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Geospatial Data Analysis Corporation

"Advanced Technology Solutions for Geospatial Applications"

www.gdacorp.com

The Use of ResourceSat AWiFS Imagery for Regional Analysis

ASRC-MS / USDA-FAS ResourceSat Seminar
October 20, 2008

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Content

- **IRS-P6 sensors and AWiFS Pre-Processing**
- **Regional Crop Analysis**
- **Generation and Distribution of Regional Datasets**

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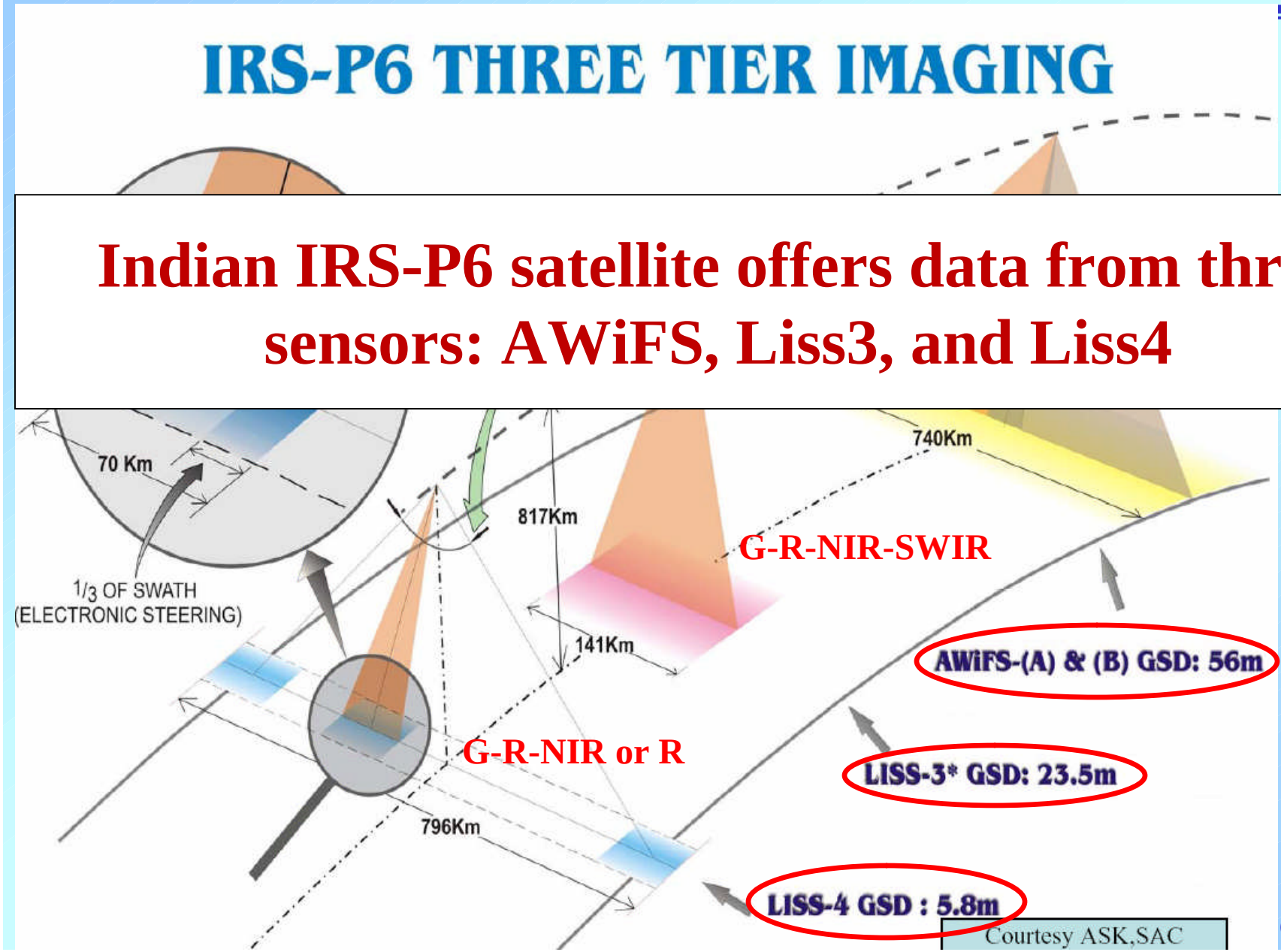
IRS-P6 Sensors



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IRS P6-AWiFS Imagery

- 5-day revisit
- Key spectral bands for vegetation and ag mapping
- Large area coverage / Regional footprint
- Medium resolution
- Data continuity / Operational
- Global coverage, Rapidly delivered
- Two other sensors acquiring data at the same time
- Access from one source
- No malfunctions

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IRS P6-AWiFS Imagery

- Variation of view elevation across the scene, from 90^{o} (nadir) to ~65^{o} (edge)
- Sensor – Ground distance on the scene edge is ~10% longer if compared to the distance for nadir location
- Variation across the scene in atmospheric transmittance along the view and solar paths
- Some degradation in pixel values from the nadir line to the edge of the scene
- The amount of degradation also varies among bands, increasing from visible to IR bands

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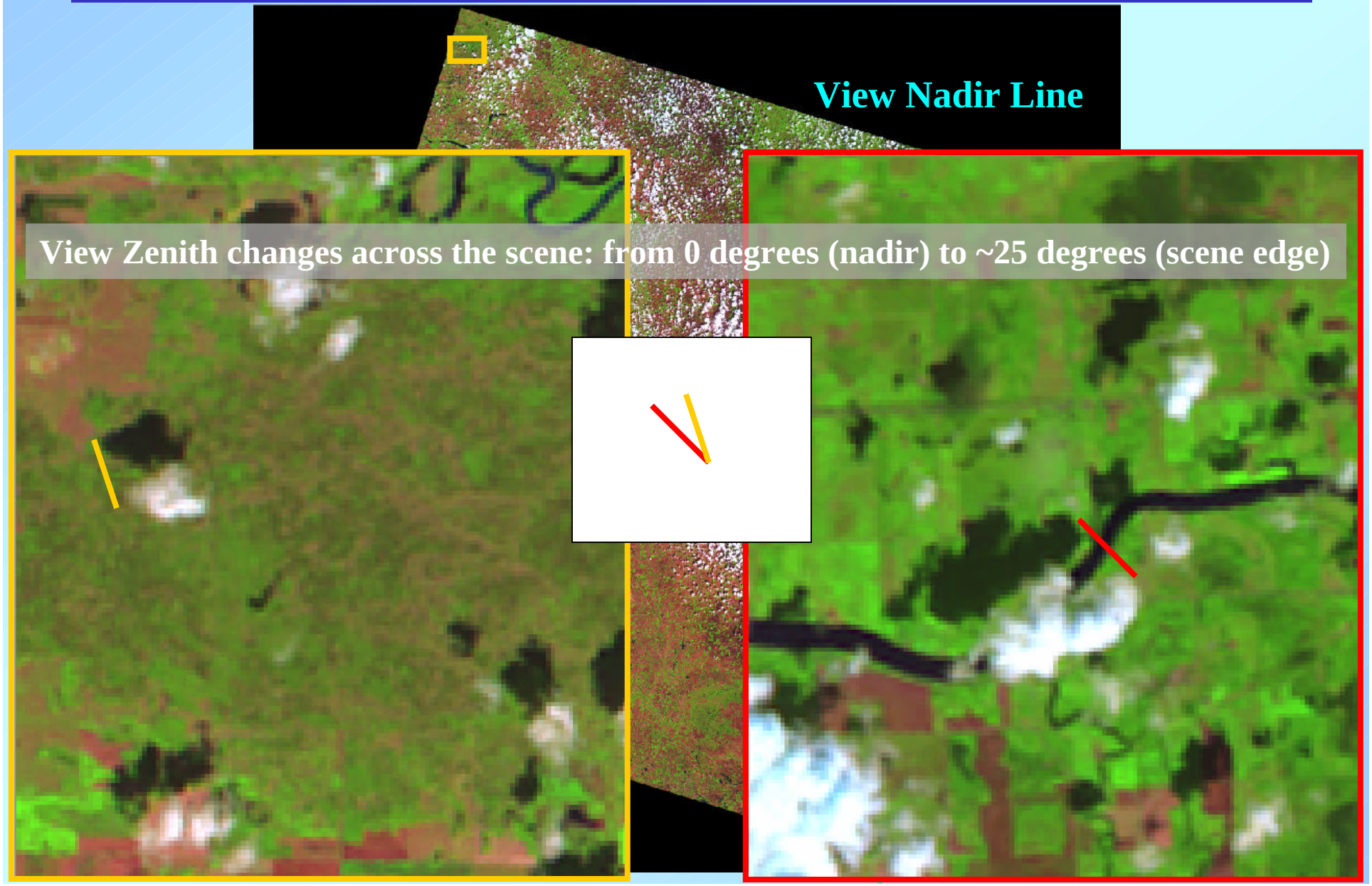
P6-AWiFS Geometry



Surface Reflectance

GDA Surface Reflectance Calibration:

- **Corrects for variations in view and solar geometry, Earth curvature, surface elevation, and atmospheric transmittance across the scene**
- **Calculates surface reflectance values assuming standard atmosphere properties**
- **Improves multi-sensor analysis / comparisons, change detection, knowledge-based classifications**
- **A General Equation is below:**

$$\rho = (\pi \bullet (L_\lambda - L_p) \bullet d^2) / (\cos(\Theta) \bullet E_0 \bullet T_z + E_d) \bullet T_v$$

ρ is surface reflectance,
L_λ is at-sensor spectral radiance,
L_p is path radiance,
d is earth-sun distance in astronomical units, varies according to the Julian day,
Θ is sun elevation,
E_o is mean per band solar spectral irradiance value,
E_d is diffuse sky irradiance,
T_z is atmospheric transmittance along the solar path,
T_v is atmospheric transmittance along the view path.

