Development of the Algorithm for EarthCARE/MSI L2 Cloud Product

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Our cloud phase & cloud properties algorithm for Earth Clouds, Aerosols and Radiation Explorer/multi-spectral imager (EarthCARE/MSI) L2 cloud products has been updated to v0.5 by FY2023. In FY2024 the v0.6 update of the algorithm is scheduled, which contains small improvements and bug fixings. Meanwhile, after the launch of EarhCARE which scheduled in May of 2024, our work switched to the validation of the measured L2 cloud product data.
In past few years, we found a situation that MSI sensitivity coefficient could largely shift (SMILE effect) among some specific wavelengths (band 1 and band 3).
To evaluate the impact of the smile effect on cloud retrieval products, we chose four detector pixels from band 1 and band 3 (as well as the nadir pixel for reference) to elucidate how much this SMILE error affects the optical thickness and effective radius of cloud droplet, by using Comprehensive Analysis Program for Cloud Optical Measurement (CAPCOM) [1]. We also evaluated the error in simulated scenes from a global cloud system-resolving model (NICAM) and a satellite simulator (Joint Simulator) to measure the effect on actual observation scenes.
For typical water clouds (τ = 8, re = 8 μm), the SMILE error on the cloud retrieval was not significant in most cases (< 6%). For typical ice clouds (τ = 8, re = 40 μm), the SMILE error on the cloud retrieval was even less significant in most cases (< 4 %). Moreover, our results from two oceanic scenes using the synthetic MSI data agreed well with the forward radiation simulation, indicating that the SMILE error was generally < 10 %. Generally, this negligible impact of the SMILE is true for water surfaces, but for the case of land surfaces, it still needs more validation as further works [2].
Using our algorithm, 15 scenes of EarthCARE/MSI L1c data generated by Joint Simulator as well as 3 scenes generated by ESA/EXAA were operated and validated. In the version 0.5, retrievals of both water clouds and ice clouds are generated. An ice cloud only version of our algorithm was provided to Kyushu University (PI: Okamoto) for EarthCARE/CPR algorithm development. Besides, we analyzed A-Train 1-year data by using latest CAPCOM algorithm, as well as MODIS-AUX data in 2007 and sent the results to U-Tokyo (PI: Suzuki, PD: Yamauchi) for further EarthCARE 4-sensors algorithm development.

References

[1] Nakajima, T. Y., and T., Nakajima, 1995: Wide-area determination of cloud microphysical properties from NOAA AVHRR measurements for FIRE and ASTEX regions. *J. Atmos. Sci.* **52**, 4043-4059.
[2] Wang, M., T. Y. Nakajima, *et al*., 2023: Evaluation of the spectral misalignment on the Earth Clouds, Aerosols and Radiation Explorer/multi-spectral imager cloud product. *Atmospheric Measurement Techniques* **16**(2), 603-623.

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