Quantifying Temporal Sampling Error for Gulab Cyclone using GPM Constellation

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(1) Introduction

- This study explores the concept of a robust satellite constellation for precipitation monitoring, aiming to enhance the accuracy and reliability of precipitation data collection (Kidd et al., 2021).
- Sampling error, caused by the space-time intermittence of observation, introduces inaccuracies into satellite-sampled rainfall averages in space and time (Iida et al., 2006).
- This study investigates the sampling considerations demanded for earth observation studies using data from five distinct sensors (GPM-GMI, F18-SSMI, MetopC-MHS, NOAA20-ATMS, and GCOMW1-AMSR2) from the current GPM constellation.
- Sampling error is formulated as a function of time across the entire stretch of the Bay of Bengal for a cyclonic event Gulab, which originated from September 24th to 27th, 2021.
- This study is conceptualized in anticipation of the Time Resolved Observations of Precipitation structure and storm Intensity with a constellation of Smallsats (TROPICS; Blackwell et al, 2018) mission

2. Study Area & Datasets

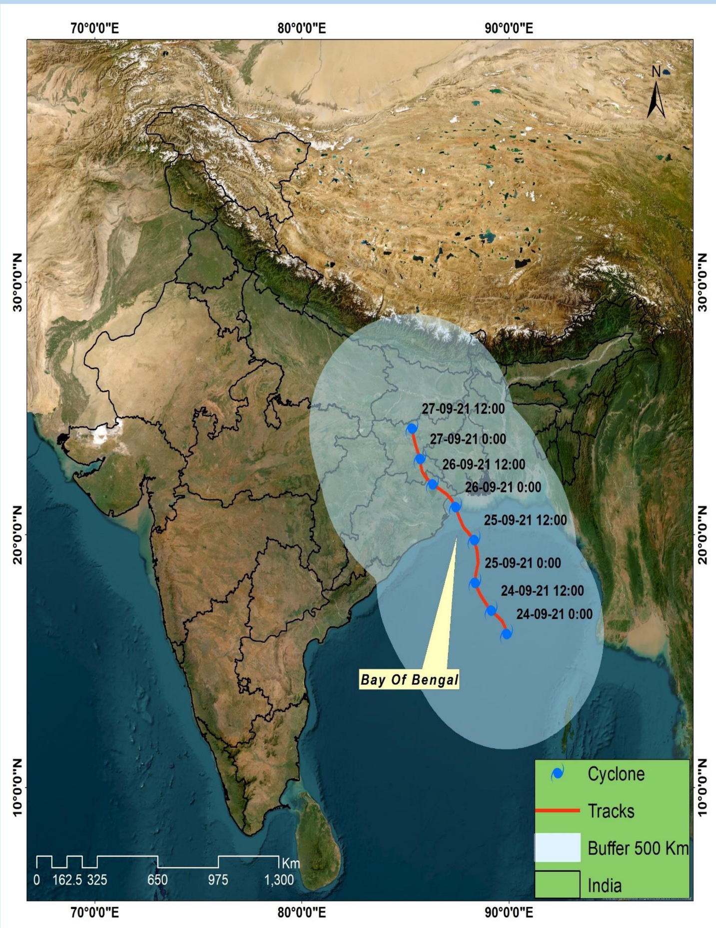


Figure 1. The study area shows the track of Gulan Cyclone, originated over Bay of Bengal on September 24th , 2021, along with 500 Km buffer Zone.

	Temporal Resolution	Spatial Resolution	Frequency (GHz)
GPM-GMI	1.5 Hours	$13 \times 13\ Km$	10.7 - 183.31
F18-SSMI/S	1.5 Hours	$12 \times 12\ Km$	19.35-183.31
MetioC-MHS	1.5 Hours	$17 \times 17\ Km$	89.0-183.31
NOAA20-ATMS	1.5 Hours	$17 \times 17\ Km$	23.0-183.31
GCOMW1-AMSR2	1.5 Hours	$10 \times 10\ Km$	6.7-89.0

Table 1. List of precipitation estimates from various sensors used in this study, including their spatial and temporal resolutions and frequencies.
*IMERG derived precipitation is also used.

