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Developing a Consistent Landsat Data Set from MSS, TM/ETM+, and International Data Sources for Land Cover Change Detection

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Project Objectives

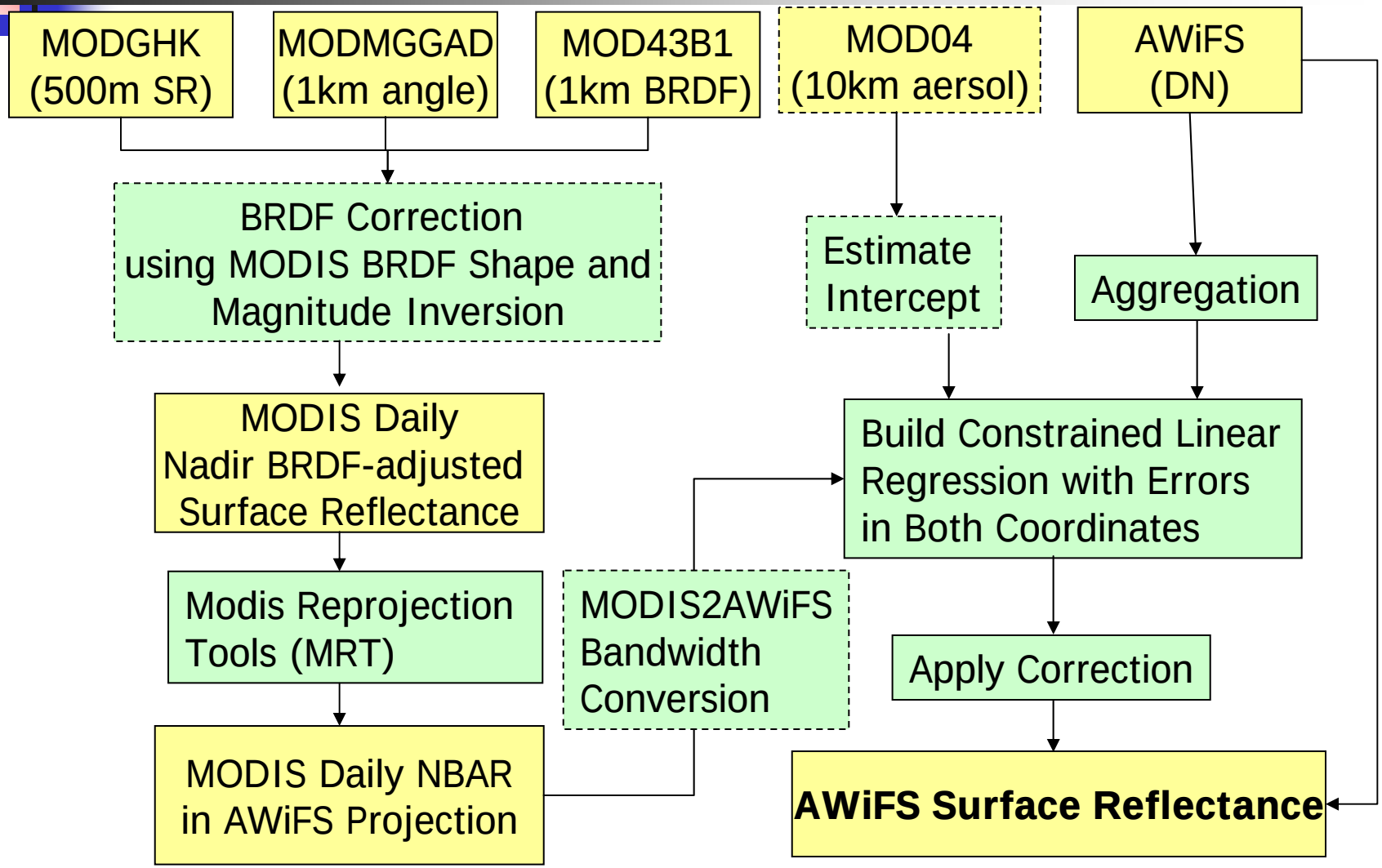
- Process Landsat and foreign Landsat-like data sources into a consistent orthorectified surface reflectance data set
- Use consistent surface reflectance data set for land cover change detection
- Simulate Landsat surface reflectance using MODIS and Landsat data
- Evaluate foreign Landsat-like data for filling possible Landsat data gap

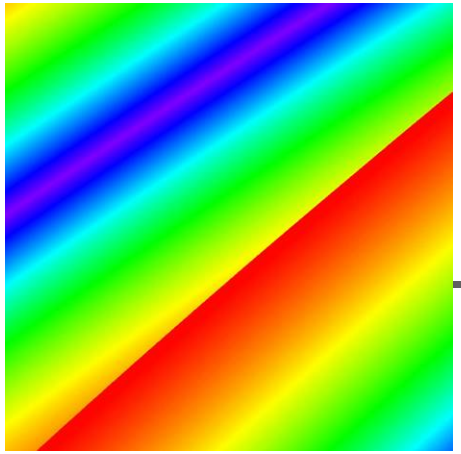
Activities

- 2006.09 - 2007. 01
  - Developed orthorectification module for Landsat and foreign Landsat-like data using previous orthorectified image (e.g., GeoCover data set) as reference
  - Produced daily Landsat surface reflectance by fusing MODIS and Landsat data
  - Tested BRDF/phenology corrected surface reflectance for ASTER data using MODIS surface reflectance as reference

- 2007.01 - 2007.06
  - Developed relative atmosphere correction approach for AWiFS data and started to evaluate product quality
  - Started collaboration on the data fusion test using MODIS and Landsat land surface temperature (with Dr. Anderson at USDA)
  - Started on land cover change detection and built collaboration on the study of urbanization and its impact to the regional climate change (with Dr. Wu at NASA GSFC)
  - Worked on the relative atmosphere correction for MSS data