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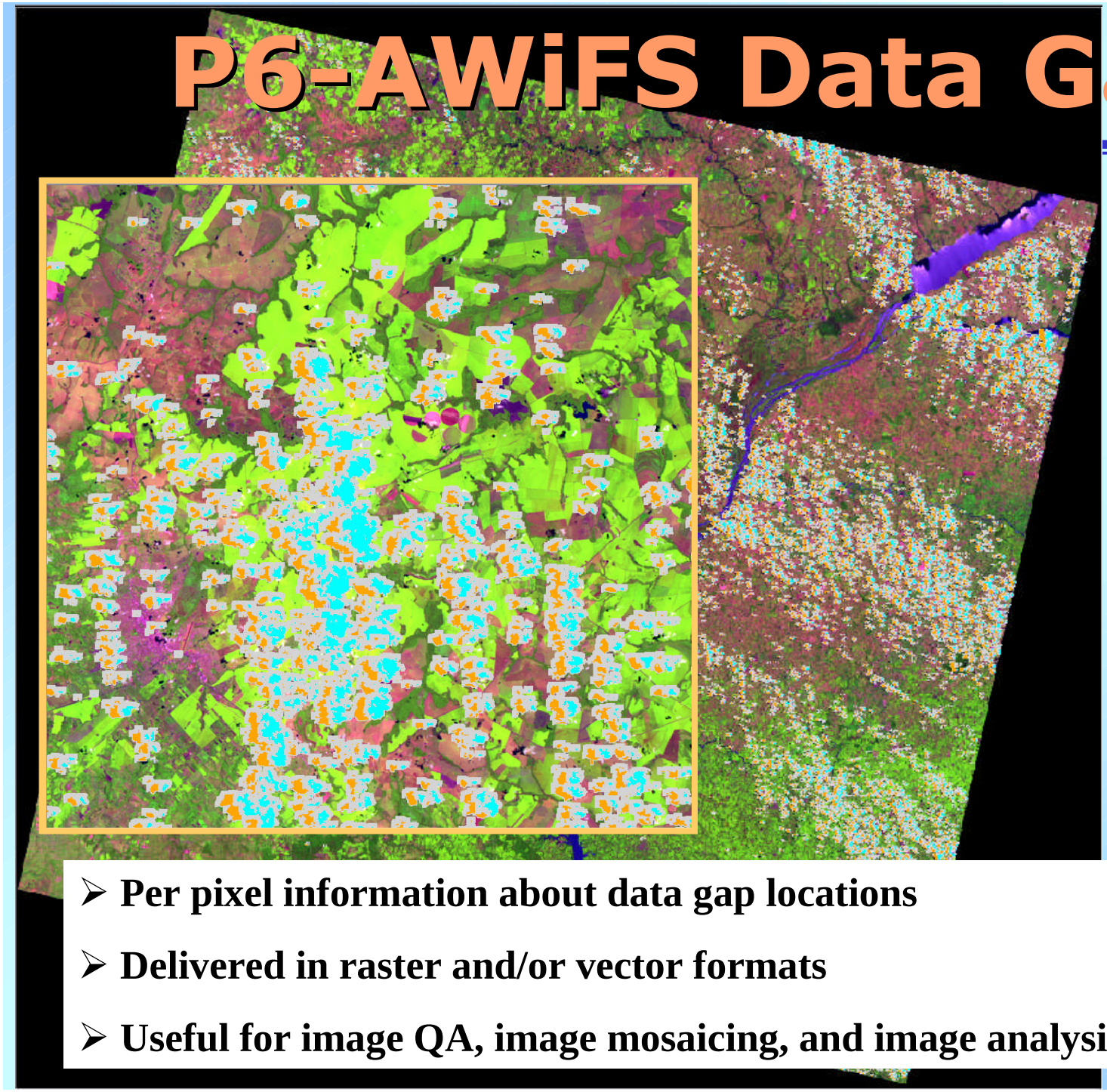
P6-AWiFS Data Gaps



Clouds

Cloud Shadows

Buffer Areas

- Per pixel information about data gap locations
- Delivered in raster and/or vector formats
- Useful for image QA, image mosaicing, and image analysis

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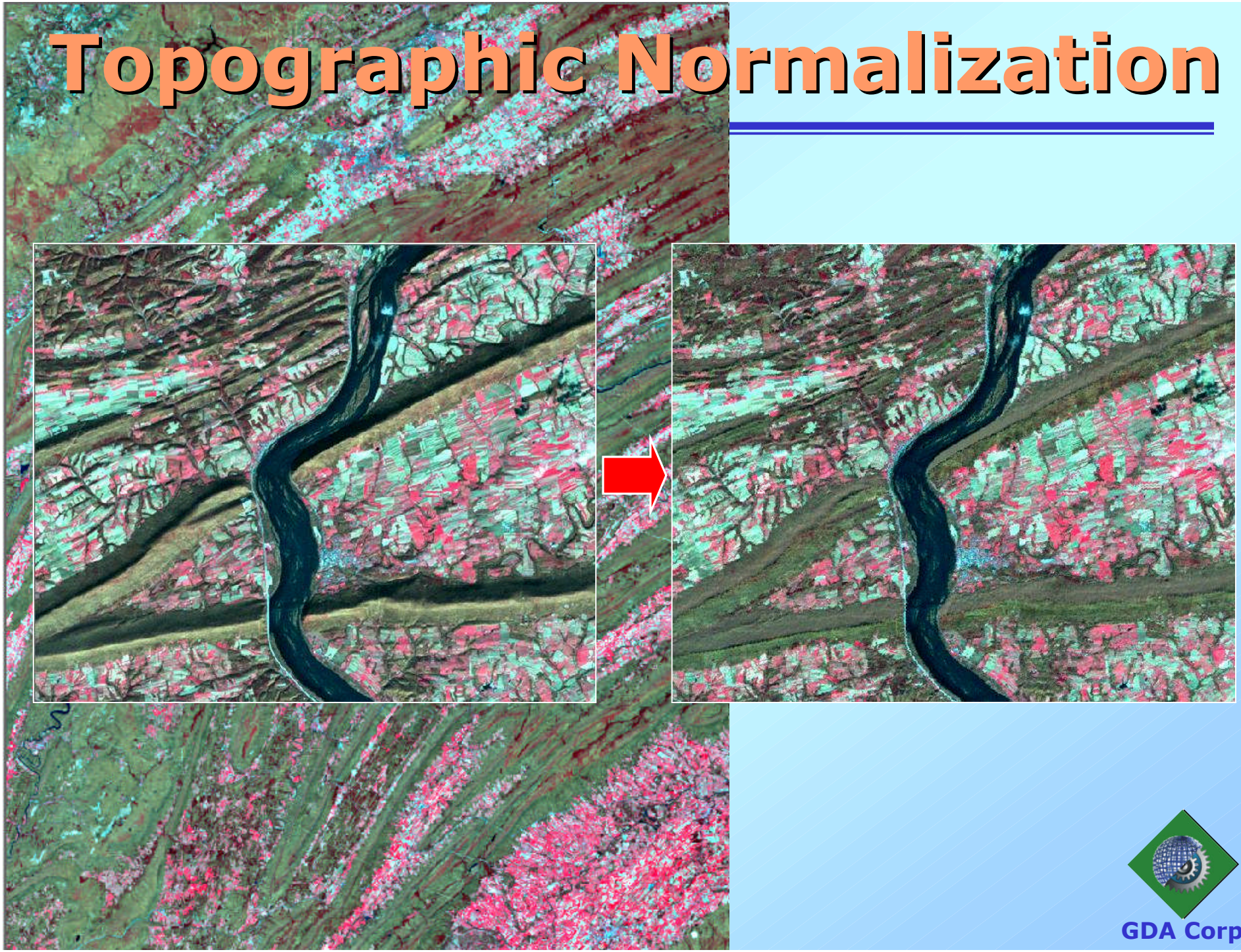
Topographic Normalization



