Bridging the GPM+CloudSat and GPM+EarthCARE coincidence datasets for expanded observations of drizzle and snow

F. Joseph Turk (1), S. Aoki (2), T. Kubota (2), N. Utsumi (3), G. Liu (4)

1) JIFRESSE/UCLA, Los Angeles, CA USA
2) JAXA/EORC, Tsukuba, Japan
3) Institute of Science Tokyo, Tokyo, Japan
4) Florida State Univ., Tallahassee, FL USA

12th Workshop of the International Precipitation Working Group (IPWG)
Institute of Meteorology and Water Management, Kraków, Poland
7-10 July 2026

Abstract

Limited detection and large uncertainty in the quantification of light (i.e., rates less than 2 mm hr^{-1}) and frozen precipitation are a longstanding issue for space-based passive microwave observations. While uncertainties owing to variable surface emissivity decrease as operating frequency increases, the measured radiances are increasingly impacted by stronger attenuation and atmospheric opacity, masking the desired precipitation nearer the surface.

The lengthy overlap between the CloudSat (various periods between 2006-2020) and GPM (2014-current) spacecraft provided a large dataset of near-coincident observations of three-frequency (Ku+Ka+W) profiling radar and 13-channel (window and sounding bands between 10-183 GHz) passive MW observations. In May 2024, the joint ESA/JAXA Earth Clouds, Aerosol and Radiation Explorer (EarthCARE) spacecraft was deployed as one of ESA's Earth Explorers. Similar to CloudSat's W-band Cloud Profiling Radar (CPR), EarthCARE's CPR possesses increased sensitivity and a nadir Doppler profiling capability. The increased backscattering efficiency at W-band reveals rain and snow that is otherwise masked by sensitivity and ground clutter in DPR's Ku/Ka-band radar. Numerous studies have utilized the GPM+CloudSat coincident dataset for developing and evaluating algorithms that invert passive MW radiances into rain and snow geophysical products.

While there is a 4+ year gap between CloudSat and EarthCARE, the GPM+EarthCARE coincident dataset being processed by JAXA offers the capability to further extend these joint observations across more diverse conditions. In particular, GPM+EarthCARE provides night-time observations that were not available from CloudSat after 2010, revealing diurnal differences in precipitation characteristics. Also, a longer period of diverse observations is advantageous when using these data for training modern-era machine learning (ML) snowfall algorithms. In this presentation, snow and drizzle regimes from GPM+CloudSat data will be contrasted with similar analyses from (the limited period to date) of GPM+EarthCARE data.

References

Aoki, S., Kubota, T., and Turk, F. J.: Exploring vertical motions in convective and stratiform precipitation using spaceborne radar observations: insights from EarthCARE and GPM coincidence dataset, Atmos. Meas. Tech., 19, 79–100, https://doi.org/10.5194/amt-19-79-2026, 2026.

Turk, F.J., S.E. Ringerud, A. Camplani, D. Casella, R.J. Chase, A. Ebtehaj, J. Gong, M. Kulie, G. Liu, L. Milani, G. Panegrossi, R. Padullés, J-F. Rysman, P. Sanò, S Vahedizade, and N.Wood, 2021: Applications of a CloudSat-TRMM and CloudSat-GPM Satellite Coincidence Dataset. *Rem. Sensing*, 13(12), https://doi.org/10.3390/rs13122264.

Milani, L.; Wood, N.B. Biases in CloudSat Falling Snow Estimates Resulting from Daylight-Only Operations. *Remote Sens.* **2021**, *13*, 2041. https://doi.org/10.3390/rs13112041