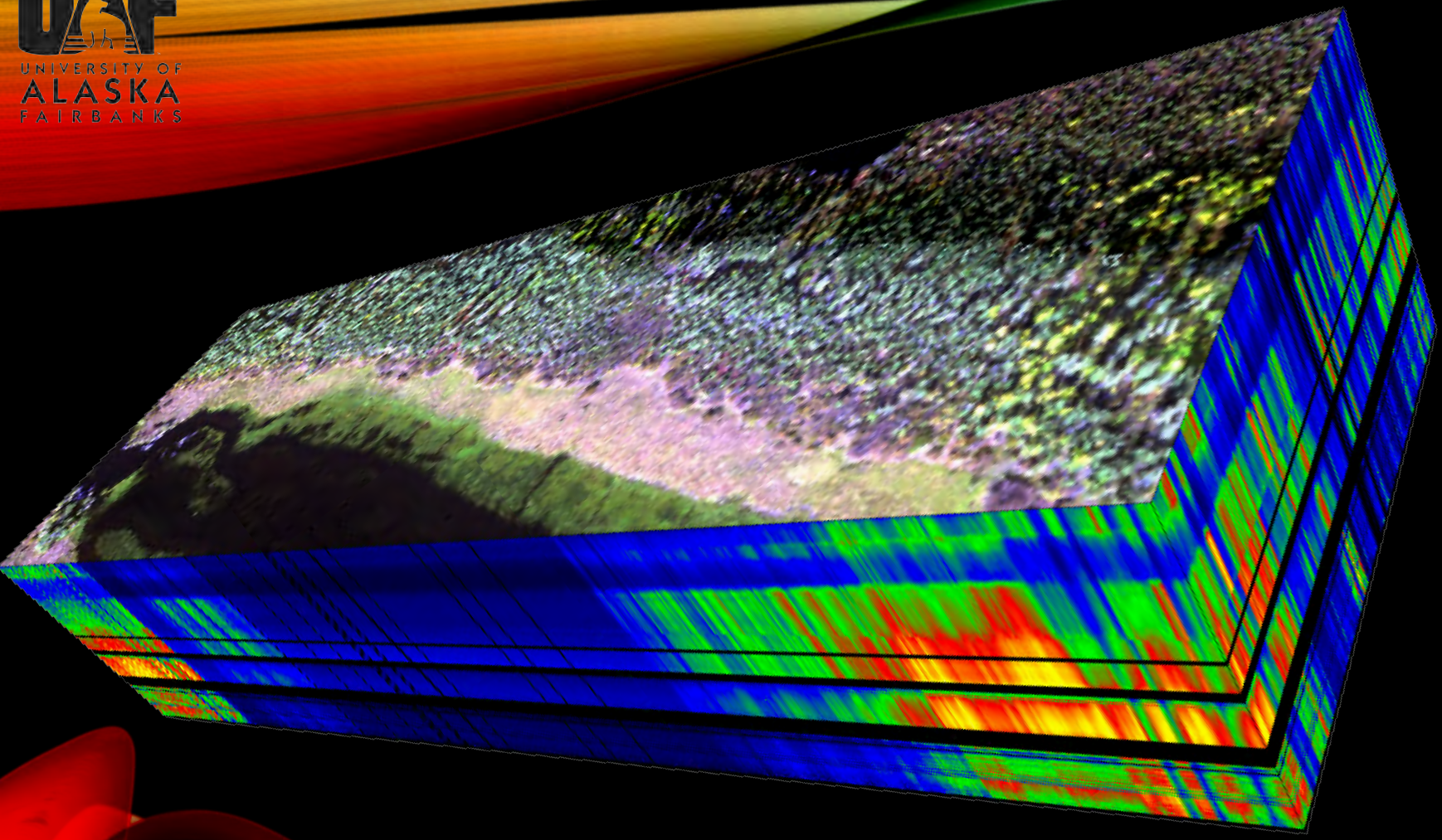


UAF - US FWS project update

YUKON FLATS: HYPERSPECTRAL CONCEPT STUDY

Meeting, March 4, 2016

Marcel Buchhorn, Jordi Cristobal-Rossello,
Anupma Prakash, Patrick Graham

PROJECT

- **Use of Hyperspectral Imaging to test "Proof of concept" technique for wetland classification and water chemistry assessment of Alaska refuges**
- to collect pilot data across the Yukon Flats Basin using Hyperspectral Imaging to test its application to classify wetlands and assess water chemistry
- Deliverables:
  - (1) The ability of Hyperspectral Imaging will be field tested to define its abilities to differentiate physical, chemical and biological parameters in Alaska wetlands.
  - (2) Future deliverables include protocols to acquire and process Hyperspectral Data, a wetland classification map that is responsive to management needs on Alaska refuges, and further defining the use of Hyperspectral Imaging with other remote sensing platforms.