(4) Results

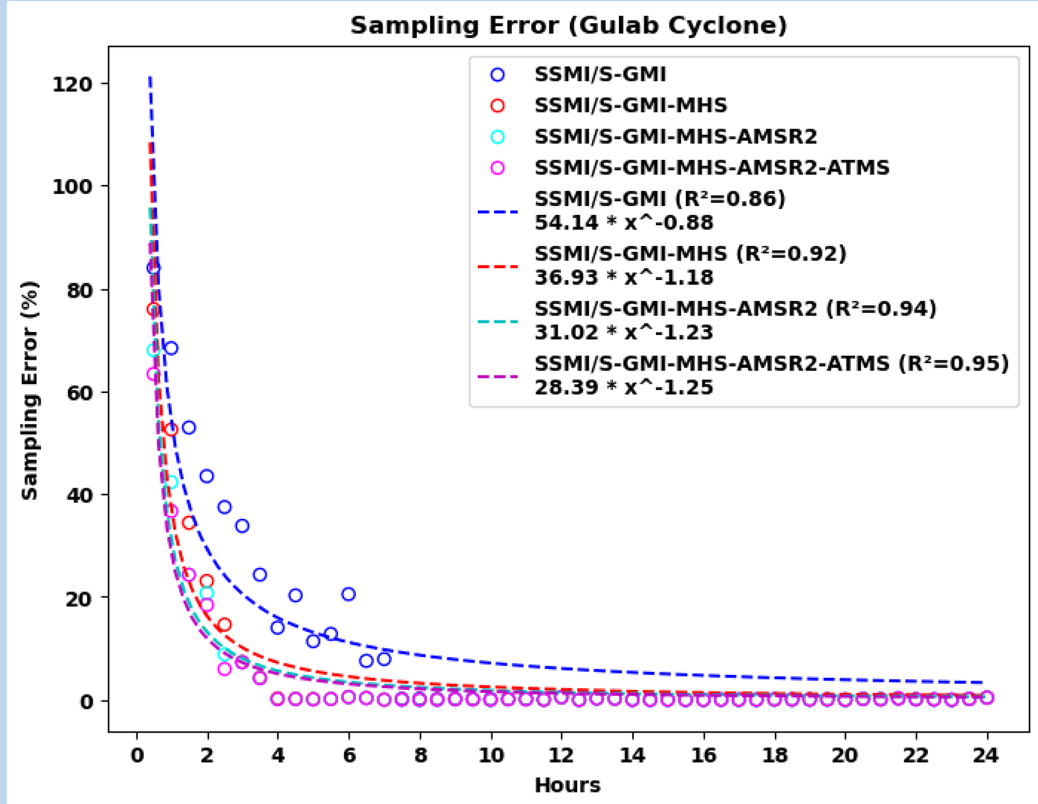


Figure 2. Illustrates the variation in sampling error percentages over a 24-hour period for different combinations of five sensors. Circular dots on the graph correspond to the observed sampling errors at specific time intervals, while the dotted line represents the exponential fit of the sampling error. This information provides insights into the accuracy and reliability of each measurement method as cyclone tracking progresses throughout the day.

