"Potential of point source imaging satellite instruments to infer diffuse methane emissions: a theoretical case study of the Near-Infrared Multispectral Camera (NIMCAM)" Review:

This manuscript evaluates the ability of a single satellite, or a constellation of high-resolution satellites (NIMCAM), to improve observational coverage and corresponding inverse estimates over the African tropics using an Observing System Simulation Experiment (OSSE). The study is motivated by the premise that higher spatial resolution enables successful retrievals under partially cloudy conditions where lower-resolution global mappers (e.g., TROPOMI and GOSAT-2) would fail.

The authors first quantify observational coverage using synthetic retrievals based on cloud cover and aerosol optical depth thresholds, comparing configurations of 1, 3, and 5 NIMCAM satellites against existing satellite capabilities. They then perform a series of flux inversions using these synthetic observations to assess the impact of increased observational density on emission estimates.

This manuscript addresses an important question regarding the satellite capabilities needed to improve methane flux estimates in the African tropics. The work is well-structured and clearly presented. I recommend acceptance pending minor revisions.

My primary concern relates to the treatment and use of super observations and their associated error assumptions in the OSSE:

- The authors assume GOSAT-like observational uncertainty for NIMCAM. Can they justify whether this assumption is appropriate given the differences in spectral resolution and retrievals between the instruments?
- In Table 1, the authors assume that super observation uncertainties decrease according to the central limit theorem (CLT). However, Equation (1) appears to impose a lower bound due to correlated error. In practice, super observations are likely to retain some degree of correlated bias and may not strictly follow CLT scaling. The analysis would be strengthened by including sensitivity tests that account for varying levels of correlated error in the super observations.
- How are super observations aggregated (e.g., by orbit, by day, or over a 10-day period)? Typically, aggregation is performed at the orbit scale to reduce random error. Aggregating over a 10-day window would potentially cause excessive temporal smoothing.
- Is the observational error covariance matrix assumed to be diagonal? Does it use a lower limit for sigma like in Equation 1, or does it follow the CLT? Additionally, what observational error covariance (S_o) is used for the TROPOMI inversions? Are super observations also applied to the TROPOMI data?

- Please also clarify how retrievals that span multiple grid cell boundaries are handled.
- In the discussion of super observations, it would be appropriate to cite foundational work such as Eskes et al. (2003), or Chen et al. (2023) for a CH_4-specific application.

Specific comments:

- Figure 3: For clarity, consider adding vertical dashed lines to delineate monthly boundaries, or include an x-axis label in the top panel.
- Figure 7b: Please clarify whether this panel shows percentage or fractional error reduction.
- Line 171: Please confirm that true boundary conditions are prescribed in the prior simulation to avoid bias from boundary effects.
- Line 173: The standard term is “Observing System Simulation Experiment (OSSE)”; consider using this instead of “closed loop system.”

Technical Corrections:

- Line 98: Typo in “capability”
- Line 136: Typo in “probabilistic”
- Line 202: Typo in the subscript of S_{obs}
- Line 275: Typo (“O” at end of line)