

Libera “split-shortwave” Radiance-to-Irradiance Conversion: Implementation and Evaluation Plans



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*Thanks to the Libera Angular distribution Model team:
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Hong Chen, Steven Massie*

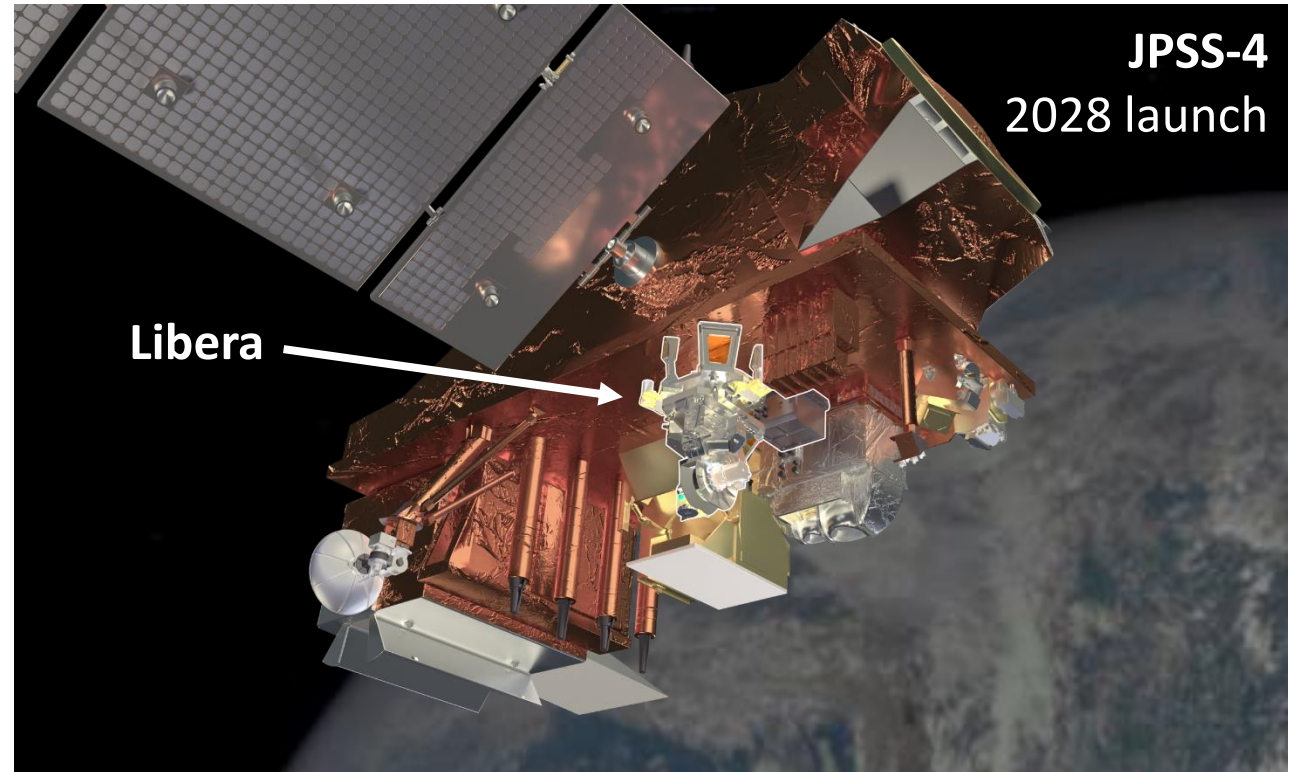
The *Libera* satellite mission

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- NASA's first Earth Venture Continuity mission
 - Nearly \$130-million mission to provide continuity of the Earth Radiation Budget (ERB) climate data record from CERES
- Libera will provide ERB continuity
 - Broadband shortwave (0.3-5 μm), longwave (5-50 μm), and total (0.3-100+ μm)
 - Characteristics almost identical to CERES
- Libera will also provide new ERB capabilities
 - "Split-shortwave" (0.7-5 μm) for understanding shortwave energy disposition
 - Wide-field-of-view camera for simple scene identification and angular distribution model (ADM) generation

