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Quantifying the deep convective temperature signal within the Tropical Tropopause Layer (TTL)

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Dynamics on a vast range of spatial and temporal scales, from individual convective plumes to planetary-scale circulations, play a role in driving the temperature variability in the TTL. Here, we aim to better quantify the deep convective temperature signal within the TTL using multiple datasets. First, we investigate the link between ozone and temperature in the TTL using the Southern Hemisphere Additional Ozonesondes (SHADOZ) dataset. Low ozone concentrations in the TTL are indicative of deep convective transport from the boundary layer. We confirm the usefulness of ozone as an indicator of deep convection by identifying a typical temperature signal associated with reduced ozone events: deep mid-upper tropospheric warming and TTL cooling. We quantify these temperature signals using two diagnostics: 1) the "ozone minimum" diagnostic, which has been used in previous studies and identifies the upper tropospheric minimum ozone concentration as a proxy for the level of main convective outflow; and 2) the "ozone mixing height", which we introduce in order to identify the maximum altitude in a vertical ozone profile up to which reduced ozone concentrations, typical of transport from the boundary layer are observed. Results indicate that the ozone mixing height diagnostic better separates profiles with convective influence than the ozone minimum diagnostic. Next, we collocate deep convective clouds identified by CloudSat 2B-CLDCLASS with COSMIC GPS temperature profiles. We find a robust large-scale deep convective TTL temperature signal, that is persistent in time. However, it is only the convective events that penetrate into the upper half of the TTL that have a significant impact on TTL temperature. A distinct seasonal difference in the spatial scale and the persistence of the temperature signal is identified.