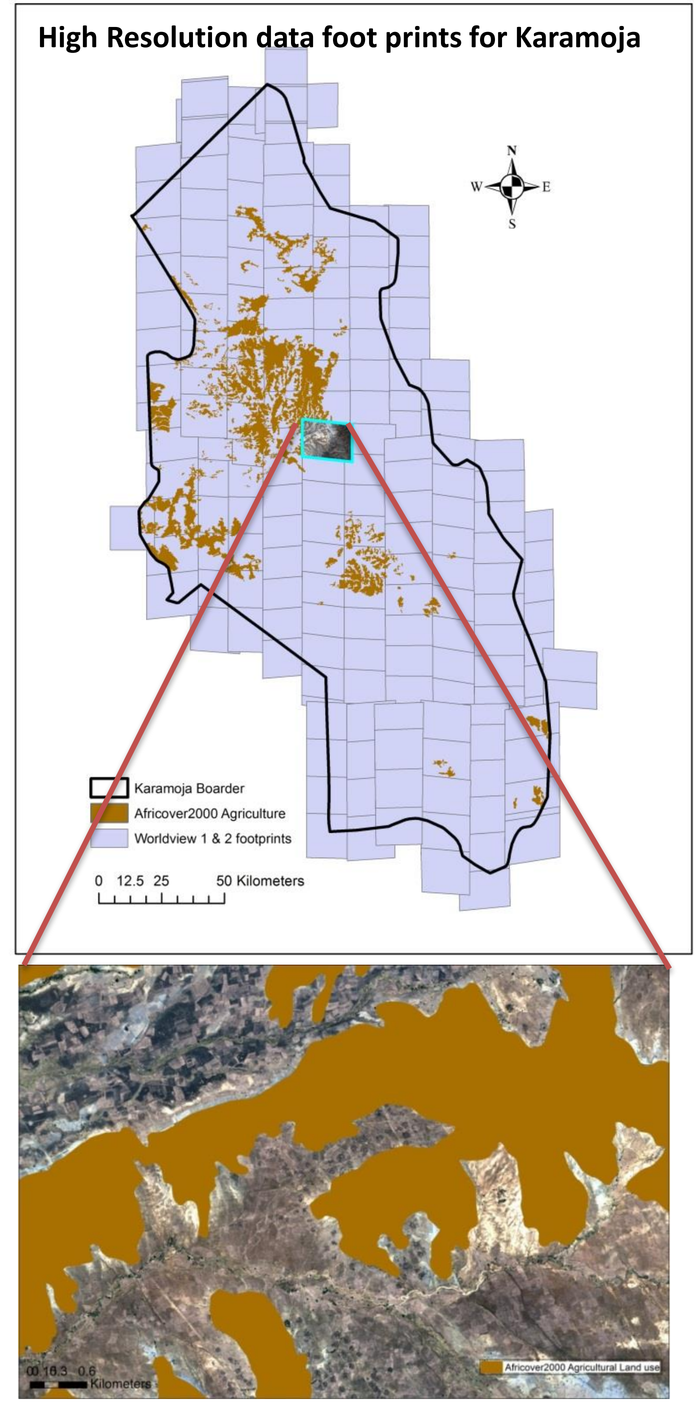
- Training data for classifier: "NGA High Resolution"
- Evaluating scaling & data fusion: "NGA", Landsat TM, ALOS PALSAR

Xiangming Xiao
University of Oklahoma

APPLIED GEOSOLUTIONS, LLC

Mapping Agricultural Land Use - Karamoja Uganda

- Current land use dataset is Africover2000 (FAO, 2000) derived from 30m Landsat - poorly represents subsistence Cropland
- Average field size in ~1.7 hectares
- High resolution data (Worldview 2 data) is being used to map land use and update FAO Africover2000 product



Nakalembe, Barker (University of Maryland)

Preliminary agricultural land use mapping using World View 2 data

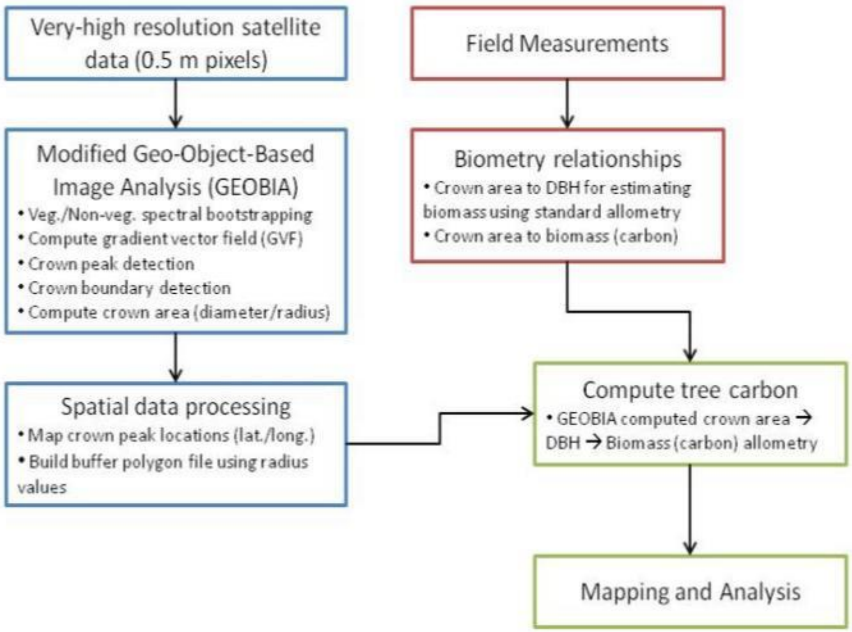
Hi- resolution Data for mapping Carbon in sparsely -treed landscapes.

- Evaluation of methods in various Landscape types
  - Savannah and woodlands
  - Agroforestry and trees on farms
  - Orchards and plantations
- Tree crown area algorithms
  - Watershed segmentation → merge algorithms → rule-based classification
  - Modified GEOBIA approach

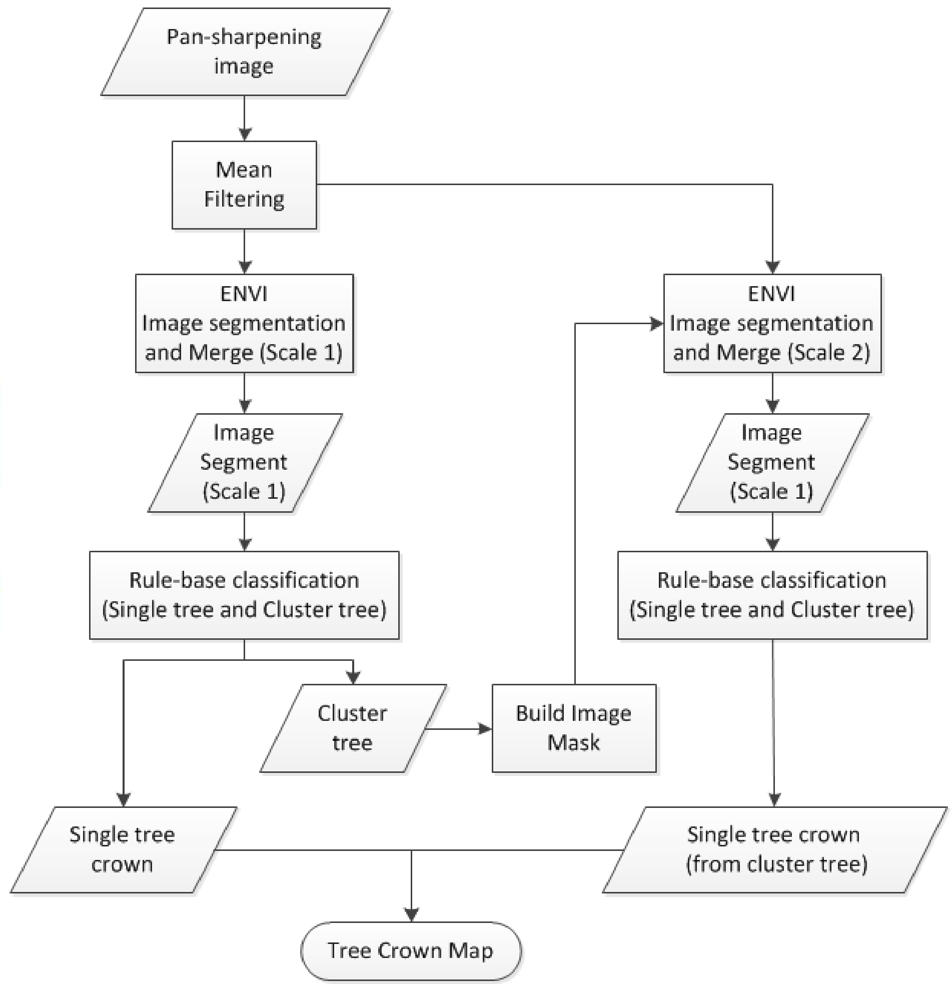
Skole et al. , Michigan State University

Methods

Modified GEOBIA

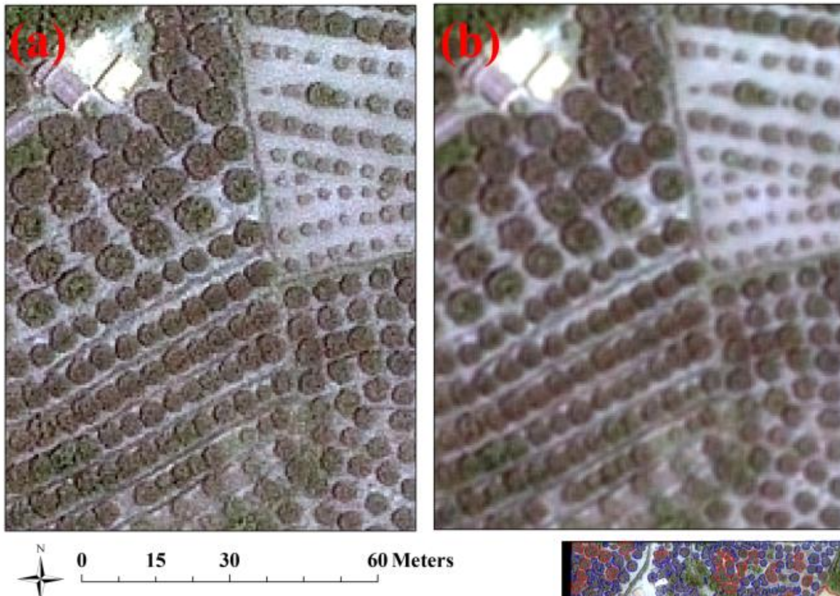


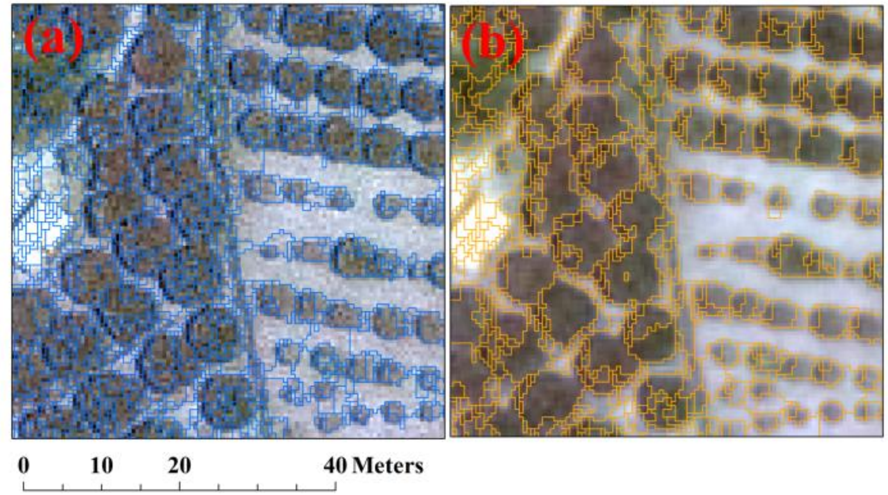
Watershed → Rules-based



Skole et al. Michigan State University

Watershed → Rules-based: Vietnam (Litchi orchards) – 0.6 m pan-sharpened QuickBird data

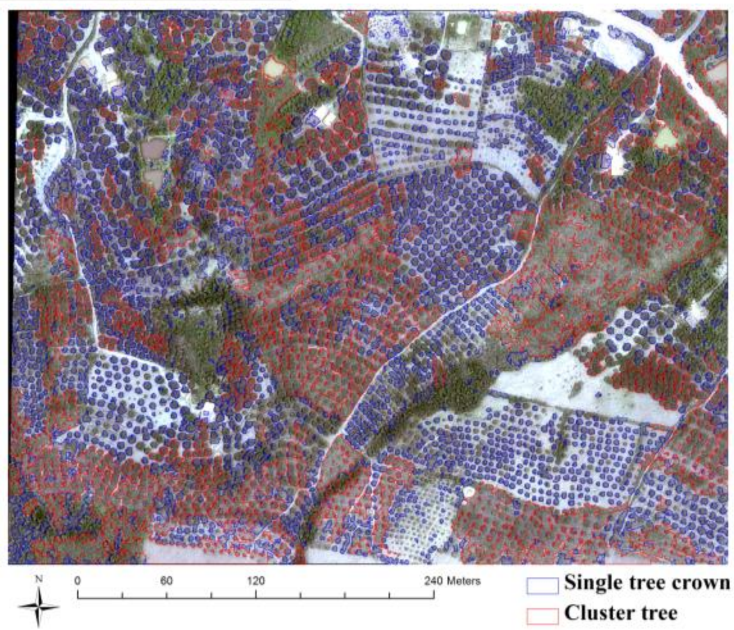




Above right and left

(a) No treatment

(b) 3 x 3 mean filter



Left – results from first order Rules-based classifiers.

First Order Classifiers

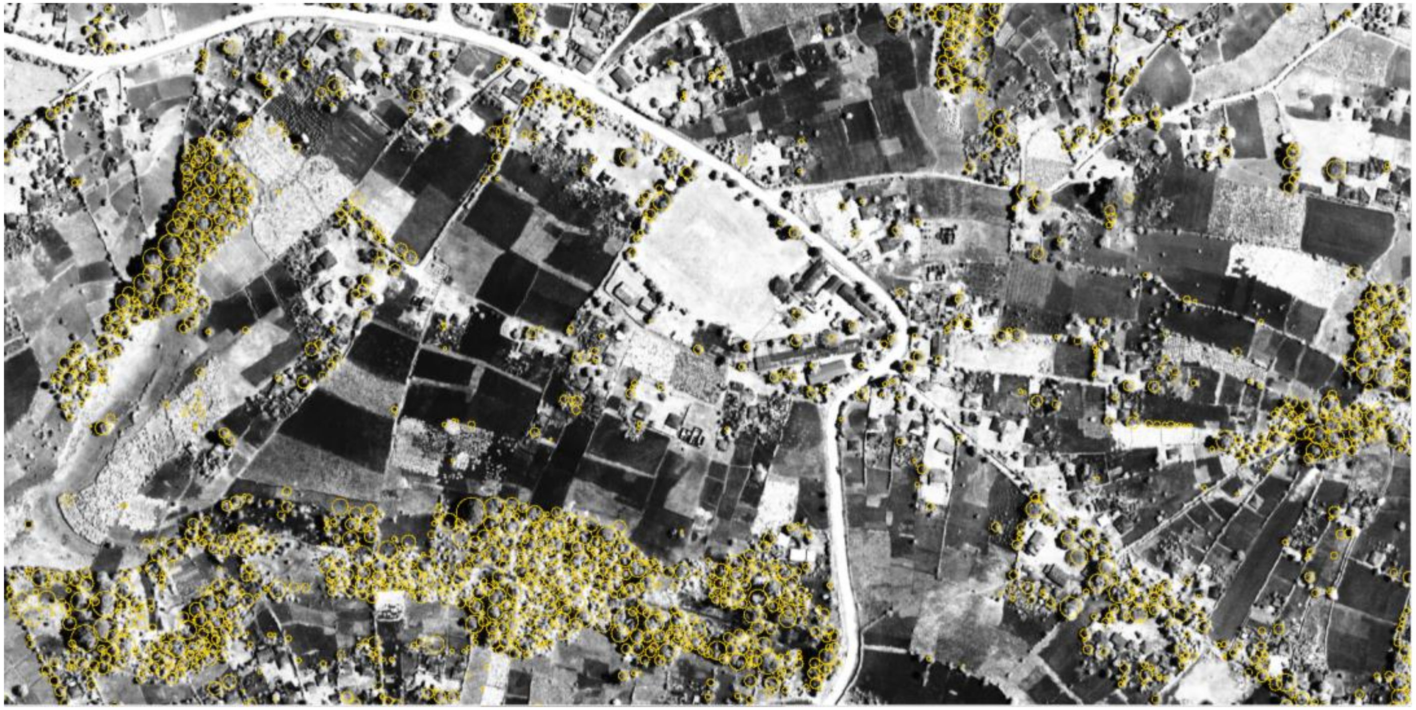
- For Single tree crown
  - Rule 1. Area : 4- 40 m^2
  - Rule 2. Roundness : >0.3
  - Rule 3. NIR : 600-760
- For Clusters of trees
  - Rule 1. Area : <40m^2
  - Rule 2. NIR : 600-760

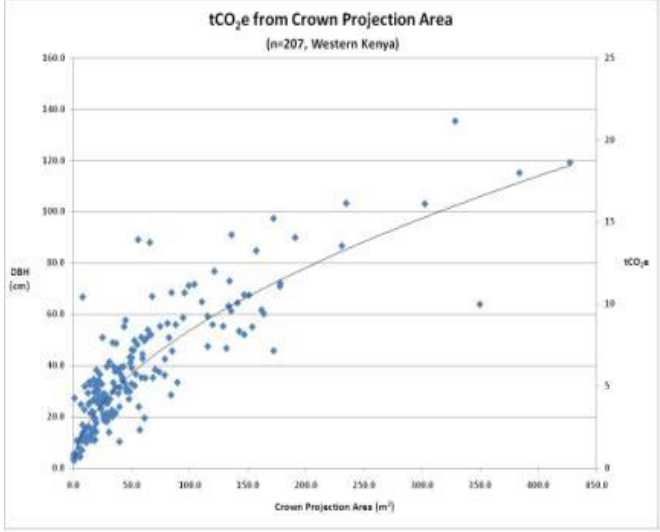
David Skole,
Michigan State University

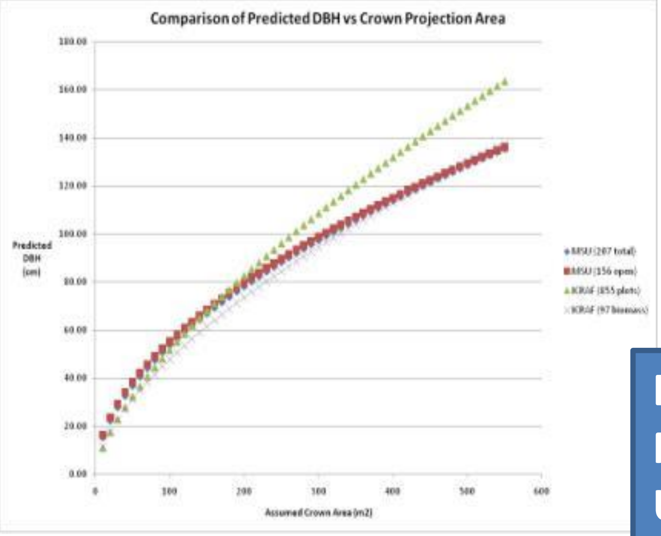
Final map of individual tree crown areas and clusters of trees