Activity I: Relative Atmosphere Correction Using MODIS Products





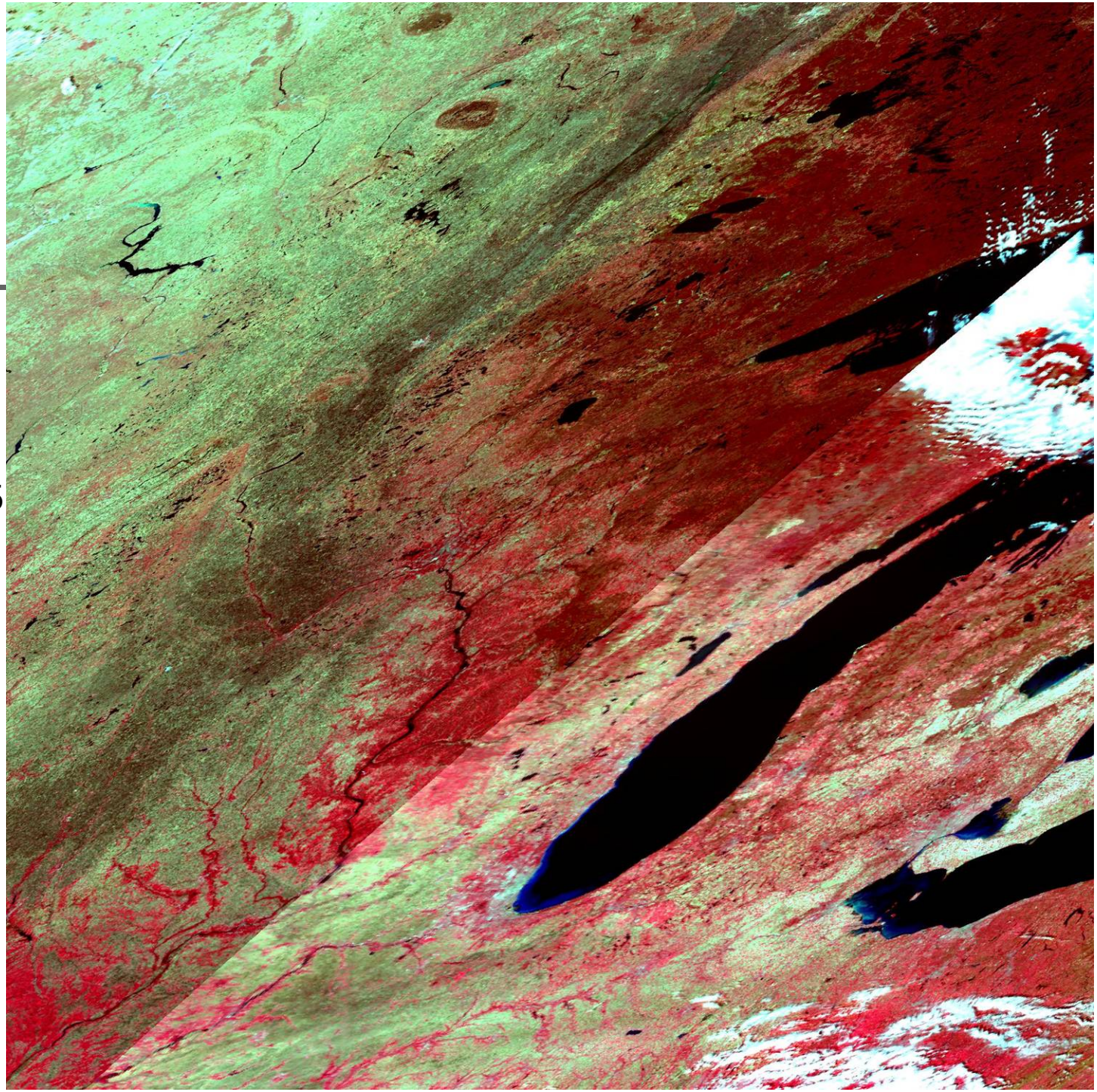
View Zenith Angle

0 32 65

MODIS Daily Surface Reflectance 500m resolution (MOD09GHK)

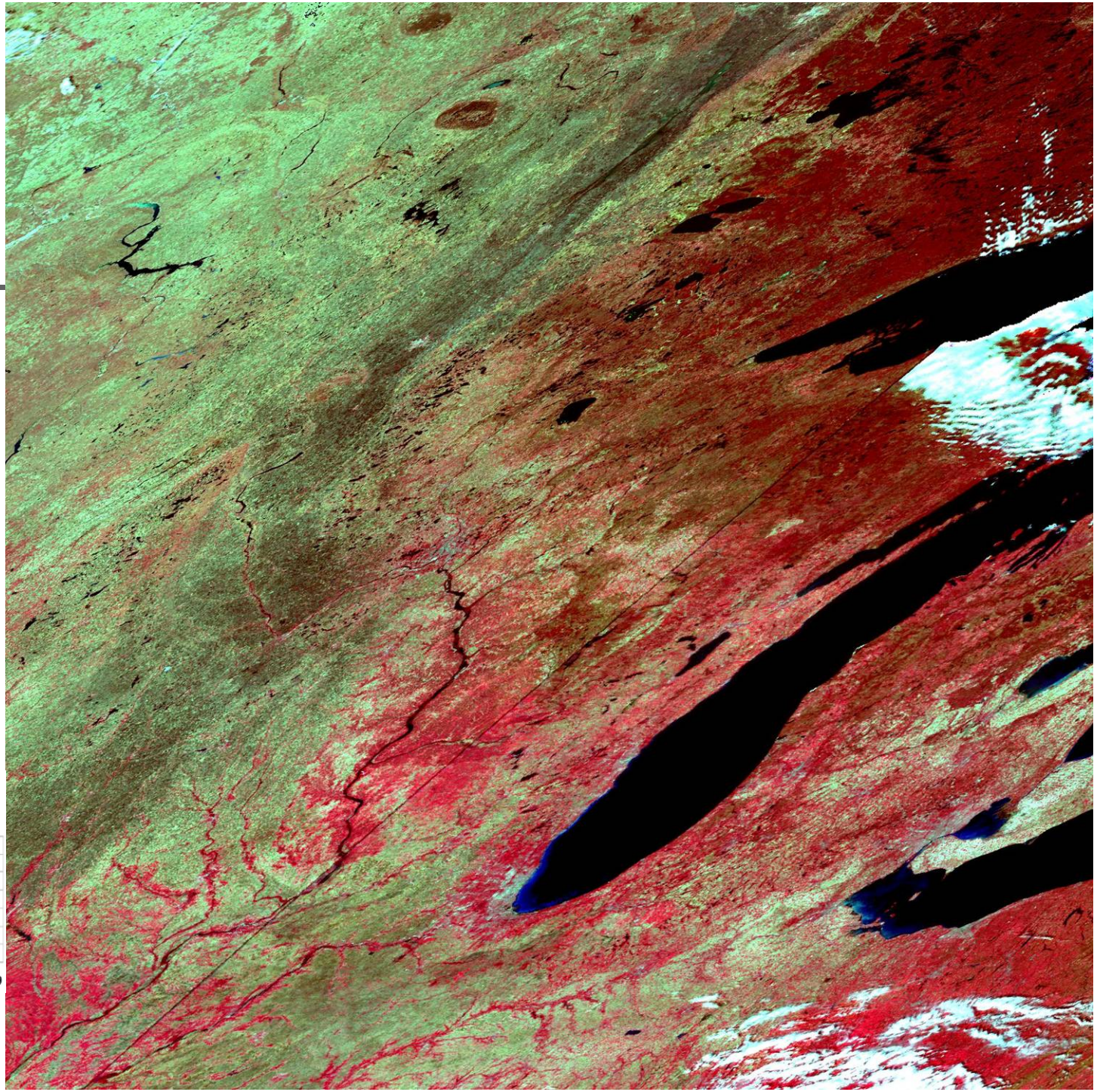
MODIS tile: h11v04

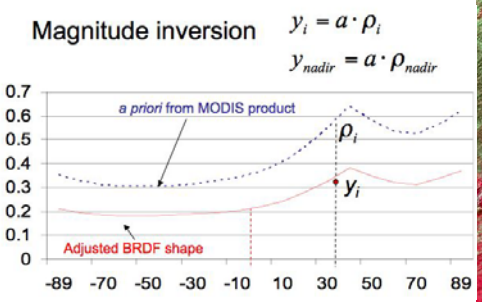
Acquired on 4/26/2006 (A2006116)



MODIS Daily
Nadir BRDF-adjusted
Surface Reflectance
Using Magnitude
Inversion Approach

