The 14th International Circumpolar Remote Sensing Symposium
September 12-16, 2016
Homer, Alaska

HyLab
University of Alaska Fairbanks Hyperspectral Imaging Laboratory

HyLab: A hyperspectral laboratory for surface water and vegetation characterization in Alaska's Arctic and boreal regions

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1- University of Alaska Fairbanks. 2- Flemish institute for technological research (VITO)

Hyperspectral Imaging or Imaging Spectroscopy

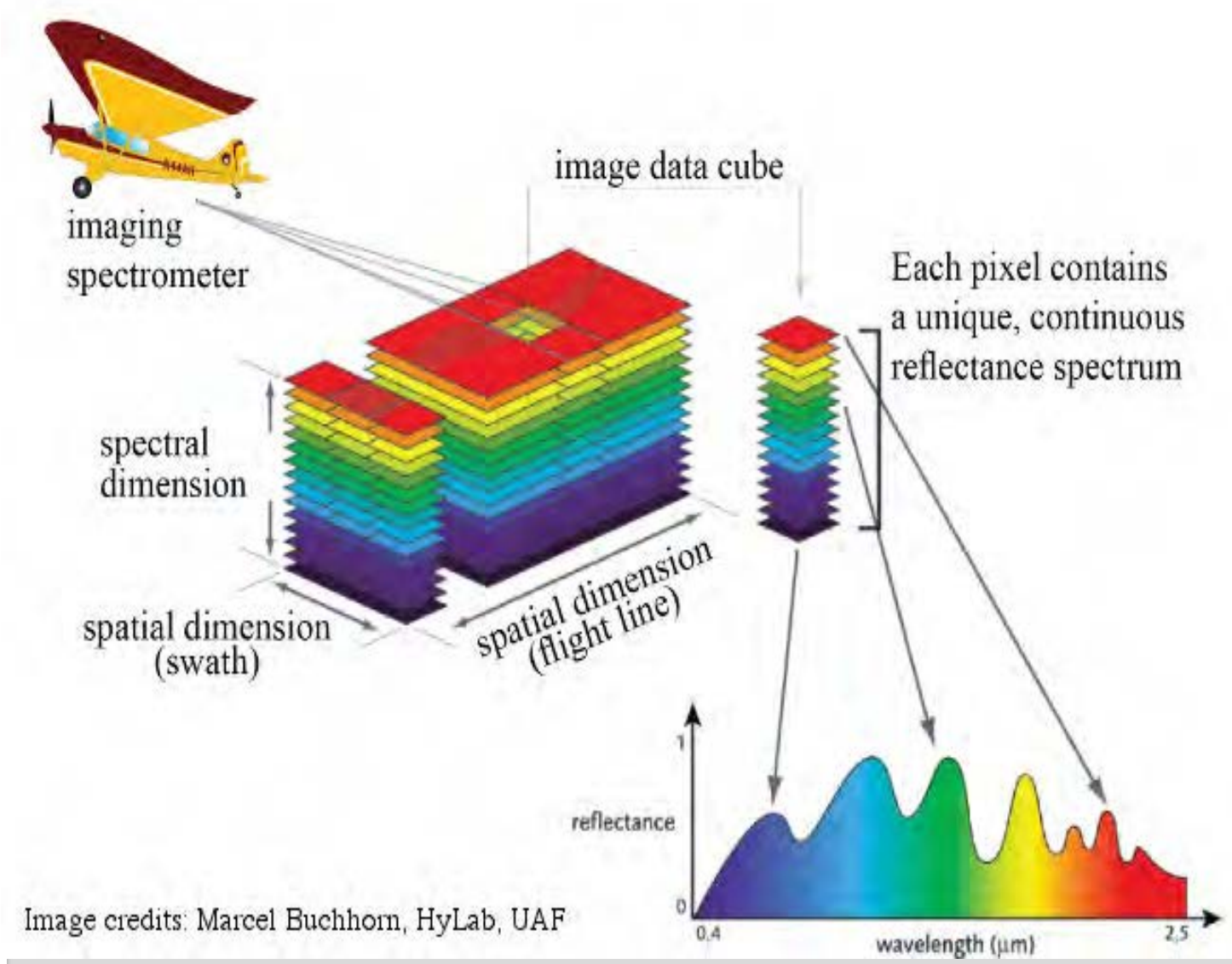
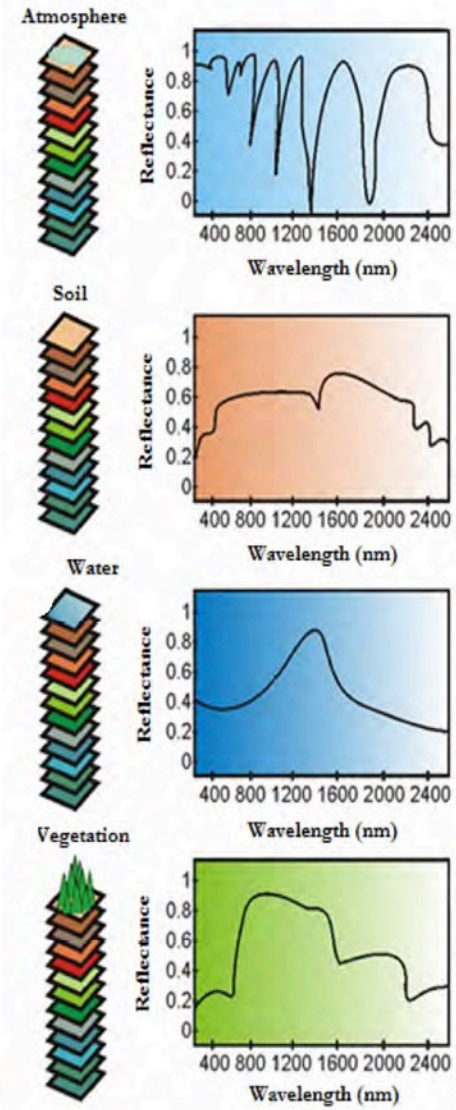


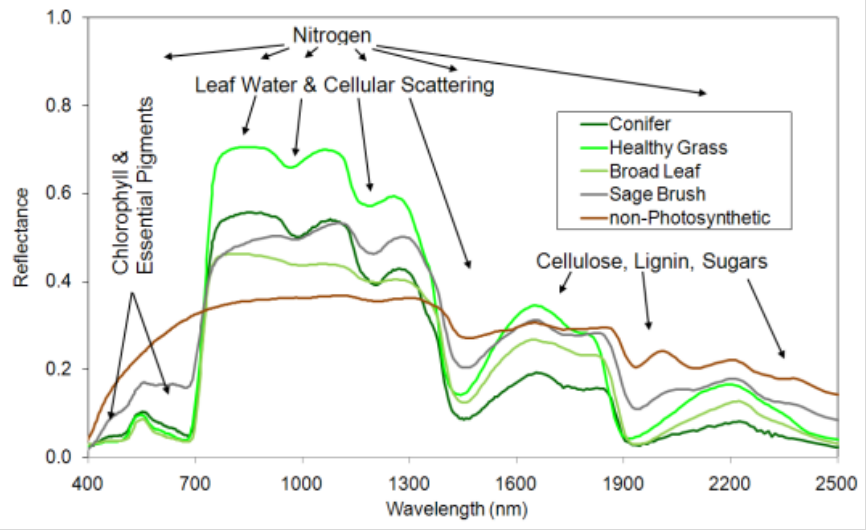
Image credits: Marcel Buchhorn, HyLab, UAF

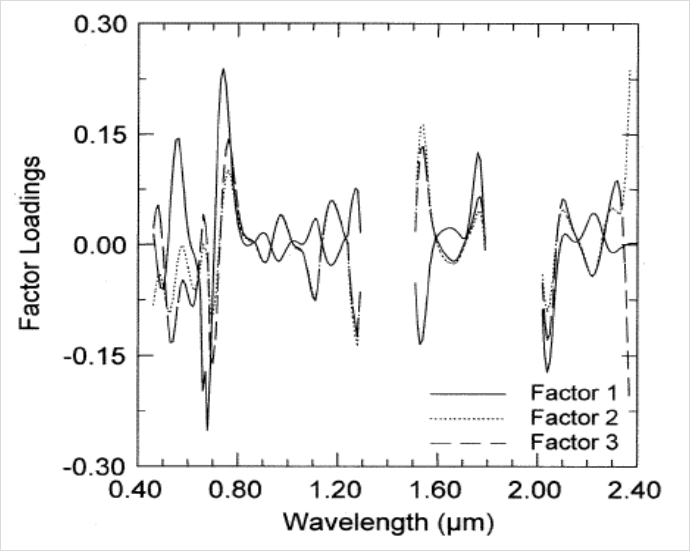


We acquire 100s of spectral bands; And extract diagnostic spectral signatures

The Need for Continuous Spectral Measurements

- Plant functional types and species have biochemical and biophysical properties that are expressed as reflectance absorption and scattering features spanning the spectral region from 380 to 2500 nm.
- Individual bands do not capture the diversity of biochemical and biophysical signatures of plant functional types, species or physiological condition.
- Changes in the chemical and physical configuration of ecosystems are expressed as changes in the contiguous spectral signatures related to plant functional types, physiological condition, vegetation health, and species distribution.
- Important atmospheric correction information as well as calibration feedback is contained within the spectral measurement.