Skole et al. MSU

Modified-GEOBIA: Kenya – 0.6 m Pan QuickBird data

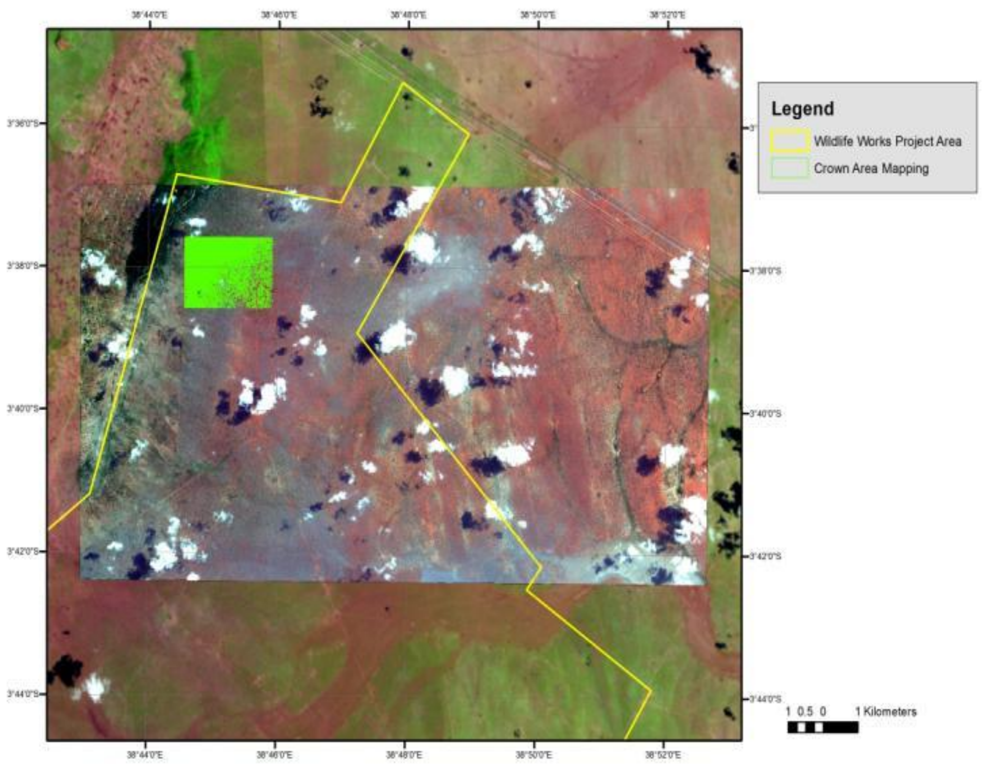


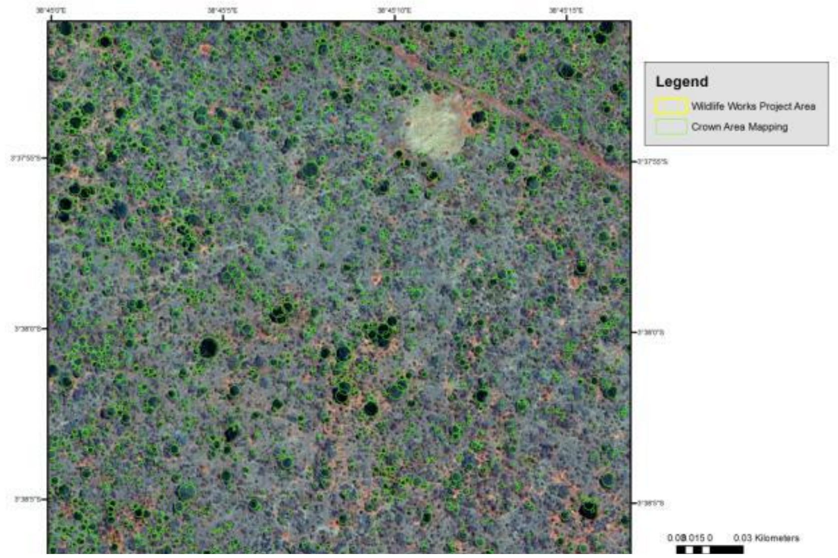


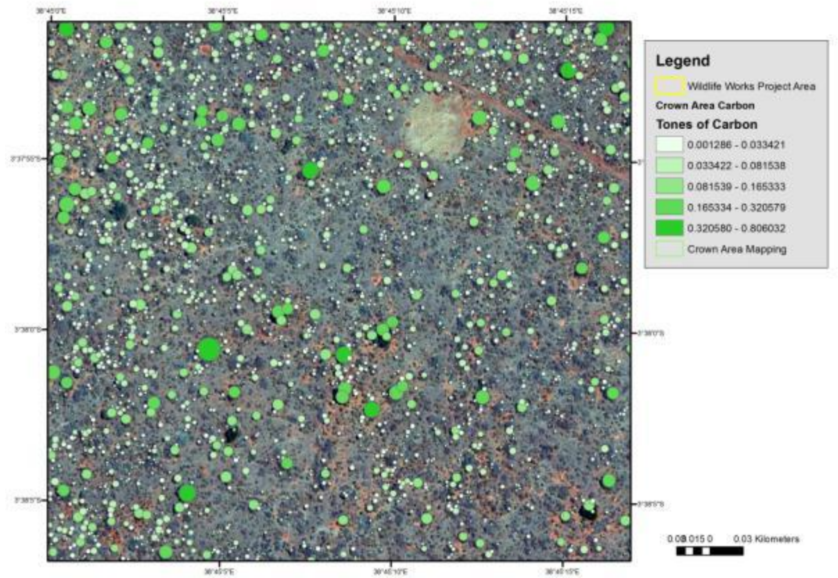


David Skole,
Michigan State University

Sparse Woodlands – Rukinga Ranch REDD Project, Voi, Kenya



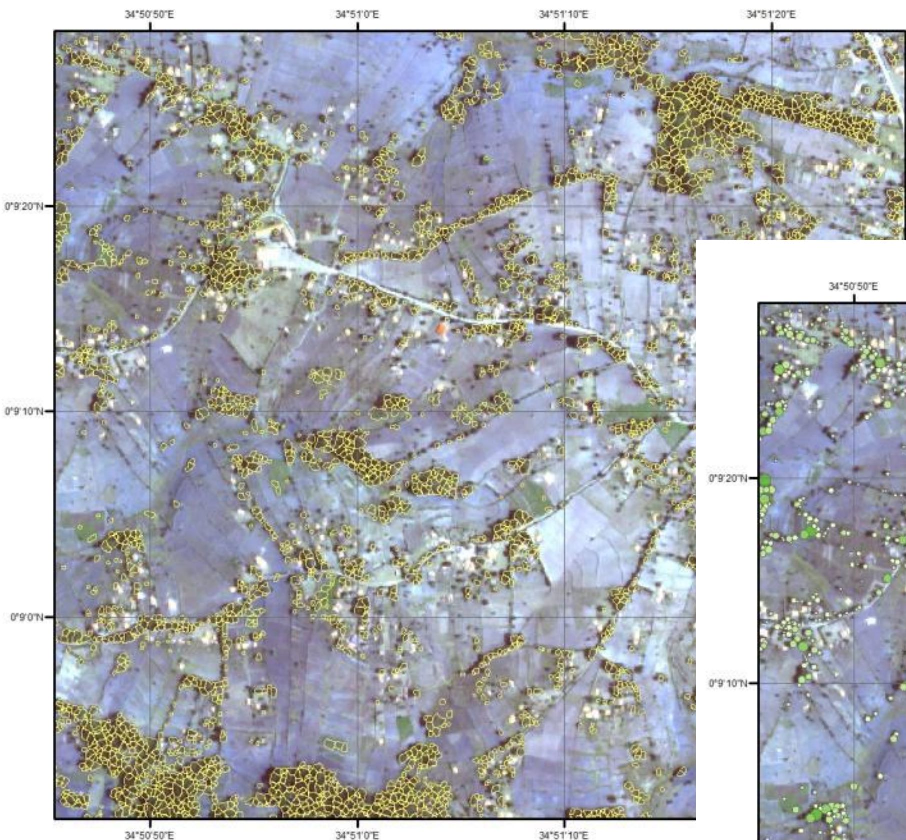




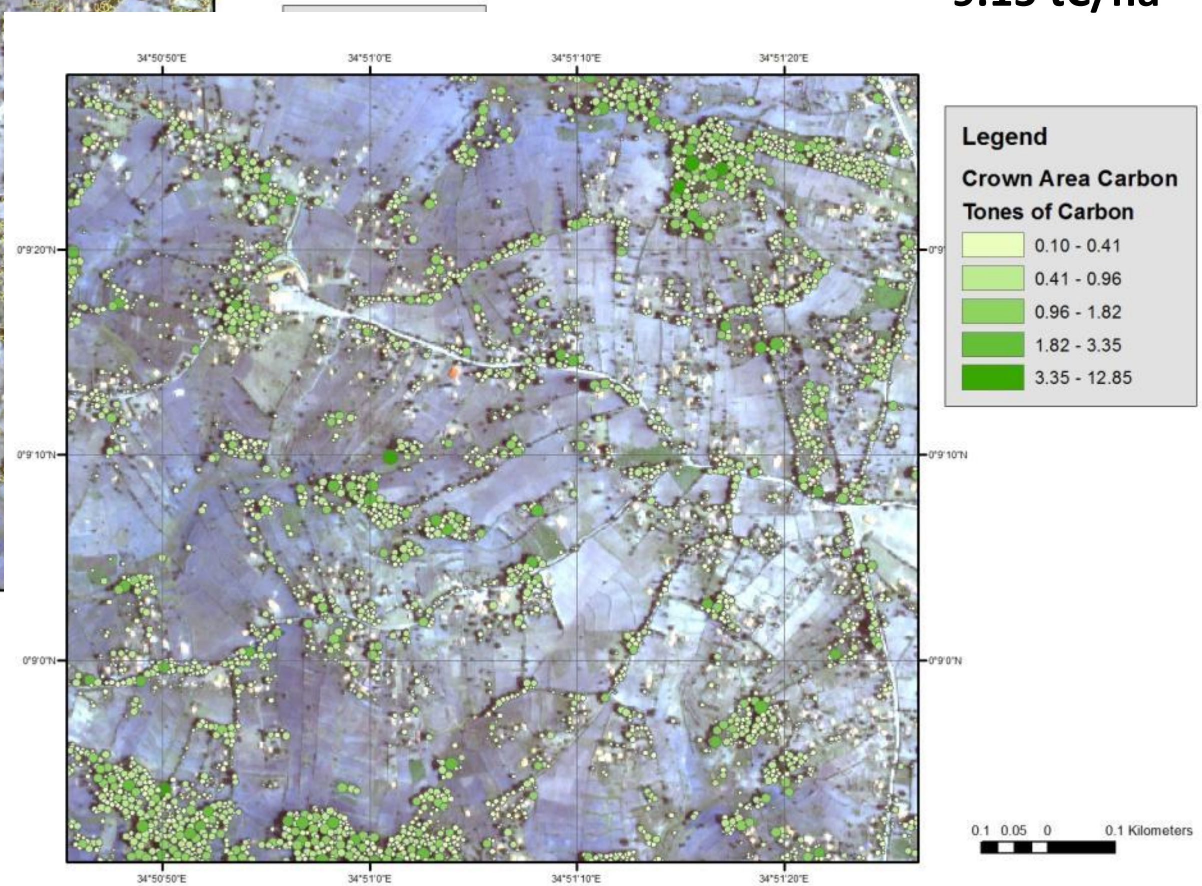
25 ha
79.09 tC
3.16 tC/ha

David Skole, Michigan State University

Kenya – Mapping trees on farms



155 ha
1418.83 tC
9.15 tC/ha



David Skole, Michigan State University

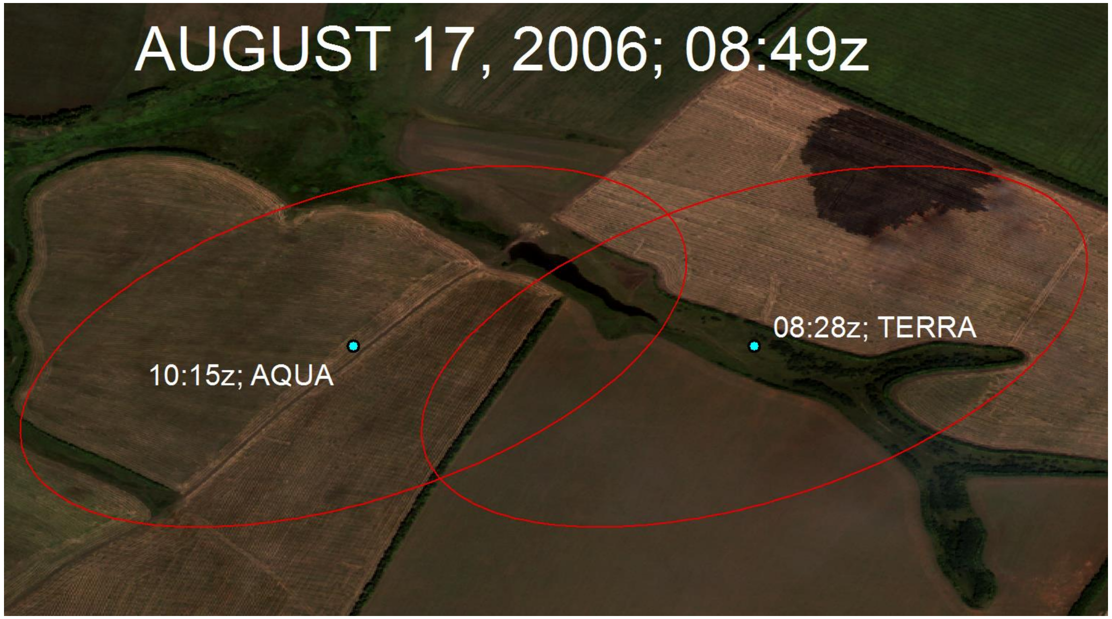
Cropland burned area mapping in Russia

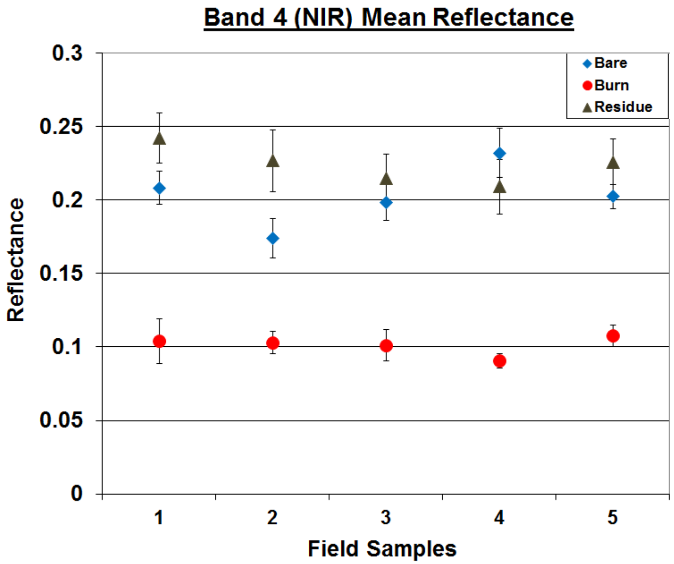
Collaborative project w. USDA aimed at quantifying amount of Black Carbon emissions from agricultural fires in Russia

VHR data are critical in:

- Locating and **characterizing cropped areas**
- Validation of active fire product
- **<u>Assessing pure pixel signature separability of burned and ploughed fields</u>**
- Developing **training and validation samples to drive MODIS-based cropland burned area algorithm development**

RIGHT: Sample plot of mean and 1 SD separability of burned (red), ploughed (blue) and containing crop residue (grey) fields from Quickbird imagery in European Russia





ABOVE: Quickbird multispectral image of an actively burning field in European Russia with superimposed MODIS active fire detections

Loboda, Hall (UMD), McCarty (USDA)

Health shocks as a driver of LCLUC

- **Objective:**
  - While the effects of land use on health are well researched, very little is understood about the reversal of this mechanism.
- **Methodology:**
  - We are combining health, socioeconomic and hi-resolution satellite data to examine **how health shocks suffered by agricultural households may contribute to land use change.**
  - We are examining how households respond to the shock and examine potential change in spectral signature from satellite imagery.
  - We will then correlate fluctuations in agricultural land with prevalence of adult health shocks, and then use survey and qualitative interviews to help establish the potential causal link while controlling for other drivers of land use change.
- **Importance of hi-resolution data:**
  - Data of this resolution are necessary given the spatial scale of the **average farm size (1.66ha in Mozambique**). This will assist with the change detection analysis that examines changes in land use. The image from the next slide depicts a collection of farms under an irrigation scheme in this area.

Silva & Dodson (UMD)

Chokwe, Mozambique: 05/24/2012

GeoEye-1 (OrbView-5)
Source: NGA

Silva & Dodson (UMD)

Agricultural mapping in Asia

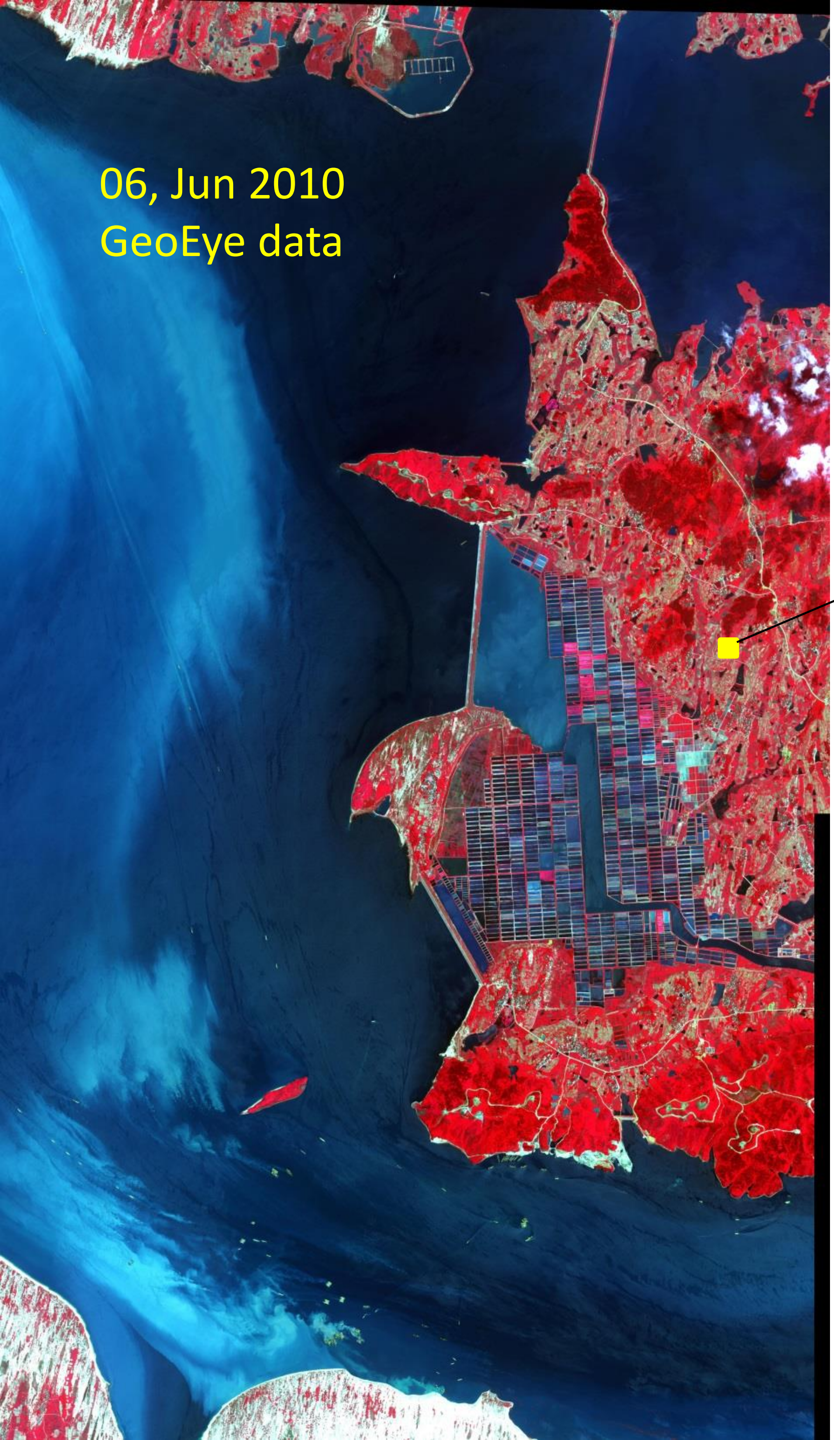
22, May, 2009 IKONOS panchromatic map

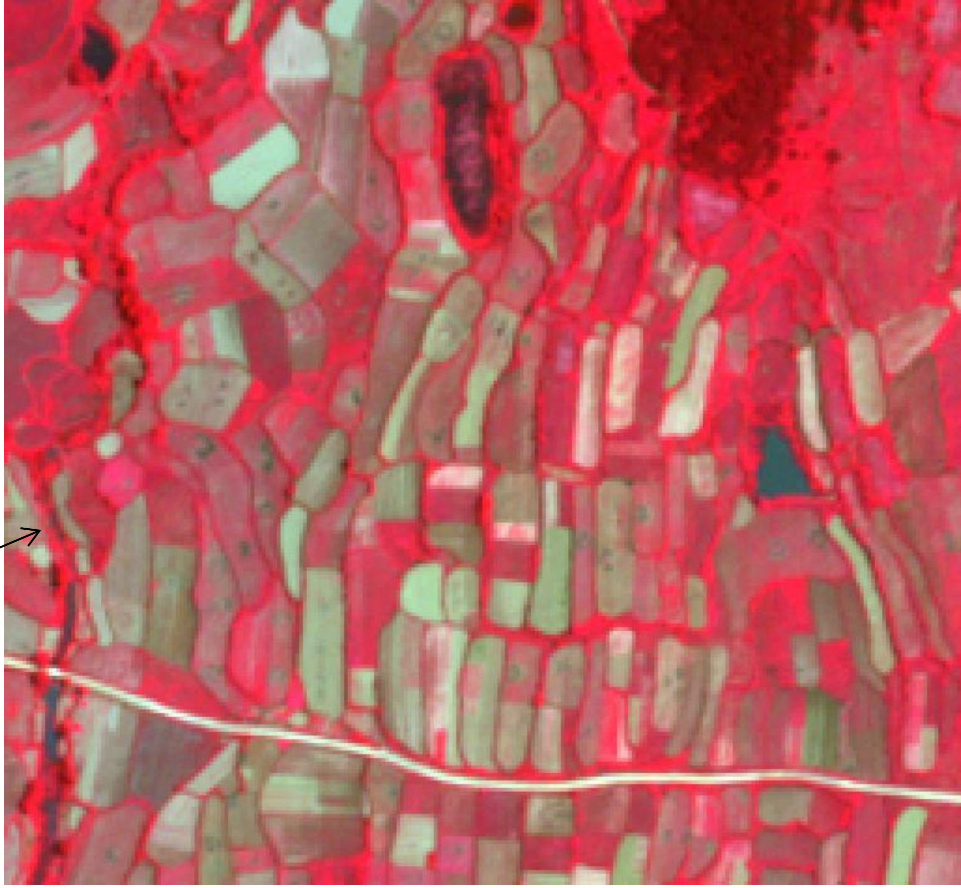
- **NGA fine resolution data support the ground truth data collection effectively in our study.**

Cropland and plantations in suburban regions of Nanchang City, Jiangxi Province

Urban area in Nanchang City , Jiangxi Province

Xiangming Xiao; University of Oklahoma





Paddy rice field in the Poyang lake Basin, Jiangxi Province

Higher resolution data enable identifying the small land parcels in fragmented and complex landscapes.