CERES: Clouds and the Earth's Radiant Energy System

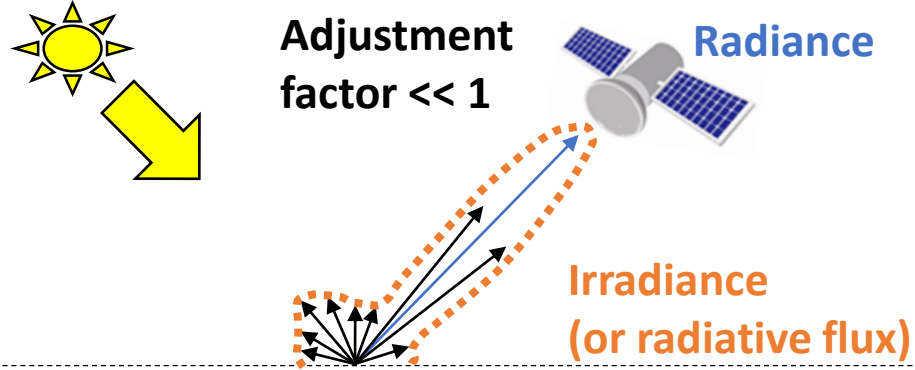
Libera: the daughter of CERES in roman mythology (not an acronym)



The angular distribution of reflected sunlight

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What we actually measure...

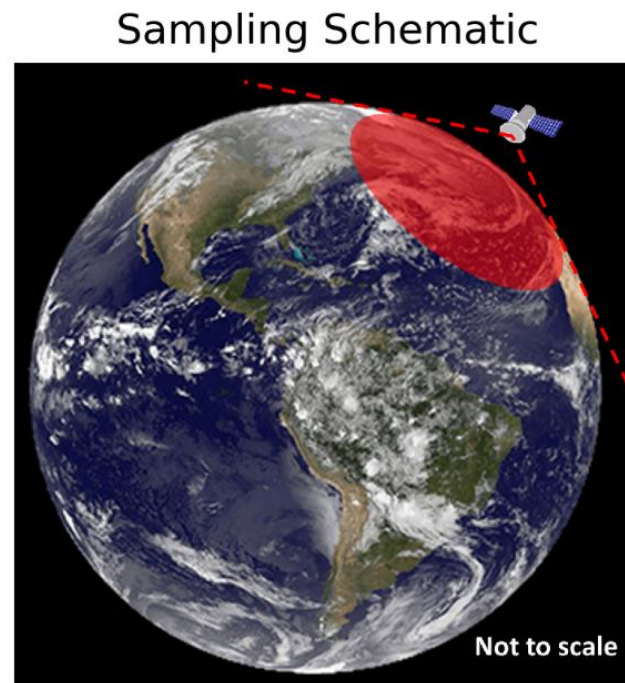
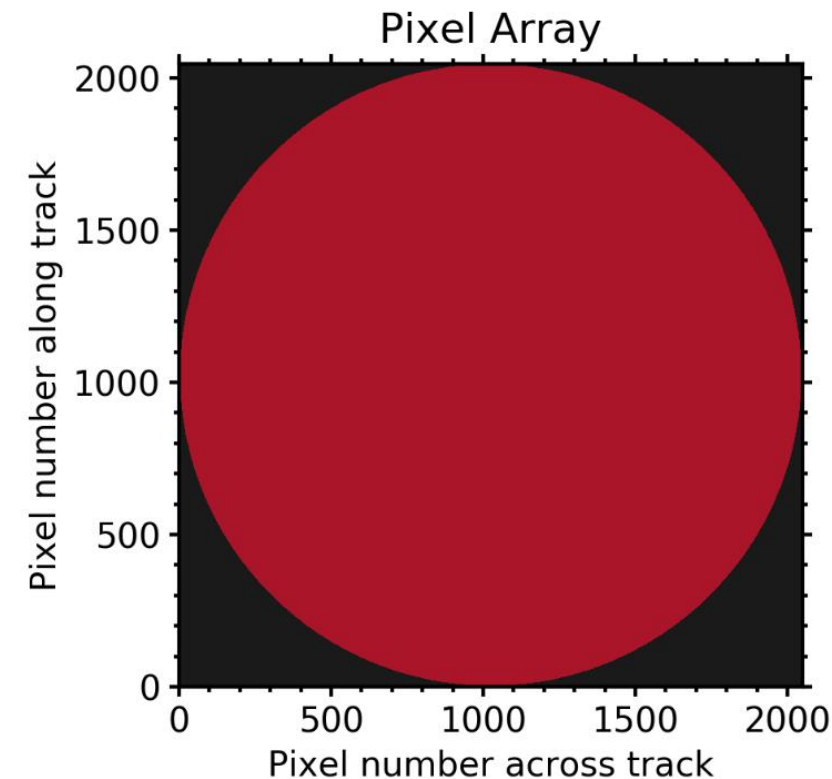


The set of “adjustment factors” that depend on 1) solar-viewing geometry and 2) scene composition is known as an Angular Distribution Model (ADM)

- ADMs already exist for the continuity channels, but not for the new Libera “split-shortwave”
 - Requires extensive sampling from multiple instruments
 - How will Libera split-shortwave radiance be converted to irradiance?

