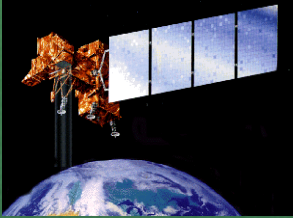


# Landsat and Sentinel-2 Data Synergy Potential for Agriculture

Garik Gutman,  
LCLUC Program Manager,  
Landsat Program Scientist,  
NASA Headquarters  
Washington, DC

# NASA LCLUC-relevant Missions

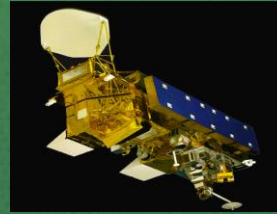
## Systematic Missions - Observation of Key Earth System Interactions



Landsat 7  
4/15/99



Terra  
12/18/99



Aqua  
5/3/02



Suomi-NPP  
10/28/11

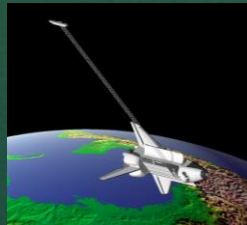


Landsat 8  
2/11/13

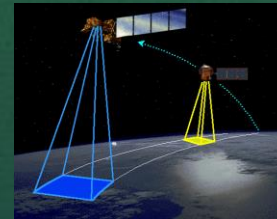
ESA Sentinel-2a end of 2014

ESA Sentinel-2b end of 2015

## Exploratory Missions - Exploration of Specific Earth System Processes and Parameters and Demonstration of Technologies