Xiangming Xiao; University of Oklahoma

Expansion of tall shrublands in Siberian tundra: Use of NGA data

Gerald Frost, Howard Epstein, University of Virginia

RECENT PUBLICATION USING NGA DATA

Frost GV et al. 2013 Patterned-ground facilitates shrub expansion in Low Arctic tundra *Environmental Research Letters* **8** 015035

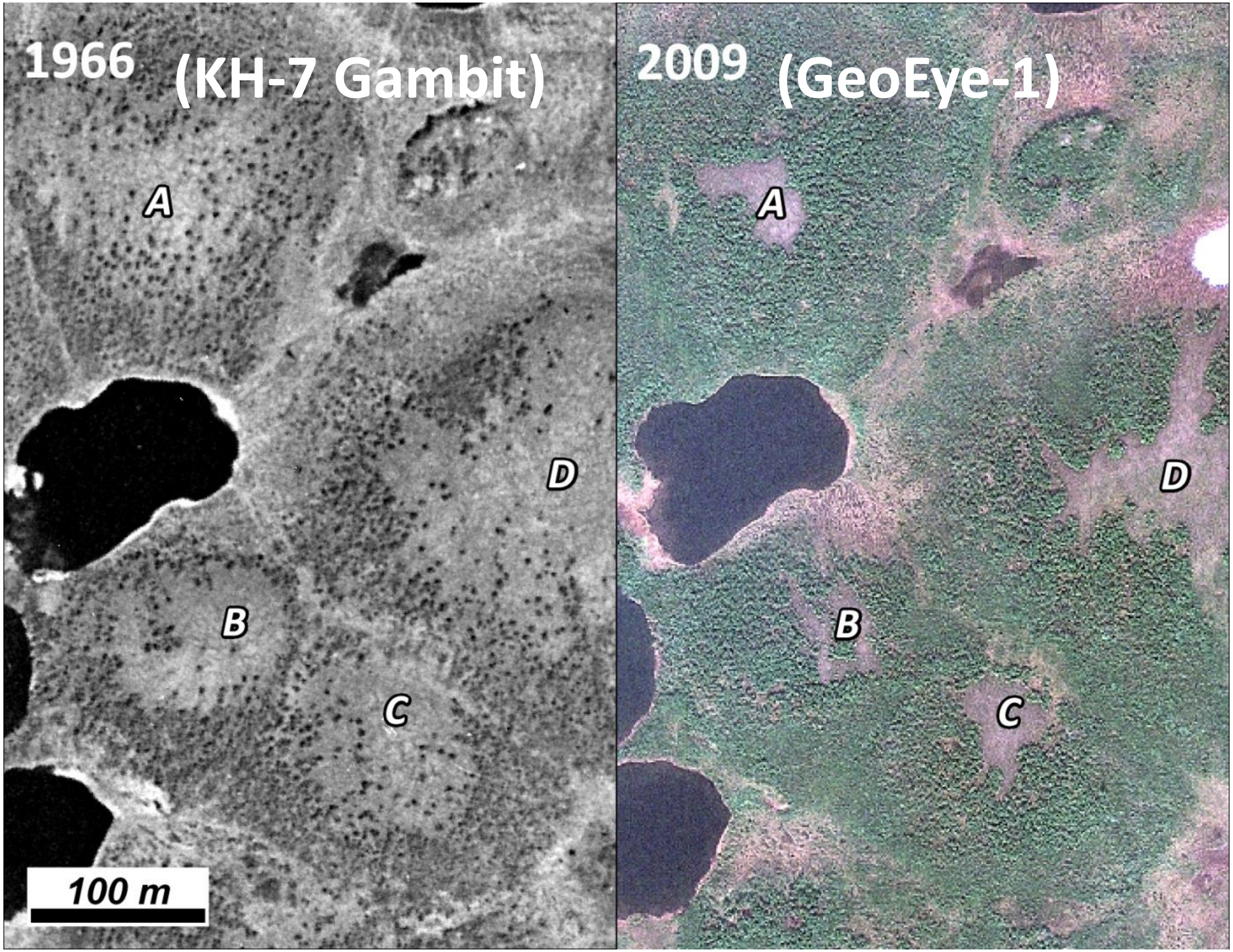
STUDY AREAS

- Approximately 10 NGA data requests for northwest Siberian Low Arctic

Gerald Frost, Howard Epstein
University of Virginia

NGA Data Applications

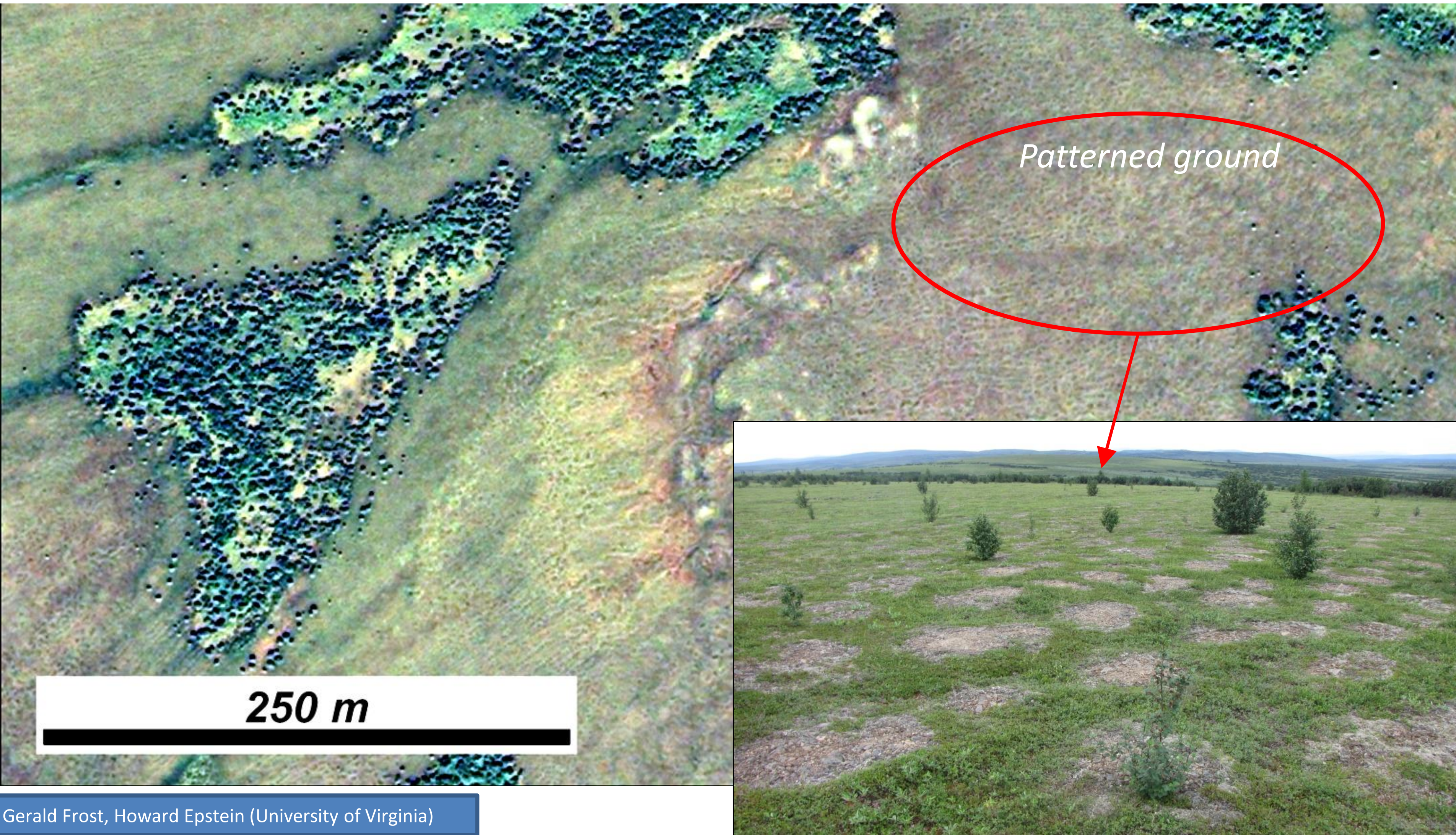
Tundra shrub change detection using 1960s high-resolution imagery



Gerald Frost, Howard Epstein (UVA)

NGA Data Applications

- NGA data enable us to identify local-scale mechanisms for landcover change. Many of these mechanisms are hidden at "sub-pixel" scale in other data sources (e.g., Landsat)



Gerald Frost, Howard Epstein (University of Virginia)

The Urban Transition in Ghana and Its Relation to Land Cover and Land Use Change Through Analysis of Multi-scale and Multi-temporal Satellite Image Data

Project Scope and Objectives Pertaining to Hi-Res Satellite Data

- Assess LCLUC and its effect on demographic and quality of life factors for four major urban centers during this time period.

- Intra-urban identification of LCLUC based on high spatial resolution image data from QuickBird, WorldView, IKONOS and Geoeye commercial satellites.

- **Emphasis on the effects of LCLUC on quality of life indicators such as child mortality, slum indices, and food security, within four of the major cities of Ghana.**

SAN DIEGO STATE UNIVERSITY

THE GEORGE WASHINGTON UNIVERSITY WASHINGTON, DC

UNIVERSITY OF GHANA

Douglas A. Stow
San Diego State University

The Urban Transition in Ghana and Its Relation to Land Cover and Land Use Change Through Analysis of Multi-scale and Multi-temporal Satellite Image Data

Characteristics of commercial high spatial resolution satellite (CHSRS) systems and data.

City	Satellite Sensor	Temporal Coverage	Spectral Bands	Spatial Resolution
Accra	QuickBird-2	2002, 2010	VNIR	2.4 m MS, 0.6 m PAN
Kumasi	IKONOS-2	2001, 2009	VNIR	4 m MS, 1 m PAN
Cape Coast	OrbView-3, IKONOS-2	2005, 2009	VNIR	4 m MS, 1 m PAN
Obuasi	IKONOS-2	2008	VNIR	4 m MS, 1 m PAN

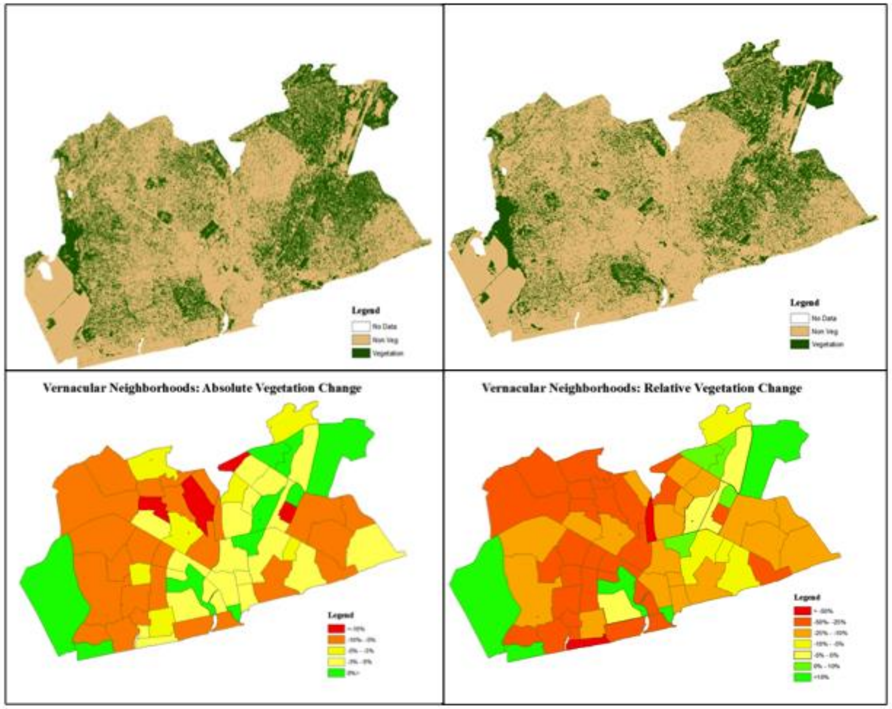
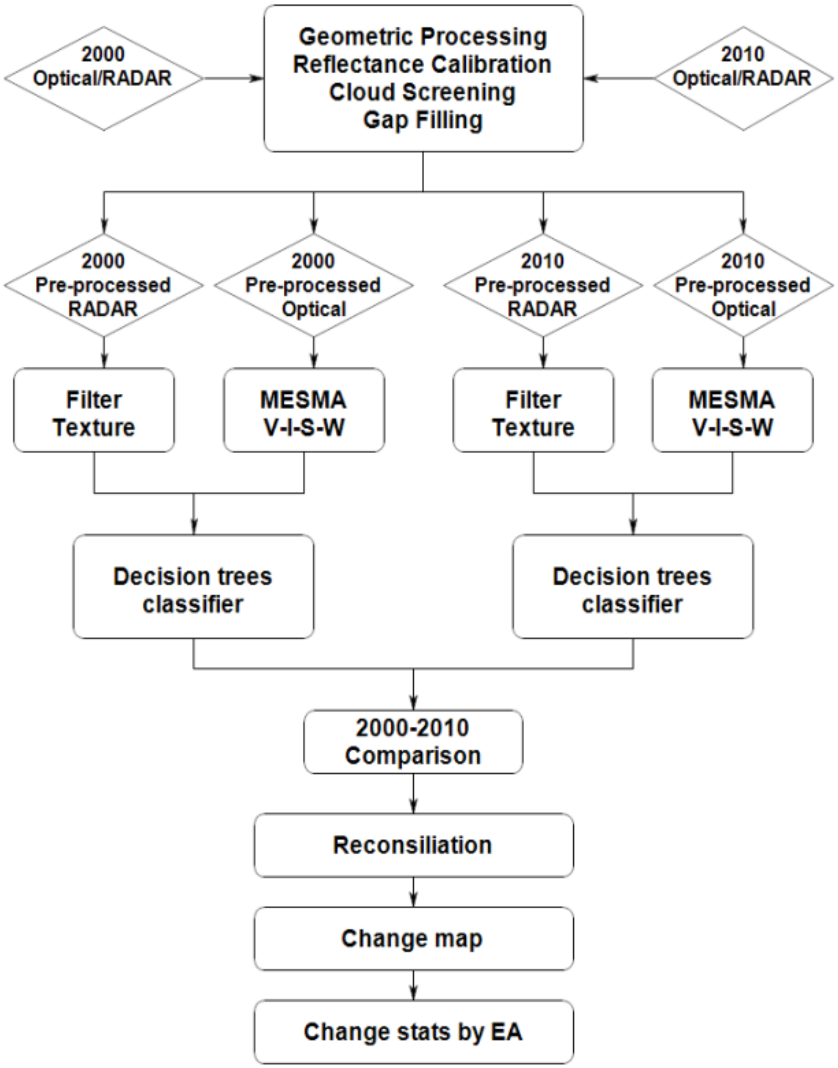
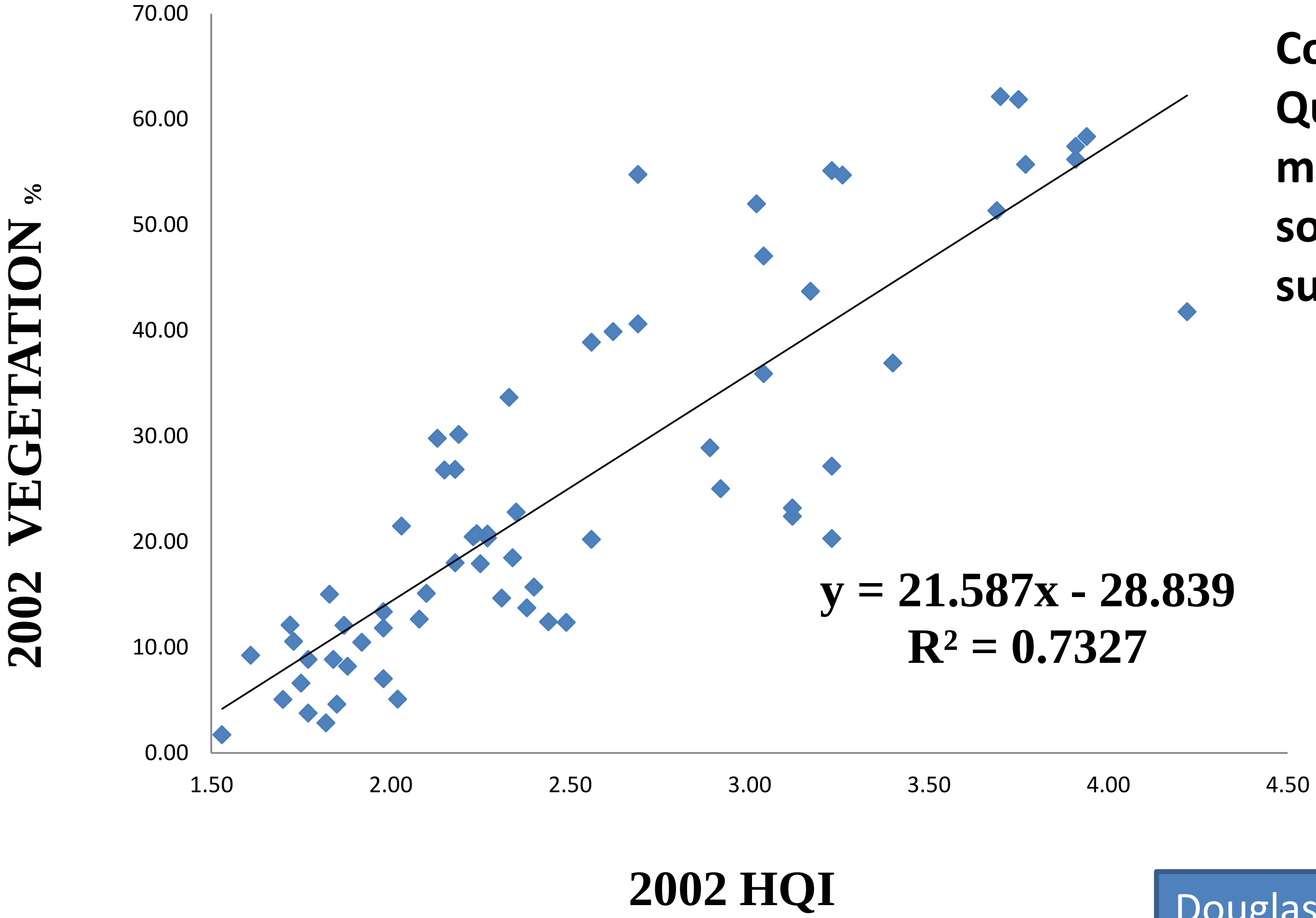


Figure 5. Vegetation change between 2002 and 2010 derived from classification of QuickBird multispectral data. A seven percent area-wide decrease in vegetation cover occurred in this period, with greatest relative decrease in slum areas.



