Session: C15 Poster: T77B

SOWER: Mixture of stratospheric and overshooting air measured by use of space-borne sensors

Suginori Iwasaki†; Takashi Shibata; Hiroshi Ishimoto; Hisayuki Kubota; Hajime Okamoto
† National Defense Academy, Japan
Leading author: iwasaki@nda.ac.jp

Because there are a few observations of overshooting, a cloud intrusion through the level of the neutral buoyancy above a deep convection, its roles in the upper troposphere and the lower stratosphere are not well known. For example, overshooting is believed as one of mechanisms to hydrate OR dehydrate the lower stratosphere. We analyze data of the space-borne lidar CALIOP, 95-GHz radar CloudSat, sounder AIRS, and imager MODIS to examine characteristics of overshooting because they measure vertical profiles and horizontal distributions of clouds, precipitation, and temperature. At first, we compare thresholds of overshooting to intercompare results of overshooting researches since the thresholds are different among researches. This is because "the level of the neutral buoyancy" is not observable in/around overshooting and the thresholds empirically determined by each sensor are different among researches. For instance, Alcala and Dessler (2002JGR) used data of the space-borne 14-GHz radar TRMM PR and their threshold of overshooting is "an echo top is higher than 14 km high." Schmetz et al. (1997ASR) used data of the space-borne imager METEOSAT and their threshold is "a difference of the brightness temperatures of 6.7 um, TBB(6.7), and 11 um, TBB(11), is greater than 0 K." Iwasaki et al. (2010JGR) used data of CloudSat and the threshold is "an echo top is higher than a height of the potential temperature of 380 K." Thus, their results, such as occurrence frequency of overshooting, are not comparable. We first summarize the dependence of occurrence frequency of overshooting on the thresholds. The results show the occurrence frequency retrieved with the difference of TBB is tens times more than the others; hence, Schmetz et al. (1997ASR) would overestimate the frequency and there is water vapor rich air in the lower stratosphere after overshooting. The results of the occurrence frequency of overshooting determined with the other thresholds are agreed within three times; hence, the threshold of TRMM PR retrieves overshooting as that of CloudSat does though TRMM PR cannot detect overshooting directly. Next we show an example that overshooting was warmed by mixing of stratospheric air. That is, ambient air temperature around overshooting estimated by use of AIRS, ECMWF, and three radiosondes launched 300 km far from the overshooting are lower than that of TBB(11) measured with MODIS, and the infrared emission from clouds in the warmer troposphere is not detectable by MODIS due to attenuation by optically dense clouds. Therefore, this overshooting would induce a 1 - 2 km downward movement of stratospheric air (e.g., Grosvenor et al 2007ACP) and mixing of overshot air and stratospheric air would occur. We extract the above mentioned overshooting by use of the following threshold: (1) a cloud top height of overshooting is higher than a height of 380 K potential temperature estimated with ECMWF, (2) ECMWF temperature at a height of a pseudo-cloud base measured by use of CALIOP is colder than TBB(11) at overshooting, and (3) ambient air temperature estimated by use of ECMWF between the cloud top of the overshooting and the pseudo-cloud base is colder than TBB(11) at the overshooting. The results show the half of overshooting whose cloud top height is higher than that of 380 K potential temperature satisfy the thresholds; hence, because the occurrence frequency of overshooting above a height of 380 K potential temperature is 1 x 10 /min (Iwasaki et al. 2010JGR), the occurrence frequency of the mixing type of overshooting is about 5 /min in 20 S - 20 N.