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The measurement of the Earth Energy Imbalance (EEI)—defined as the difference between incoming solar radiation and the outgoing fluxes of reflected sunlight and re-radiated heat—is a key challenge in current climate research. Although EEI has been proven to be increasing and is estimated to be on the order of 1 Wm-2 today, measurements with reliable uncertainty bounds (i.e., <0.4 Wm-2) have only been achieved over decadal timescales and/or by combining space-based radiometry with in-situ ocean heat content measurements, which entail inherent uncertainties due to sampling limitations and associated assumptions in the analysis. For the sake of model validation and to enhance the confidence of climate projections, an accurate and independent measurement of EEI with better temporal resolution is urgently needed. Given that the possibility of achieving this in the near future with traditional space-based radiometry remains uncertain, we propose to tackle the problem using an accelerometry-based approach instead.

Preliminary research at JPL has shown that a dedicated constellation of satellites is capable of retrieving the incoming and outgoing radiation fluxes of the Earth system by measuring the non-gravitational accelerations due to Solar Radiation Pressure and Earth Radiation Pressure (both from thermal emissivity and reflected sunlight). By using optically homogeneous spherical satellites equipped with next-generation accelerometers, such accelerations are expected to be reconstructed within 10-11 ms-2 or <0.1% of their peak values. We present the high-fidelity numerical simulation framework used to further prove the viability of the method, together with a discussion of the ongoing results and software limitations found in the process.

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