What Spatiotemporal Sampling is Needed to Determine Earth Radiation Imbalance from GEO-MEO-LEO Constellation?

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Earth Radiation Imbalance (ERI) at the top of atmosphere (TOA) is a difficult variable to measure, requiring not only accurate and stable radiometers but also sufficient spatiotemporal sampling from multiple platforms. Assuming future radiometers (e.g., RAVAN) can provide accurate (0.3 W/m^2) radiance measurements, what is the minimum number of constellation satellites from GEO, MEO and LEO platforms that can measure the daily EBI better than 0.5 W/m^2? In this study we present a preliminary OSSE study using the MERRA TOA data to evaluate the best sampling strategy for the ERI measurements. We find that the GEO and MEO platforms produce the most accurate ERI measurements with efficient use of the platforms, as few as seven-satellite constellation. At the GEO and MEO orbits, Earth is seen like an exoplanet, allowing a total power radiometer to capture most of its irradiance and use of several radiometers to measure its outgoing radiation fluxes. The study shows that the samplings at poles are critical for the accurate determination of ERI due to strong seasonal variations of the TOA albedo at high latitudes. It is also found in the study that the equatorial GEO satellites may be better distributed unevenly in longitude so as to sample cloud-induced albedo variations more efficiently. The results from this study yield a promising solution to the ERI problem, and support development of accurate (<0.3 W/m^2) radiometers for future ERI observations from GEO-MEO constellation.