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Regional Crop Analysis

Goal:

Rapidly, and with an acceptable level of accuracy, map crops of interest during the growing season for areas where *minimal or no information is available regarding actual conditions on the ground* while being able to rely on a limited set of imagery

Approach:

Relies on multiple lines of evidence, including:

- *** forecasts of crop types and crop areas from historical crop statistics,**
- *** historical / expected crop phenology / crop calendar,**
- *** expected spectral properties of crops and spatial properties of ag fields,**
- *** evidence from the scene**

Employs Bayesian probabilistic, weight of evidence classification

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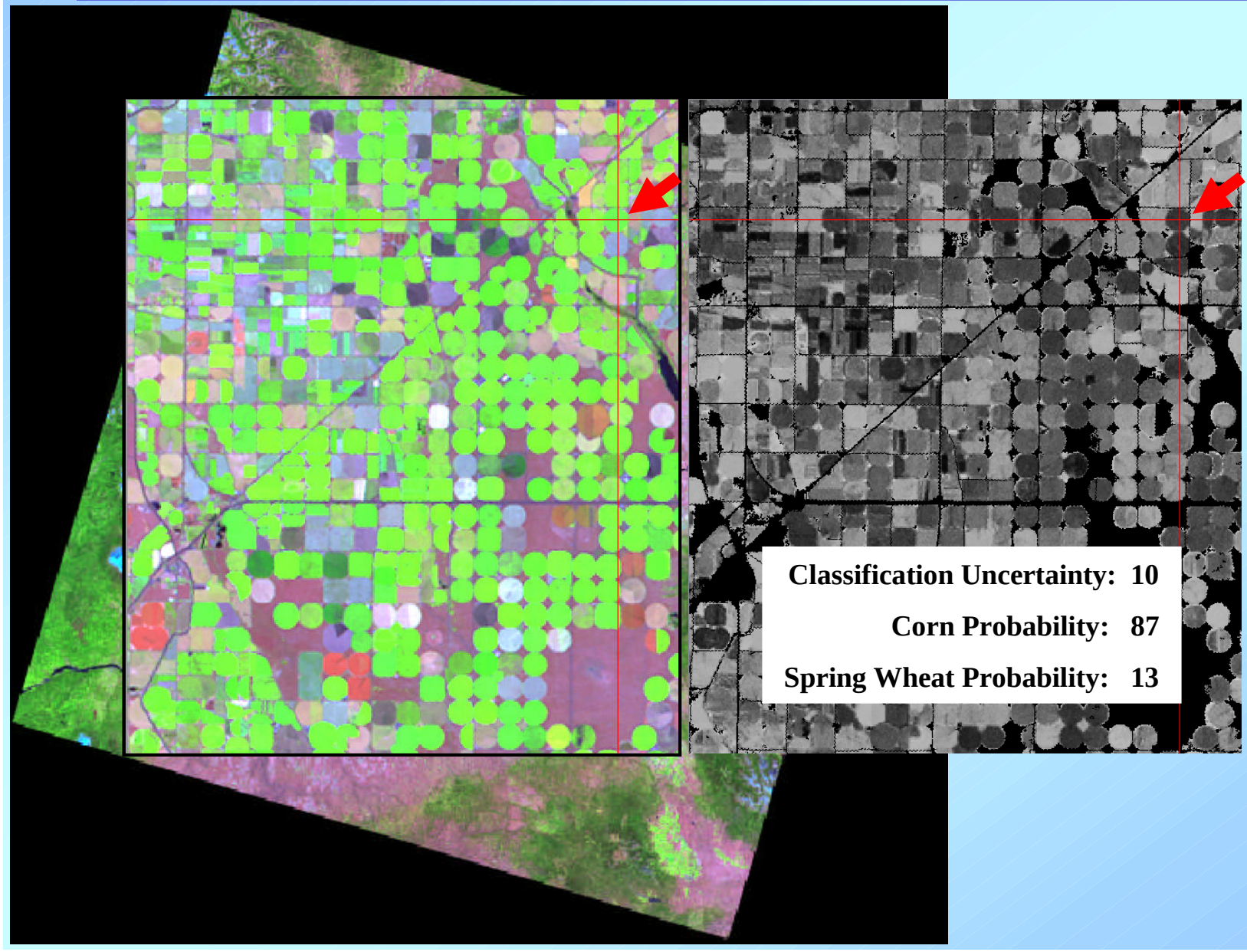
Regional Crop Analysis



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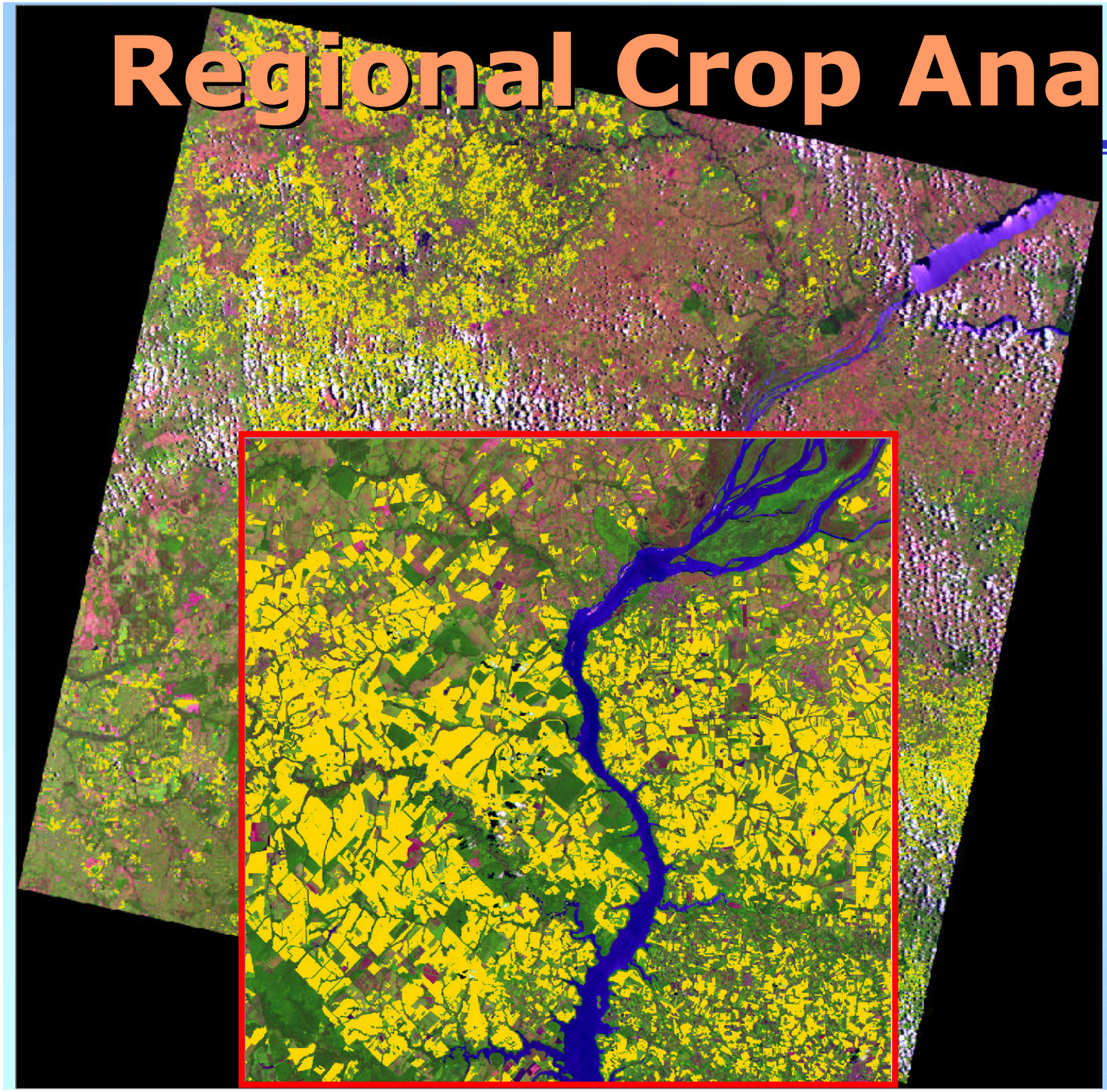
Regional Crop Analysis