Images courtesy: Rob Green & HyspIRI Science Working Group

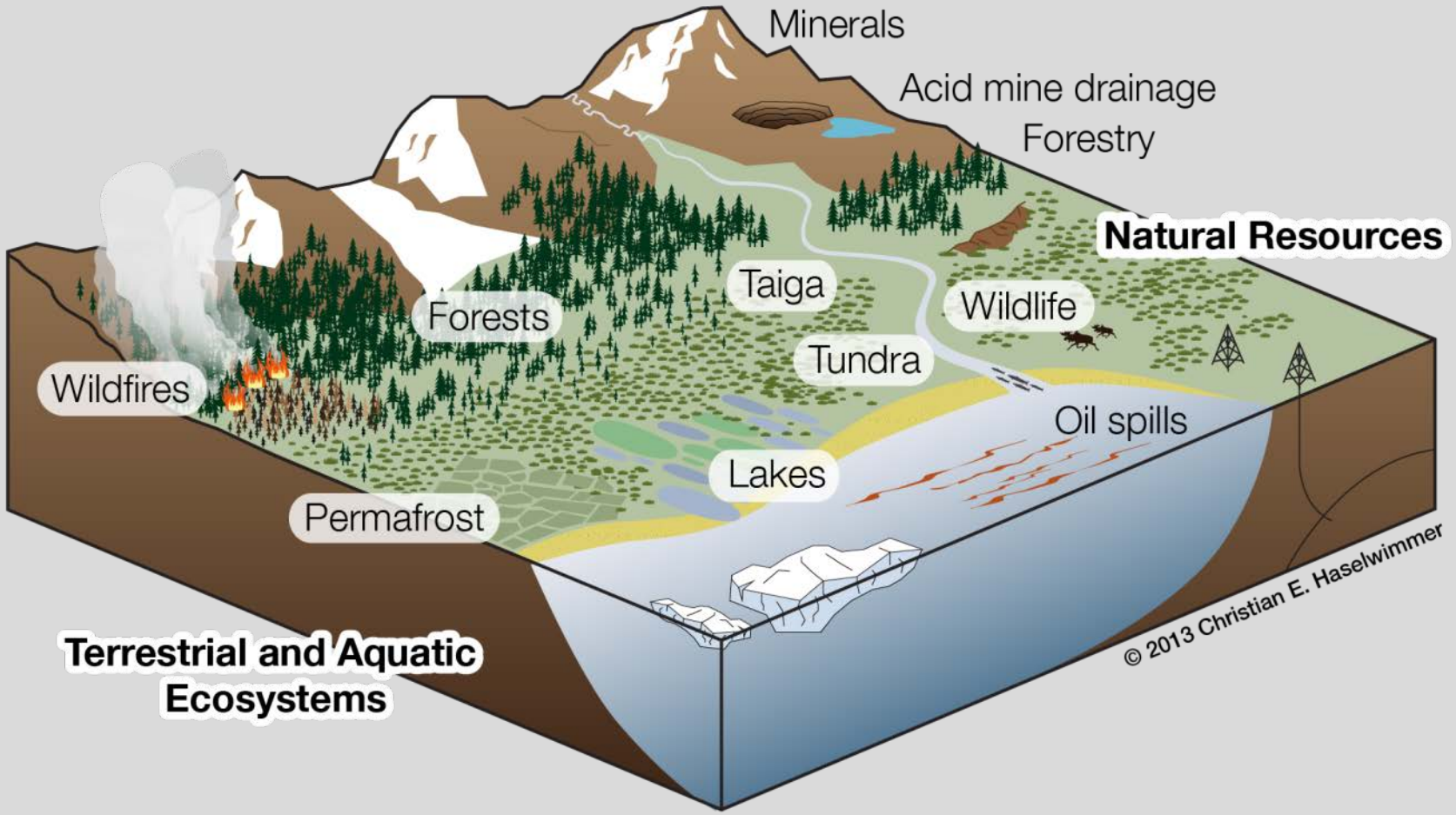
NSF Major Research Instrumentation (MRI) Award

- Sept 2013 – Aug 2016
- UAF Hyperspectral Imaging Laboratory (HyLab)
- Project objectives (2013-16):
  - Acquire, integrate, and commission HySpex system
  - Develop in-house calibration + data processing workflow
  - Complete testing over an Alaskan study site
- 2016 onwards: deployments supporting collaborative research across a range of application areas