IMAGING SPECTROSCOPY

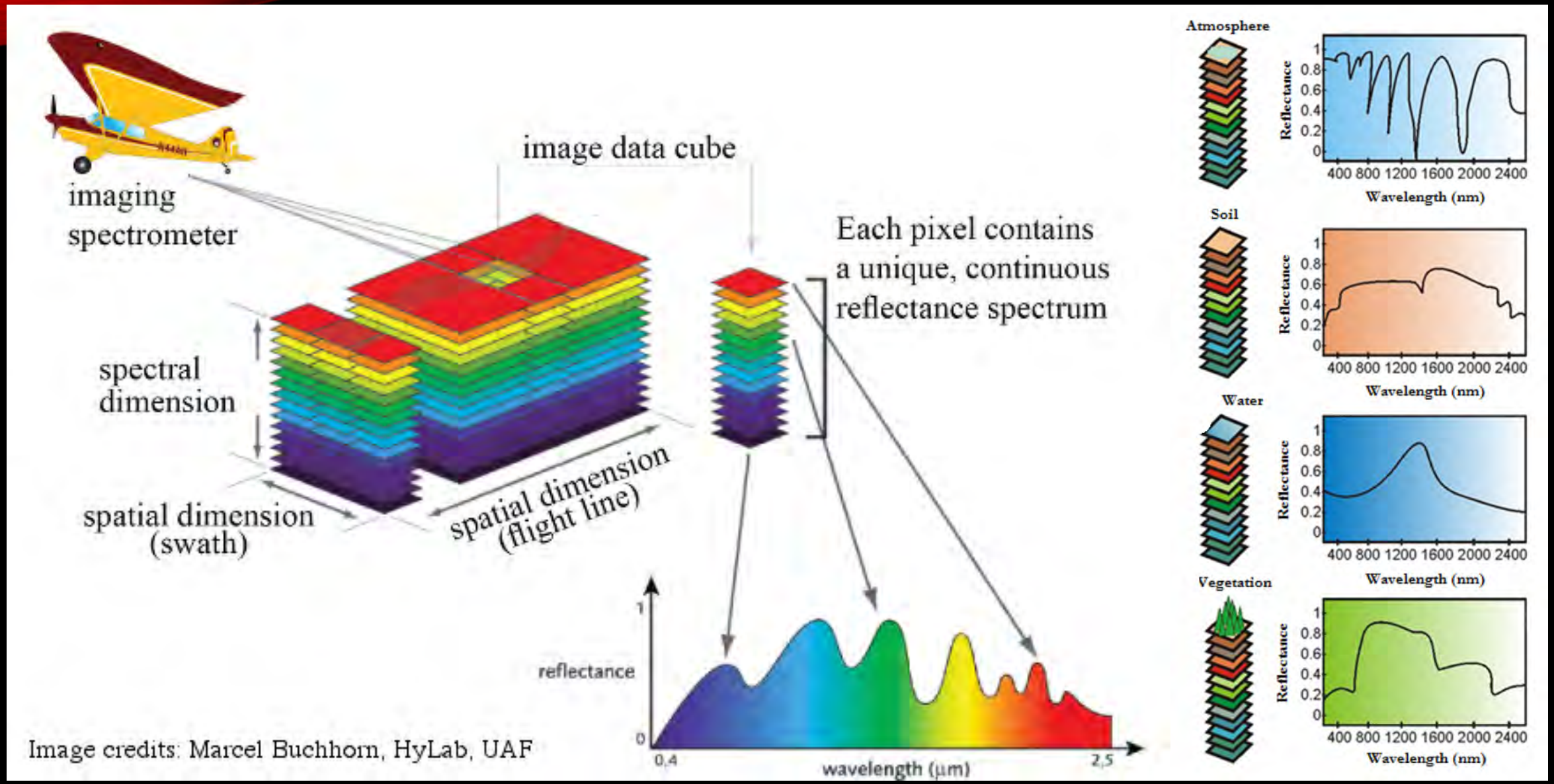


IMAGE ACQUISITIONS

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.

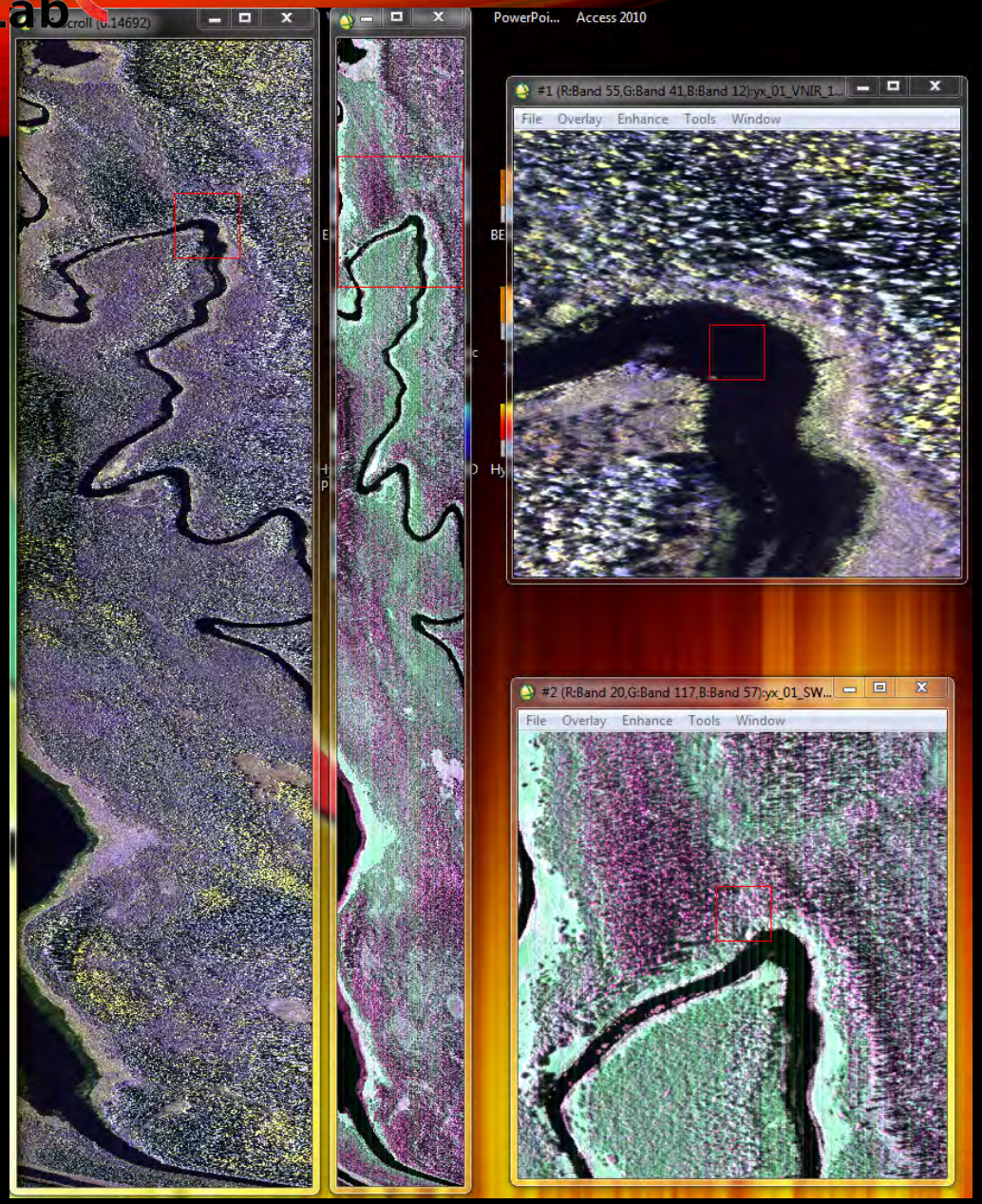
Detailed flight planning for 5 areas

HySpex commission, test, and image acquisitions

IMAGE ACQUISITIONS

- Two days of data acquisitions: 2nd and 3th September, 2015
- Nearly perfect weather conditions
- Acquired **71flight lines** over 7 target areas (plus 9 flight lines UAF targets)
- Overall 550 GB of RAW data !!!!!