4/26/2006



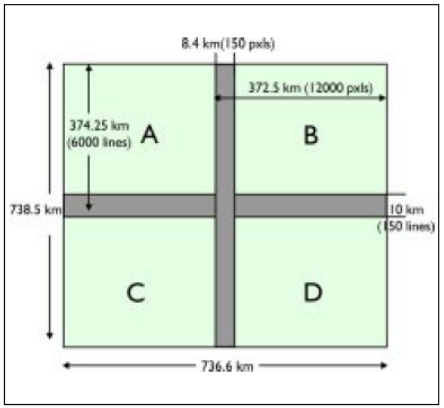


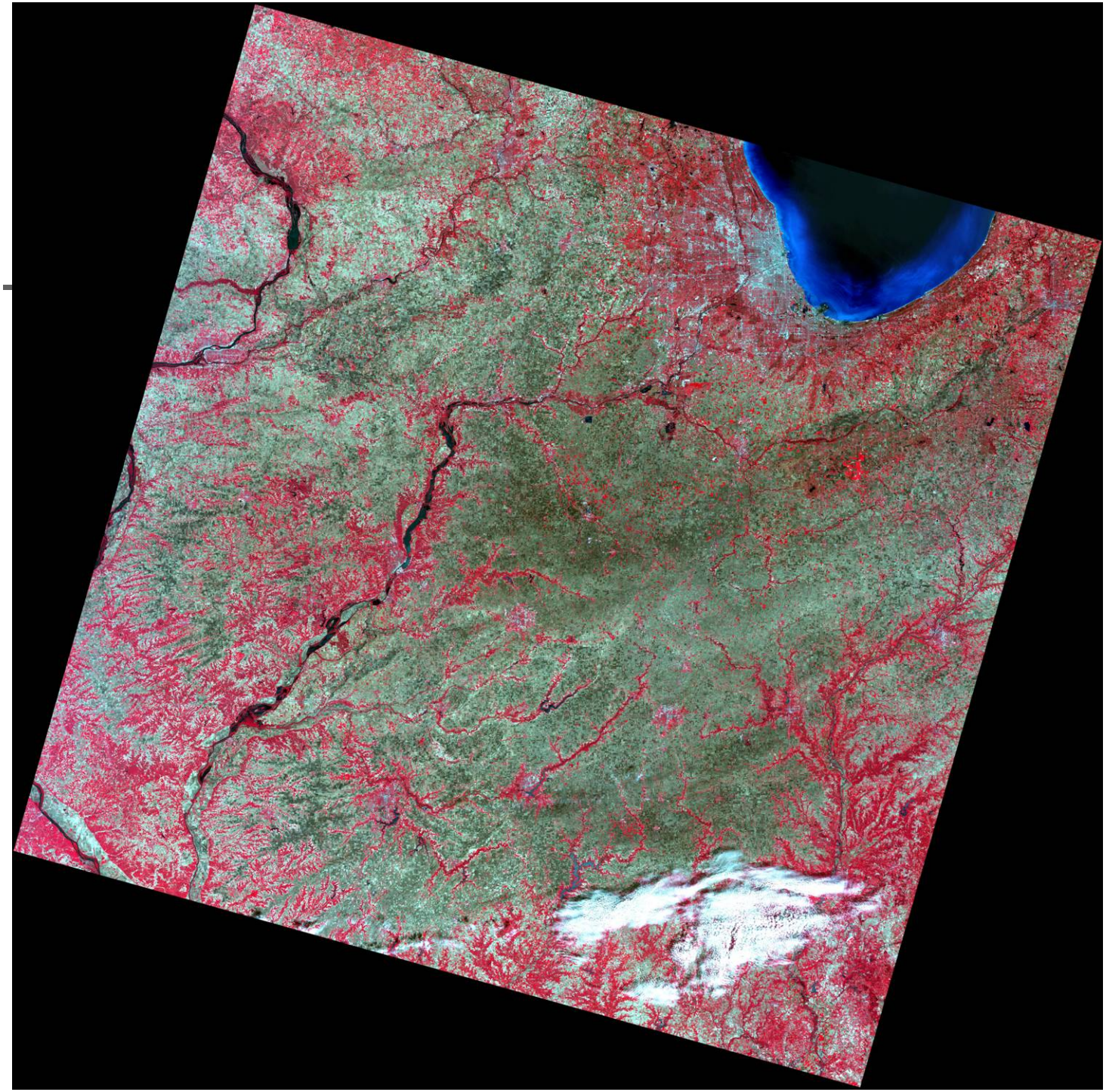
Linear Regression with Errors in Both Coordinates

- y = a*x + b
  - x: AWiFS DN aggregated to MODIS resolution
  - y: MODIS surface reflectance
  - samples are extracted in 3km resolution to reduce bowtie effects
- Consider errors from both x and y
  - Errors from x are caused by BRDF variations (vzn=0-25 degrees) and geolocation etc., use 5% errors
  - Error from y caused by calibration and atmosphere correction etc. According to the Eric Vermote etc., the overall accuracy of MODIS surface reflectance are 0.005, 0.005, 0.014 and 0.006 for band 2-5 respectively.
  - Used numeric recipe approach for straight-line data with errors in both coordinates (Deming approach)

Constrain Linear Regression

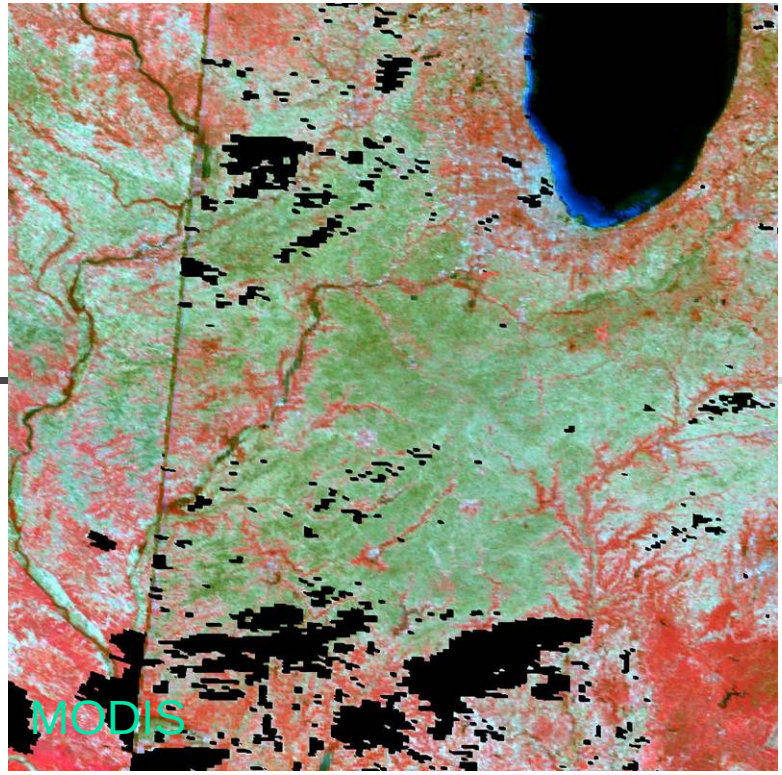
- Hard bound
  - No aerosol information available
  - Assume AOT varies from 0 to 0.5
  - Estimate variations of intercept base on the relation between TOA reflectance (or DN) and surface reflectance from physical model
  - Use hard bound for intercept if out of range
- Soft bound
  - Use aerosol information from MODIS
  - Compute distribution of intercept
  - Consider a priori knowledge of intercept in the regression

