SIMULATION AND CORRECTION OF TRIANA VIEWED EARTH RADIATION BUDGET WITH ERBE DATA

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ABSTRACT

Triana is designed to continually monitor the sunlit side of the earth and promises to offer new insights into how our planet's climate works as an integrated system. It will be the first Earth-observing satellite in a Lagrange-1 (L1) position at distance of roughly 1.5 million kilometers from the Earth. The L1 point is the location where the Earth's gravitational field equally counters that of the sun. Since the strength of the gravitational attraction determines the orbital period, Triana will orbit the sun at the same rate as the Earth. Triana will be placed in an elliptical Lissajous orbit about L1 and will vary from 4° to 15° about the Earth-sun line. It will continuously measure between 92 and 97% of the Sunlit Earth, never viewing the dark side of the planet. Triana's Earth-viewing instruments consist of the Scripps-EPIC (Earth Polychromatic Imaging Camera), a 10-channel imager, and the Scripps-NISTAR (National Institute of Standards and Technology Absolute Radiometer), a single-pixel 4-channel broadband cavity radiometer. Data from the Scripps-EPIC and Scripps-NISTAR will be used to monitor the Earth's radiant power and to analyze weather systems and cloud patterns in an entirely new way..

The Earth Radiation Budget (ERB) consists of the balance between absorbed solar radiation and longwave radiation emitted by the Earth's surface and atmosphere. The emitted radiation is measured while the absorbed sunlight is determined as difference between the incident and the observed solar radiation reflected by the Earth system. ERB measurements at the top of the atmosphere (TOA) are fundamental quantities for monitoring the global climate system. These measurements have traditionally been obtained from ERB instruments on polar-orbiting satellites that typically view a region of the earth only twice each day. They cannot provide continuous spatial coverage of the Earth's entire surface at a specific time or provide continuous temporal coverage for a specific location. NISTAR is designed to facilitate determination of the radiation budget for an entire hemisphere every 10 min or less from a single set of 3 measurements. The NISTAR channels measure the total (TOT, 0.2 - 100 µm), shortwave (SW, 0.2 - 4.0 µm), and near-infrared (NIR, 0.7 - 4.0 µm) radiances with an active cavity radiometer and visible (0.3 - 1.0 µm) radiances with a photodiode. Longwave (LW, 4 - 100 µm) radiances are computed by subtracting the SW from the TOT radiances. Each Triana radiance measurement represents the entire Earth view. However, to derive the ERB from these radiances, it is necessary to convert each radiance to a flux and to account for the radiation field

of the dark half of the earth. The Earth's surface and atmosphere are anisotropic reflectors and emitters resulting in a relatively complex variation of radiance leaving the Earth as a function of the viewing and illumination conditions. Triana views the Earth from a limited range of angles corresponding to scattering angles between 165° and 176°. Therefore, to convert radiance to flux requires the use of anisotropic directional models (ADM) to account for the emittance and reflectance anisotropies. Additionally, a sliver of the sunlit Earth (missing light) is out of view (replaced by a dark sliver) because the satellite will not be positioned exactly on the Earth-sun line. This missing light must be taken into account for a complete ERB. Finally, no LW measurements are taken at night. Thus, some means is needed to account for the LW fluxes at night.

This paper describes the simulation of a Triana-viewed ERB and the development of correction models using data from the Earth Radiation Budget Experiment (ERBE). ERBE was a multi-satellite system designed to measure the ERB. ERBE data were collected from three satellites (the Earth Radiation Budget Satellite ERBS, NOAA-9, and NOAA-10). Each satellite measured broadband SW and LW radiances from cross-track scanners and wide-field-of-view radiometers. This combination of multiple satellite is used to produce a Triana-viewed ERB. In this study, we use 4 years (Jan. 1985 to Dec. 1988) of ERBE S-9 data to develop a simulated Triana dataset. The ERBE S-9 data consist of hourly estimates of SW albedo and OLR on a 2.5° global grid The simulated ERB based on 4 years of ERBE data have been used to develop of correction models to convert Triana-viewed whole disc radiances into values of global albedo and OLR. The simulation results show that the accuracy of the Triana-viewed ERB depends on the sub-satellite offset position from L1. Time series analysis indicates that the long-term trend, diurnal and seasonal variations are also significant for all the correction factors. The preliminary prediction results indicate that these correction models can be used to produce the most accurate global ERB to date. However, the correction models are purely statistical and it is not possible to distinguish between physical and random relationships in the data. Also, the models may be biased by the sampling patterns of the ERBE satellites. For example, the NOAA-9 and ERBS were used to produce the first 2 years of ERBE data while ERBS and NOAA-10 were used for the last 2 years. The NOAA-9 is an afternoon orbiter while the NOAA-10 has a morning Equatorial crossing time. These two different satellite combinations can produce diurnal sampling biases. To improve on the ERBE sampling, 3 hourly geostationary data will be used to fill the gaps between the ERBE measurements. Further studies will use combinations of ERBS and ISCCP (International Satellite Cloud Climatology Project) datasets to simulate the ERB as measured by Triana. The correction factors developed from each of these datasets will be used for the initial analyses of the Triana NISTAR radiances. A more advanced approach using cloud information from the EPIC is also under development to explicitly account for physical variations in the scene that are not taken into account with the purely empirical method used here. In the meantime, the technique developed here will provide a highly reliable method for monitoring the global radiation balance from Triana.