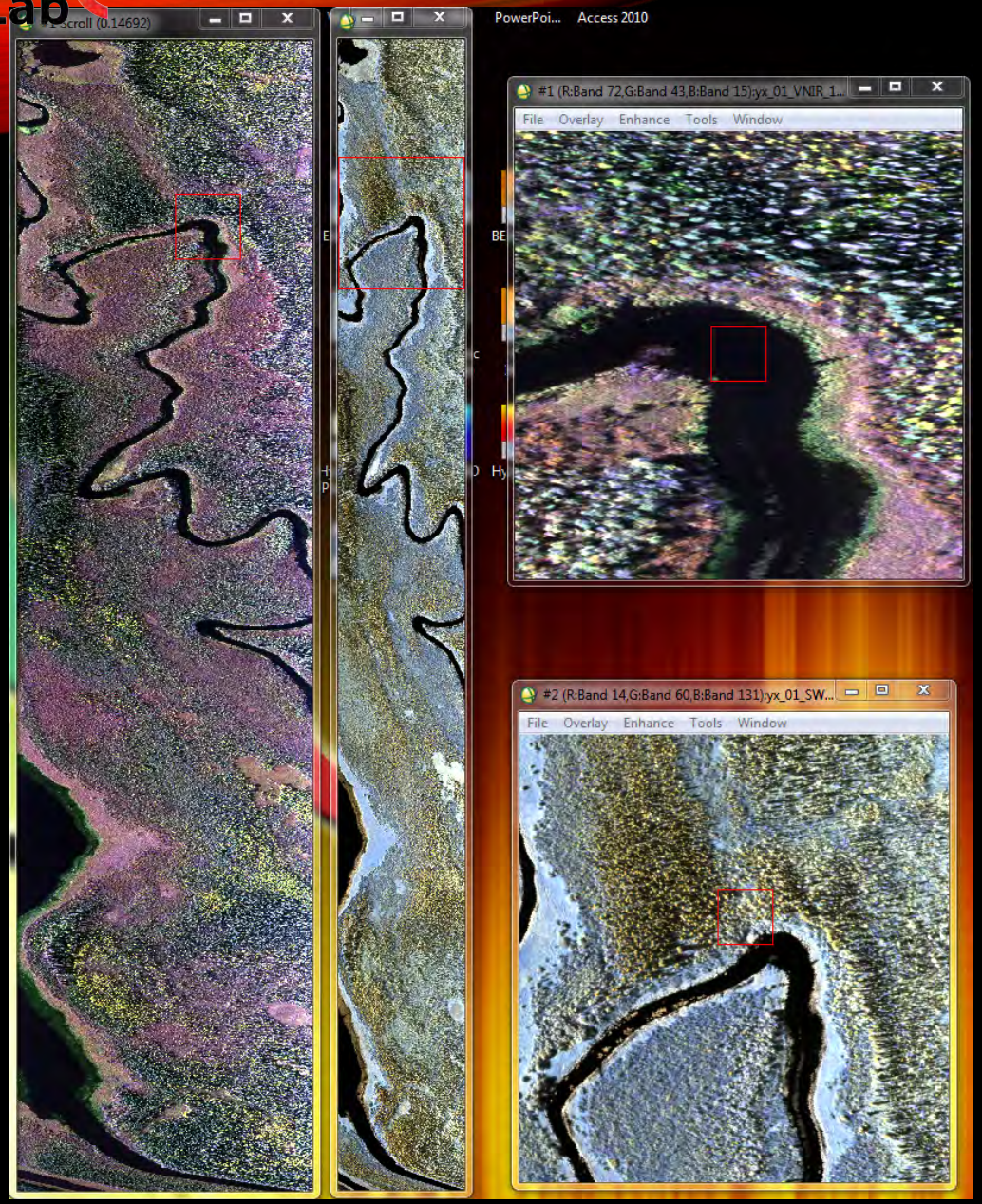
DATA PROCESSING I



- Use here one flight line from YX Site next to Yukon Flats site A as example
- RAW data still in DN values
- We can see sensor artifacts and stripes
- Images are distorted and in raw pixel resolution
- VNIR sensor: 182 bands (0.4 to 0.9 µm) with 0.5x0.3 m resolution
- SWIR sensor: 288 bands (0.9 to 2.5 µm) with 0.9 x 0.9 m resolution

Data amount for 2 flight lines in YX site -> **10.4 GB**

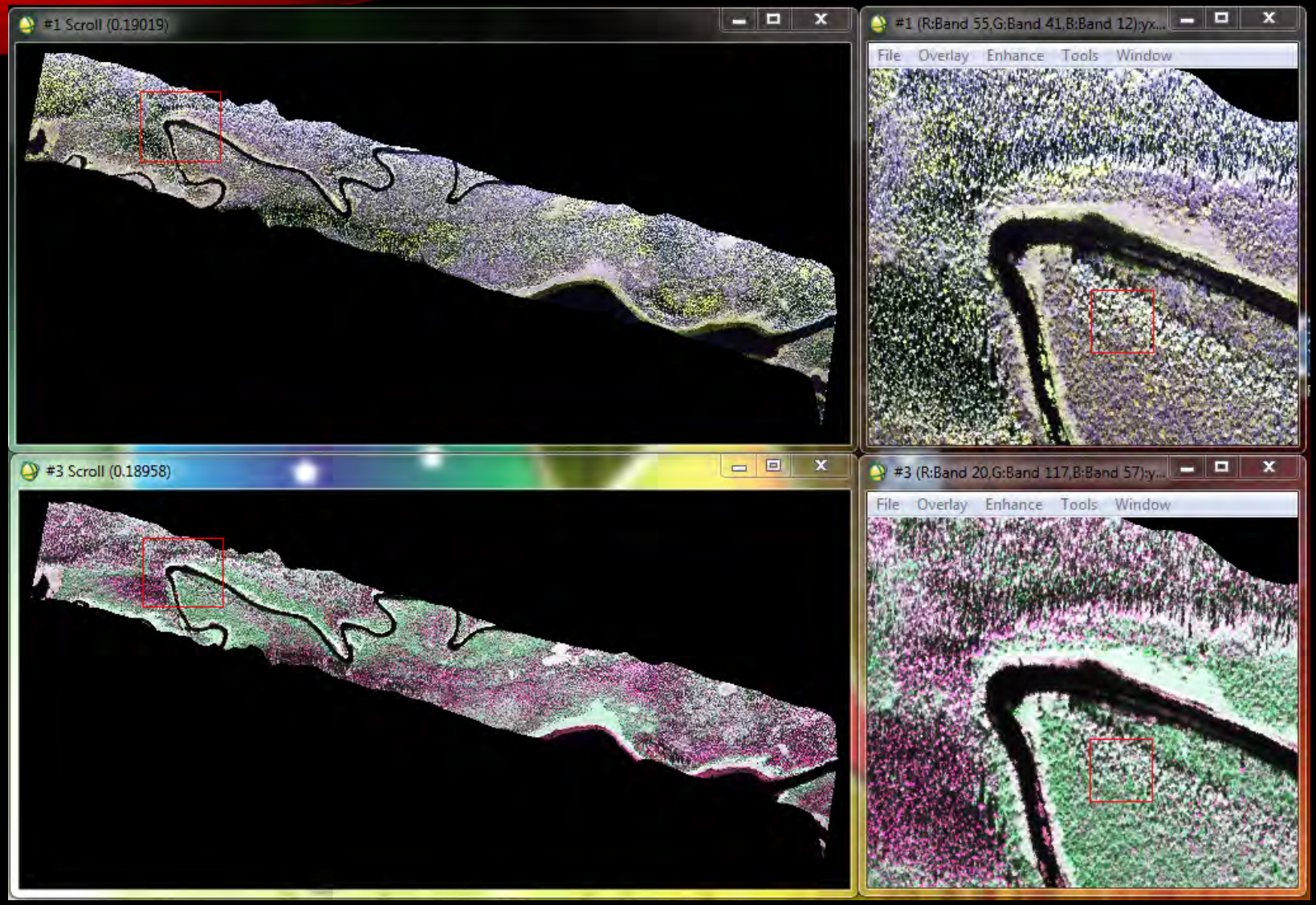
DATA PROCESSING II



- Data converted to at-sensor-radiance
- Sensor artifacts and stripes removed
- Images are still distorted and in raw pixel resolution

