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Shortwave Flux Retrieval for the EarthCARE Broad-Band Radiometer: Baseline Algorithm

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The overarching requirement of the Earth Cloud Aerosol Radiation Explorer (EarthCARE) mission is to constrain retrievals of cloud and aerosol properties along the vertical cross-section defined by the active sensors on board the platform such that top-of atmosphere (TOA) radiative fluxes for each 10x10 km domain surrounding the cross-section are accurate to within 10 W m^{-2}. In order to assess whether this goal is reached, a procedure must be devised to perform a continuous radiative closure experiment using data from the broad-band radiometer (BBR) instrument of the mission which are not used for cloud/aerosol retrievals.

A fundamental part of the radiative closure experiment is the development of a radiance-to-flux conversion algorithm. Based on the development risk and accuracy expected, two different procedures will be developed to infer flux estimates from BBR data. A robust and reliable algorithm whose accuracy is expected to rival that of current Earth Radiation Budget (ERB) missions and an experimental algorithm whose aim is to be compliant with EarthCARE's demanding radiative closure requirement. This study presents the results of the former algorithm, an angular distribution model (ADM) for estimation of TOA fluxes from radiances measured by EarthCARE's BBR.

Previous studies on the BBR retrievals shown good results when an artificial neural network (ANN) based ADMs exploited the multi-angular capability of the BBR to derive shortwave fluxes from radiances. However, the degradation or failure of any of the BBR telescopes and the consistency of retrievals for any scenario were not adequately considered. These limitations are solved with a new design of the ANN-derived ADM. In the new design of the angular models, three different ANN-based ADMs are developed for each of the three BBR viewing angles (forward, backward and nadir). The neural networks are trained with three years of radiance measurements, acquired in rotating azimuth plane scan (RAPS) mode, and flux estimates from the Clouds and the Earth's Radiant Energy System (CERES) and Moderate Resolution Imaging Spectroradiometer (MODIS) instruments on board Terra. The angular geometry of the training data sets is restricted to the relative azimuth and solar zenith angles constraints defined by the EarthCARE BBR orbit and additionally all training inputs are stratified and averaged in order to introduce in the ANN a statistically significant number of scenes. Three flux estimates per scene are obtained from the BBR views, thus any of the remaining fluxes could be used in case of failure of one of the views. However, since the radiative flux is a magnitude only dependent on the solar geometry and reflectance properties of the target a unique flux product is expected from every target in the EarthCARE L2 retrievals. A procedure to merge the resulting fluxes based on the uncertainty of the retrieved flux is developed and successfully tested with a data base of corrected along-track CERES acquisitions and Multi-angle Imaging SpectroRadiometer (MISR) measurements previously converted from narrow-band to broad-band shortwave radiances.