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Long-term records of global radiation, carbon and water fluxes derived from multi-satellite data and a process-based model

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To gain insights about the underlying impacts of global climate change on terrestrial ecosystem fluxes, we present a long-term (1982-2015) global radiation, carbon and water fluxes products by integrating multi-satellite data with a process-based model, the Breathing Earth System Simulator (BESS). BESS is a coupled processed model that integrates radiative transfer in the atmosphere and canopy, photosynthesis (GPP), and evapotranspiration (ET). BESS was designed most sensitive to the variables that can be quantified reliably, fully taking advantages of remote sensing atmospheric and land products. Originally, BESS entirely relied on MODIS as input variables to produce global GPP and ET during the MODIS era. This study extends the work to provide a series of long-term products from 1982 to 2015 by incorporating AVHRR data. In addition to GPP and ET, more land surface processes related datasets are mapped to facilitate the discovery of the ecological variations and changes. The CLARA-A1 cloud property datasets, the TOMS aerosol datasets, along with the GLASS land surface albedo datasets, were input to a look-up table derived from an atmospheric radiative transfer model to produce direct and diffuse components of visible and near infrared radiation datasets. Theses radiation components together with the LAI3g datasets and the GLASS land surface albedo datasets, were used to calculate absorbed radiation through a clumping corrected two-stream canopy radiative transfer model. ECMWF ERA interim air temperature data were downscaled by using ALP-II land surface temperature dataset and a region-dependent regression model. The spatial and seasonal variations of CO_2 concentration were accounted by OCO-2 datasets, whereas NOAA's global CO_2 growth rates data were used to describe interannual variations. All these remote sensing based datasets are used to run the BESS. Daily fluxes in 1/12 degree were computed and then aggregated to half-month interval to match with the spatial-temporal resolution of LAI3g dataset. The BESS GPP and ET products were compared to other independent datasets including MPI-BGC and CLM. Overall, the BESS products show good agreement with the other two datasets, indicating a compelling potential for bridging remote sensing and land surface models.