Reexamination of Precipitation Type Classification for Spaceborne Radar Using a Ground Based Doppler Radar Over the Tibetan Plateau

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1. Introduction

- Observing the updraft is important for precipitation type classification. However, unable to observe it by current spaceborne precipitation radars.
- Z-factor intensity and distribution are used as proxy index.
- Suggested a misclassification of the Tropical Rainfall Measuring Mission (TRMM) Precipitation Radar (PR) precipitation types over Tibetan Plateau.
  - Misidentified a surface echo as the Bright Band (BB) which is an important feature of stratiform precipitation (Fu and Liu 2007).
  - Misclassified the orographic warm shallow rain into stratiform precipitation.(Funk et al., 2013)
- No validations between TRMM PR and ground-based radar over the Tibetan Plateau has been conducted sufficiently.

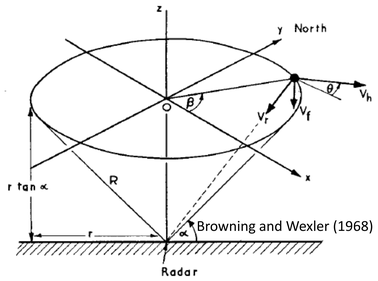
Motivation:

- To reexamine precipitation type classification of TRMM PR over the Tibetan Plateau using a vertical profile of horizontal divergence.

2. Data and Method

NASDA X-band Doppler Radar (NASDA radar)

Period	May 1998 – Sep. 1998 during GEWEX project
Variables	Reflectivity factor Doppler velocity
Mode	PPI, RHI
Elevation	1.5–20.0 deg (10 elev)
Time interval	10 min
Range reso.	125m
Obs. range	64km Shimizu et al. (2001)



- To estimate the vertical profile of horizontal divergence, the Velocity Azimuth Display (VAD) method was used (Browning and Wexler 1968).
- To reduce VAD analysis errors, observation data was averaged in the special-temporal domain (Mapes and Lin 2005).

3. Characteristics of TRMM PR precipitation types

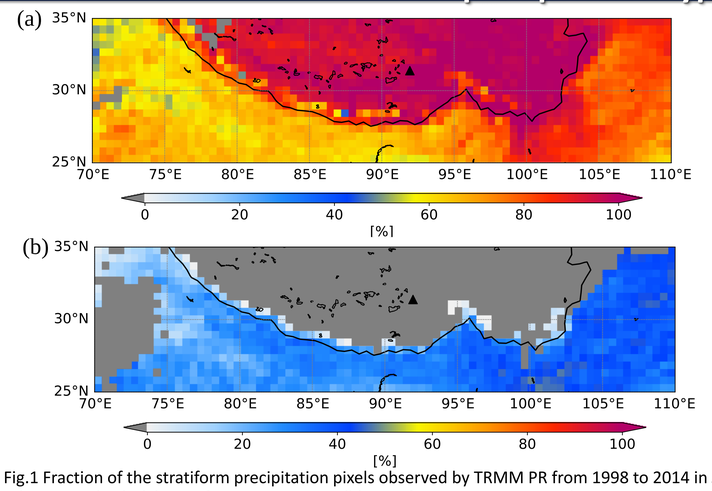


Fig.1 Fraction of the stratiform precipitation pixels observed by TRMM PR from 1998 to 2014 in June, July, August (JJA). (a) Stratiform precipitation (b) Stratiform precipitation with BB.

- 95.4% of precipitation pixels were classified as stratiform precipitation over the Tibetan Plateau (Fig.1a).
- Few BBs has been detected over the Tibetan Plateau(Fig.1b).

4. Simultaneous observation

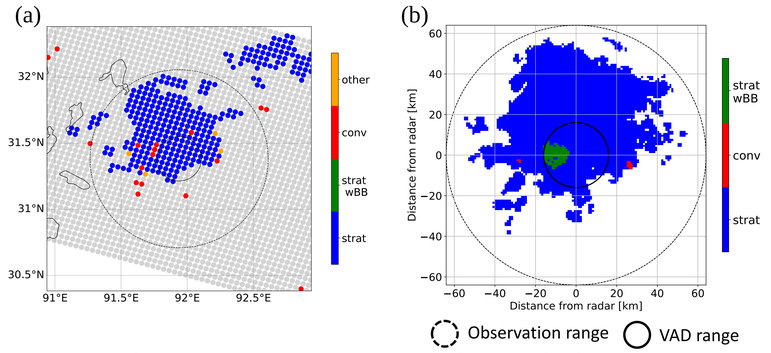


Fig.2 TRMM PR observation at 22:43 LT on 1 August 1998 and NASDA radar observation at 22:40 LT on 1 August 1998. (a) Precipitation types of TRMM PR estimated by Awaka et al., 2021. (b) Precipitation types of NASDA radar estimated by Steiner et al., 1995.

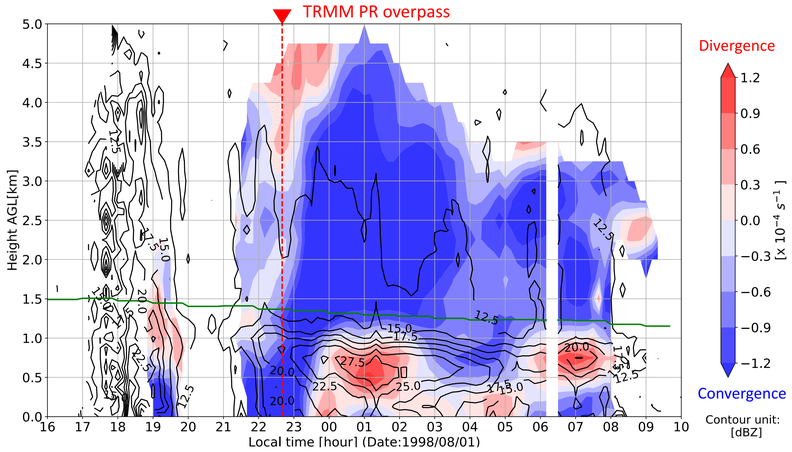


Fig.3 Time series of the vertical profiles of horizontal divergence and Z-factor from 16:00 LT on 1 August 1998 to 10:00 LT on 2 August 1998. contour indicates Z-factor. Green line indicates 0°C height (ERA5).

