

On-Orbit Performance and Calibration of the EMIT Imaging Spectrometer

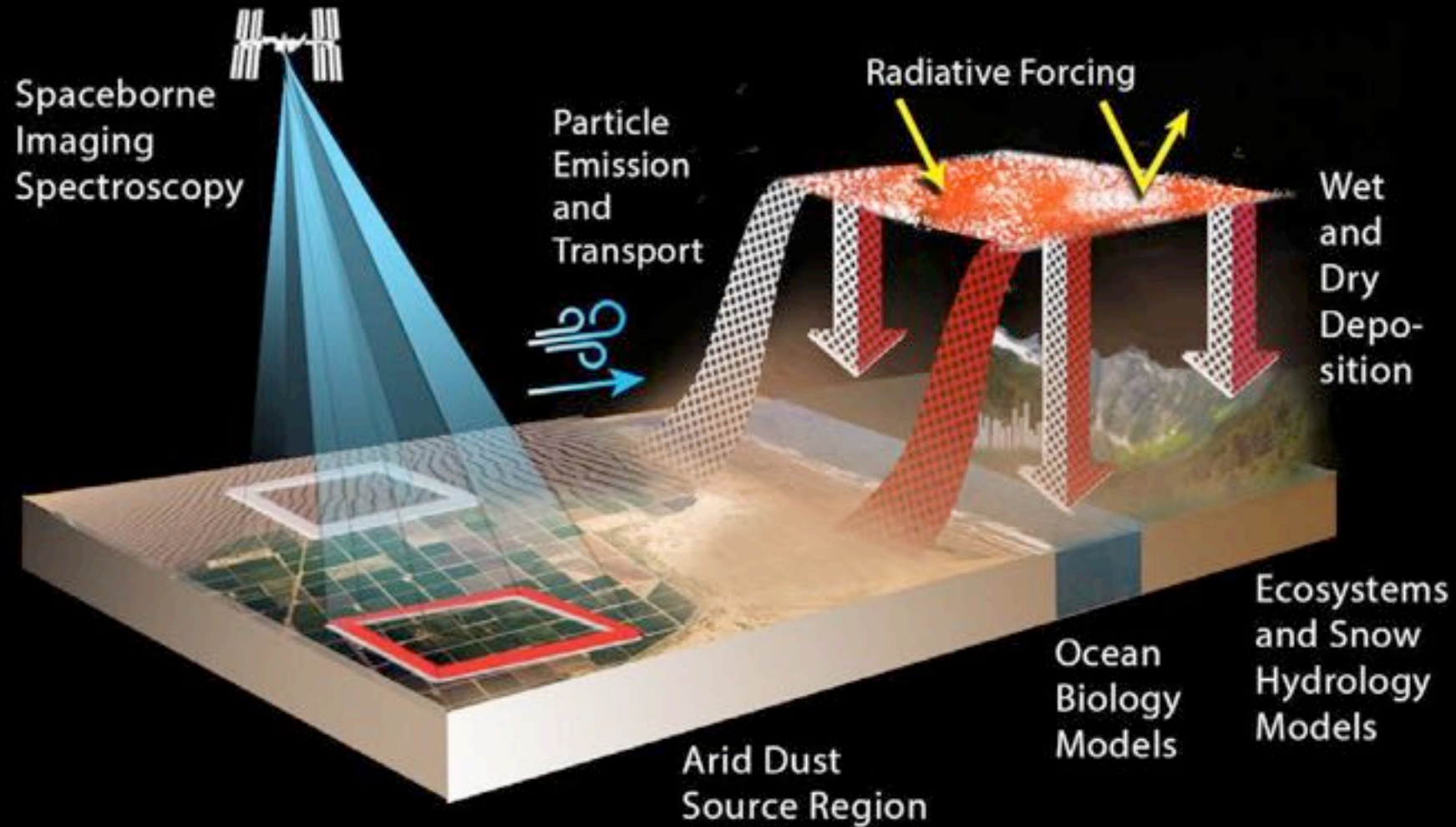
David R. Thompson, Robert O. Green (PI), Natalie Mahowald (Deputy PI), Charlene Ung, Christine Bradley, Philip Brodrick, and the EMIT team

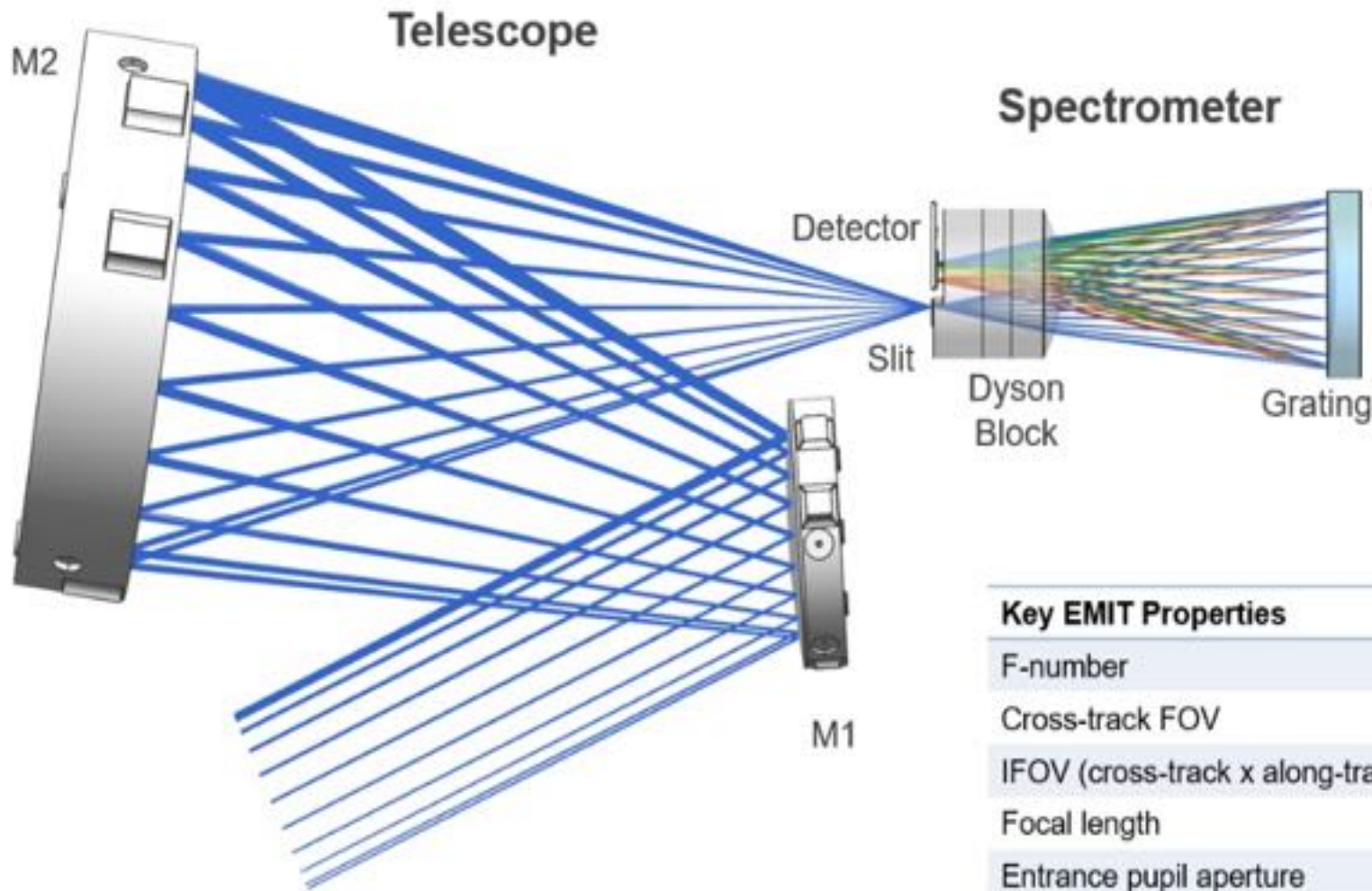
Jet Propulsion Laboratory, California Institute of Technology

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The Earth surface Mineral dust source InvesTigation (EMIT)



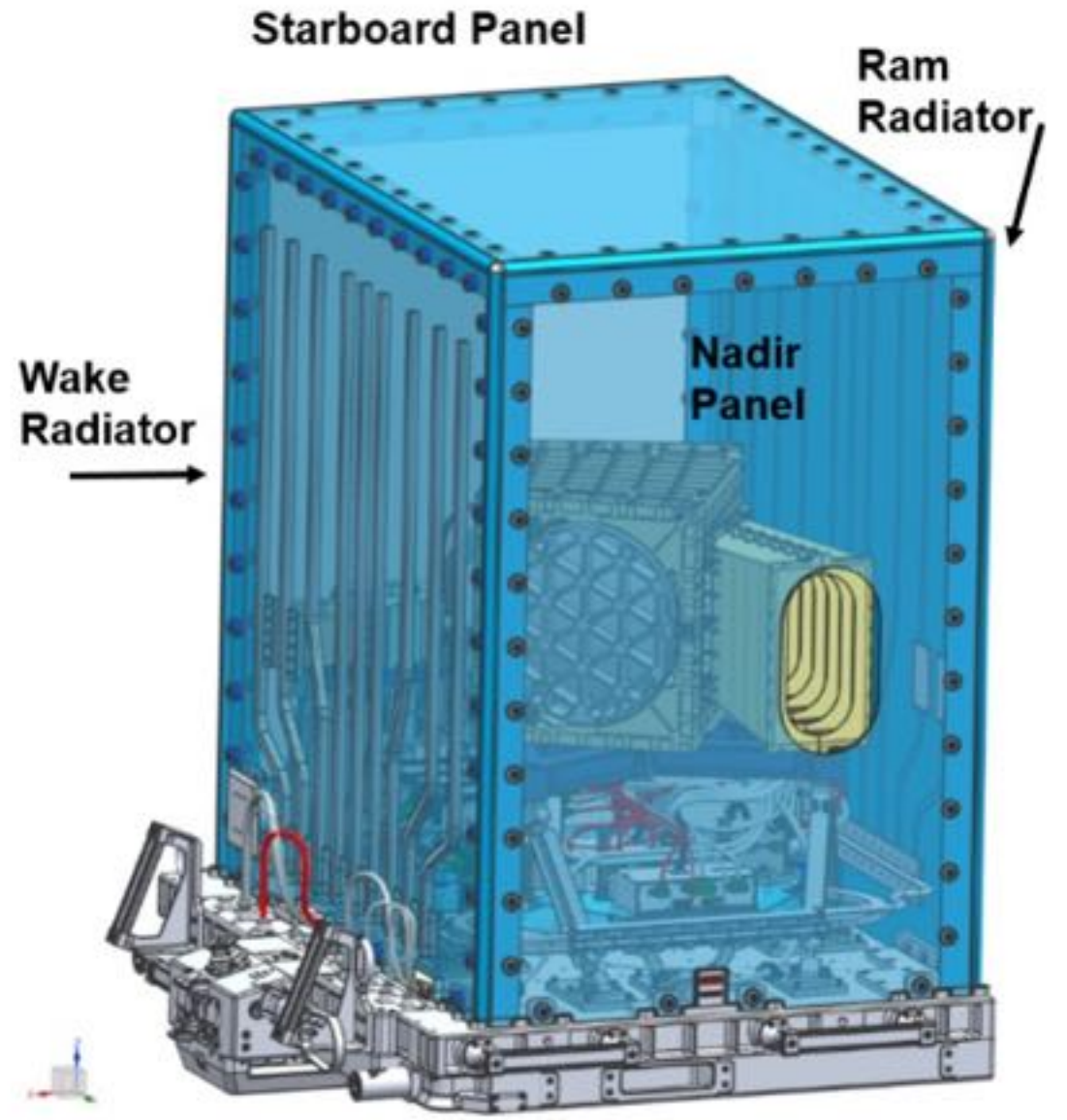
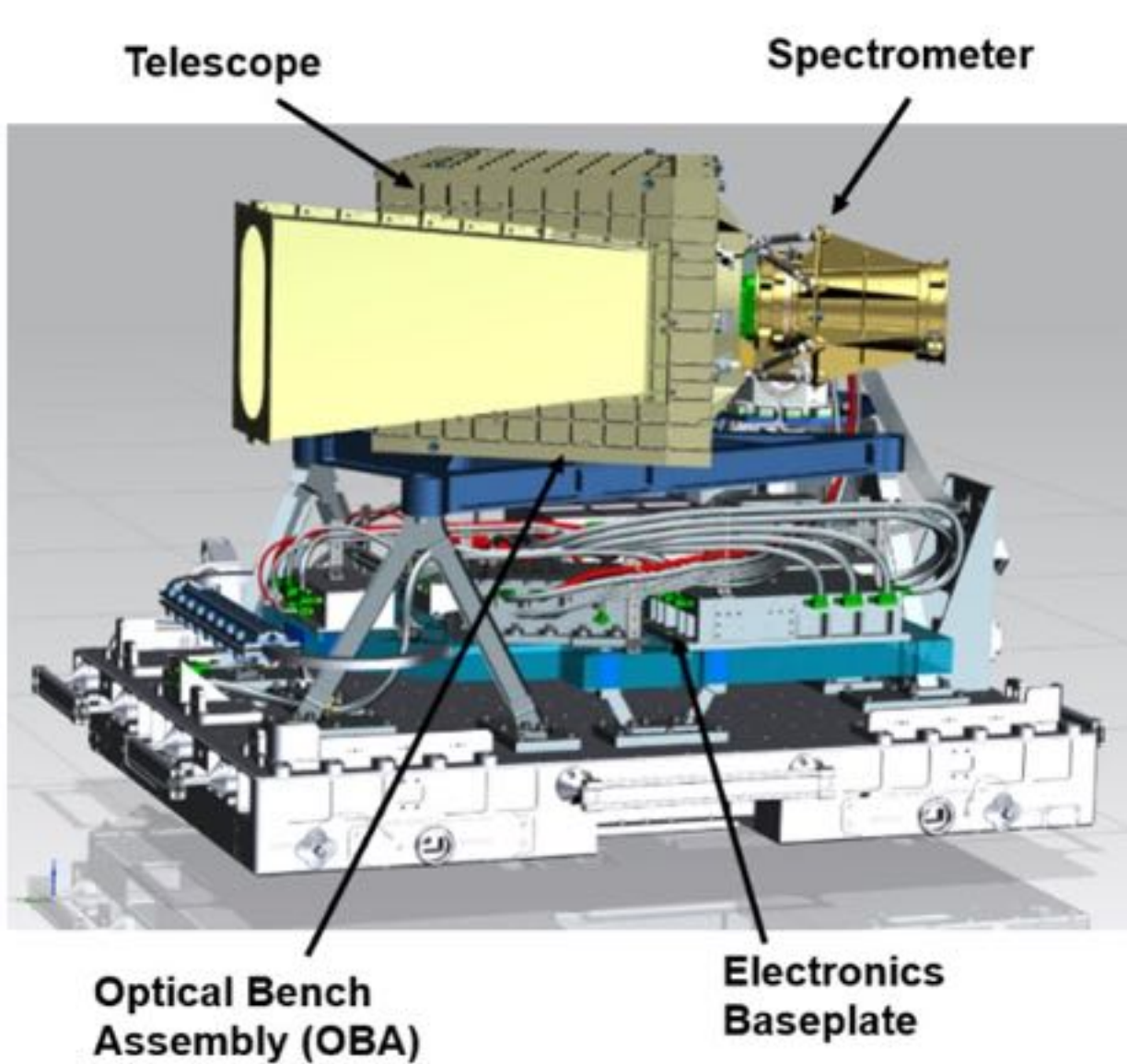


