

# A radar-only combined radar-radiometer precipitation algorithm by the spaceborne precipitation radar

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From the long-term data with the spaceborne precipitation radar observations, the origins of extreme rain events can be investigated globally. It is, however, the precipitation rate derived by the radar is very occasionally estimated as outliers so that the reliable estimates for very high and infrequent precipitation rates are required for users to easily detect the extreme rain events. From this kind of circumstance, we propose a combined radar-radiometer precipitation algorithm only with the radar data. The standard precipitation algorithm is the hybrid estimate of the Hitschfeld-Bordan method and the surface reference technique (SRT), but the radar algorithm proposed in this study is utilized additionally with radiometric information measured by the radar. Since the radar viewed from space measures the thermal emission from precipitation over the oceans, the brightness temperature at the radar's frequency is utilized for the precipitation estimates as an additional constraint. The brightness temperature is computed from the hydrometer profile obtained by the radar echoes and is optimized to the observed brightness temperature taking its measurement accuracy into account. In the current study, the data of the Ku-band precipitation radar (KuPR) onboard the Global Precipitation Measurement mission's core satellite are analyzed. To improve the measurement accuracy of the radar's noise, we also develop the echo judgement algorithm for using non-echo, that is the background noise, at range-bin sampled data. Over the ocean surface, the original precipitation algorithm sometimes estimates outliers at off-nadir angles because the normalized radar cross section at off-nadir angles unstably changes in calm wind area and results in the erroneous estimates of the path-integrated attenuation by the SRT. In contrast to the original algorithm, the current algorithm mitigates such outliers by constraining the radar's brightness temperature.

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