Douglas A. Stow, San Diego State University

Housing Quality Index (Census) vs.% Vegetation (QuickBird) - Neighborhoods in Accra, Ghana



Connecting QuickBird derived metrics to socioeconomic survey data

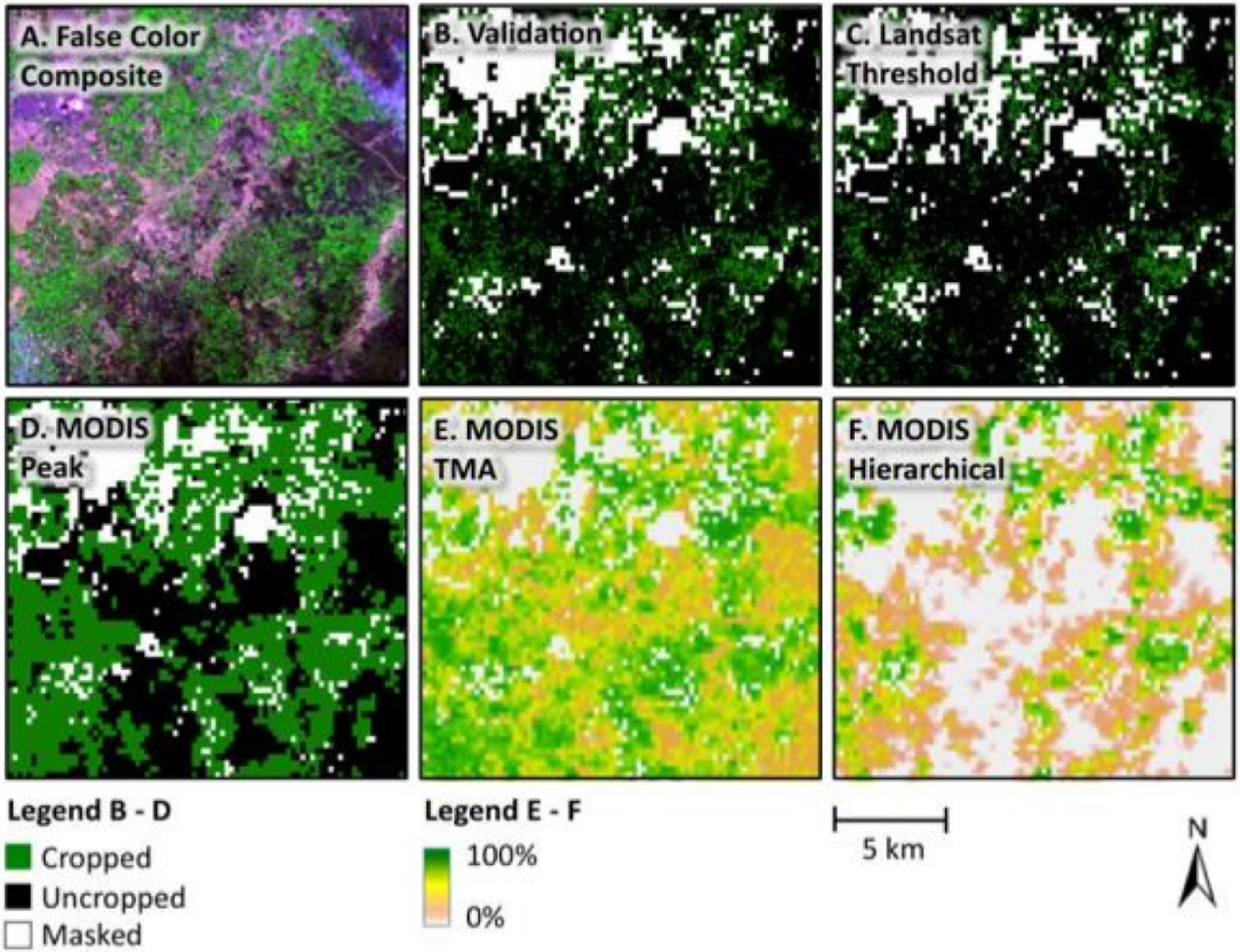
Douglas A. Stow et al.
San Diego State University

Multi-sensor fusion for measuring climate variability in South Asia

- **Mapping cropping intensity of smallholder agricultural fields across India from 2000 to the present using MODIS and Landsat data**

- **Using high-resolution Quickbird and WorldView-2 imagery (NGA database as validation of "true cropped" area**

Ruth DeFries, Meha Jain, Pinki Mondal, Chris Small, Gillian Galford, Columbia Univ.



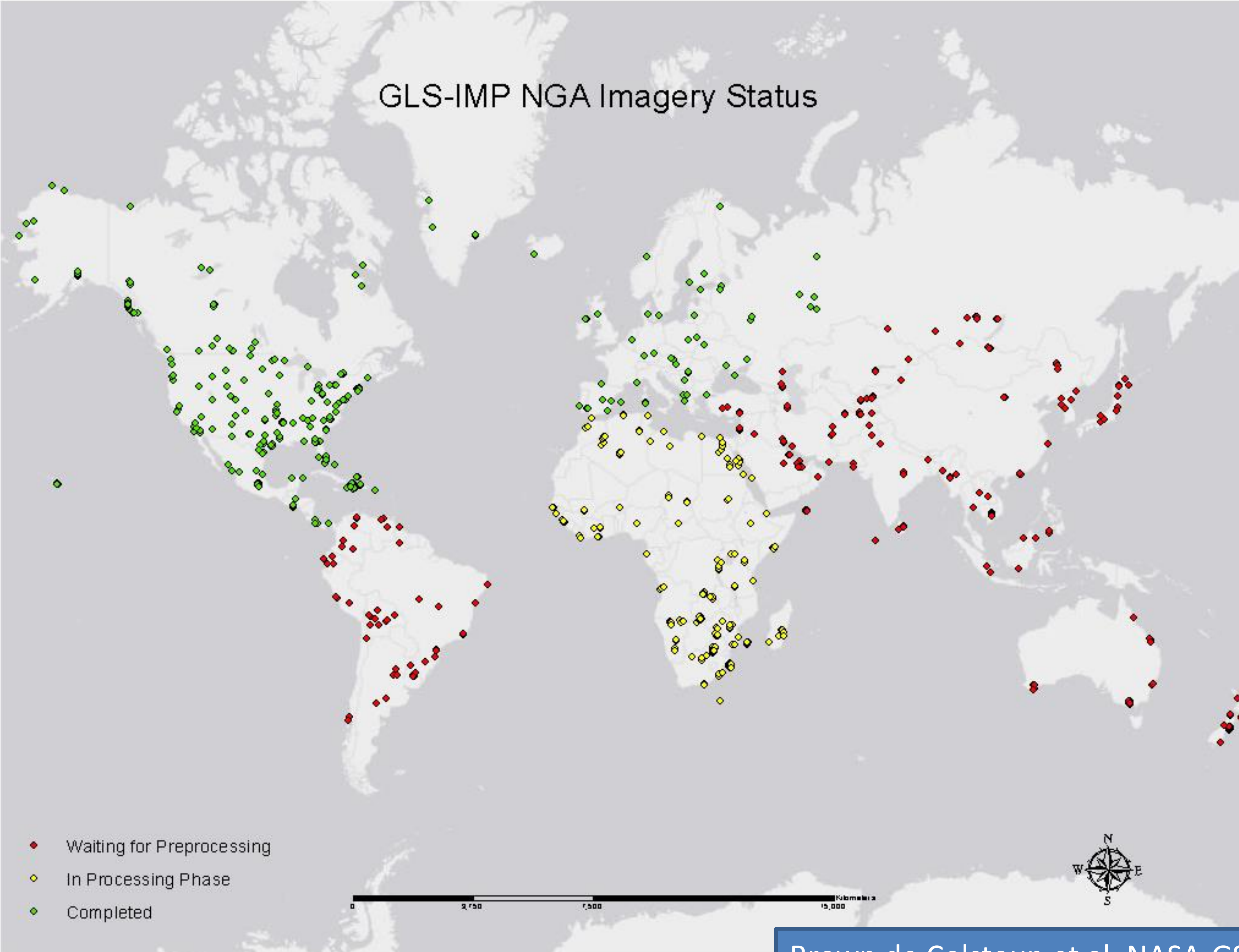
Cropped area during winter 2009-10 in Gujarat, northwest India quantified using our four methods: (C) Landsat threshold, (D) MODIS peak, (E) MODIS temporal mixture analysis, and (F) MODIS hierarchical. High resolution Quickbird data (A and B) were used to validate our four models. Jain et al. *Remote Sensing of Environment.* In press

DeFries et al. Columbia U.

Global Land Survey-Imperviousness Mapping Project

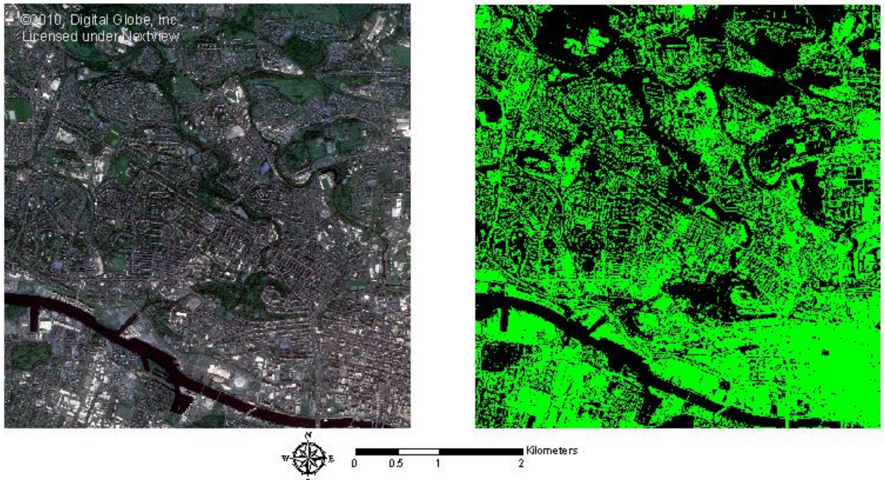
Eric Brown de Colstoun[1] and Chengquan Huang[2] (Co-PIs) and others
1 Earth Sciences Division, NASA Goddard Space Flight Center
2 Dept. of Geographical Sciences, Univ. of Maryland

- The GLS-IMP is attempting to map global urbanization at 30m Landsat scale for the first time.
  1) Map %Impervious cover at global 30m resolution using GLS 2010, 2000 data.
  2) Map areas of global urban expansion between 2000 and 2010.
- We use the NGA imagery to **provide training and validation**. This project would likely not be possible without access to a global archive of very high resolution satellite data.
  - We have acquired a selected archive of NGA data across all continents (700+, see figure).
  - We use the data to produce training masks of impervious/non-impervious cover across each continent using Hierarchical Image Segmentation.
  - The high resolution data are aggregated to 30m resolution of Landsat for training a regression tree algorithm (~2.4M training pixels for Europe alone).
- Caveats:
  - The 'processed' archives from NGA such as 'CitySphere' not useable for science.
  - Currently we are developing our own orthorectification software to more effectively process our data and to do it in an automated, consistent fashion.
  - Processing and pre-processing of NGA data, including searching and ordering is difficult, not geared towards scientific uses, and can be a significant resources sink.

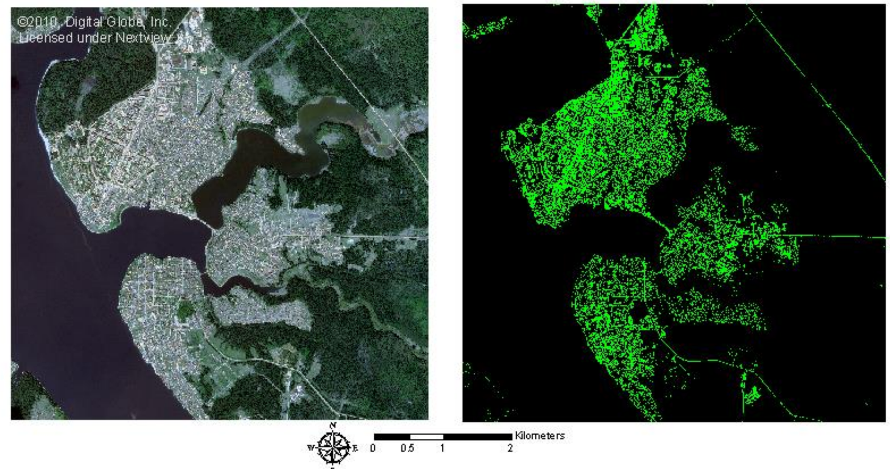


Brown de Colstoun et al .NASA-GSFC

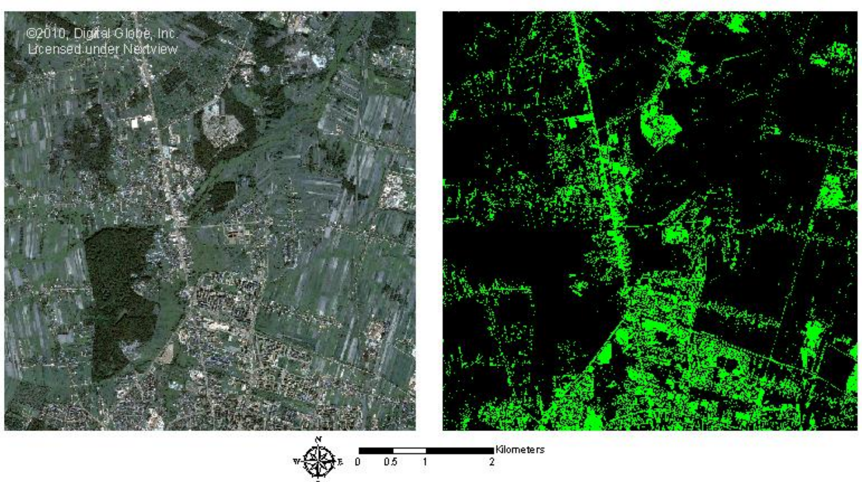
Training Mask Examples



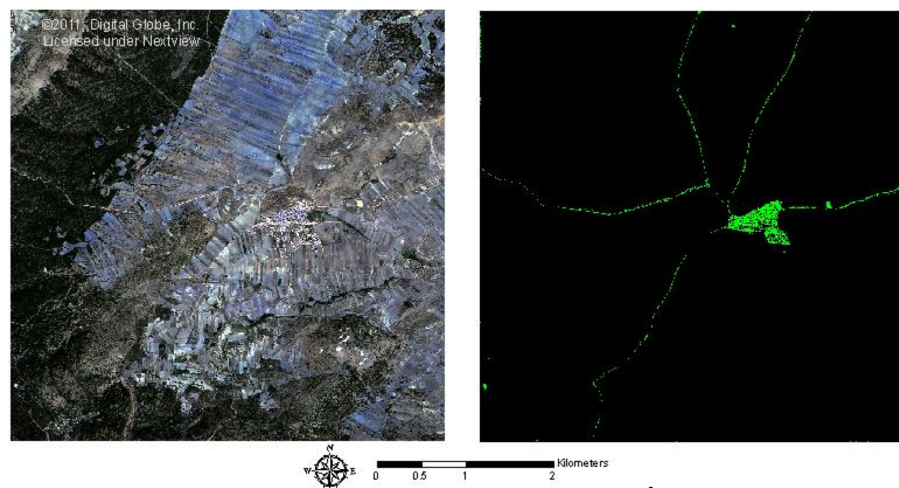
Glasgow, UK



Dobryanka, Russia



Jedlinsk, Poland



El Toro, Spain

Eric Brown de Colstoun, NASA-GSFC

Global Soybean Area Project

Objectives

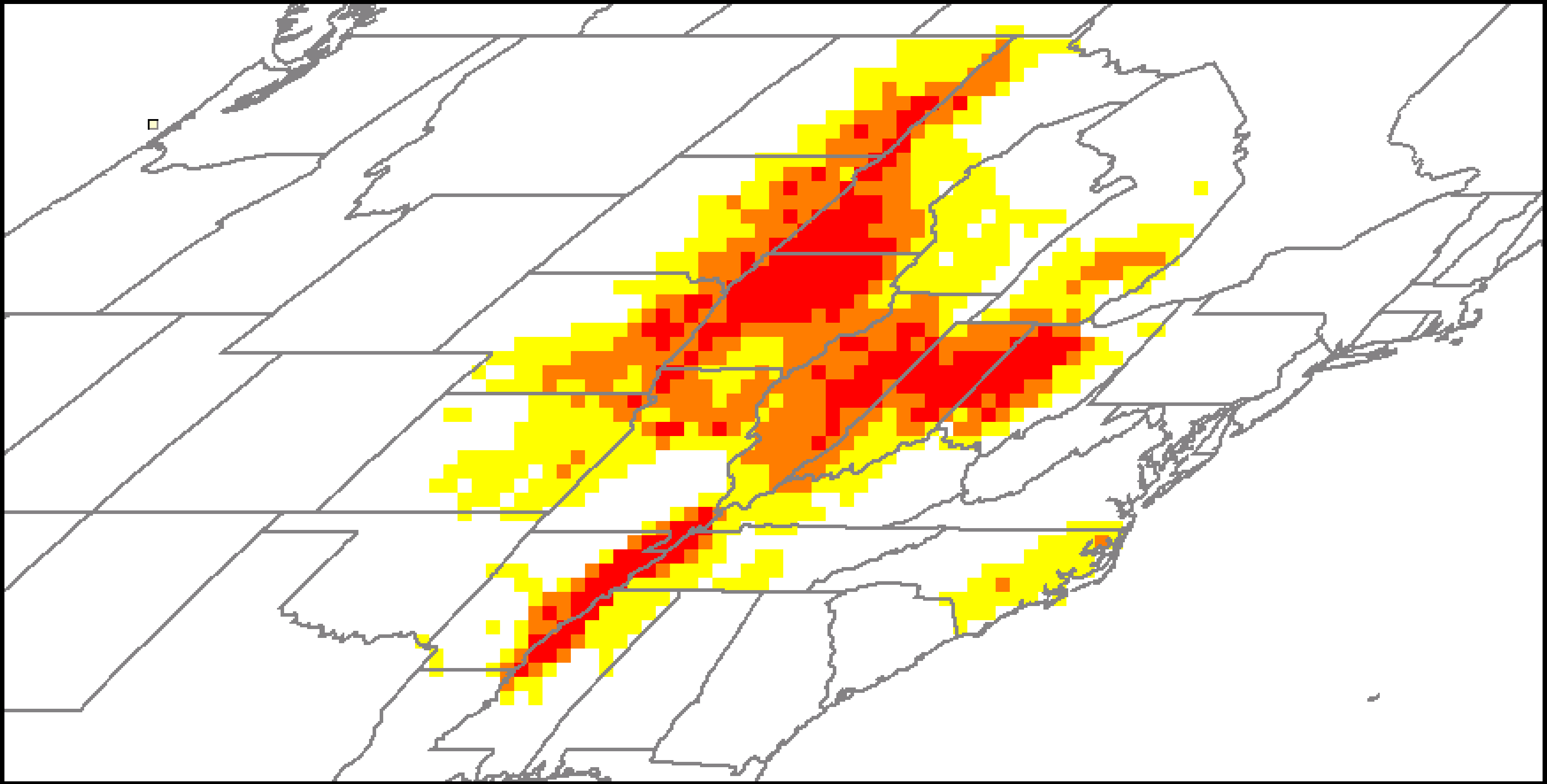
- Employ multiple resolution data: MODIS, Landsat, RapidEye and field data to estimate national-scale crop area by type
- Test a generic approach to estimate cultivated soybean area in the USA, Brazil, Argentina and China (accounts for c. 90% of global soybean production)
- Illustrate the viability of remote sensing-based global crop type area estimation using a sampling approach

Approach

- MODIS used for generalized models to generate per nation/sub-region to indicate within growing-season soybean cultivation based on sub-pixel percent cover training data
  - The models estimate percent soy-cover and enable the stratification of national-scale cropland growing regions for sampling purposes
- S1- Landsat samples used to map per sample block soybean cultivated area
- S2- RapidEye allows for per country/region calibration of Landsat area estimates
- The Landsat sample blocks are then analyzed to quantify national-scale crop type area