EMIT Imaging Spectrometer Elements

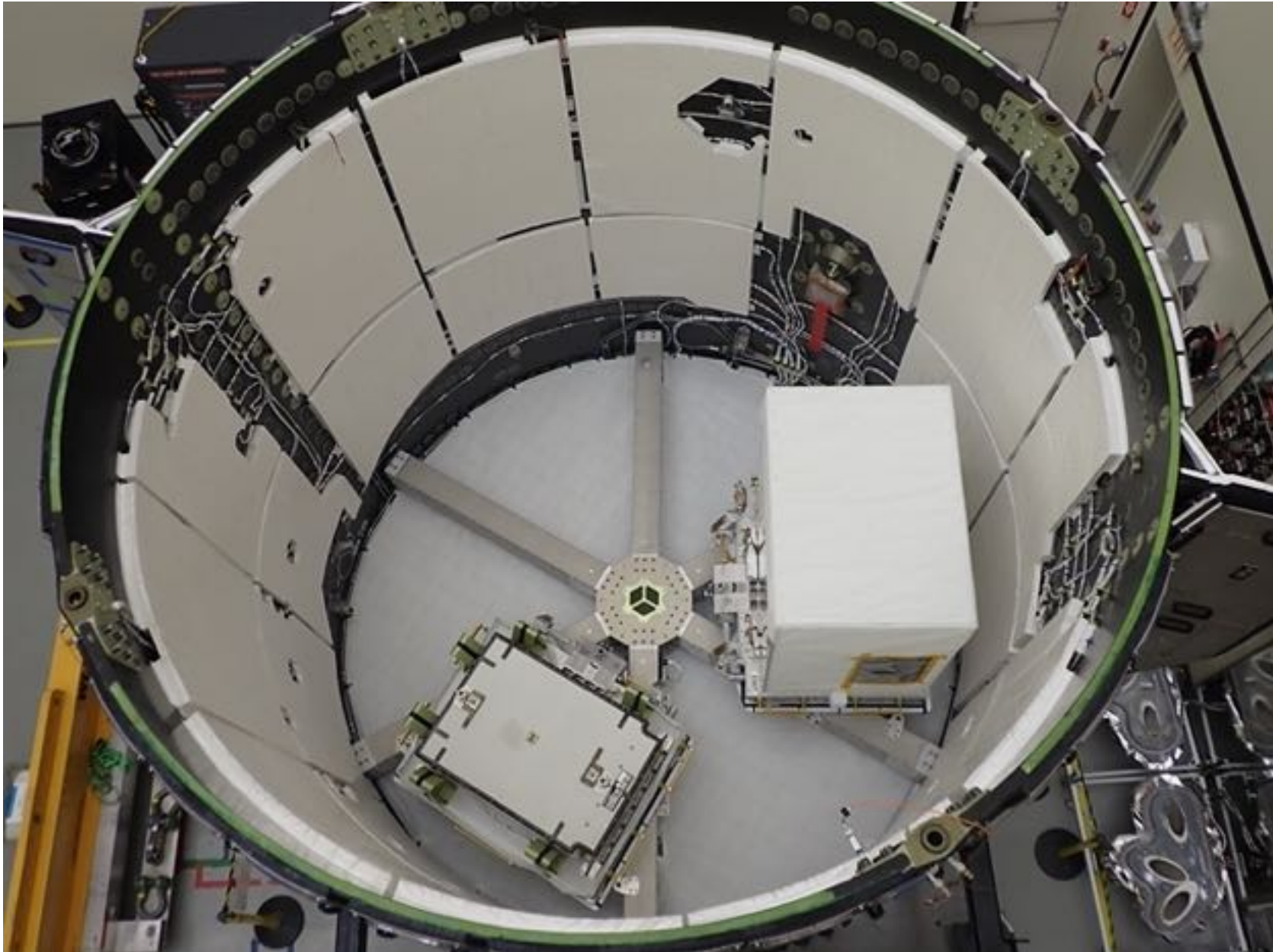
- **Two-mirror Telescope**
 - M1 (y-decentered, asphere)
 - M2 (y-decentered, asphere)
- **Dyson spectrometer**
 - Dyson block: CaF₂ lens with step
 - Slit (30 μm width, 37.2 mm length)
 - Diffraction grating (structured blaze)
- **FPA Assembly**
 - Order sorting filter (three zone)
 - Detector (HgMgTe)
 - 1280 x 480 pixel format
 - 30 μm pixel size

Key EMIT Properties

F-number	F/1.8
Cross-track FOV	11°
IFOV (cross-track x along-track)	155 x 171 μrad
Focal length	193.5 mm
Entrance pupil aperture	110 mm
Spectral Range	380 – 2500 nm
Spectral Sampling	7.4 nm







12/19/22

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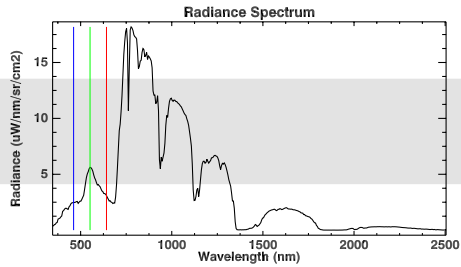
6



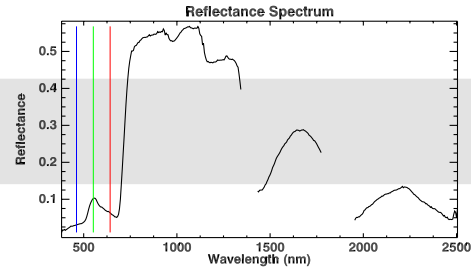


EMIT

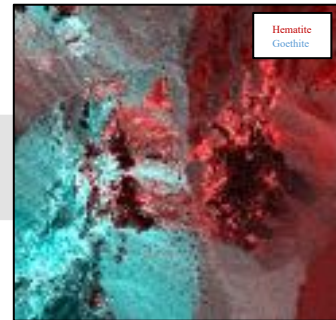
EMIT Data Analysis



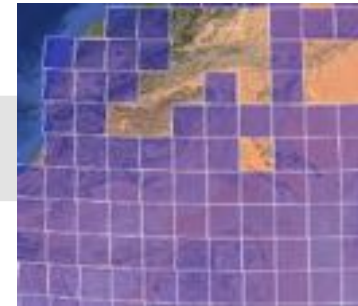
L1b: Radiance at Sensor



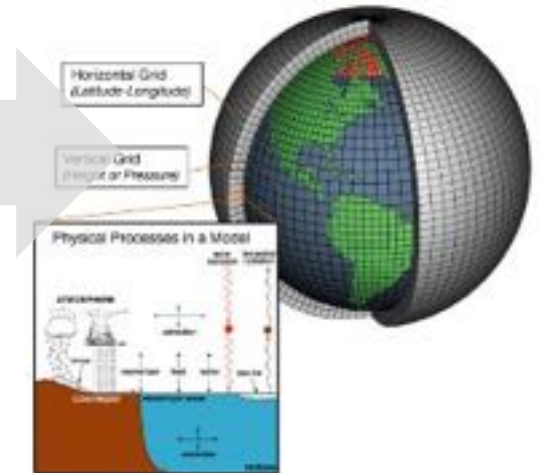
L2a: Surface Reflectance (HRDF)



