Contribution ID: **46** Type: **not specified**

Validation of the Earth planetary albedo using top-of-atmosphere fluxes of numerical weather prediction model

Thursday 27 October 2022 12:15 (15 minutes)

The Earth Planetary (or Bond) albedo is one of the crucial indicators of the Earth system energy budget. State-of-the-art approach to estimate the Earth Bond albedo is by processing satellite measurements of the Earth outgoing short-wave radiation. An exceptionally large albedo values (up to 0.35 daily maximum) in December 2020 were obtained using the data by Earth Polychromatic Imaging Camera (EPIC) on board NOAA's Deep Space Climate Observatory (DSCOVR). We compared the finding to the Bond albedo from numerical weather prediction (NWP) model, called OpenIFS.

The reference Bond albedo by NWP does not capture the surge seen from EPIC processed data, showing maximum of 0.327 during December 2020. However, the EPIC-based albedo and its weather model reference match well during December 2016. In this study, we attempt to investigate the cause of discrepancy.

The retrieval of the Earth Bond albedo involves usage of radiation angular distribution models (ADMs), consideration of Earth-Satellite-Sun geometry, and footprint identification. NWP-based Bond albedo relies on accuracy of radiation transfer modelling. Among listed, we see flaws in applicability of available ADMs in certain geometry scenarios and for apparent footprints. While located close to L1 point during December 2020, DSCOVR receives the Earth outgoing radiation close to back-scattering, and vast Antarctic ice sheet is apparent.

To address the flaws, we applied ADMs, provided by Clouds and the Earth's Radiant Energy System (CERES), to the top-of-atmosphere fluxes from NWP model to estimate total Earth irradiance (W/m^2) that DSCOVR satellite receives. We compared our Earth irradiance simulation with measured by NIST Advanced Radiometer (NISTAR) on board DSCOVR. The simulation systematically underestimates the measurements during December 2020. We suggest that the reason of both discrepancies in irradiance and in albedo is underestimation of short-wave flux anisotrophic factors in conditions close to back-scattering.

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Session Classification: Atmospheric studies and space geophysics