Cirrus Cloud-Top Height Estimation using Geostationary Satellite Split-Window Measurements Trained with CALIPSO and CloudSat data

Noriyuki Nishi[1,*], Atsushi Hamada[2], and Hitoshi Hirose[3]

[1]*Faculty of Science, Fukuoka University, Fukuoka, Japan*
[2]*Faculty of Sustainable Design, University of Toyama, Toyama, Japan*
[3]*The Center for Environmental Remote Sensing, Chiba University, Chiba, Japan*

We developed a method for the estimation of cloud-top height using only split-window channels of infrared observations from geostationary satellites. The split-window method is based on the premise that difference of two brightness temperatures at different wavelengths in the atmospheric window range is large for semi-transparent clouds like cirriform clouds (Inoue, 1985). The original version of the product (Hamada and Nishi 2010) was made using the lookup tables (LUTs) constructed based on regression with direct observations of cloud top height from the Cloud Profiling Radar (CPR) onboard CloudSat. The dataset was effective for monitoring the activity of mesoscale convection and dense anvil clouds because the estimated cloud tops are close to the actual tops in the cases of precipitating clouds and/or the surrounding dense stratiform clouds. However, cirriform clouds generally have lower optical depths but may be geometrically thick; thus, the cloud-top heights observed by the CPR could be considerably different from the actual cloud-top heights, which can cause bias in the LUTs. In this study, LUTs were constructed based on regression with direct observations of cloud top height from the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) onboard CALIPSO. By using CALIOP data, we succeeded in reducing the underestimation of the height of cirriform clouds. Although CALIOP can detect optically thin clouds around the tropopause, their top heights unfortunately cannot be estimated well using split-window observations. By defining the altitude at which the optical depth from the top had a specified value $\tau_{\min}$ $(= 0.2)$ as the cloud-top height, we could create a practical LUT. In the LUT, the underestimation of the heights of cirriform cloud was corrected substantially, while reducing the effect of the low sensitivity of split-window observations to thin tropopause cloud. The detail of the method is shown in Nishi et al. (2017). Our products are accessible from http://database.rish.kyoto-u.ac.jp/arch/ctop/index_e.html.

Key words: cirrus, split-window, cloud top, geostationary satellite

References

Hamada, A., N. Nishi, 2010: *J. Appl. Meteor. Climatol.*, **49**, 2035-2049.

Inoue, T., 1985, *J. Meteor. Soc. Japan,* **63**, 88-99.

Nishi, N., et al., 2017: *SOLA,* **13**, 240−245, doi:10.2151/sola.2017-044.