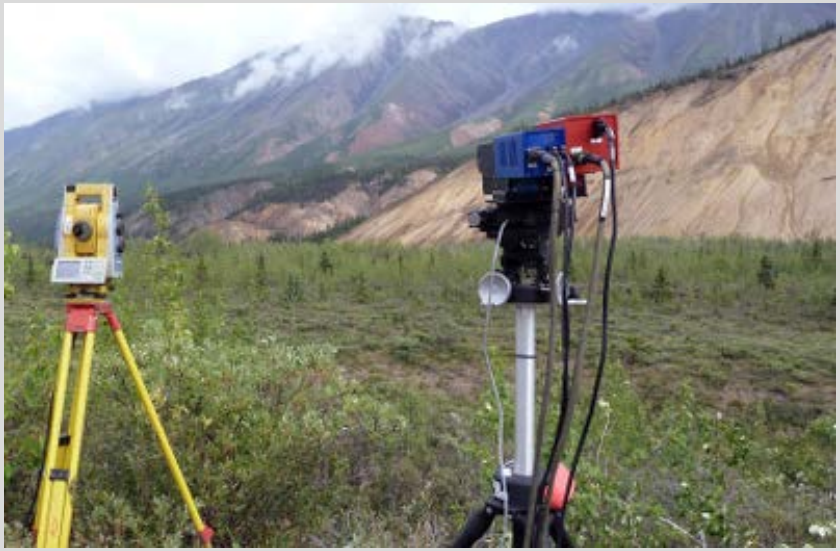
www.hyperspectral.alaska.edu

Alaskan/Arctic Applications

- Terrestrial and aquatic ecosystem applications
- Natural resource studies



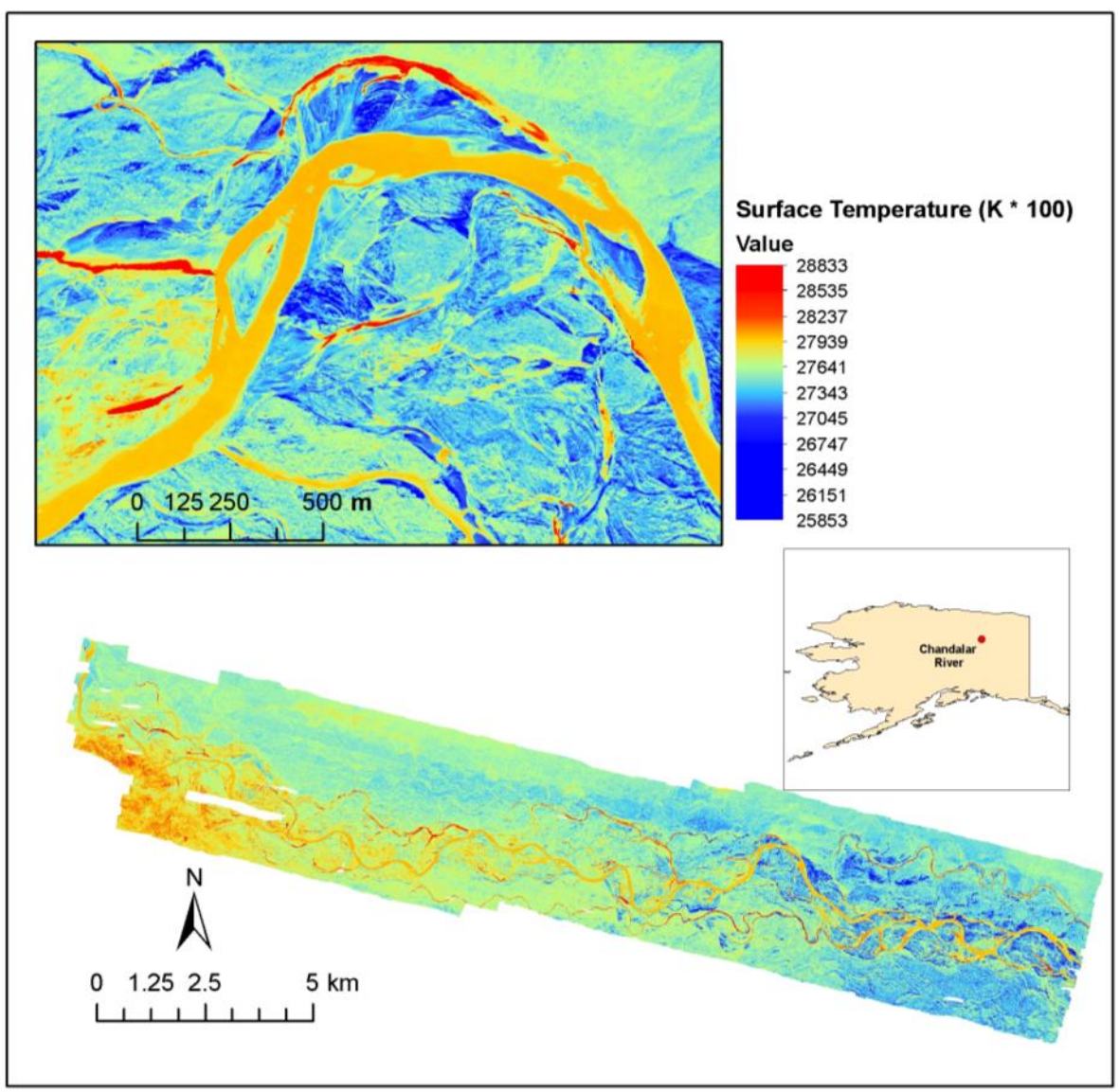
Equipment



HySpex System

Manufacturer	NEO / HySpex	
Model	VNIR-1800	SWIR-384
Spectral range (nm)	400 - 1000	930 - 2500
No of bands	182	288
Radiometric resolution	16 bit	14 bit
Spectral sampling (nm)	3.3	6
Spatial pixels	1800	384
SNR (peak)	255:1	500:1
Dimensions (lwh in cm)	39 x 14 x 36	
Approx weight for system (kg)	20	
Power consumption (W)	160	

Thermal sensor: FLIR camera



The FLIR instrument

1- FLIR A325/A655 Infrared Camera (7.5 - 13.0 µm).

2- HFOV and VFOV of 25° and 18.8°, respectively.

Calibration

- Full calibration (to NIST standards) performed prior to each flying season at external facilities
- In-house calibration facilities will be used to monitor instrument stability (GI Optical Lab)
- Field calibrations
- Support from NEON, JPL, DLR

Source: NERC

Aviat Husky A-1B aircraft

HySpex Commissioned in a USFWS BushHawk Aircraft

- Vibration dampening mount; IMAR iTrace RT-F400; IMU/GPS; Compact, data acquisition unit with 1 Tb solid state drive and a touch screen flat-panel monitor

UAF BushHawk Yukon Flats - flight plan

Flight date: September 2 & 3, 2015 **Flight Time:** 12 p.m. to 16 p.m. (AKDT)

Flight Time: 1:30 p.m. to 3:20 p.m. (AKDT)

Pilot: Nikki Guldager

Flight crews: Dr. Jordi Cristóbal Rosselló, Patrick Graham (Geophysical Institute-UAF).

HySpex operator: Patrick Graham

Field crew: N/A

Flight details:

We plan to fly Yukon Flats and we have requested 15 hours flight around solar noon (2 p.m. AKDT) for at least 3 days. We selected 5 possible flight scenarios and ranked them from 1 to 5 (see table 1). Flights from 1 to 5 should be doable within a 3-hour flight.

Ranking	Sensor-object distance (ft)	Flight height (ft)	Direction	GSD (m)
1	2800 feet, **W-to-E**	2800 ft	West → East	0.5
2	2800 feet, **N-to-S**	2800 ft	North → South	0.5
3	2800 feet, **W-to-E**	2800 ft	West → East	0.5
4	2800 feet, **W-to-E**	2800 ft	West → East	0.5
5	2800 feet, **W-to-E**	2800 ft	West → East	0.5

The imagery will be acquired with a HySpex VNIR-1800 and HySpex SWIR-384 hyperspectral cameras from NEO (more info at http://www.hyspex.no/products/vnir_1800.php).

In all cases we plan to fly at 165 km/h (102 mph or 89 knots) and with an effective frame width 40% to 75% sidelap.

More information about each flight below.

Detailed flight planning for 5 areas

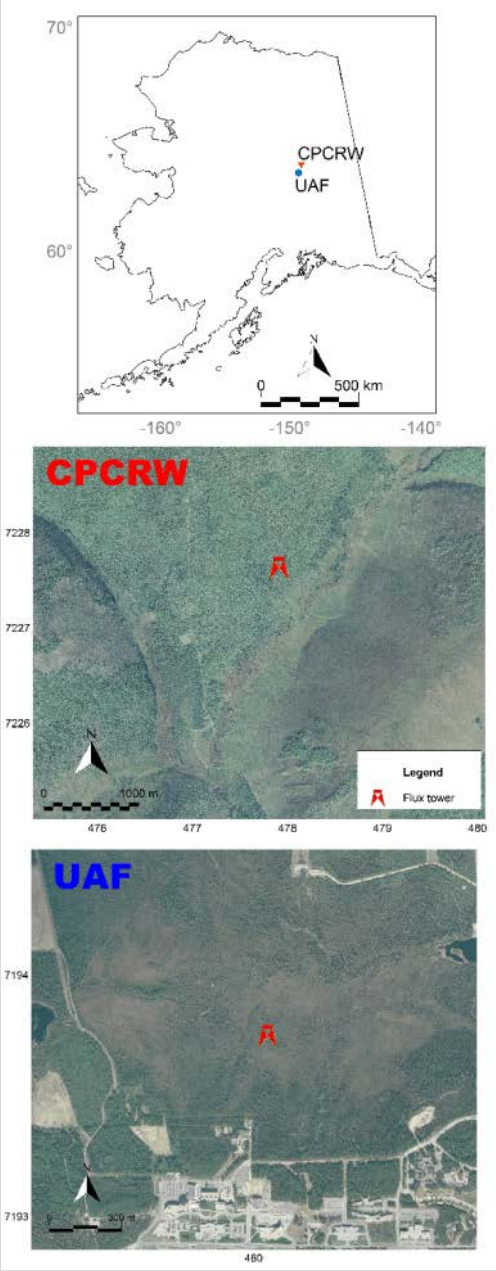
HySpex commission, test, and image acquisitions

