

Surface Radiation Budget Observations: Progress and Challenges

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While the importance of observing the earth's surface radiation budget has been recognized since before the beginning of the twentieth century, it is only from the past couple decades that data of adequate coverage and precision are available to begin to address modern scientific questions about its spatial and temporal variability. The major conversion of solar radiant energy to infrared, latent, and sensible heat occurs at the earth's surface, which subsequently warms the oceans and atmosphere as well as driving their incessant circulations. Those atmospheric motions further redistribute water vapor and other atmospheric constituents that have additional impacts, or feedbacks, on the surface radiation budget's spatial and temporal distributions. These variations in the components of the surface radiation budget, along with their absolute values, are of considerable interest in understanding the details of present and future atmospheric states. To this end, as well as for other applications, long-term surface radiation budget measurement programs have been established both at climatically diverse ground sites using limited direct measurements and from satellites utilizing constrained-inversion remote sensing methods. The longest of the records for which the authors are now responsible began in 1976 in the case of the ground-based downwelling solar observations and 1983 for the satellite records of all four components, upward and downward long- and short-wave irradiances. Reliable ground-based measurements of the infrared and upwelling irradiances did not begin nationally until the mid 1990s, just a few years after related and concerted international projects began. The longer and temporally-complete but spatially-sparse ground-based data and the spatially-unbiased global satellite records are now being examined for climate related variability. Although the ground-based data have been extensively utilized for the validation of the satellite products, both records remain independent. Similarities between features in the two time series can be indicative, but not necessarily substantive, of mutual detection of those features as real physical signals, and potentially reduces statistical uncertainties of a feature's detection that would arise from a single record. These data records show some consistency with recent reports of inter-decadal variations in surface solar irradiance but magnitudes of the temporal tendencies vary between data sets. The representativeness of the various ground-based sites when comparing to satellite or gridded model products for both validation and mutual feature detection is investigated with cross-correlations and other techniques. This presentation will also include a brief discussion of other challenging areas for these observational capabilities and applications of their products.