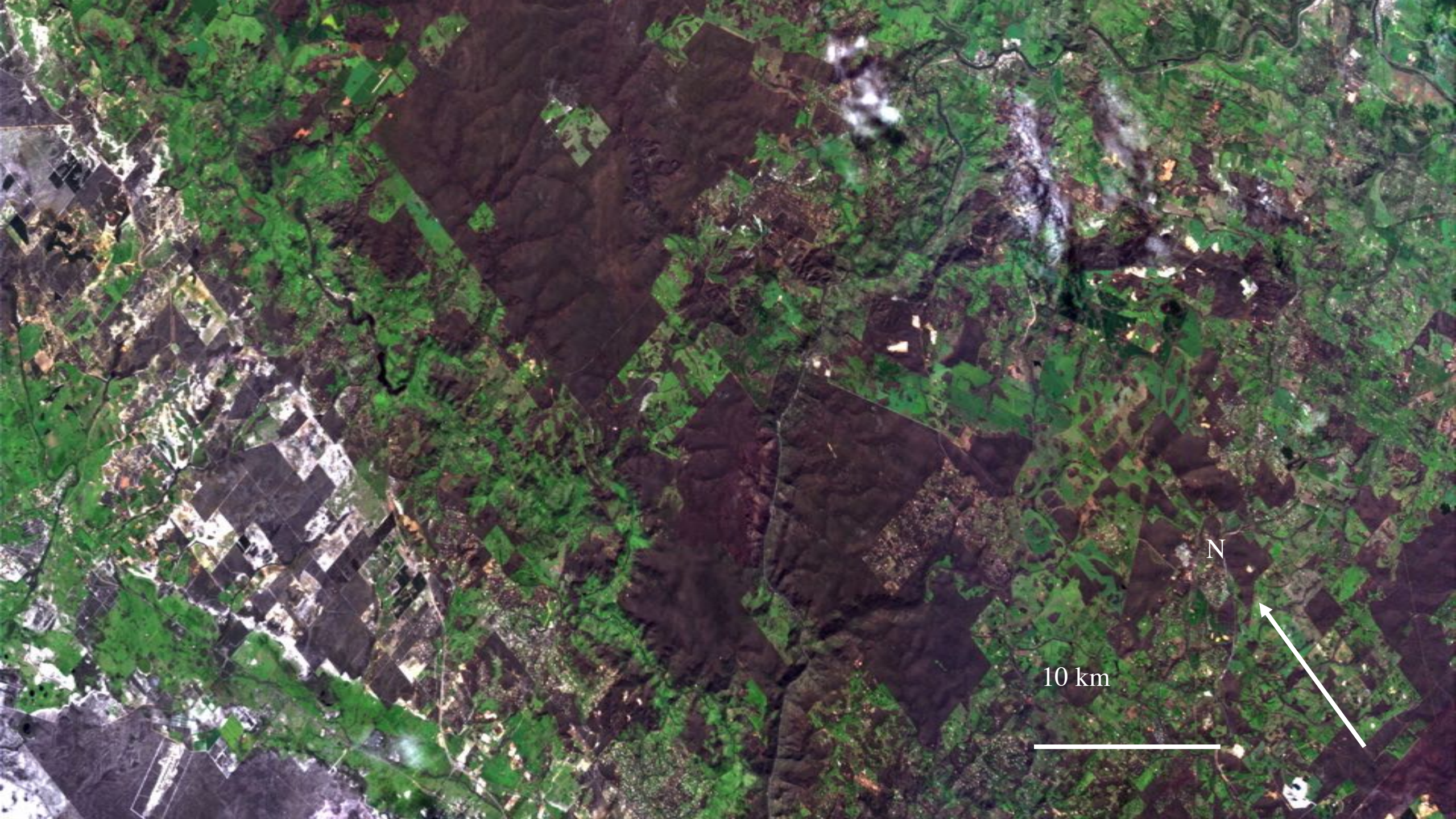
L2b: Mineralogical Maps



L3: Aggregated Mineralogy



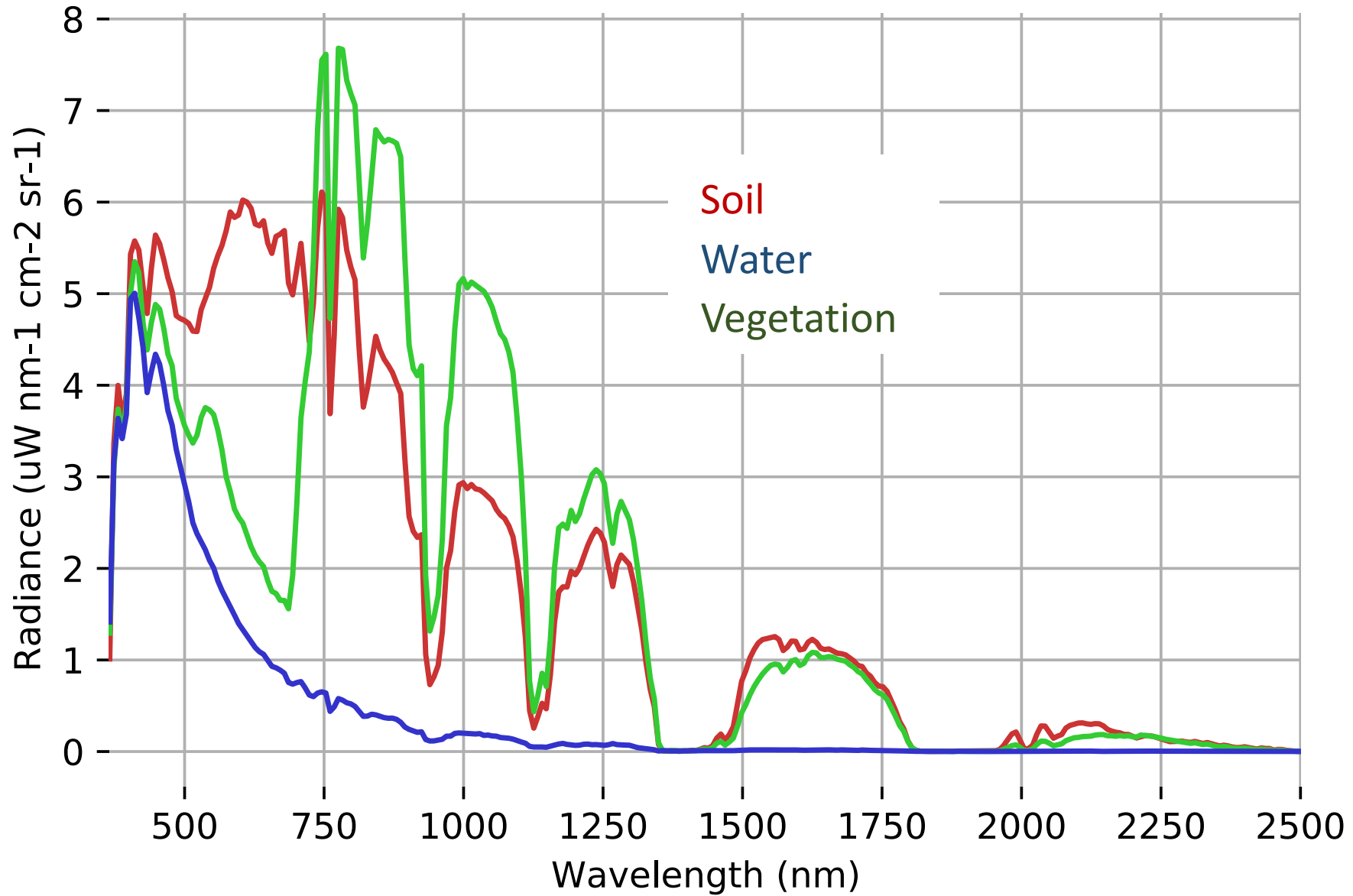
L4: CESM, GISS Model Runs

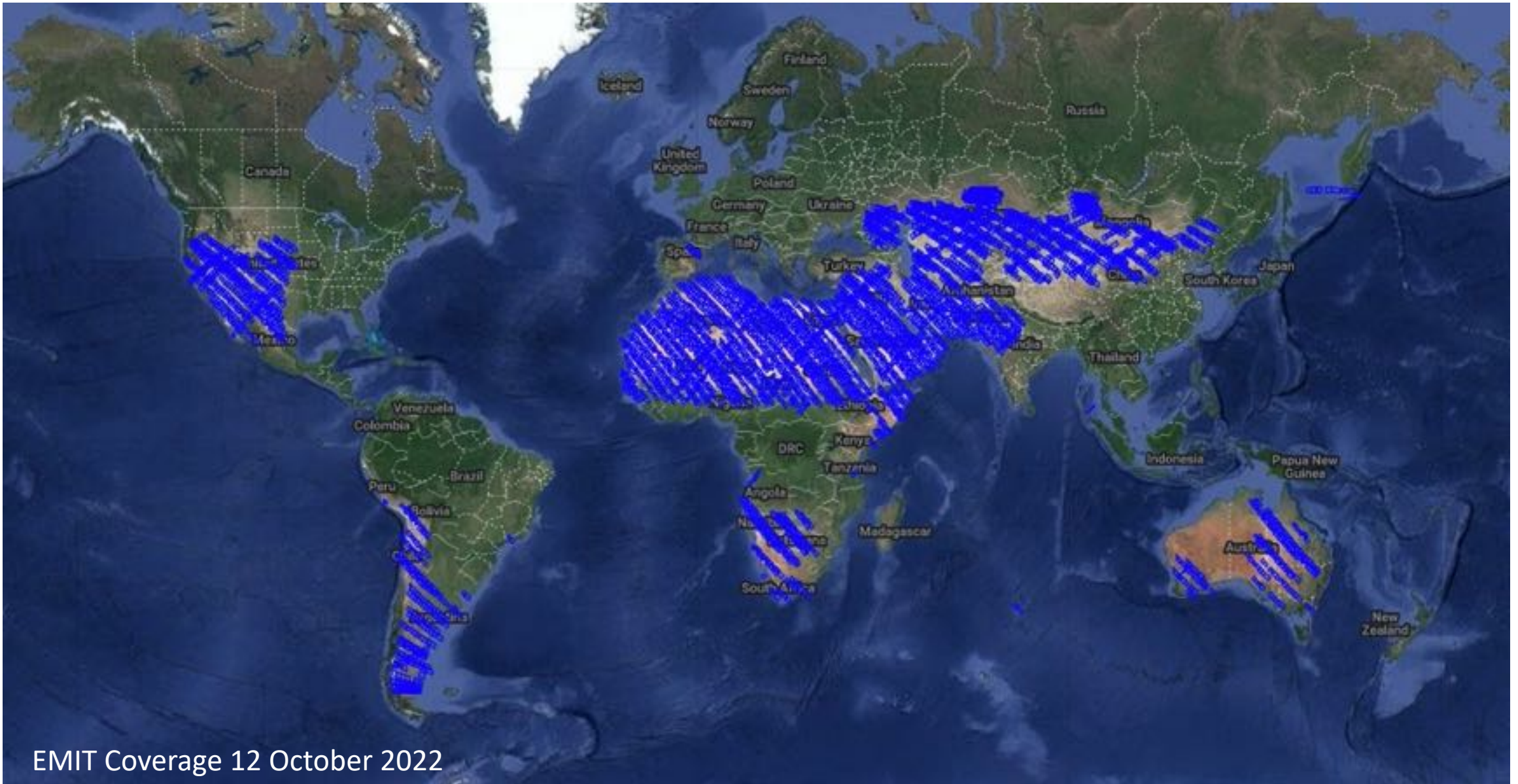


10 km

N







EMIT Coverage 12 October 2022



Clocking

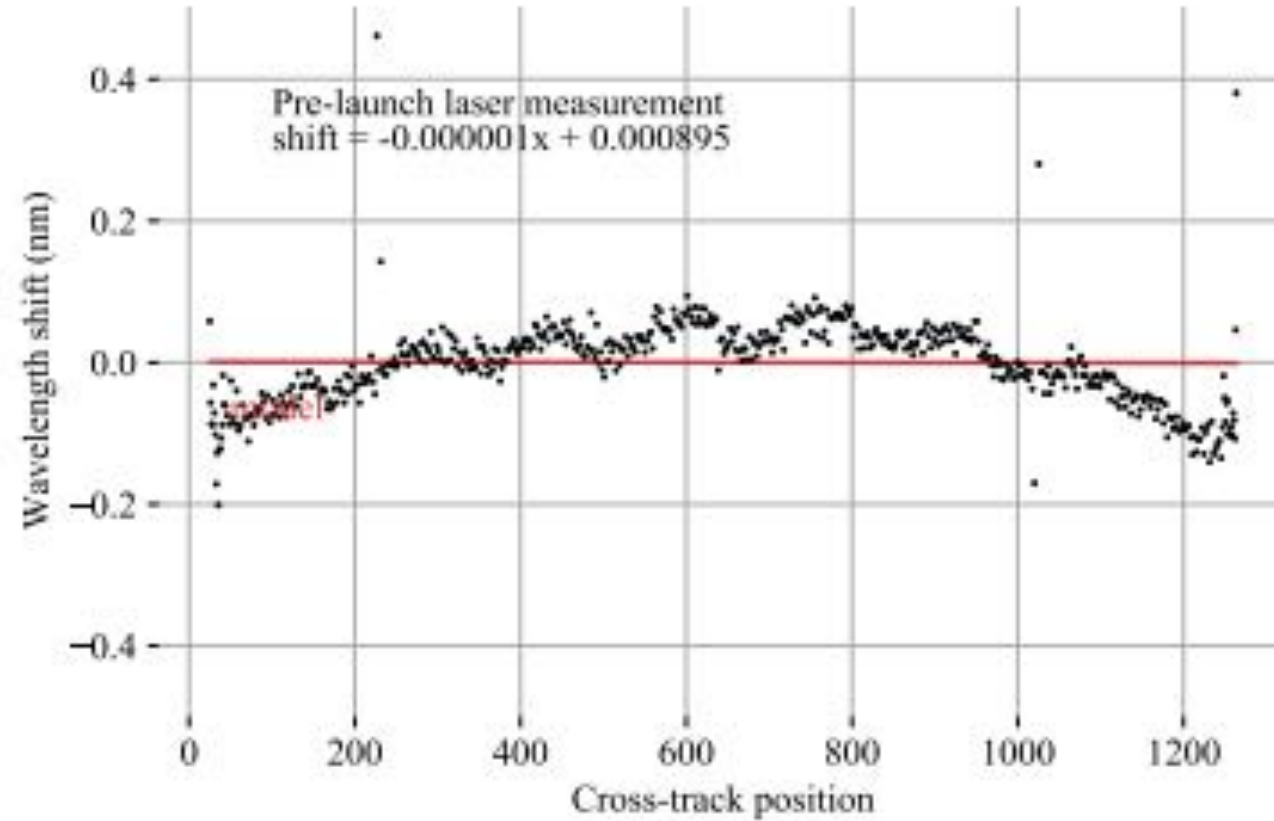


Figure 4: EMIT FPA clocking before launch, as measured at 1949 nm with a laser source.

Clocking

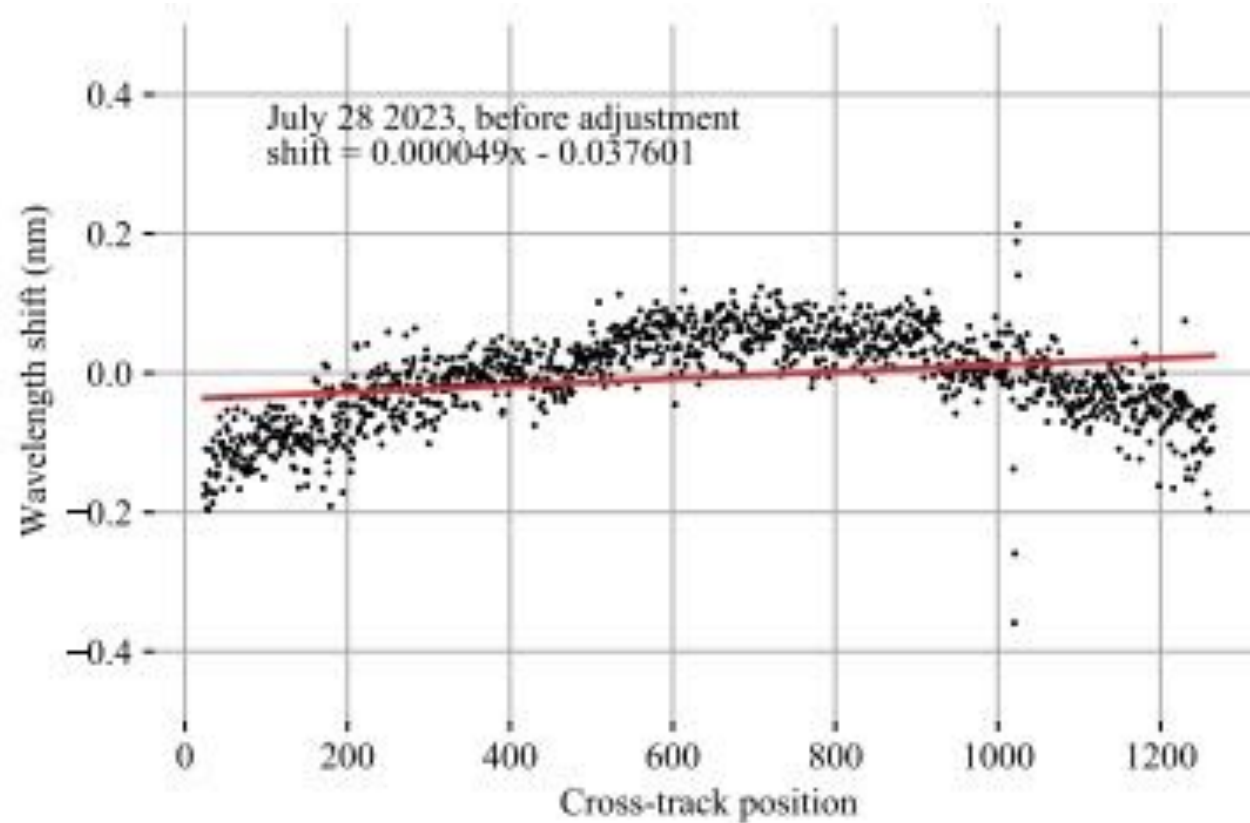


Figure 5: EMIT FPA clocking after launch, as measured with atmospheric water vapor.

Clocking

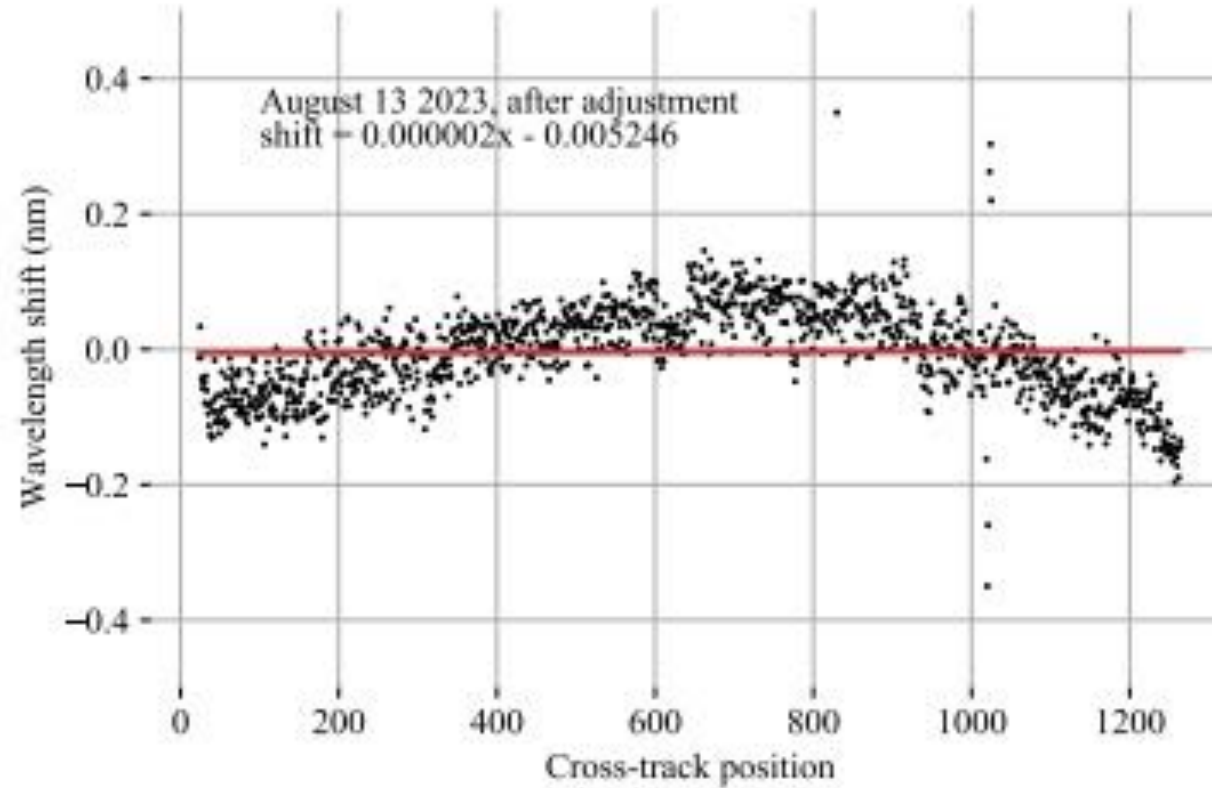
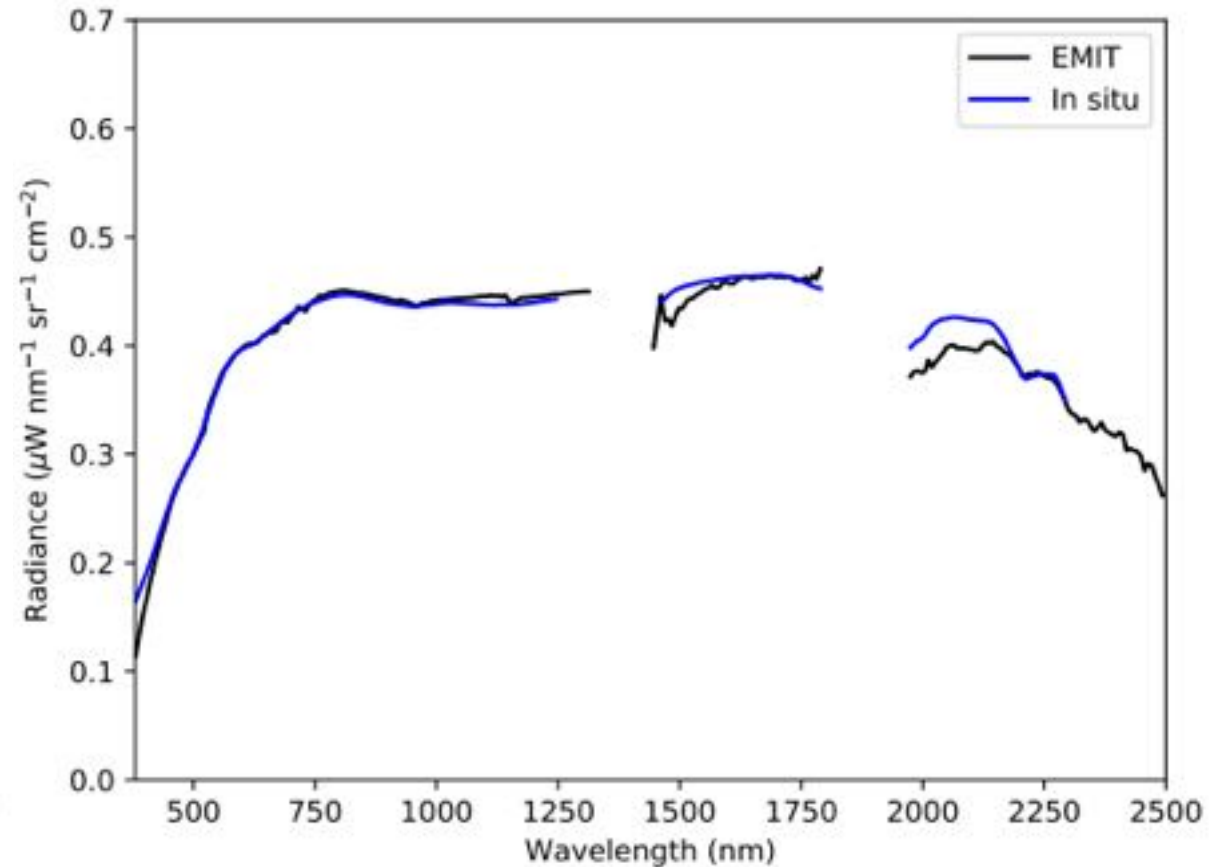
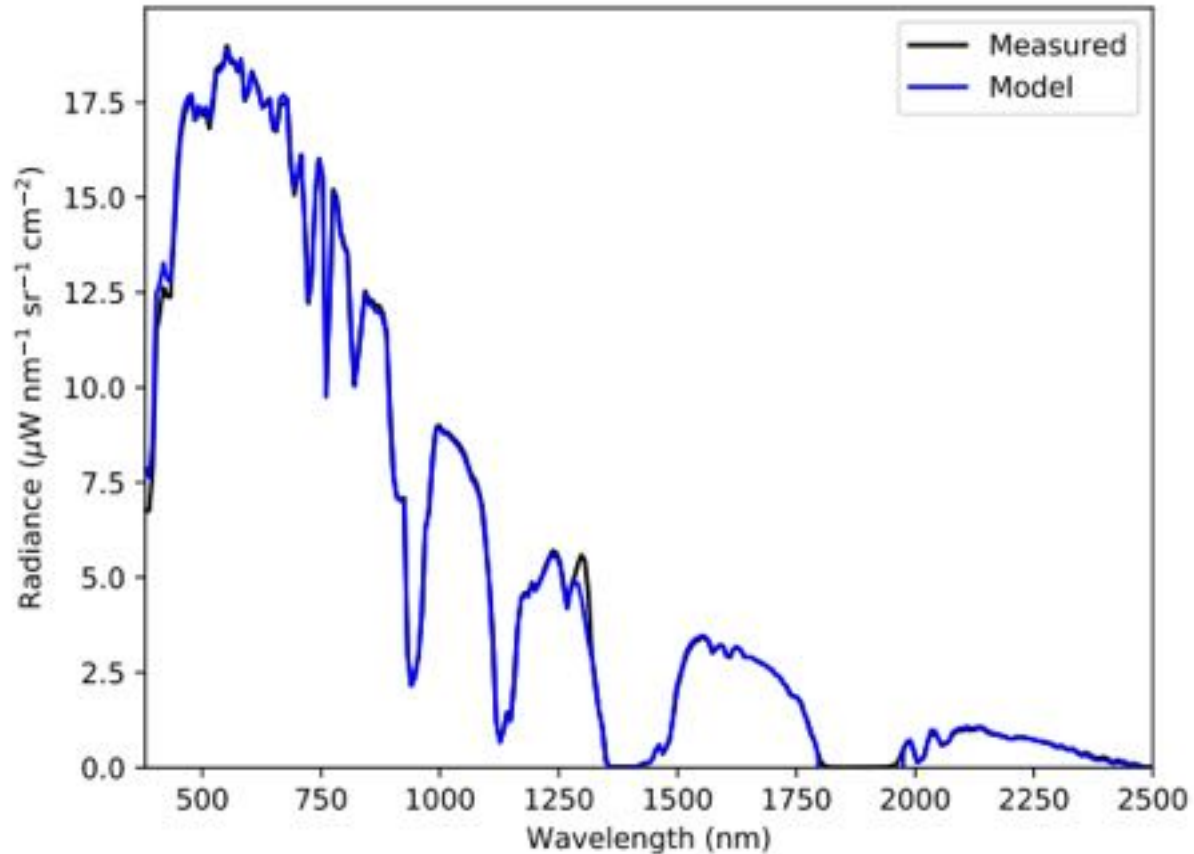