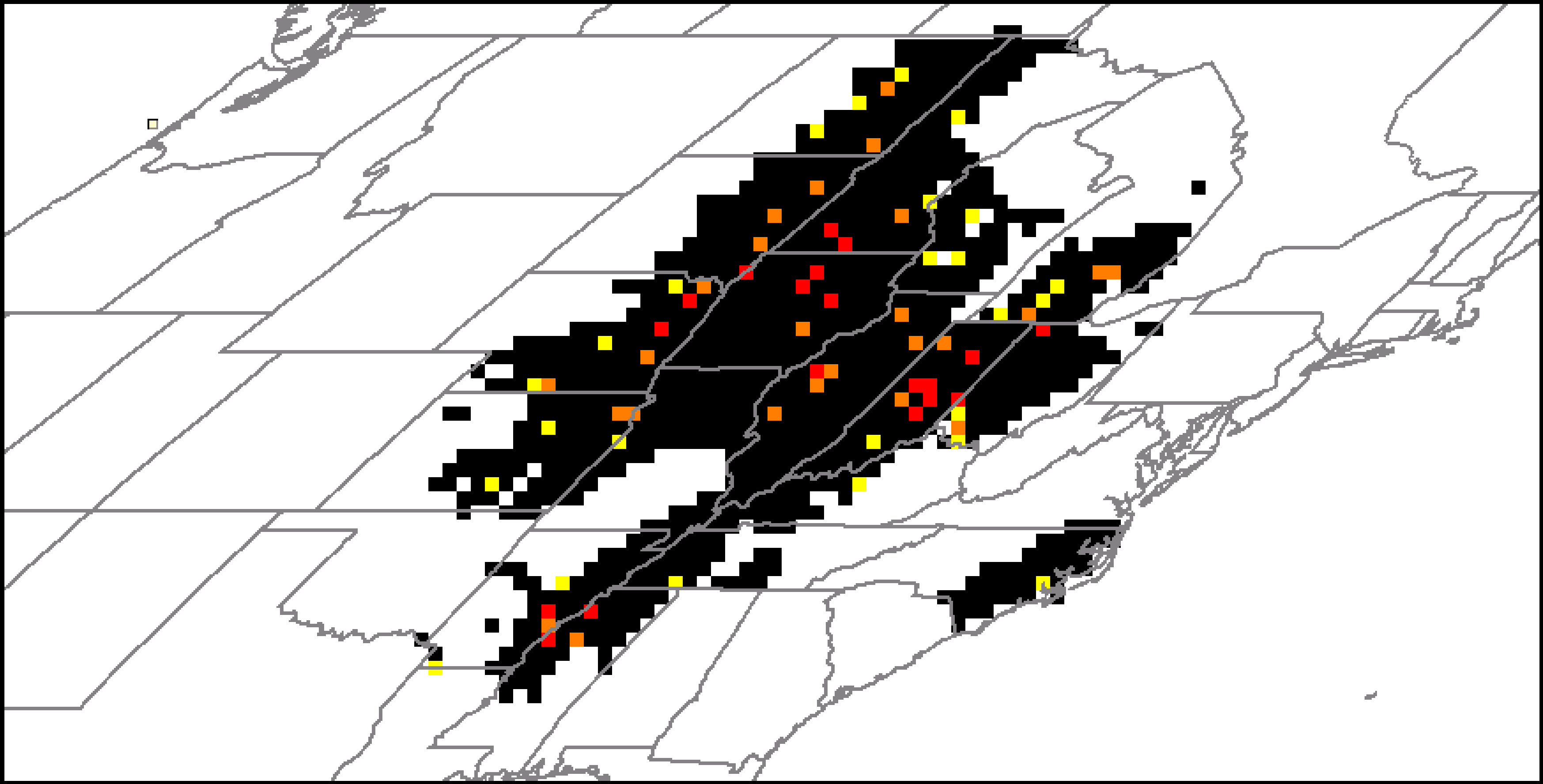
Matt Hansen et al. UMD

High, medium and low soybean strata using MODIS

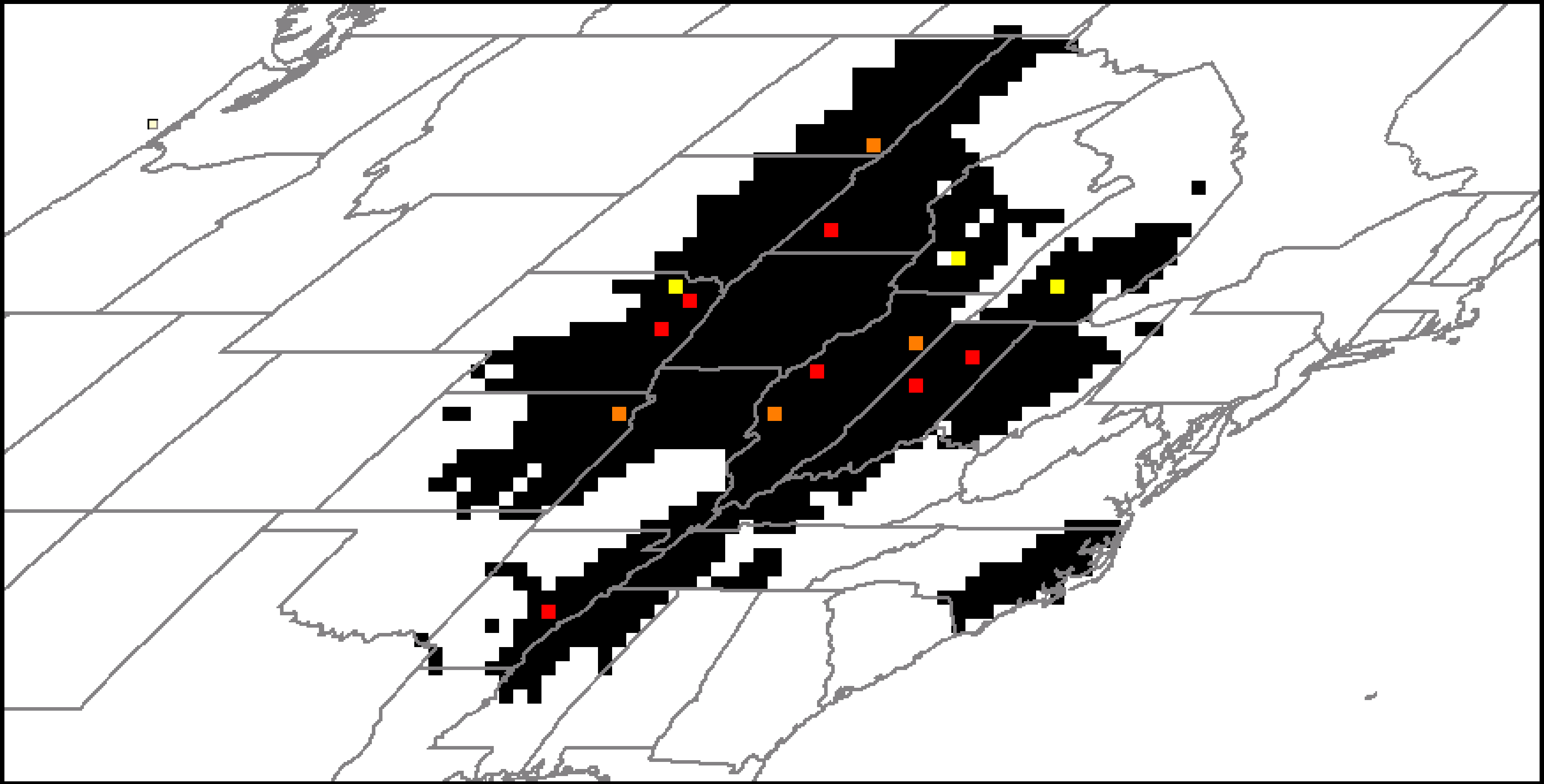


Red=high (>19.8%), orange=medium (7.2-19.8%), yellow=low (0.5-7.2%)

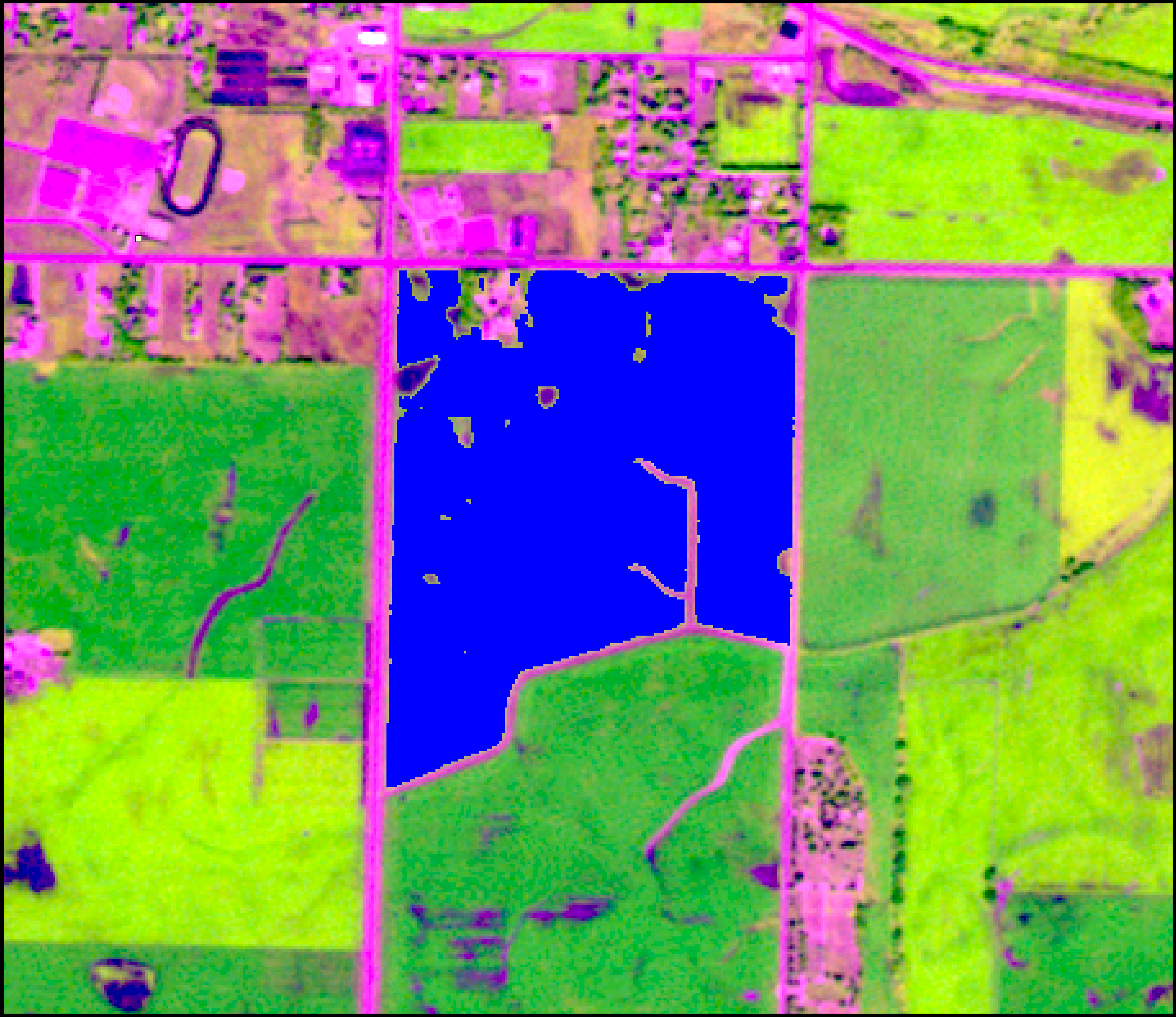
Landsat sample blocks (S1)
3-4 acquisitions during growing season



RapidEye sample blocks- S2



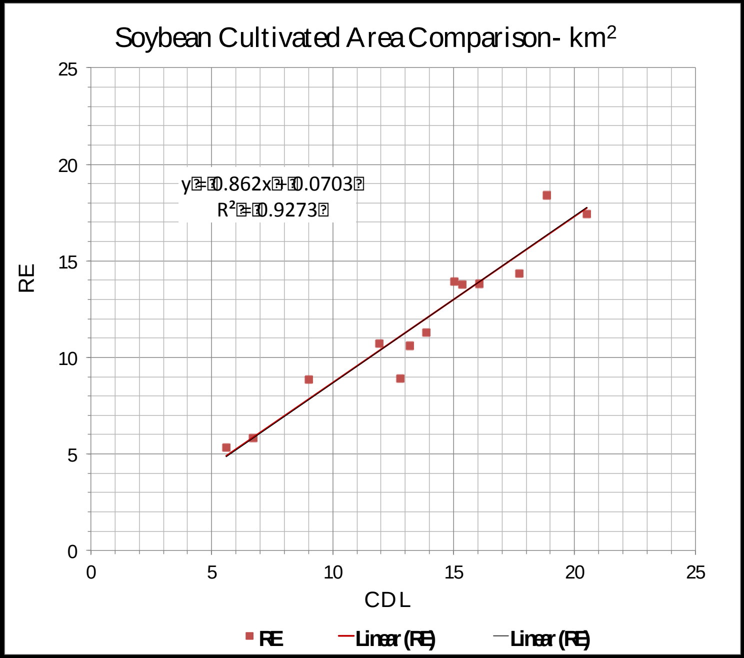
Red=high (>19.8%), orange=medium (7.2-19.8%), yellow=low (0.5-7.2%)



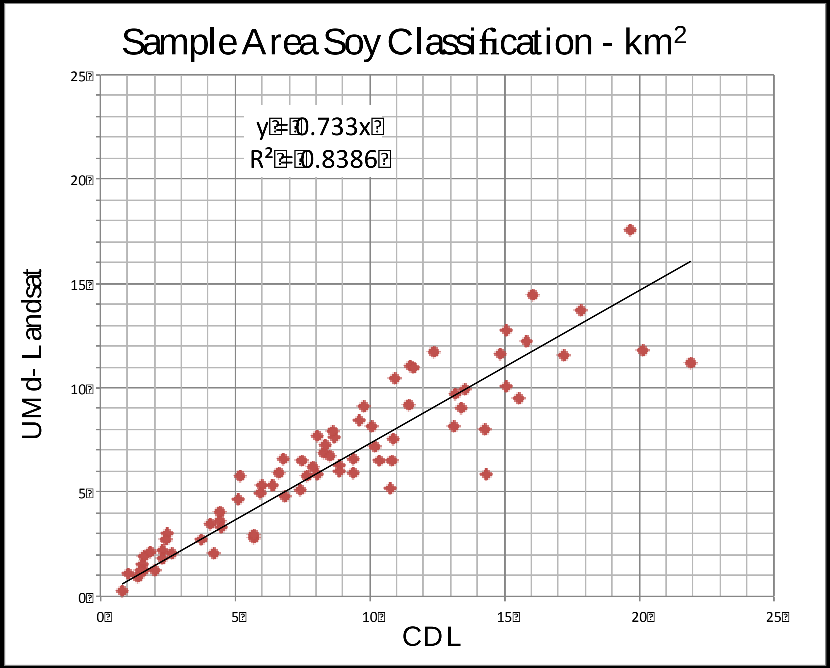
Preliminary Results

Calibration of Landsat with Rapid Eye

Rapid Eye vs. Landsat Area estimates per Block



Comparison of Area Estimates using Landsat sample blocks vs. wall to wall Landsat based estimate



Hansen et al

Developing Tools for Hi-resolution Automated Classification (SIAM™)

World View 2: Brazilia

Stage 1 Automated Spectral Classification

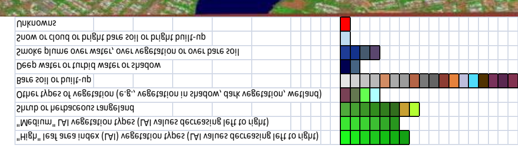


Fig. 2(a). WorldView-2 (WV-2) image of Brazilia (Brazil), spatial resolution: 2 m, acquisition date 2010-08-04, radiometrically calibrated into TOA reflectance values and depicted in false colors (R: 5, G: 7, B: 2). Default image histogram stretching: ENVI linear stretching 2%.

Fig. 2(b). Q-SIAM™ preliminary map of the WV-2 image shown in Fig. 2(a). Spectral categories are depicted in pseudo colors.

Andrea Baraldi UMD

Automated Spectral Categories SIAM™

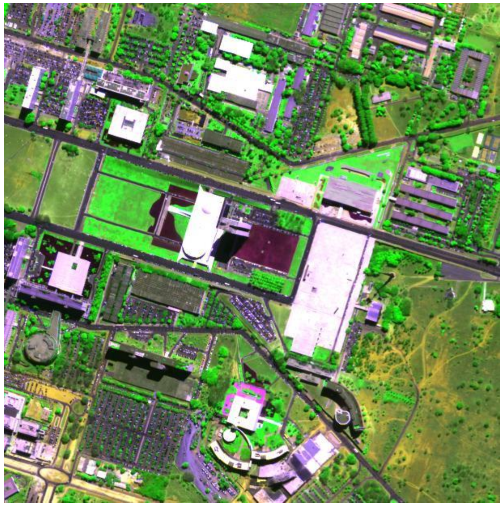


Fig. 2(c). Zoom of the WV-2 T2 image, 2 m spatial resolution, acquisition date 2010-08-04, radiometrically calibrated into TOARF values shown in Fig. 2(a), depicted in false colors (R: 5, G: 7, B: 2). Default image histogram stretching: ENVI linear stretching 2%

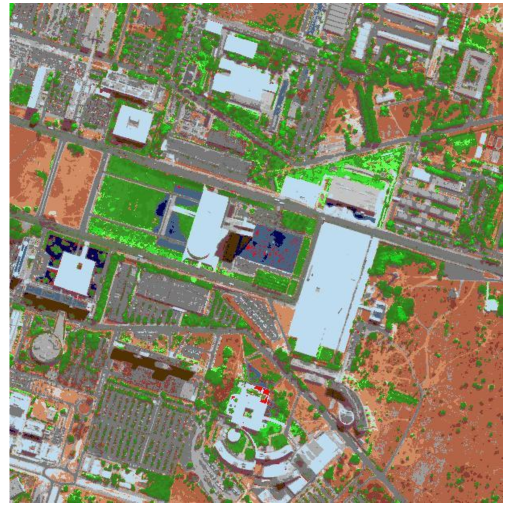
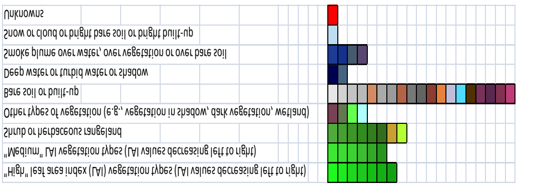


Fig. 2(d). Zoom of the Q-SIAM™ preliminary map, shown in Fig. 2(b), corresponding to Fig. 2(c). Spectral categories are depicted in pseudo colors. Map legend: see Fig. 2(b).

Spectral Classes



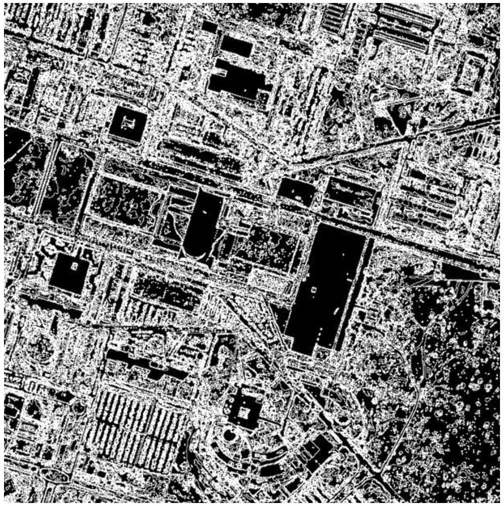


Fig. 2(e). 4-adjacency cross-aura measure generated from the Q-SIAM™ preliminary map, shown in Fig. 2(d). Cross-aura values range in {0, 4}.