P6-AWiFS:
02/03/2008
path 322
row 93
quad D
Brazil/Paraguay

soybeans

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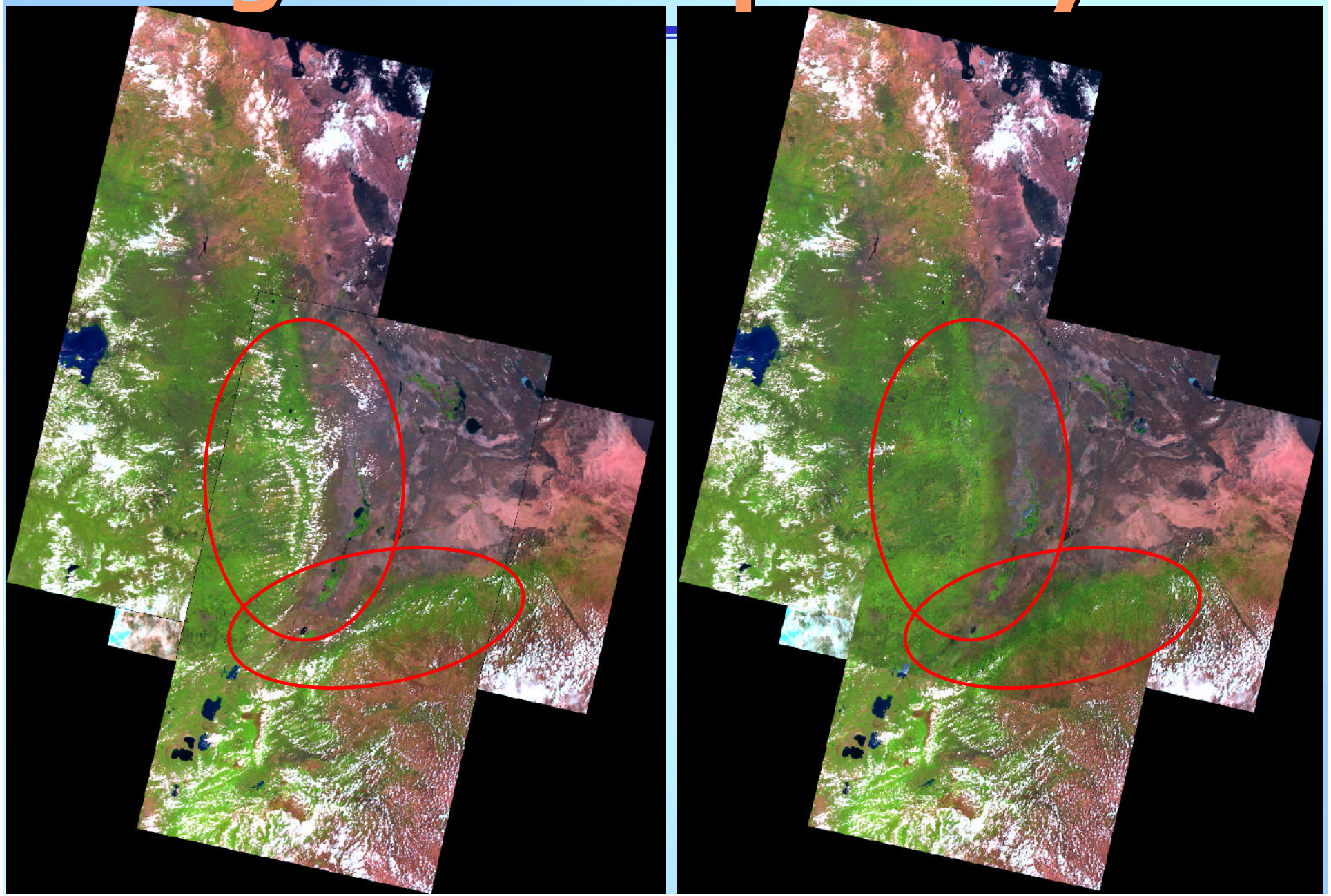
Regional Crop Analysis



Corn and Wheat Areas
ETHIOPIA: Aug-Sept 2008

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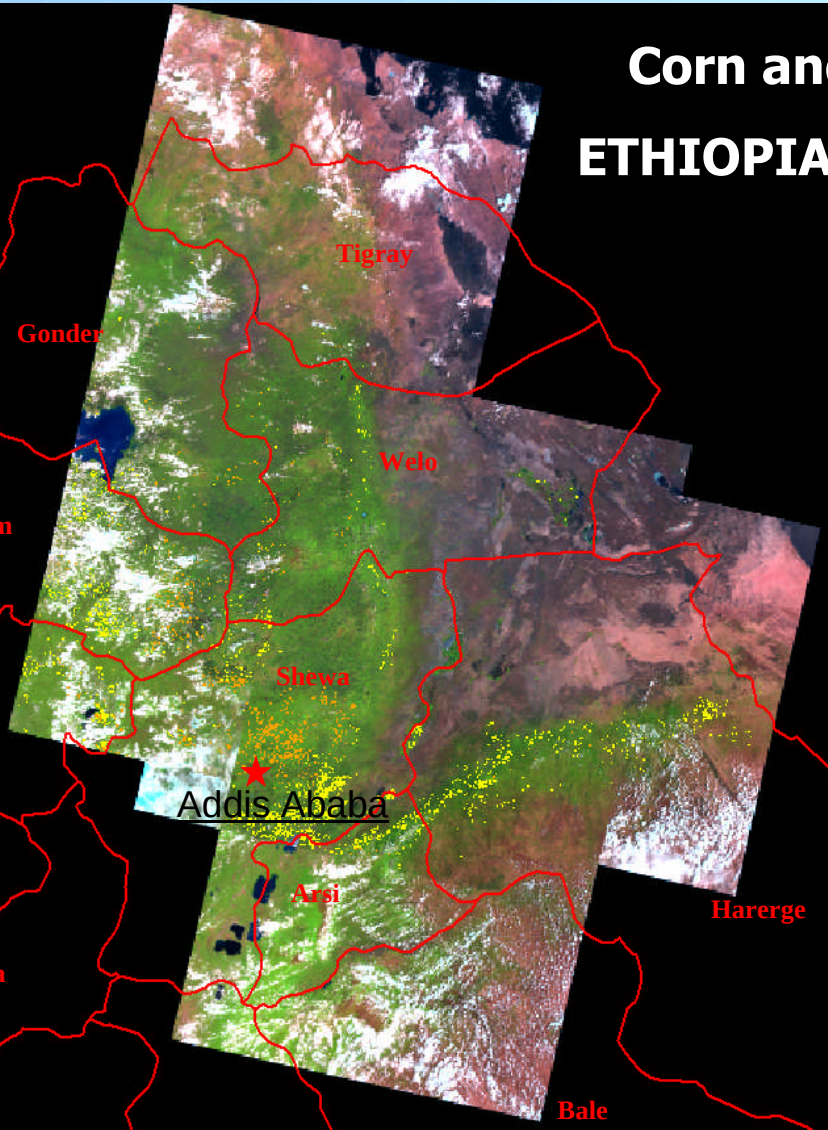

Tigray
Gonder
Welo
Gojam
Shewa
Welega
Addis Ababa
Ilubabor
Arsi
Harerge
Kefa
Bale
Gamo Gofa
Sidamo

