

National Aeronautics and
Space Administration



CLARREO Pathfinder

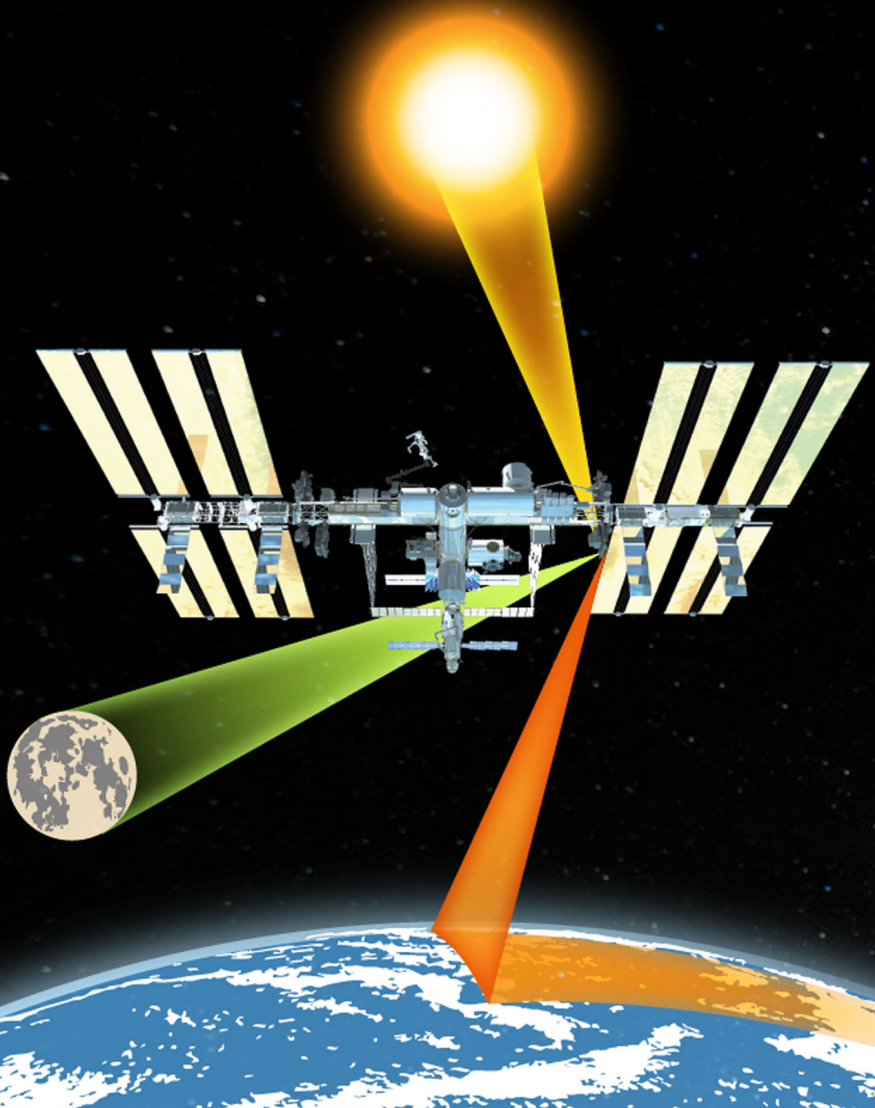
What's Next? Considerations for a Space-based Climate Observing System

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What is Needed for Climate Monitoring?

