Impact of the Tropical Lower Stratospheric Cooling on Deep Convective Activity During a Boreal Summer Monsoon

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To clarify the role of stratospheric cooling on the tropical troposphere, case studies of the seasonal transition from early to midsummer are investigated using cloud top and convective overshooting data obtained from satellite observations. Stepwise seasonal march in monsoon activity is a well-known regional phenomenon, but the focus here is on a globally synchronized change over African–Asian and American monsoon sectors. The northward shift of convection is initiated by sudden tropical stratospheric cooling due to enhanced planetary wave activity in the winter southern hemisphere. Upward velocities in the tropics first increase in the stratosphere and the tropical tropopause layer by amplified Brewer-Dobson circulation, which is followed by an enhancement of extreme deep convection and convective overshooting around the rising branch of the Hadley circulation,10° N–20° N. The intensification of Hadley circulation due to stratospheric change also involves a formation or a development of tropical cyclones over warm oceans, in particular over Northwestern Pacific. This confirm previous study of the impact of sudden stratospheric warming on the southern hemisphere convective activity during austral summer (Eguchi et al., 2015; Kodera et al., 2015).

Also the similarity between the structures associated with variations in the seasonal transition, documented here, and the recent decadal change in boreal summer suggests that the recent trend in the poleward shift of tropical convective zone can be explained by the same mechanism, further demonstrating that the cooling of the stratosphere, together with the warming of the Earth's surface, should play an active role in the recent tropical change.

Key words: Sudden stratospheric warming, tropical tropopause layer, deep convection, monsoon, tropical cyclone

References

Eguchi, N., Kodera, K., and Nasuno, T, *Atmos. Chem. Phys.*, **15**, 297–304, doi:10.5194/acp-15-297-2015.
Kodera, K. et al., *Atmos. Chem. Phys*., **15**, 6767–6774, doi:10.5194/acp-15-6767-2015, 2015.