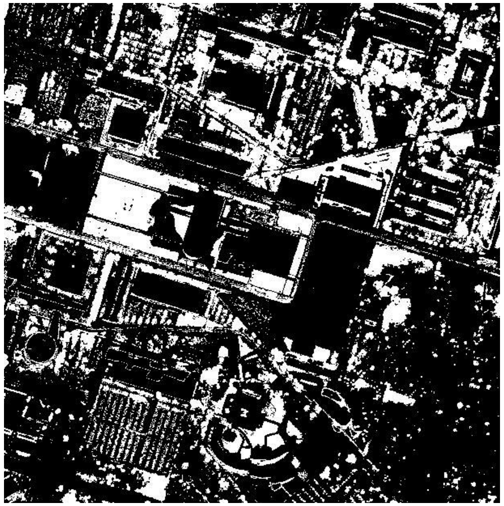
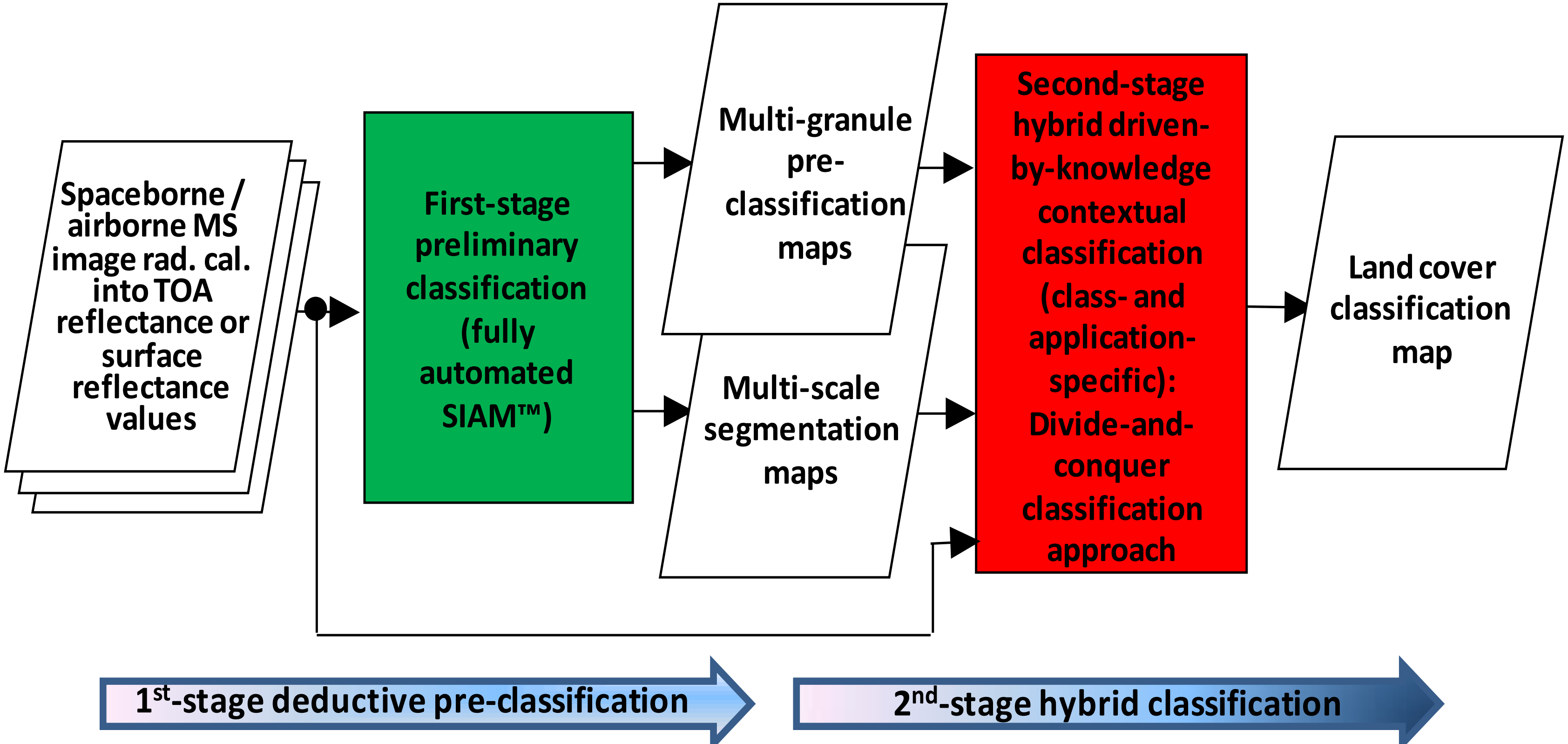


Fig. 2(f). Binary vegetation mask generated from the Q-SIAM™ preliminary map, shown in Fig. 2(d).

Andrea Baraldi UMD

Recommended Two Stage Approach



Semantic information gap to fill up, from sensory data to land covers: ~ 50%.

Semantic information gap to fill up, from sensory data to land covers: ~50%.

Stage zero for image pre-processing is not shown.

Baraldi UMD

Use of NGA high resolution imagery in NASA USAID CARPE - Congo Basin Research

Potapov, Hansen, Tyukavina, Barker, Molinario (UMD)

1) Validate Landsat scale wall-to-wall remote sensing based maps of forest cover loss in the Congo Basin – the FACET product of Potapov et al 2010.
2) Sampling design to analyze a statistically significant portion of the DRC and assess :
   a) The vegetation classification of “ non-forest”, “secondary” and “primary” forest classes of the “rural complex” as well as
   b) The spatio-temporal cycle of shifting cultivation: how it affects forest cover.

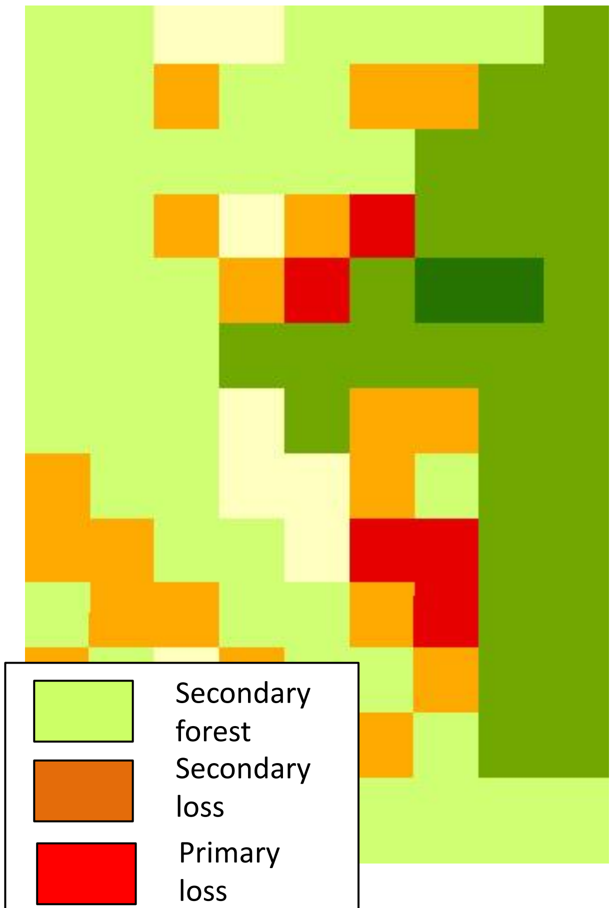
First step develop necessary Hi-Resn tools :

- Data block interrogation and multi-temporal coverage diagrams
- Perform image ortho-rectification, file type conversion and radiometric calibration
- Testing Automated Classification SIAM Stage 1 quick looks and stratification

A considerable amount of forest cover loss in the DRC occurs in the range of 1-3 Landsat pixels.

- Potapov et al. 2010 estimate the median clearing size at 1.4 ha.
- Need high resolution to further study the slash and burn forest cover dynamic.

Potapov et al 2010 – 60m

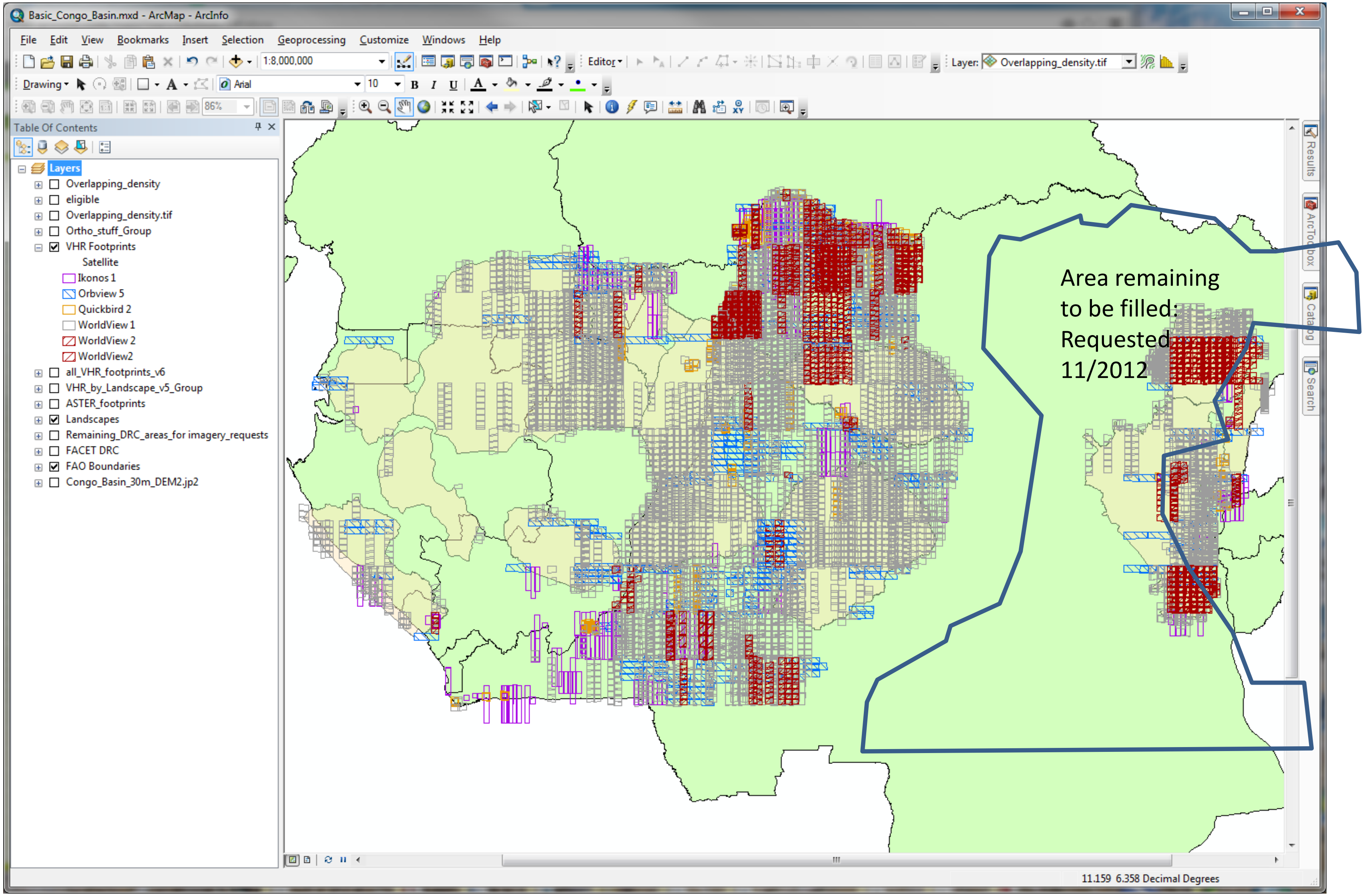


Orbview 5/Geoeye 1 - 1.65m

Worldview 1 – 0.60 m

Potapov et al UMD

CARPE's VHR Acquisitions



Molinario and Braker , UMD

Generic Hi-Resn Image Processing Tools

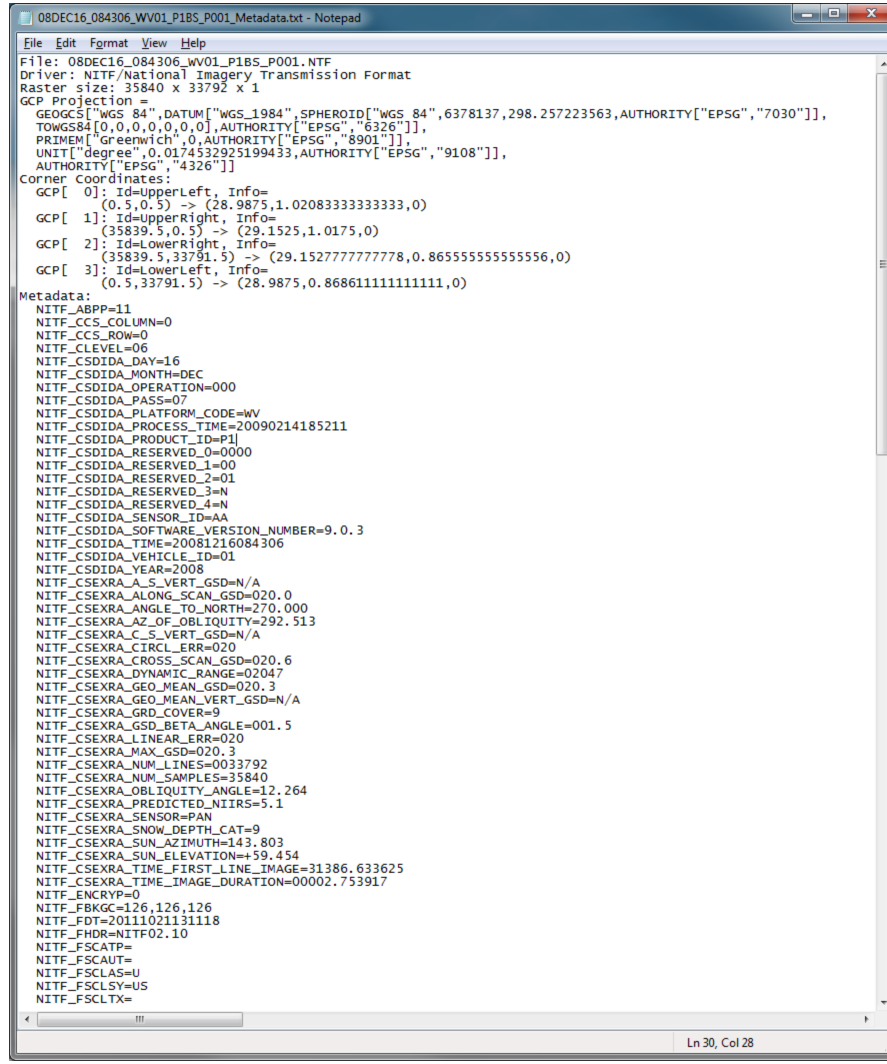
- Metadata extraction
  - to text files, .shp and PostGREs-PostGIS DB
- Basic footprint creation (.shp)
- Cloud free footprint creation (.shp)
- Hyperlinks for footprint/image visualization
- Multi-temporal image querying
- Renaming of imagery to a standard naming convention
- One click, batch Orthorectification *
  - File type conversion from NITF to GeoTiff or ENVI standard
- One click, batch TOA radiance and TOA reflectance calibration **
- One click, batch SIAM processing on a directory of images #

* Code provided by Claire Porter UMN, and adapted
** Calibrators provided by L. Boschetti , A. Baraldi and modified and adapted by Brian Barker, UMD
# Trademarked software by A. Baraldi, UMD

Molinario, Barker, Baraldi et al. (UMD)

Metadata Extraction

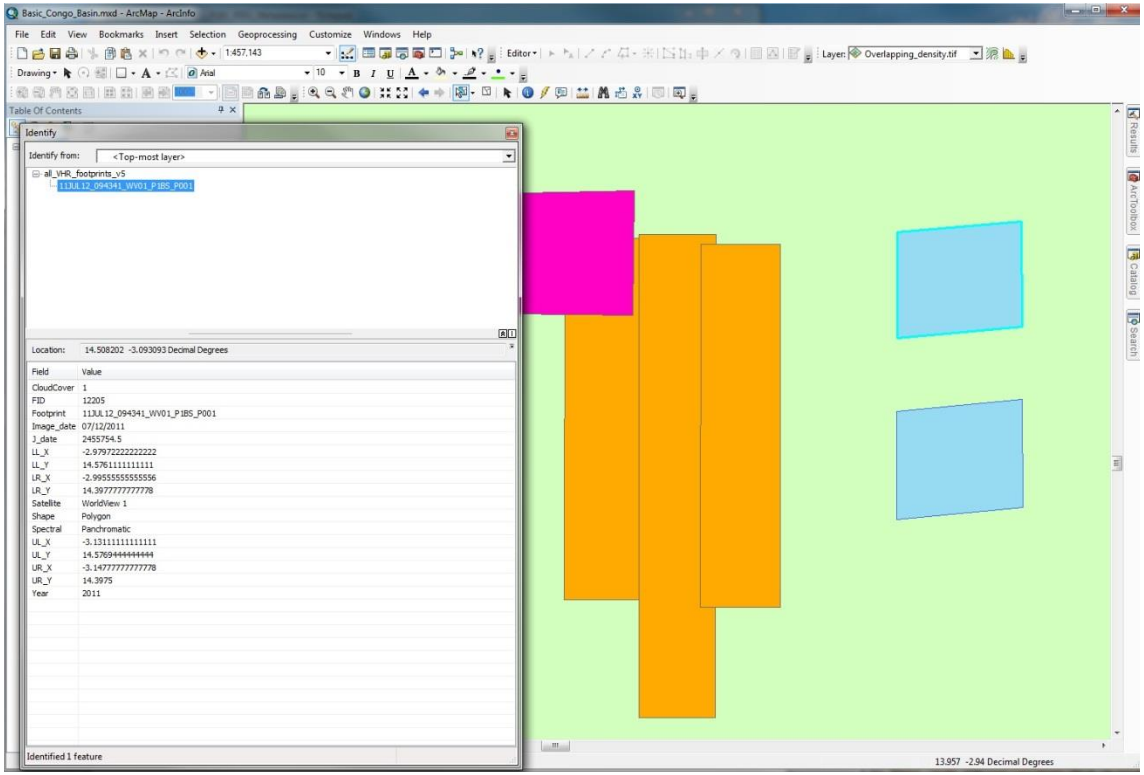
- Metadata is extracted from the image through a python script and provided in a simple txt file.
- The txt file can then be referenced in other processes such as footprint creation or radiometric calibration.



```
08DEC16_084306_WV01_P1BS_P001_Metadata.txt - Notepad
File  Edit  Format  View  Help
File: 08DEC16_084306_WV01_P1BS_P001.NTF
Driver: NITF/National Imagery Transmission Format
Raster size: 35840 x 33792 x 1
GCP Projection =
  GEOGCS["WGS 84",DATUM["WGS_1984",SPHEROID["WGS 84",6378137,298.257223563,AUTHORITY["EPSG","7030"]],
  TOWGS84[0,0,0,0,0,0,0],AUTHORITY["EPSG","6326"]],
  PRIMEM["Greenwich",0,AUTHORITY["EPSG","8901"]],
  UNIT["degree",0.0174532925199433,AUTHORITY["EPSG","9108"]],
  AUTHORITY["EPSG","4326"]]
Corner Coordinates:
  GCP[  0]: Id=UpperLeft, Info=
          (0.5,0.5) -> (28.9875,1.02083333333333,0)
  GCP[  1]: Id=UpperRight, Info=
          (35839.5,0.5) -> (29.1525,1.0175,0)
  GCP[  2]: Id=LowerRight, Info=
          (35839.5,33791.5) -> (29.1527777777778,0.865555555555556,0)
  GCP[  3]: Id=LowerLeft, Info=
          (0.5,33791.5) -> (28.9875,0.868611111111111,0)
Metadata:
  NITF_ABPP=11
  NITF_CCS_COLUMN=0
  NITF_CCS_ROW=0
  NITF_CLEVEL=06
  NITF_CSDIDA_DAY=16
  NITF_CSDIDA_MONTH=DEC
  NITF_CSDIDA_OPERATION=000
  NITF_CSDIDA_PASS=07
  NITF_CSDIDA_PLATFORM_CODE=WV
  NITF_CSDIDA_PROCESS_TIME=20090214185211
  NITF_CSDIDA_PRODUCT_ID=P1
  NITF_CSDIDA_RESERVED_0=0000
  NITF_CSDIDA_RESERVED_1=00
  NITF_CSDIDA_RESERVED_2=01
  NITF_CSDIDA_RESERVED_3=N
  NITF_CSDIDA_RESERVED_4=N
  NITF_CSDIDA_SENSOR_ID=AA
  NITF_CSDIDA_SOFTWARE_VERSION_NUMBER=9.0.3
  NITF_CSDIDA_TIME=20081216084306
  NITF_CSDIDA_VEHICLE_ID=01
  NITF_CSDIDA_YEAR=2008
  NITF_CSEXRA_A_S_VERT_GSD=N/A
  NITF_CSEXRA_ALONG_SCAN_GSD=020.0
  NITF_CSEXRA_ANGLE_TO_NORTH=270.000
  NITF_CSEXRA_AZ_OF_OBLIQUITY=292.513
  NITF_CSEXRA_C_S_VERT_GSD=N/A
  NITF_CSEXRA_CIRCL_ERR=020
  NITF_CSEXRA_CROSS_SCAN_GSD=020.6
  NITF_CSEXRA_DYNAMIC_RANGE=02047
  NITF_CSEXRA_GEO_MEAN_GSD=020.3
  NITF_CSEXRA_GEO_MEAN_VERT_GSD=N/A
  NITF_CSEXRA_GRD_COVER=9
  NITF_CSEXRA_GSD_BETA_ANGLE=001.5
  NITF_CSEXRA_LINEAR_ERR=020
  NITF_CSEXRA_MAX_GSD=020.3
  NITF_CSEXRA_NUM_LINES=0033792
  NITF_CSEXRA_NUM_SAMPLES=35840
  NITF_CSEXRA_OBLIQUITY_ANGLE=12.264
  NITF_CSEXRA_PREDICTED_NIIRS=5.1
  NITF_CSEXRA_SENSOR=PAN
  NITF_CSEXRA_SNOW_DEPTH_CAT=9
  NITF_CSEXRA_SUN_AZIMUTH=143.803
  NITF_CSEXRA_SUN_ELEVATION=+59.454
  NITF_CSEXRA_TIME_FIRST_LINE_IMAGE=31386.633625
  NITF_CSEXRA_TIME_IMAGE_DURATION=00002.753917
  NITF_ENCRYP=0
  NITF_FBKGC=126,126,126
  NITF_FDT=20111021131118
  NITF_FHDR=NITF02.10
  NITF_FSCATP=
  NITF_FSCAUT=
  NITF_FSCLAS=U
  NITF_FSCLSY=US
  NITF_FSCLTX=
Ln 30, Col 28
```

