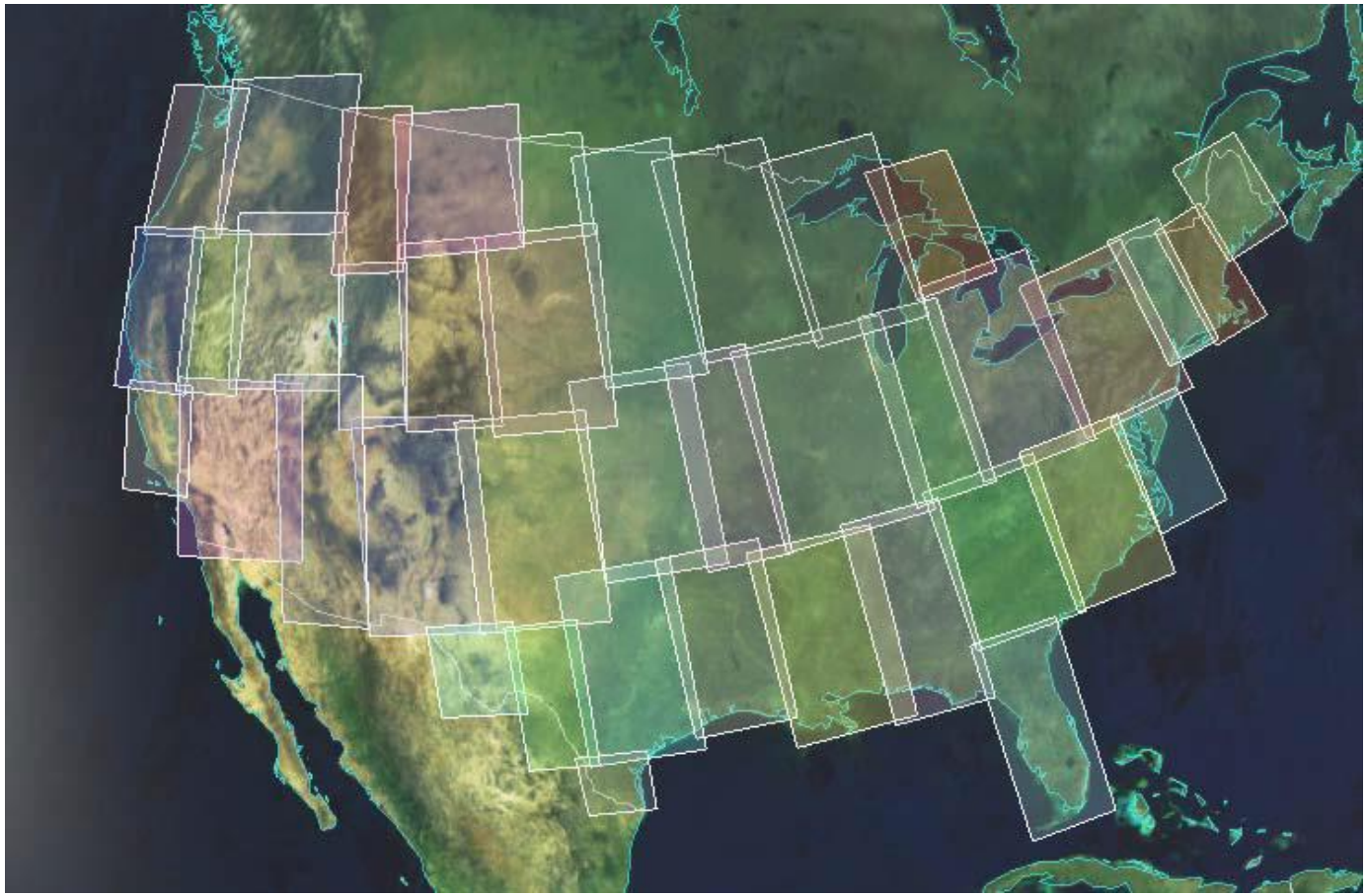
Small Satellites

Glenn R. Bethel
USDA Remote Sensing Advisor
April 12, 2016

USDA has been purchasing DMC Deimos-1 & UK2 since 2011 to augment the temporal resolution of Landsat