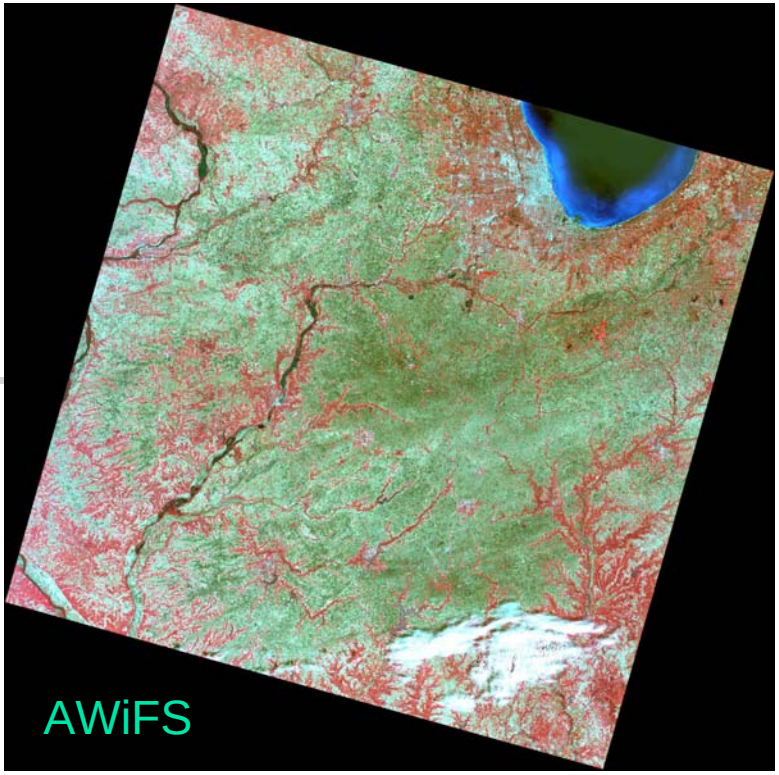


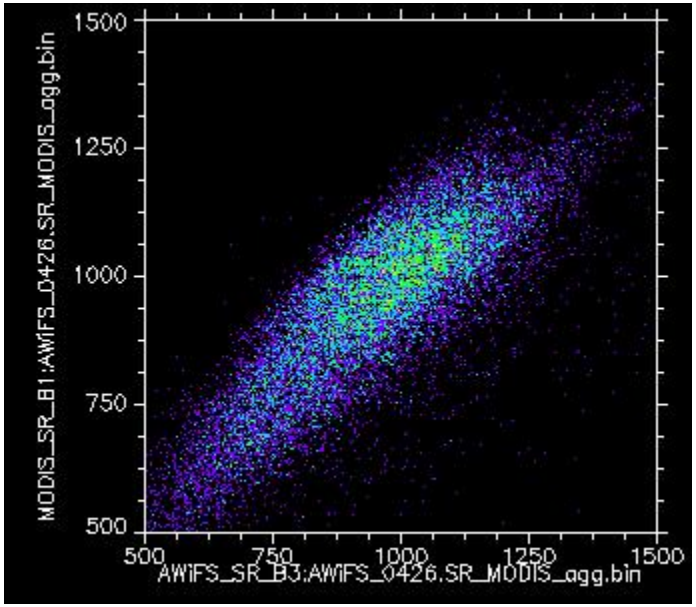


AWiFS
Digital Number
(sub-scene D)

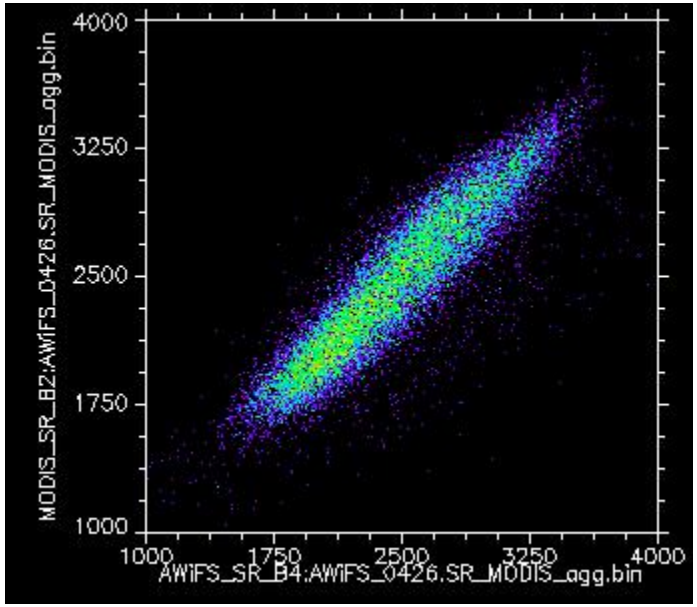
4/26/2006







Red (B3)



NIR (B4)