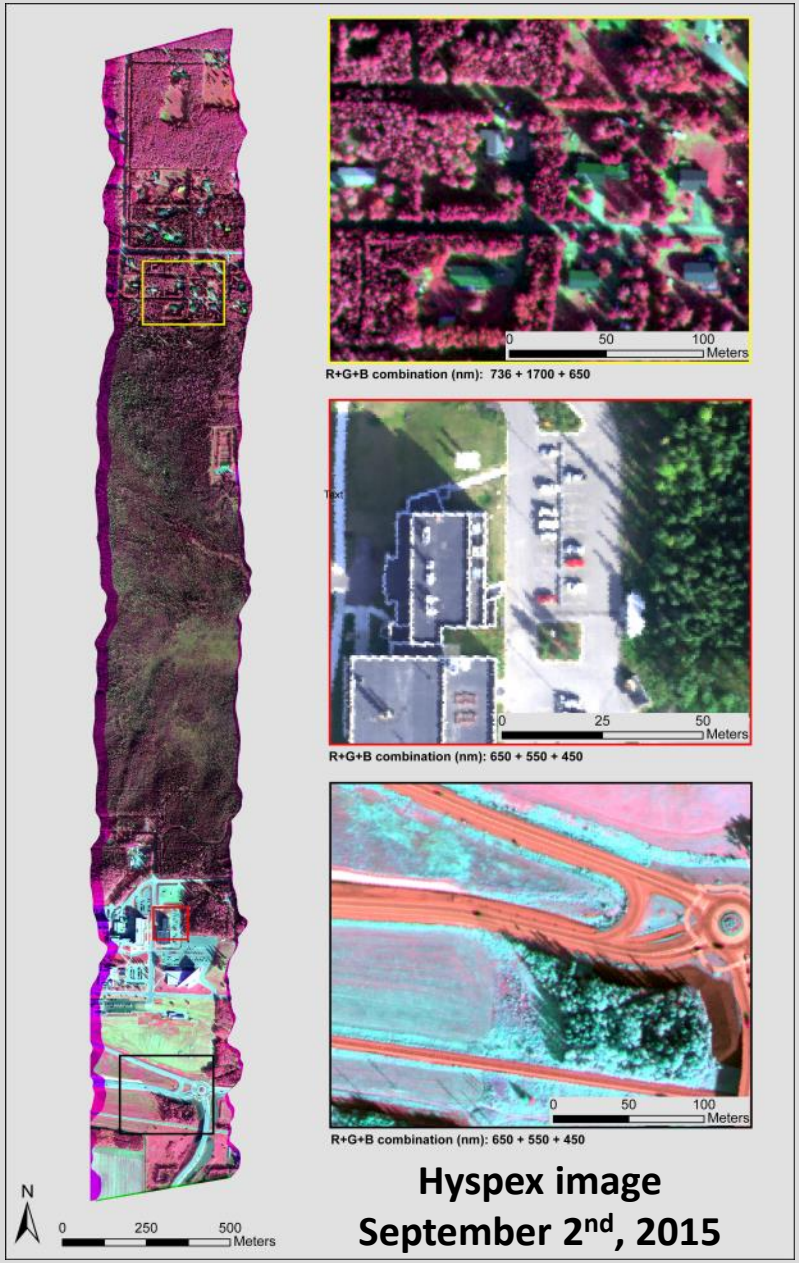
Flight planning

Yukon Flats National Wildlife Refuge

Hyperspectral flight on 2nd and 3th September, 2015 ➔
71 flight lines

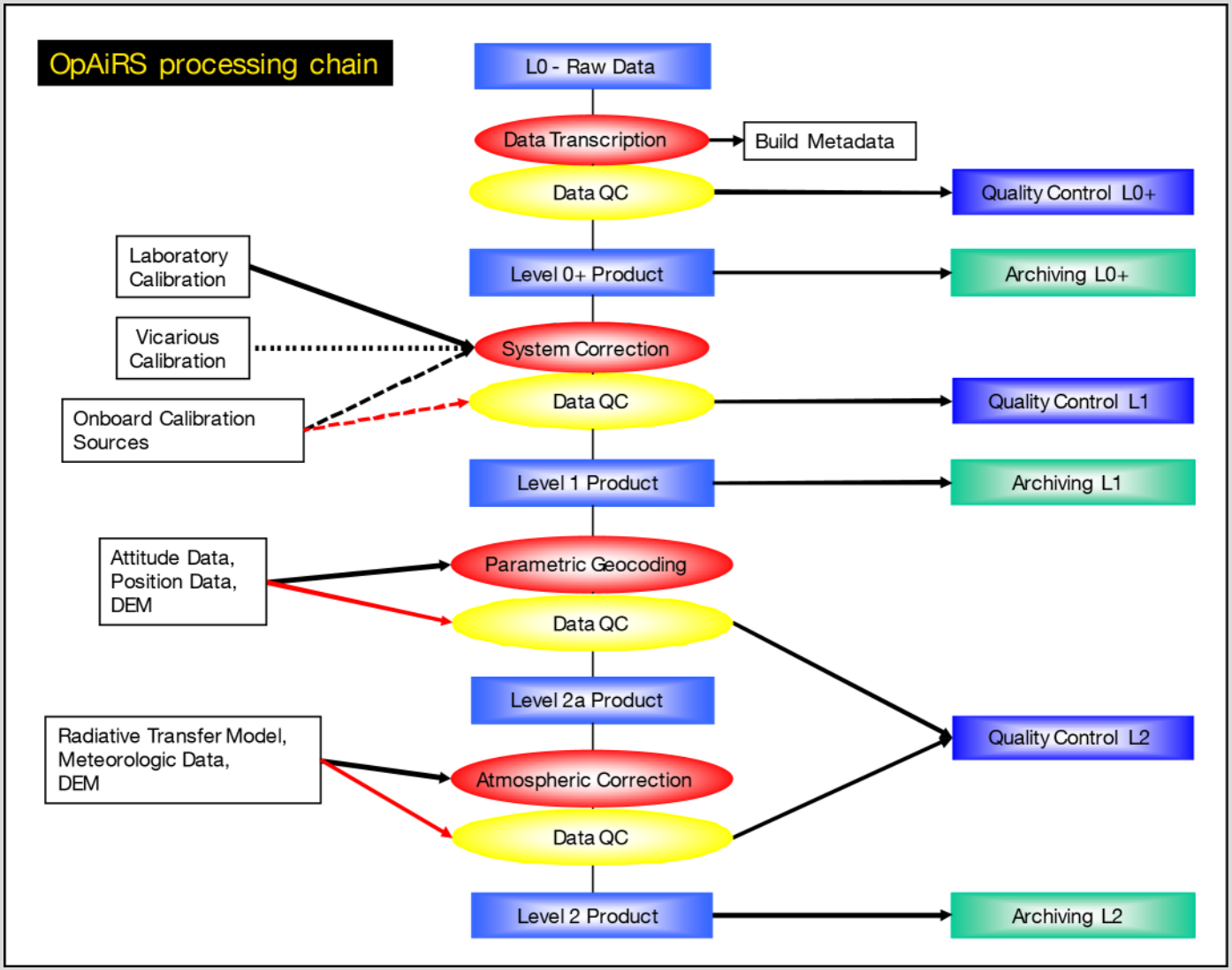
CAL/VAL sites (Evapotranspiration Mapping)





