A Novel Approach to Report HyspIRI Location and Observation Information in a Compact Format for Data Distribution and Utilization

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Outline and Overview

- Some background on my biases
- AVIRIS, M3, CAO & ARTEMIS lessons
- Ray Tracing vs Rendering
- LOC and OBS files as backplanes
- HyspIRI Specifics
- Whole Earth is the Target
- >11 years to get ready?

Unique Spatial Aspects of Imaging Spectrometry Data

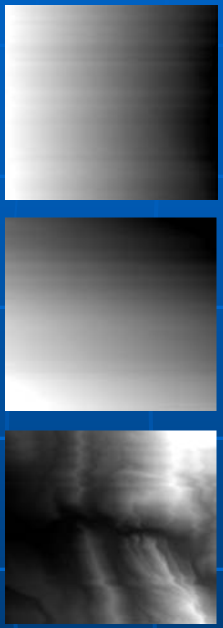
- It’s all about the spectra
- While map-projected products are the goal, the science must happen BEFORE the rendering/gridding
- Multi-temporal, multi-angle, BRDF, photometry, unmixing, etc all demand it
- Best-use of the data require supporting info regarding observation geometry
- Honor the spectral data, yet support the end users of products, with Pbytes...

Science THEN Rendering

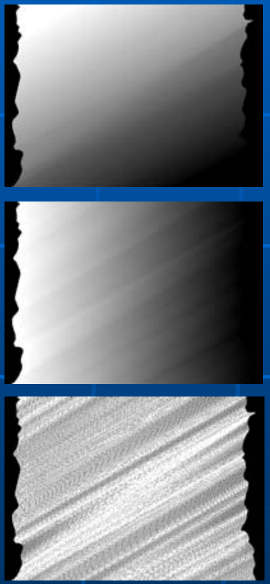
NASA	CODMAC	Description
Packet Data	Raw - Level 1	Telemetry data stream as received at the ground station, with science and engineering data embedded.
Level 0	Edited - Level 2	Instrument science data (e.g., raw voltages, counts) at full resolution, time ordered, with duplicates and transmission errors removed.
Level 1-A	Calibrated - Level 3	Level 0 data that have been located in space and may have been transformed (e.g., calibrated, rearranged) in a reversible manner and packaged with needed ancillary and auxiliary data (e.g., radiances with the calibration equations applied).
Level 1-B	Resampled - Level 4	Irreversibly transformed (e.g., resampled, remapped, calibrated) values of the instrument measurements (e.g., radiances, magnetic field strength).
Level 2	Derived - Level 5	Geophysical parameters, generally derived from Level 1 data, and located in space and time commensurate with instrument location, pointing, and sampling.
Level 3	Derived - Level 5	Geophysical parameters mapped onto uniform space-time grids.