Libera wide-field-of-view (WFOV) camera overview

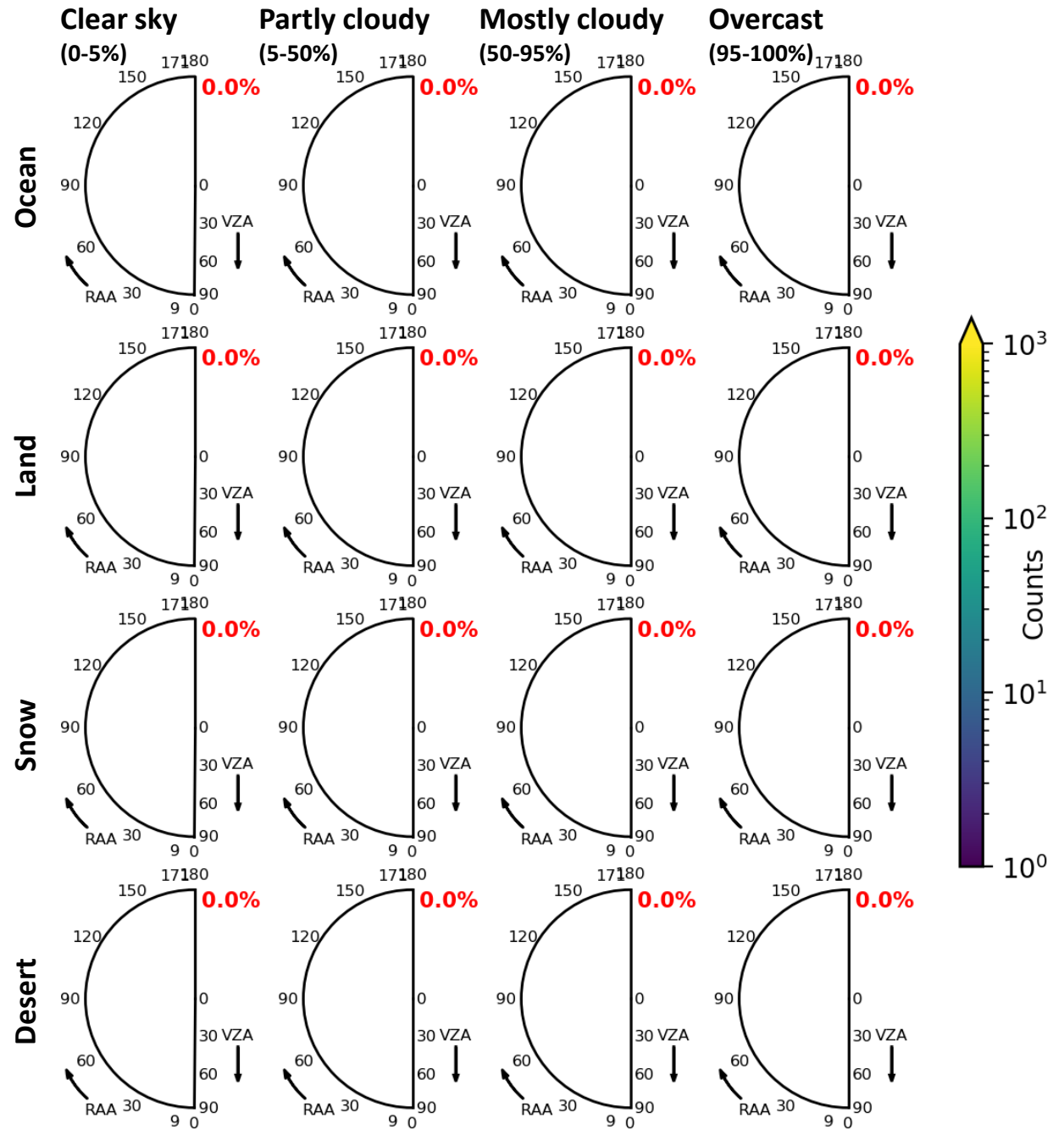
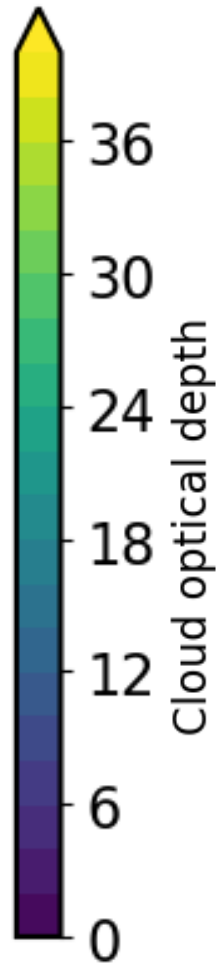
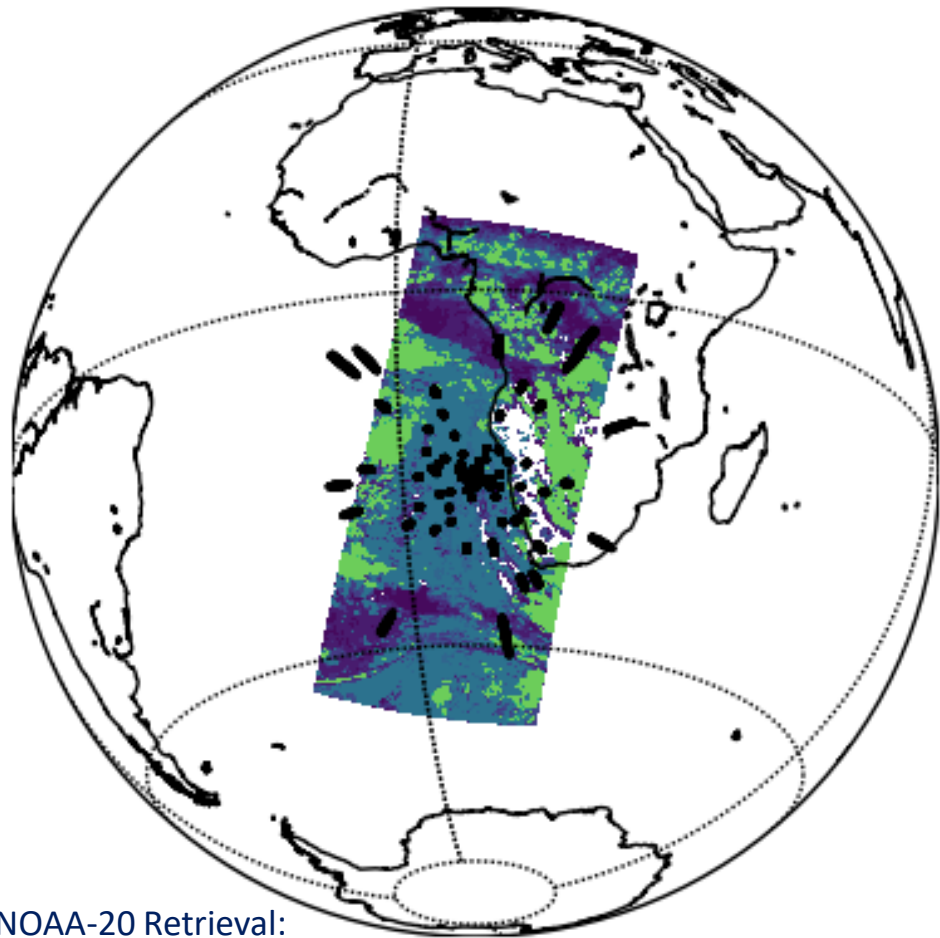
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- 2048 × 2048 pixel array samples entire Earth disk subtended from the satellite
- < 1km pixel spacing @ nadir
- horizon-to-horizon 124° field of view, (~6000 km @ surface)
- Single spectral channel – 555 nm (proxy for split-shortwave visible)
- Photograph every 5 secs
- 1.5% uniformity, 5% absolute accuracy

Gristey et al., AMT [2023]

