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Improvement of the cloud top database based on geostationary satellite observation

Noriyuki Nishi[1*], Atsushi Hamada[2], Hitoshi Hirose[1]

[1]Graduate School of Science, Kyoto University, [2]AORI, University of Tokyo

Stratiform clouds (nimbostratus and cirriform clouds) in the upper troposphere accompanied with cumulonimbus activity extend in the large part of the tropical region and largely affect the radiation and water vapor budgets there. Recently new satellites (CloudSat and CALIPSO) can give us the information of cloud height and cloud ice amount even over the open ocean. However, their coverage is limited just below the satellite paths; it is difficult to capture the whole shape and to trace the lifecycle of each cloud system by using just these datasets. We made, as a complementary product, a dataset of cloud top height and visible optical thickness with one-hour resolution over the wide region, by using infrared split-window data of the geostationary satellites and released on the internet. (http://database.rish.kyoto-u.ac.jp/arch/ctop/).

We made lookup tables for estimating cloud top height only with geostationary infrared observations by comparing them with the direct cloud observation by CloudSat (Hamada and Nishi, 2010, JAMC). We picked out the same-time observations by MTSAT and CloudSat and regressed the cloud top height observation of CloudSat back onto 11micro m brightness temperature (Tb) and the difference between the 11micro m Tb and 12micro m Tb. We will call our estimated cloud top height as "CTOP" below. The area of our coverage is 85E-155W (MTSAT2) and 80E-160W (MTSAT1R), and 20S-20N. We briefly introduced the first version of the product in the JPGU meeting 2012.

We compared the cloud top statistics between our CTOP product and CloudSat 2B-GEOPROF data. In the upper troposphere above 11 km, the distribution of cloud top in CTOP has good agreement with that in CloudSat direct observation both seasonally and longitudinally. Next, we tried to extend the analysis into the middle troposphere (6-11 km), where we have not estimated how CTOP can be reliable. We found that the number of such cloud systems is not constant with seasons but frequently increased in some specific seasons in both datasets. However, the large discrepancy between the datasets was detected near the edge of MTSAT view. It is probably due to the effect of the thin overlapped clouds in the upper troposphere which has longer optical path in the condition of large zenith angle near the edge of the view.

We are now making a new version of the dataset. Major revisions are made on the following points: Exclusion of the CloudSat pixels with no-cloud when making lookup table (LUT). Maybe due to imperfect matching between MTSAT sample and CloudSat sample and presence of the optically thin cloud that cannot be observed by CloudSat, some cloud-free pixels of CloudSat have lower Tb value than that of fine-weather pixel. In revised version, we will exclude such pixels for regression. It improves the estimation in the parameter range where the estimation error is large in the first version. We also conducted the geometric adjustment when regressing MTSAT data with CloudSat data. Edge region of MTSAT picture has satellite zenith angle larger than 60 degree. Therefore, the cirrus whose height is larger than 10 km is recorded to the position where is shifted several grid from the actual place. We will take into account the shift when making LUT. We introduce the improvement in the estimation from the previous version.

Keywords: geostationary satellite, cloud top, infrared radiation, tropical atmosphere