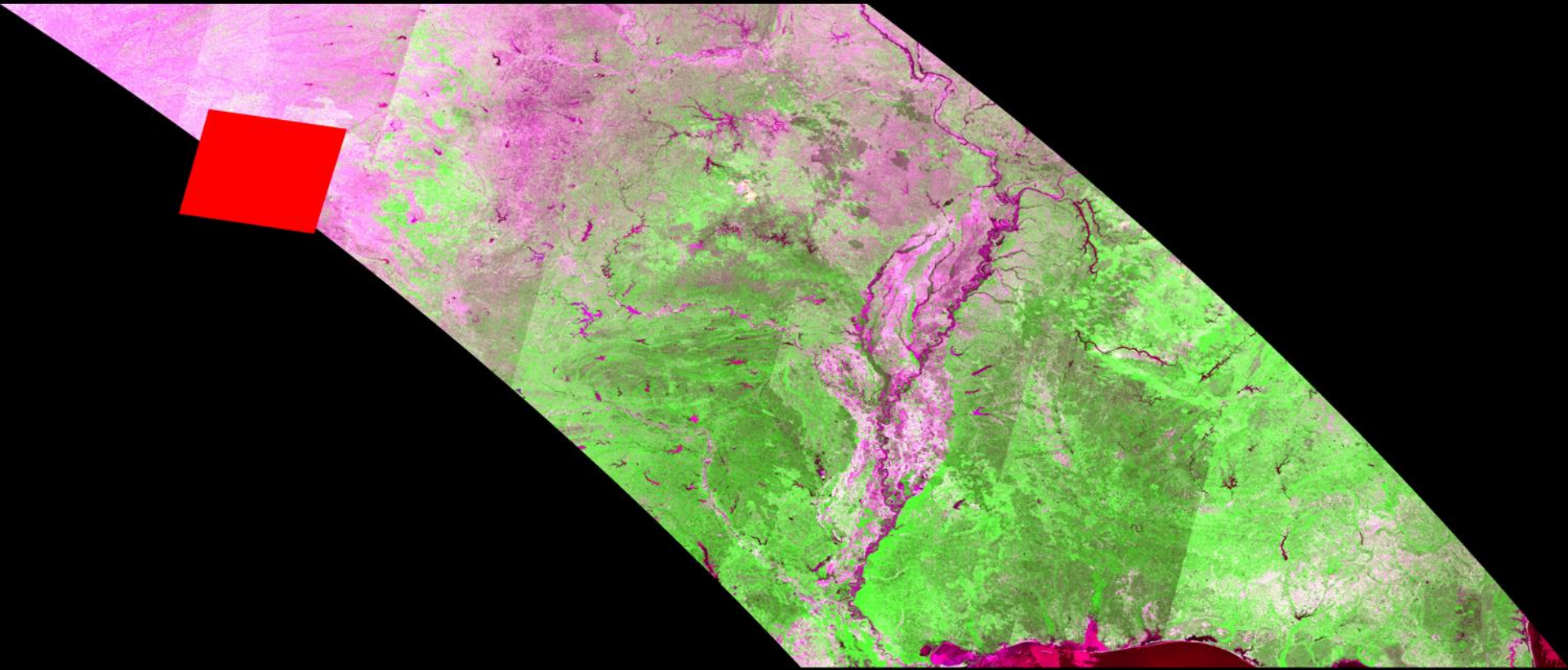


SRTM  
2/11/00

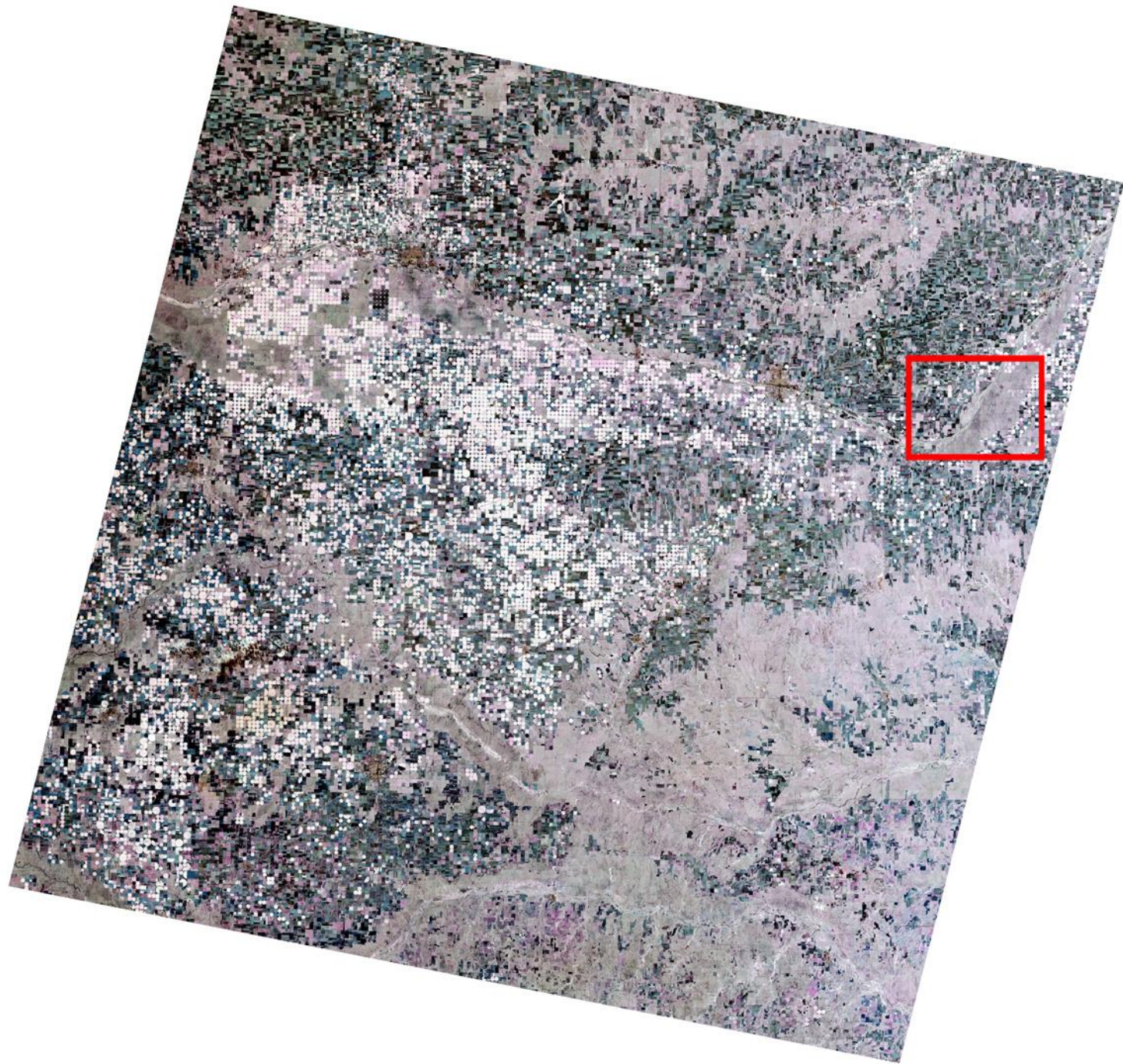


EO-1  
11/21/00

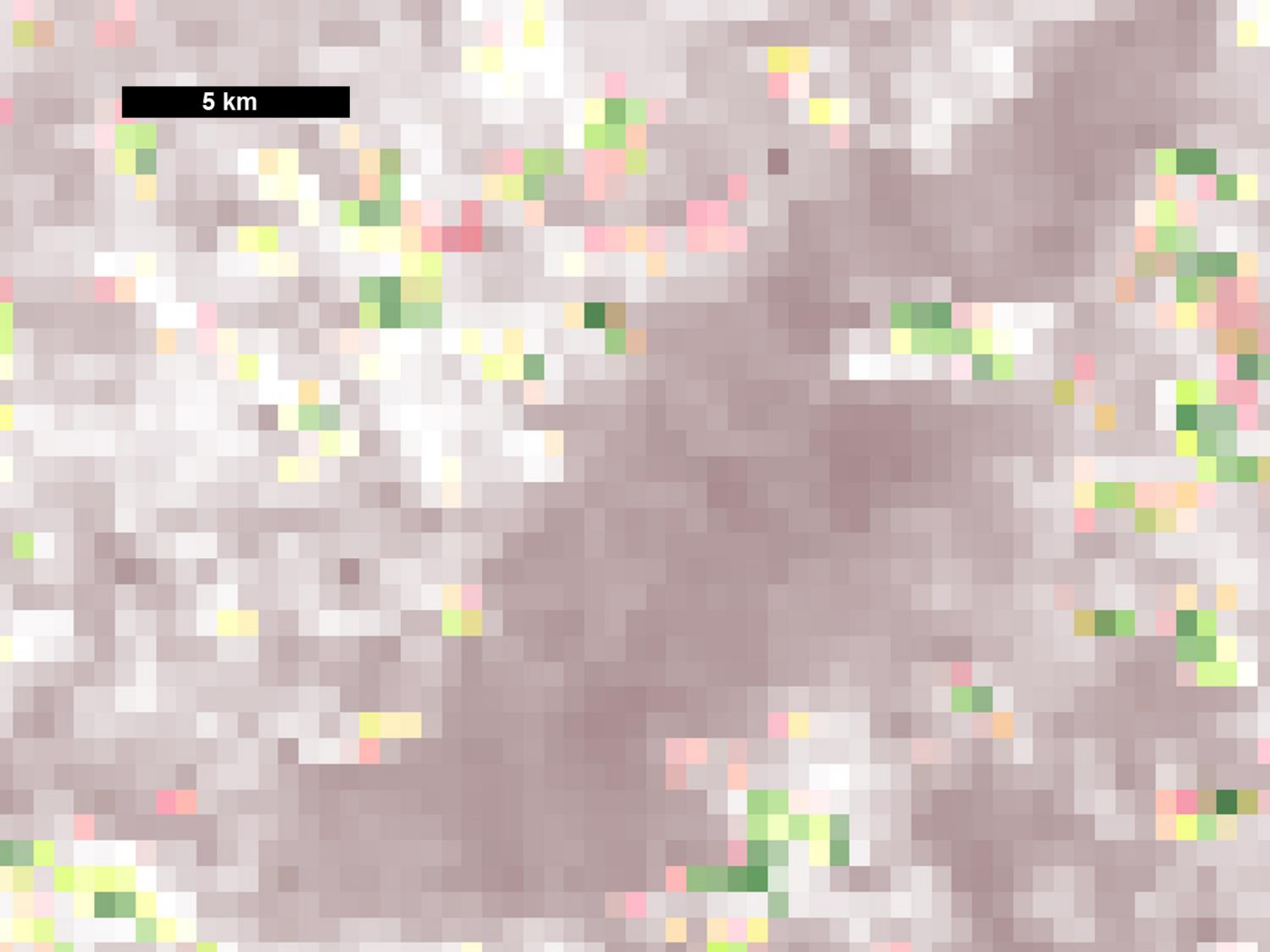






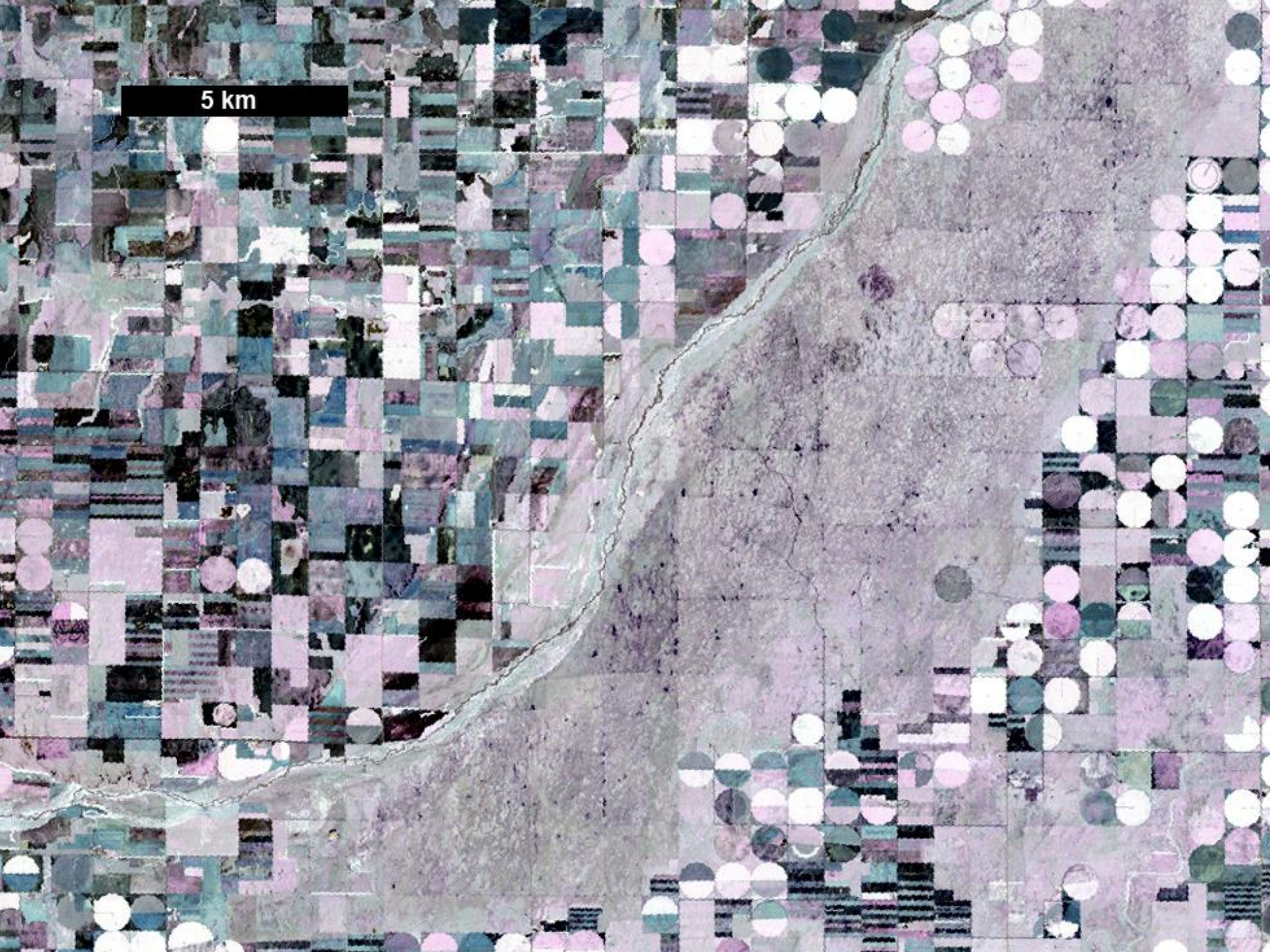


5 km



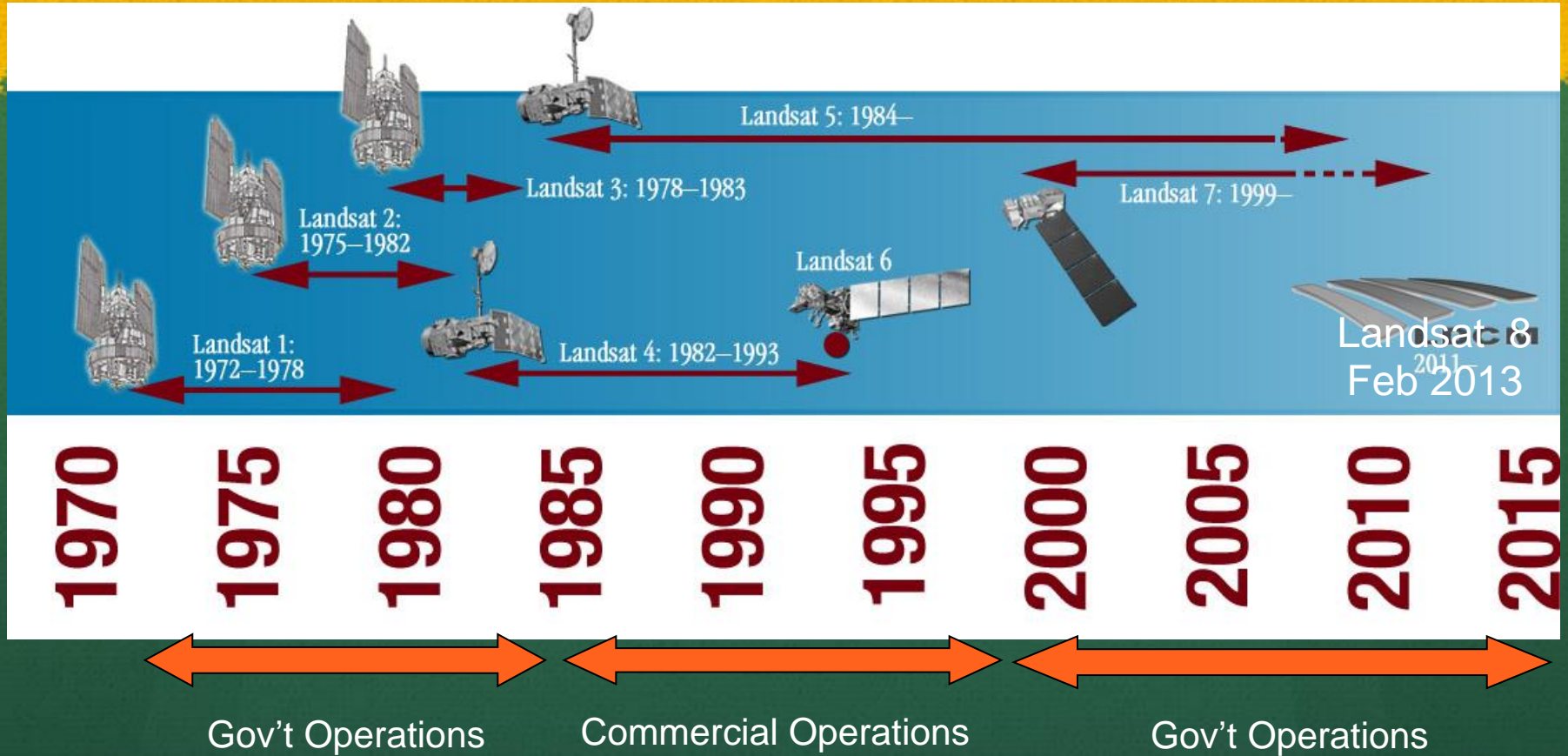


5 km





# History of the Landsat Program



# Landsat

- Infrequent observations
  - One-Landsat system: 16 day revisit time
  - Two-Landsat system: 8 days
  - Tests with 2-, 4-, 6-yr intervals for forest monitoring – optimal time depends on applications
- Cost
  - Until 2010 expensive, free now!
  - Preferable (and now possible) continuous monitoring
- Cloud occurrence
  - 16-day repeat cycle in the areas with frequent cloud may not provide enough time series for monitoring seasonal changes in vegetation
  - Need daily observations like from coarse-resolution sensors



