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Characteristics of tropical cyclones and overshooting from GPS radio occultation data

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Tropical cyclones (TCs) are extreme weather events causing every year huge damages and several deaths. In some countries they are the natural catastrophes accounting for the major economic damages. The thermal structure of TCs gives important information on the cloud top height allowing for a better understanding of the troposphere-stratosphere transport, which is still poorly understood.
The measurement of atmospheric parameters (such as temperature, pressure and humidity) with high vertical resolution and accuracy in the upper troposphere and lower stratosphere (UTLS) is difficult especially during severe weather events (e.g TCs). Satellite remote sensing has improved the TC forecast and monitoring accuracy. In the last decade the Global Positioning Systems (GPS) Radio Occultation (RO) technique contributed to improve our knowledge especially at high troposphere altitudes and in remote regions of the globe thanks to the high vertical resolution, avoiding temperature smoothing issues (given by microwave and infrared instruments) in the UTLS and improving the poor temporal resolution and global coverage given by lidars and radars.
We selected more than twenty-thousand GPS RO profiles co-located with TC best tracks for the period 2001 to 2012 and computed temperature anomaly profiles relative to a RO background climatology in order to detect TC cloud tops. We characterized the thermal structure for different ocean basins and for different TC intensities, distinguishing between tropical and extra-tropical cases. The analysis shows that all investigated storms have a common feature: they warm the troposphere and cool the UTLS near the cloud top. This behavior is amplified in the extra-tropical areas. Results reveal that the storms' cloud tops in the southern hemisphere basins reach higher altitudes and lower temperatures than in the northern hemisphere basins. We furthermore compared the cloud top height of each profile with the mean tropopause altitude (from the RO archive) in order to detect overshooting. We present a map of TC overshooting events indicating tropical areas which contribute most to UTLS transport and the large-scale atmospheric circulation.