Overview of MethaneSAT algorithm versions

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The MethaneSAT Team is committed to providing the most accurate emissions estimates consistent with MethaneSAT observations. We regularly update the algorithms that calculate emission rates to increase accuracy and scientific confidence.

All previously-released products are being reprocessed with algorithm version 1.0.0. **These reprocessed products supersede public-preview and interim versions.** Users comparing scenes or producing regional analyses should use reprocessed products only. The reprocessed products provide a robust methodological foundation for MethaneSAT analyses and publications.

How have the algorithms changed?

The public-preview product used a spatially uniform emissions prior. This was found to induce a small noise-associated emission across the scene that accumulated to drive a bias in low-emitting scenes, leading to their rejection during quality control. The interim product was introduced to reduce this bias. It removed likely-zero cells before rerunning the inversion. It did not preserve full Bayesian uncertainty.

Version 1.0.0 uses a revised prior to produce more accurate spatial allocation in both low- and high-emitting regions, and maintains accurate regional totals across all scales. It was developed and tested using synthetic and real-data experiments.

Public preview: Versions 0.5.0 to 0.7.10

These algorithm versions, which powered our public preview, introduced our approach to providing emissions estimates. We use a method called CORE (Column Observations to Regional Emissions), which accounts for transport of emitted methane by winds and for the influence of topography and other factors. This version averaged 4,000 maps to find the best estimate of emissions from each grid cell.

Interim model: Versions 0.9.x to 0.15.x

This group of releases improved how the model accounts for regions where the emissions were likely zero. These grid cells were flagged with the description “below noise threshold.”

These algorithm versions supported an **interim heatmap product** that reduced the influence of bias associated with small emissions that arise due to the treatment of measurement and modeling error. The method yielded improved total emission estimates by excluding likely-zero emitters. The procedure represented our best estimate at the time. However, the associated uncertainty intervals on the *total regional emissions* are uncharacterized: in particular, the *upper bound to the total regional emission* may be biased low.

Current model: Version 1.0.0

This release incorporates information from a global inverse model with satellite data from TROPOMI (East et al., 2025). Two methodological updates improve the accuracy of total emissions and spatial allocations:

1. The MethaneSAT averaging kernel is now applied when vertically weighting the Jacobian that links emissions to observed concentrations.

   The averaging kernel application corrects an approximately 3% average underestimate in modeled sensitivity that produced a similar overestimate in inferred emissions. The averaging kernel is dependent on elevation, leading to improvements in the spatial allocation of emissions in scenes with complex topography.

2. The spatially uniform prior and interim solution were replaced with a spatially informed prior based on East et al. (2025). This revised prior assumes sector-specific variability and a minimum emission rate that allows emissions to be detected anywhere.

The MethaneSAT Level-4 product characterizes emissions uncertainty using samples from the posterior distribution. Posterior samples for the reprocessed data are now publicly available. Because these samples do not fully capture uncertainty in fixed inputs, such as meteorological data, we recommend expanding the posterior-derived uncertainty bounds by 20% of the mean emissions estimate.

The up-to-date Algorithm Theoretical Basis Document for CORE is available on Zenodo.

What's next?

No additional reprocessing is anticipated. However, the CORE algorithm will continue to be updated as the team improves the methodology. Any significant changes in methodology will be documented through updates to the MethaneSAT Level-4 Dispersed Emissions Product Algorithm Theoretical Basis Document.

For more information about our methodology, please reach out to info@methanesat.org.