The IGM, GLT, GEO, ORT Model

example raw imagery



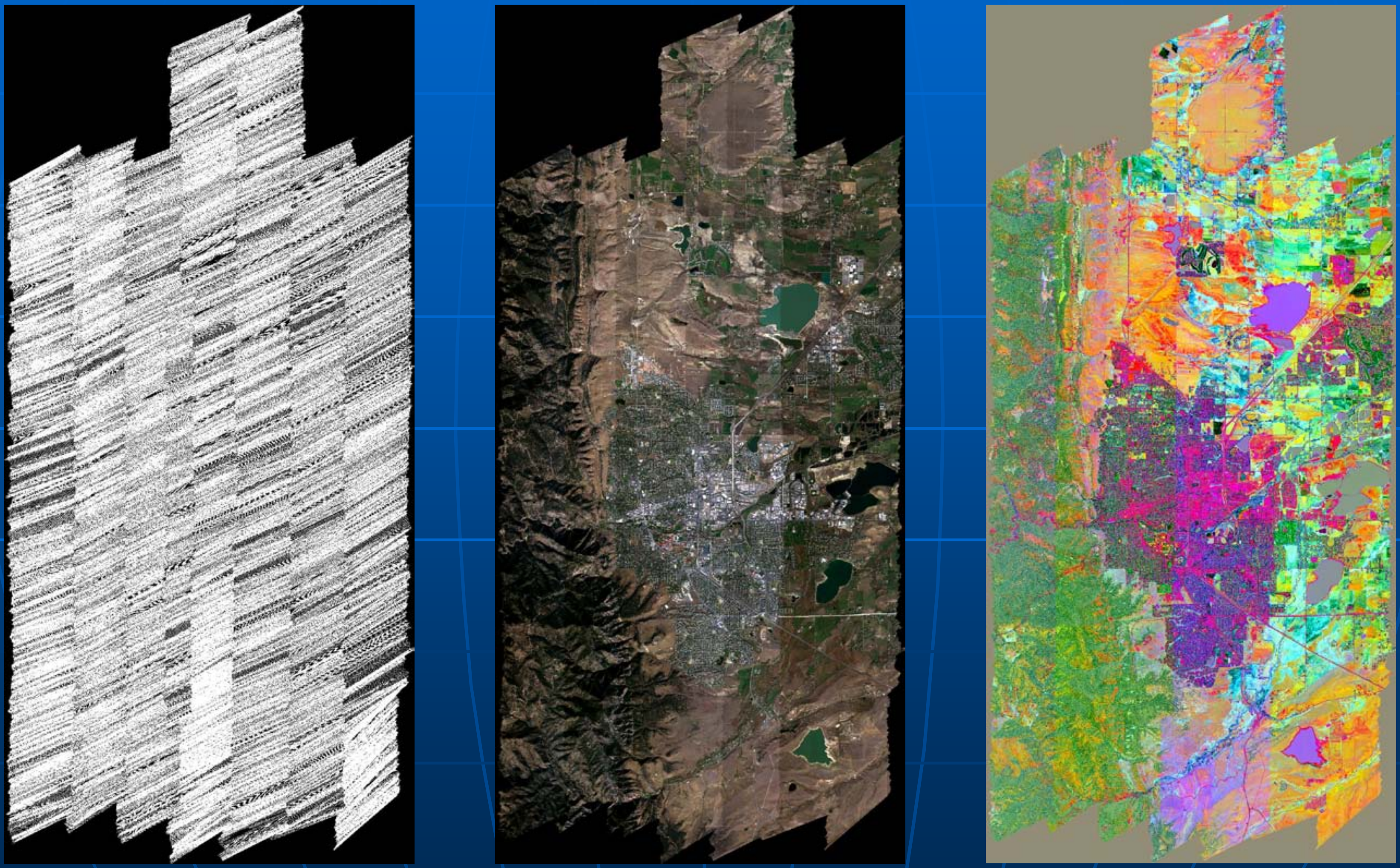
IGM products



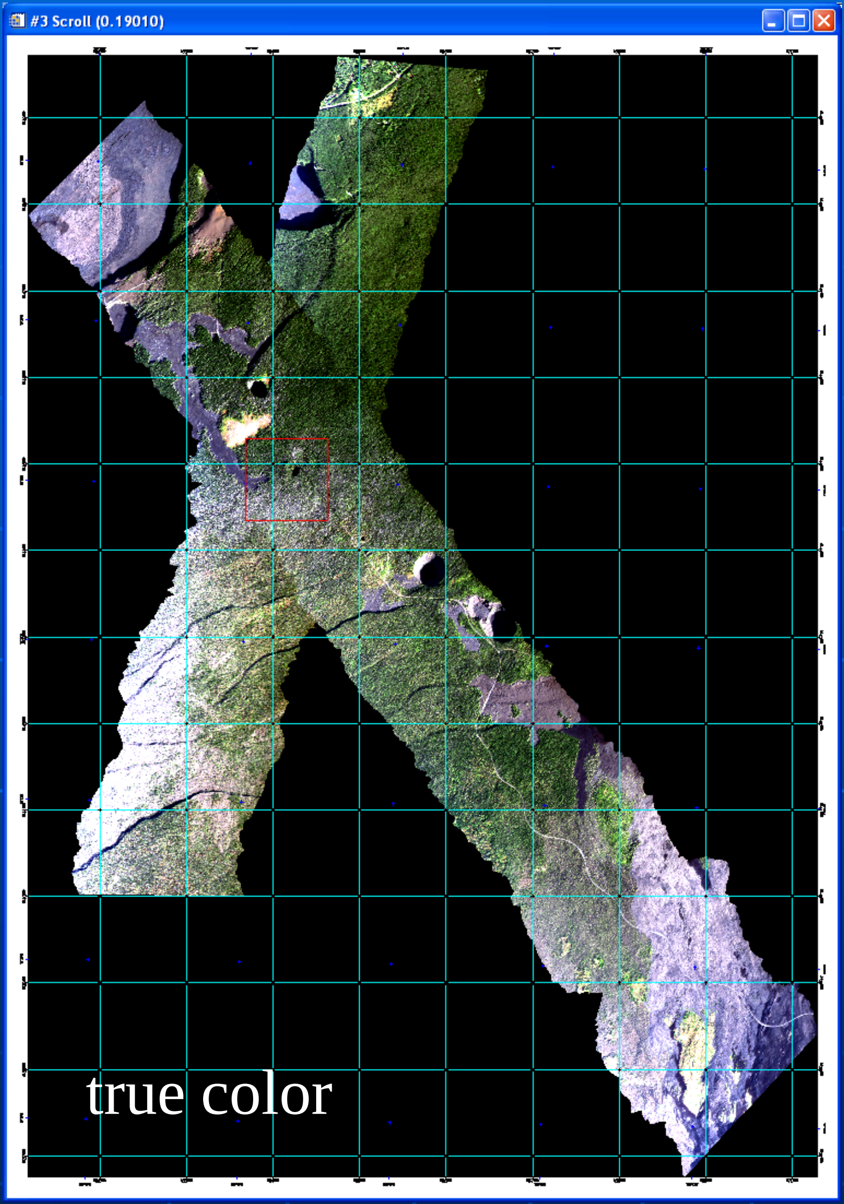
GLT products

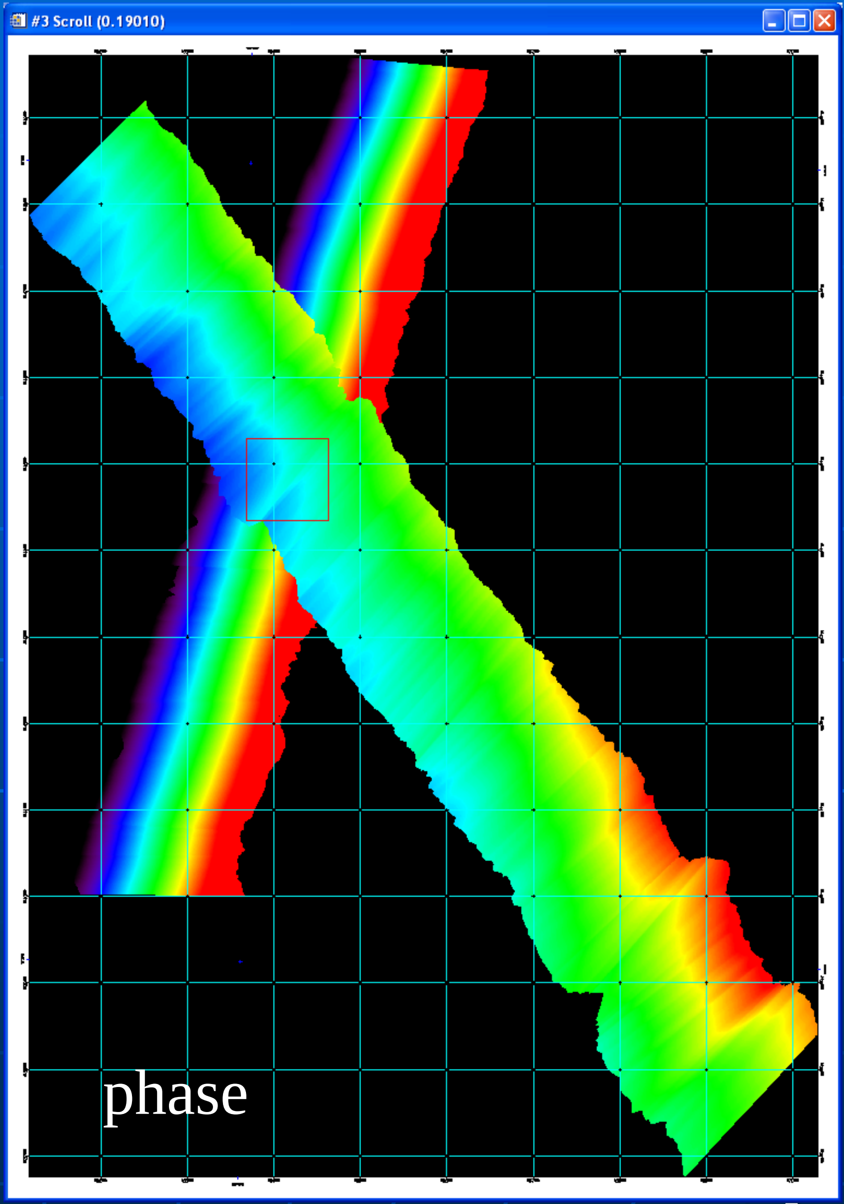
3-d orthomosaic