# Single Landsat: 16-day Repeat Coverage since 1972

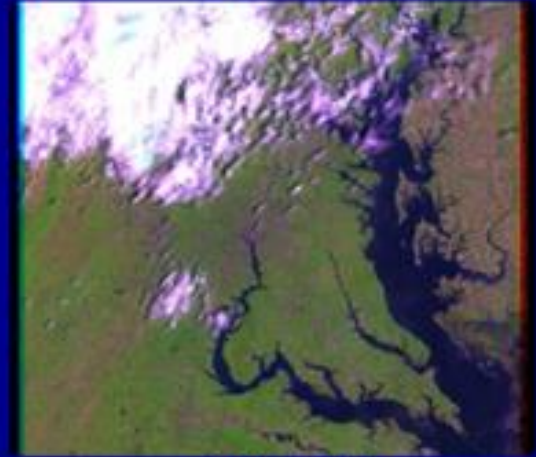
May 11



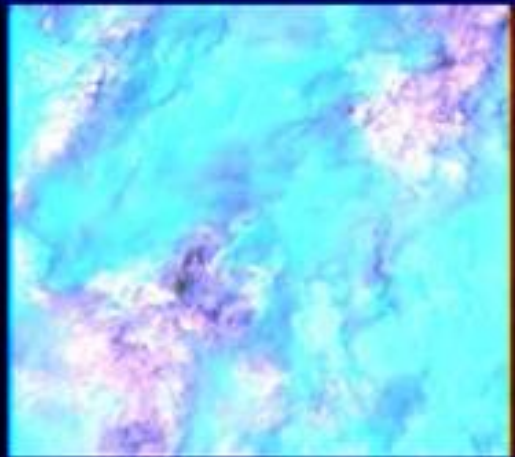
May 27



June 12



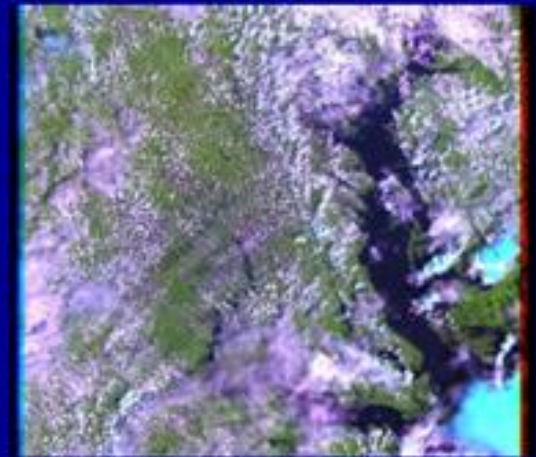
June 28



July 14



July 30



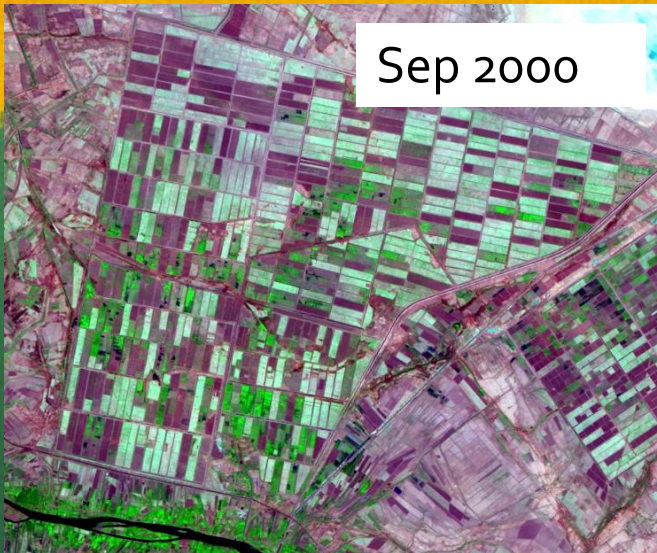
More frequent imaging is needed to maximize opportunity for cloud free observations particularly for rapidly changing phenomena: Fire, Flooding, Agriculture

# Advanced Use of Optical Mid-Resolution Data

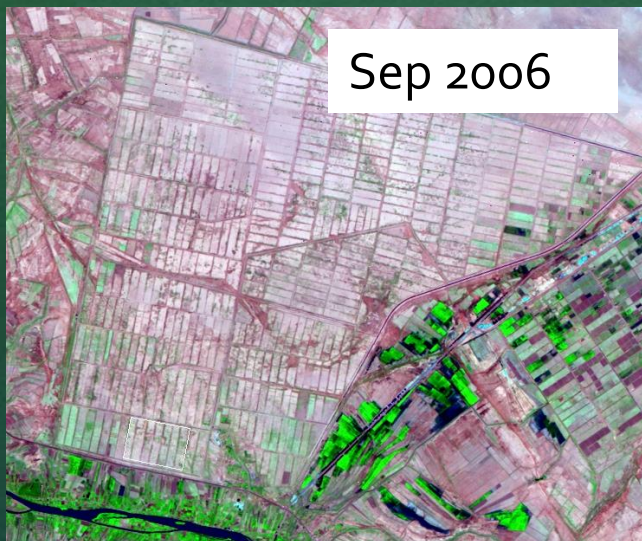
- Fusing coarse- and mid-res data
- Using ALL cloud-free pixels in the imagery
- Fusing data from different mid-res sensors