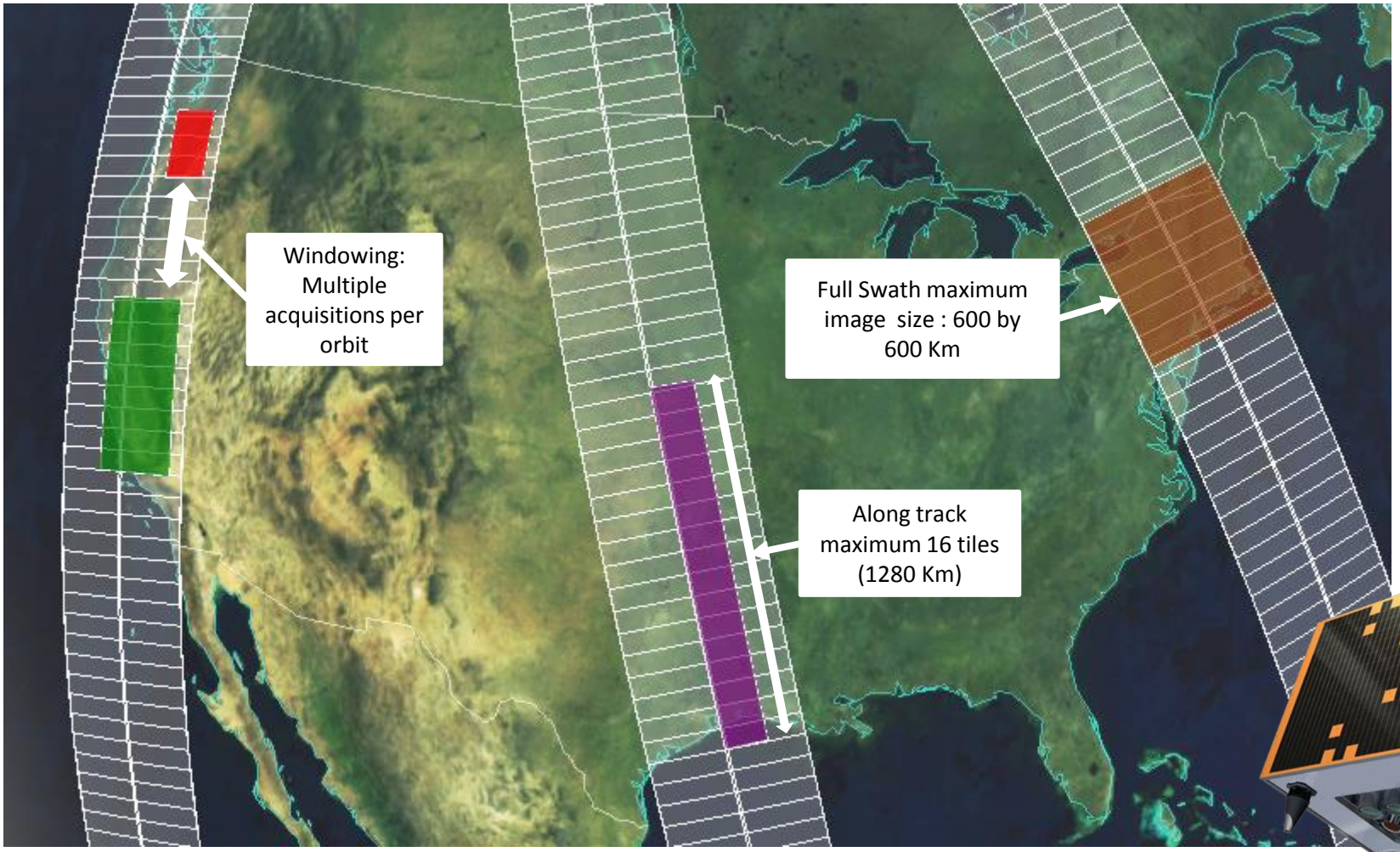
DMC Deimos-1 & UK2

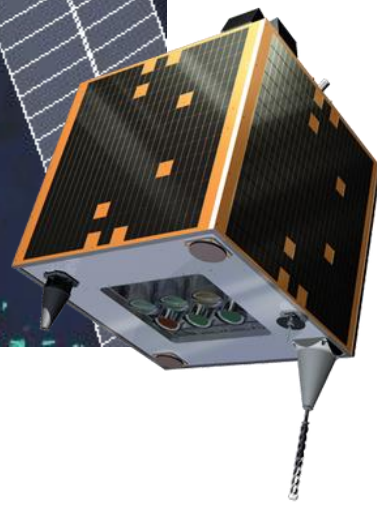


1 or more images acquired every 15 days during the growing season.

3 bands NIR, R, G, 22m resolution. Spectral bands good for many applications.

Deimos-1/UK2 Satellite Tasking





Global Requirements

- Agriculture areas between 55 degrees N and S
- Ready to use imagery
  - GIS Ready, No additional processing required
  - Ortho-Corrected for pixel level change detection
  - Use either surface reflectance or top of atmosphere corrections
  - Calibrated / Cross Calibrated between sensors
- Delivery within 72 hours, 24 hours preferred
  - Only exception is crop insurance that can use historic imagery as long as it can be certified to use in court.

USDA-ARS HRSL Hydrology & Remote Sensing Lab Beltsville, Maryland, USA