31.3 GB

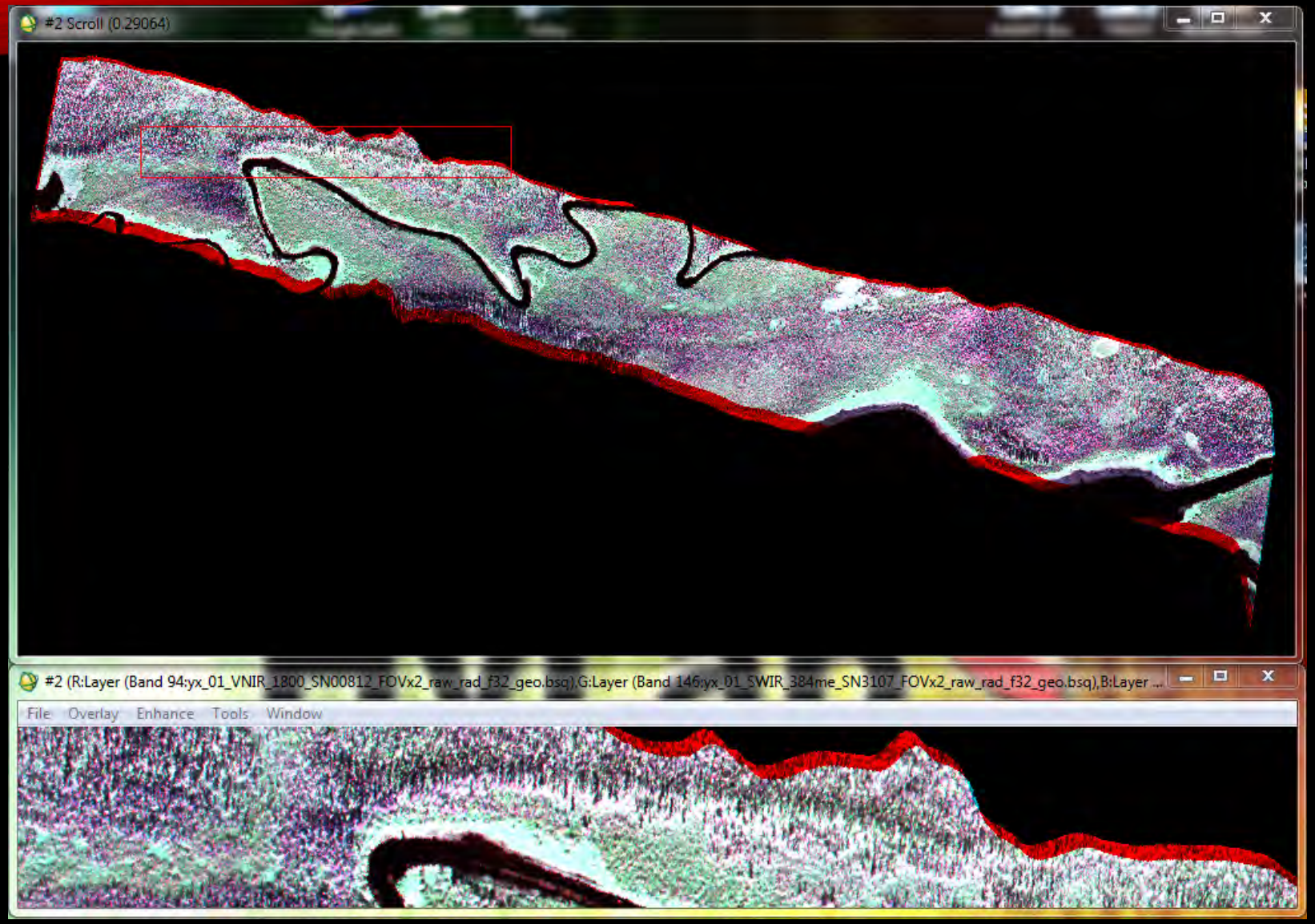
DATA PROCESSING III



- Images are orthorectified using a sensor model and a DEM
- Both sensors (VNIR & SWIR) are resampled to target GSD of 1x1 m
- Images are co-registered to each other with 0.5 pixel accuracy
- Needs good boresight calibration (time intensive process)

