Spaceborne radar-based precipitation retrieval: Sensitivity analysis

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1. INTRODUCTION

The temporal and spatial variations of precipitation are significant, and the sensitivity of different parameters to precipitation retrieval varies greatly. High precision quantitative retrieval faces great challenges. Sensitivity of retrieval parameters analysis not only deepens the understanding of retrieval theory and algorithms, but also provides reference basis for the design of large-scale field experiments in the later stage. By using field experiments for sensitive parameter modeling, the ultimate goal is to improve the accuracy of precipitation retrieval .

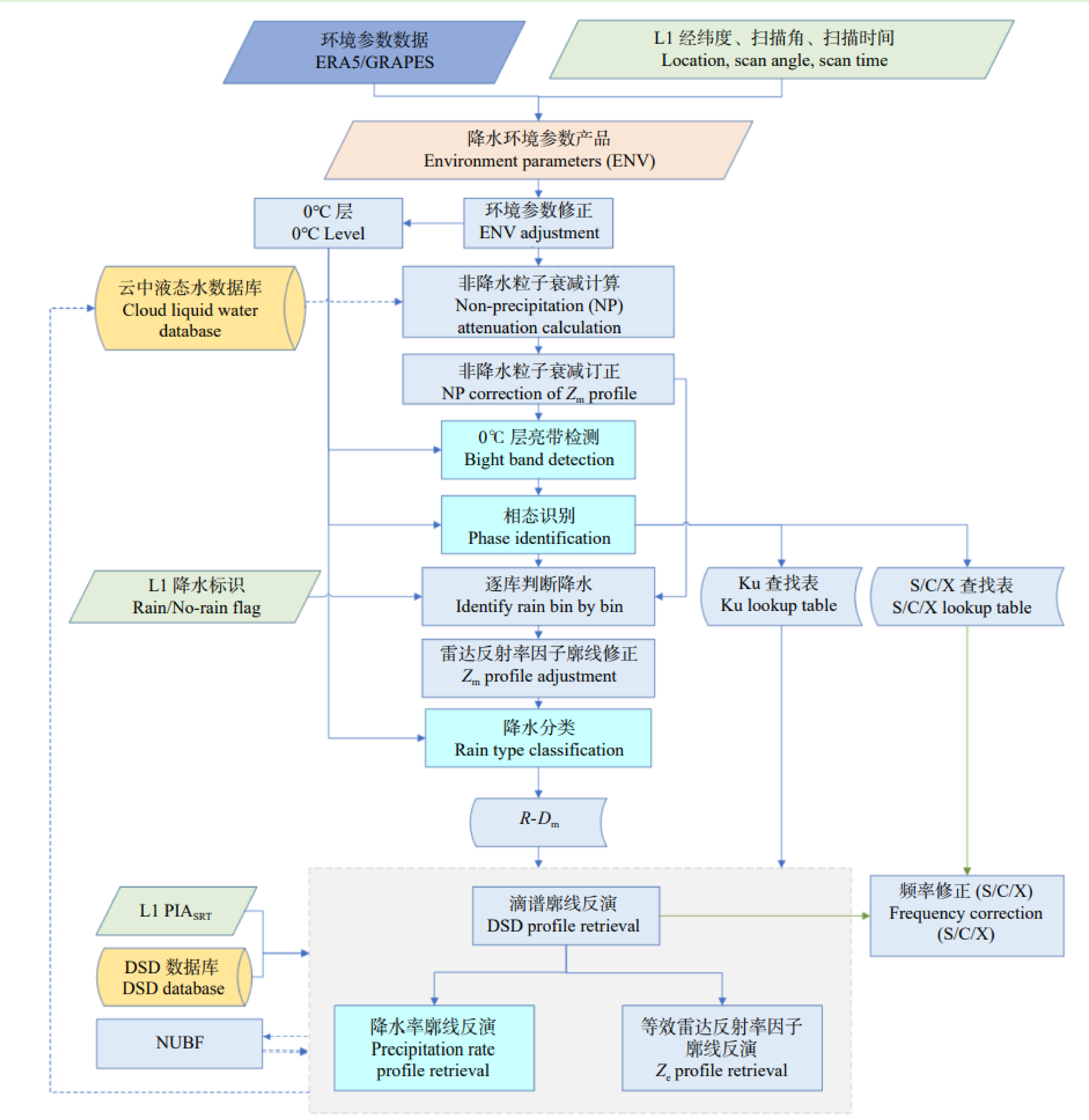
2. FY-3G AND PMR

On April 16, 2023, China's first low inclination orbit precipitation Measurement satellite - Fengyun-3G satellite (FY-3G) has successfully launched on Jiuquan satellite launch center.