2021-10-01 00:30 UTC



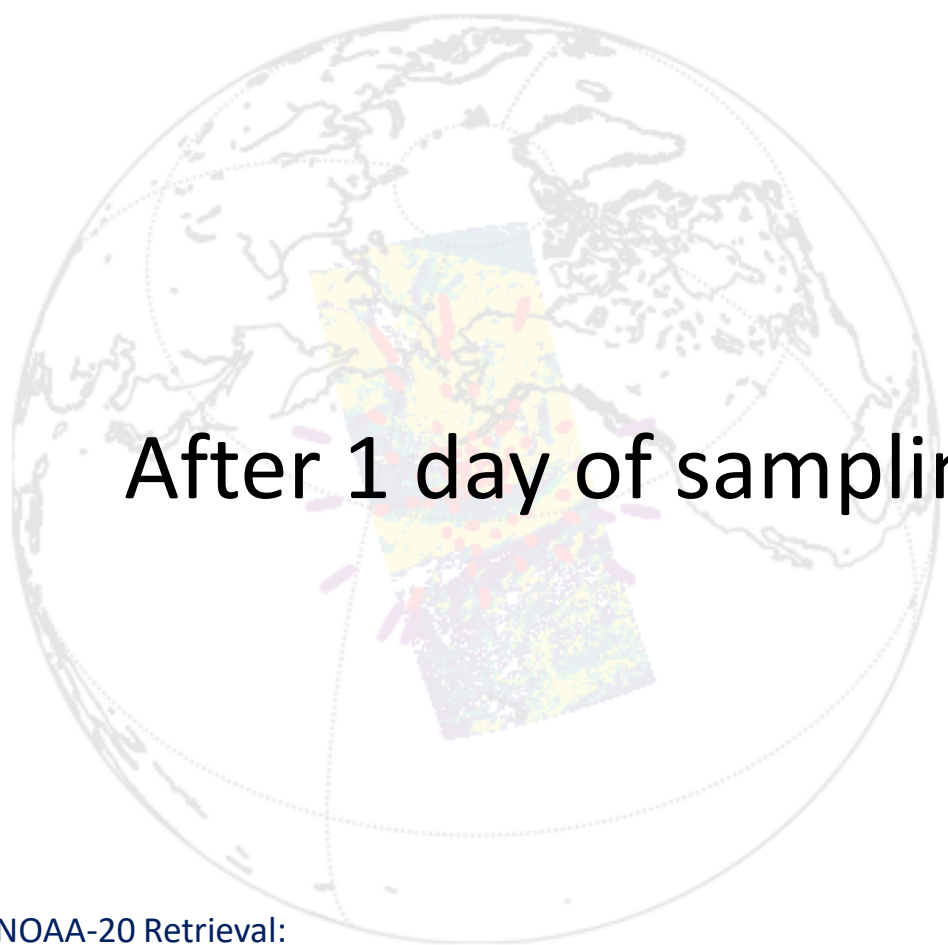
NOAA-20 Retrieval:
Minnis et al., IEEE [2021]

Gristey et al., AMT [2023]

Key

- Night ADM sample
- Day ADM sample, outside VIIRS swath
- Day ADM sample, added to count

2021-10-01 23:28 UTC



After 1 day of sampling...

NOAA-20 Retrieval:
Minnis et al., IEEE [2021]

Gristey et al., AMT [2023]