AVIRIS Mosaic of Boulder

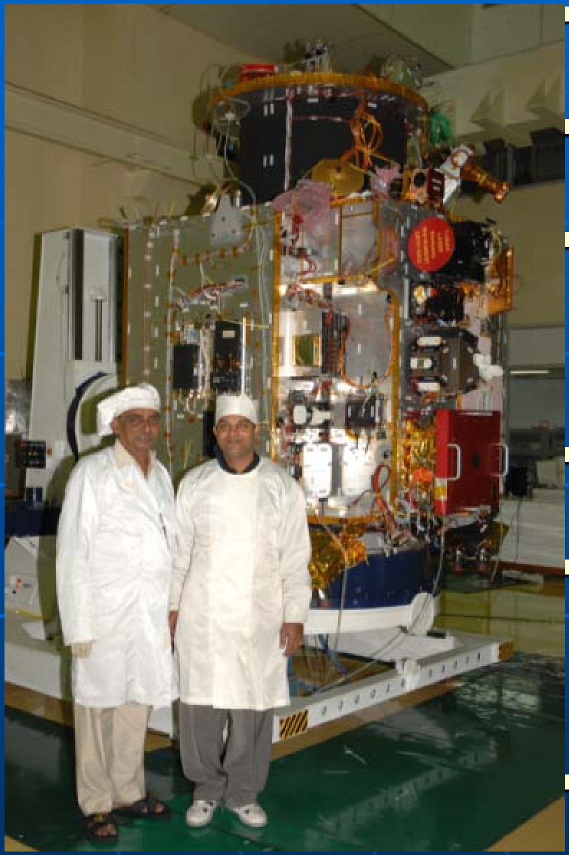


AVIRIS/CAO Fusion





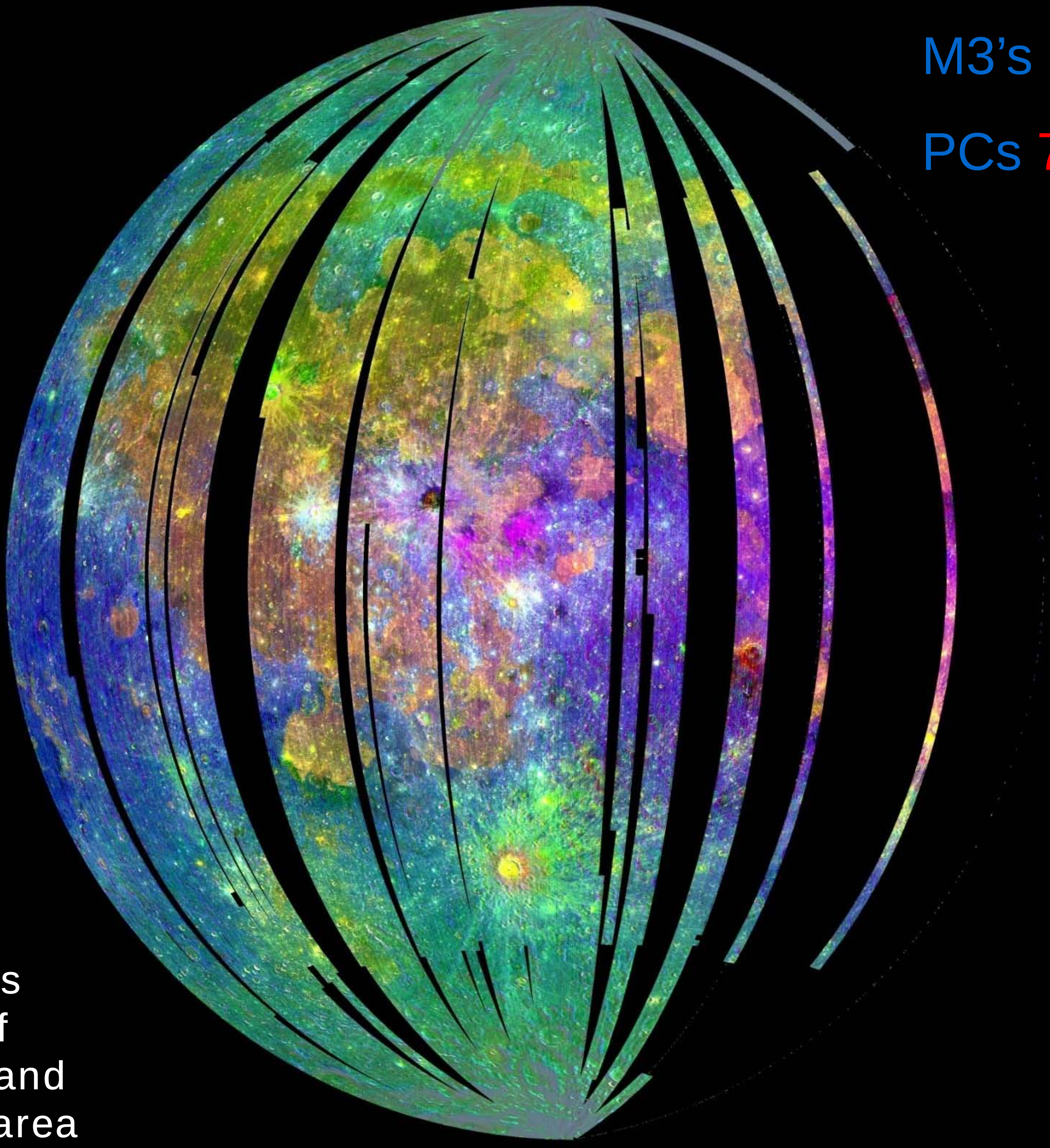
M3 on CH-1 at the Moon



- Launched on PSLV October 22, 2008
- Lunar Orbit Insertion November 8, 2008
- Completed two of four planned Optical Periods (Nov08-Feb09 and Apr09-Aug09)
- CH-1 S/C comm. lost on August 29, 2009
- More than 90% of Moon covered with usable Global Mode data
- Minimal Target Mode collections