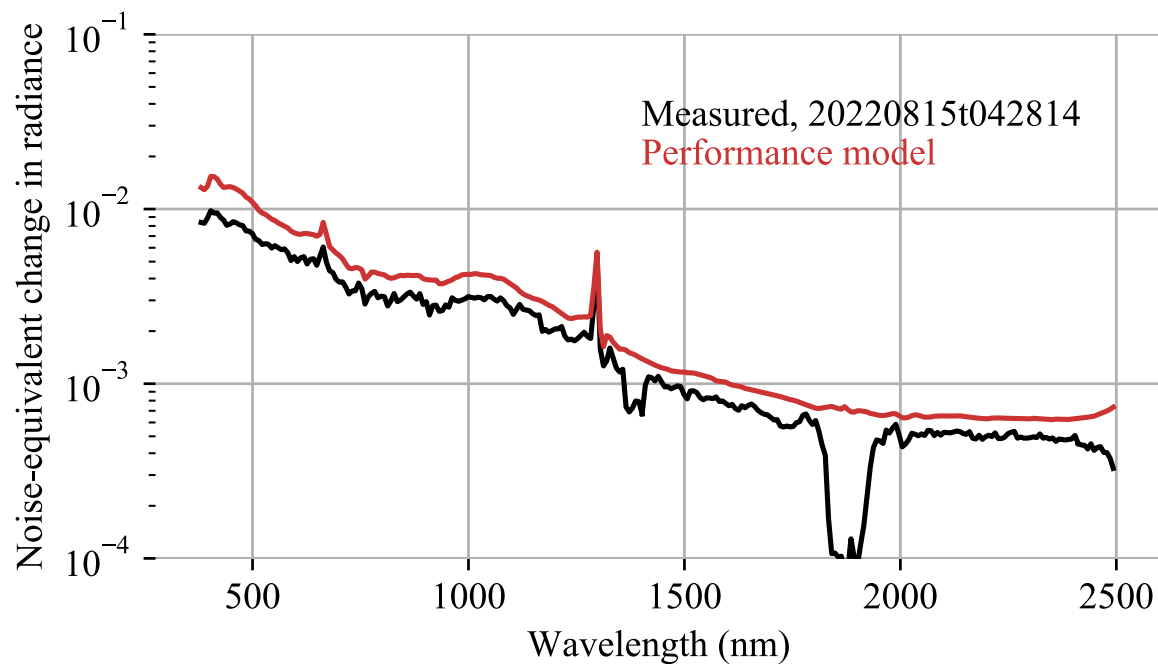
Figure 6: EMIT on-orbit FPA clocking update, as measured with atmospheric water vapor.

RRV validation- 3 August 2022

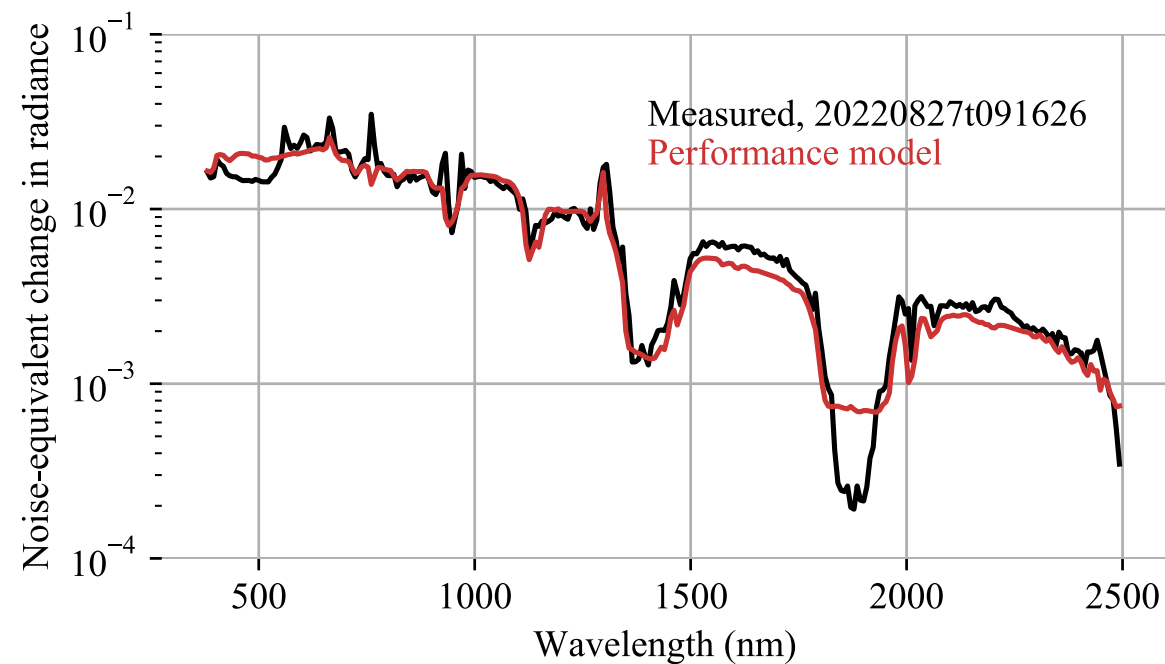


Radiometric model validation

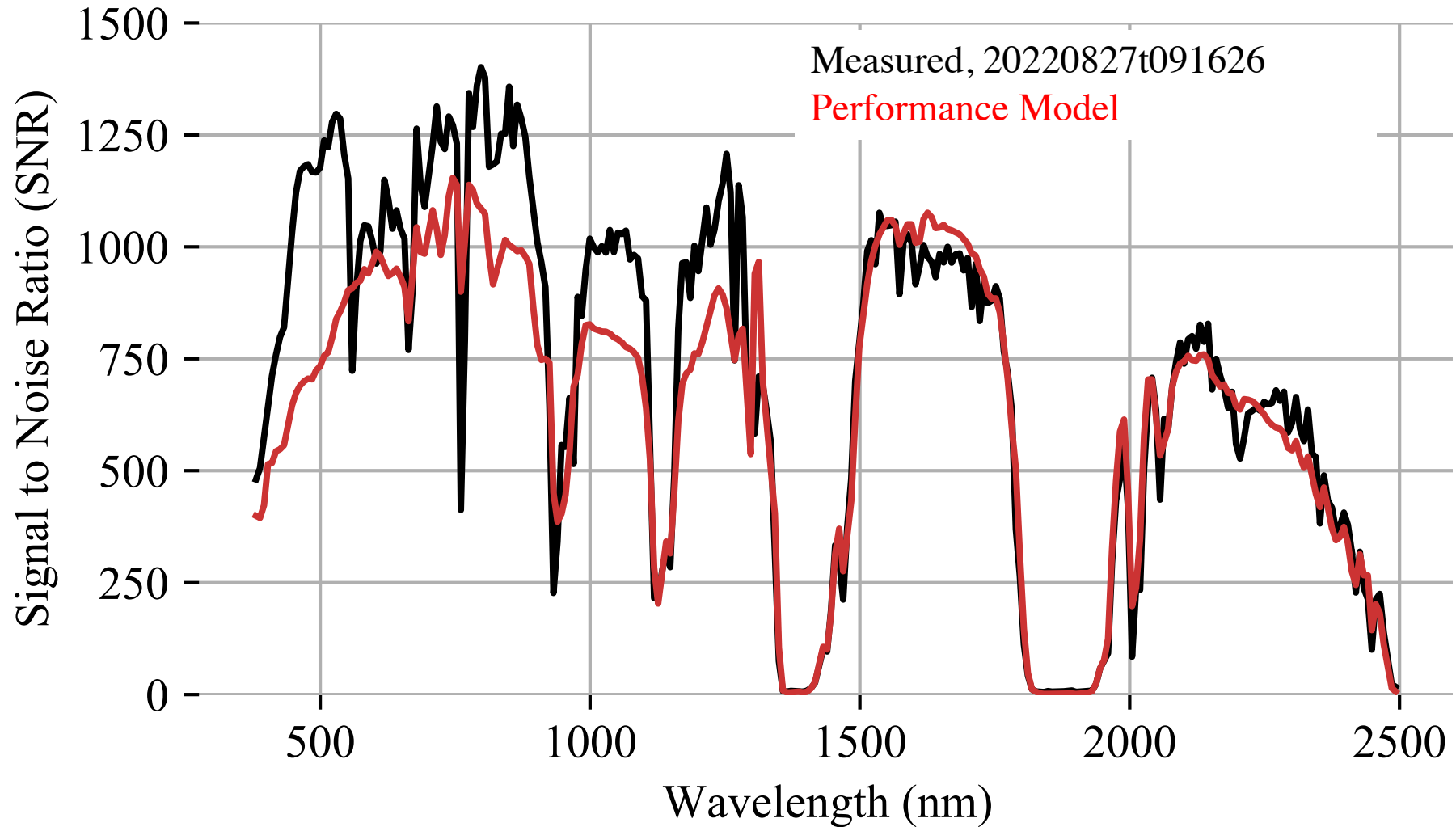
Caspian Sea



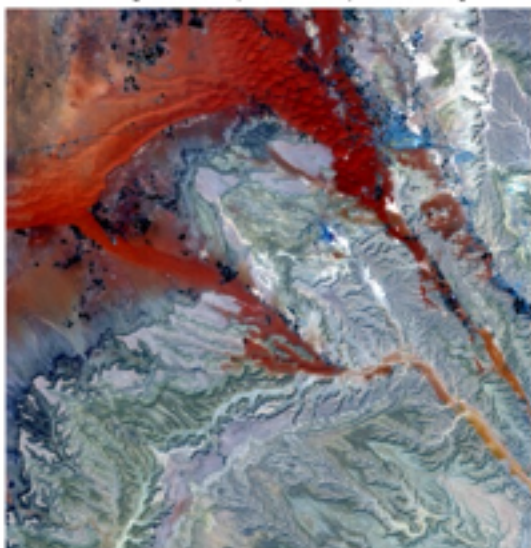
Libya 4 USGS Calibration site



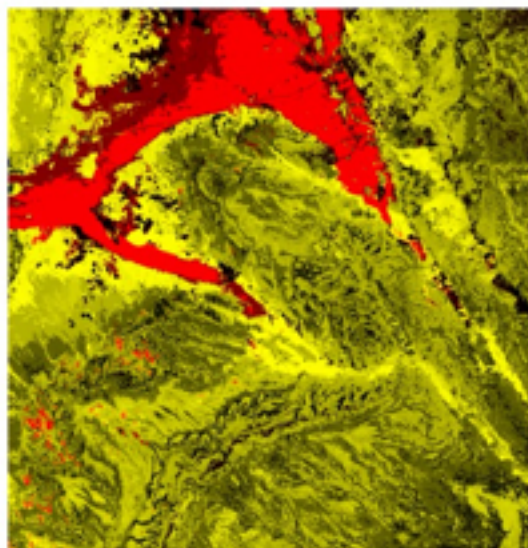
Radiometric model validation



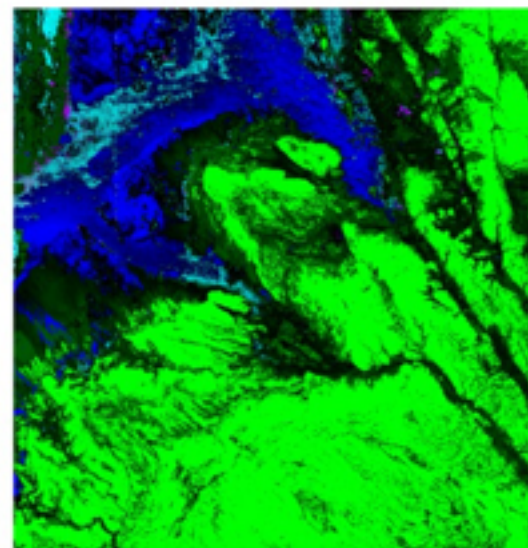
RGB [649 nm, 559 nm, 470 nm]



