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A study of the probability of clear line of sight (PCLoS) through cumulus clouds in the tropical western Pacific

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The plane-parallel hypothesis (PPH) used to approximate clouds in global climate models neglects the 3-D effects of clouds. Such effects can contribute as much as 20 Wm^{-2} to the downward longwave flux at the surface. Several investigators have proposed accounting for longwave 3-D cloud effects by using information on the Probability of Clear Line of Sight (PCLoS) to modify the PPH approximation. This study investigates the PCLoS at the Atmosphere Radiation Measurement (ARM) Program's Tropical Western Pacific (TWP) site and its dependence on cloud properties. PCLoS is determined for single-layer cumulus events over 2-hour intervals using Whole Sky Imager (WSI) data at the Nauru and Manus sites simultaneous to numerous observations of the location of cloud boundaries and the downward longwave flux. The WSI PCLoS is compared to calculations from a set of PCLoS models using measured cloud field statistics as input (e.g., cloud fraction and aspect ratio). A PCLoS climatology is also prepared for the observation periods at both sites, and the results are used to investigate the spatial variability of the PCLoS and effects on the downward longwave flux at the surface. Comparisons to similar data obtained at the ARM Southern Great Plains site will also be made.