# Fusing Moderate and Coarse Resolutions

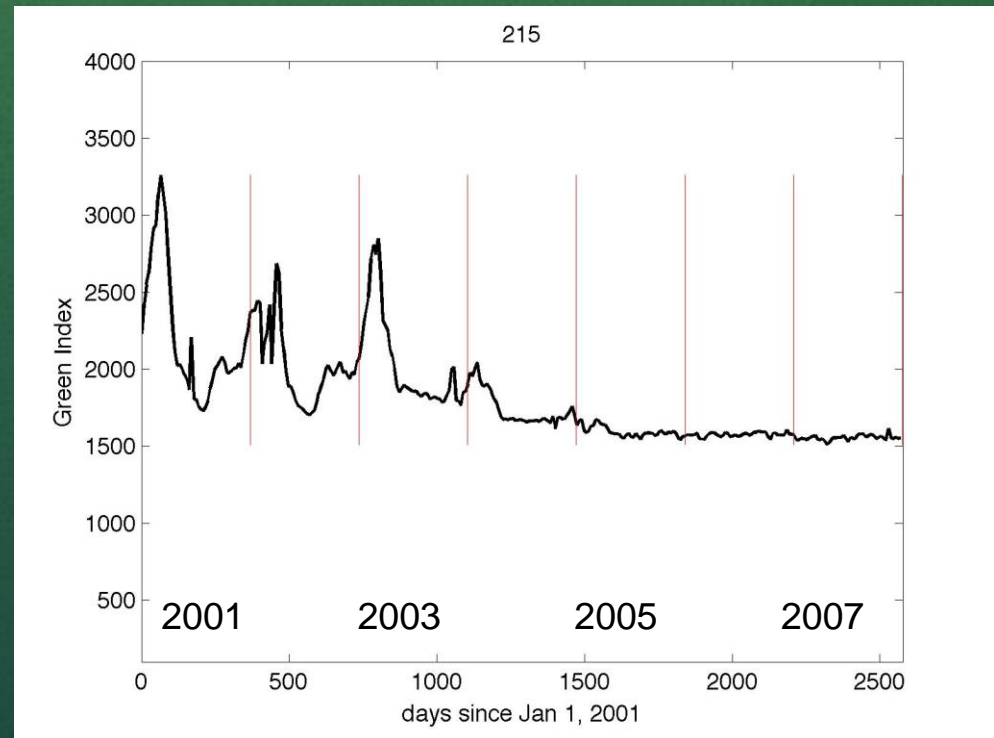


Iraq

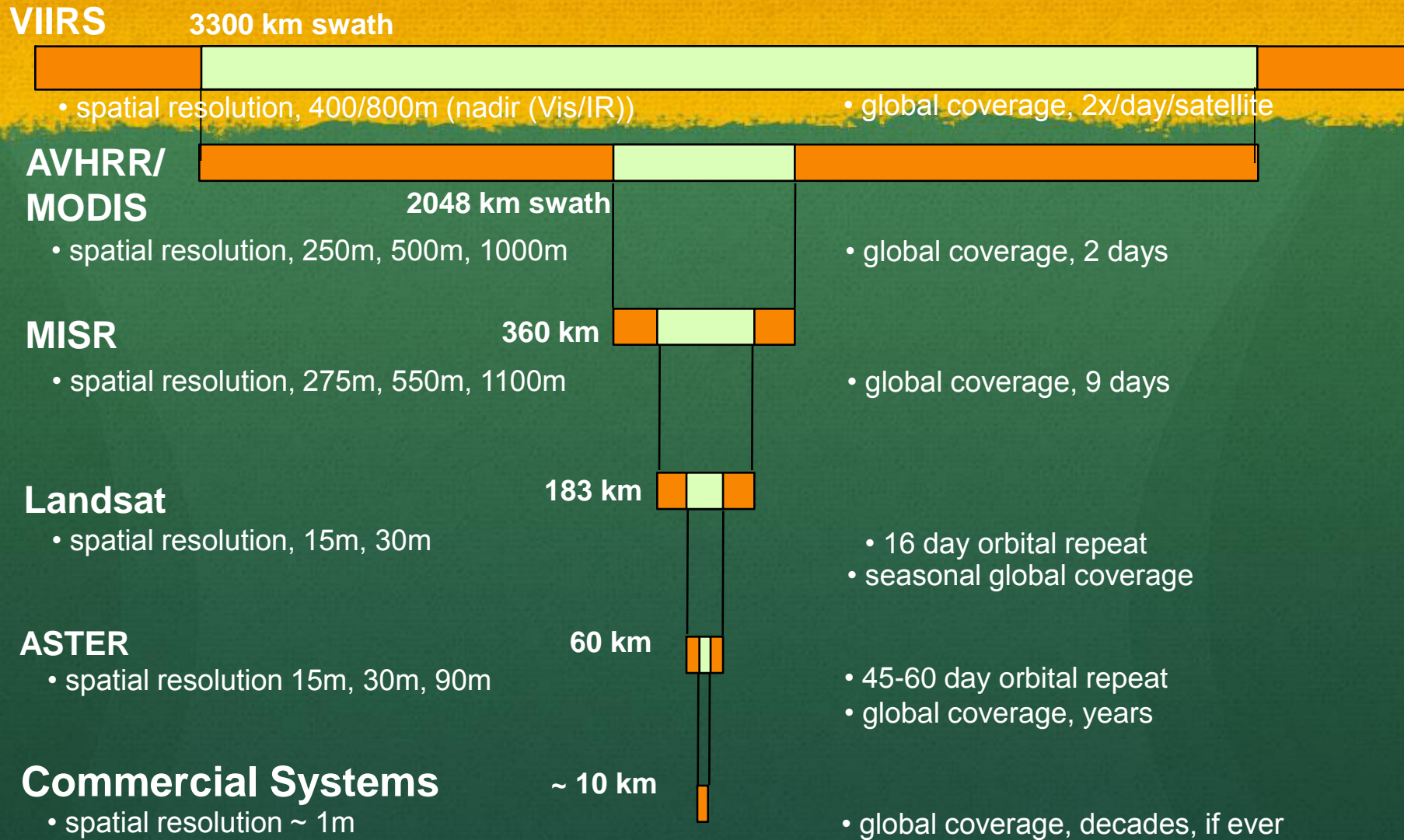


Landsat images over an area in Iraq  
6 years apart (like in GLS)

MODIS time series of Green Index for an  
abandoned irrigated area



# Synergistic Use of Optical Remote Sensing





# Using ALL Cloud-Free Pixels in the Imagery

File Edit View History Bookmarks Tools Help

http://landsat.usgs.gov/WELD.php

USGS science for a changing world NASA

USGS Home Contact USGS Search USGS

Landsat Missions

Home About Gallery Products Science Tools Links Contact

## Web-enabled Landsat data (WELD) Project

The WELD project is systematically generating 30 m composited Landsat ETM+ mosaics at weekly, monthly, seasonal and annual time periods for the conterminous USA (CONUS) and Alaska. The composited mosaics are designed to provide consistent Landsat data that can be used to derive land cover and geo physical and bio physical products for regional assessment of surface dynamics and to study Earth system functioning.

Version 1.3 of the WELD monthly, seasonal and annual products generated from Landsat ETM+ terrain corrected (Level 1T) data with cloud cover  $\leq 80\%$  sensed December 2007 to November 2008 are available here.

### WELD Browse Imagery

The thumbnail images below illustrate the currently available Version 1.3 WELD data products, please click on them to see a higher resolution version. These true color browse images show the Landsat ETM+ red, green and blue wavelength bands at approximately 500 m resolution.