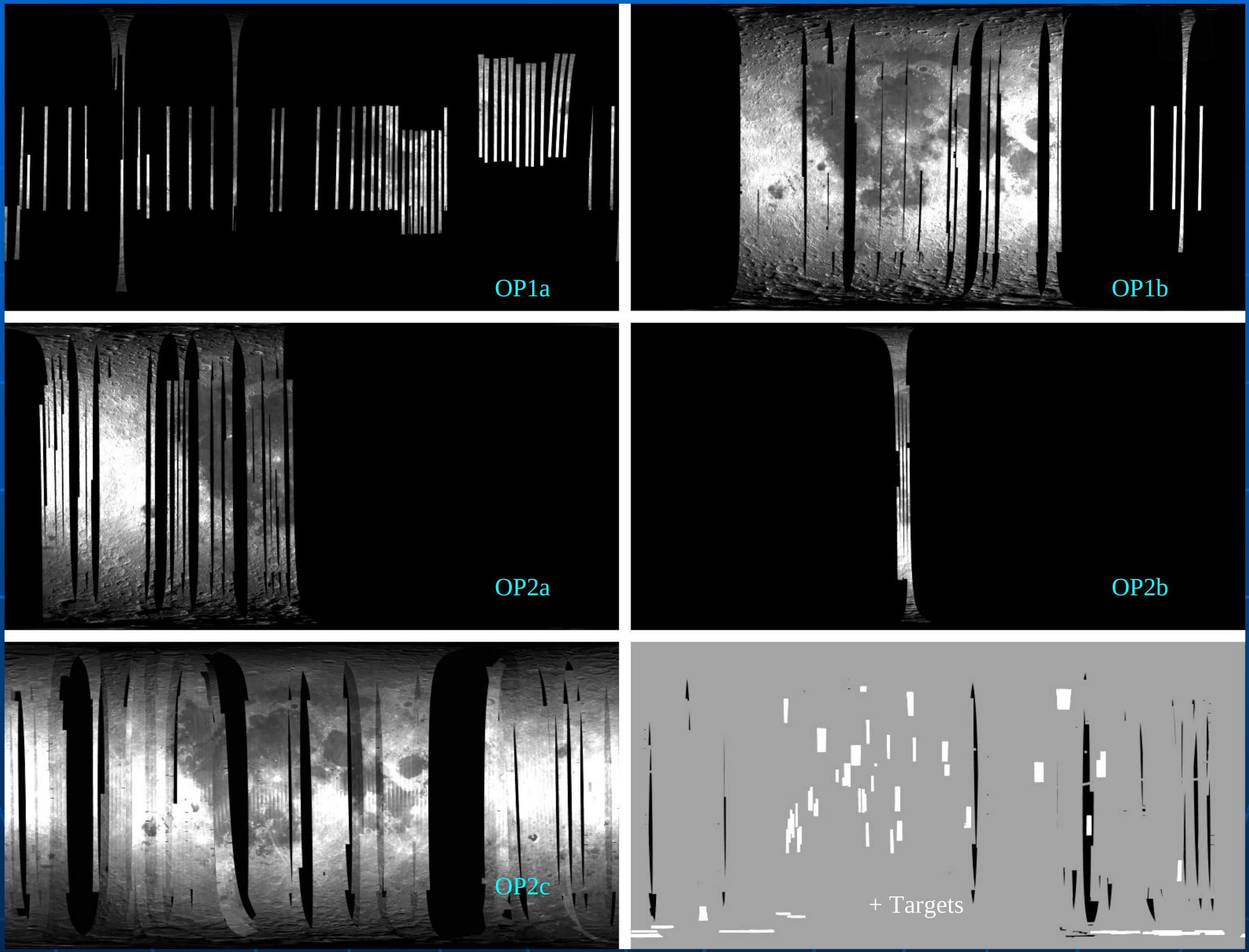
M3's Moon

PCs 7,8,9



Moon has ~20% of Earth's land surface area

M3 Coverage Summary



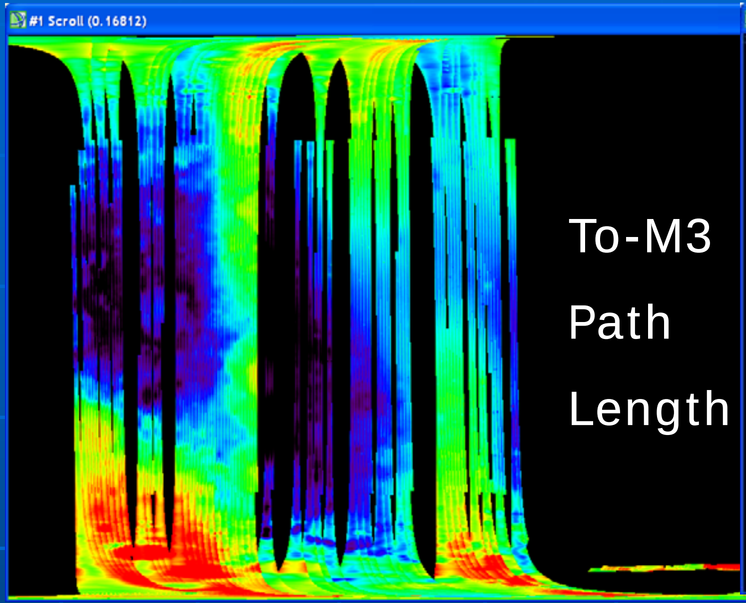
Ray Tracing

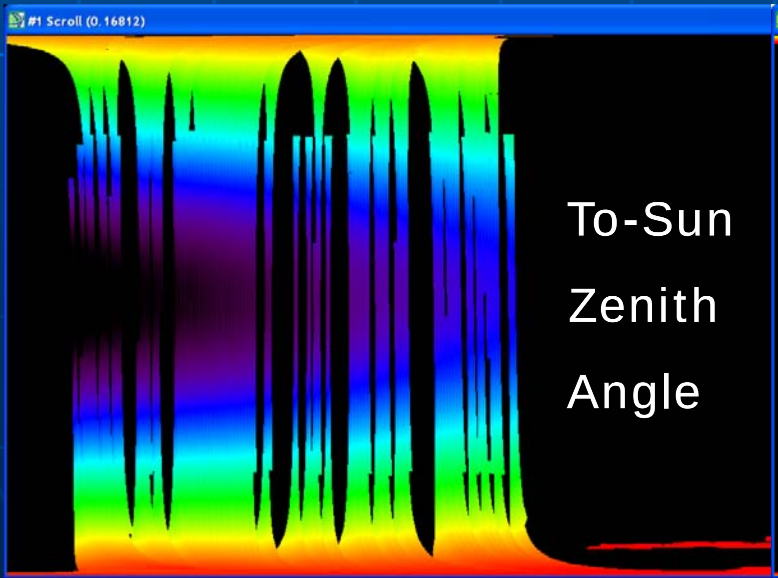
- Astrodynamics, geodesy, geometry, geophysics and photogrammetry (fun stuff)
- Timing, ephemeris, attitude and camera model (HyspIRI design requirements)
- ECI-to-ECEF: UT1 variations, nutation, precession, polar motion (operational)
- Refraction, velocity aberration, light time of flight (minor effects but well-modeled)
- Topographic model (adequate for 60m)
- Expect sub-pixel accuracy and stability