52.1 GB

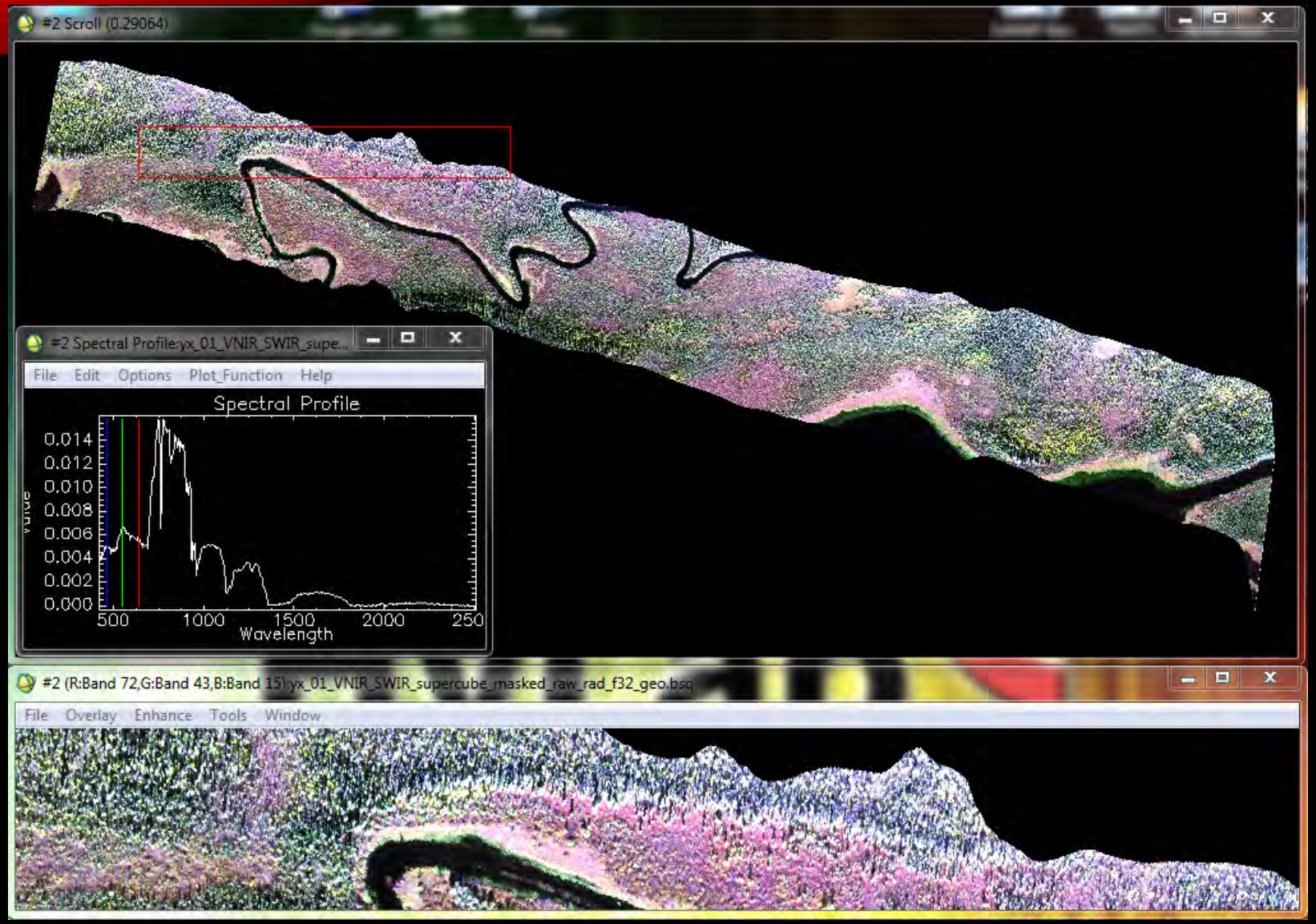
DATA PROCESSING IV



- Creation of supercube for radiometric processing
- Data of both sensors is layer stacked and double wavelength bands are removed
- Super cube has 457 bands from 0.4 to 2.5 µm
- In **red** you see the different spatial extents of the sensor swaths

71.5 GB

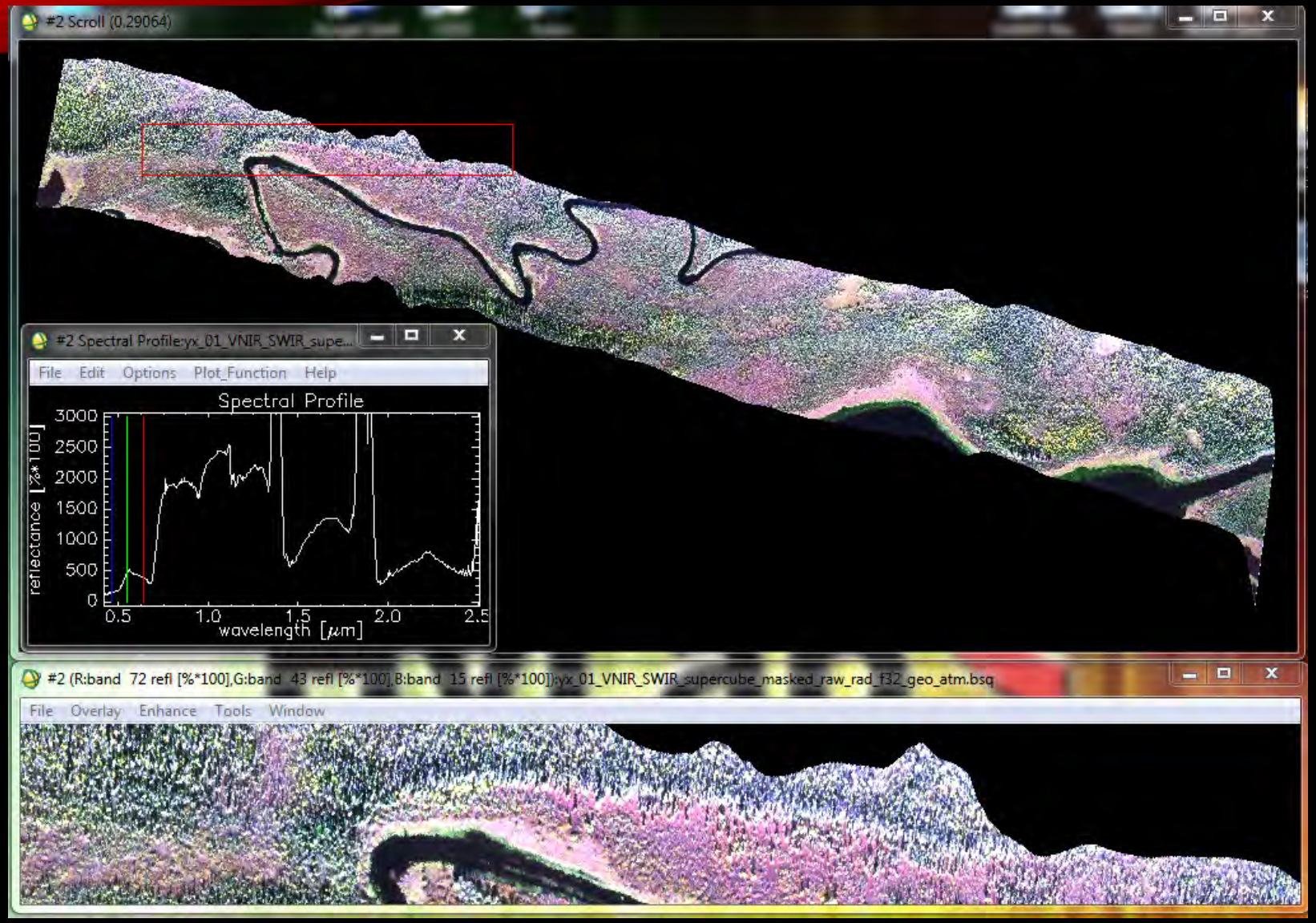
DATA PROCESSING V



- Areas with data from only one sensor was removed
- Data is still in at-sensor-radiance
- Next to DEM, additional products are needed for the radiometric correction (slope, aspect, sky view, scan angle, etc files)