corn
wheat
admin boundaries

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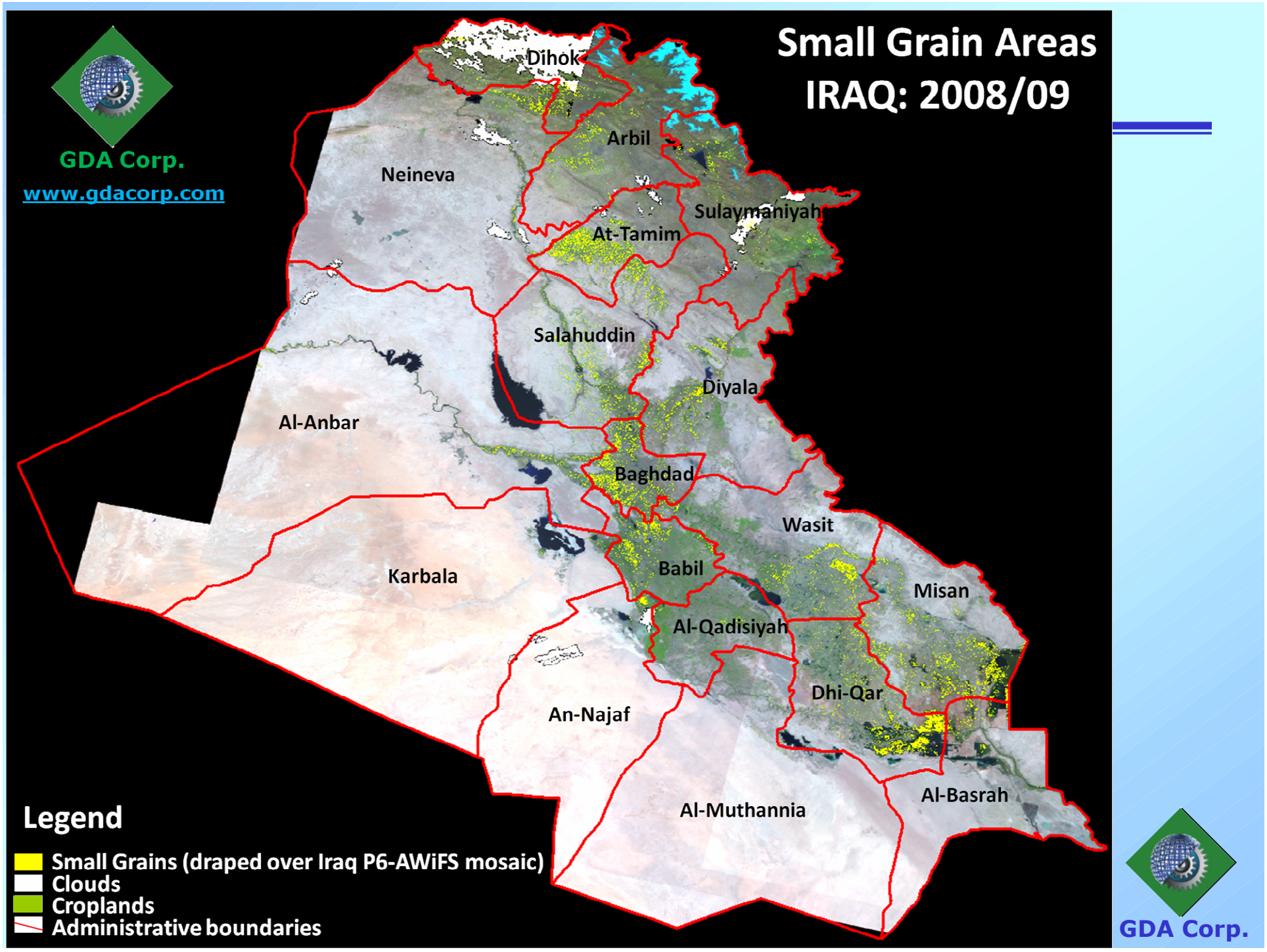
Small Grain Areas
IRAQ: 2008/09
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Dihok
Arbil
Neineva
Sulaymaniyah
At-Tamim
Salahuddin
Diyala
Al-Anbar
Baghdad
Wasit
Babil
Misan
Karbala
Al-Qadisiyah
Dhi-Qar
An-Najaf
Al-Basrah
Al-Muthannia
Legend
Small Grains (draped over Iraq P6-AWiFS mosaic)
Clouds
Croplands
Administrative boundaries
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Regional Crop Analysis

Validation:

- **Ground Truthing by USDA FAS crop analysts: visual observations and GPS photographs**
- **High resolution imagery confirm cropland locations and field boundaries (thank you, Google Earth!)**
- **Evaluation by local experts**
- **Comparisons to published maps and statistics**

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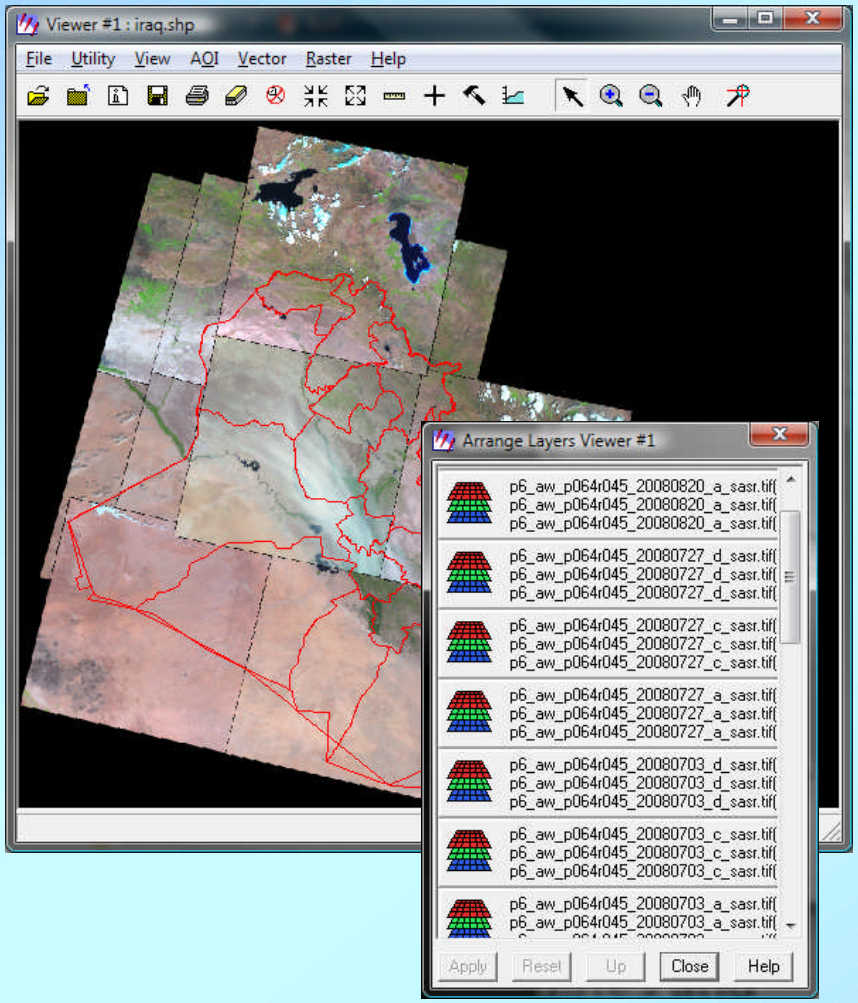
Regional Datasets: Generation & Distribution



GDA works with USDA FAS and ASRC-MS to develop operational procedures for generation and distribution over the web of regional imagery and derived datasets

The USDA would like to:

- simplify management of multiple individual images and derived products
- improve assess to the data
- embed metadata into the imagery and
- maintain relational information about the data source(s) in derived products

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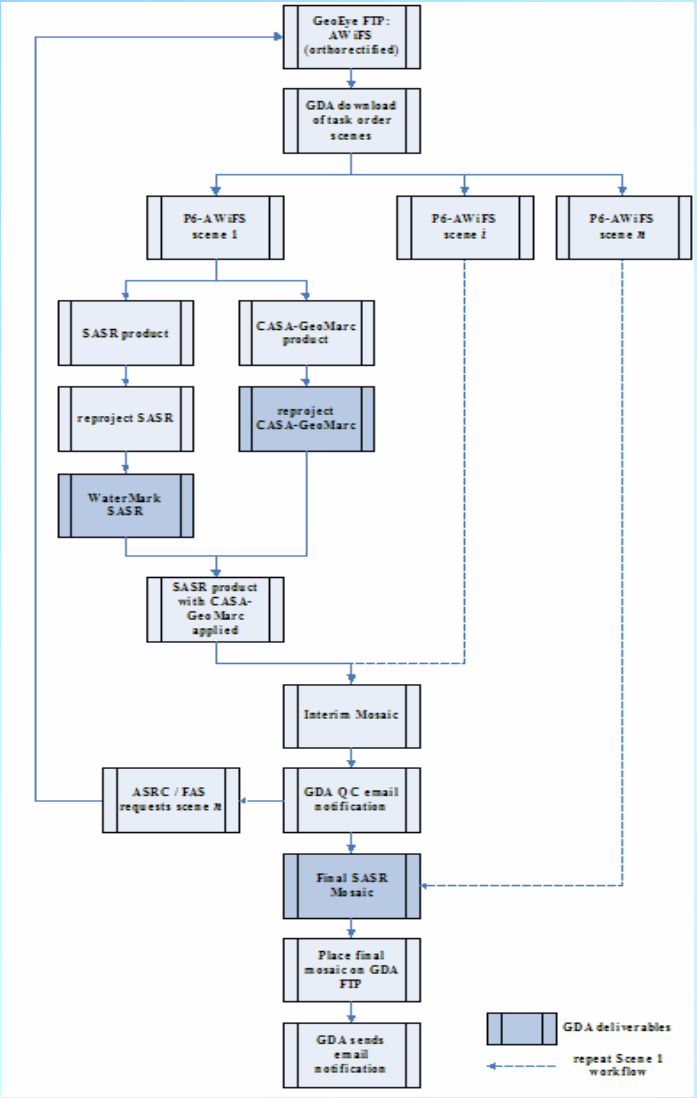
Regional Datasets: Generation & Distribution



