Evaluation of Microwave Radiances of GPM/GMI for the all-sky assimilation in RTToV Framework

[1]*Rohit Mangla* (*mangla1991@gmail.com*), [2]*J Indu* (*indusj@civil.iitb.ac.in*)

[1,2]*Department of Civil Engineering, Indian Institute of Technology Bombay, India*

[2] *Interdisciplinary Center for Climate Studies, Indian Institute of Technology Bombay, India*

Abstract

This study investigates the statistical characteristics of all-sky GPM/GMI radiances at 183 $\pm$ 7 GHz. Simulations at higher frequencies are challenged by uncertainty in shape and size distribution of frozen hydrometeors which produces unrealistic scattering. This study was carried out with four DDA non-spherical shapes (thinplate, black column, 6-bullet rosette and sector snowflake) for reproducing the three cyclones (hudhud, vardah and kyant) over Bay of Bengal region using RTToV-SCATT model. The input data used in RTTOV model includes vertical hydrometeor profiles (cloud water, ice, snow and rain), humidity and surface fluxes. Furthermore, the first guess profiles were generated from Weather Research Forecast (WRF) model at 15km resolution using ERA-Interim reanalysis datasets. The symmetric error model was used to study the observed minus first guess (FG departures) in all-sky situations. The normalized probability density function (PDF) of FG departure shows high peak and small standard deviation than Gaussian curve due to high spatially correlated errors. The h-statistics and skewness results between observed and simulated distribution show optimum results for thinplate shape in all the cases. These results illustrate a potential to integrate the GMI sensor data within a WRF data assimilation system.

Introduction

- Assimilation of all-sky microwave radiances improves the initial state of atmosphere and has a positive impact on temperature and humidity.
- Accurate simulation of deep convective events at 183 GHz are challenging due to difficulty in modelling of scattering effects from frozen hydrometeors.
- Issue of non-Gaussian FG departure statistics in all-sky satellite data assimilation produces inaccurate estimate of the analysis.

Objectives

- Evaluation of normalized FG departures for the assessment of cloud effect at 183 $\pm$ 7 GHz.
- Investigation of DDA shapes of frozen hydrometeors for cyclonic events over Bay-of-Bengal region.

Study Area

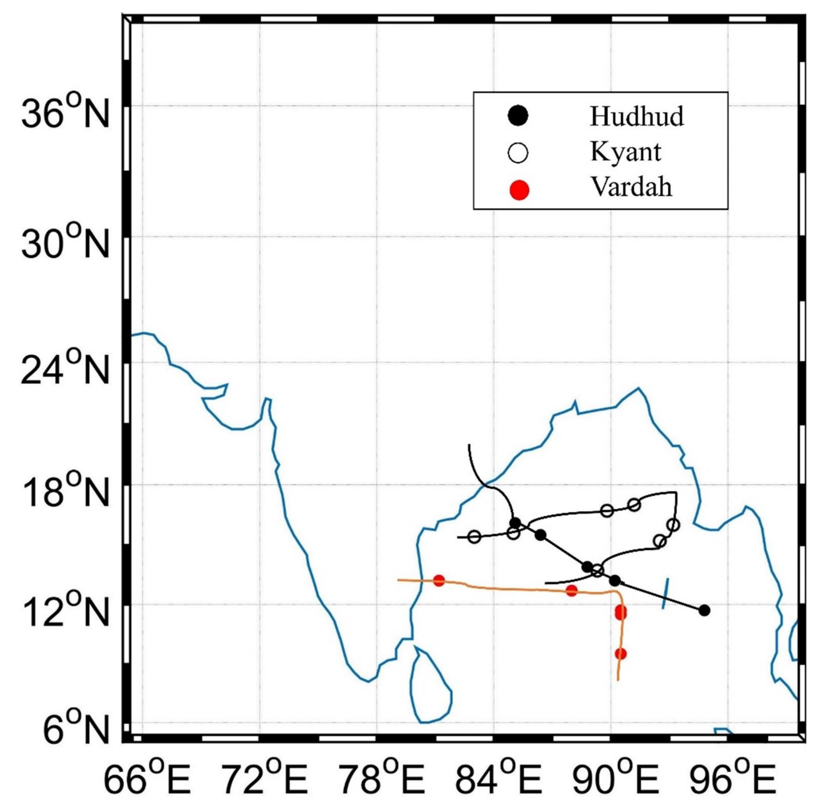


Figure 1: show the track of tropical cyclones (hudhud, vardah and kyant) over Bay of Bengal. The red point denotes the location of GMI observations near the eye of cyclone.