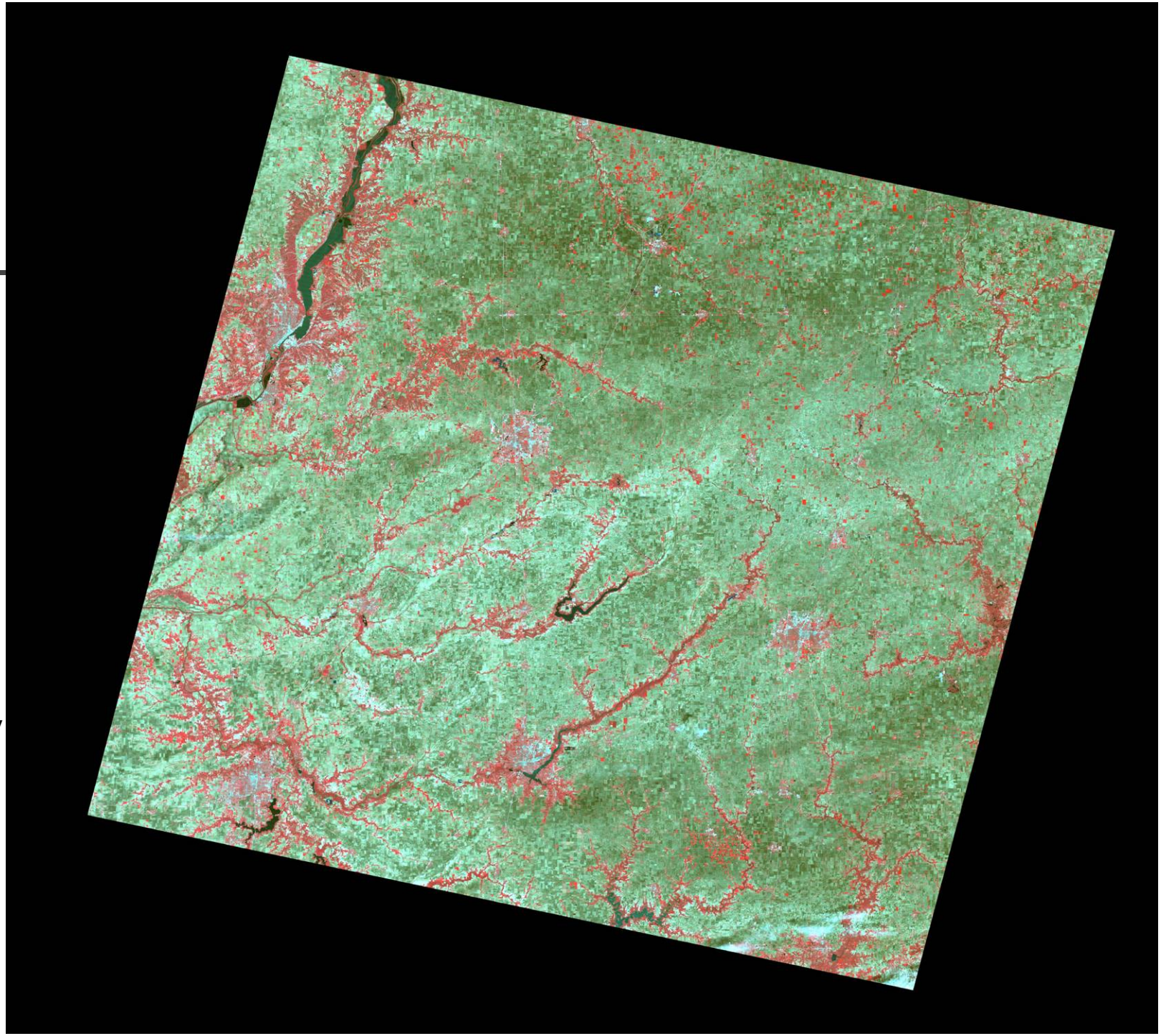
MODIS

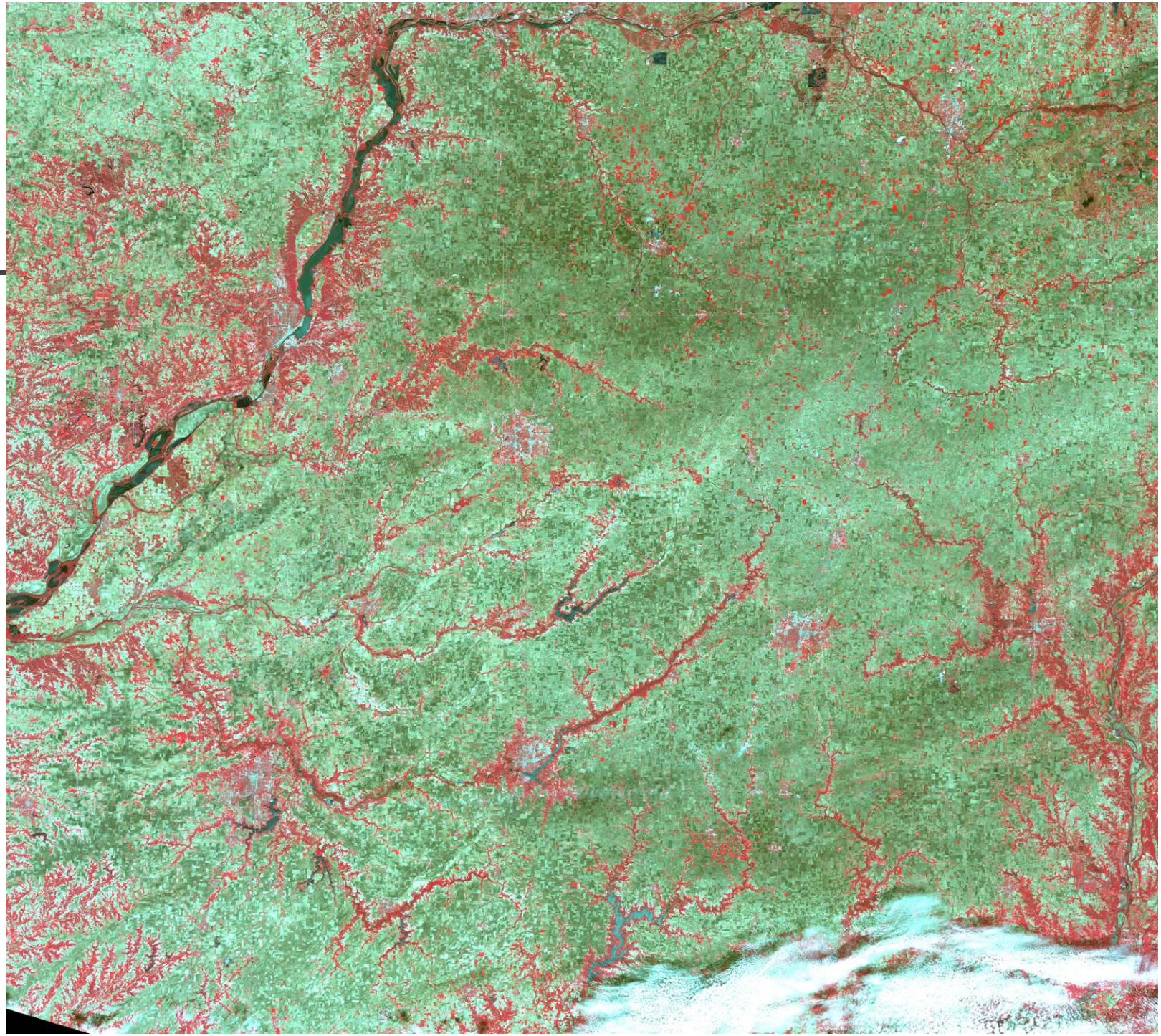
AWiFS

Use Relative Atmosphere Correction Approach on Landsat TM

TM surface reflectance used same day MODIS surface reflectance as reference

4/26/2006

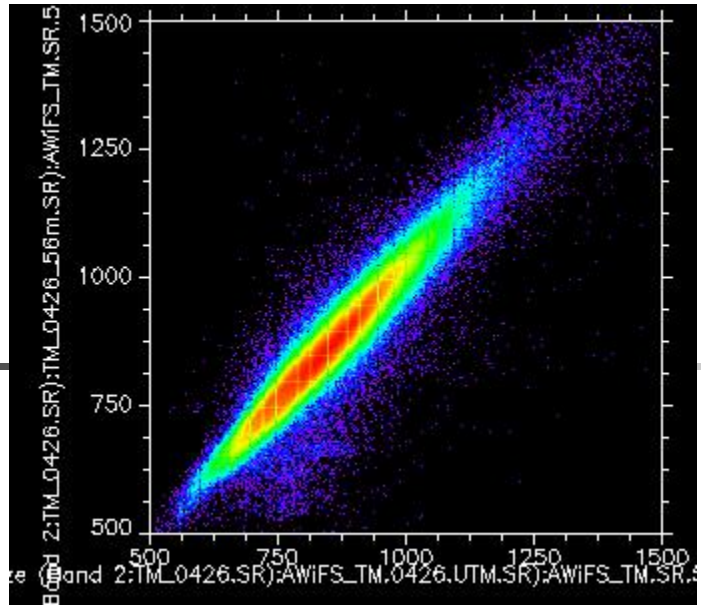




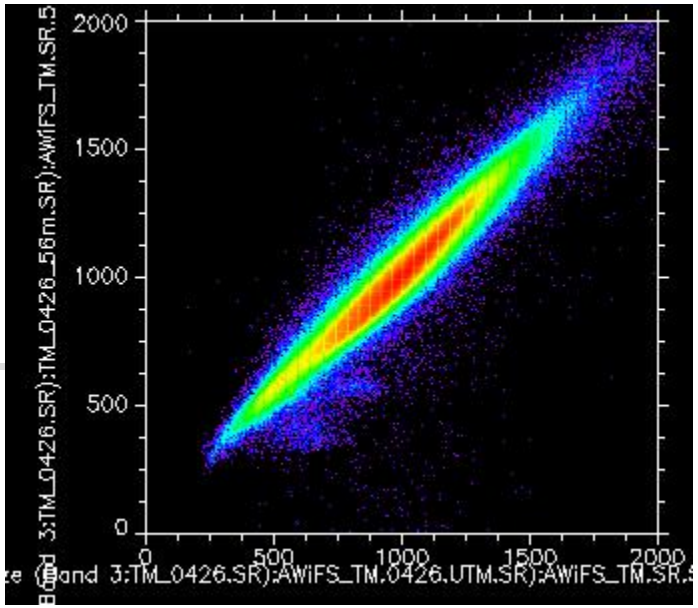
AWiFS surface reflectance

used same day MODIS surface reflectance as reference

4/26/2006

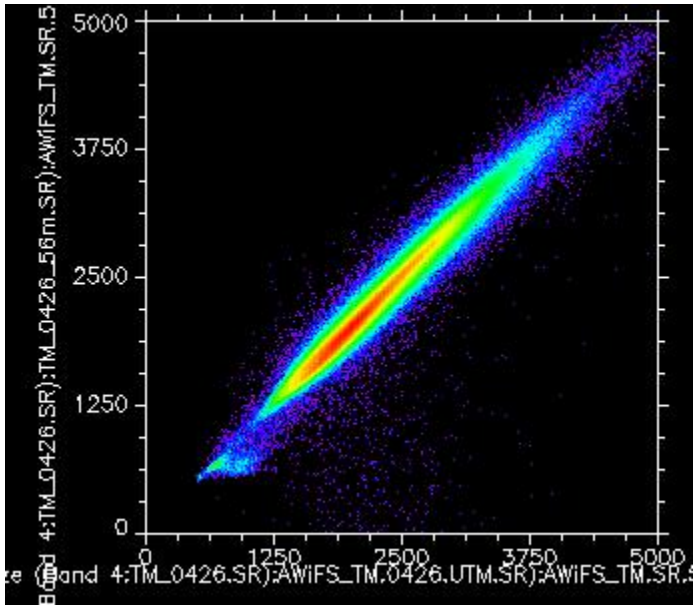


Green (B2)