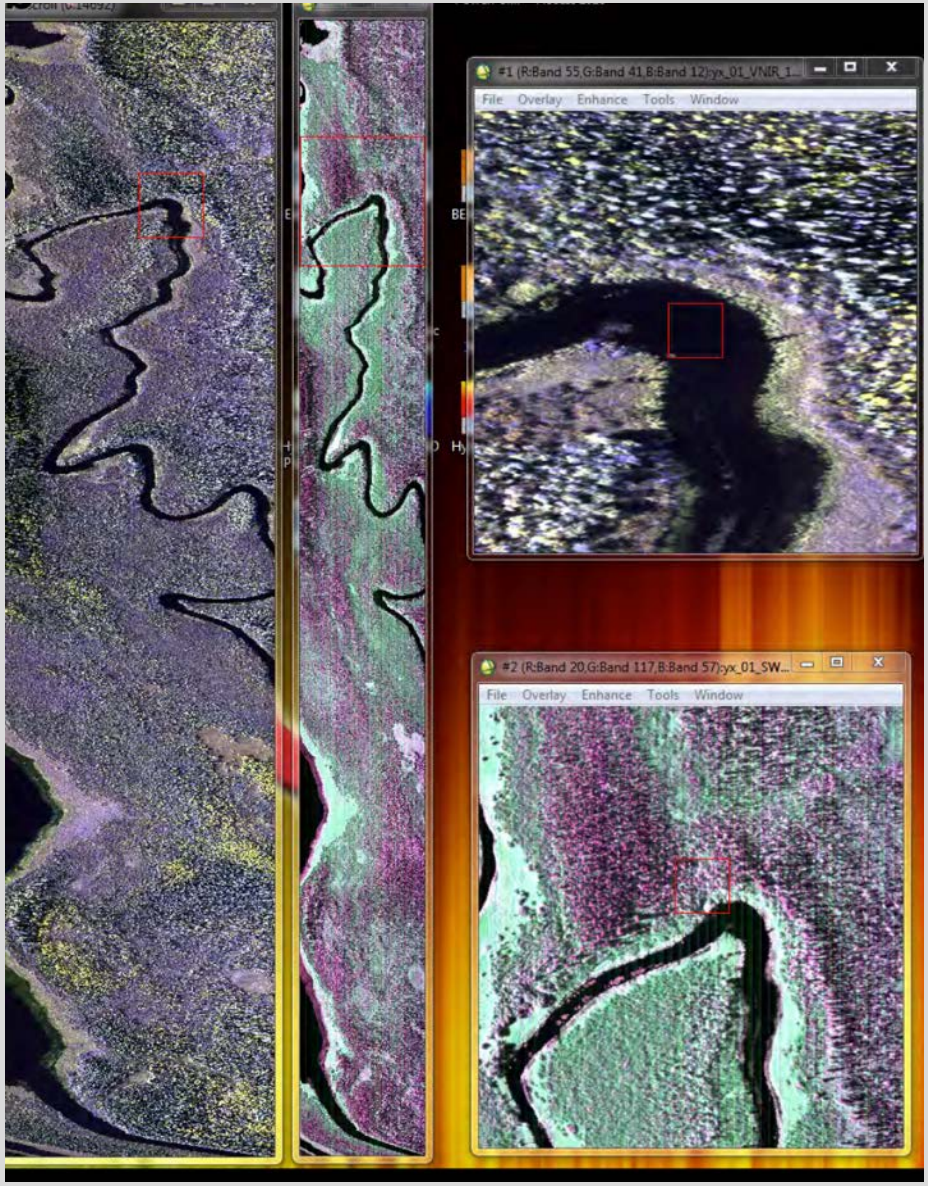
Hyspex image
September 2nd, 2015

Data Processing



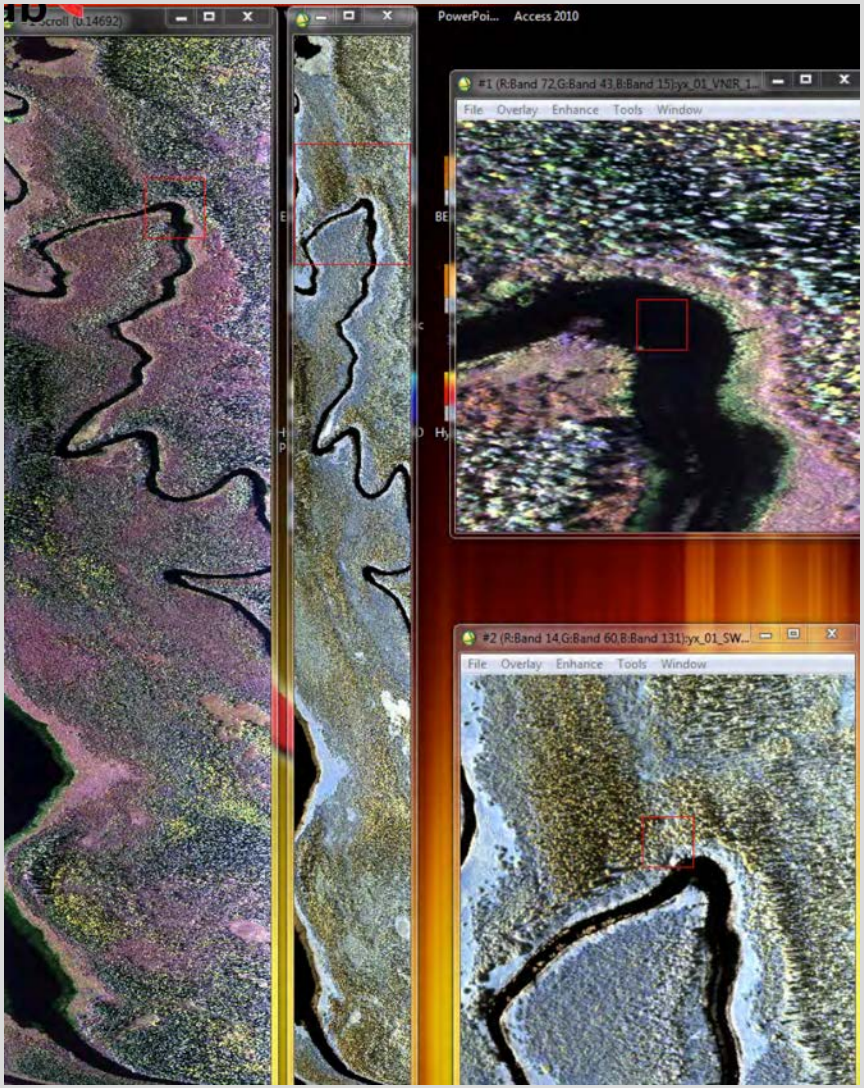
Pre-processing chain used by the German Space Agency (DLR) OpAiRS facility to convert raw HySpex data to Level 2 georegistered and atmospherically corrected surface radiance and reflectance products (from Bachmann et al., 2012)

Data Processing - 1



- Raw data (DN)
- Has stripes & artifacts
- Look distorted
  - VNIR (0.5x0.3m)
  - SWIR ().9mx0.9m)