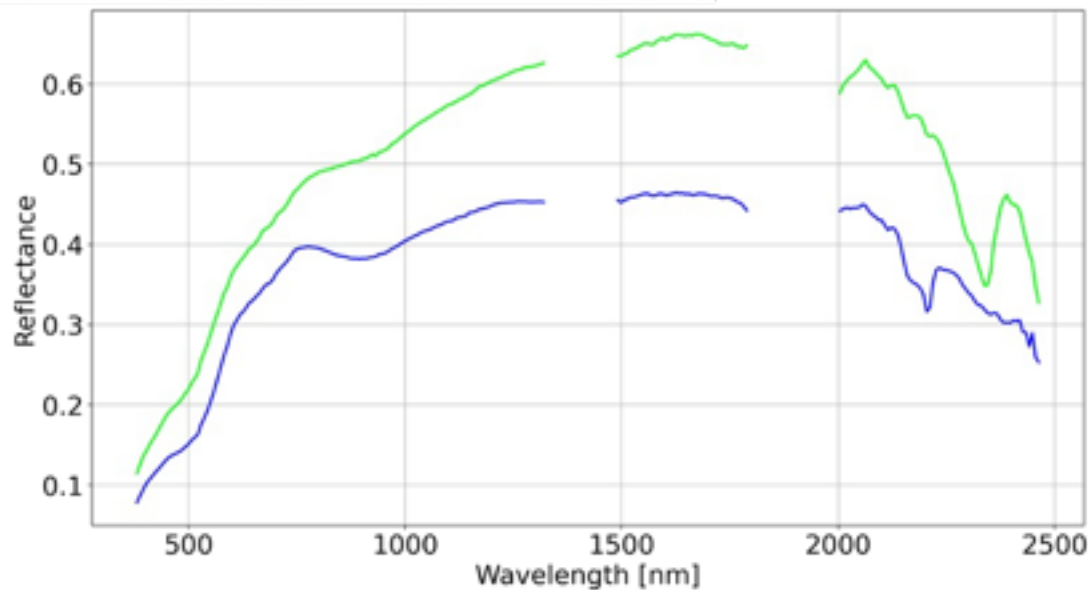
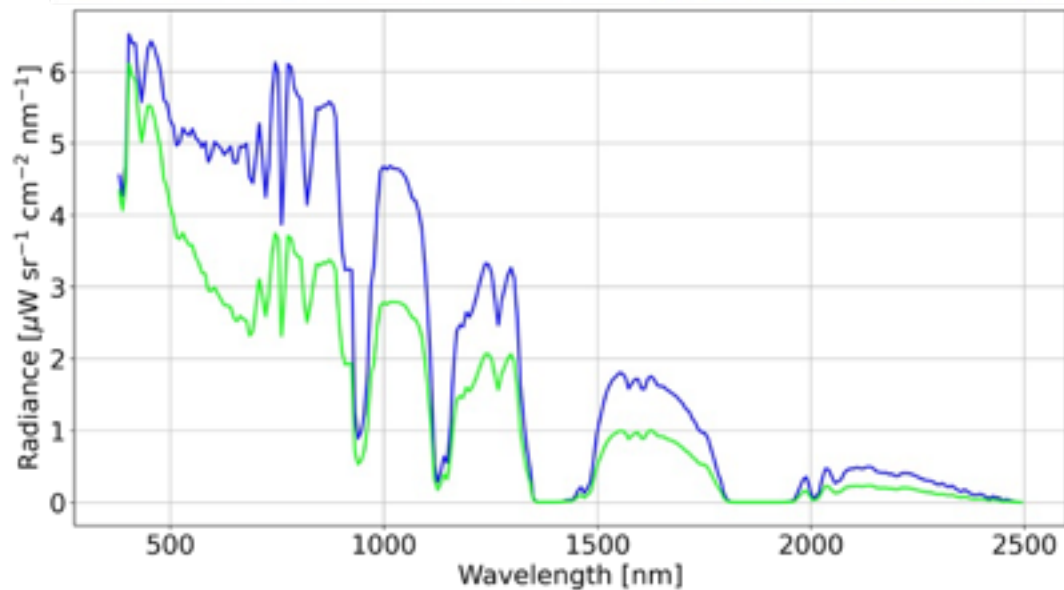
Dominant Mineral Abundances - Iron Oxides



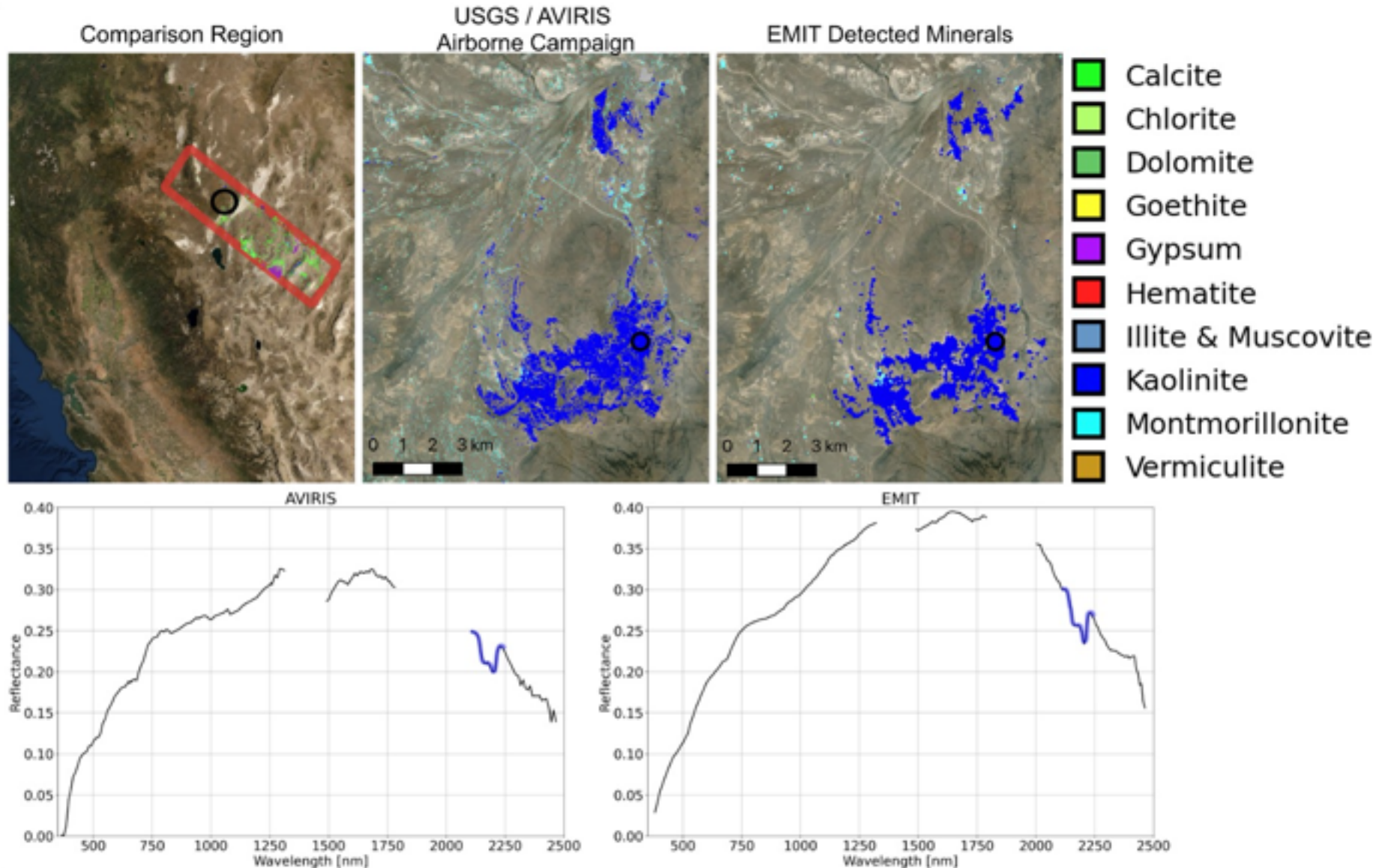
Dominant Mineral Abundances



- Calcite
- Chlorite
- Dolomite
- Goethite
- Gypsum
- Hematite
- Illite & Muscovite
- Kaolinite
- Montmorillonite
- Vermiculite

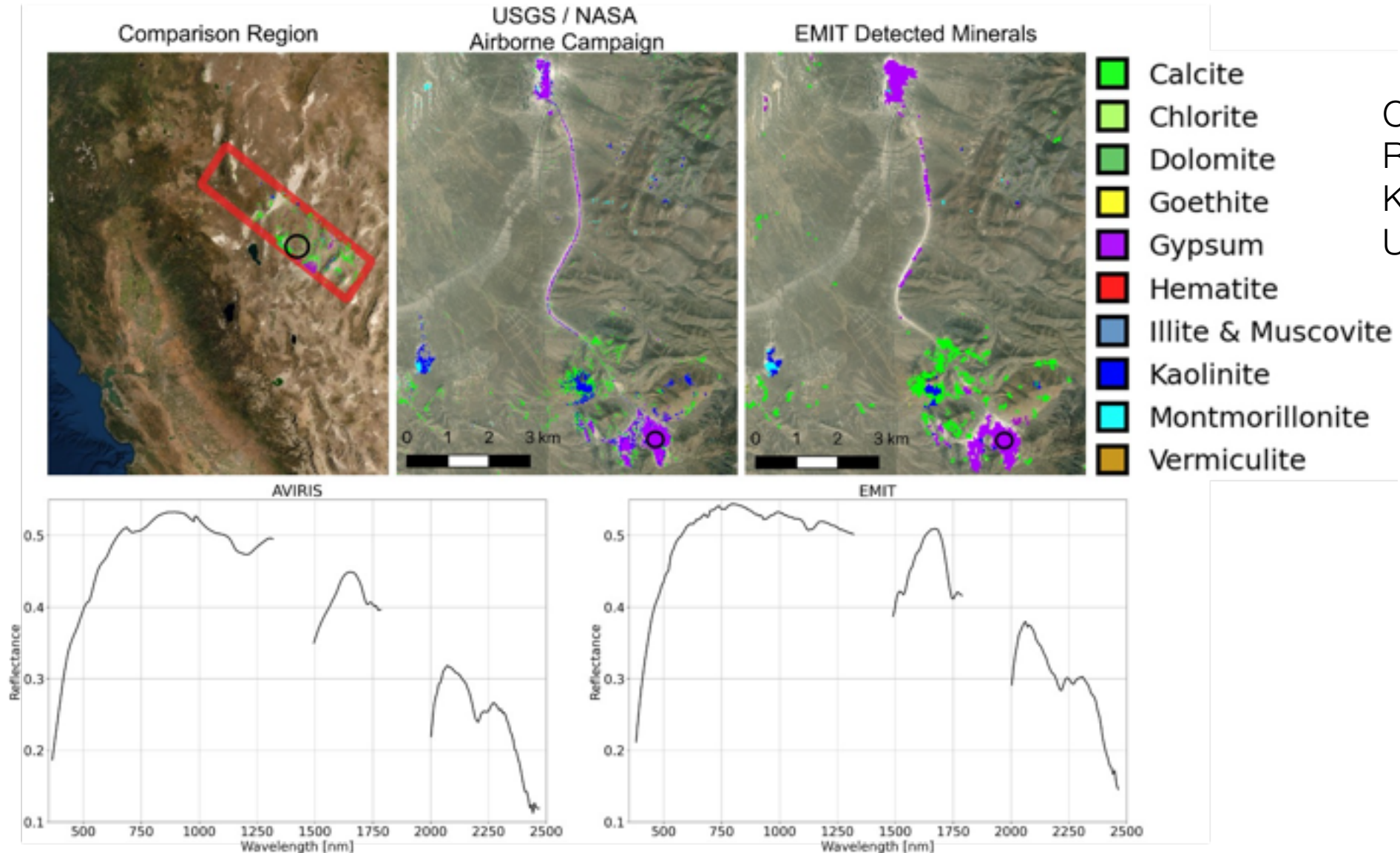


Mineral Validation with USGS Field Data

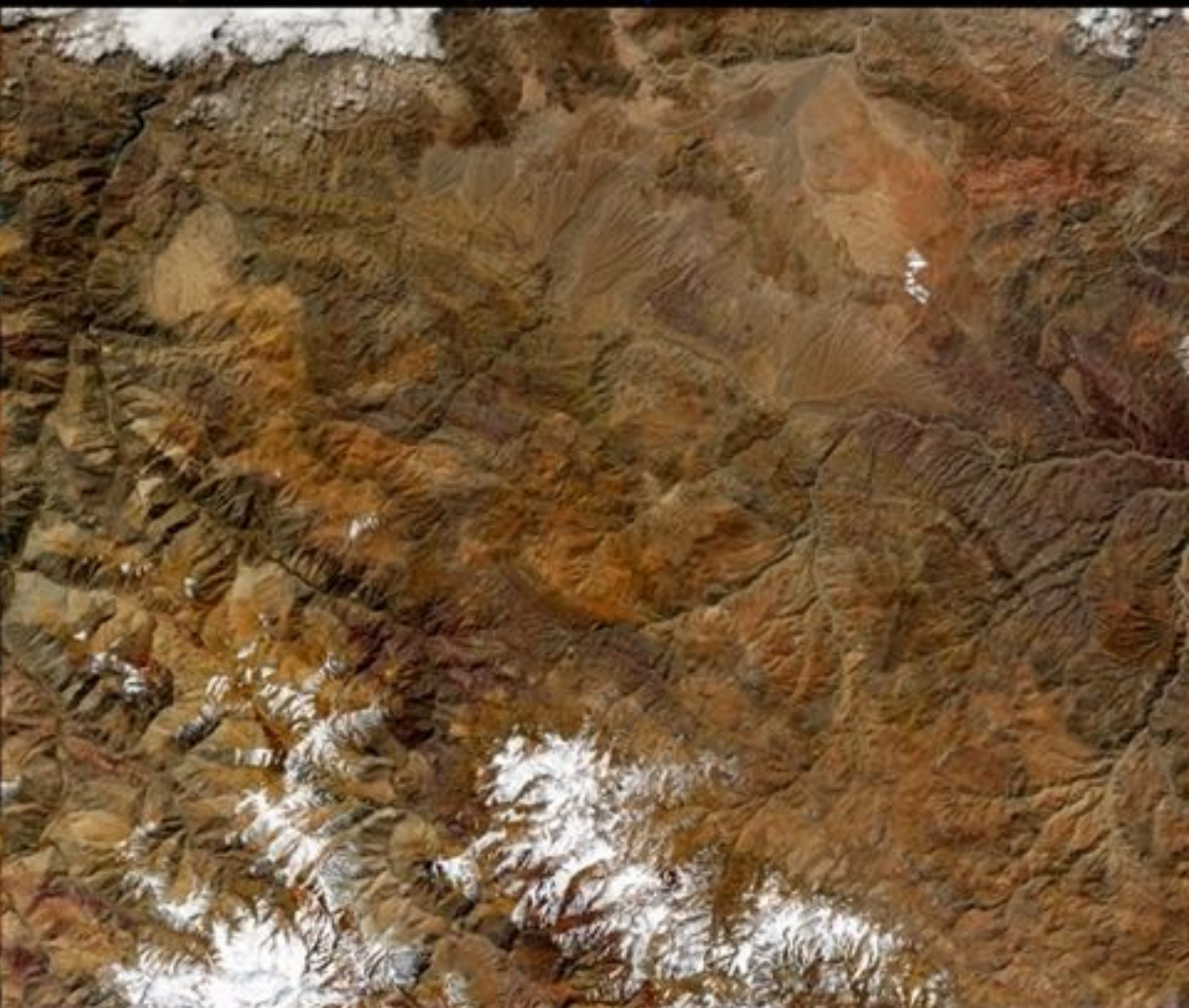
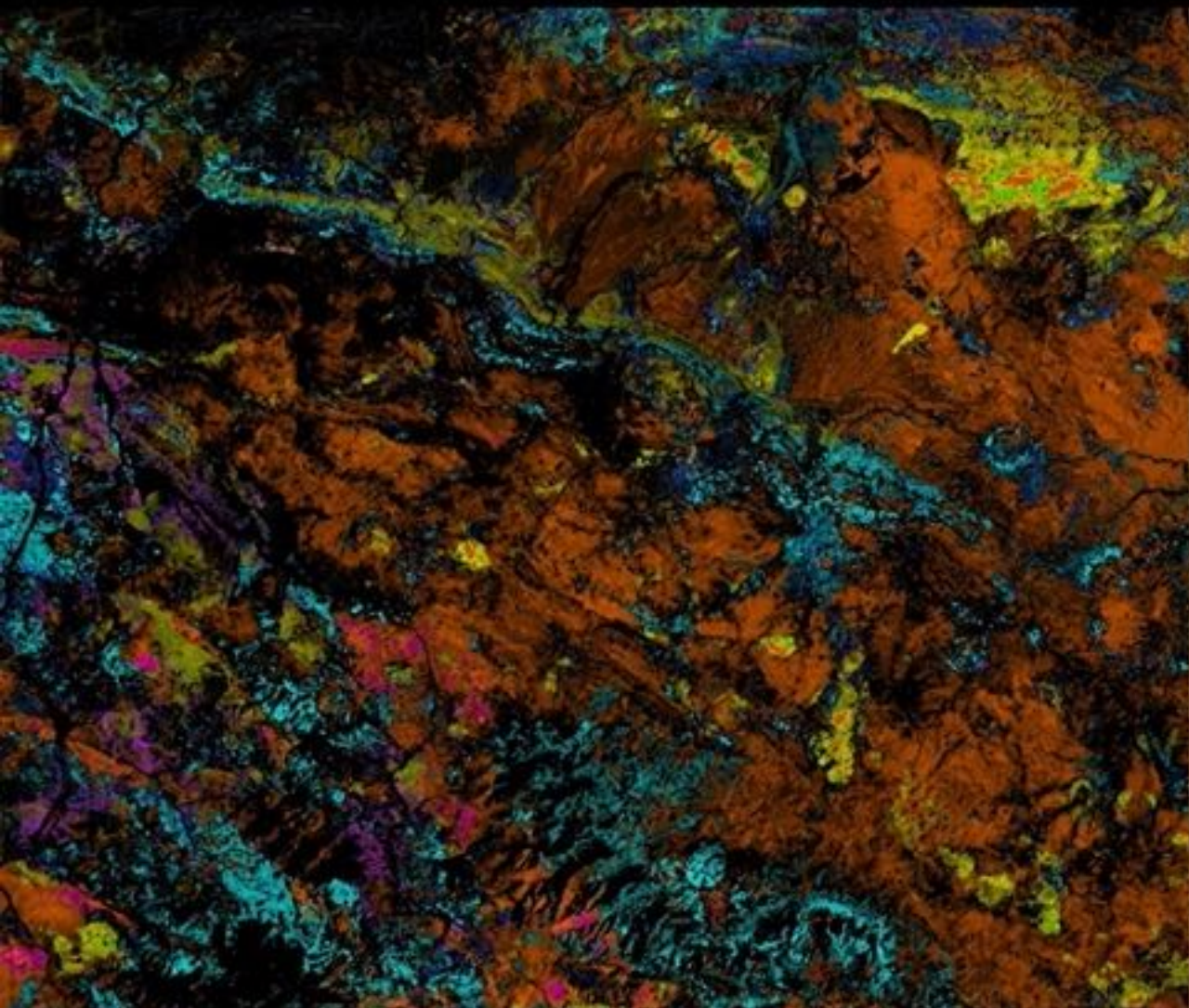

