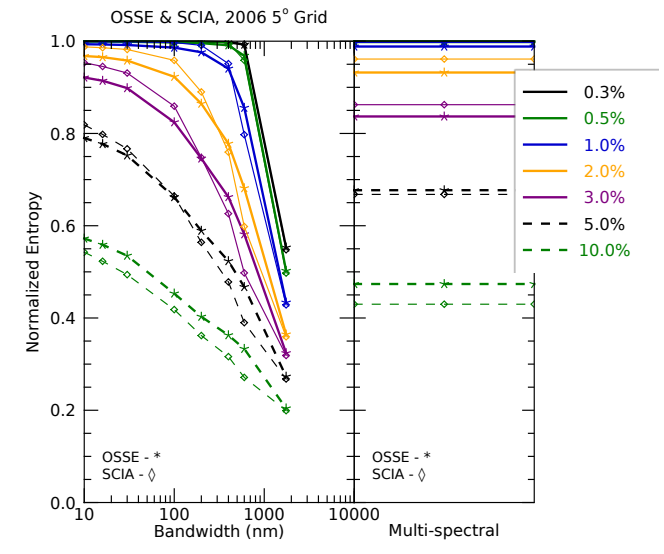
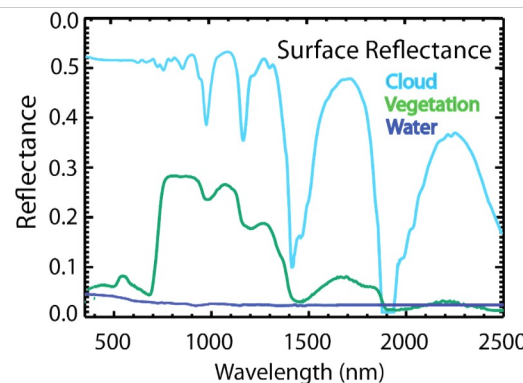
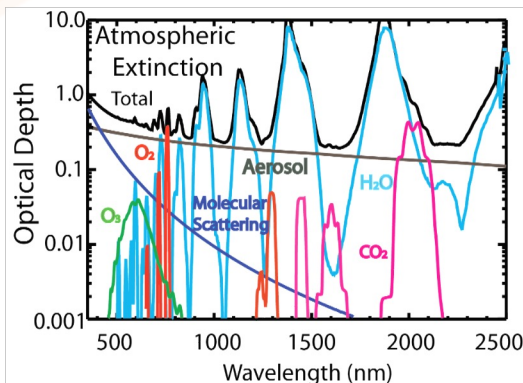
- 1) Information-packed Measurements *for Geophysical Attribution*
- 2) High Accuracy *for Climate Change Detection*
- 3) Independent Verification *for Confidence in Results*
- 4) Continuity *for Observational Resilience*





Information-packed Measurements *for* Geophysical Attribution

- Measurements with sufficient information to unambiguously attribute observed changes to geophysical drivers (i.e. hyperspectral measurements)
- **Critical to Answer:** What are the physical causes of changes in Earth's climate?



Higher Accuracy & Smaller Bandwidth -
> More Information, Shea et al, 2022

CPF Spectral Characteristics

Spectral Range

350 nm – 2300 nm

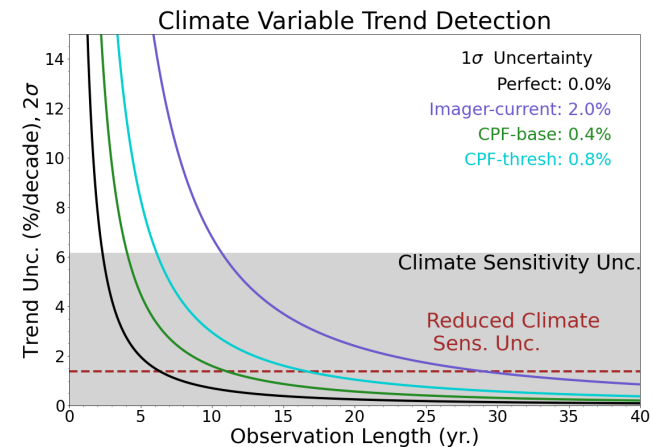
Spectral Sampling

~3 nm

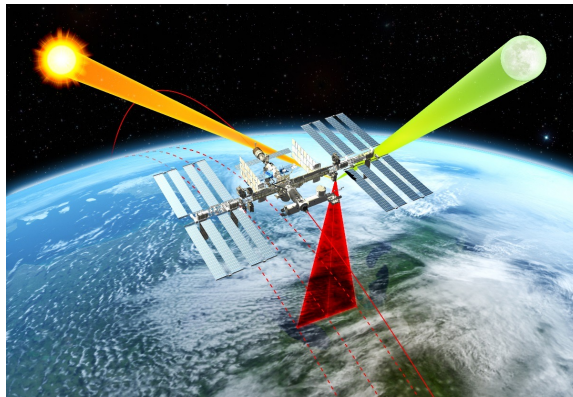


High Accuracy *for Climate Change Detection*

- High accuracy measurements tied to rigorous calibration standards
- **Critical to Answer:** How are TOA measurements changing with Earth's climate over space, time, and wavelength?