Observation Geometry

- 11 critical parameters on a per-pixel basis:
  - To-sun zenith angle (degrees)
  - To-sun azimuth angle (degrees)
  - To-sensor zenith angle (degrees)
  - To-sensor azimuth angle (degrees)
  - Phase angle (degrees)
  - To-sun path length (AU)
  - To-sensor path length (meters)
  - Local slope angle (meters)
  - Local aspect angle (meters)
  - Incidence angle wrt topo model (degrees)
  - Exitance angle wrt topo model (degrees)

Example M3 OBS Data





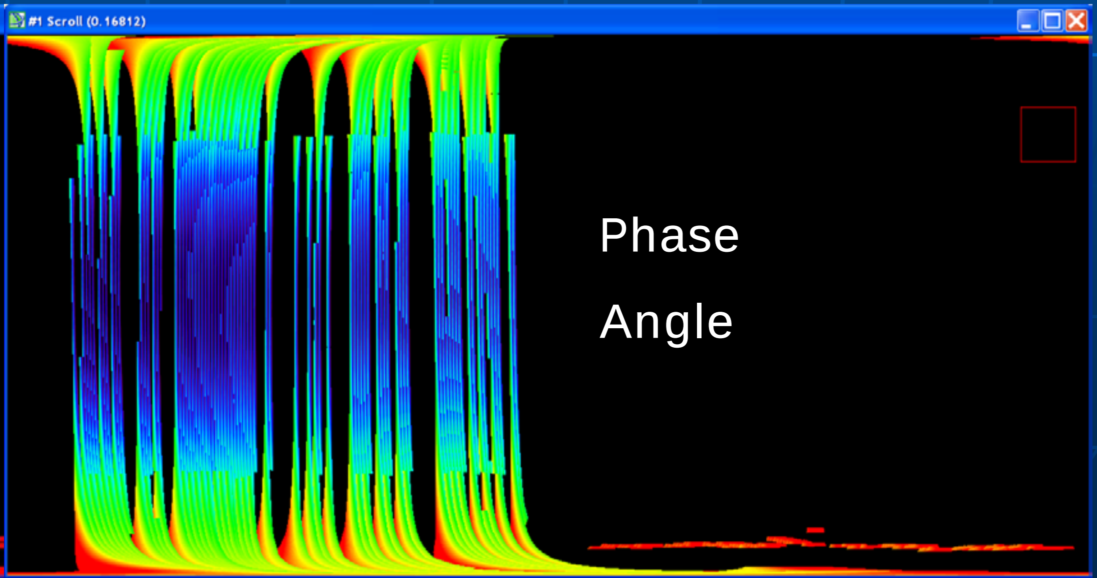
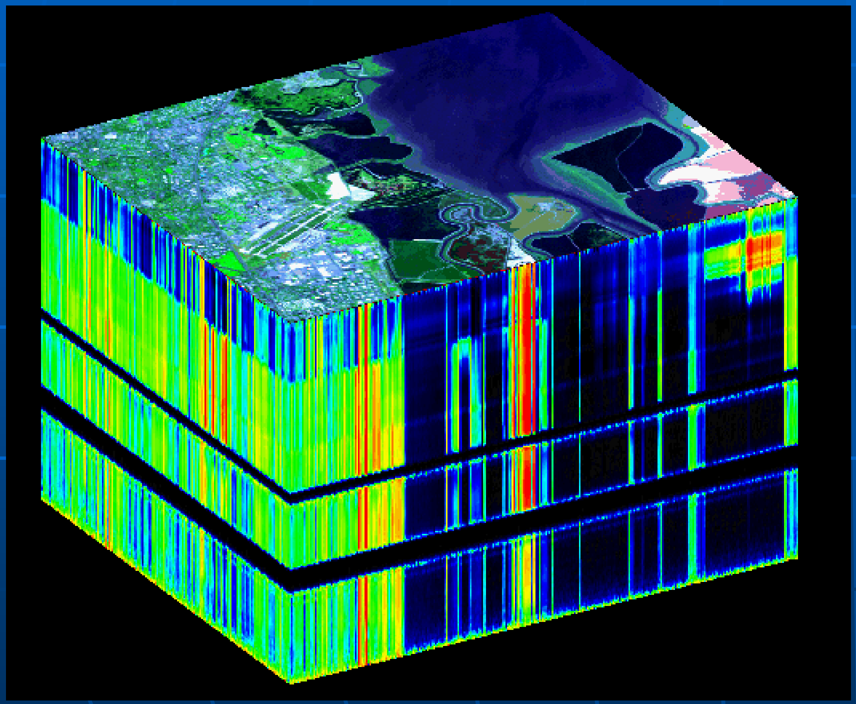
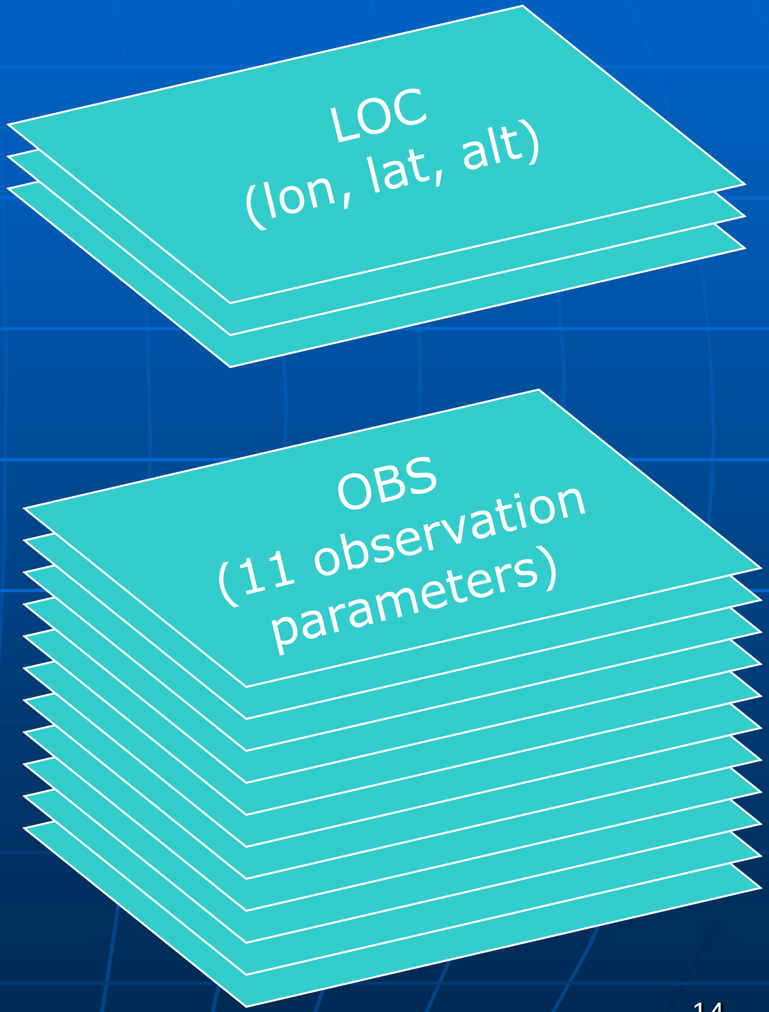