Datasets

GMI Radiances (observed data) at 183 $\pm$ 7 GHz-V (4.4 x 7.3 km)	ERA-Interim (71 km & 6hr) meteorological datasets used in **WRF** model
Geographical Static datasets such as LULC, topography, soil information were used by **WRF** model	Vertical atmospheric profile as cloud liquid water, water temperature, snow and rain given to **RTToV** model

Methodology

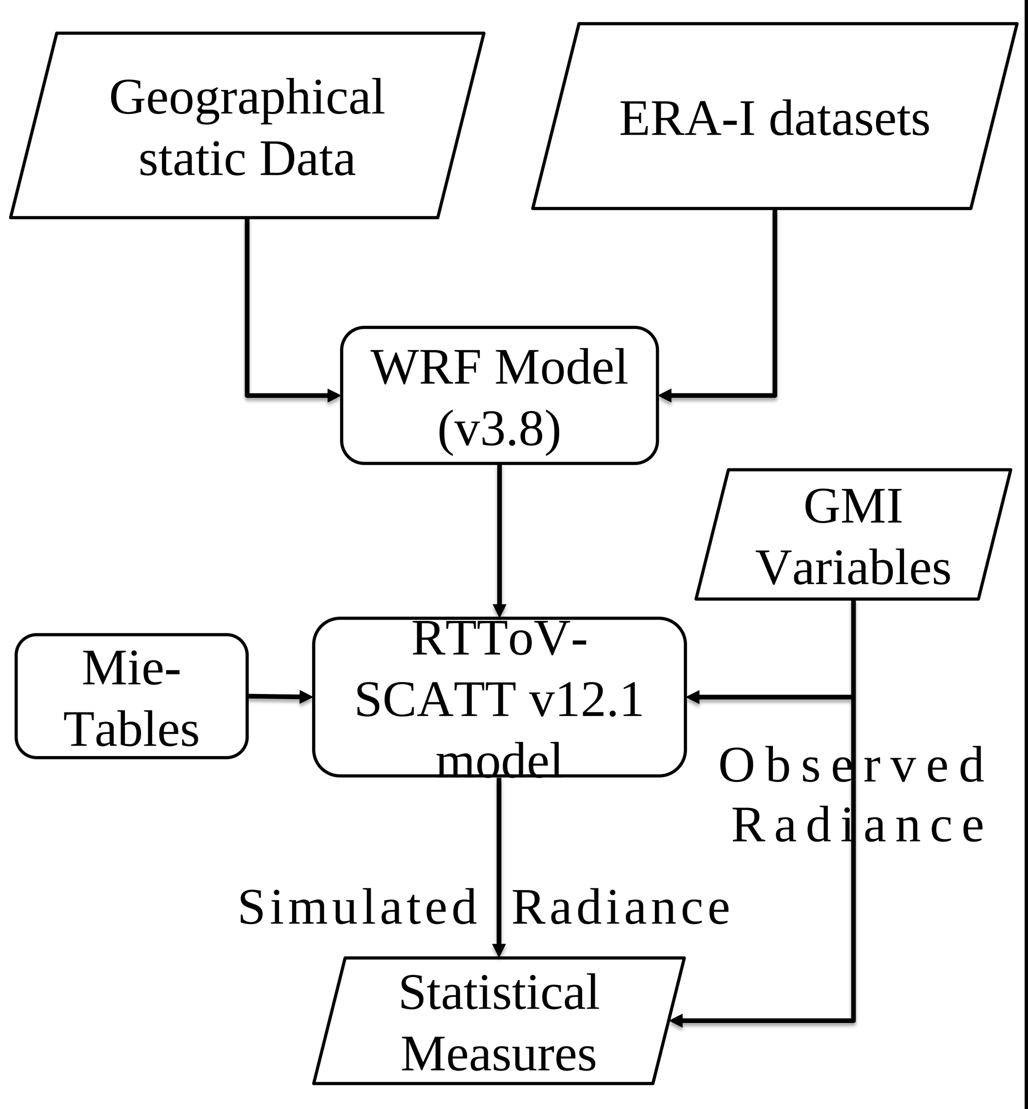