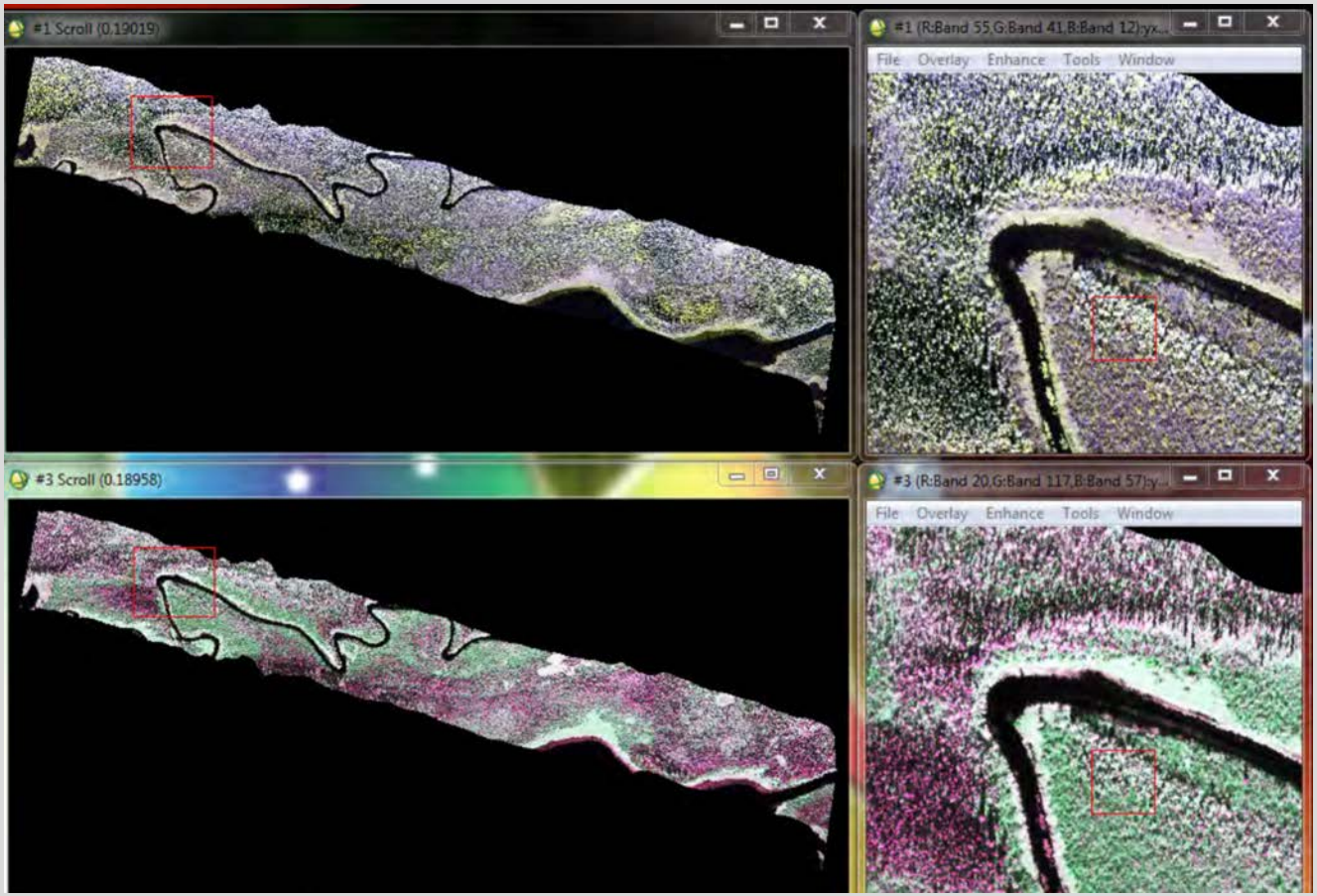
Data Processing - 2



- At sensor radiance
- Stripes removed

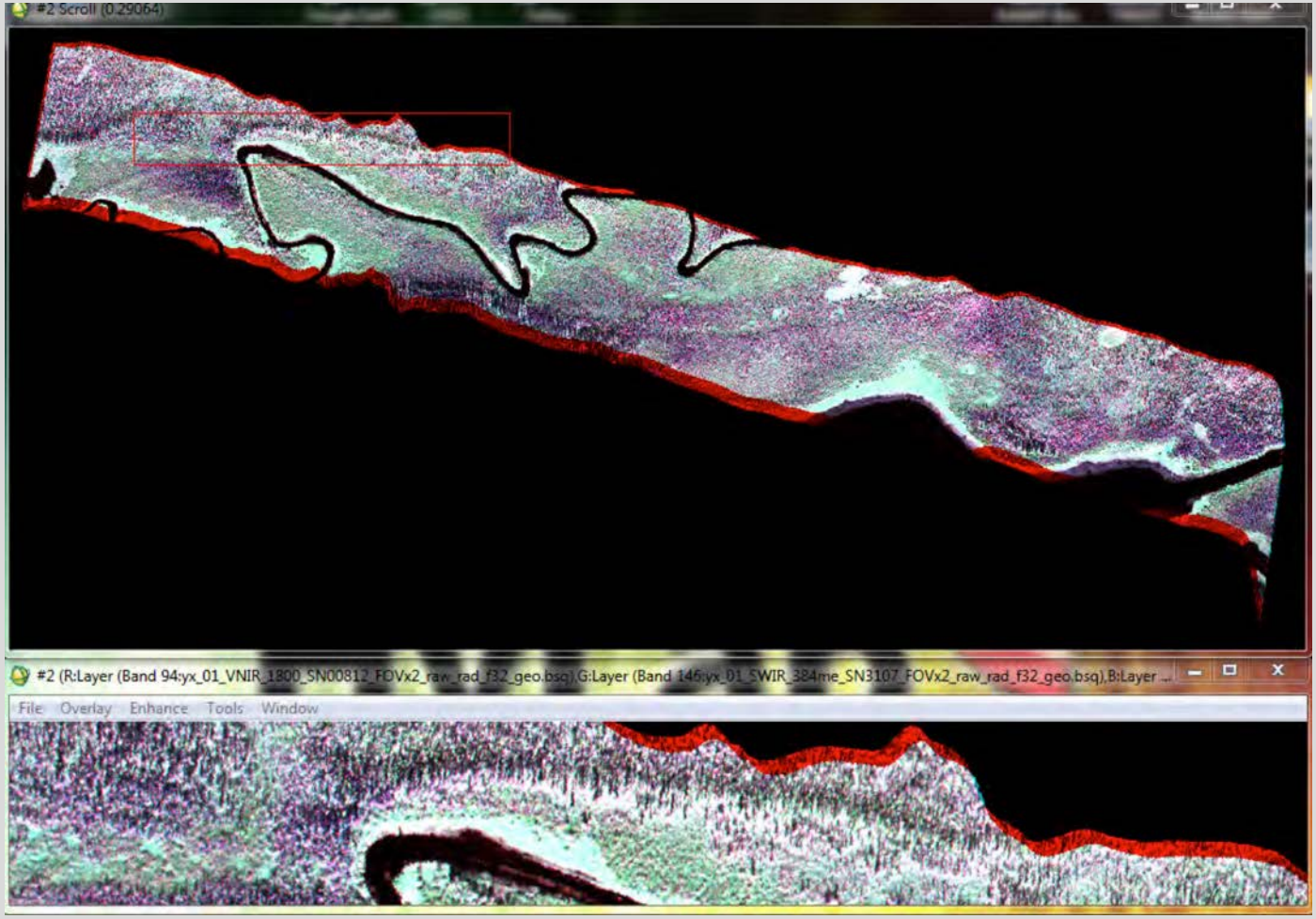
Data Processing - 3

- Images orthorectified using a sensor model and a DEM
- VNIR and SWIR resampled to 1x1m
- Coregistered with 0.5 pixel accuracy
- Requires boresight calibration