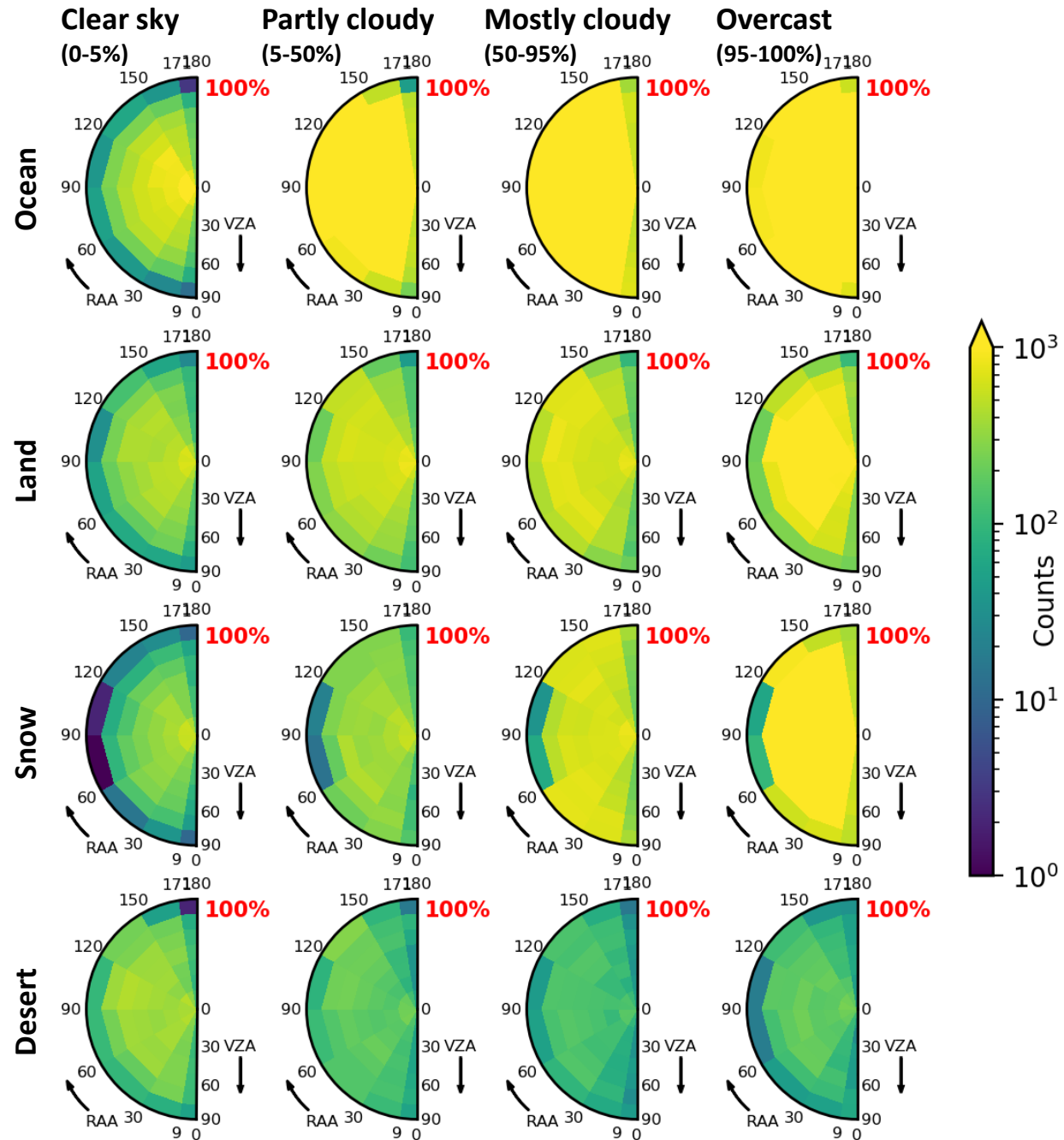
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17 June 2024

International Radiation Symposium: Hangzhou, China

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ADM evaluation with the split-shortwave radiometer ₇

1. Camera assumptions uncertainty: re-generate subset of radiometer-based ADMs

- Most frequent scenes are sampled very quickly
- A cadence of **every 3-5 days for 1 year** appears sufficient

} Next talk!

2. Regional irradiance uncertainty: “direct integration” test

- Integrate angularly-binned radiances over a given region and compare to mean of ADM-predicted irradiances for the region
- CERES used 3-months of continuous data for this test; cadence of **every 4 days in Year 1** should be sufficient