CONUS Annual 2008

Winter

December 2007

January 2008

February 2008

Spring

March 2008

April 2008

May 2008

Summer

June 2008

July 2008

August 2008

Autumn

September 2008

October 2008

November 2008

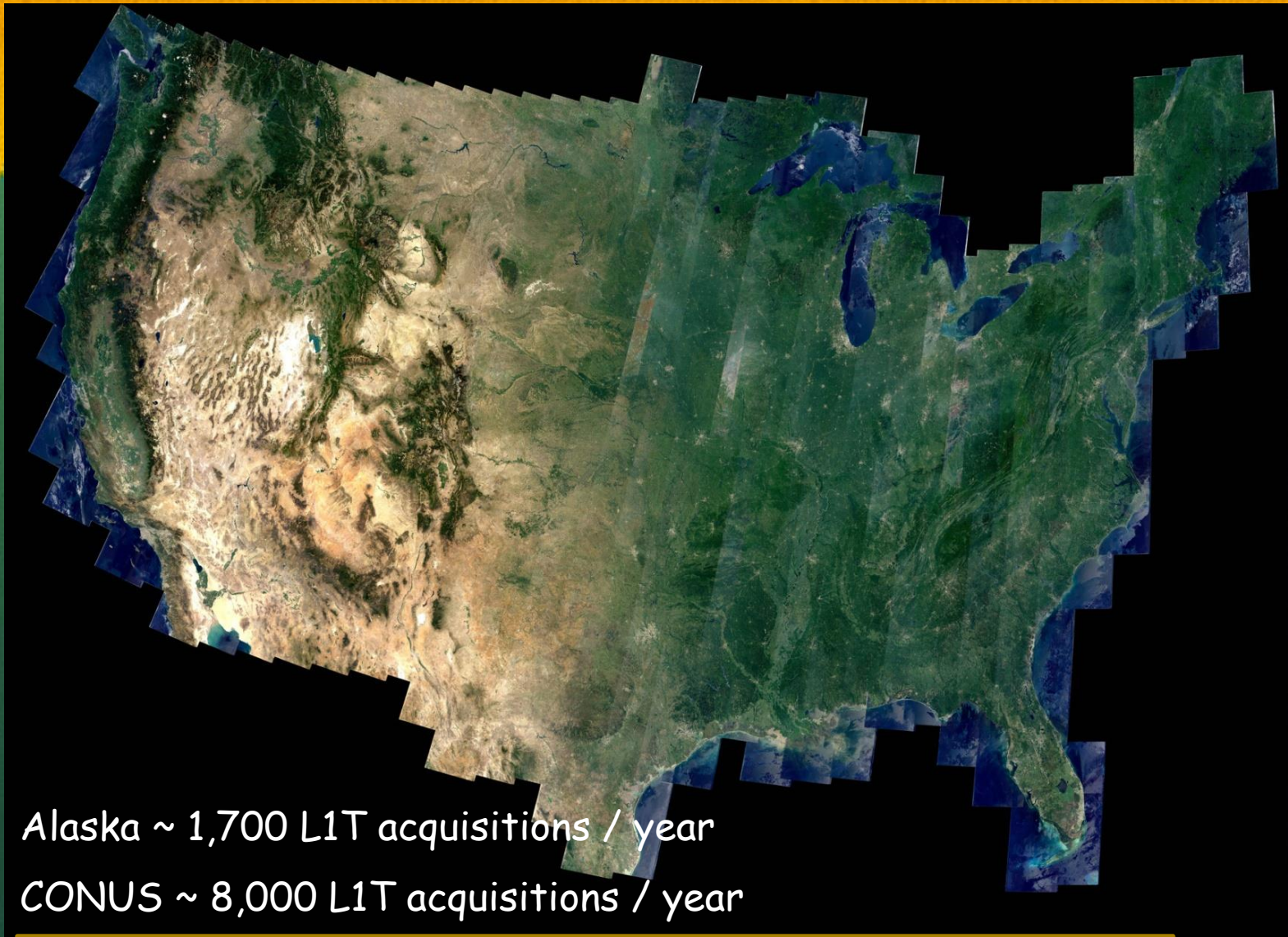
Done <http://landsat.usgs.gov/WELD.php>

Using  
All Clear  
Pixels by  
Compositing

Annual,  
Seasonal,  
Monthly  
Composited  
Mosaics



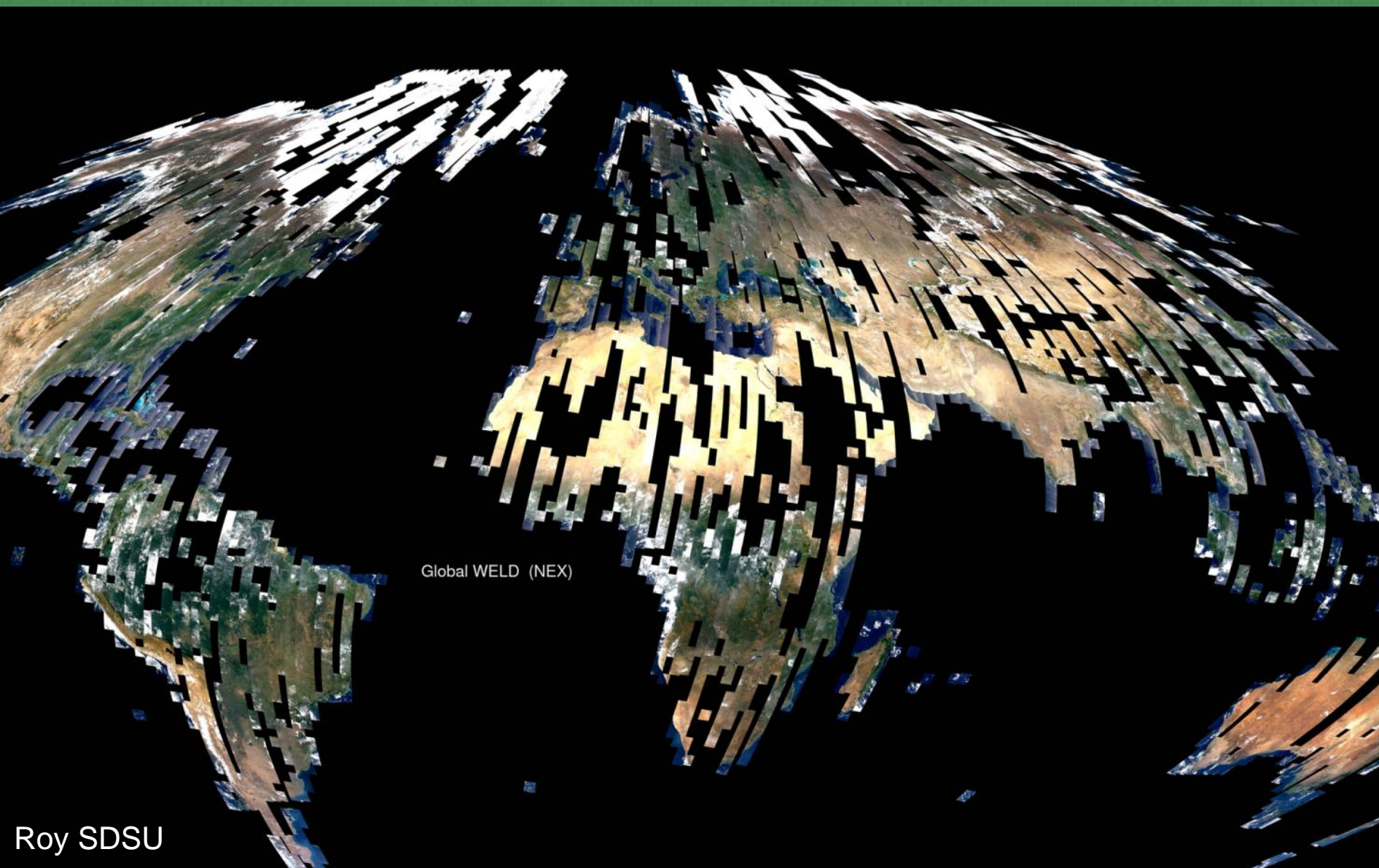
# Web-Enabled Landsat Data (WELD). Year: 2009