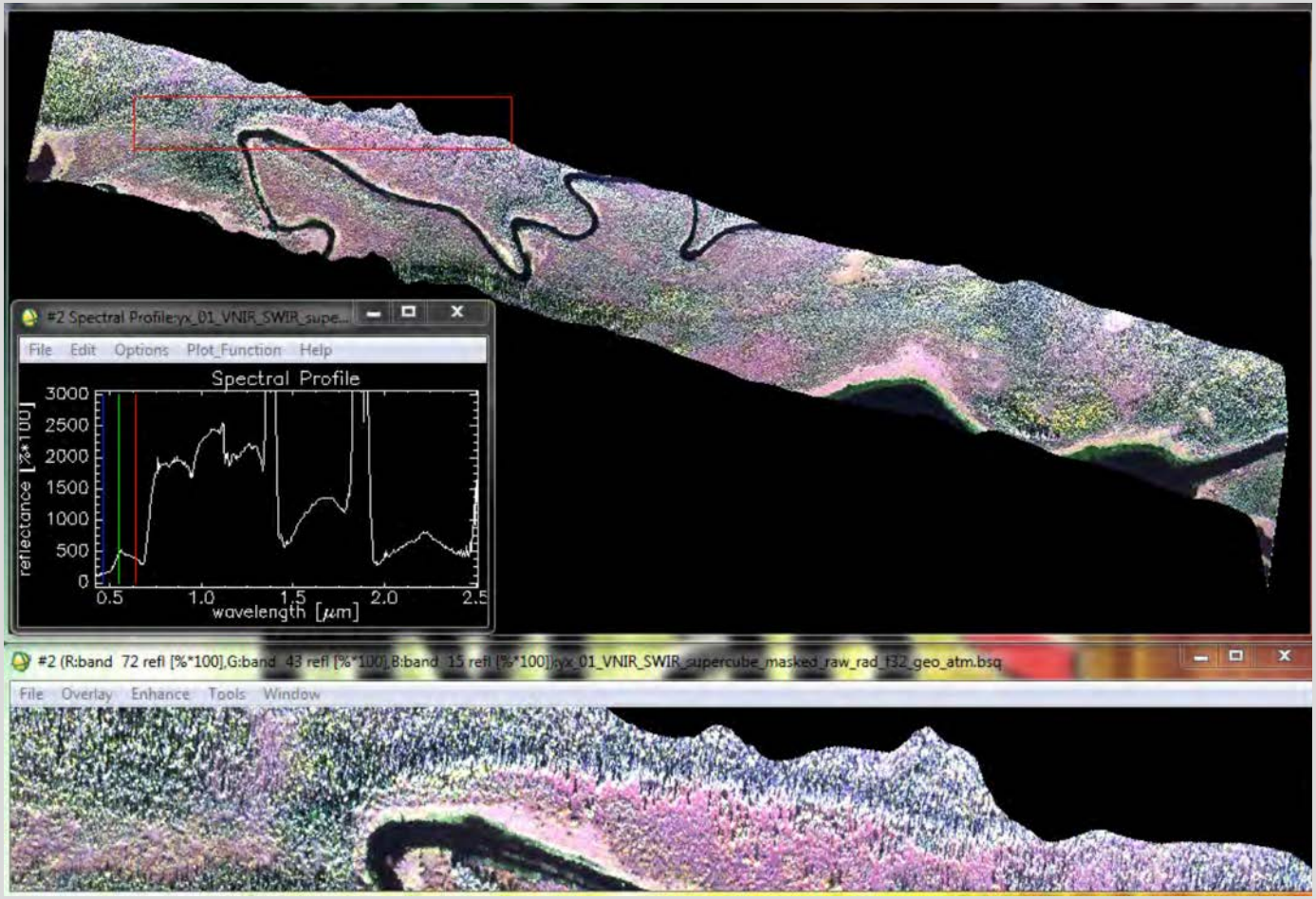
Data Processing - 4

- Create 457 band supercube
- Red is sensor swath difference



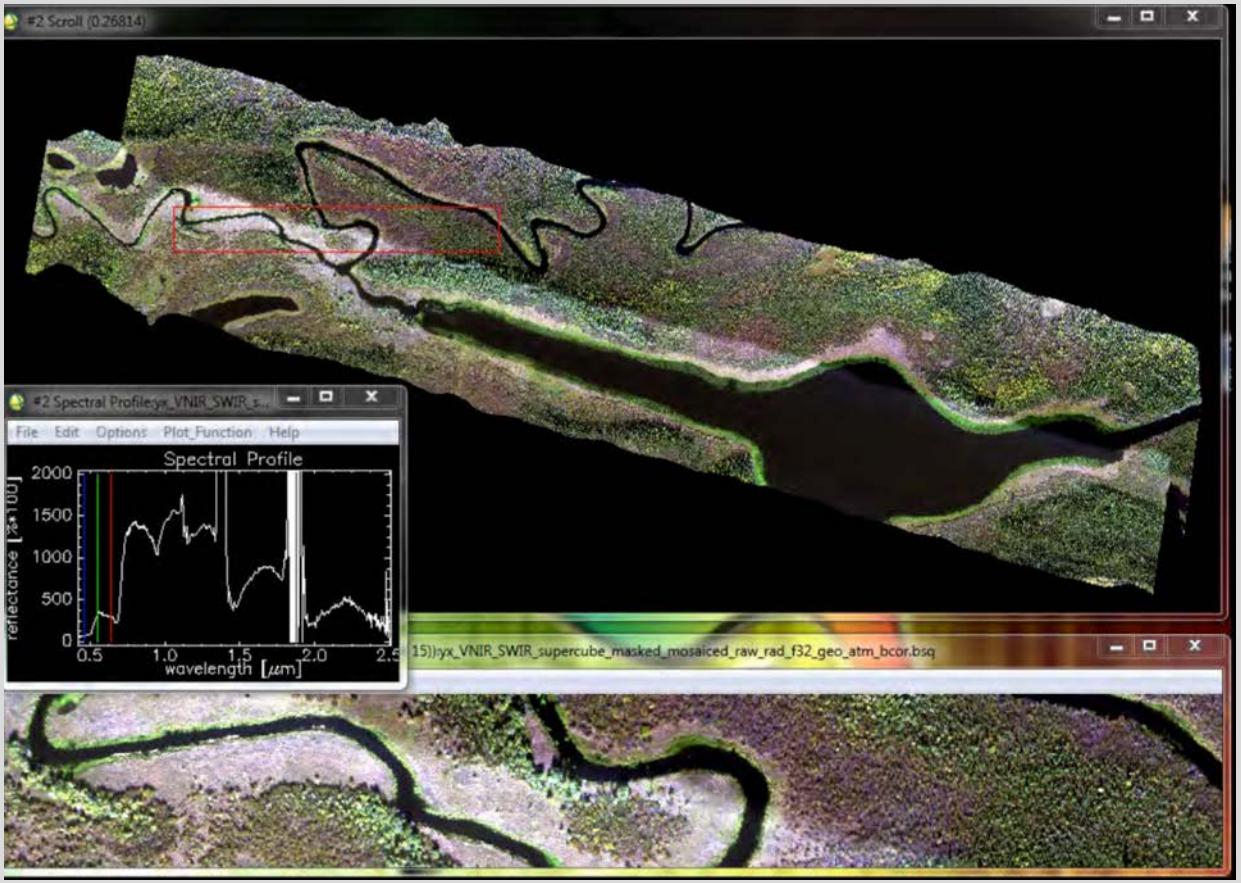
Data Processing - 5

- Trim edges
- Radiometric correction
- Conversion to surface reflectance



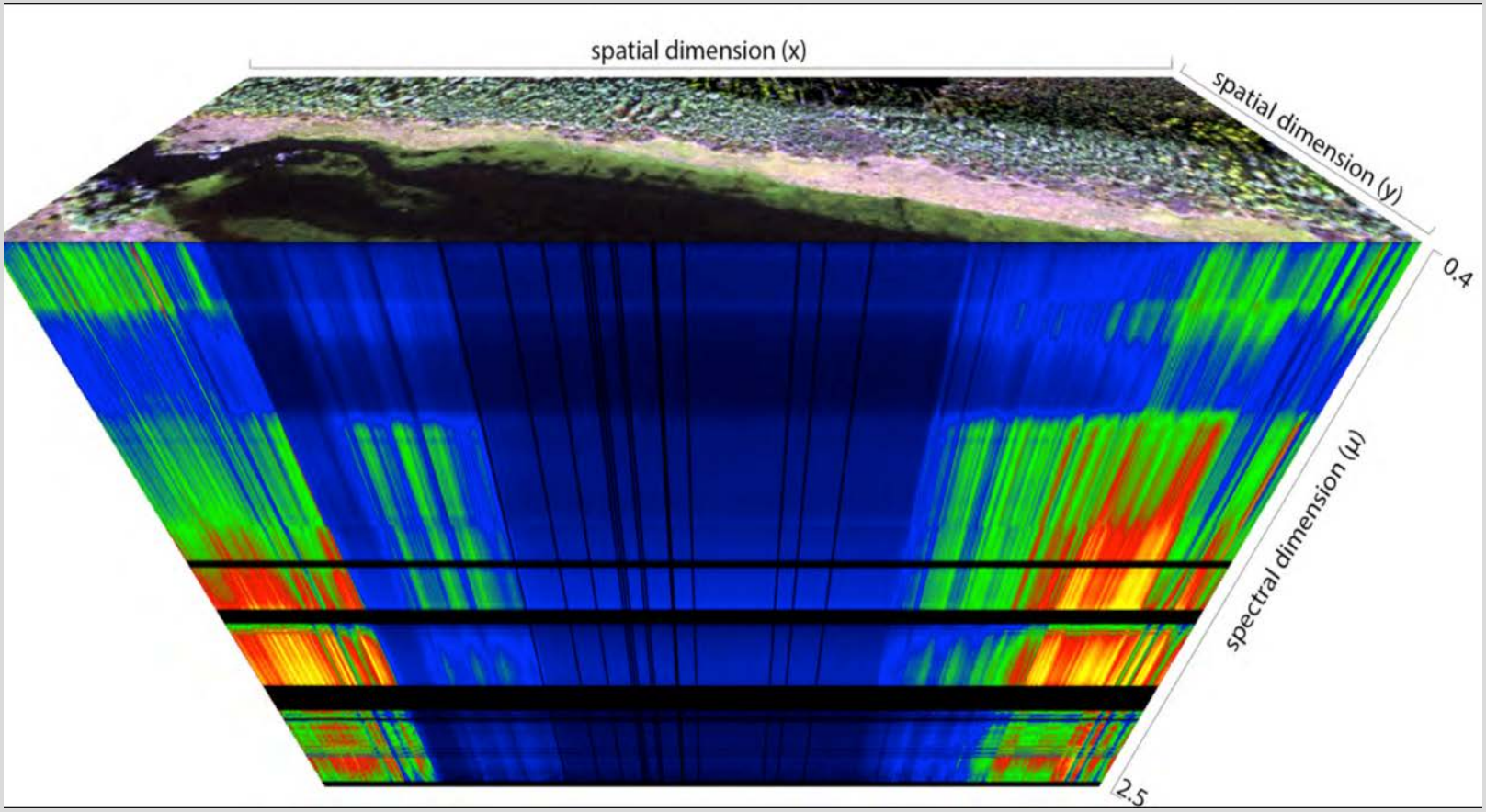
Data Processing - 6

- Create & apply BRDF model to flight lines
- Important to fly N-S or E-W in Alaska !!
- Processing bi-products can be used for classification

