6.9 Evaluation of the latest version of the Global Satellite Mapping of Precipitation (GSMaP) focused on orographic rainfall

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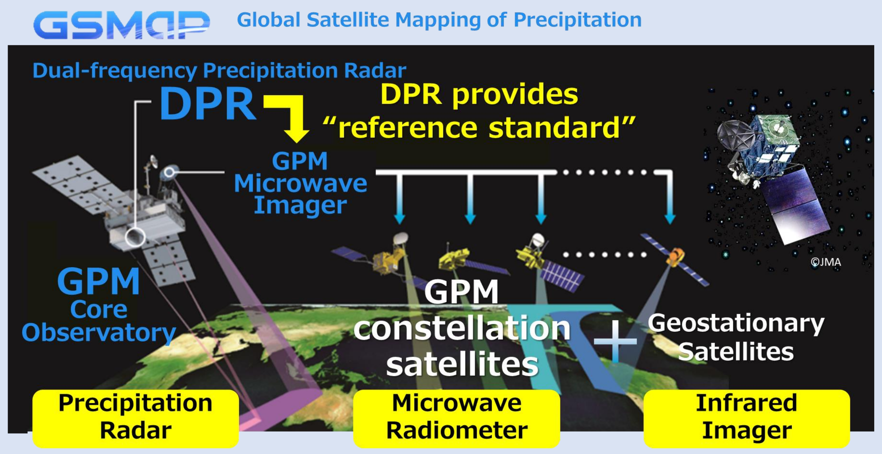
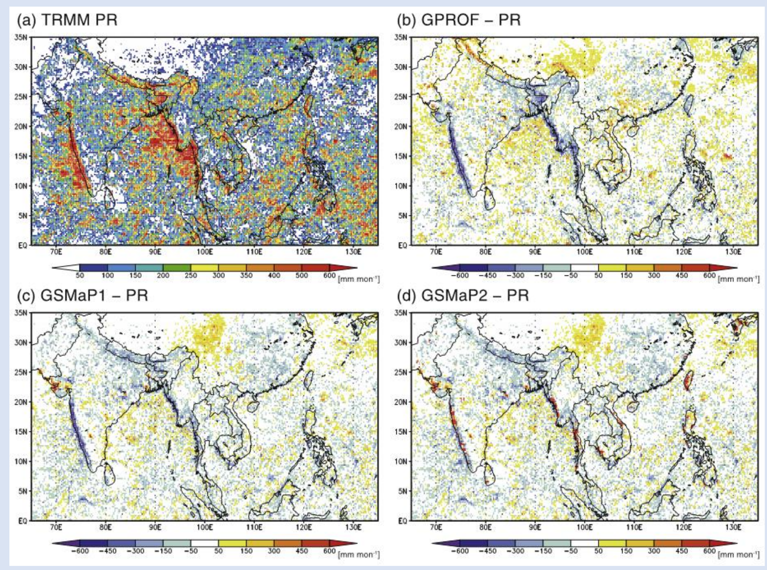
Introduction

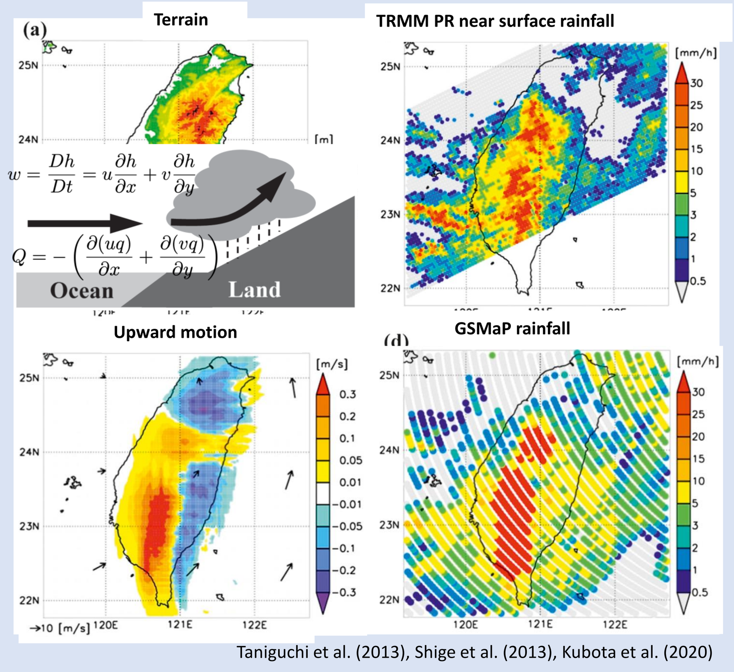
- Precipitation estimates from PMW are often underestimated over mountainous regions such as **Western Ghats (WG)** due to presence of shallow but heavy precipitation associated with **warm rain processes**.
- To improve the underestimation of orographic precipitation, the orographic/nonorographic rainfall classification scheme has been implemented globally in the GSMaP algorithm.
- The latest version (algorithm version 8 (v8)※) of GSMaP products are released in December 2022.
- **Purpose** of this study is **to investigate the performance of GSMaP V05** to compare with the previous version (V04), some other satellite rainfall products, and rain gauges