Courtesy
Ray
Kokaly,
USGS

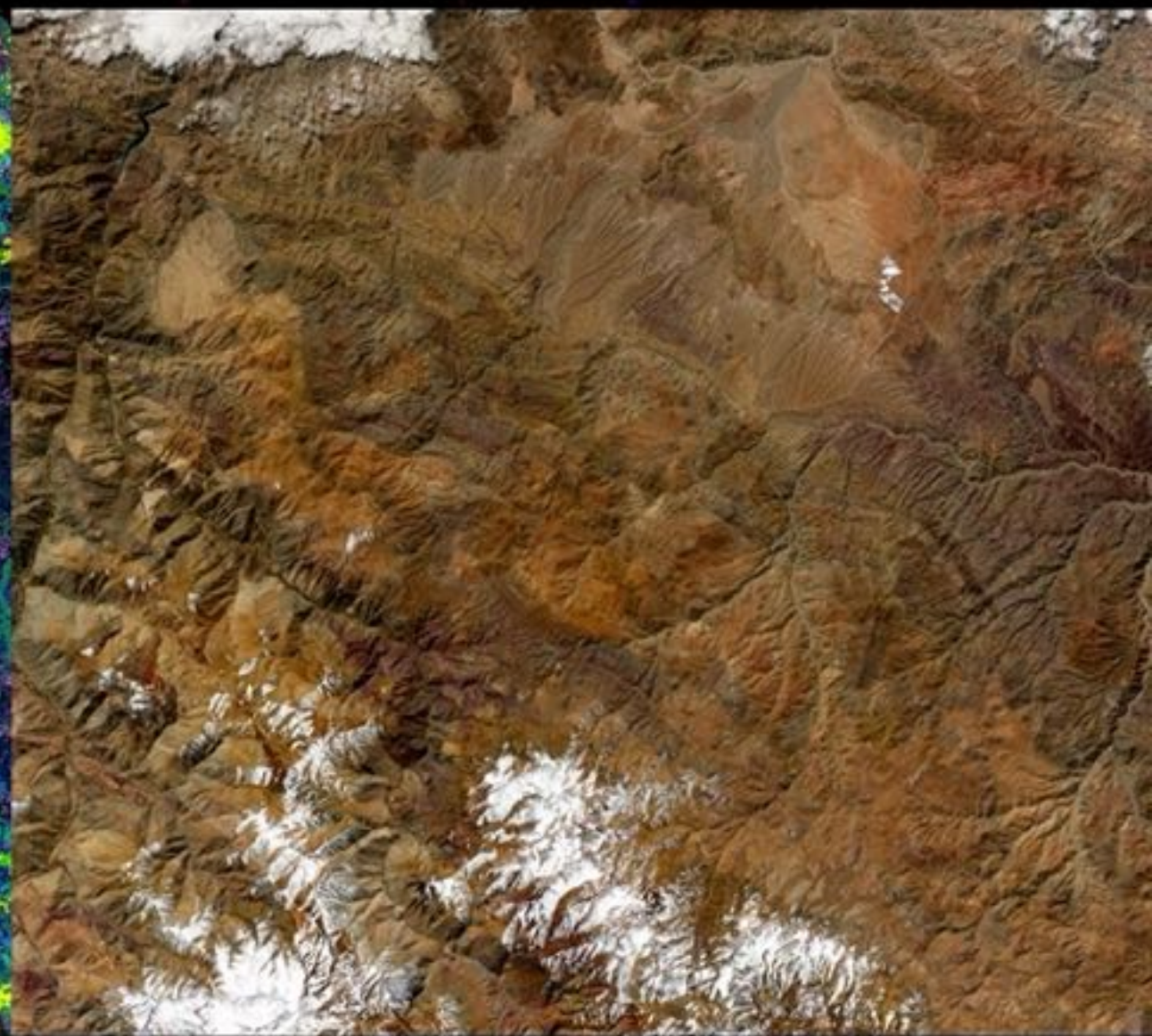
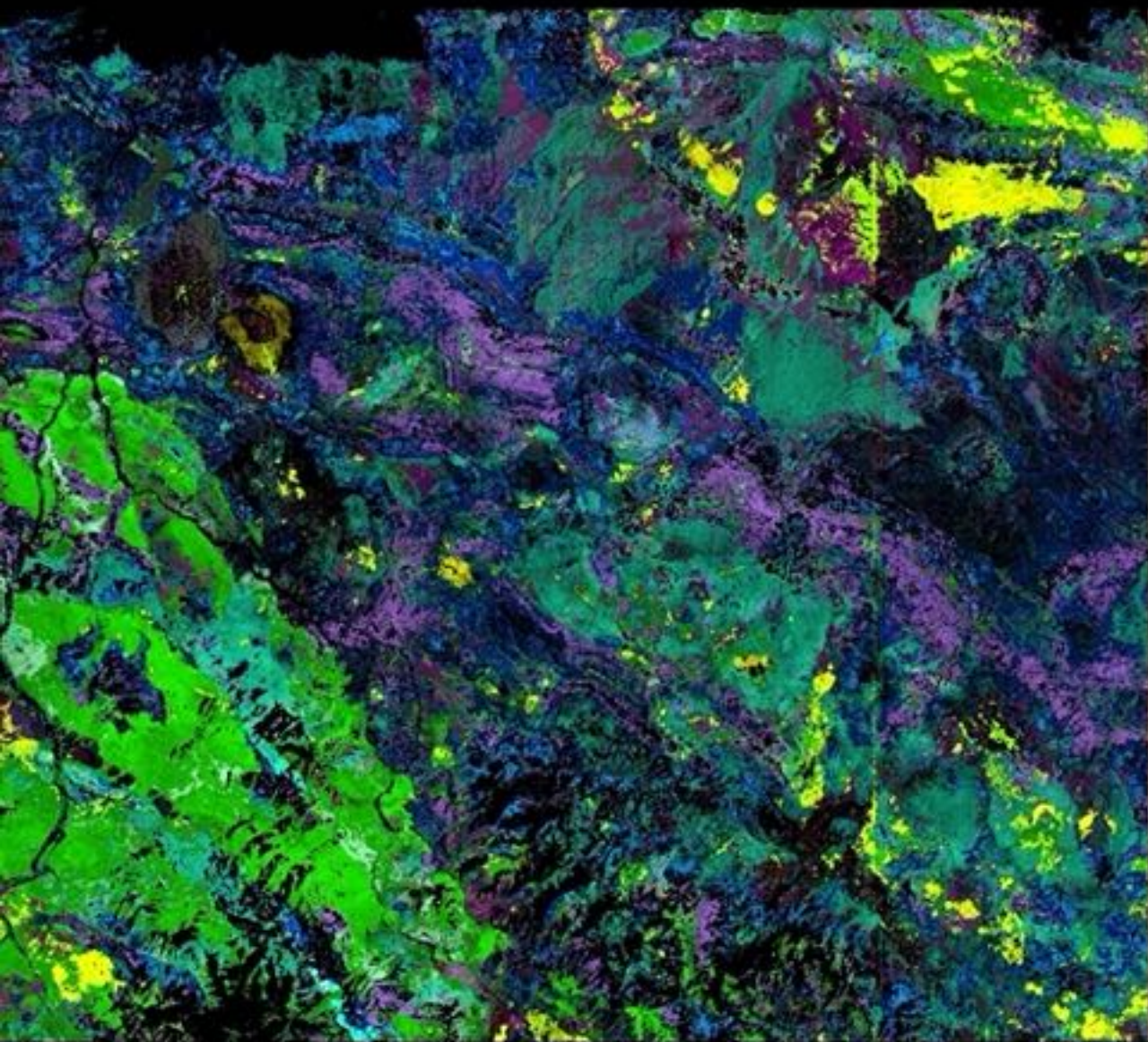
Mineral Validation with USGS Field Data



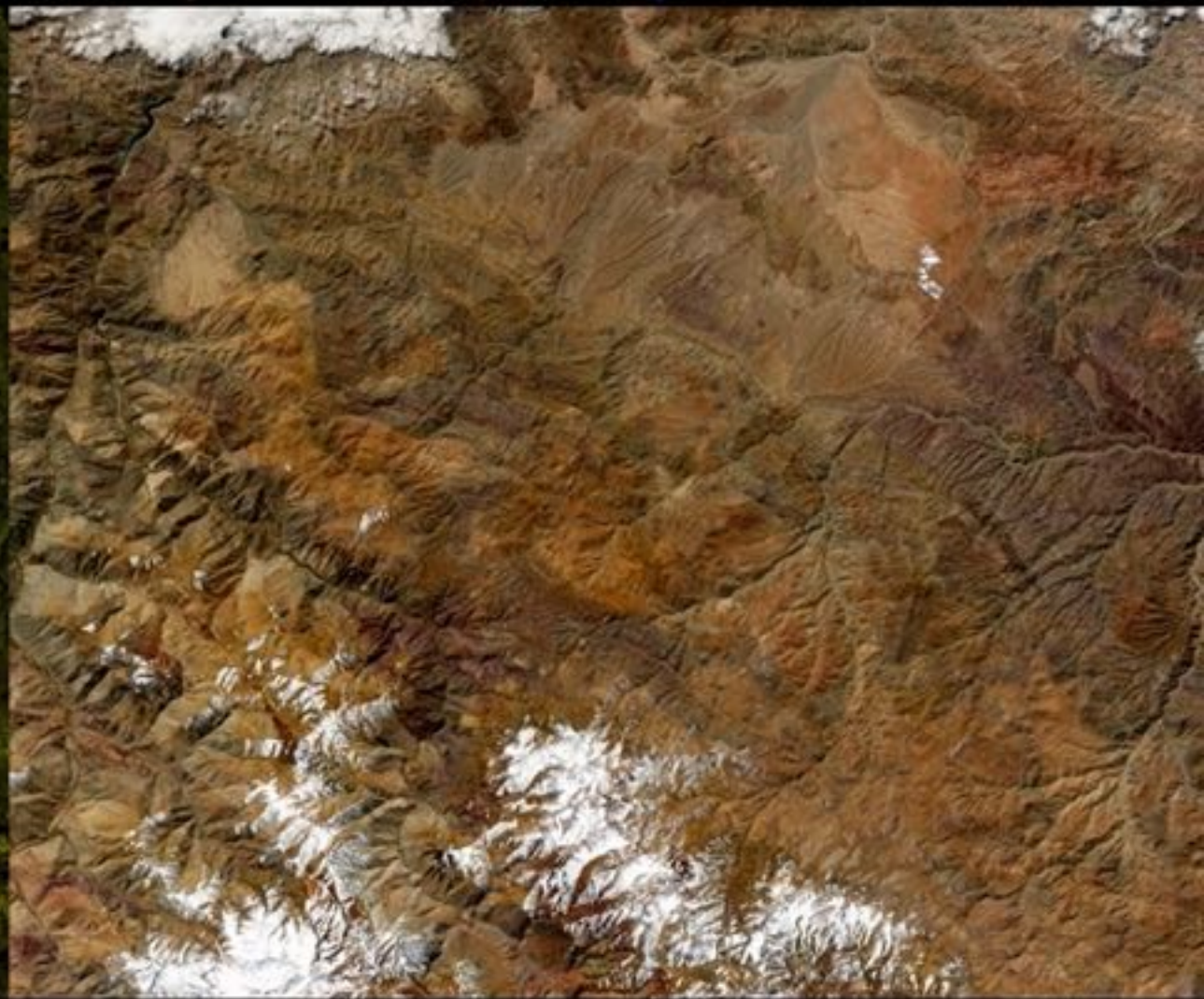
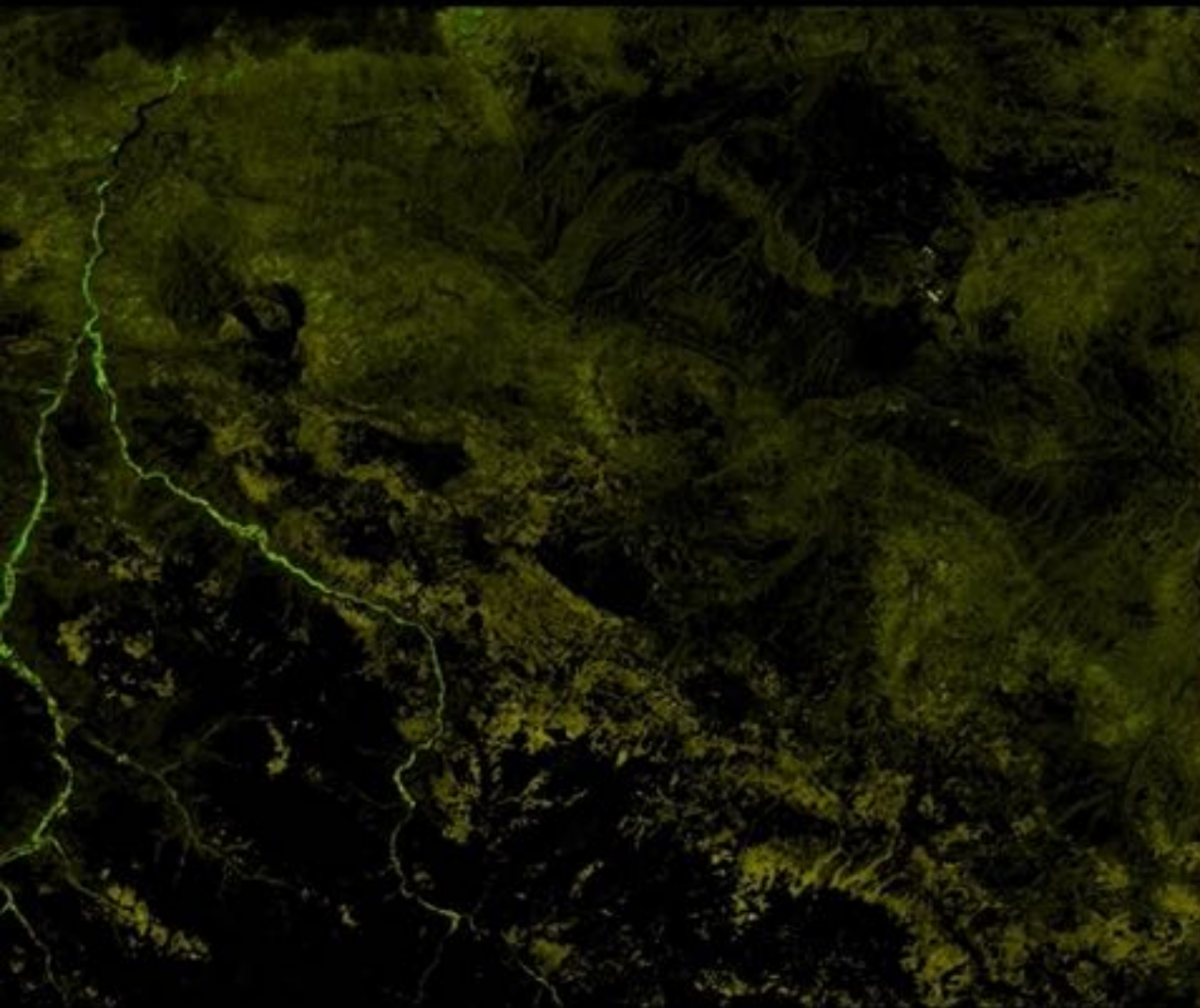
Courtesy
Ray
Kokaly,
USGS