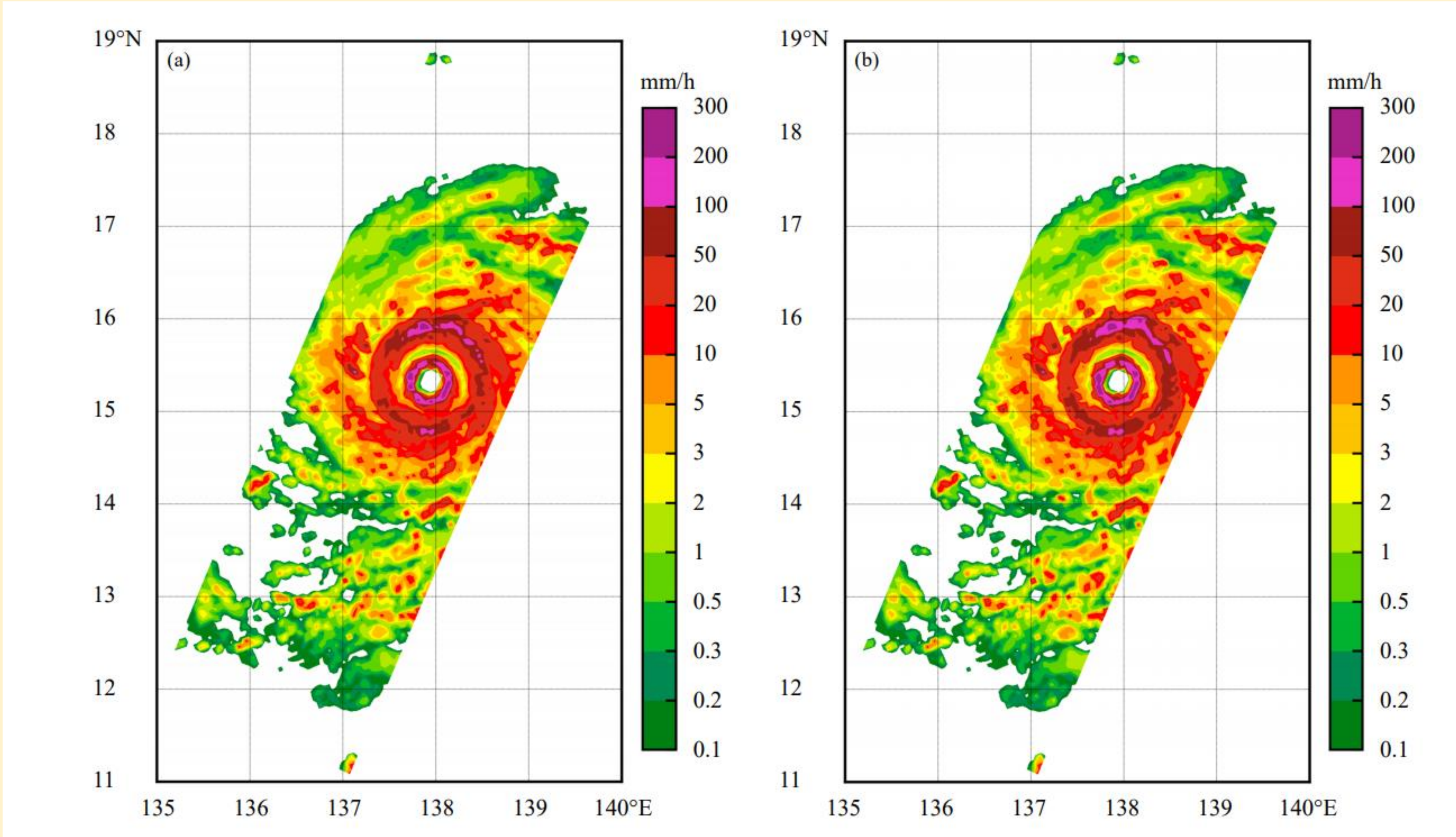
The design life of FY-3G is 6 years, with a track height of 407 km and the inclination angle is 50 °. Equipped with four business payloads, which are Precipition Measuring Radar(PMR)、Microwave Radiation Imager-Rainfall Mission(MWRI-RM) 、Medium Resolution Spectral Imager Rainfall Mission(MERSI-RM) and GNSS Radio Occupation Sounder (GNOS-II).

Ku and Ka dual frequency precipitation measurement radars enable China to achieve spaceborne active precipitation detection for the first time. The design indicators for radar detection sensitivity are 18 and 12 dBz, respectively, and the minimum detectable instantaneous precipitation rate is 0.2 mm/h. The radar adopts a fully matched scanning mode, scanning angle is ± 20.3 °, beam width is 0.71 °, horizontal resolution is 5 km at the sub satellite point, vertical resolution is 250 m, sampling interval is 50 m.