91.0 GB

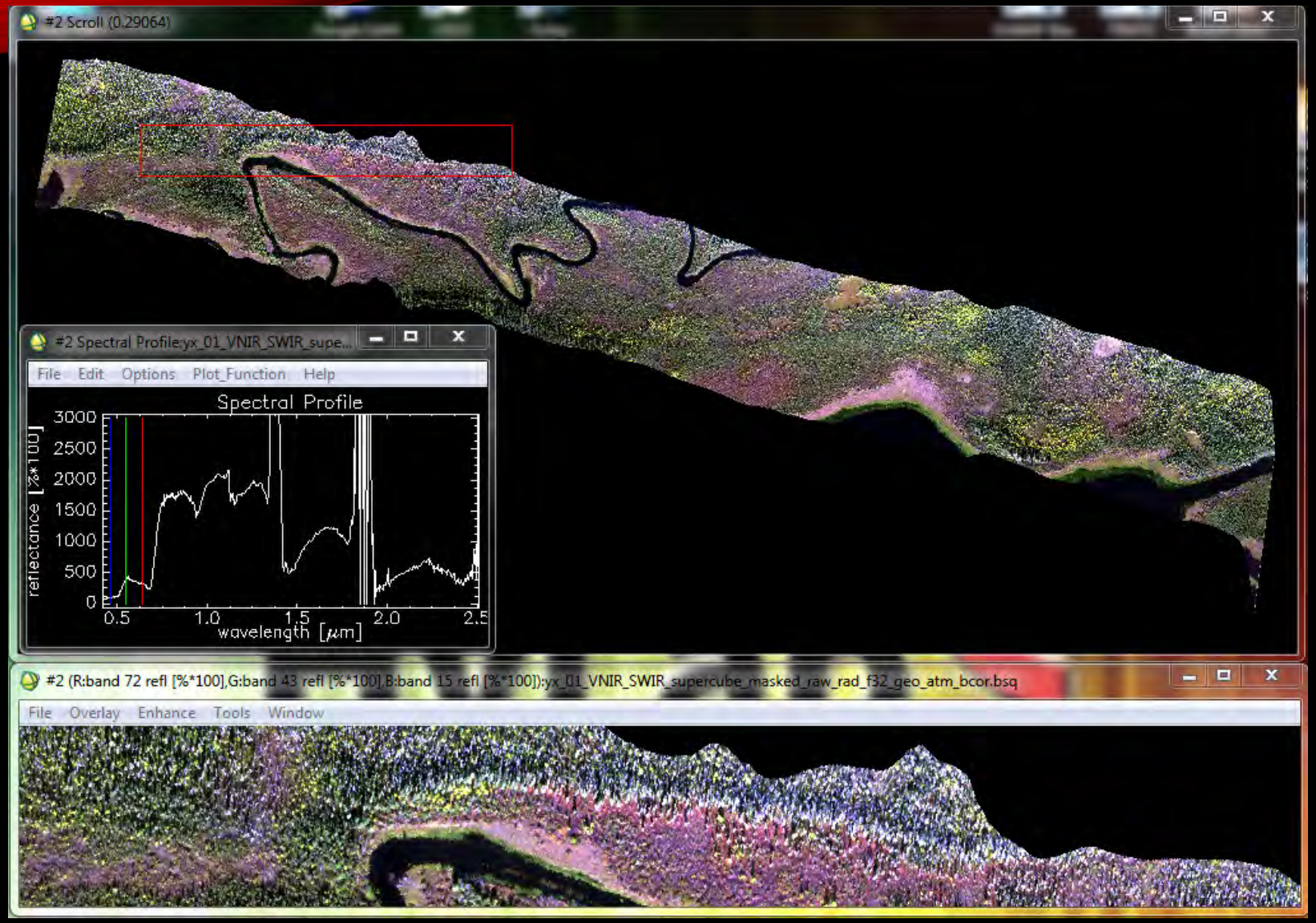
DATA PROCESSING VI



- Supercube has been radiometric corrected
- We have now surface reflectance
- Data still show color changes along the swath -> that are BRDF effects
- Additional products have been derived (fPAR, LAI, NDVI, SAVI, water vapor, etc.)

100.9 GB

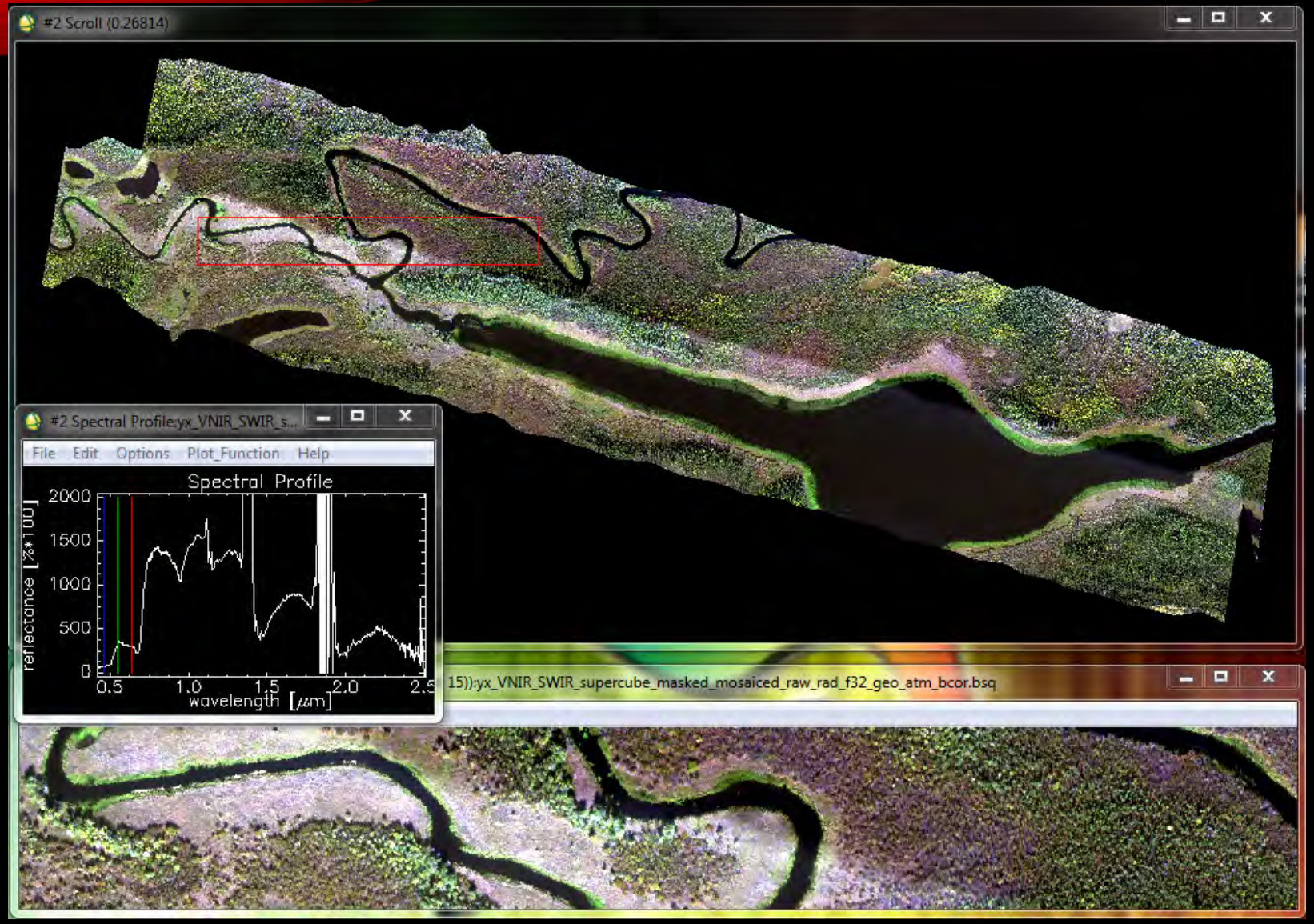
DATA PROCESSING VII



- We create out of the data a BRDF model
- This BRDF model is then applied to all flight lines in the scene
- Developed BRDF model shows good results (with shortcomings in extreme situations – see later)
- Co-product are ANIF maps- can be used for classifications

