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A Spaceborne Camera To Augment Future Earth Radiation Budget Satellite Observations

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Earth radiation budget (ERB) satellite observations require conversion of the measured radiance, which is a remotely-sensed quantity, to a derived irradiance, which is the relevant energy balance quantity routinely used in modelling and analysis of the climate system. The state-of-the-art approach for radiance-to-irradiance conversion taken by the Clouds and the Earth's Radiant Energy System (CERES) benefits from the exhaustive sampling of radiance anisotropy by multiple CERES instruments across many years. Unfortunately, the CERES approach is not easily extended to new ERB spectral channels that lack previous sampling, such as the “split-shortwave” planned to be part of the next-generation ERB mission: Libera. As an alternative approach, the capability of a monochromatic, wide-field-of-view camera to provide dense angular sampling in a much shorter timeframe is assessed. We present a general concept for how this can be achieved and quantify the proficiency of a camera to provide rapid angular distribution model (ADM) generation for the new Libera ultraviolet-and-visible (VIS) sub-band. A single mid-visible camera wavelength (555 nm) is shown to be ideal for representing the VIS sub-band, requiring only basic scene stratification for 555 nm to VIS conversion. Synthetic camera sampling with realistic operating constraints also demonstrates that the angular radiance field of various scenes can be well populated within a single day of sampling, a notable advance over existing approaches. These results provide a path for generating observationally-based VIS ADMs with minimal lag time following Libera’s launch. Coupled with efforts to utilize a camera for scene identification, this may also pave the way for future ERB satellite systems to develop stand-alone irradiance products for arbitrary sets of spectral channels, opening up new measurement and science possibilities.