**New tools and methods to process  
large data volumes from Landsat**



# Global Landsat Processing Using High Performance Computing (7,281 input images, Monthly Composite May 2010)



Global WELD (NEX)

Roy SDSU

1.8km TOA true color browse, each pixel generated from 60 x 60 30m Landsat ETM+ pixels

MODIS Land Sinusoidal Projection



# Agricultural Monitoring Needs

## Agricultural monitoring has emerged as a key priority for GEO

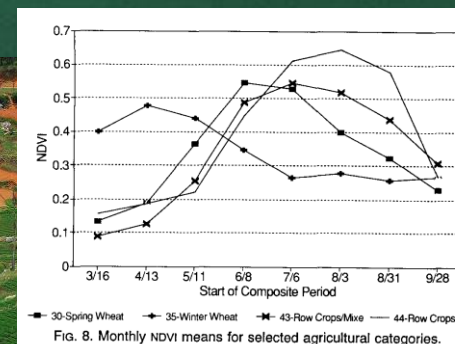
- Global provisioning of food and water among most critical environmental issues in 21st century
- Maize (2008) and wheat (2010) supply constrictions caused global price spikes and food insecurity
- G20 Ag ministers requested creation of GEO-GLAM (Global Agricultural Monitoring initiative); ratified by CEOS (2011).

## Crop assessments (type, condition) require ~weekly data @ <50m resolution

## Currently no single remote sensing system satisfies this requirement

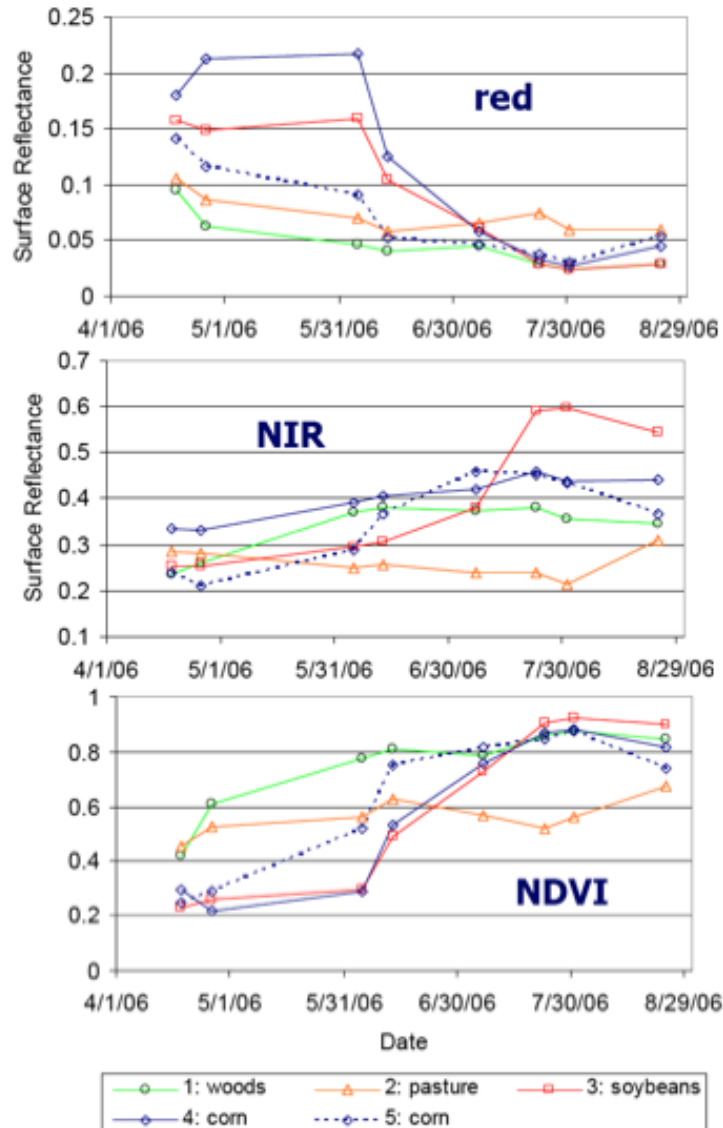
- MODIS & MERIS can provide weekly phenology but at regional scales
- Landsat can resolve individual fields, but only seasonally

Hillsides in the Nilgiris being prepared for planting vegetables, shot by Rafeek Manchayil,





# Fusing Data From Landsat-like Sensors: Land-cover phenology at 30 m



- Red reflectance, near-infrared (NIR) reflectance, and NDVI values for individual fields from central Illinois during the first half of the 2006 growing season

