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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impact of land convection on the thermal structure of the lower stratosphere as inferred from COSMIC GPS radio occultations" *by* S. M. Khaykin et al.

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We are thankful for appreciation and supporting review. We agree that it is somewhat a stretch to claim that the overshooting is the most likely mechanism responsible for cooling of the LS in the afternoon. The recommendation to give equal prominence to both non-migrating tides / gravity waves and overshoot hypotheses has been carefully taken into account. We have revisited the relevant literature on atmospheric tides and gravity waves for better understanding their potential contribution to the temperature diurnal cycle in the lower stratosphere over convective land areas. The manuscript has been revised accordingly. The core changes, entailing the whole revision, are listed below.

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Discussion Paper

1) Since temperature variations are considered exclusively at diurnal scale, the title has been changed for “Impact of land convection on temperature diurnal variation in the tropical lower stratosphere inferred from COSMIC GPS radio occultations”; 2) The introduction has been abridged by shortening the overly detailed description of convective overshooting. The review of large-scale convective cooling of little relevance for the diurnal cycle, has been reduced as well. 3) The discussion has been deeply revised: it rules out first the large-scale TTL/LS cooling related to convectively-coupled equatorial waves of periods longer than 24 h and then gravity waves of 24 hours period, non-synchronous with local time and finally leaves the two remaining mechanisms capable of generating zonally-variable temperature diurnal cycle: non-migrating tide and convective overshooting modulated by the diurnal cycle of the land-based deep convection. This is followed by a summary of information available from the literature on non-migrating tides and gravity waves above convective domes leading to the formation of “jumping cirrus”. The gravity wave nature of non-migrating tides and their convective latent heat release origin in the troposphere are emphasized, although no clear information could be found in the literature on their possible impact on the LS temperature, mainly because tides are considered mid and upper atmosphere features. The possibility of an interaction between non-migrating (restricted to most convective regions) and migrating tidal components, resulting in a LS temperature diurnal cycle is underlined. It is further noted that tidal oscillations can not result in a cross-tropopause mass transport, whose existence is fully confirmed by a number of observations and model simulations, showing e.g. a local cooling of up to 21 K in an overshoot, reaching 18.2 km (Jensen et al., 2004). The details of the size and frequency of these events at global scale are better explained. That said, we conclude that both non-migrating tides and convective overshooting may be responsible for the observed temperature diurnal cycle. The fundamental difference between the two mechanisms is the nature of the process, energy transfer for the first and mass transfer for the second. Thus, the response to tidal waves may occur higher in the stratosphere and distant horizontally from the most active thunderstorm regions, whereas the impact of overshooting would

be limited to the maximum altitude of the updrafts around 19-20 km. We note further that convective overshooting process is adequately reproduced by mesoscale cloud models, whereas model representation of non-migrating tides and, in particular, their effect on LS temperature is still problematic. We finally note that quantifying the relative contributions of these processes would require synoptic-scale modelling, allowing cross-tropopause convective transport and/or simulation of lower stratospheric temperature response to non-migrating tides. The conclusions have been revised accordingly. The English has been checked at best, but the manuscript could be further proof-read by the ACP copy-editing service if necessary.

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