3. PRECIPITATION FLOWCHART

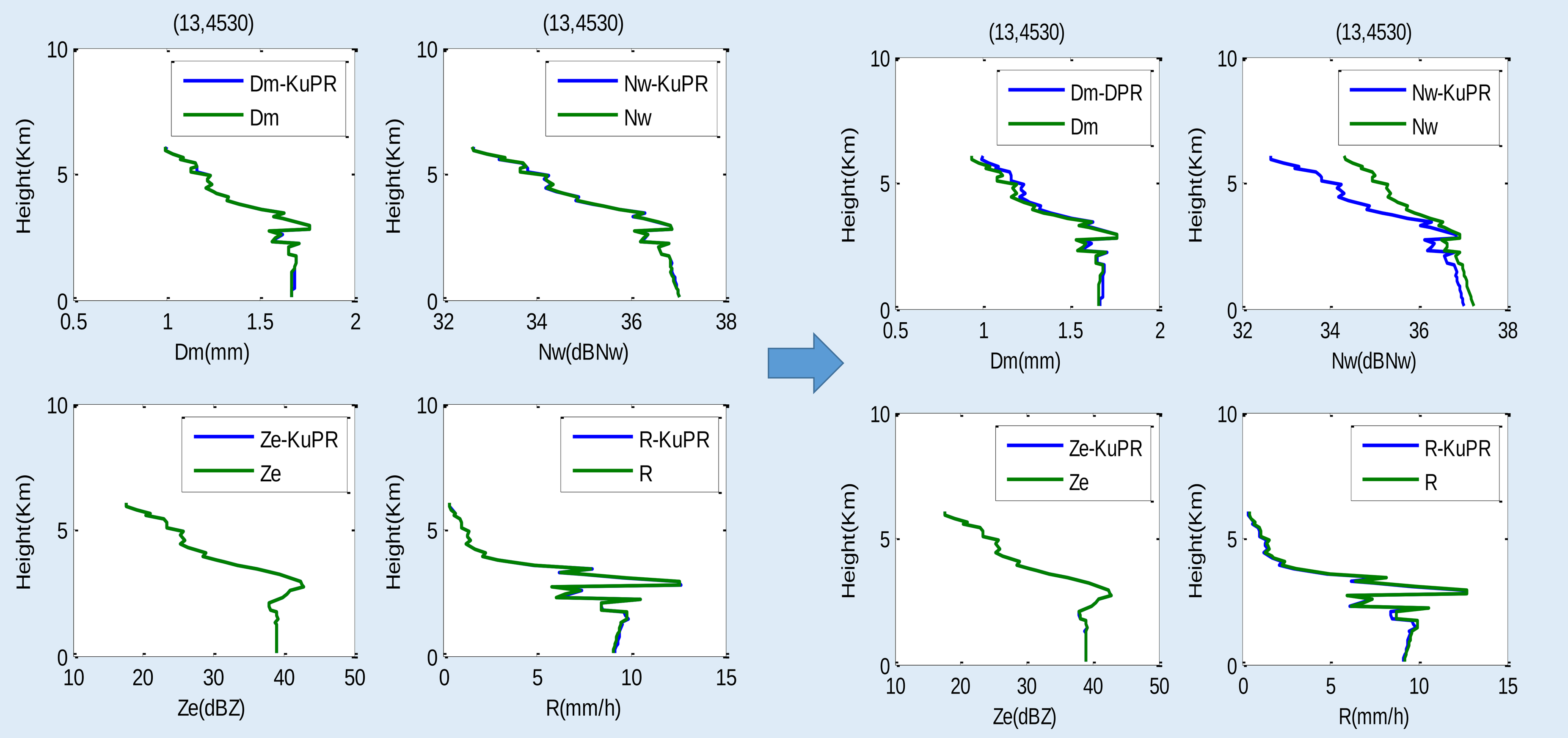


4. ALGORITHM COMPARISON



Distributions of retrieved near-surface precipitation rate by GPM KuPR(a)and FY-3G PMR prototype algorithms(b)

4. SENSITIVE ANALYSIS



The comparison between retrieved and KuPR before and after the adjust of $R-D_\mathrm{m}$

Table. Sensitive test of $R-D_\mathrm{m}$

Scan location	type	ε Before	ε After	R(mm/h) Before	R(mm/h) After	R(mm/h) KuPR
4525，12	stratiform	0.96	0.75	0.646	0.671	0.667
4530，13	stratiform	1.00	0.83	9.027	9.191	9.161
2342，17	stratiform	1.18	0.96	15.504	15.304	15.476
5138，34	convective	0.80	1.03	0.775	0.776	0.780
2203，17	convective	0.89	1.10	7.037	7.200	7.270
2363，20	convective	1.06	1.26	37.659	37.640	37.256

5. SUMMARY

The results indicate that $R-D_m$ is not sensitive to the retrieval of radar reflectivity factor profiles and precipitation rate profiles, but it is relatively sensitive to DSD profiles. Misjudgment of phase, especially between mixed phase states and solid or mixed phase states and liquid states, affects precipitation rate near the 0 degree layer and has little impact on ground precipitation rate. ParamNUBF is a highly sensitive factor, and the greater the difference from the true value, the greater the error of the precipitation rate profiles. Conducting sensitivity analysis on spaceborne radar precipitation rate retrieval algorithms can not only deepen understanding of precipitation rate retrieval theories and methods, improve the accuracy of precipitation rate retrieval, but also provide design ideas for the upcoming field experiments of FY-3G PMR.