- At TRMM PR overpass on 1 August 1998:
  - Filled stratiform precipitation over VAD analysis area of both TRMM PR (Fig.2a) and NASDA radar (Fig.2b) on 1 August 1998.
  - NASDA radar (VAD): Convective profile (Fig.3).
  - Needed to improve the TRMM PR's precipitation type.

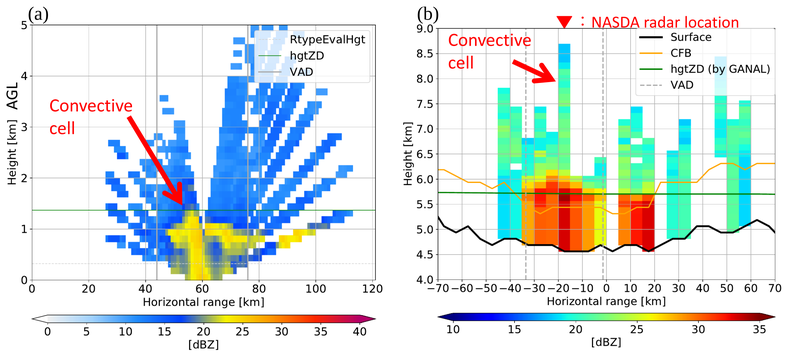


Fig.4 Vertical cross section of Z-factor (a) NASDA radar (b) TRMM PR (used *zFactorFinal* in L2 product)

- Convective cell was detected, and BB was spread around the convective cell (Fig.4a).
- BB was spread close to the Clutter Free Bottom, CFB (Fig.4b).

5. Reexamine the parameters of algorithm

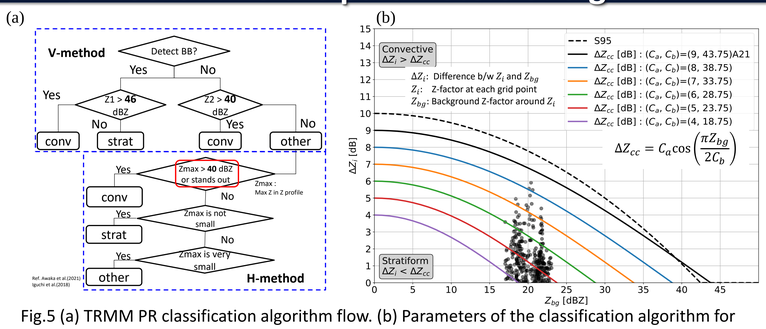


Fig.5 (a) TRMM PR classification algorithm flow. (b) Parameters of the classification algorithm for reexamination.

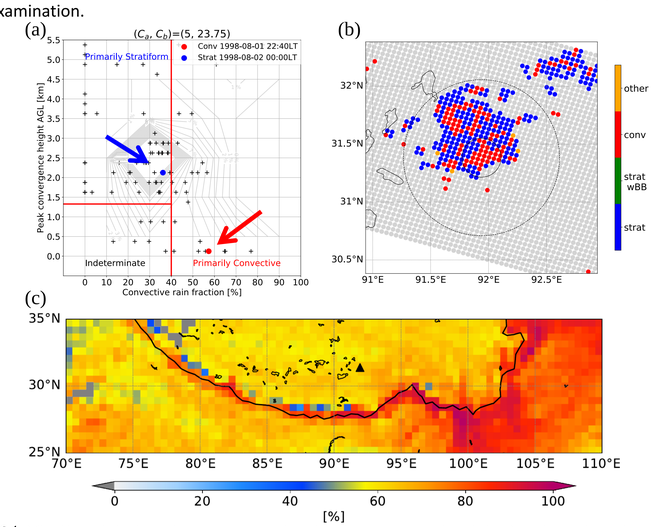


Fig.6 (a) Scatter plot of peak convergence height above ground level (km) and fraction of convective precipitation rate (%). (b) Same as Fig.2b expect for applying the new parameters. (c) Same as Fig.1a expect for applying the new parameters.

- Reexamined the parameters (C_a,C_b) of H-method in TRMM PR algorithm (Fig.5).
- New parameters of $C_a = 5$,$C_b = 23.75$ were determined with the Homeyer's category (Homeyer et al., 2014). (Fig.6a)
- With the new parameters:
  - Convective pixels increased 61% on 1 August 1998 (Fig.6b).
  - Fraction of the stratiform precipitation pixels over the Tibetan Plateau was improved 95.4% to 63.5% in JJA (Fig.6c).

6. Conclusions

- We reexamined the precipitation type classification of TRMM PR over the Tibetan Plateau using the vertical profile of the horizontal wind divergence revealed by the Doppler radar.
- Convective profile was revealed by the vertical profile of horizontal divergence at TRMM overpass on 1 August 1998.
  ⇔ Classified as stratiform precipitation by TRMM PR classification algorithm.
- To improve the precipitation type classification parameters over the Tibetan Plateau, we applied the Homeyer's method.
- As a result, convective pixels increased 61% on 1 August 1998 and the fraction of the stratiform precipitation pixels over the Tibetan Plateau was improved 95.4% to 63.5% in JJA.

Reference:
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