- Data are combined from Landsat-5, -7, ASTER, and IRS

# Background for Sentinel-2

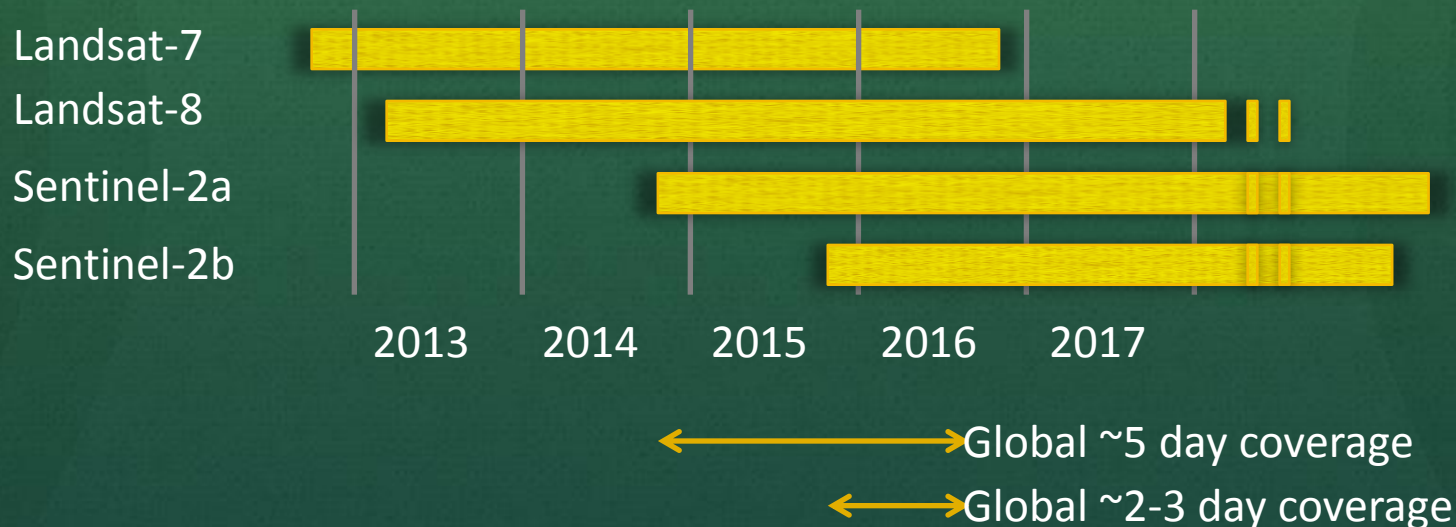
- The goal is to provide enhanced continuity to Spot- and Landsat-like data
- Optical payload with visible, near infrared and shortwave infrared sensors
- 13 spectral bands: 4 bands at 10 m, 6 bands at 20 m and 3 bands at 60 m spatial resolution
- Altitude of ~ 800 km
- Swath width of 290 km
- For a planned pair of S-2 the revisit time will be 5 days at the equator (under cloud-free conditions)
- More frequent (~3 days) at mid-latitudes
- The first satellite is planned to launch in late 2014



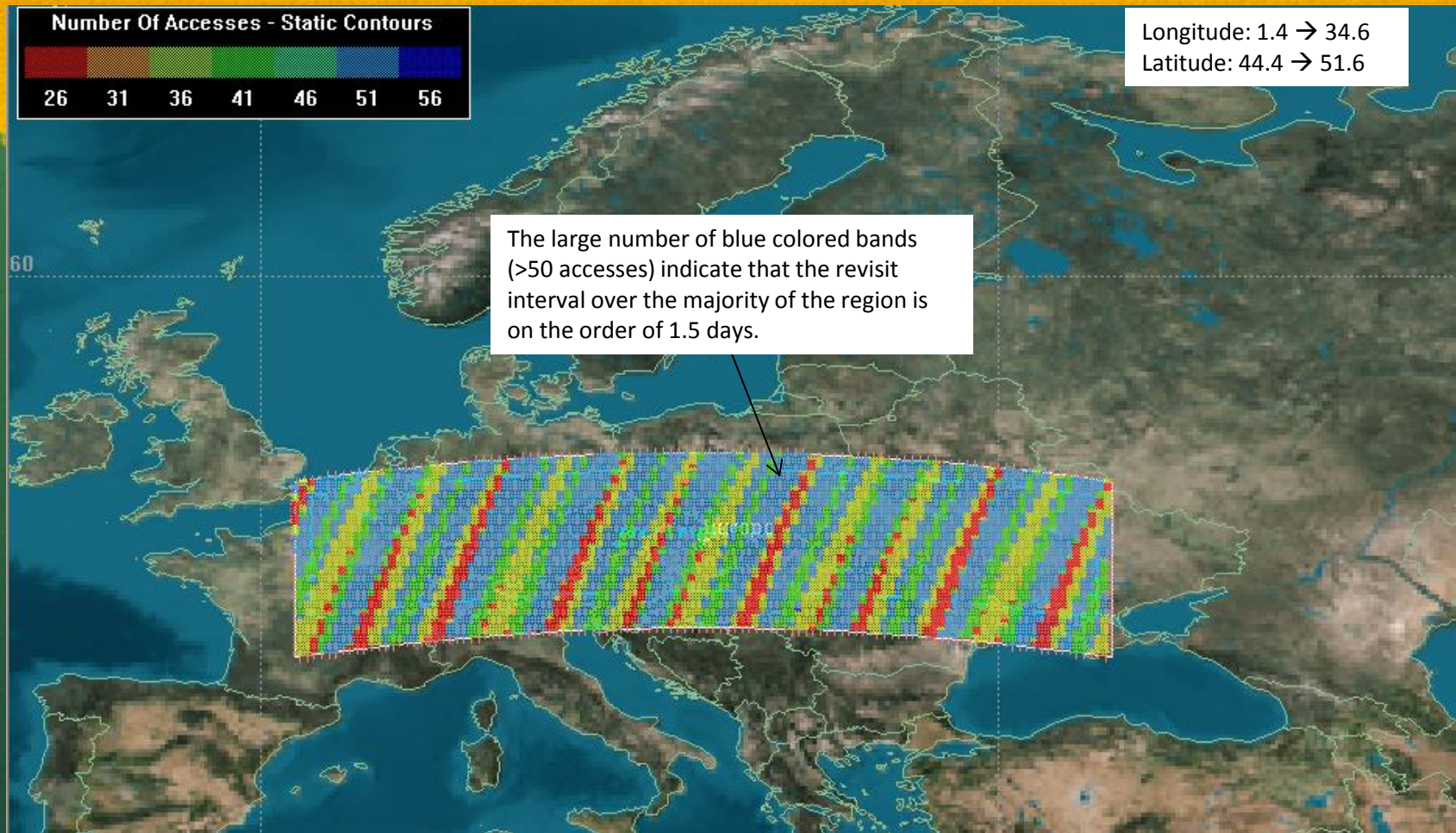
# Sentinel-2 and Landsat Fusion

Merging Sentinel-2 and Landsat data streams could provide < 5-day coverage required for Ag monitoring

- Both sensors have 10-30m coverage in VNIR-SWIR
- Satellite orbits complementary
  - Landsat-7 & -8 8 days out of phase
  - Sentinel-2a & 2b 5 days out of phase
  - Landsat and Sentinel sun synch orbits precess relative to each other



# Sentinel 2a,b - Landsat 7, 8: Europe



- The picture shows the number of times the sensors for the Sentinel 2s, L-7, and LDCM (L-8) accessed areas on the ground over an 80 day period of time.
  - 26 accesses indicates a maximum revisit interval of ~3 days 2 hours
  - 56 accesses indicates a minimum revisit interval of ~1 day 10 hours



谢谢

Thank you!

спасибо

РАҲМАТ