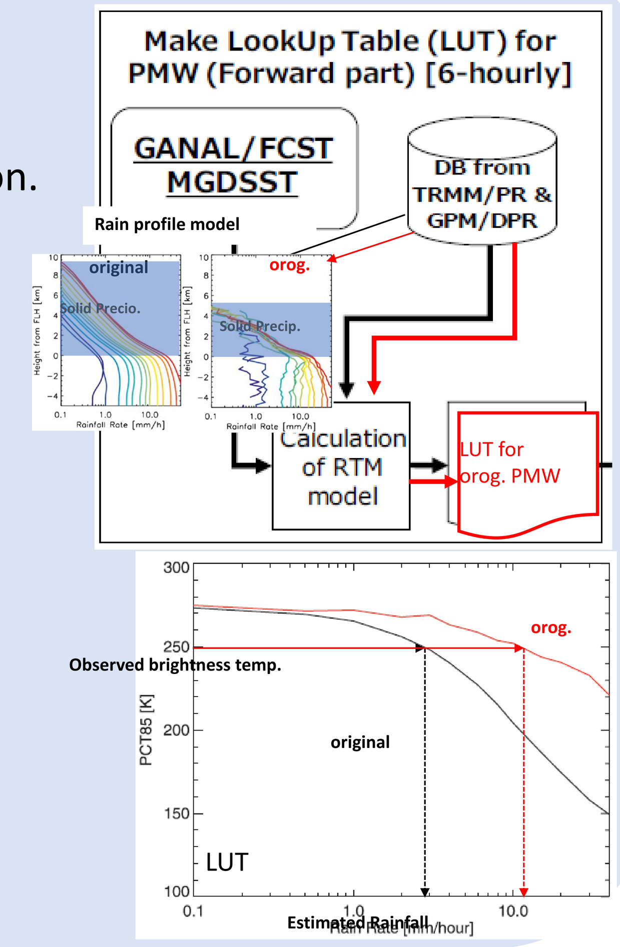


Orographic rainfall Classification Scheme

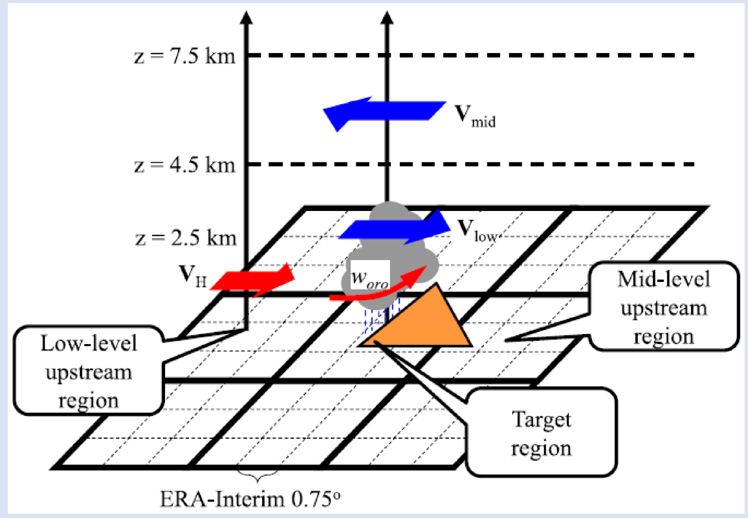
- Orographic rainfall condition is detected from <u>orographically forced upward motion</u> and <u>convergence of moisture flux</u>.
- LUT and graupel density is switched in the condition.