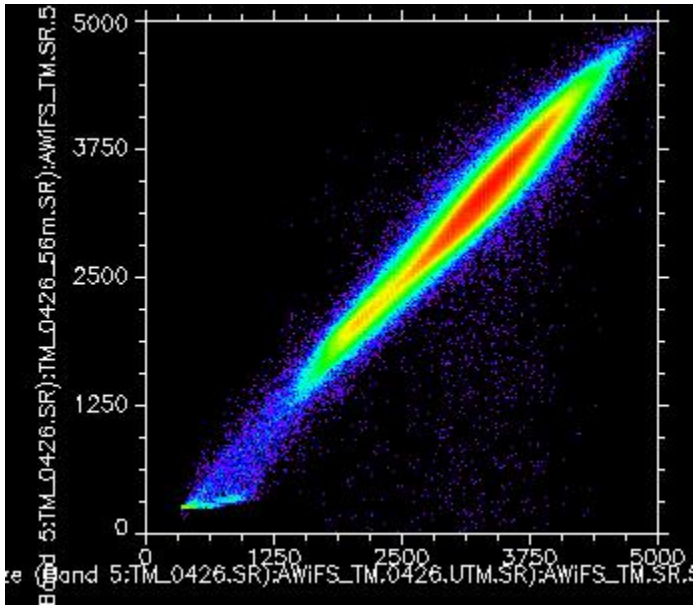


Red (B3)

Both used
RAC approach



NIR (B4)



MIR (B5)

TM

AWiFS

Applicability of the Relative Atmosphere Correction Approach

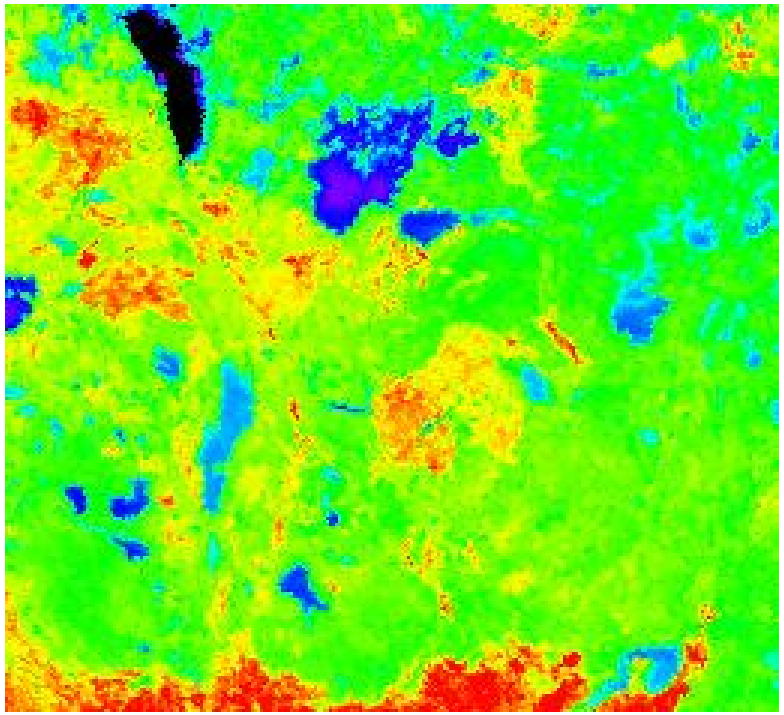
- One step conversion to MODIS-like surface reflectance
- Works without aerosol information
- Works on both morning (Terra) and afternoon (Aqua and NPOESS) satellites
- In theory, biophysical parameter retrieving algorithms used for MODIS products can be applied for AWiFS SR directly
- Can apply to different data sources (such as Landsat, AWiFS and CBERS) and thus make one consistent data set for change detection or time series analysis

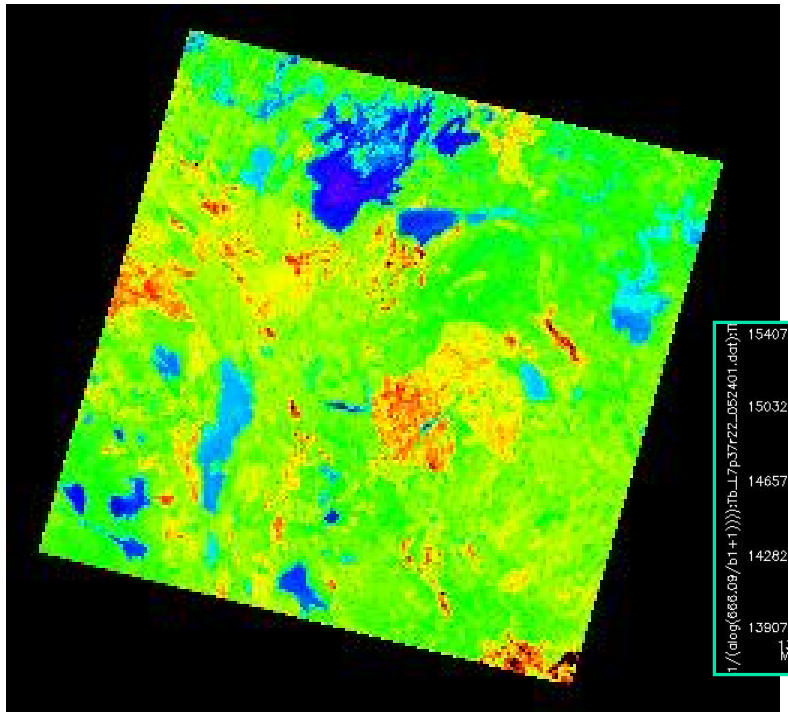
Further Improvements

- Consider AWiFS BRDF effects
  - Samples exclude vzn > 15 degrees
  - Use typical MODIS BRDF shapes (per land cover) to correct AWiFS angular effects
- Use MODIS aerosol as ancillary information
  - Compute probability of intercepts (based on simulations from physical model)
  - Use Combined cost function from a priori intercept (parameter space) and samples (data space)
- Use local moving window regression approach
  - Account aerosol variation (MODIS 10km)
  - BRDF effects (in 80km about 5 degrees)
  - Local region should be large enough to include enough good samples (maybe 80km-100km)
- Include quality assessment (interpolate or extrapolate?)

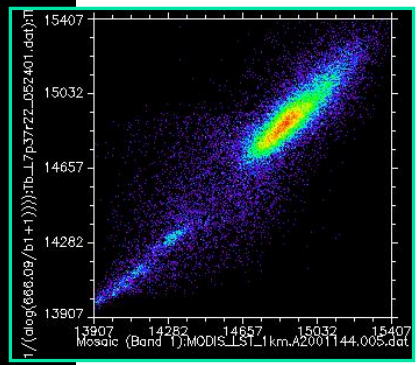
Activity II: Data Fusion Test on Land Surface Temperature (LST)

- Collaborated study with Dr. Martha Anderson
- Fuse fine spatial resolution Landsat LST and MODIS daily LST