GDA has developed procedures and a workflow which incorporate GDA image processing technology and GSC GeoMarc watermarking software to generate regional data mosaics with per pixel embedded metadata

The solution simplifies access to the data, reduces data volume, and, through the data watermarking, allows for secure data distribution

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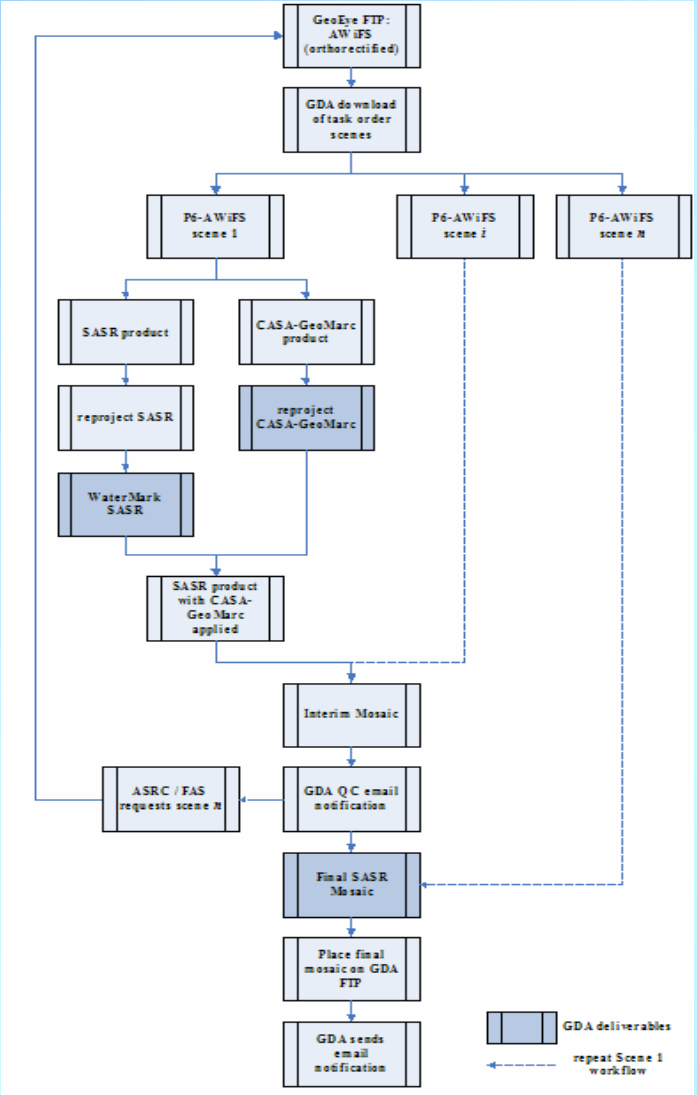
Regional Datasets: Generation & Distribution



GDA procedures allow for operational collection and processing of the imagery and for further mosaicing of the imagery as well as derived products and for mosaic updating

Individual image processing includes:

- Calibration to the surface reflectances
- Reprojection to a common projection
- Watermarking of each band of each image
- Detection and masking out of cloud / data gap areas

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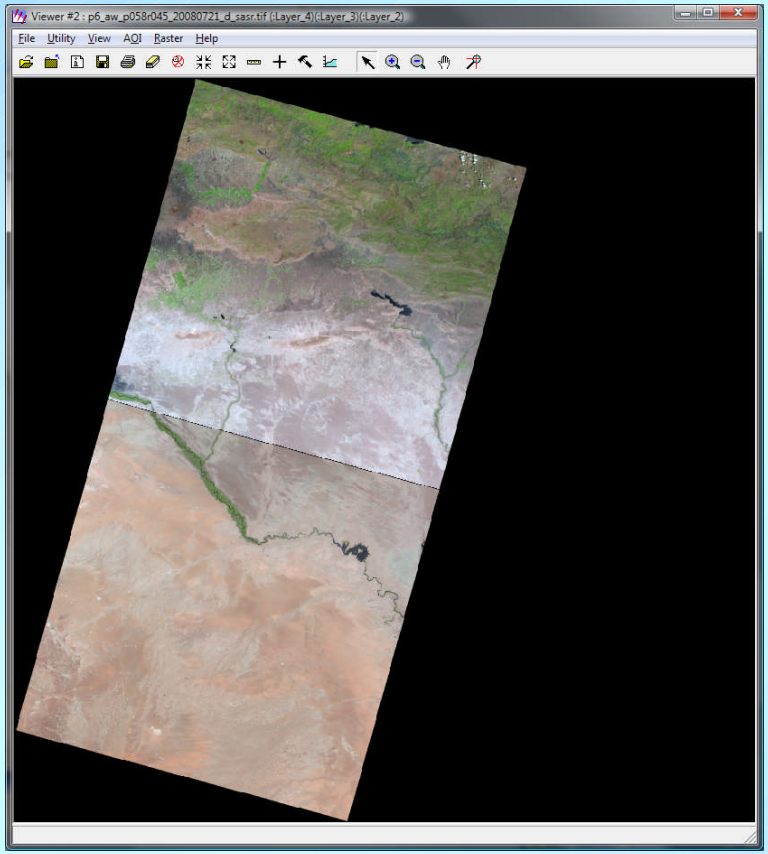
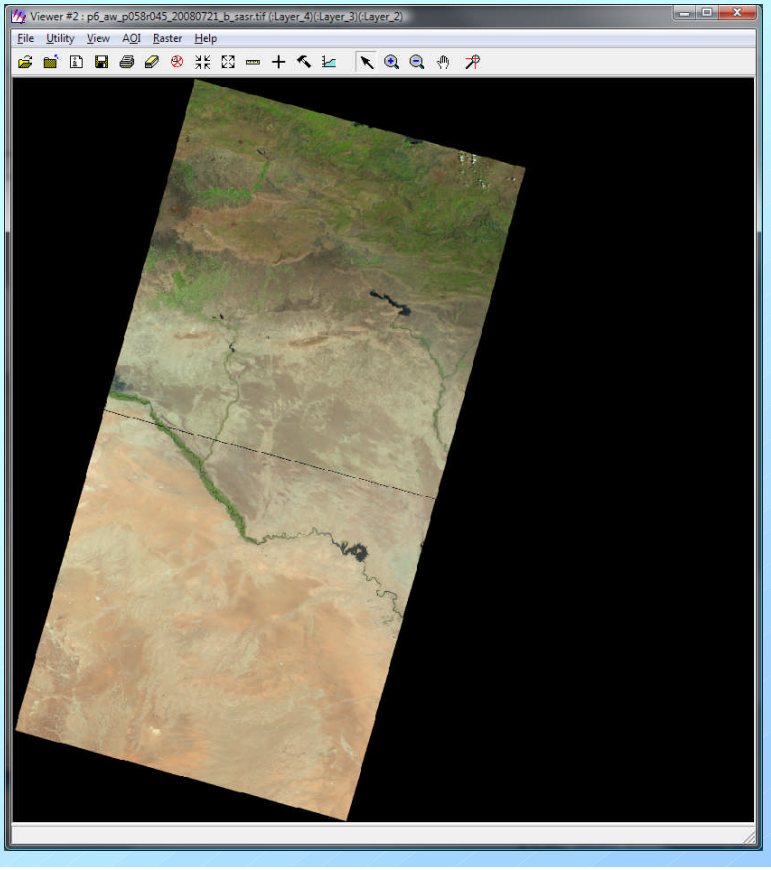
Regional Datasets: Generation & Distribution

Calibrating the images to surface reflectance minimizes the differences between images, as images acquired at different times and locations may vary spectrally