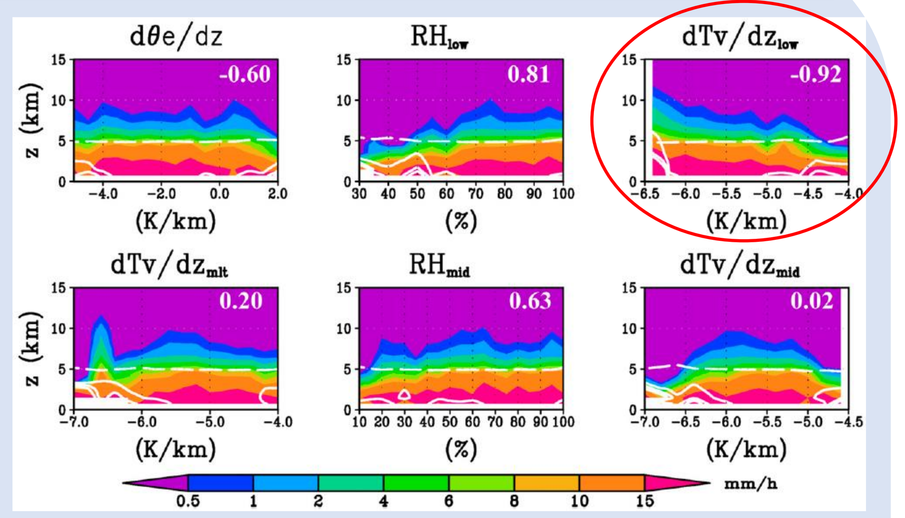


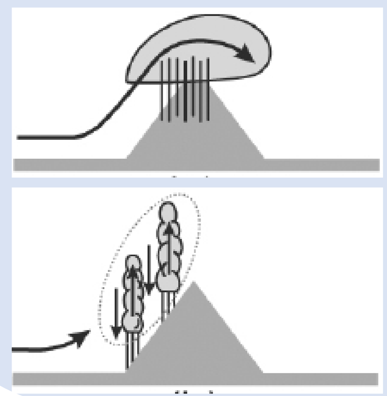
Taniguchi et al. (2013), Shige et al. (2013), Kubota et al. (2020)



Precip.-top heights vs thermodynamic info.