CPF will Take
High Accuracy
SI-Traceable
Reflectance
Measurements



Radiometric Uncertainty of CPF Spectrally & spatially averaged reflectance 0.3%-0.6% (1σ)

Level-1 Data Products

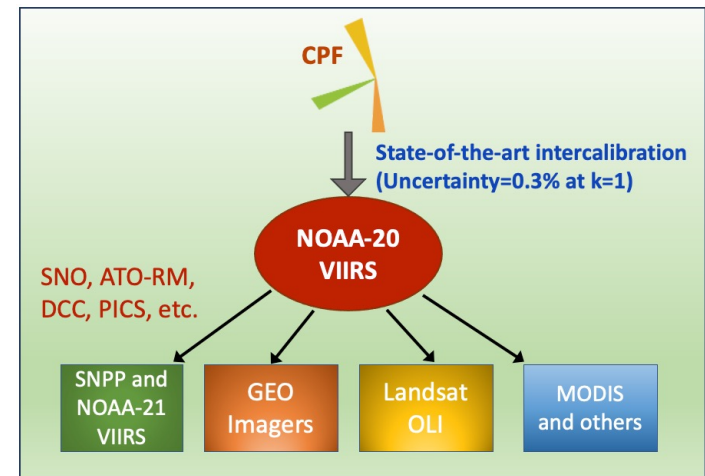
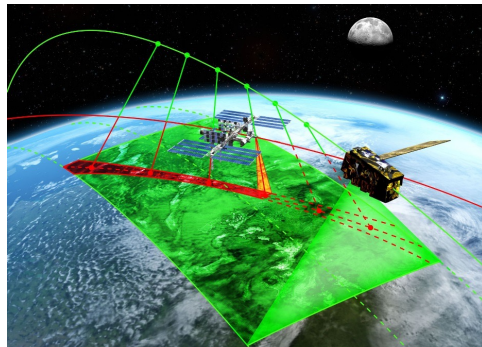
- Level 1A: Highest accuracy, best for intercal, lunar obs
- Level 1B: Approx. consistent spectral & spatial sampling, best for science studies using nadir spectra



High Accuracy *for Climate Change Detection*

- High accuracy measurements tied to rigorous calibration standards
 - Needed from multiple satellite instruments – One alone cannot do it all
- **Critical to Answer:** How are TOA measurements changing with Earth's climate over space, time, and wavelength?

CPF Will
Demonstrate
State-of-the-Art
Intercalibration
Capabilities



Intercalibration methodology uncertainty: 0.3% (1σ)

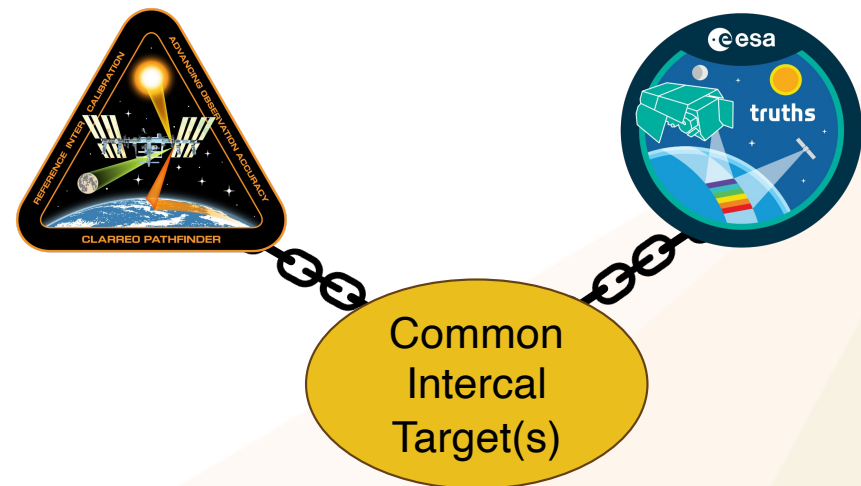
Level-4 Data Products

- Level 4: One each for CPF-VIIRS & CPF-CERES intercalibration
- Merged data products including all required info for intercal analysis