Image Cube + LOC and OBS Backplanes

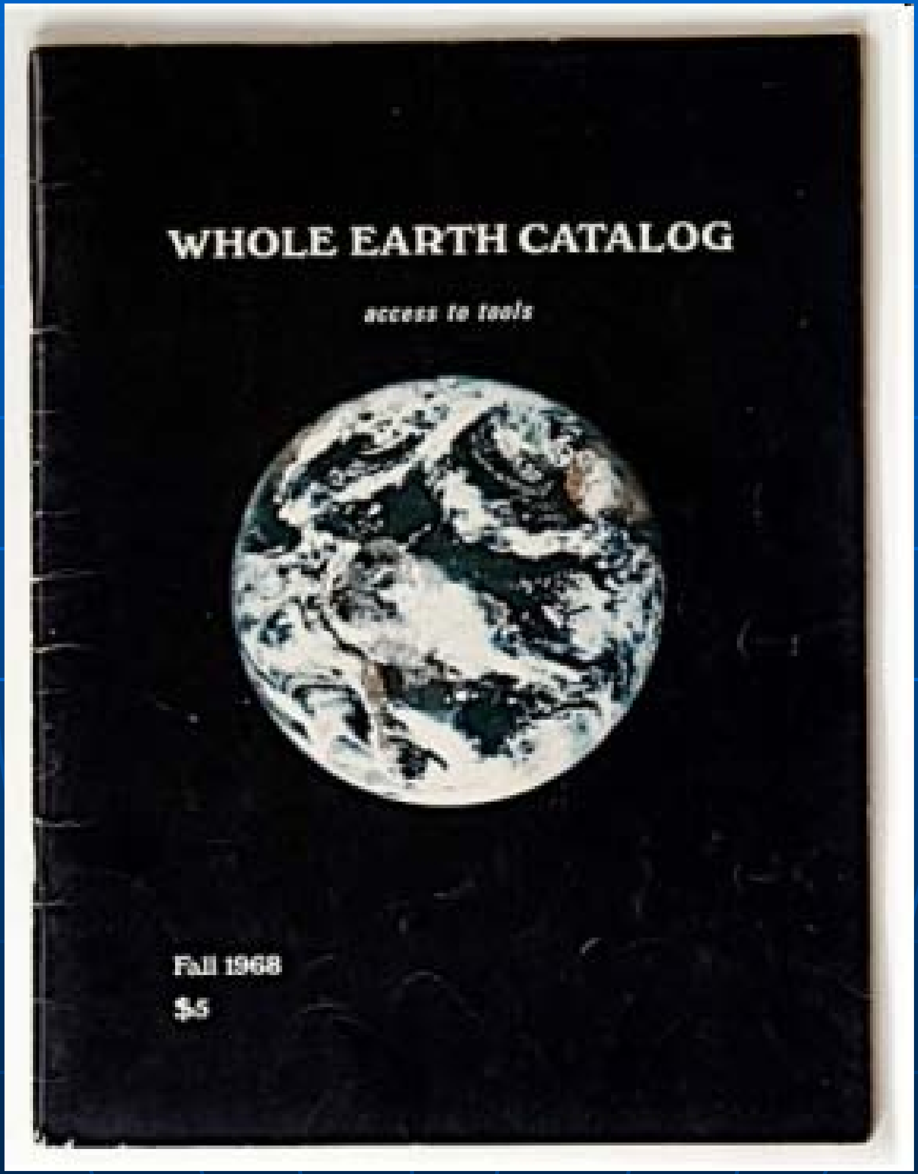




Some HyspIRI Specifics

- 626 km orbit -> 97.2 min period
- ~114 Hz frame rate, 2500 samples
- Avg. 35% of lit limb -> 292 M-pixels
- ~281 orbits / full Earth -> 19 days
- 82 G-pixels / 19 days
- 213 bands -> 426 bytes of radiance
- 20 bytes LOC, 44 bytes OBS
- Auxiliary data ~13% of combined
- 5.6 Tbytes of backplanes per 19-days
- 35.0 Tbytes of spectra per 19-days
- 2.3 Pbytes of combined result in 3 years