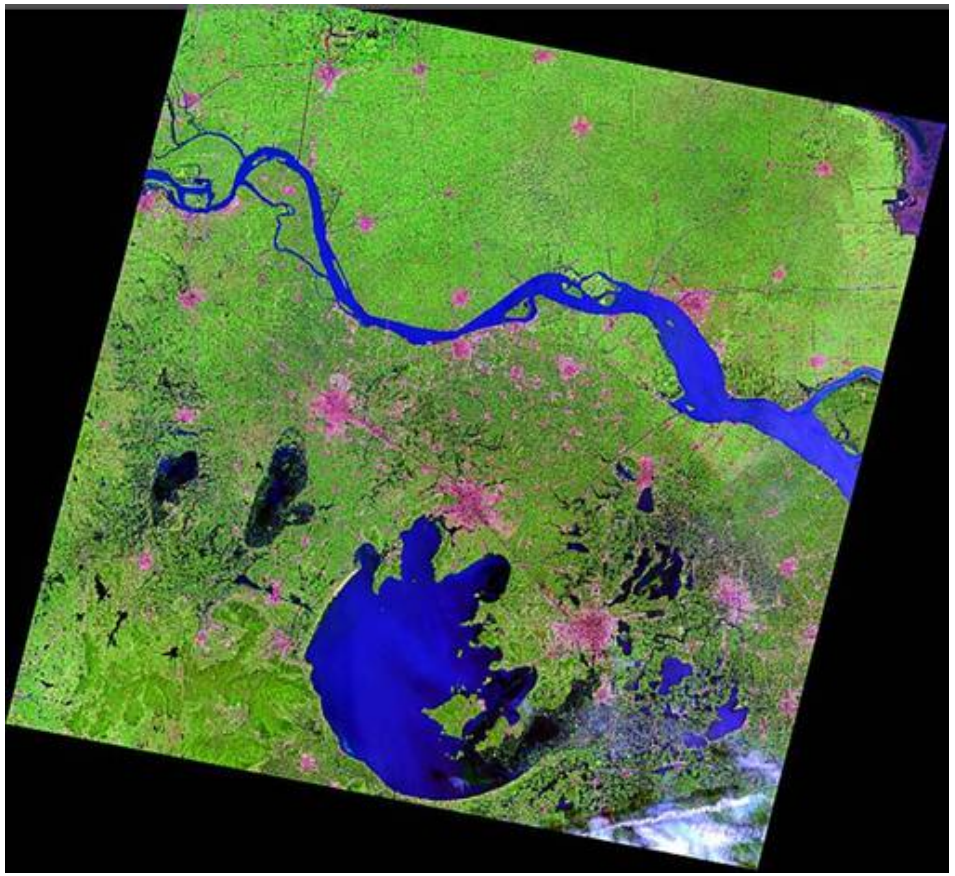


May 24, 2001



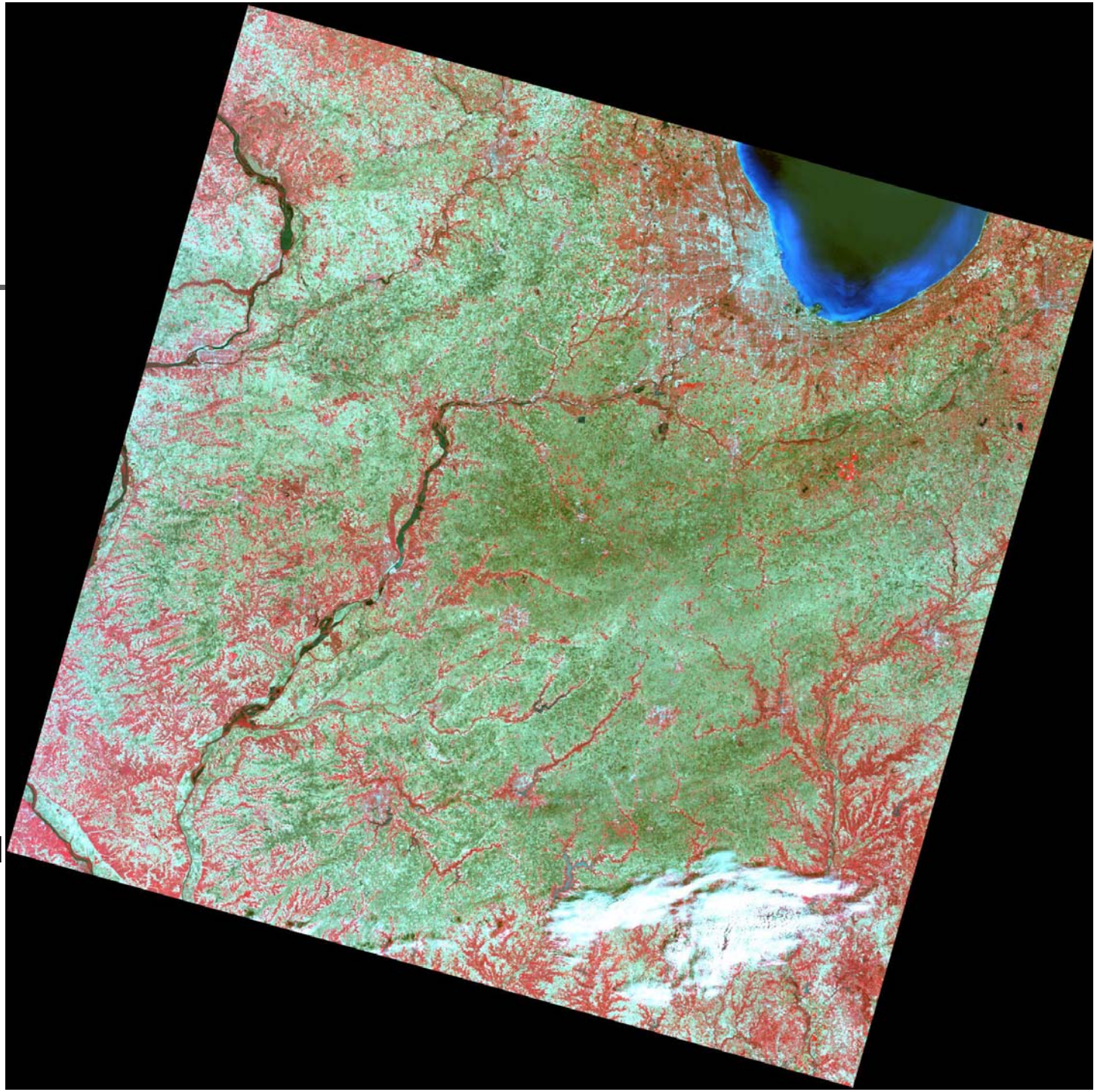
Activity III: Case Study on Land Cover Change Detection

- Urbanization Detection from Landsat and Foreign Landsat-like Data
  - Yangtse Delta: one of the fastest economic growth region in China
  - 18 Landsat scenes have been ordered (1973 - 2004)
  - CBERS data obtained from China (2003- 2007)
- Urban Heat Island Effect
  - Observed temperature increase in urban area while decrease in surrounding area in last several decades
  - Collaborate with NASA GSFC Scientist on the model simulation of the effects of urbanization