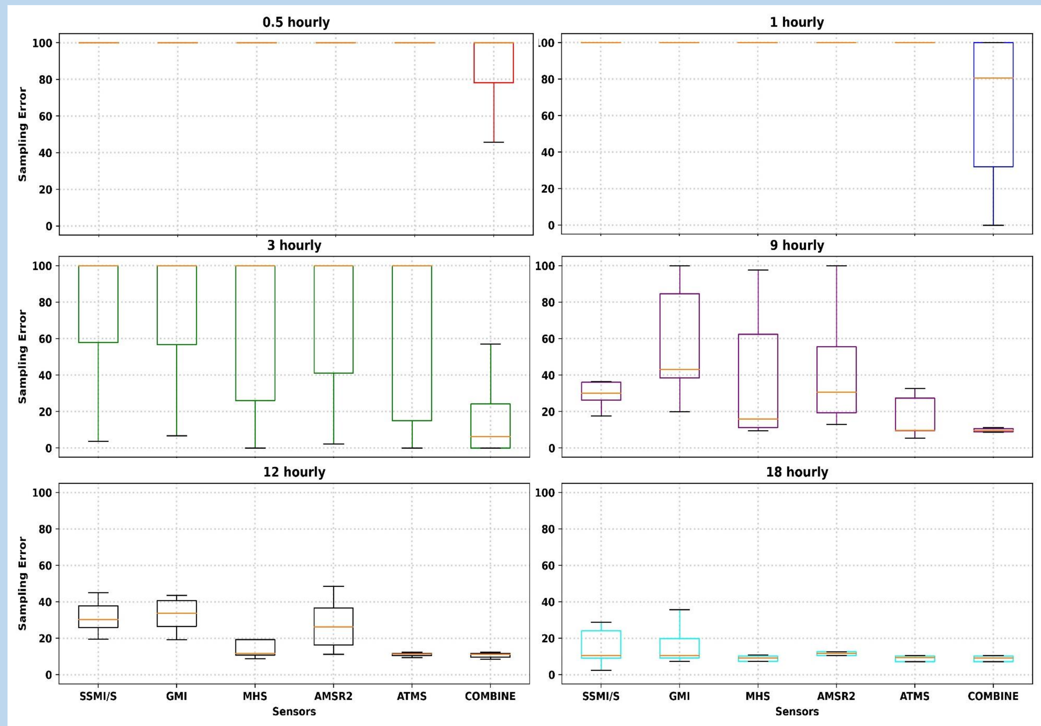


Figure 3 displays a series of box plots illustrating the sampling errors for five different sensors (SSMI/S, GMI, MHS, AMSR2, ATMS) and their combination (COMBINE) at various time intervals (0.5 hourly, 1 hourly, 3 hourly, 9 hourly, 12 hourly, 18 hourly).