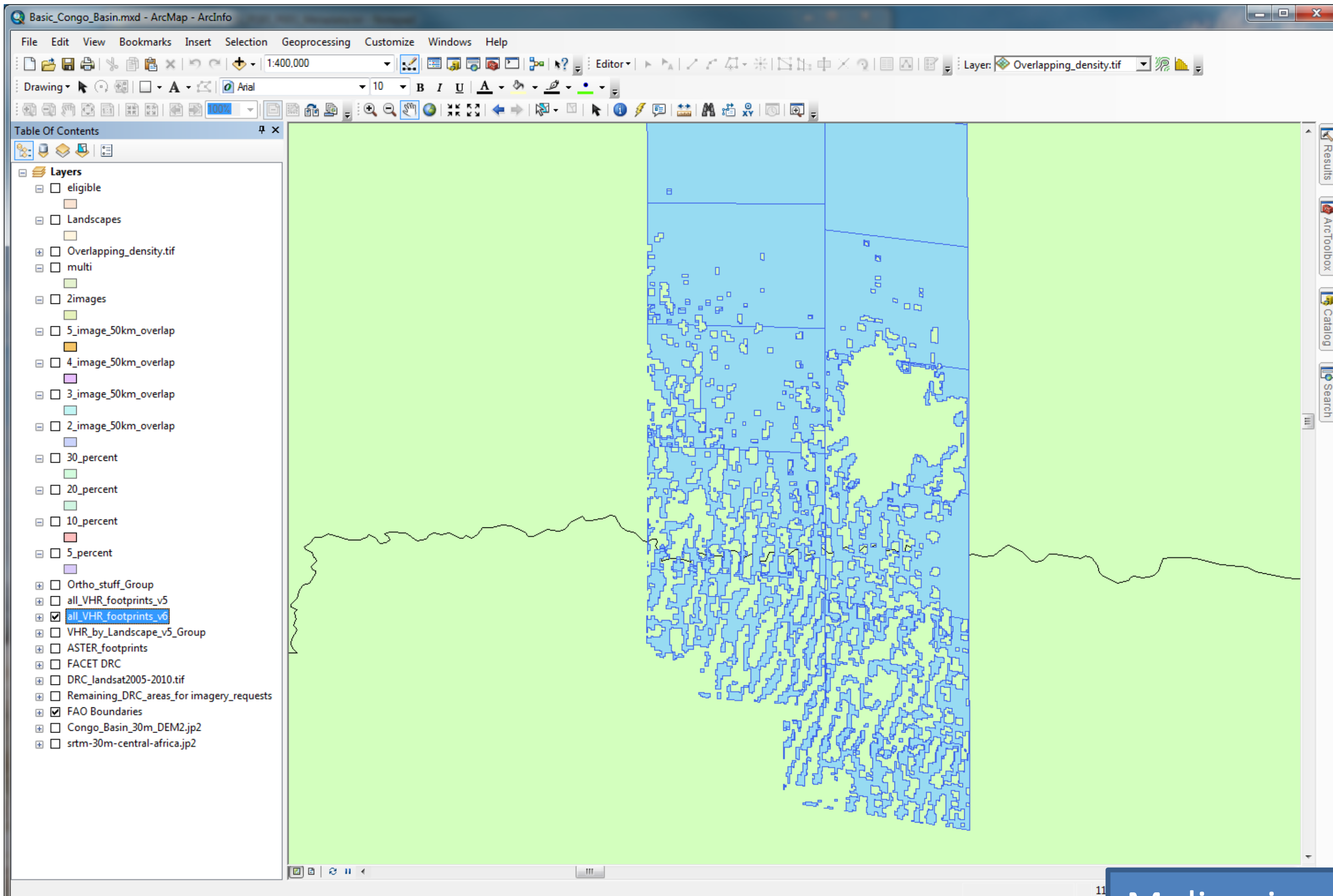
Basic Footprints

- The basic footprints can be tailored to provide any portion of the metadata that is required by the user. Currently image acquisition date, cloud cover, satellite platform, and image name are primarily used.



Cloud Free Footprints

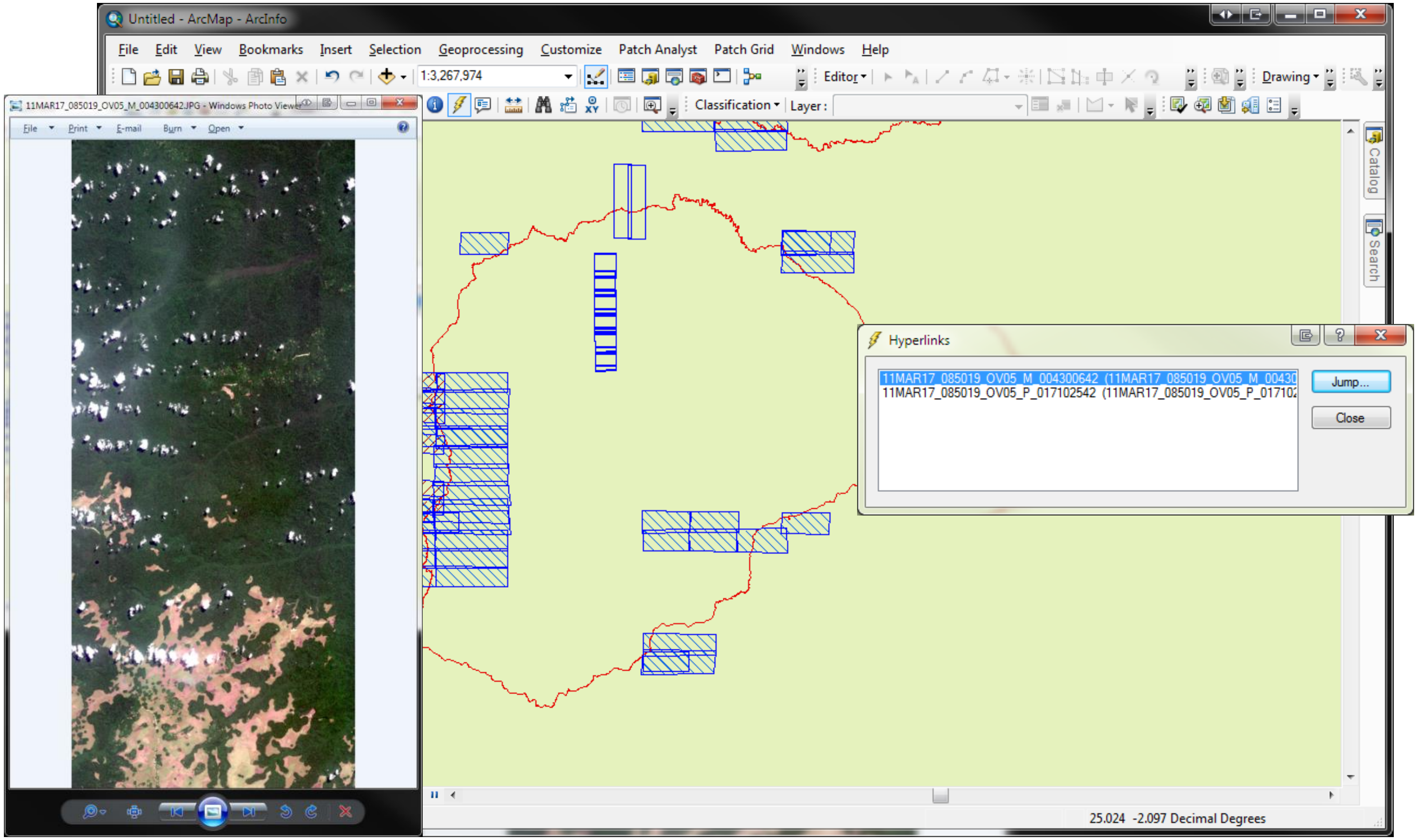
- The cloud free footprints use the embedded cloud mask within the NITF file in order to create a footprint that shows the location of cloud free areas.
- This gives the user a better understanding of the usable portion of the imagery



Molinario and Braker , UMD

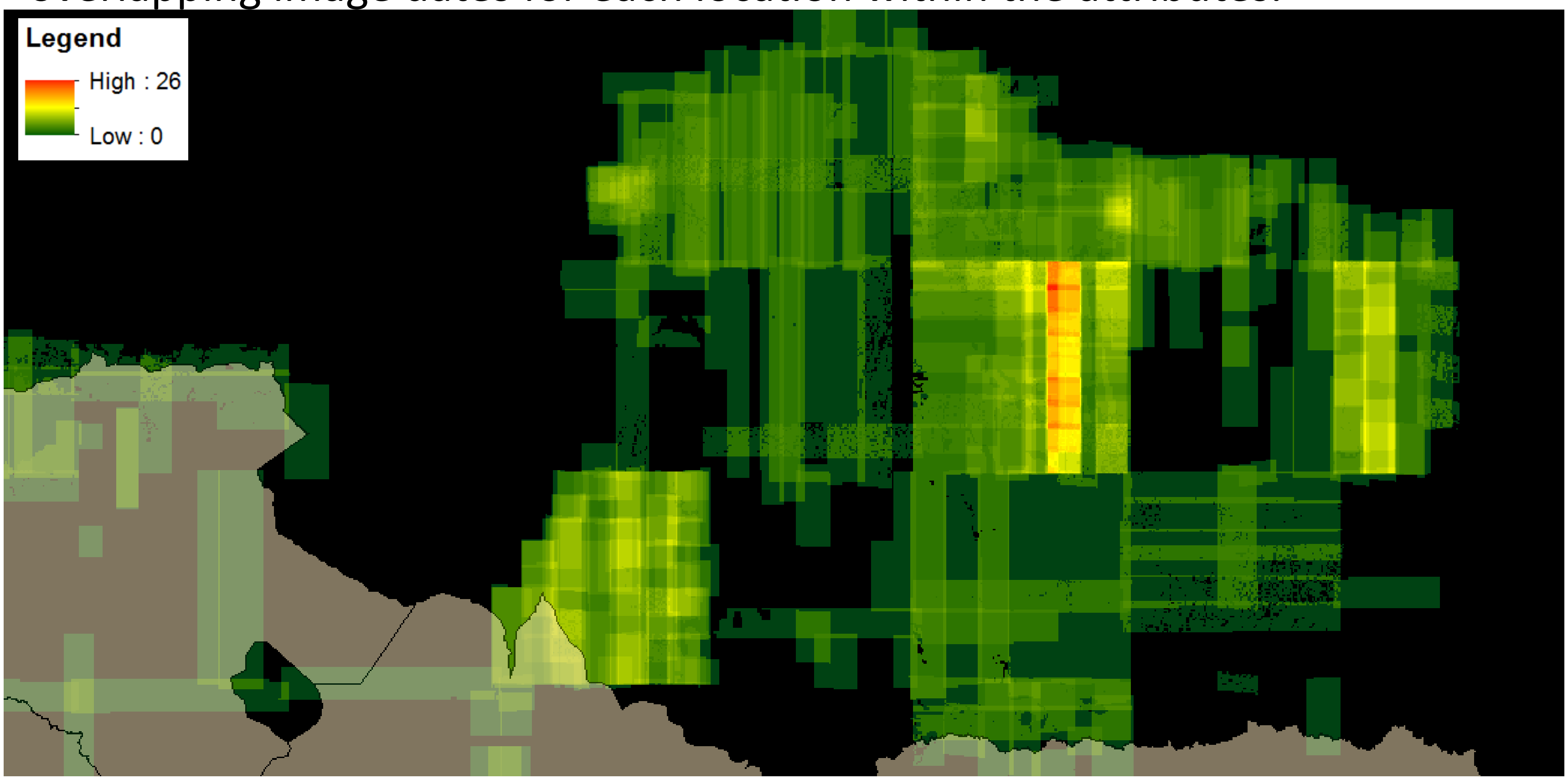
Quicklooks: Hyperlinks for Footprint/Image Visualization

- The hyperlink setup allows for a quick visualization of a low resolution jpeg of the satellite image, helping to better judge the quality of the specific image.



Multi-temporal Image Querying

- Use PostGIS to perform spatial queries on the imagery footprints
- A raster visualization of data density.
- Each $1km^2$ cell contains the number of multi-spectral, cloud free data overlapping that specific location.
- A shapefile format of this visualization is also available, containing the list of overlapping image dates for each location within the attributes.



Batch Orthorectification

- We are able to batch perform orthorectification on the imagery using a modified version of a python script from Claire Porter at the Polar Geospatial Center.

- Within this script we are also able to convert the image format from NITF to GeoTiff or to an ENVI standard format. Making the imagery easier to use across different image processing software that might not be able to handle the NITF format.

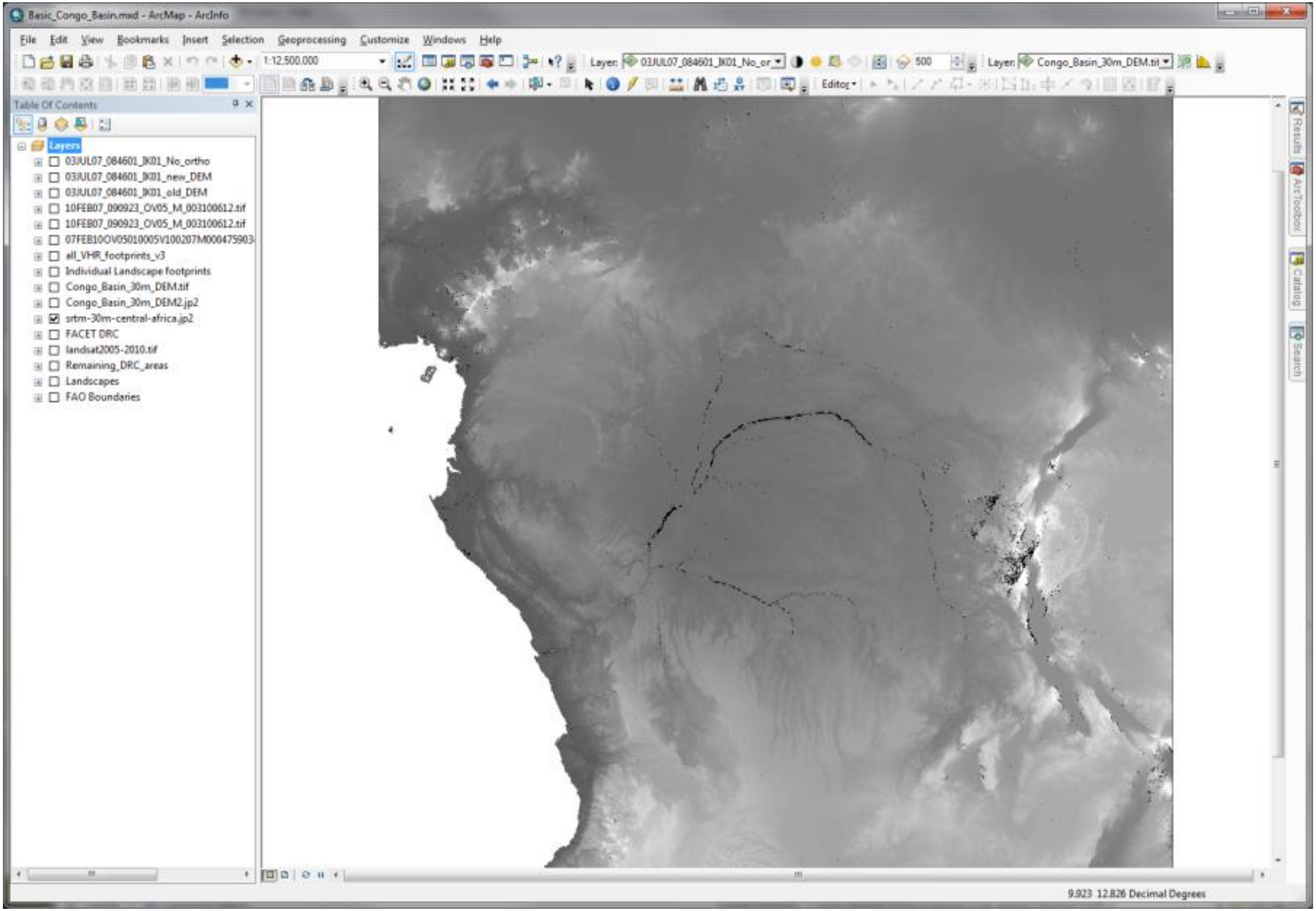
- We have adapted the scripts to work on the Linux platform. Natively they rely on the OSGEO GDAL and Python Bindings in a windows environment.

- Great collegial support from **Claire Porter of PGC @ UMN**

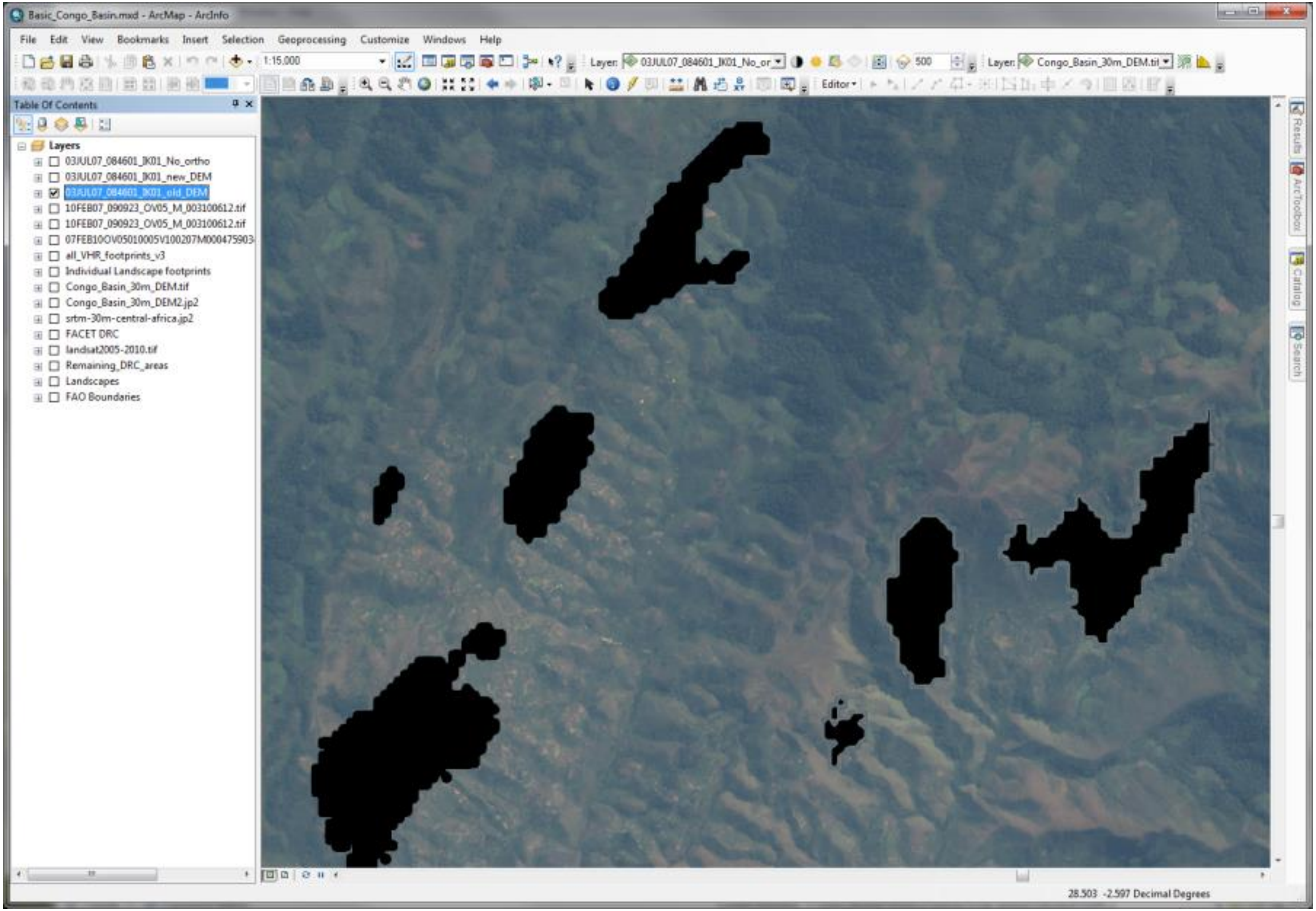
DEM Acquisitions

- For the orthorectifcation process a suitable DEM is required.
- For CARPE, we acquired a restricted 30m Central Africa SRTM DEM and repaired areas of missing data with data from ASTER GDEM V2 tiles.
- For external projects requesting our assistance, we use a DEM provided by the requesting project, however we are able to acquire, build, and in some cases repair a DEM for accurate orthorectification if needed.
- Within the U.S. a 10m NED can usually be acquired through the USGS, outside the U.S. a 30m DEM can be build from several ASTER Global Digital Elevation Model Version 2 (GDEM V2) tiles.