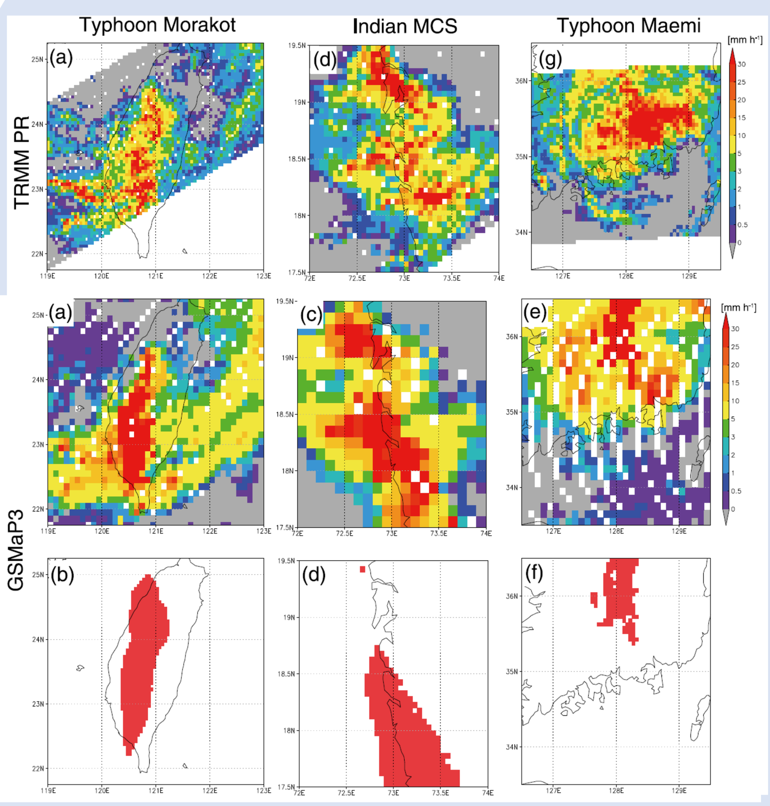




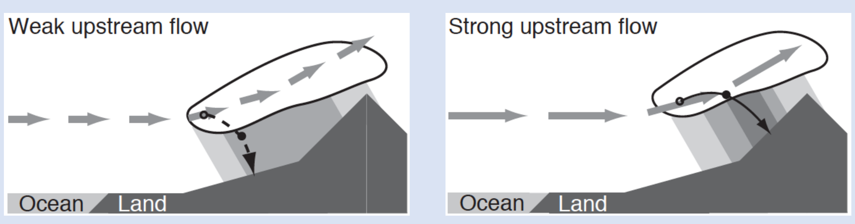
- Low-level static stability is the key parameter determining precipitation top heights
- Heavy orographic rainfall wigh low PTHs correspond to stable upslope mechanisms

Shige and Kummerow (2016)

Orographic rainfall scheme updates



- V03 (released in 2014)
  - Newly implemented globally
  - ☺Improvement of rainfall underestimation around WG
  - ☹False alarm/overestimation for orographic rainfall detection/estimation
- V04 (released in 2017)
  - Considered rainfall enhancement by low-level upslope wind
  - Modification of rain amount using 37 GHz information
  - ☺ Improvement of false alarm/overestimation
  - ☹ No detection over in land region/convective rainfall type