Figure 2: Flow diagram of methodology adopted for simulation of all-sky radiances using WRF and RTToV Model

Results and Discussion

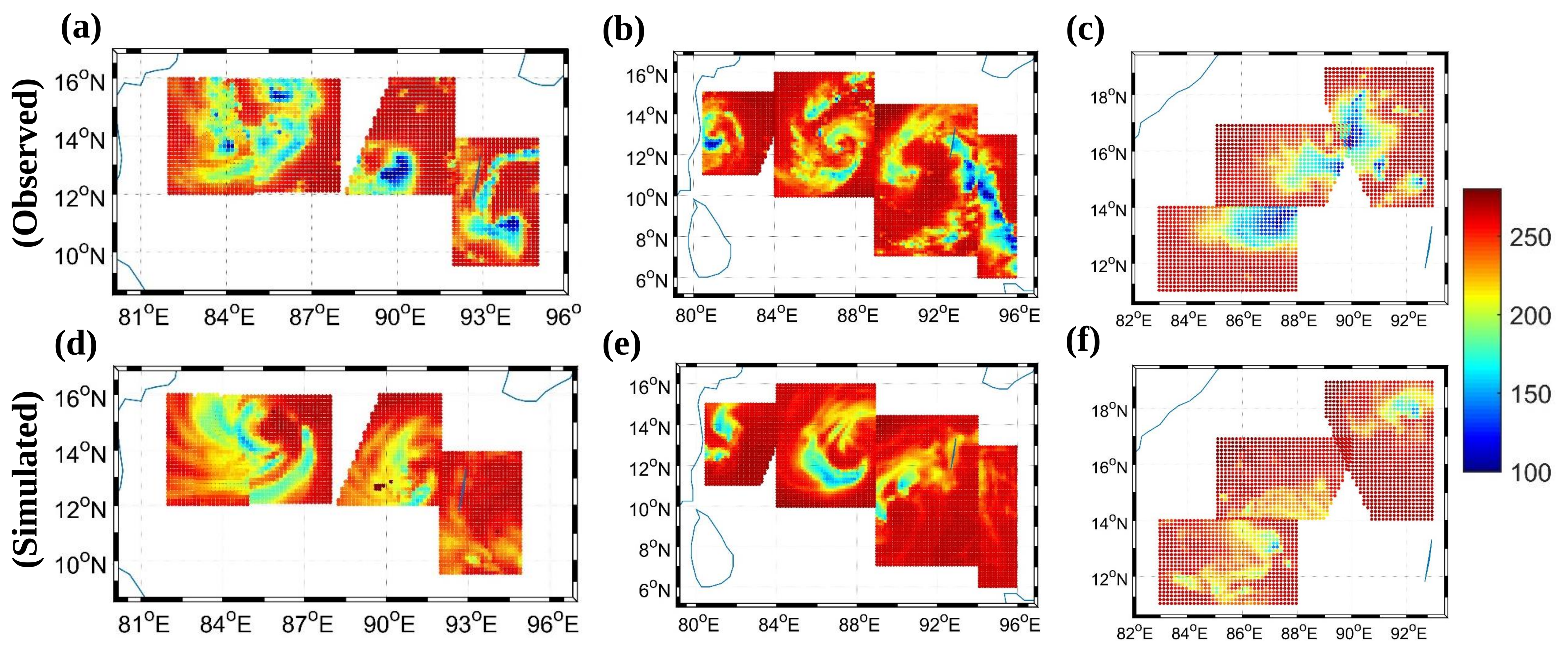


Figure 3: show the comparison of spatial distribution of observed and simulated brightness temperature (Tb) for hudhud (a, d), vardah (b, e) and kyant (c, f) cyclone with DDA sector snowflake shape at 183 $\pm$ 7 GHz.