Independent Verification *for Confidence in Results*

- CPF will be the first globally recognized Earth-viewing SI-Traceable Satellite Sensor
 - CPF includes an independent calibration approach
- TRUTHS will be the second such sensor - *and* will be achieving its unprecedented accuracy with a different approach from CPF
- **Critical to Answer:** How much can we trust [these] climate observations?





Continuity *for Observational Resilience*



- Continuity of key measurements is critical for monitoring and understanding Earth's climate
- The U.S. has had several successes with continuity: e.g. weather satellites, Landsat (land-imaging), CERES (radiation budget)
- Plans for SITSat Sensor continuity have not yet been established
- **Critical to Answer:** How *has* the TOA signal changed with Earth's climate over a long period of time (e.g. multiple decades)?



CPF - NASA

2026



TRUTHS - ESA

2030



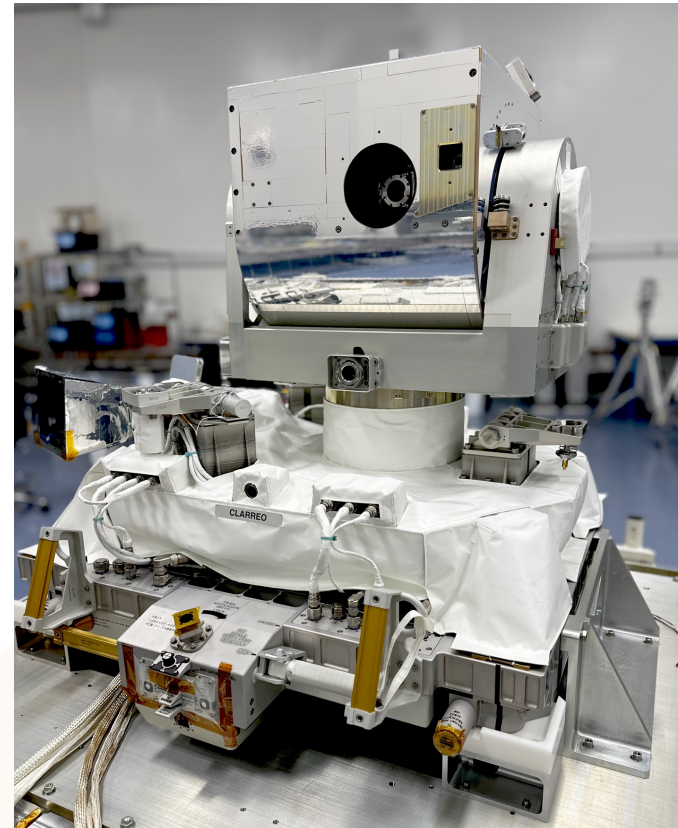
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CLARREO Pathfinder on ISS: Status

CPF is reach for launch!

- The CPF Payload is in storage at LASP until it is time to prepare the payload for launch
- Nominally 1-year mission operations (but hopefully more!) + 1-year science data analysis
- Launch Timeframe: 2026 (TBC)
- <https://clarreo-pathfinder.larc.nasa.gov/>





What's Next for the Space-Based Climate Observing System?

- 1) Information-packed Measurements *for Geophysical Attribution*
 - **Critical to Answer:** What are the physical causes of changes in Earth's climate?
- 2) High Accuracy *for Climate Change Detection*
 - **Critical to Answer:** How are TOA measurements changing with Earth's climate over space, time, and wavelength?
- 3) Independent Verification *for Confidence in Results*
 - **Critical to Answer:** How much can we trust [these] climate observations?
- 4) Continuity *for Observational Resilience*
 - **Critical to Answer:** How *has* the TOA signal changed with Earth's climate over a long period of time (e.g. multiple decades)?