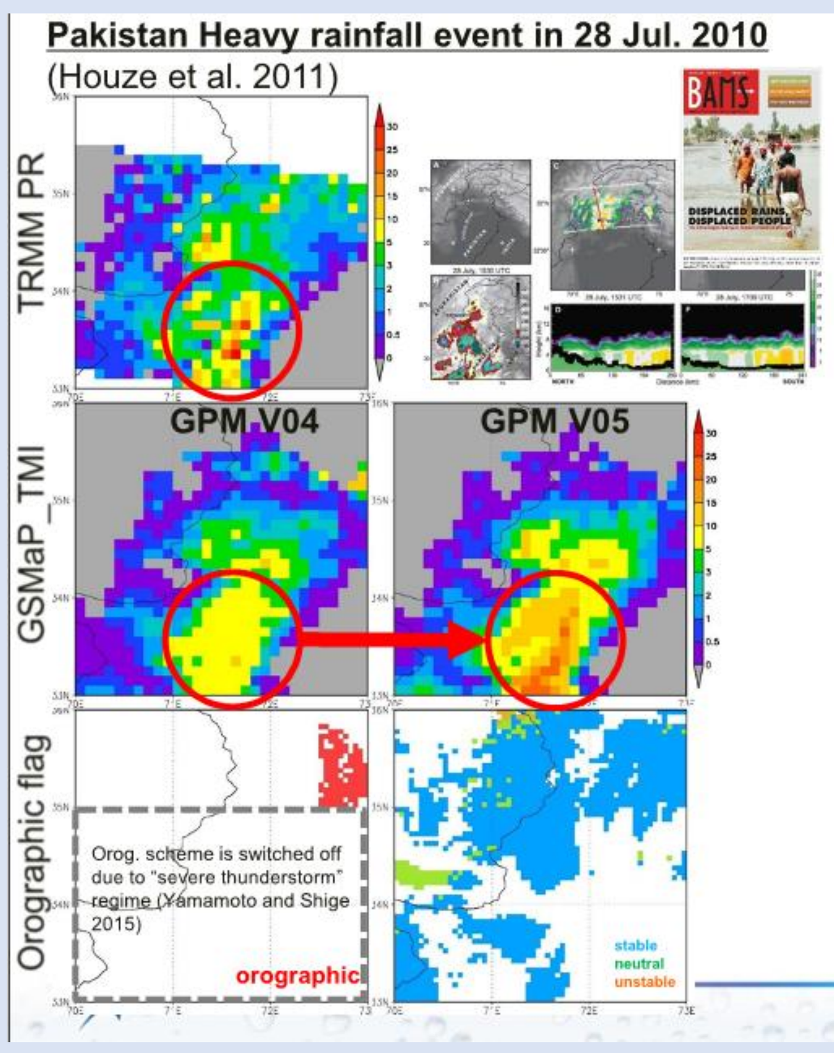


$$w = 0.01 + \text{weight} \times 0.19 \quad \text{and}$$

$$\text{weight} = \begin{cases} 0 & \text{for } U < 10\,\text{m s}^{-1} \\ (U-10)/10, & \text{for } 10 \le U \le 20\,\text{m s}^{-1} \\ 1 & \text{for } U > 20\,\text{m s}^{-1} \end{cases}$$

$$\text{rainpct3785} = \text{weight} \times \text{rainpct37} + (1.0 - \text{weight}) \times \text{rainpct85} \quad \text{and}$$

$$\text{weight} = \begin{cases} 0 & \text{for } \text{rainpct85} < 1\,\text{mm h}^{-1} \\ (\text{rainpct85} - 1.0)/(10.0 - 1.0) & \text{for } 1 \le \text{rainpct85} \le 10\,\text{mm h}^{-1} \\ 1 & \text{for } \text{rainpct85} > 10\,\text{mm h}^{-1} \end{cases}$$



Issues of orographic rainfall scheme in GPM V04:

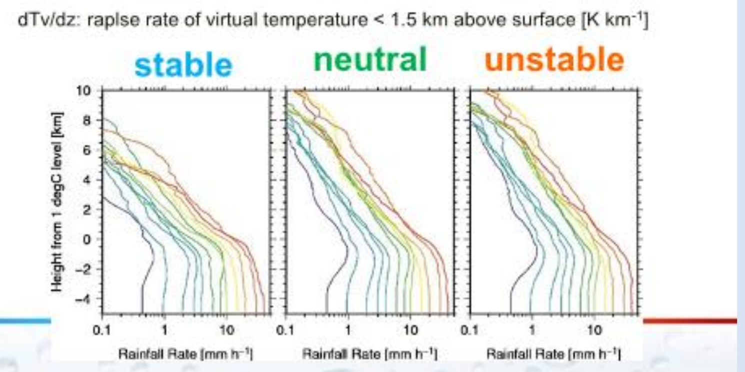
Switching off of the scheme over the regions with strong lightning activity results in underestimation of warm orographic rainfall such as Pakistan Heavy rainfall event in 28 Jul. 2010.