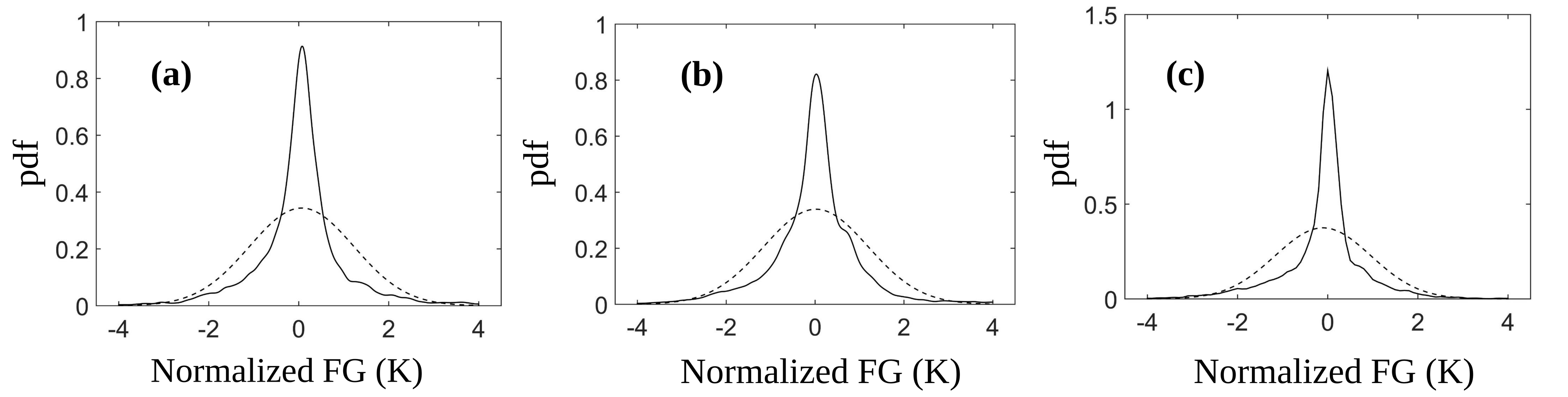
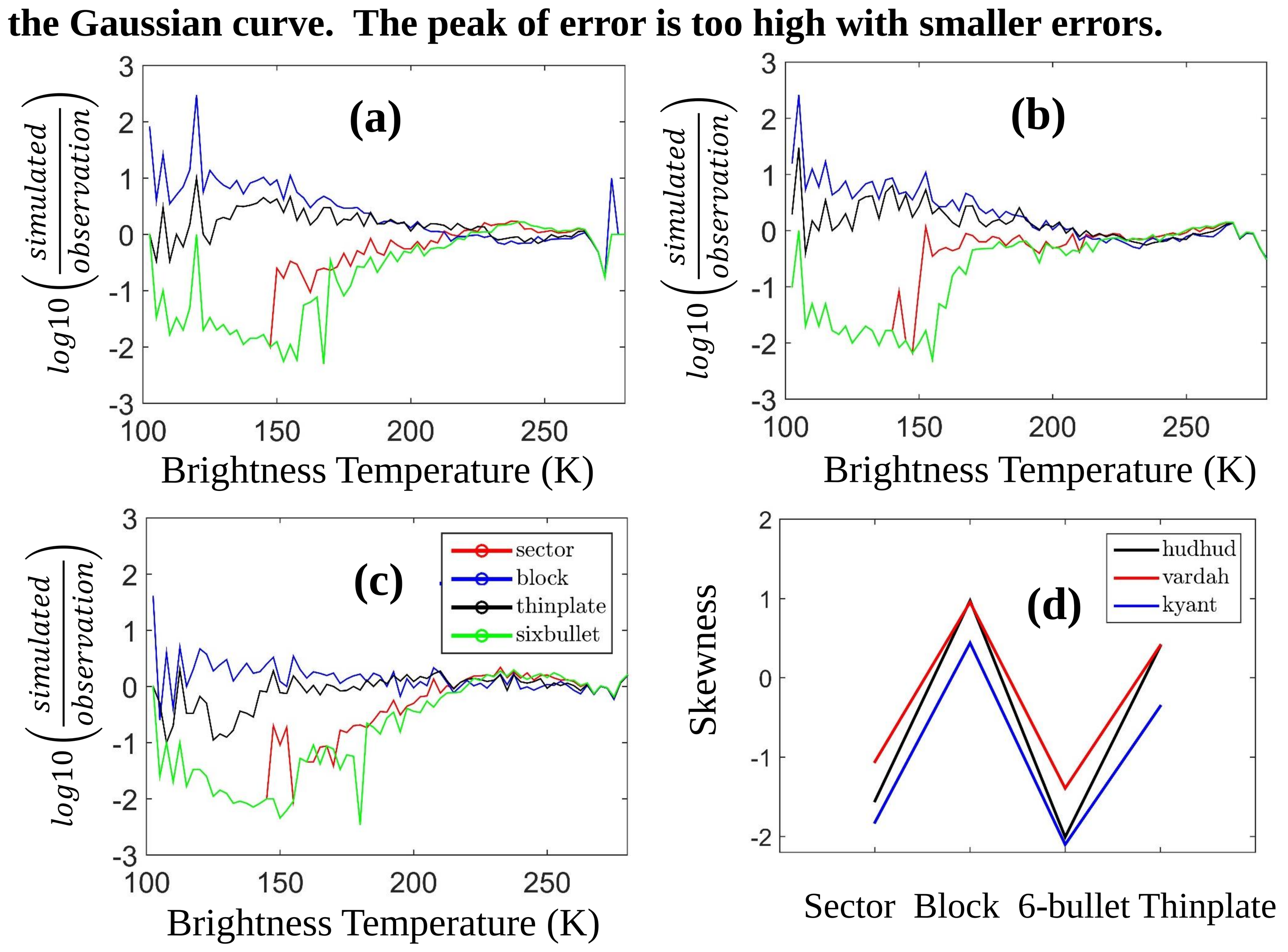


