# A global inverse problem: determining the Bond albedo of the Earth

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Accurate knowledge of the Earth's radiative energy budget is vital for precise climate modeling. This energy budget is determined by the total outgoing emitted radiation and the Earth's spherical albedo, which determines the ratio between the incident total radiation and the outgoing scattered radiation from the top of the atmosphere (ToA). The current monitoring of the Earth's emitted total radiation and spherical albedo is mainly based on radiometric satellite measurements that require interpolation.

We propose a method for determining the time evolution of the Earth's spherical albedo and the emitted total radiation with an unprecedented level of accuracy, using the effects of the Earth's radiation pressure on the satellite orbits along with the imaging data gathered by instruments such as the Earth Polychromatic Imaging Camera on the Deep Space Climate Observatory satellite. In the forward problem, we use a discretized model of the ToA for modeling the imaging data and the acceleration caused by Earth's radiation pressure on the satellites. The discretization is done using a Hierarchical Equal Area isoLatitude Pixelization scheme for the ToA where we classify segments of the pixelization grid based on the underlying scene type.

This first study uses a simplified model with a small number of unknowns for the ToA, a single wavelength for the emitted radiation as well as the scattered radiation, and a box-wing model for the satellites to solve this global statistical inverse problem. Markov chain Monte Carlo sampling is used to estimate the ToA radiation and its effects on the satellites' orbits, and to find the best fit to both the acceleration data and the imaging data. Then, numerical integration over the entire globe is used to derive the Earth's spherical albedo and the emitted radiation along with the uncertainties.

We show that the inversion of the spherical albedo and the outgoing emitted total radiation with reasonable accuracy is feasible from the current satellite imaging and space-geodetic measurements. Our next aim is to expand our forward model to include a wide wavelength range for the scattered and emitted radiation, a more detailed satellite model, and a more descriptive ToA model.

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