

Final Report (Grant No. DOE DE-FG02-97ER62366):

The primary research effort supported by Grant No. DOE DE-FG02-97ER62366 titled "Retrieval of Cloud Fraction and Type Using Broadband Diffuse and Total Shortwave Irradiance Measurements" was application of clear-sky identification and cloud fraction estimation algorithms developed by Charles N. Long and Thomas P. Ackerman to the downwelling total, direct and diffuse shortwave irradiance measurements made at all of the central, boundary, and extended facilities of the DOE Atmospheric Radiation Measurement (ARM) Program Southern Great Plains (SGP) site. Goals of the research were finalization and publication of the two algorithms in the peer-reviewed literature and operational application of them to all of aforementioned data streams from the ARM SGP site.

The clear-sky identification algorithm was published as Long and Ackerman (2000) in the Journal of Geophysical Research, while a description of the cloud fraction estimation algorithm made it to the scientific literature as Long et al. (1999) in the Proceedings of the 10th American Meteorological Association Conference on Atmospheric Radiation held in Madison, Wisconsin. The cloud fraction estimation algorithm relies on empirical relationships between the outputs of the clear-sky identification algorithm and cloud fraction; as such, the cloud fraction estimation algorithm requires significant amounts of data both to properly develop the empirical relationships and to thoroughly test them. With this perspective in mind the major focus of our research efforts in the later half of the project became the operational implementation of the clear-sky identification algorithm on DOE ARM SGP data so that we could develop the data set necessary for final tuning of the cloud fraction estimation algorithm in research extending beyond the lifetime of the project.

During 1998 and 1999 the ARM program consistently advocated that investigators with ARM-related support develop what is called a Value Added Procedure (VAP). (A VAP is the operational implementation at ARM-supported centers of research code for retrieving geophysical parameters of broad interest to the scientific community.) So, our approach for operational implementation of the clear-sky identification algorithm was to turn it into a VAP. We applied the knowledge gained by developing the Active Remote Sensing of Clouds (ARSCL) VAP to implementing the clear-sky identification algorithm as the 1-min Resolution Shortwave Flux Analysis of Long (1swfanallong) VAP. The 1swfanallong VAP is now an operational VAP running in beta testing mode at the ARM Experiment Center located at the Pacific Northwest National Laboratory (PNNL) (Long, 2001).

The 1swfanallong VAP produces estimates of clear-sky irradiance and cloud effects on the surface shortwave irradiance at 1-min intervals. As Long et al. (1999) argue, estimating cloud fraction from the ground-based irradiance measurements is more accurate if applied to 15-min resolution data. Consequently, we developed a second operational

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VAP, called the 15-min Resolution Shortwave Flux Analysis of Long (15swfanal1long) VAP, that both reduces the 1-min resolution data to 15-min resolution and produces an estimate of the average and standard deviation of cloud fraction at 15-min resolution (Long, 2001). The 1swfanal1long and 15swfanal1long VAPs have now been applied to the vast majority of DOE ARM SGP surface shortwave irradiance data and are being applied to new data that arrive from this site.

Throughout the DOE ARM SGP Cloud and Radiation Testbed (CART) domain there are 21 locations at which the surface downwelling total, direct, and diffuse shortwave irradiances are measured. To organize these data for model and satellite studies we developed one last VAP, called the 15-min Resolution Shortwave Flux Gridding of Long 15swfgrd1long VAP, with support from this project. The 15swfgrd1long VAP applies the Caracena (1987) interpolation scheme to the output of the 15swfanal1long VAP to produce a 0.25 degree by 0.25 degree latitude/longitude grid of clear-sky irradiance, ratio of measured to clear-sky irradiance, and cloud fraction estimates across the ARM SGP network area. The 15swfgrd1long VAP is also running operationally in beta testing mode at the ARM Experiment Center at PNNL.

Activities that are continuing beyond the period funded by this project include analyses of the 1- and 15-min data products produced by the family of three Shortwave Flux Analysis of Long VAPS and documentation of them for long-term scientific use of their outputs.

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