120.2 GB

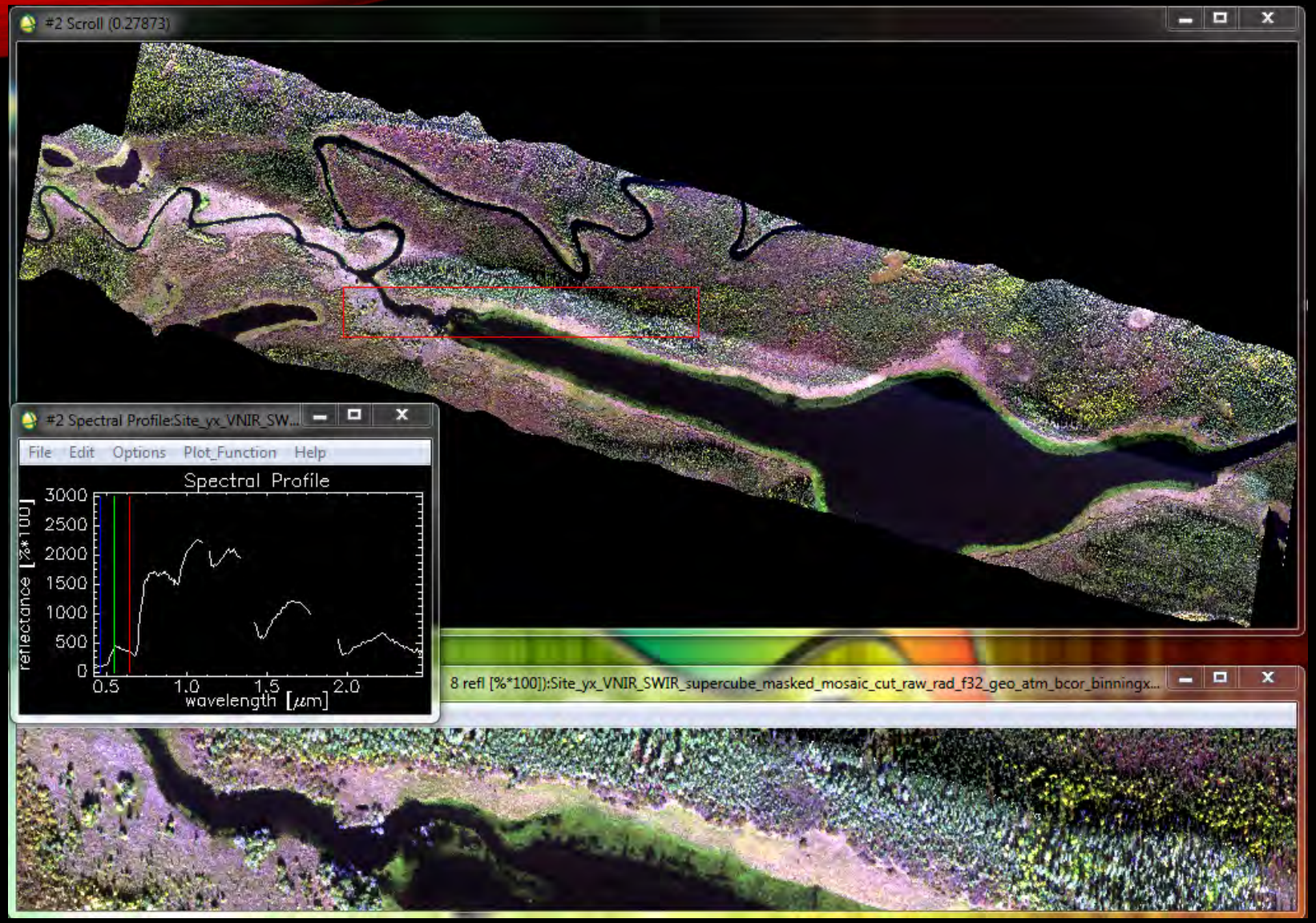
DATA PROCESSING VIII



- Next step is to mosaic all flight lines
- Normally gives a seamless product after BRDF correction -> this scene is special!!! Has been flown with suboptimal flight direction.
- That is the reason flight direction should be N -> S or W -> E

125.8 GB

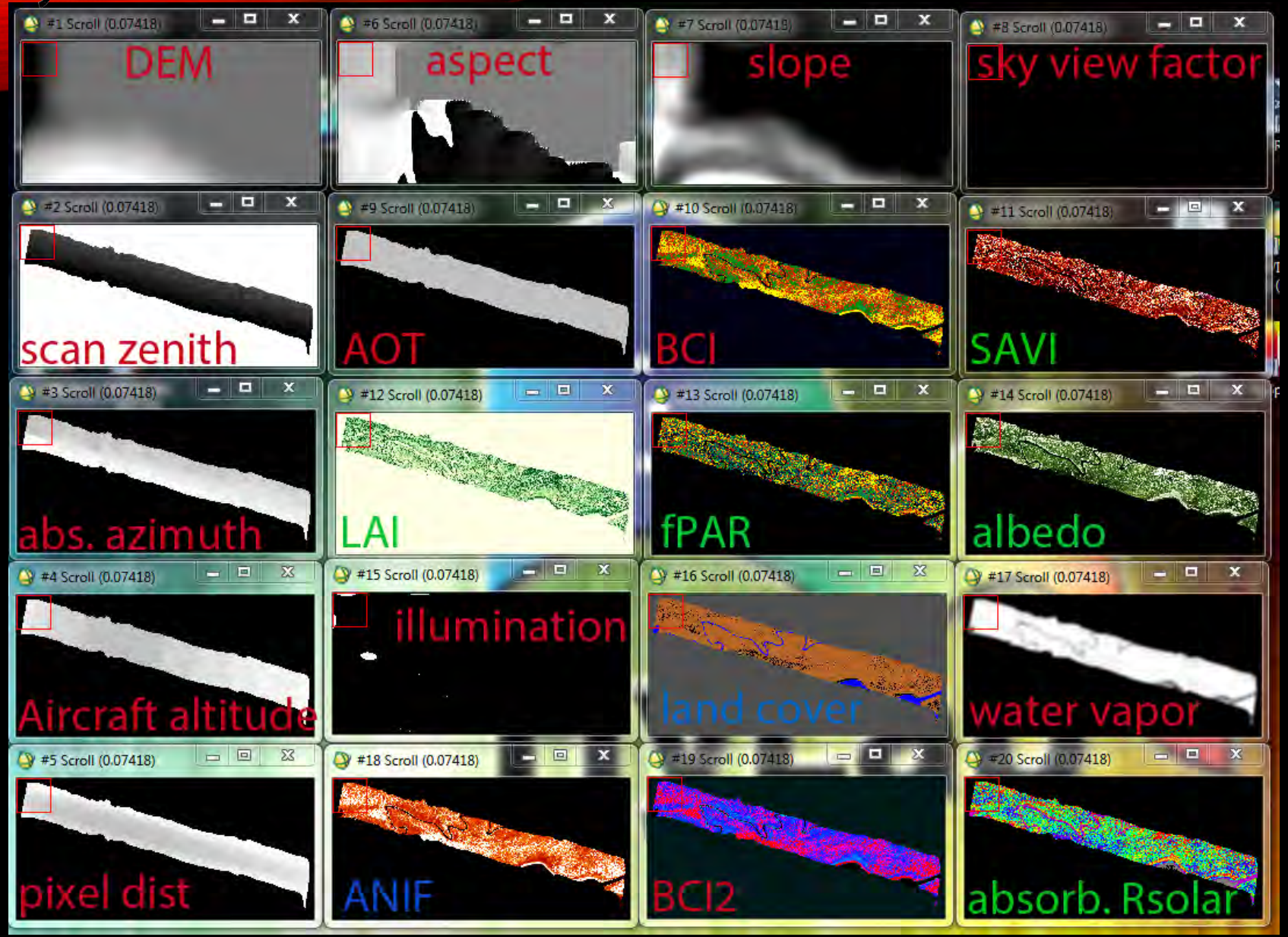
DATA PROCESSING IX



- Final steps
- Cutting of scene
- Spectral binning as well as spectral polishing (when needed)
- Metadata description
- Bad bands selection
- ENVI header file clean up
- Documentation
- Final scene size: 2.5 GB (plus additional products)