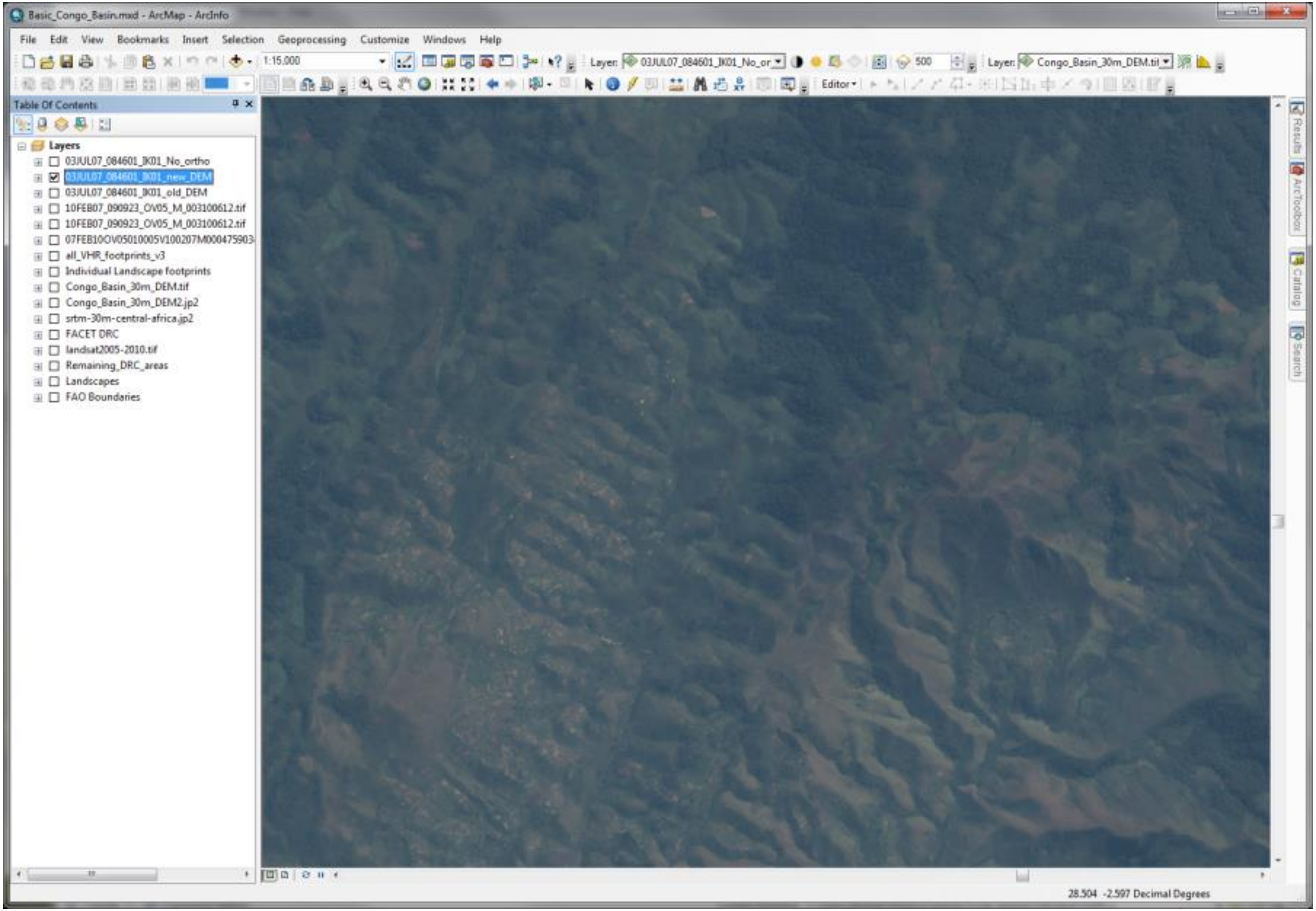
Uncorrected 30m restricted SRTM DEM – Central Africa



Orthorectification with a standard SRTM DEM results in holes



ASTER-corrected 30m SRTM DEM orthorectified image



TOA Radiance and TOA Reflectance Calibration

- Ikonos-1, Quickbird-2, Woldview-2 calibrated using IDL scripts provided by Andrea Baraldi and adapted to our environment.

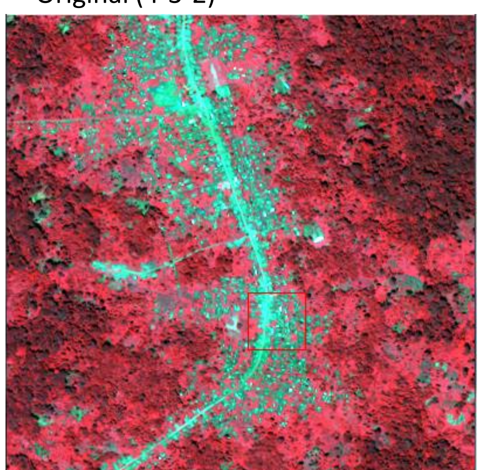
- Orbview-5/GeoEye-1 calibrator structure provided by Andrea Baraldi, and modified to Orbview-5/GeoEye-1 by Brian Barker.
  - Through direct contact with GeoEye engineers and assistance from Andrea Baraldi, we were able to identify the correct OV05/GE01 exo-atmospheric irradiance and band bias values needed.
  - In addition, Brian Barker was able to identify for the GeoEye Engineers a time period where their product was incorrectly writing the irradiance and band bias values within the metadata.
  - The calibrator was adapted to OV5/GE1

SIAM™ Spectral Stratification

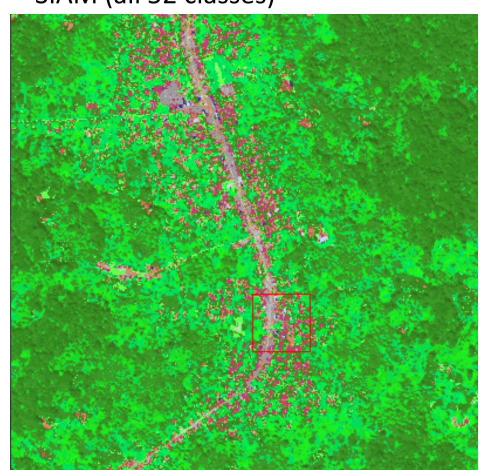
- Developed script to run SIAM™ in batch on a directory of images for CARPE/Congo Basin.
- Once images are brought to TOA Reflectance we are able to run them through the unsupervised automatic spectral rule classifier Satellite Image Automatic Mapper (SIAM™) by Andrea Baraldi, which outputs maps classified and labeled in 52 spectral classes.
- We can then regroup those classes in order to obtain a specific land cover classification and differentiate certain areas such as rural complex vs. intact forest.

Original (3-2-1)

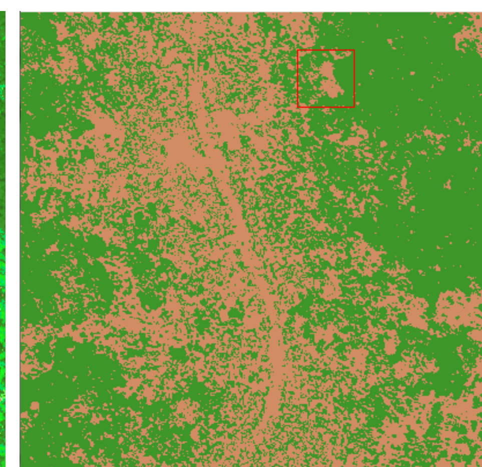
Original (4-3-2)



SIAM (all 52 classes)



Manual expert interpretation
and class grouping:
Rural Complex vs. Intact Forest



Example of SIAM Stratification

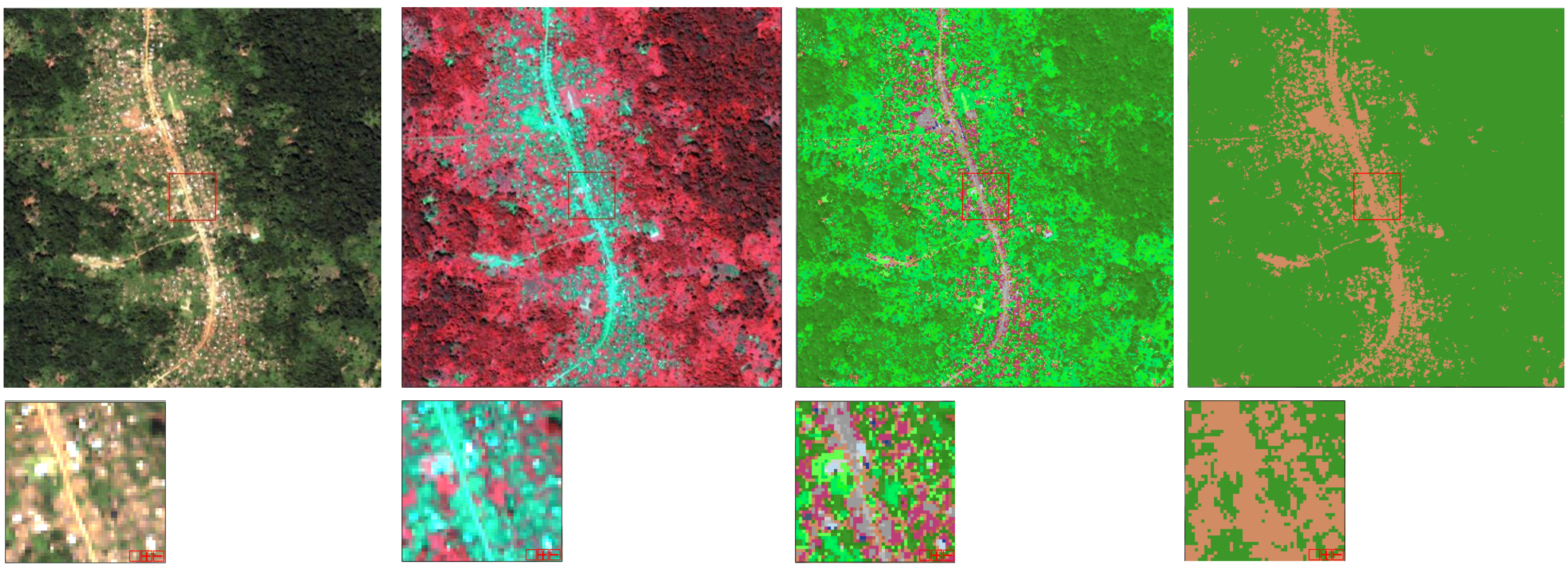
- Bare Ground vs. Vegetation Extraction

Original (3-2-1)

Original (4-3-2)

SIAM (all 52 classes)

Manual expert interpretation
and grouping:
Bare Ground vs. Vegetation



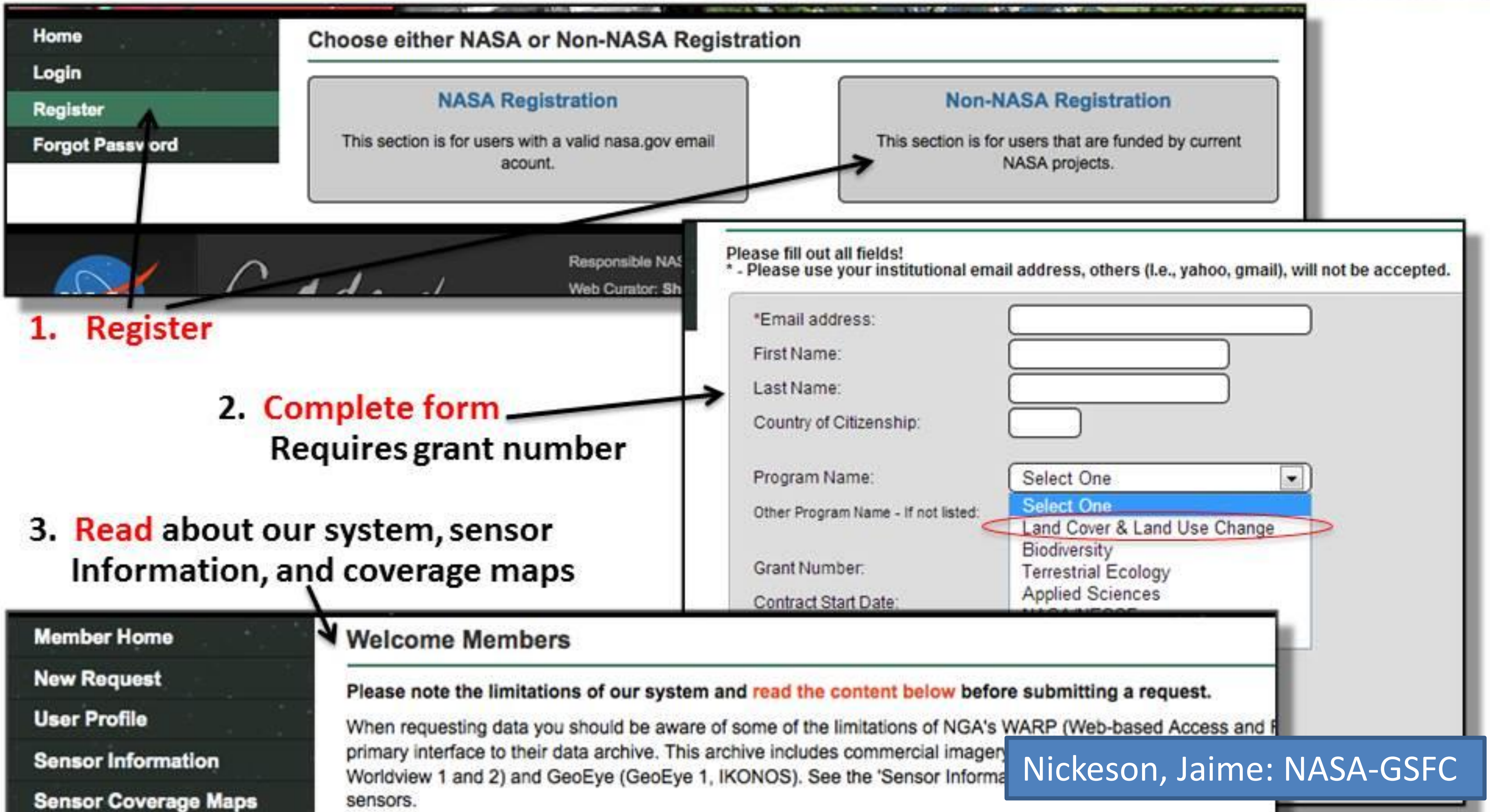
NASA-NGA Next View Data Access and Use

NASA discussions with NGA Ongoing re. data access for NASA Science (Tucker, Nickeson et al. GSFC - Berrick, Maiden HQ)

- **For data already acquired by US Government (largely NGA)**

- **Registration required & Data Use Agreement Form must be signed**

- **Data for scientific research**
    - **Restricted for use within NASA-funded projects only**
    - **No transfer to unaffiliated parties**
    - **No commercial use**



1. Register

2. Complete form
   Requires grant number

3. Read about our system, sensor Information, and coverage maps

Nickeson, Jaime: NASA-GSFC

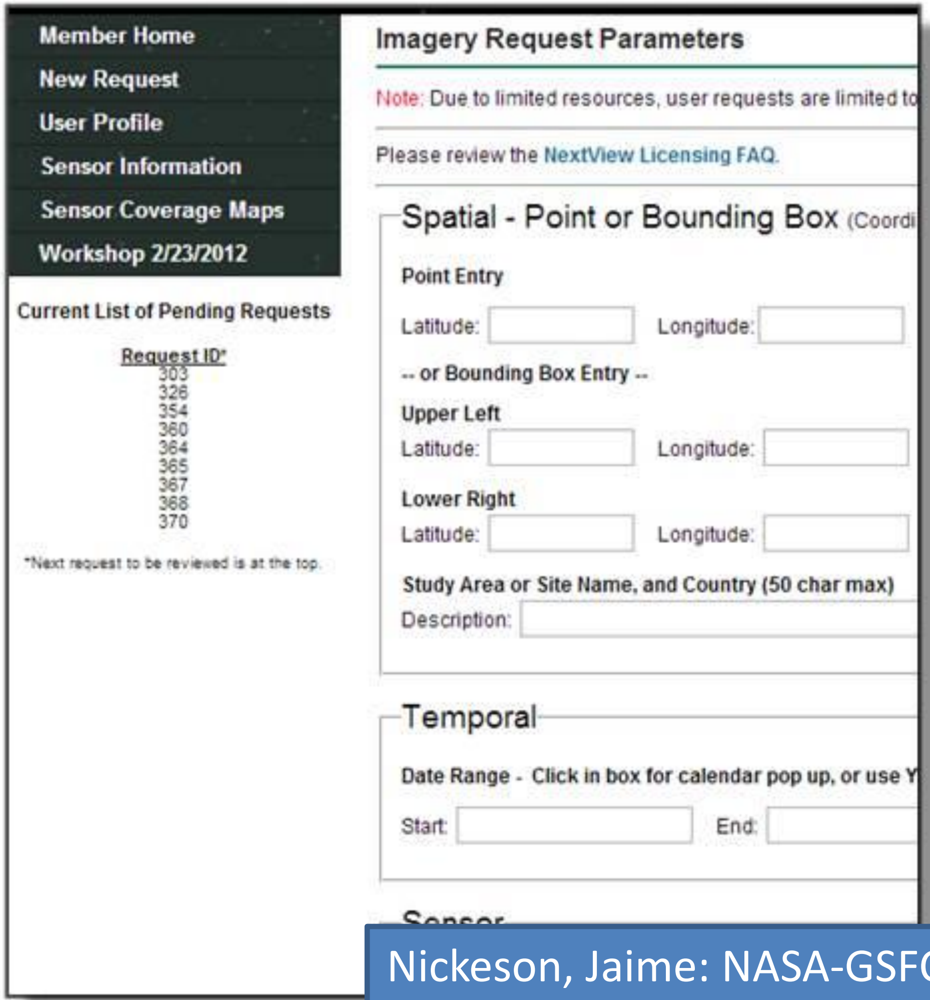
Submit a Request

After verifying your User Profile, you can submit an imagery request.

Orders generally take 1-2 weeks to fill, depending upon the order type and backlog.

Once received, data are placed online and download instructions are provided.

Data must be kept secure with limited access and all users must be tracked.



Nickeson, Jaime: NASA-GSFC

Summary Hi Resn Data for LCLUC Research

- Fine Resn data opens up a new dimensions for LCLUC Research
- Hi-Resn Data are being ordered by LCLUC Community and starting to be used in a range of science applications
- Anticipating considerable growth in demand for data
- Facility at GSFC currently providing data ordering/brokering services – effort needs to be right-sized for the demand
- Also need a suite of additional Data Services and Tools for Analysis (spectral and textual) to reduce redundancy and burden on users (especially for large orders - data bricks)
- LCLUC Program should continue to promote and support hi-resolution data analysis for its projects