↓

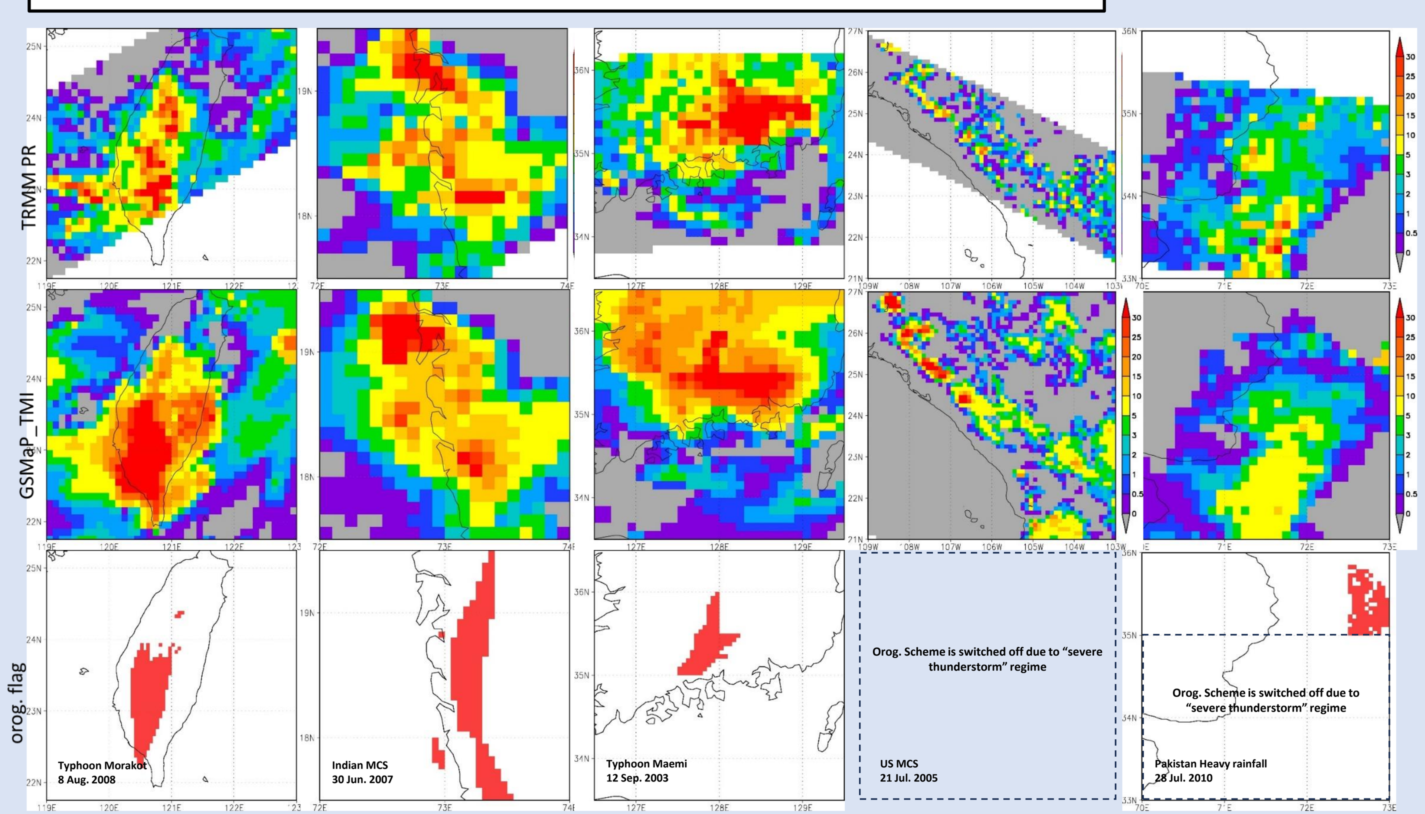
Low-level static stability (Shige and Kummerow 2016) enable the scheme to detect warm orographic rainfall over the regions with strong lightning activity

- Stable upslope: -5.5 < dTv/dz
- Neutral upslope: -6.5 < dTv/dz ≤ -5.5
- Unstable upslope: dTv/dz ≤ -6.5

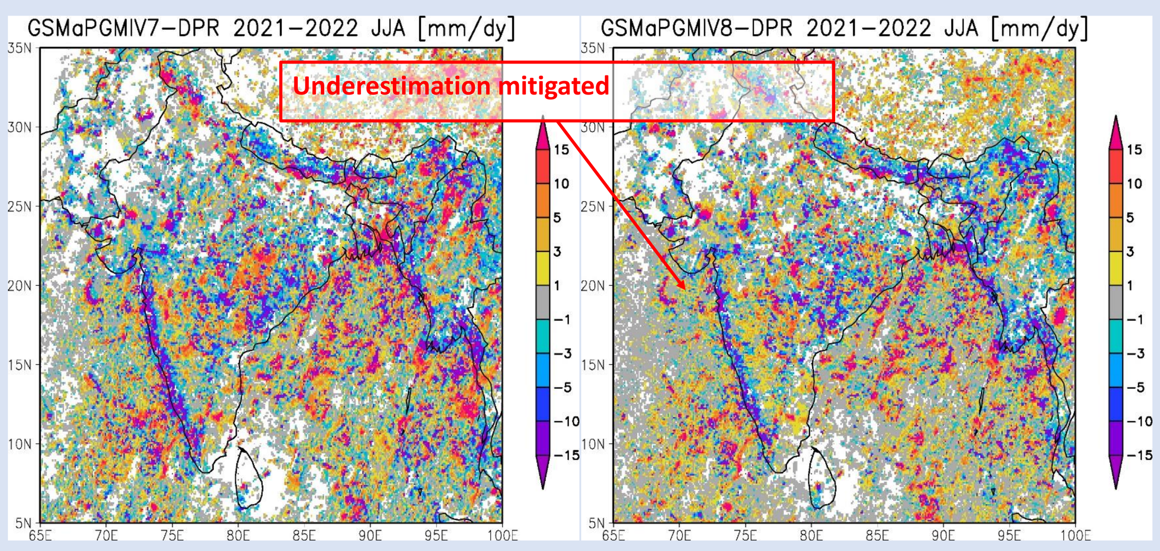
dTv/dz: rapise rate of virtual temperature < 1.5 km above surface [K km⁻¹]