- | Fe3+ oxide: | | Fe3+ hydroxide: | | Fe2+, Fe3+ minerals | | | |
|---|--------------------------|---|--------------------------|---|---------------|---|---------------------|
|  | Hematite, coarse grained |  | Goethite, coarse grained |  | Fe2+ Minerals |  | Fe2+, Fe3+ Mixtures |
|  | Hematite, medium grained |  | Goethite, medium grained |  | Fe2+ Minerals |  | Fe3+ Mixtures |
|  | Hematite, fine grained |  | Goethite, fine grained |  | Fe2+ Minerals |  | Fe3+ Iron Sulphates |
|  | Hematite, nano |  | Goethite, thin coating | | |  | Fe3+ Jarosite |

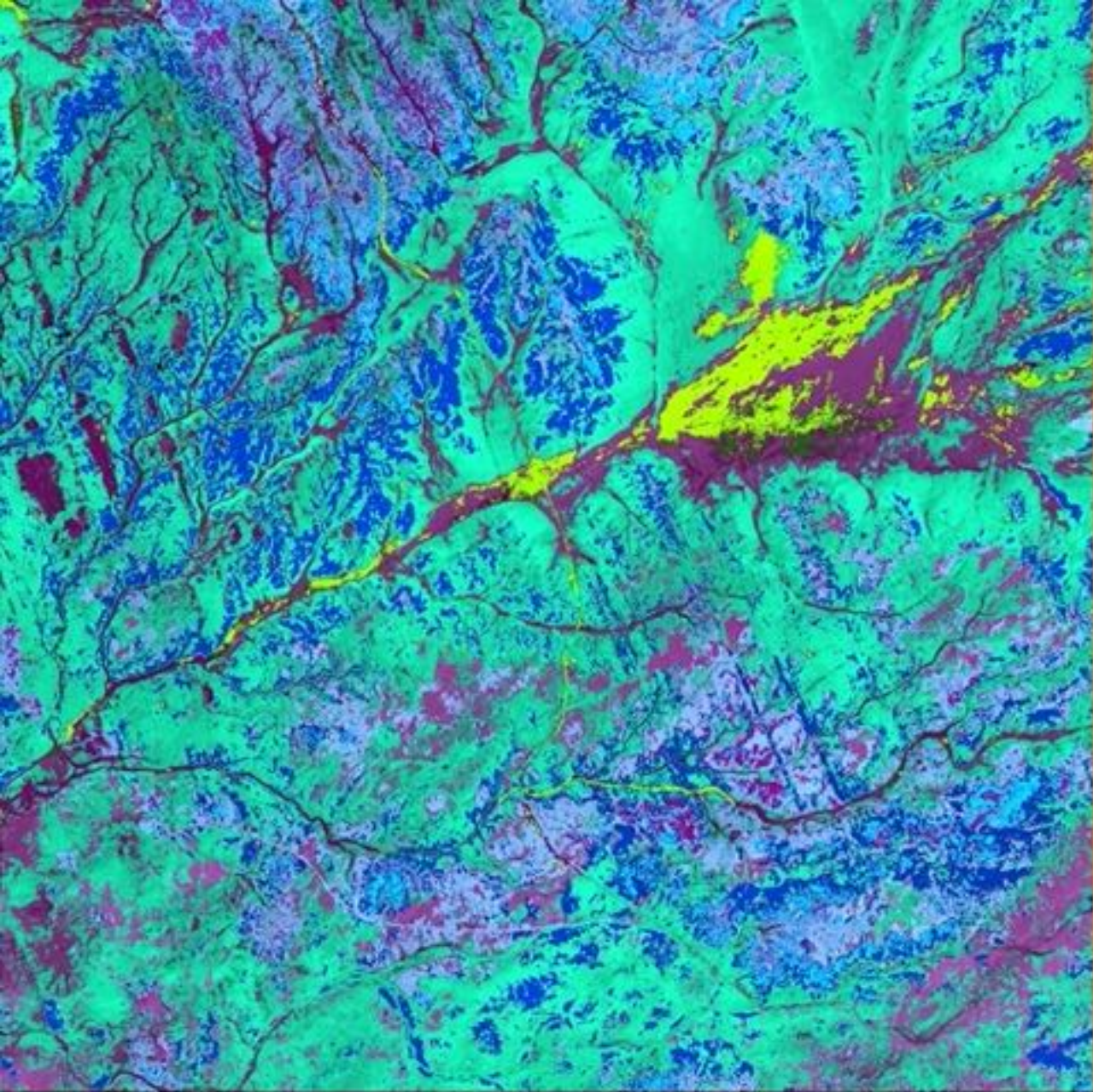


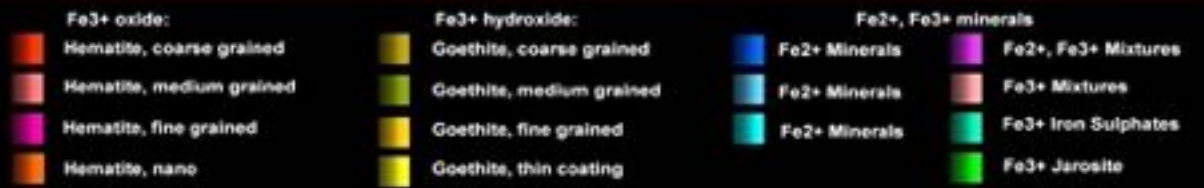
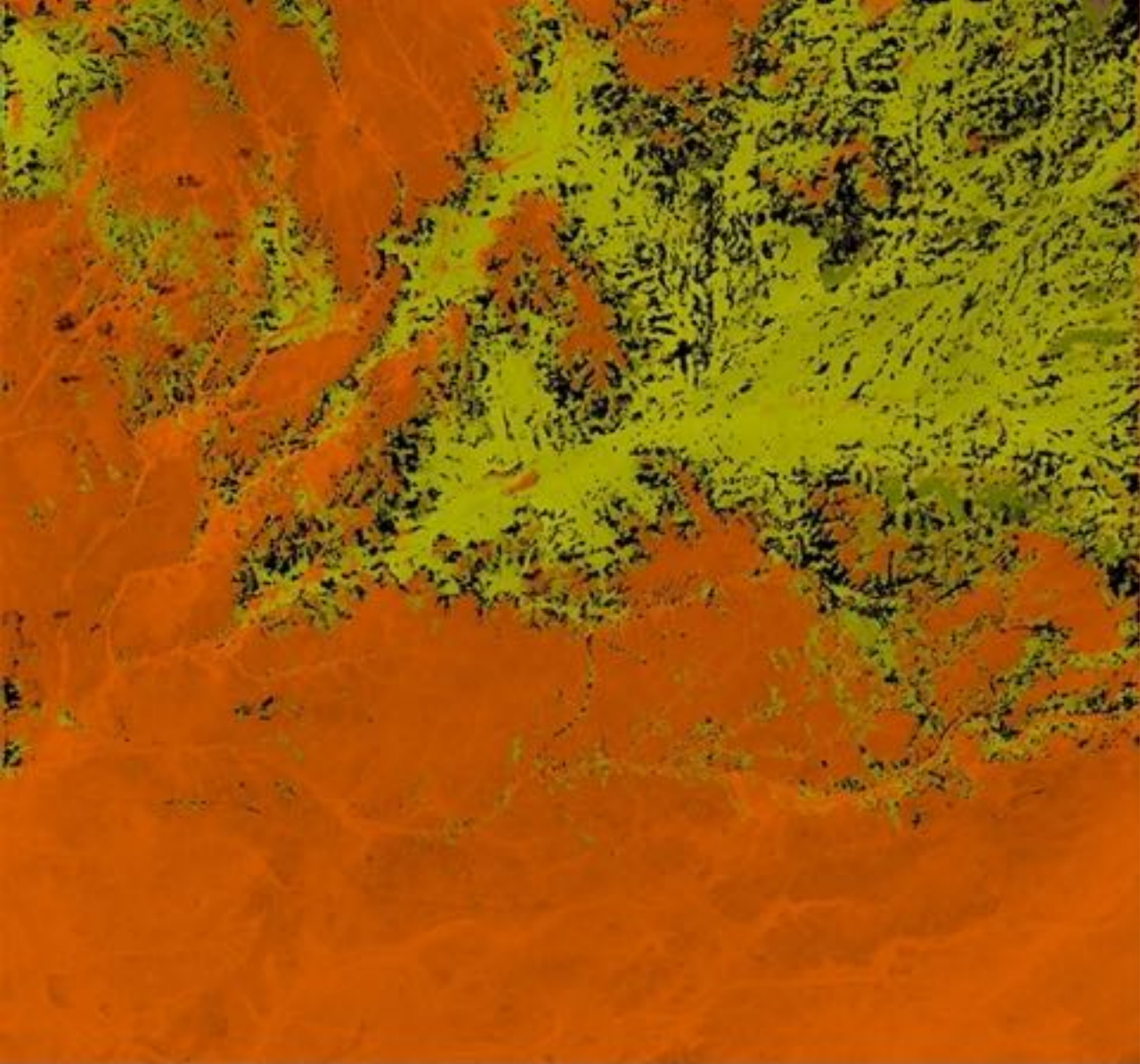
- Calcite
- Chlorite
Serpentine
- Dolomite
- Gypsum
- Illite +
Muscovite
- Kaolinite
- Montmorillonite
- Vermiculite
- Combinations