128.3 GB

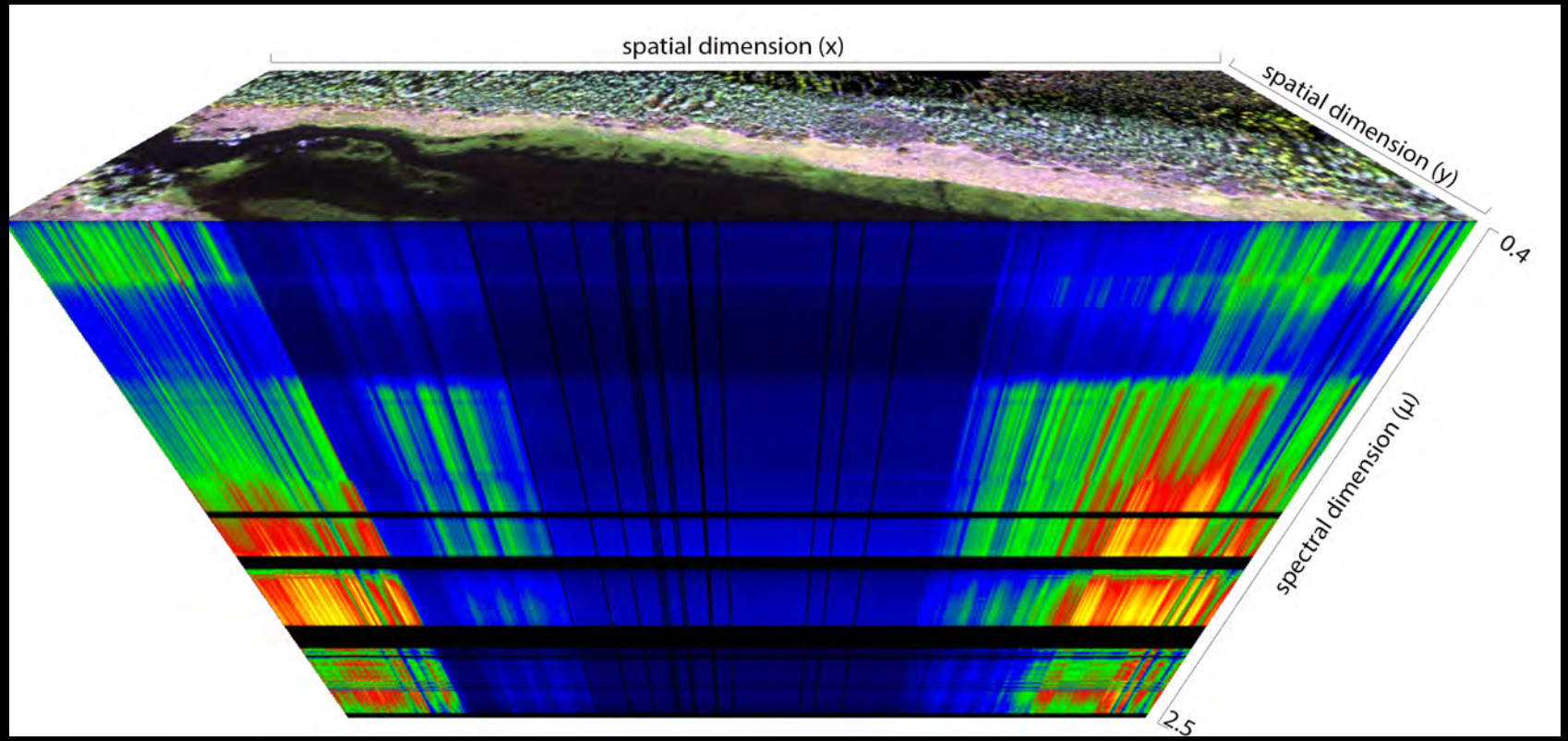
DATA PROCESSING X



- We produce many additional products during the processing or as direct output of the processing
- **Red** = product produced for processing
- **Green** = product of processing
- **Blue** = product of processing, but produced for processing

128.3 GB

PRODUCT



- Final product is a seamless hyperspectral cube of the target area together with additional co-products
- All products can be directly used and are in standard formats
- Not all data of the data processing chain has to be archived, BUT

- IMPORTANT steps during the data processing have to be archived
- Overall 109 GB of the 128.3 GB in this example should be archived!!!
- Be aware of that 10x increase in data volume

TO DO

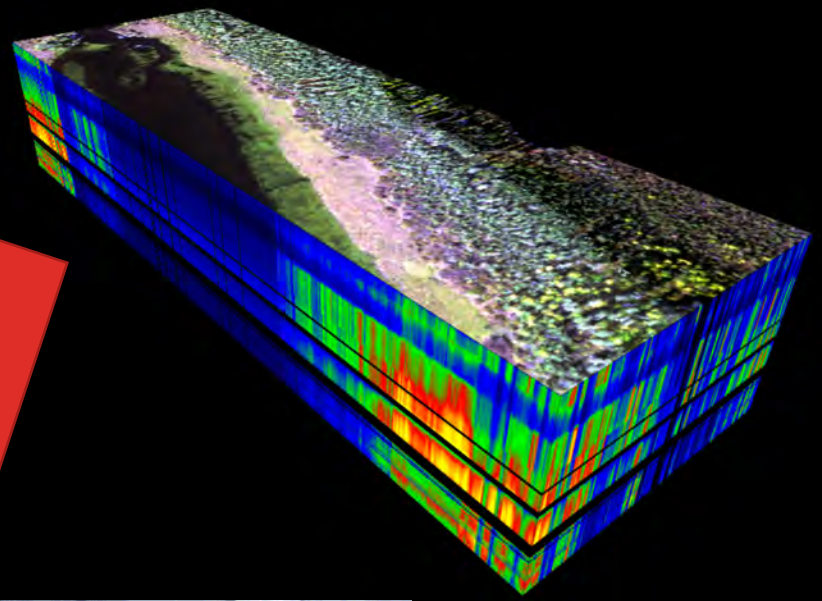
- We have finalized the data processing chain for processing the 71 Yukon Flats flight lines
- Working on a more automated processing at the moment (BATCH processing)
- Final hypercubes of the 7 target areas have to be analysed to test the abilities of hyperspectral remote sensing to differentiate physical, chemical and biological parameters in Alaska wetlands → US F&WS can give us now the ground samples for the areas
- Wetland classification maps has to be produced
- Protocols to acquire and process Hyperspectral Data have to be finalized

- Estimated data volume for archiving all 7 hypercubes for the Yukon Flats area:

4 – 5 TB

THANKS

long interesting way with lots of hurdles



… and check out also the posters next to me