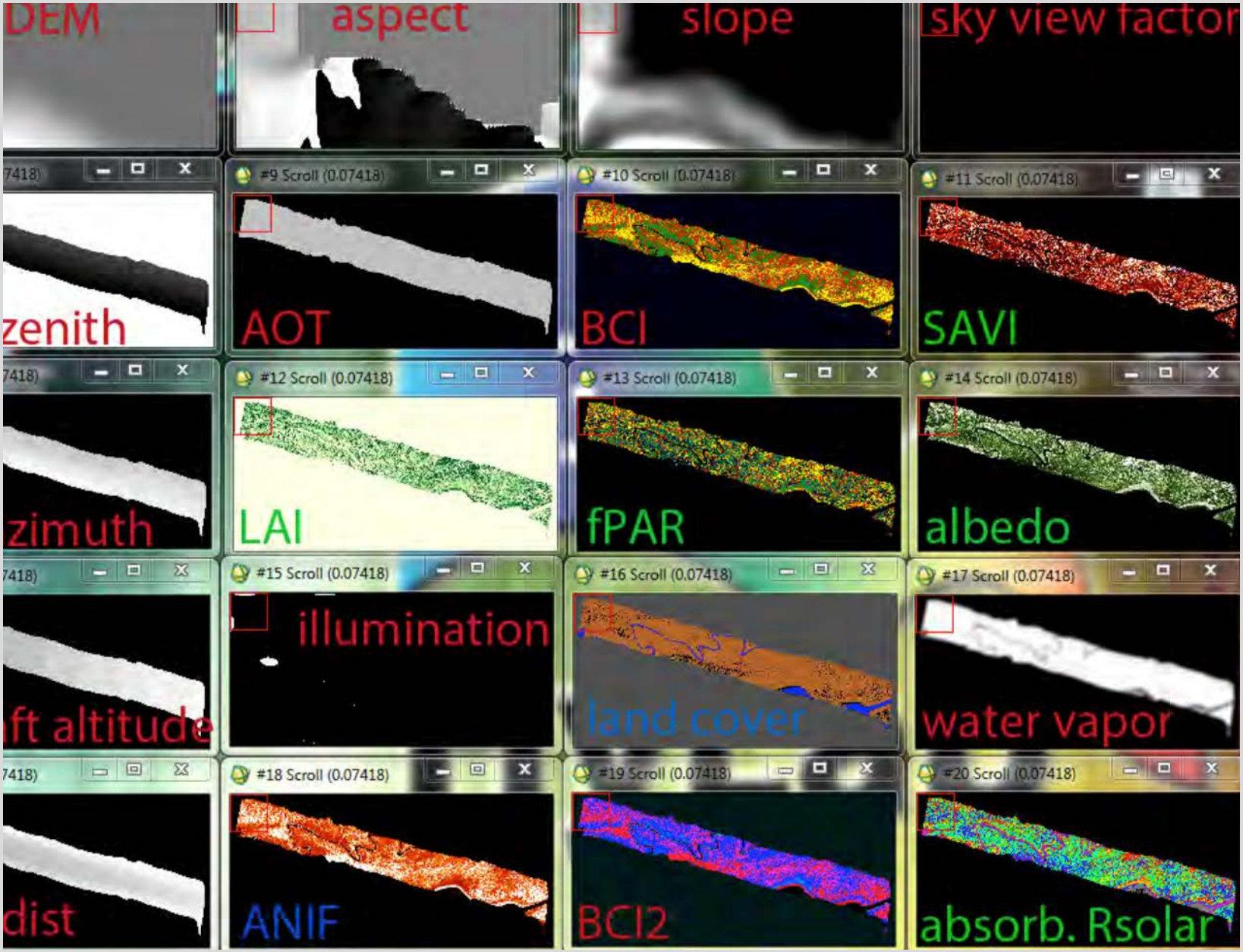


Final Data Processing - 7

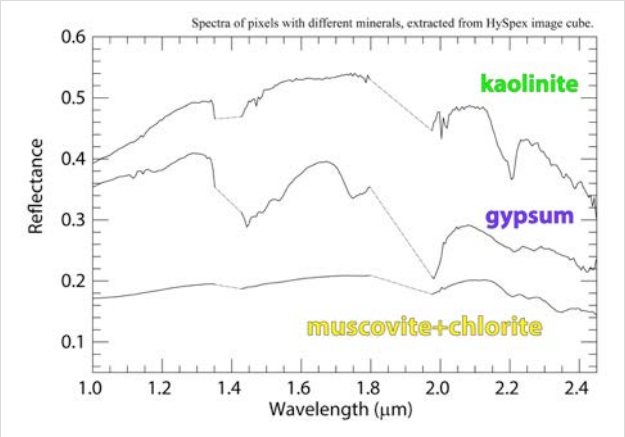
- Spectral binning; bad band removal
- ENVI header cleanup
- Metadata & documentation

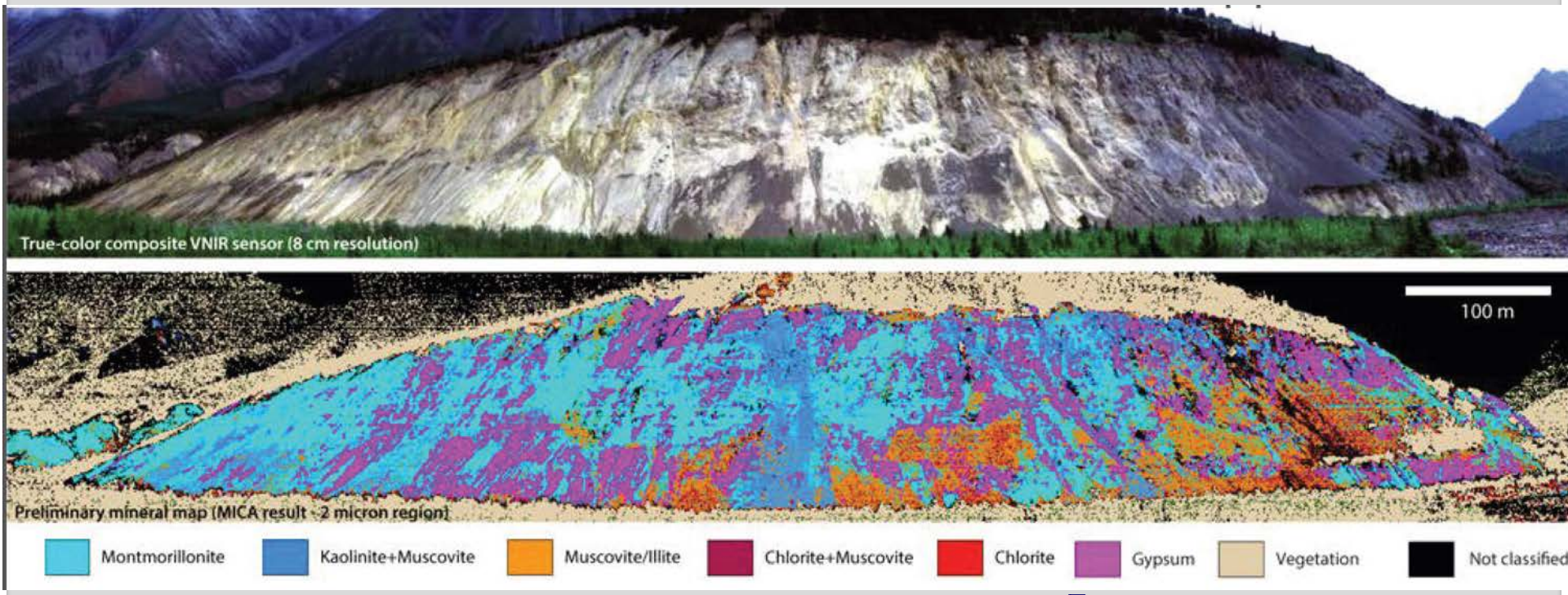


Products & bi-products



Hyspex horizontal scan at Orange Hill (2015)





USGS+UAF+DGGS Hyspex flight → 2016

Needs

- Algorithm calibration for local context
- Field validation of processing results