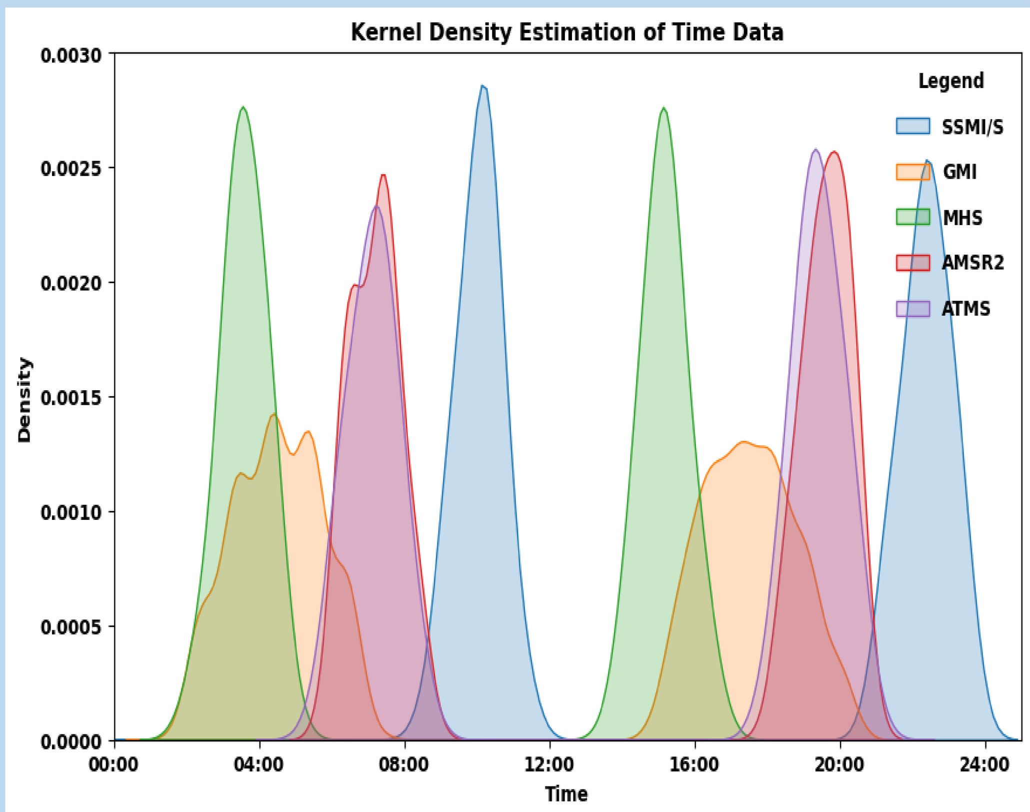
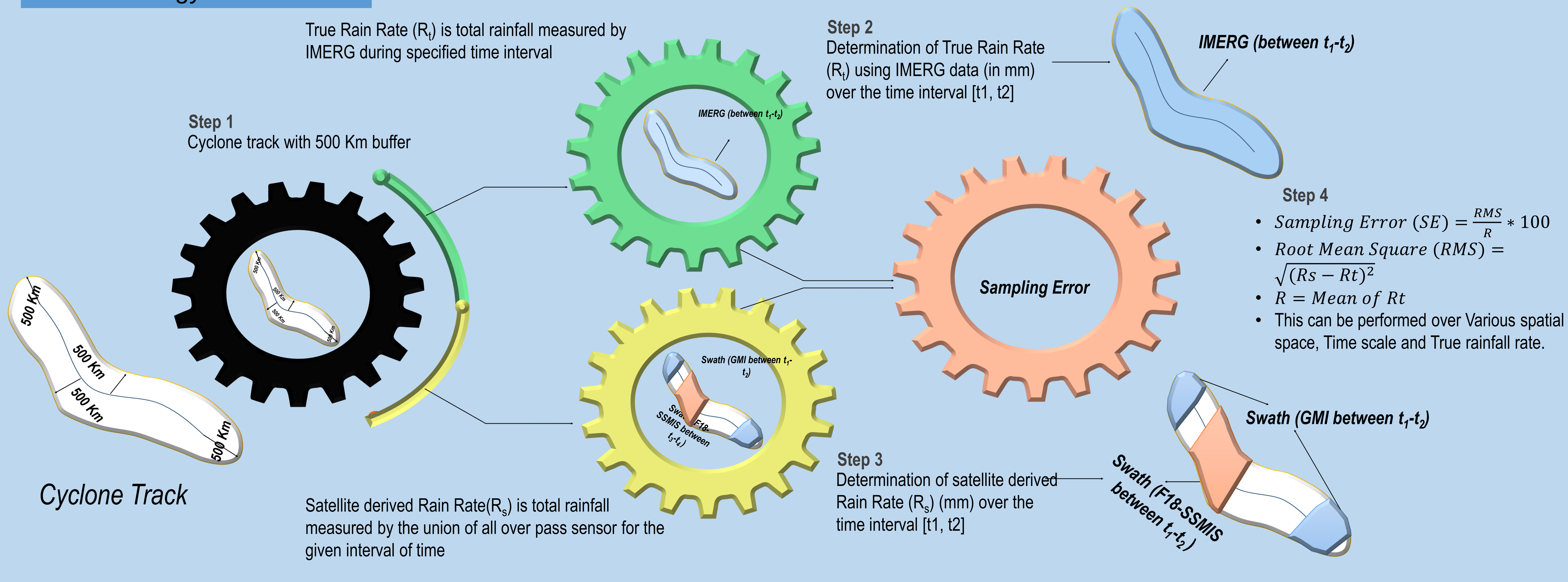


Figure 4. Displays the probability density of satellite measurements (SSMIS, GMI, MHS, AMSR2, ATMS) over a 24-hour period. Each peak represents the most frequent data collection times for each satellite..

3. Methodology



5. Summary

- Results of sampling uncertainty are presented for different temporal aggregations for the cyclonic event.
- The findings suggest combination of three or more sensors can effectively reduce the sampling errors providing comprehensive coverage within a temporal interval ranging between every 2 to 2.5 hours.
- Emerging technologies, such as smallsats and cubesats, can partially address the need for improved temporal sampling in scientific research and user applications.

5. References

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