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How Significant are the Longwave Radiative Effects of the Cloud-Aerosol Transition Zone?

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In this communication, we have found that the broadband longwave radiative effect of the cloud-aerosol transition zone conditions is of the order of 8.0 ±3.7 W m^{-2} by combining satellite measurements with radiative transfer modeling. It is often required to differentiate clouds and aerosols from each other in atmospheric studies, but the decision on where the boundaries of the clouds should be put is a point of debate. As a result, what detected as cloud by one method/instrument may be labeled differently by another. This is because 1) clouds and aerosols often co-exist and interact with each other, and 2) change in the state of sky from cloudy to cloudless (or vice versa) comprises an additional condition called "*transition zone*" (or "*twilight zone*") at which the characteristics of the particle suspension lay between those corresponding to pure clouds and atmospheric aerosols [Koren et al. (2007) GRL, 34(8): L08805. 10.1029/2007GL029253]. Nevertheless, a vast area that potentially may represent the transition zone is usually neglected in the observations or assumed as an area that contains either aerosols or optically thin clouds. In this communication, we provide quantitative information about the broadband longwave radiative effects of the transition zone conditions at the top of the atmosphere based on the radiative observations made by the CERES and MODIS instruments onboard Aqua spacecraft and radiative transfer simulations. Specifically, we used the MODIS measurements to look for CERES footprints with homogeneous transition zone and clear-sky conditions over the Southeast Atlantic Ocean for August 2010. Then, CERES observations under homogeneous transition and clear-sky conditions were compared with the corresponding clear-sky radiances, which were simulated using the SBDART radiative transfer model, fed with ERA5 reanalysis atmospheric profiles. For the studied period and domain, transition zone broadband longwave radiative effect was on average equal to 8.0 ±3.7 W m^{-2} (heating effect; median: 5.4 W m^{-2}), although cases with radiative effects as large as 50 W m^{-2} were observed. Furthermore, low-level transition zone conditions defined as those with suspension top height below 2 km (determined based on the difference between the layer top and surface temperature) on average produced a radiative effect of about 4.6 W m^{-2}. The lowest layers (temperature difference less than 4 K) produced on average a radiative effect of 0.8 W m^{-2}.