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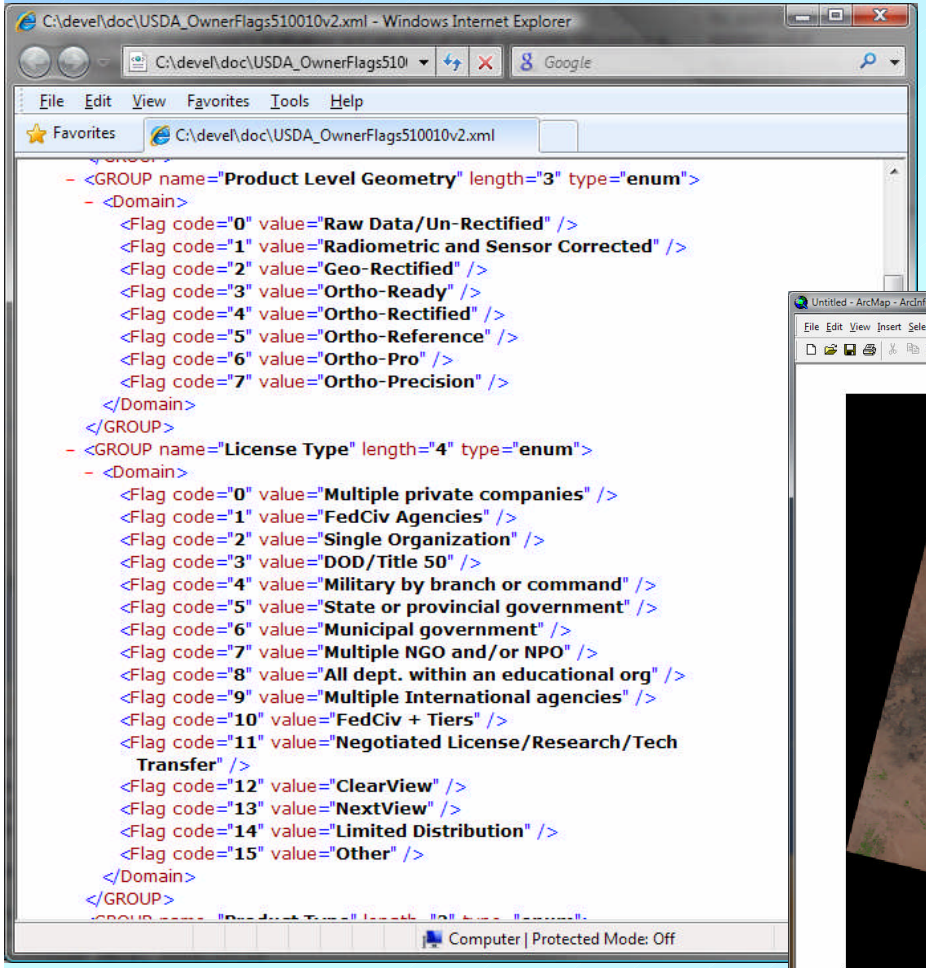
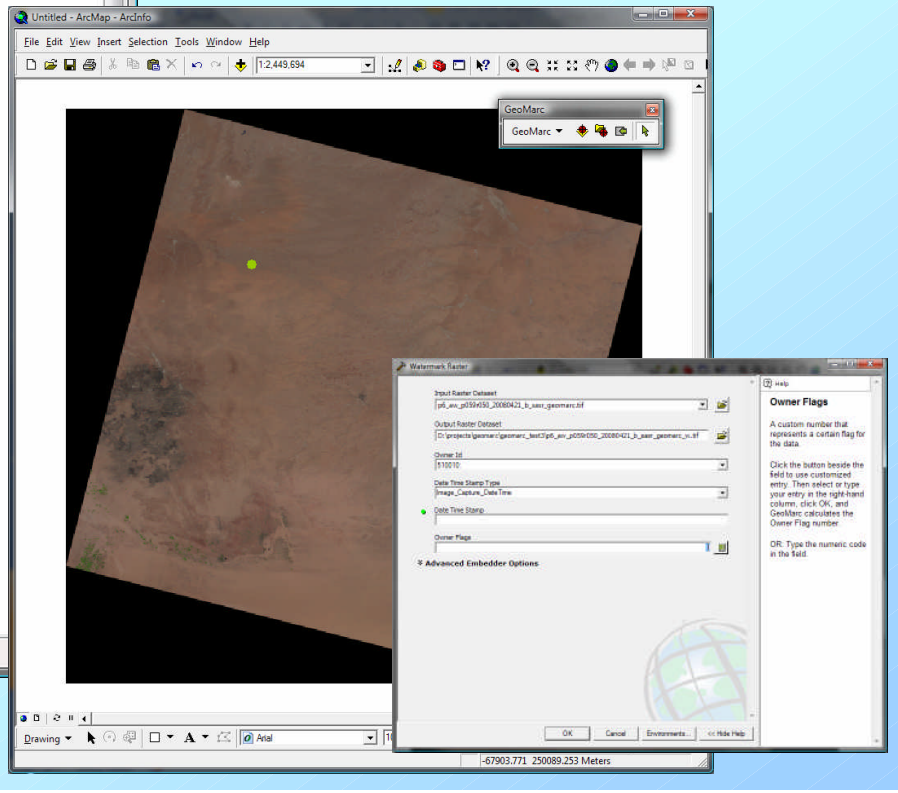
Regional Datasets: Generation & Distribution



Use of GeoMarc digital watermarking technology from GCS Research allows to embed the relevant metadata directly into the image and to preserve it in the mosaic



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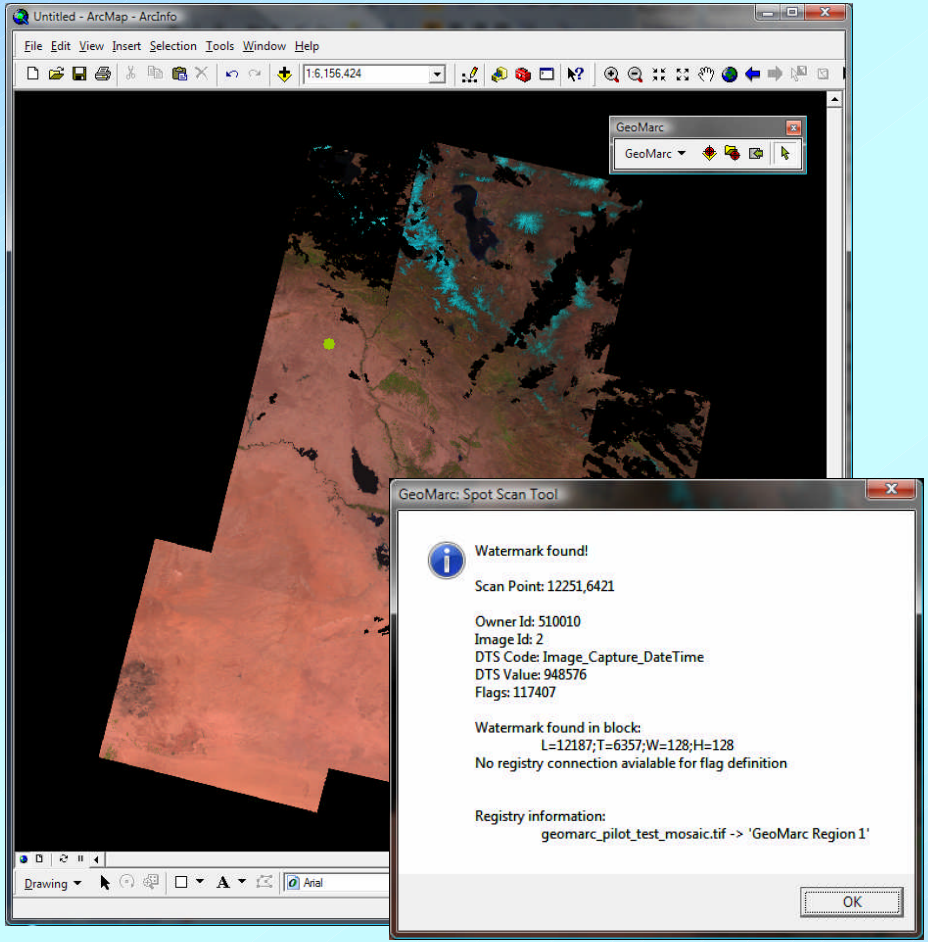
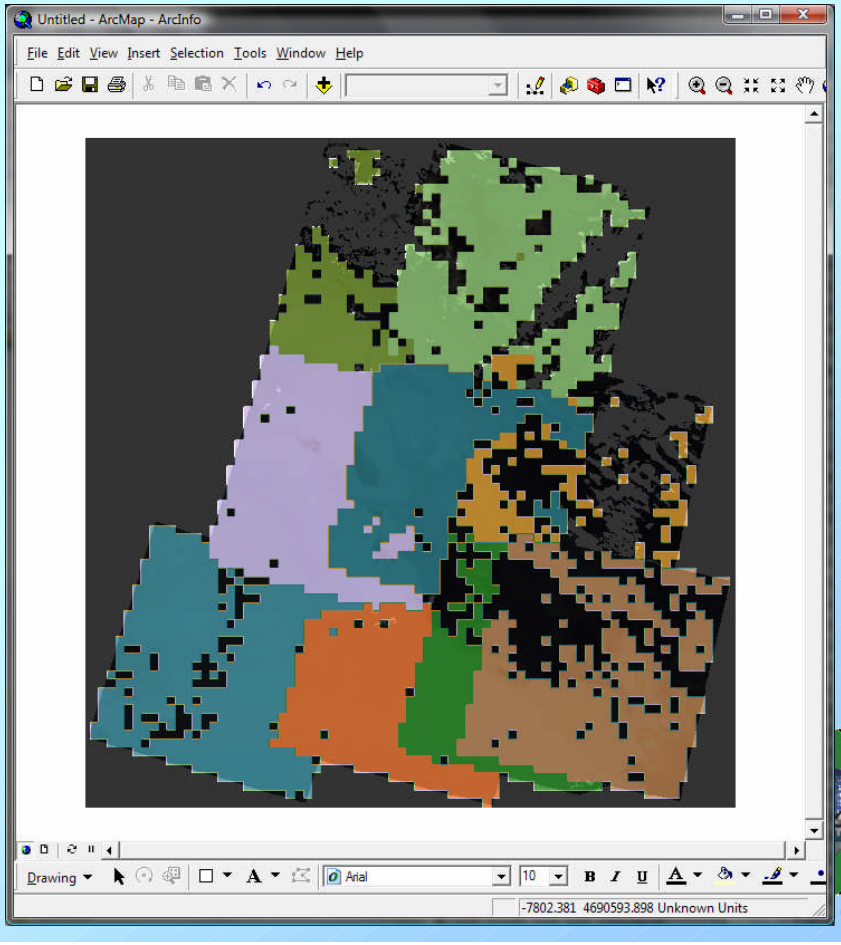
Regional Datasets: Generation & Distribution

