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Impact of stratospheric sudden warming event on tropical circulation and convection

K. Kodera (1), H. Mukougawa (2), Y. Kuroda (3), and N. Eguchi (4)

(1) Solar-Terrestrial Environment Laboratory, Nagoya University, Nagoya, Japan (kodera.kk@gmail.com), (2) Disaster Prevention Research Institute, Kyoto University, Kyoto, Japan, (3) Climate Research Department, Meteorological Research Institute, Tsukuba, Japan, (4) Research Institute for Applied Mechanics, Kyushu University, Fukuoka, Japan

The stratospheric sudden warming (SSW) is produced by enhanced planetary wave activity, which induces a strong hemispherical mean meridional circulation in the stratosphere: downwelling in the polar region produces a warming, while tropical upwelling produces a cooling in the lower stratosphere. Accordingly, a sudden changes in the tropical circulation and the convective activity occur during the SSW event. A case study was made on a recent large SSW event in January 2009. The results of analysis show an abrupt change in the Hadley circulation, and the tropical convective activity shifted southward following the SSW event.

However, it is difficult to identify only from the observational studies whether the SSW impacted on the tropical convection or the tropical circulation change is the origin of the SSW. To identify the causality, we conducted a numerical experiment using a general circulation model. The occurrence of the SSW was controlled by implementing a blocking type circulation anomaly in the extratropical northern hemisphere in the initial conditions. Thus, through a comparison between the runs with and without the SSW, the impact of the SSW event on the tropics is identified. It is shown that when the planetary waves propagate upward into the stratosphere, increased stratospheric mean meridional circulation produces coolings in the tropical lower stratosphere, which lead to an enhanced convective activity in the equatorial southern hemisphere, consistent with the observational studies.