Advanced Multispectral Sensor Requirements for Agricultural and Environmental Monitoring

Guy Serbin[1], E. Raymond Hunt Jr.[2], Craig S.T. Daughtry[2], and Martha C. Anderson[2]

[1] Teagasc, Dublin 15, Ireland
[2] USDA/ARS Hydrology and Remote Sensing Lab, Beltsville, MD

Content for CAI was adapted from the work of these scientists and contains a subset of the recommendations.

Tillage systems and residues

A. Intensively tilled field

B. Conservation tilled (No-tilled) field

- Intensive tillage removes residue, exposes soil to erosion.
- Conservation tillage (e.g., no-till) leaves residue on fields.
- Springtime tillage operations typically occur over a 2-3 week period.
- With conservation tillage, farmers save money on fuel, can sell carbon credits, and receive monetary benefits.

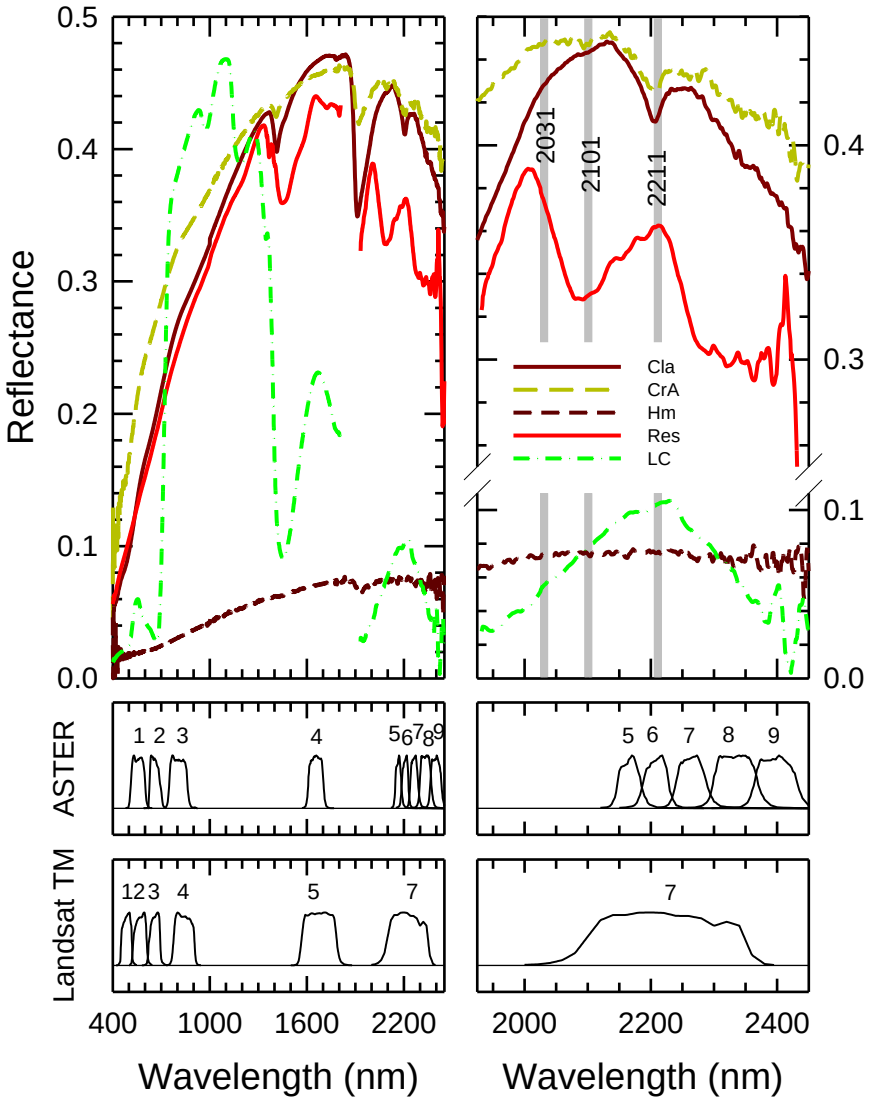
Where else is mapping non-photosynthetic vegetation important?