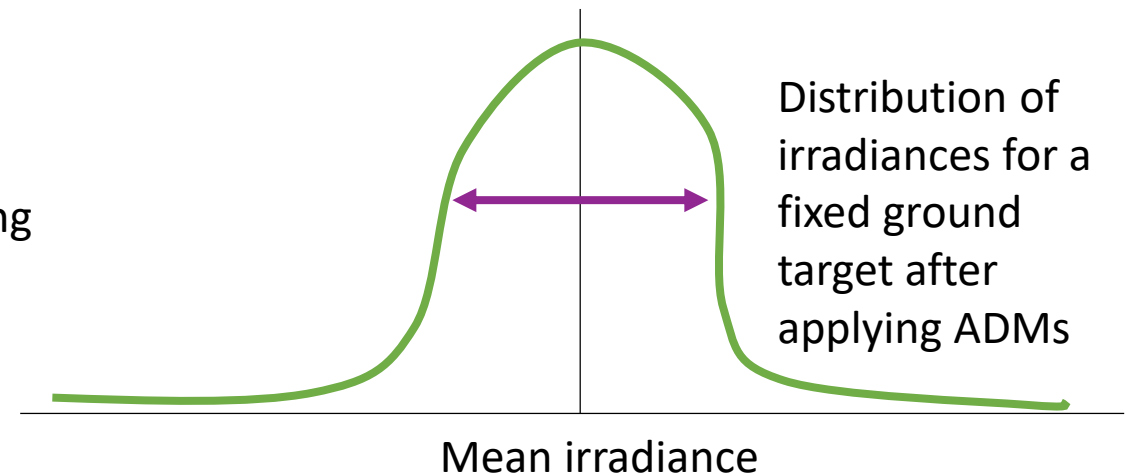
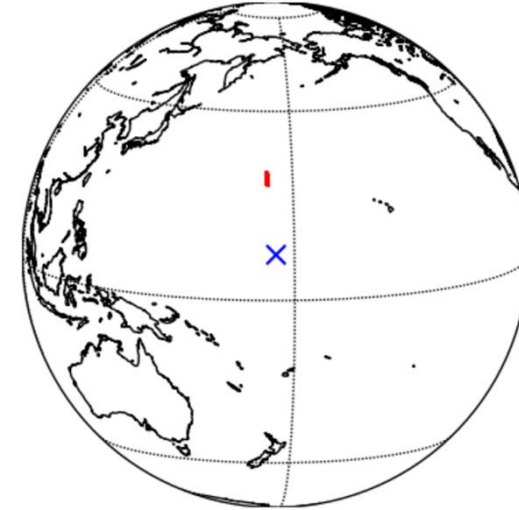
} Established approach
Loeb et al., JAOT [2007]
Su et al., AMT [2015]

3. Instantaneous irradiance uncertainty: Ground-target test

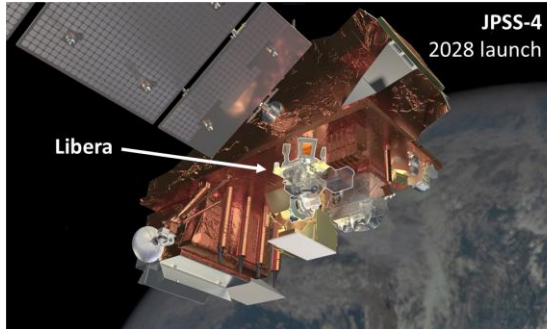
Instantaneous uncertainty: Ground target test

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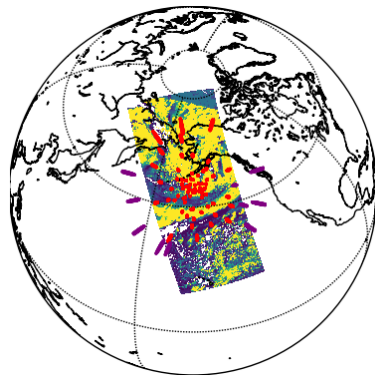
- Stare at a **fixed Earth target** as the **satellite** overpasses
 - Radiance will vary but irradiance should not
 - **Width of the distribution** of **retrieved irradiance** is therefore a measure of irradiance uncertainty
- Exploring implementation as a routine part of operations
- Important caveat: change in footprint size/shape
 - Will explore the use of the Libera camera for quantifying spatial sampling issues



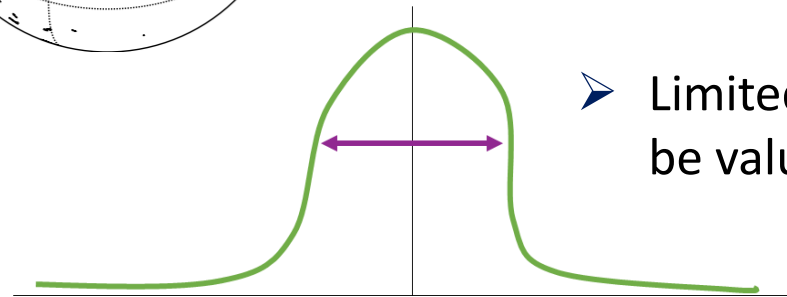
Summary and conclusions



- Libera is poised to provide the next generation of Earth Radiation Budget satellite observations



- Simulations demonstrate the capability of the Libera camera to support split-shortwave irradiance generation



- Limited bespoke sampling by the Libera radiometers will be valuable for split-shortwave irradiance evaluation