The embedded data can then be retrieved from any point in the mosaic





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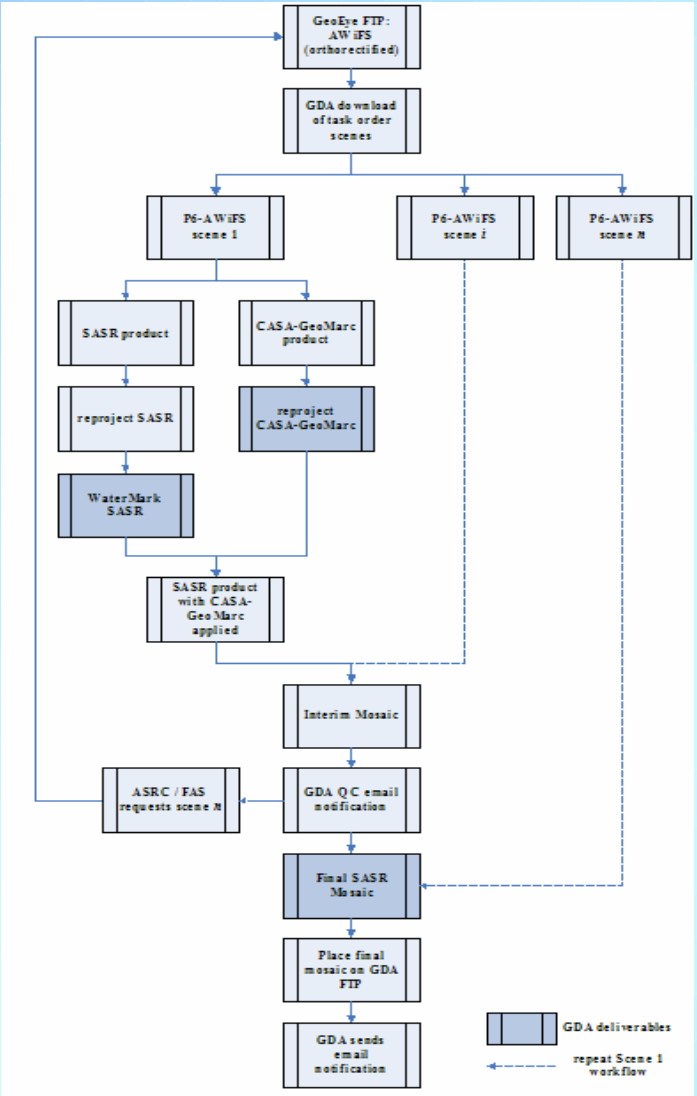
Regional Datasets: Generation & Distribution



GDA processing flow is designed to maximize the quality of the final regional mosaic

Mosaic processing includes:

- Sorting processed images so that images closest to the mean date for the collection are given highest priority / value
- Combining all of the images into a single mosaic
- Collecting, processing, and introducing of additional scenes if necessary
- Preserving image reflectances and watermarking -- No feathering, averaging, *etc*. is done

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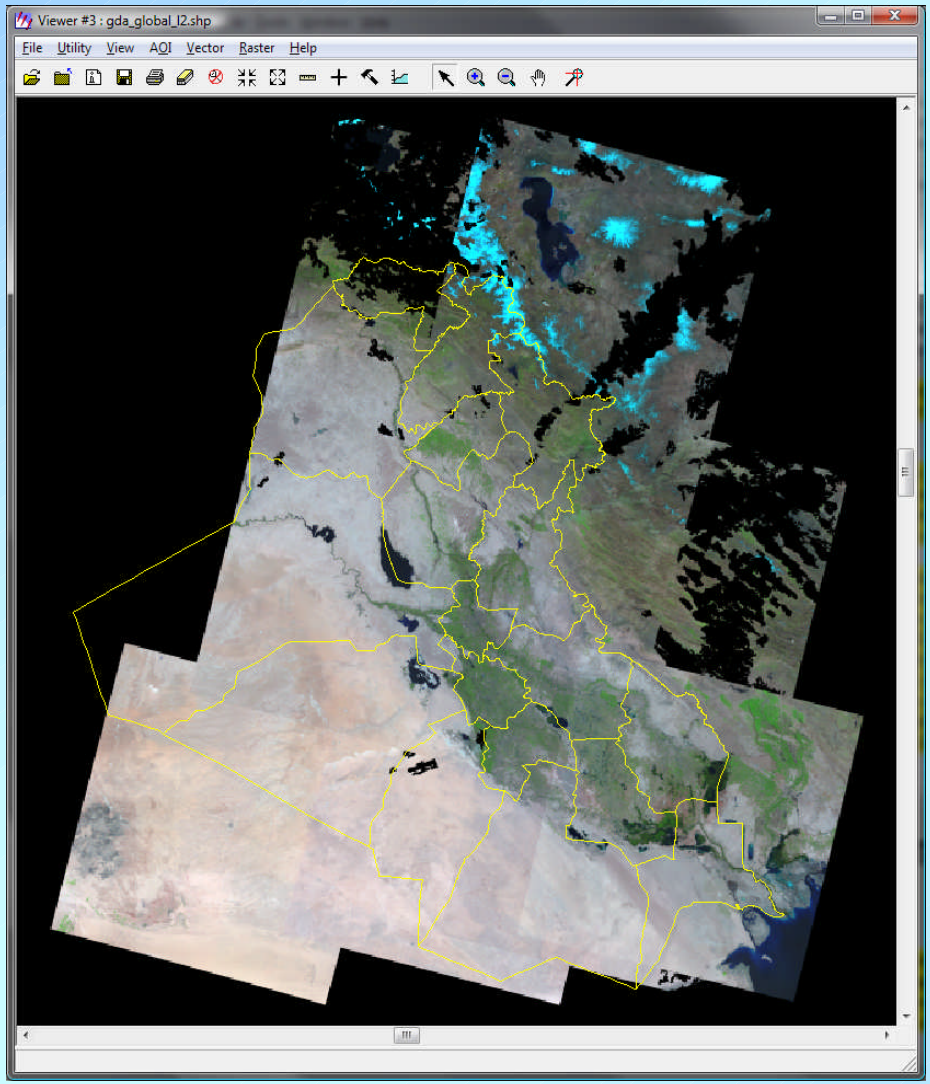
Regional Datasets: Generation & Distribution



The final mosaic provides USDA FAS with a spatially complete regional dataset for a predefined (and prioritized) time-window where each pixel is calibrated to the surface reflectance and contains an embedded metadata

The image mosaic serves as the unifying background to which derived datasets can be related to through the GeoMarc registry

The mosaics can be distributed to the users while preserving licensing, metadata, and inter-mosaic relational information

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Acknowledgements

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GDA Corp.

GDA Contact Information

GDA Corp.

200 Innovation Blvd.

Suite 234

State College, PA 16803

T: 814-237-4060

F: 814-689-3375

E: info@gdacorp.com

www.gdacorp.com

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THANK YOU!

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