Prescribed rangeland burn, image courtesy Wyoming Wildlife and Natural Resource Trust

Simi Valley, CA, Oct. 14, 2008. (Associated Press)

- Dry vegetation is an important indicator of rangeland quality and soil health.
- Dry plant material easily catches fire:
  - Prescribed burning is an important management practice in Western US.
  - In Oct. 2007, California wildfires caused over $1 billion in damage.
  - Over 200 people killed in Australian wildfires in 2009.
  - Fires across Russia caused $15 billion in damage in 2010.

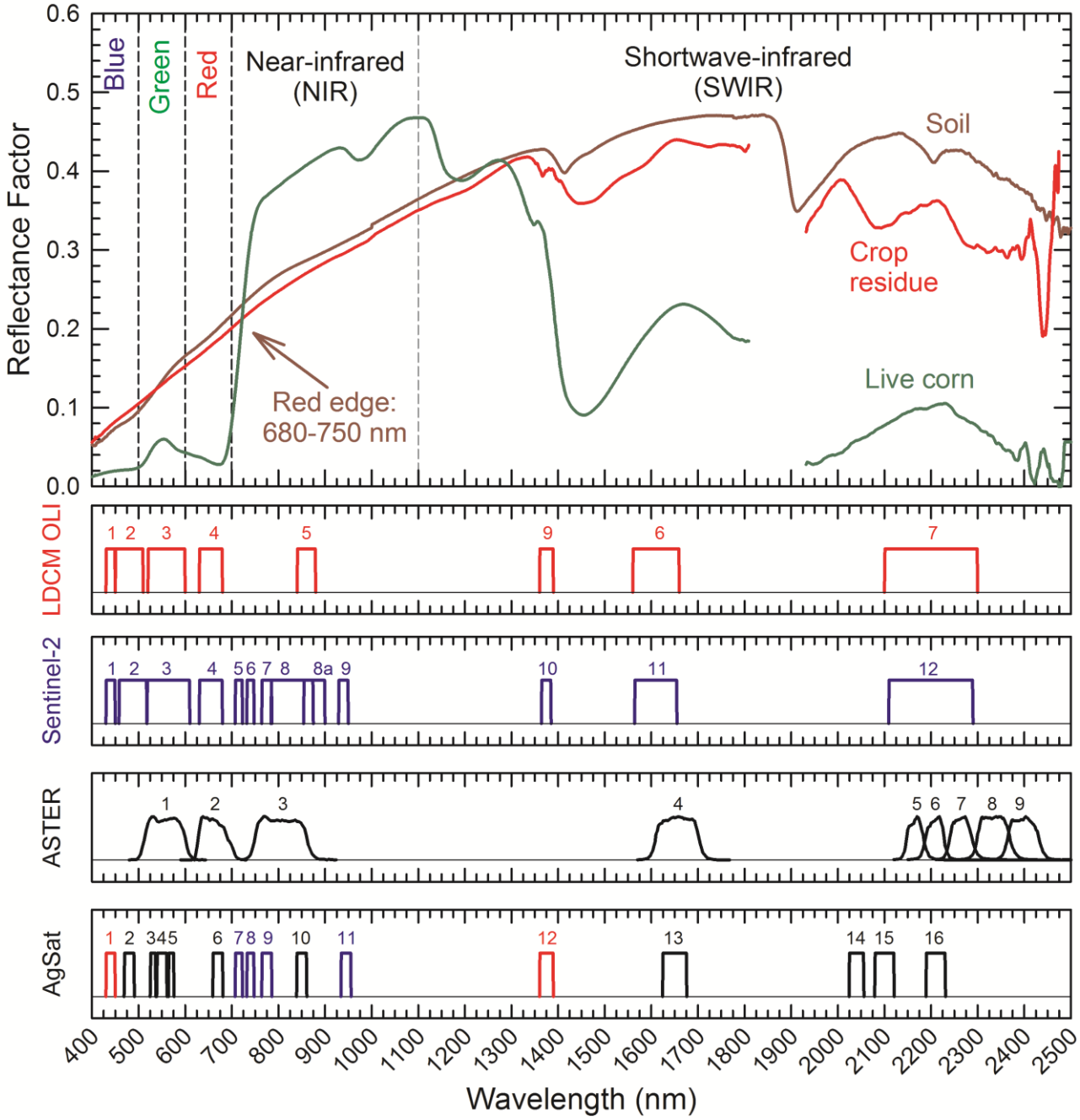
Remote sensing crop residue cover



- Below 2000 nm, crop residues and soils can be spectrally similar.
- Broad Landsat TM bands cannot discriminate narrow spectral features of dry vegetation components.
- Cellulose Absorption Index (CAI) ideal for sensing dry vegetation:

$$CAI = 100\left[\left(R_{2030} + R_{2210}\right)/2 - R_{2100}\right]$$

- CAI targets an absorption occurring at 2100 nm present for all sugars, including cellulose.
  - Most soil minerals do not have absorptions in this region.
- CAI has a linear relationship between bare soil, 100% residue cover.


Reflectance Factor
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Blue
Green
Red
Near-infrared
(NIR)
Shortwave-infrared
(SWIR)
Soil
Crop
residue
Live corn
Red edge:
680-750 nm
LDCM OLI
1 2 3 4 5 9 6 7
Sentinel-2
1 2 3 4 5 6 7 8 8a 9 10 11 12
ASTER
1 2 3 4 5 6 7 8 9
AgSat
1 2 345 6 78 9 10 11 12 13 14 15 16
400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400 2500
Wavelength (nm)

+ TIR Bands

Disclaimer

This concept is based on discussions about satellite data requirements for agricultural monitoring and does not represent official USDA or ARS policy.

Satellite Needs Working Group
US Group on Earth Observations Subcommittee

- Formed to conduct an annual process by which agencies identify and articulate Federal needs for Earth observations from space
- Supports USGEO activities for national approaches to identify and articulate Earth observations needs
- Helps address current challenges in transitioning experimental observations into sustained observations, to support public services and research in the public interest

USGEO Satellite Needs Working Group (cont'd)

- Agency needs will be documented and provided to NASA and other US space system provider agencies
  - High-level needs, not requirements; they will not define design, engineering, and operation of future observing systems
- USGEO intends to publically release information on potential measurements and capabilities of interest to agencies, to encourage private sector and government partnerships