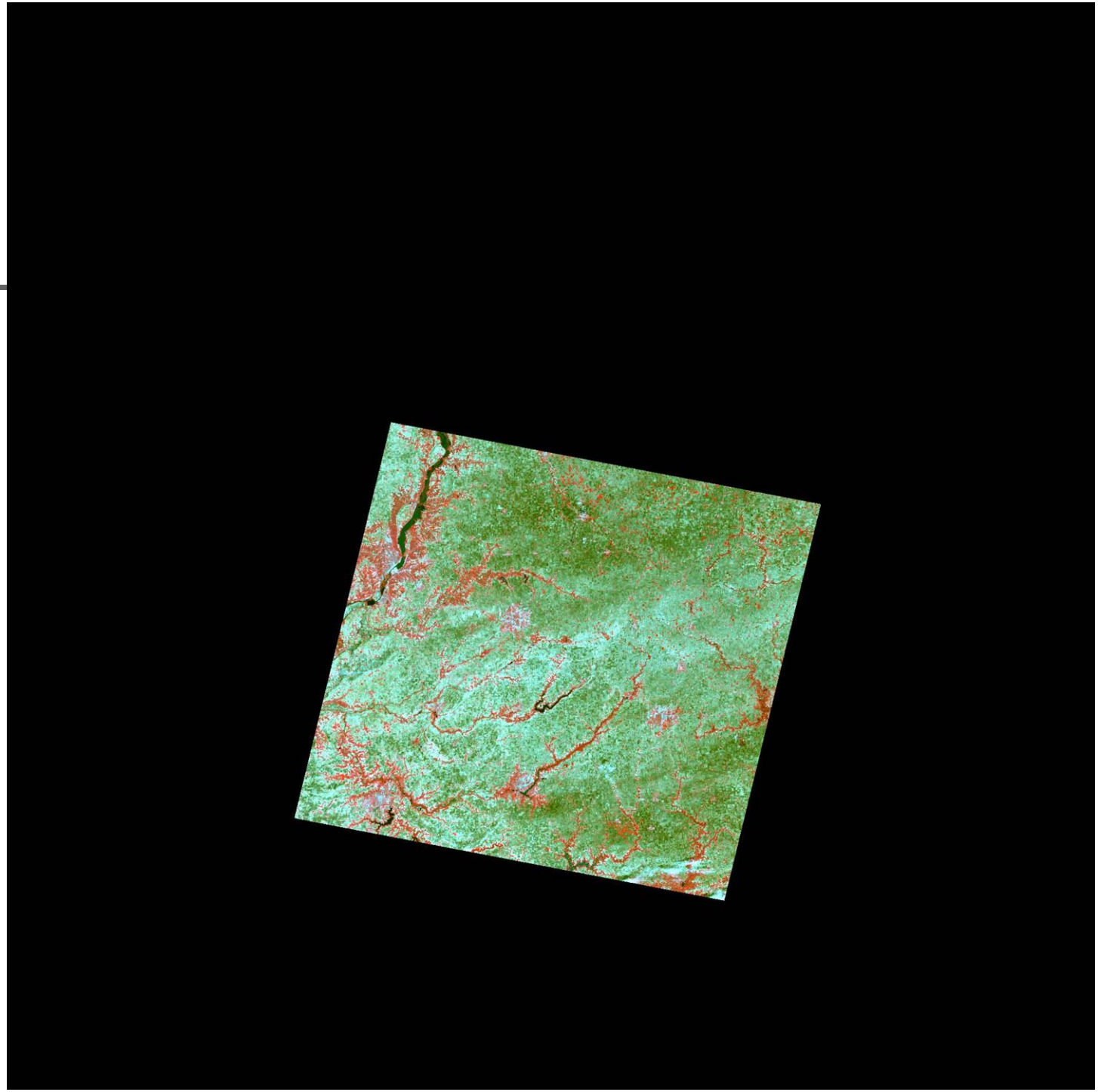
Near Term Goals

- Continue improve and evaluate relative atmosphere correction (RAC) approach for AWiFS data processing
- Try RAC approach for CBERS data
- Continue collaborate on data fusing test for land surface temperature from Landsat and MODIS data
- Detect urbanization from Landsat (include MSS) and foreign Landsat-like data and collaborate on the evaluation of its impacts to local climate and weather changes



AWiFS Relative
Atmosphere Corrected
Surafce Reflectance

4/26/2006

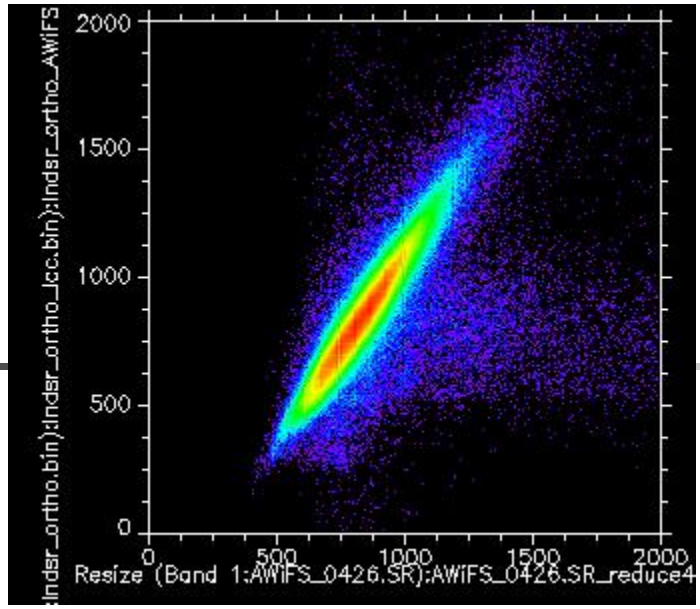


Landsat 5 TM
Surface Reflectance
From LEDAPS

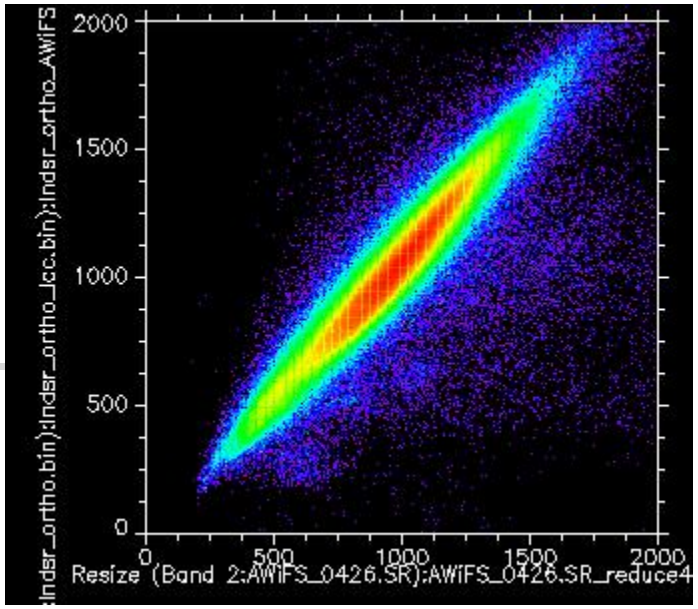
4/26/2006

TM SR from LEDAPS

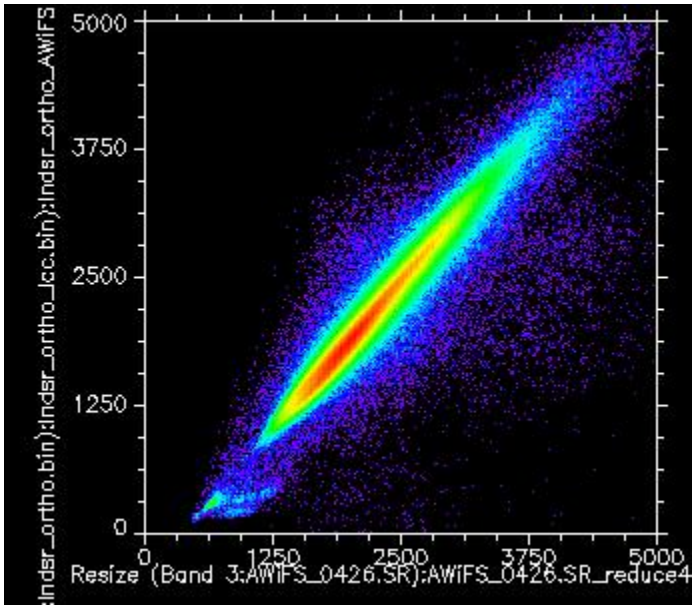
AWiFS SR from RAC approach



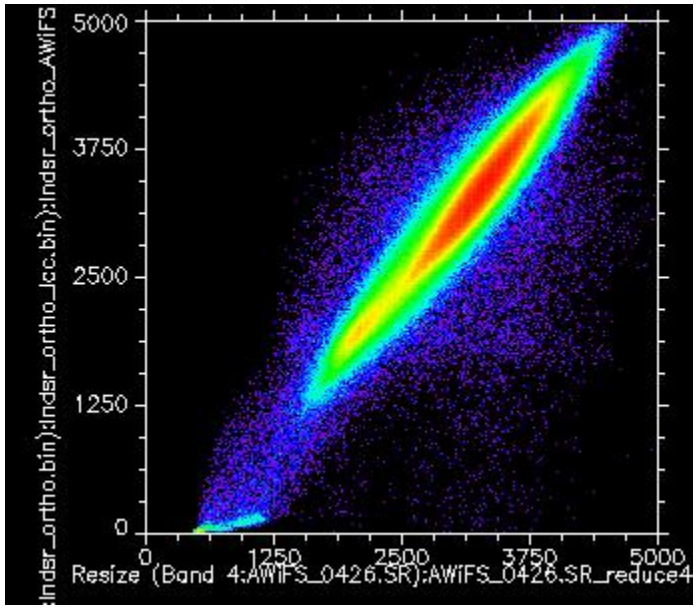
Green (B2)



Red (B3)



NIR (B4)



MIR (B5)

TM

AWiFS