GSMaP V04 (previous version)

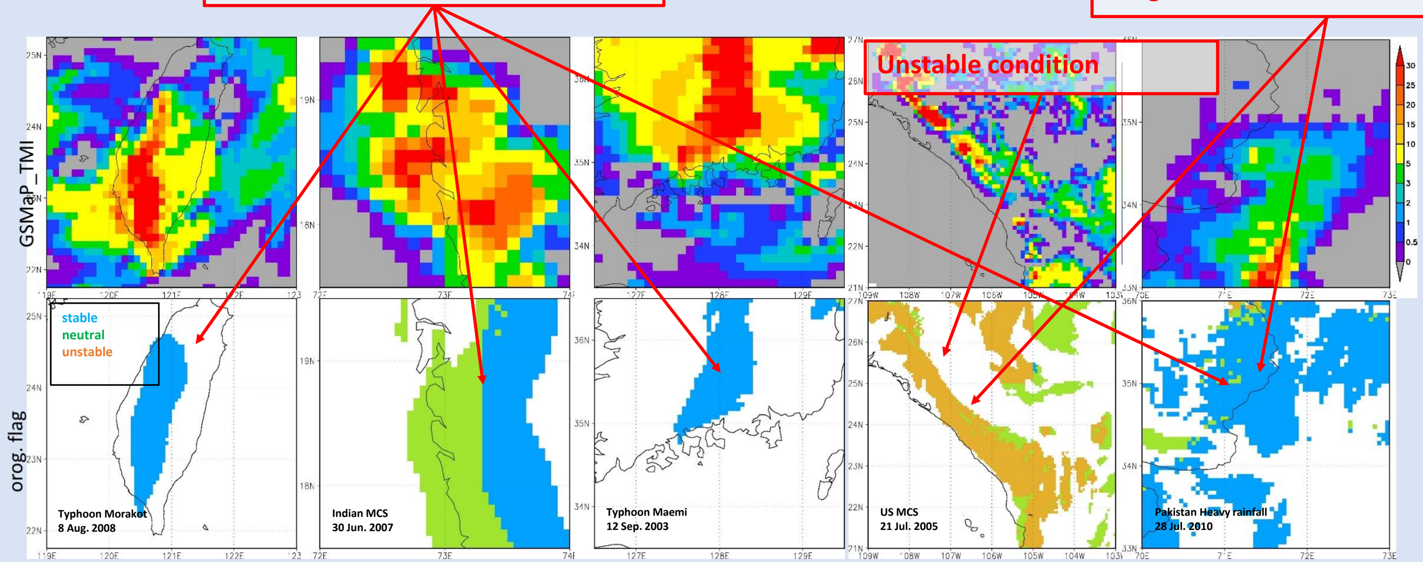


Evaluation of GSMaP GMI against DPR



	NUM			RAIN AMOUNT	
	POD	FAR	MISS	/ISRO	MISS
GMIV04	0.22	0.04	0.78	1.44	0.53
GMIV05	0.23	0.04	0.77	1.01	0.51

GSMaP V05 (current version)



Summary

- Orographic/nonorographic rainfall classification scheme was updated in the latest version (V05) of GSMaP, changing classification factor from moisture flux to static stability to detect inland orographic rainfall.
- GSMaP GMI V04/V05 is evaluated against GPM DPR and IMD rain gauge corrected data (GSMaP_ISRO).
- Bias of monthly mean rainfall for GSMaP GMIV05 is mitigated compared to V04.