Vegetation Cover

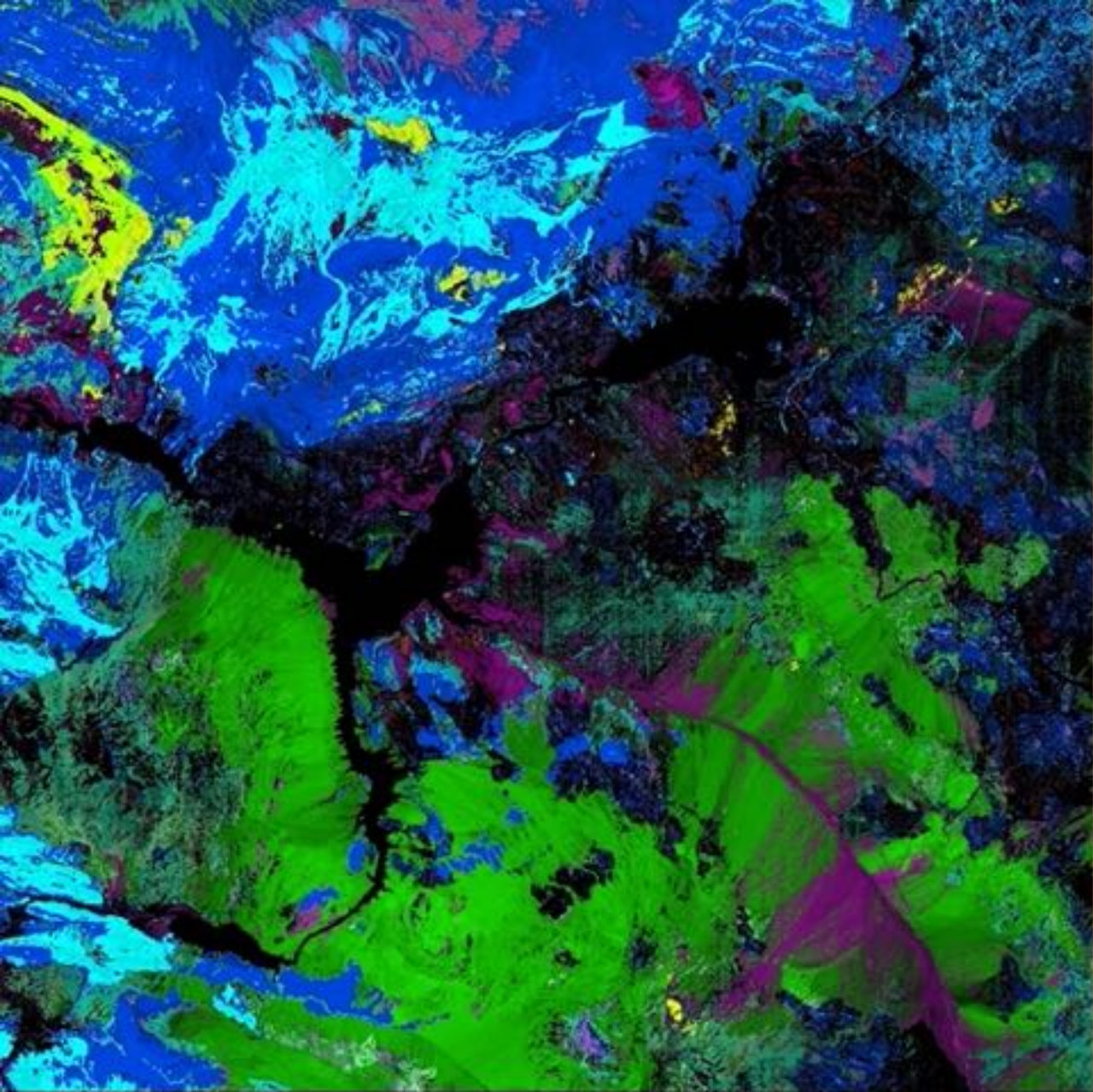


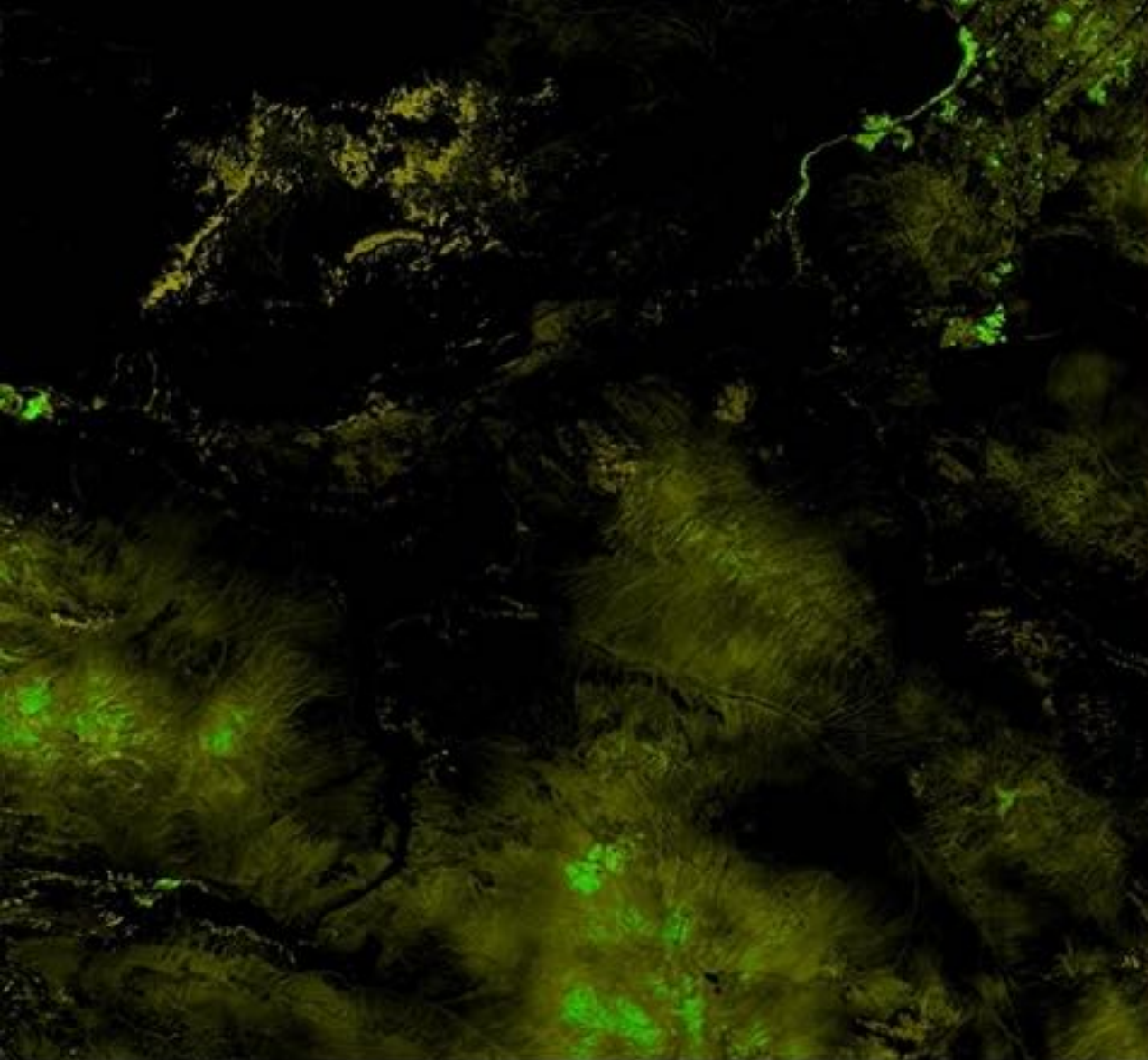




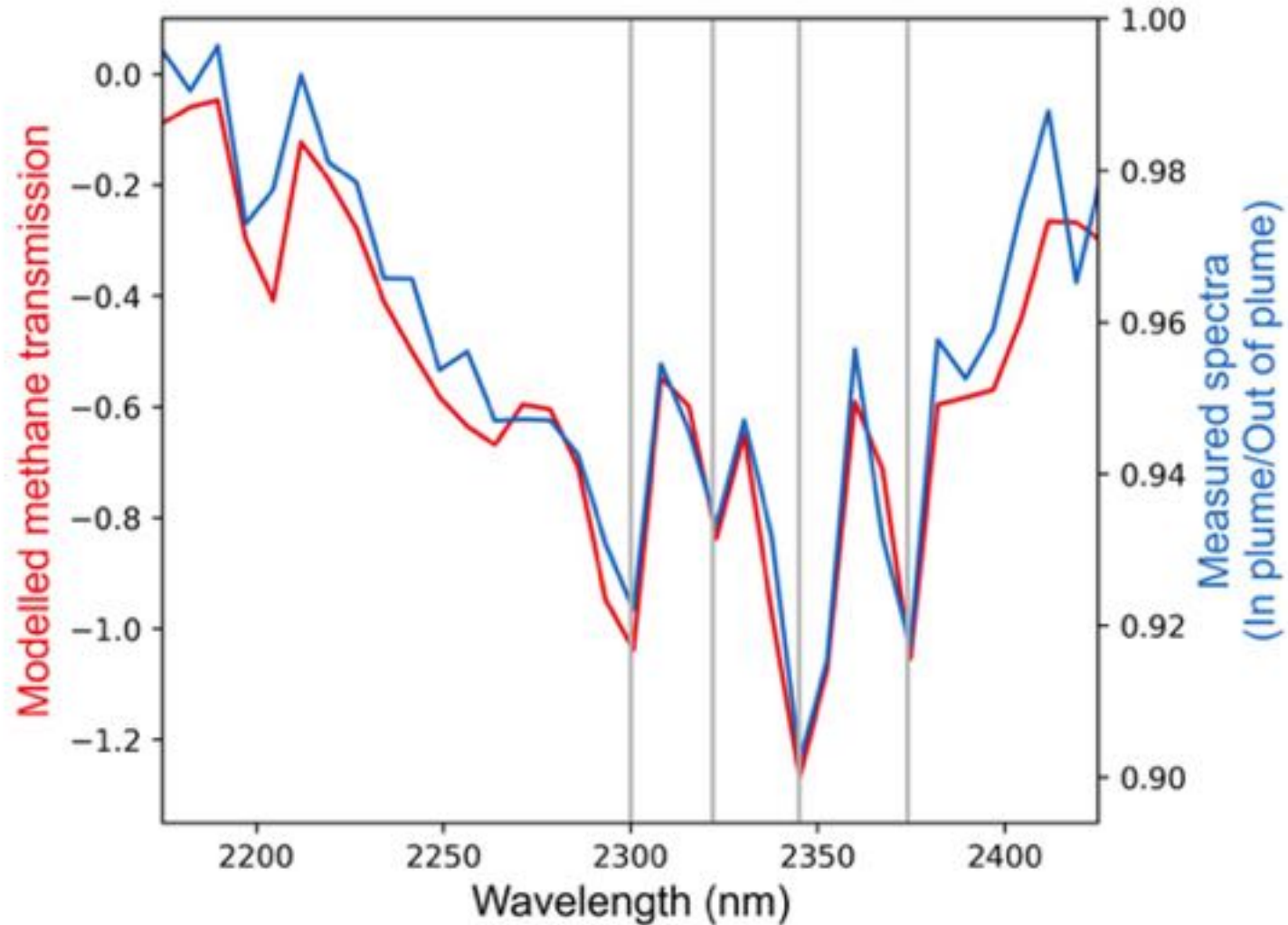


- | | | | |
|-------------------------------|-----------------------------------|--|--|
| Fe³⁺ oxide: | Fe³⁺ hydroxide: | Fe²⁺, Fe³⁺ minerals | |
| Hematite, coarse grained | Goethite, coarse grained | Fe ²⁺ Minerals | Fe ²⁺ , Fe ³⁺ Mixtures |
| Hematite, medium grained | Goethite, medium grained | Fe ²⁺ Minerals | Fe ³⁺ Mixtures |
| Hematite, fine grained | Goethite, fine grained | Fe ²⁺ Minerals | Fe ³⁺ Iron Sulphates |
| Hematite, nano | Goethite, thin coating | | Fe ³⁺ Jarosite |





Other applications



Plans for the future

- Deliver data to the DAAC in January
- Continue to monitor for radiometric changes, and update calibrations.
- Validate atmospheric retrievals with AERONET sites in diverse atmospheres
- Validate surface reflectances at multiple sites, for multiple atmospheric conditions
- Validate and refine higher level products
 - Vegetation fractions
 - Mineral maps
- Assess cloud screening performance



02/22/2022



Backup slides



12/19/22

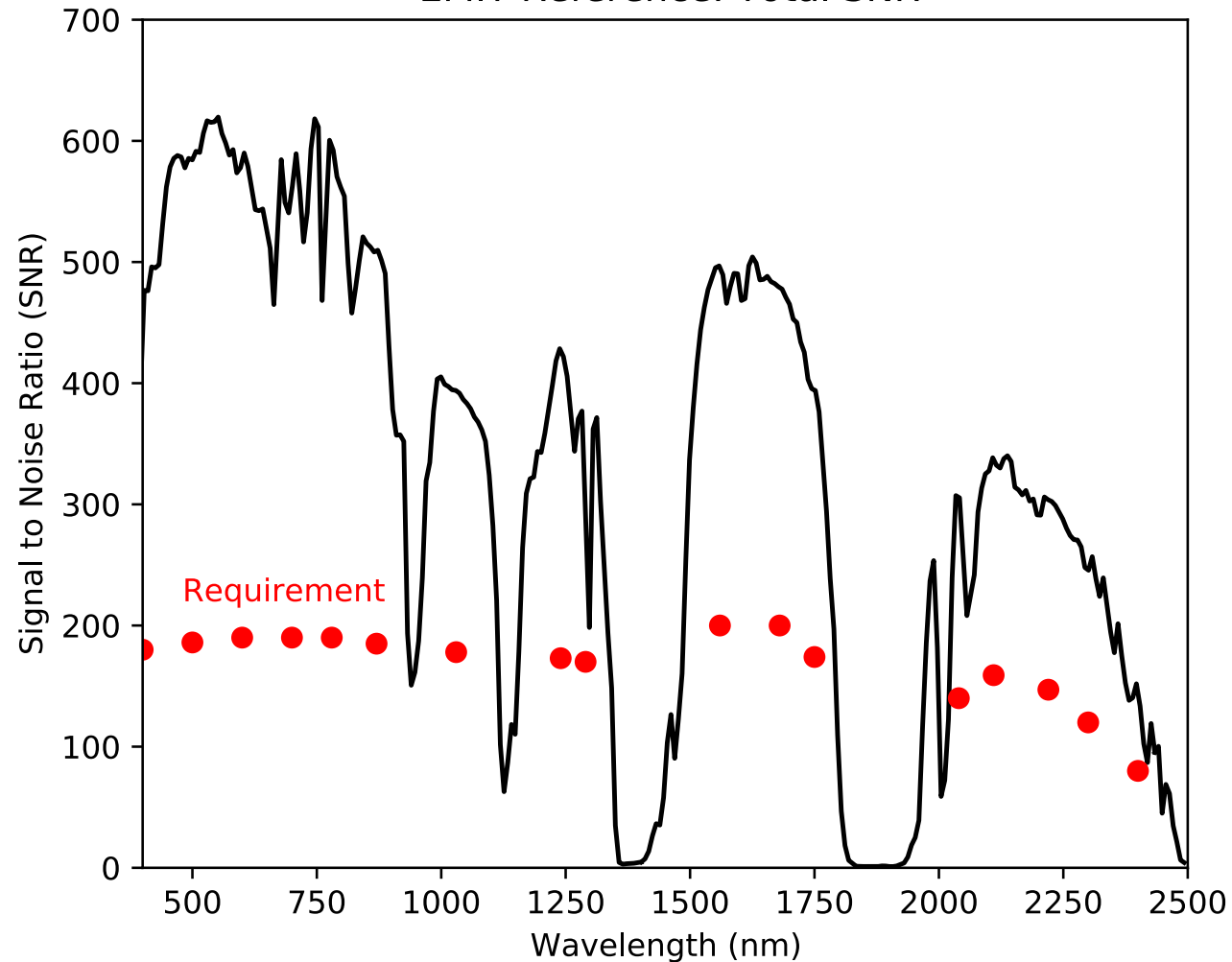
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SNR on reference case vs. requirements

EMIT Reference: Total SNR



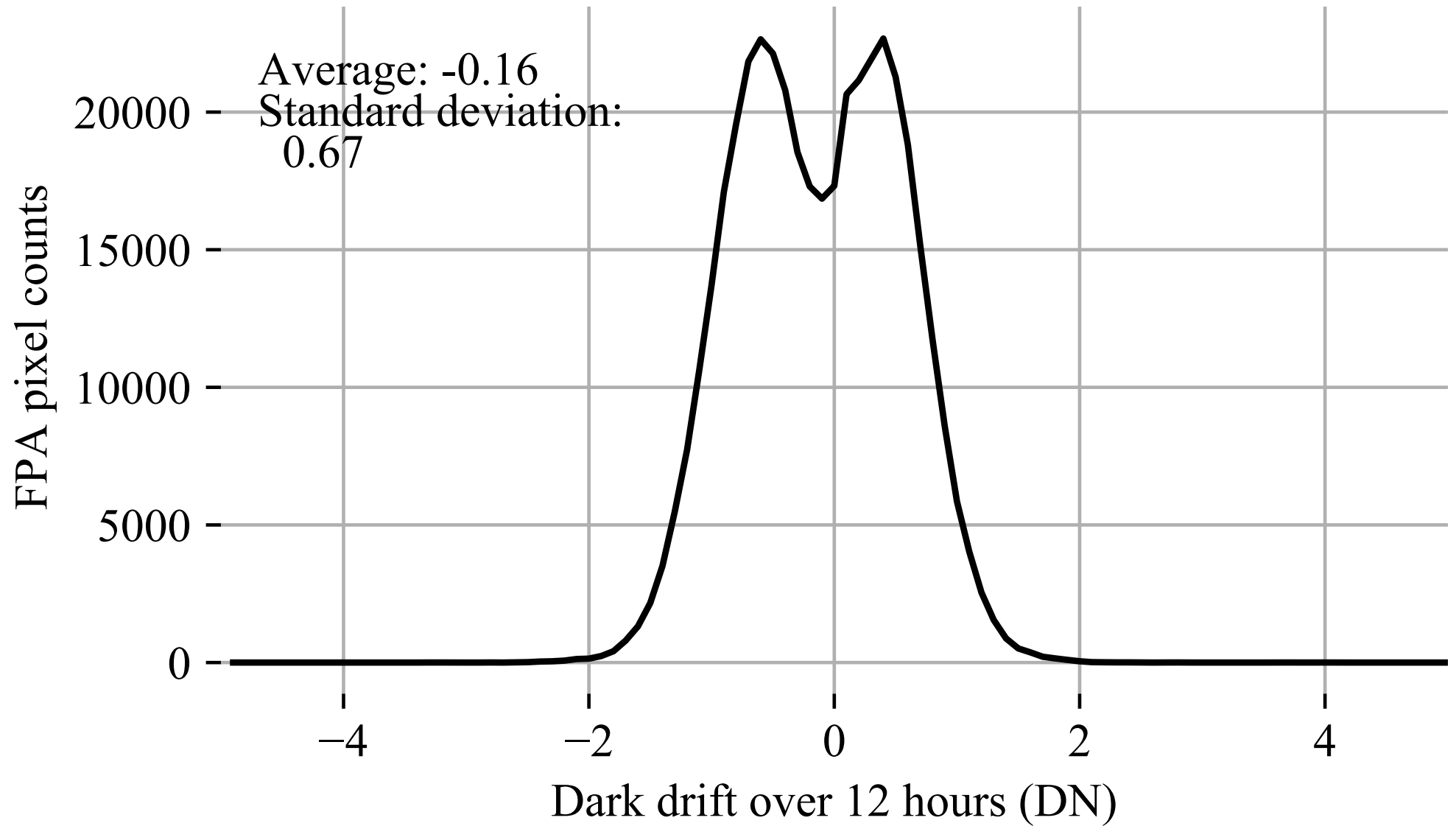
Flat field update



Scene-wise destriping







Geolocalization Accuracy