The Whole Earth is the "Target"



The Whole Earth is the “Target”

- Land surface of Earth ~50G 60m cells
- Perhaps the right approach is to pre-grid the whole planet in fixed 60m cells
- Global views, study sites, special projections pre-defined and gridded
- For 5 bytes/spectrum we could carry a “reverse GLT” index/lookup table
- For example, use UTM/UPS as a basis
- All spectra integer-coded to specific 60m cell

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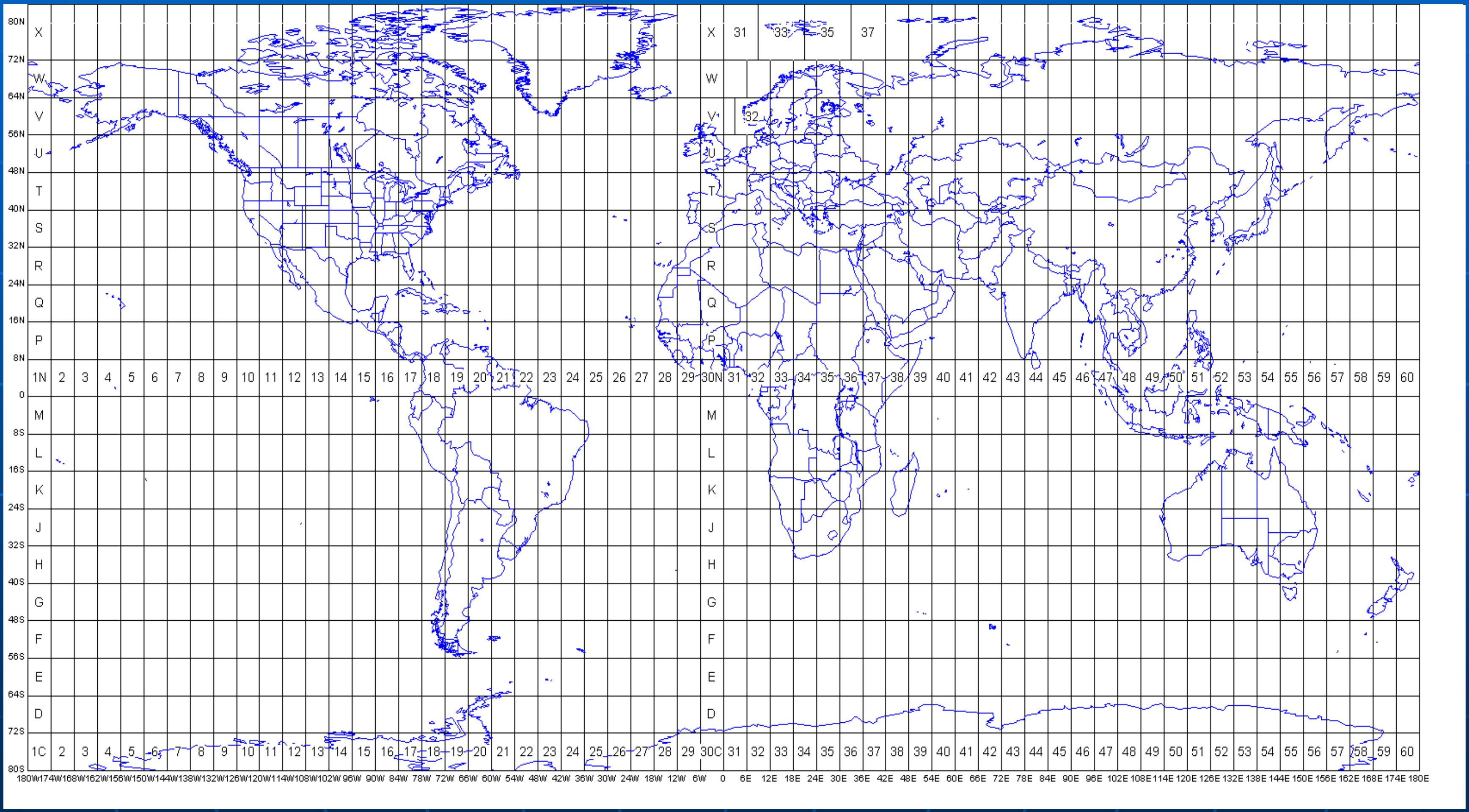

>11 Years to Get Ready?

- On one hand, certainly we'll benefit from computer/bandwidth/storage advances
- Other global missions will implement their own data models, may or may not support special needs of HyspIRI
- Clean slate, relevant heritage and plenty of time to implement the optimal system
- CAO, NEON, NGIS etc are valuable path finders and should be exploring this aspect of the HyspIRI model as test beds
- Jupiter, Saturn, Mars, Venus, Moon…Earth?