Figure 4: Probability distribution function (PDF) of FG departure normalized by standard deviation as function of average cloud amount for (a) hudhud (b) vardah and (c) kyant cyclone at 183 $\pm$ 7 GHz. The dotted curve represent the Gaussian curve. The peak of error is too high with smaller errors.



$$h = \frac{\left(\sum_{bins}\left|log\frac{\#\,simulated}{\#\,observation}\right|\right)}{total\ no\ of\ bins}$$

Geer and Baordo, (2014)

- The positive log ratio indicates the high occurrence of low Tb due to excessive scattering from clouds and precipitation regions and vice-versa for negative log ratio.

Figure 5: The log ratio of the histogram (simulated divide by observation) for four DDA shapes over (a) hudhud (b) vardah and (c) kyant cyclone. The bin size is 2.5 K. (d) represents the skewness of FG departures. Thinplate has least h-value to all the cases.

Conclusion

- The Normalized error curve is symmetric with low size errors. Hence, it allows to use cloudy radiances in all-sky data assimilation.
- DDA thinplate have robust nature in simulation of consistently all-sky radiances over Bay of Bengal.

References

- Geer, A.J., Bauer, P. (2011) Observation errors in all-sky data assimilation. Q. J. R. Meteorol. Soc. 137, 2024-2037, https://doi.org/10.1002/qj.830.
- Geer, A.J., Baordo, F., (2014) Improved scattering radiative transfer for frozen hydrometerors at microwave frequencies. Atmos. Meas. Tech. 7, 1839-1860. https://doi.org/10.5194/amt-7-1839-2014