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The impact of deep convective clouds on lower stratospheric heating rates

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We quantify the impact of tropospheric clouds on radiative heating rates in the tropical lower stratosphere using the data collected from the Atmospheric Radiation Measurement (ARM) Tropical Western Pacific sites Manus and Nauru. The cloud fields are retrieved from ground-based millimeter cloud radar observations. We find that the radiative heating rate change due to enhanced upwelling shortwave fluxes only partially compensates that due to reduced upwelling longwave fluxes, resulting in a net change of about -0.2 K/day in the 70-30 hPa layer during the periods of frequent high cloud occurrence. The impact of clouds is particularly large relative to clear sky radiative heating rates around 60 hPa (435-475 K, the base of the "tropical pipe") where they show a local minimum. The radiative heating rates in this layer with the consideration of cloud effects are close to zero and can be even negative (i.e., diabatic descent). The seasonal and spatial structures of tropical convection, and associated high cloud coverage, suggest that their effect, leading to longitudinal (in addition to the well known latitudinal) gradients in radiative heating rates, may be partially responsible for stratospheric mixing. It is suggested that the effect of high tropospheric clouds on radiative heating rates cannot fully explain the amplitude of diabatic descent in the lower stratosphere over the maritime continent reported in previous studies.