MethaneSAT Dispersed Area Emissions

Definitions and Limitations

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MethaneSAT measures the concentrations of methane averaged from the Earth's surface to the satellite. Locations where methane is being emitted, and areas downwind, display higher concentrations than areas where there are no emissions. Using sophisticated atmospheric inversion algorithms, we produce methane emission "heatmaps" (maps showing the spatial distributions of emissions) based on these data.

These maps represent the best estimates of the underlying emissions that gave rise to the observed concentrations in the atmosphere. The emission rate given for each grid cell represents the average of 4,000 maps obtained from different distributions of emissions. The algorithm for finding the best average map is called CORE (Constrained and Optimized Retrieval of Emissions). It accounts for transport of emitted methane by winds and for the influences of topography and other factors.

The results shown in the emission heatmaps are subject to uncertainty due to winds from our meteorological data, model structure, and other factors, especially at the fine scale of MethaneSAT. The largest sources of error are inaccuracies in wind speed and direction and errors in methane concentration measurements. Below are some known artefacts that may appear in the heatmaps.

Wind Streaking

Emissions sometimes appear smeared out downwind of a strong source — much like if someone takes a brush and spreads a drop of paint across a canvas. This usually occurs under strong wind conditions, with the streaks aligned along the plume emanating from a source point. It occurs because localizing sources is inherently easier across the wind direction than along it. The streaking redistributes emissions within the reported area, but fortunately, the total emission assigned to the source remains essentially unchanged, and the location of the point of origin of the plume is preserved.

General Transport Errors

The MethaneSAT heatmaps product estimates how methane moves through the atmosphere using meteorological data from the NOAA Global Forecast System (GFS), a leading global weather model. However, errors in wind speed and direction lead to emission rate uncertainties of roughly 30%, and sometimes more. In particular, *the locations of emissions can be shifted*, placing the sources of methane concentration anomalies *where the model winds indicate*, and therefore potentially in the wrong place on the ground. Additionally, the atmospheric boundary layer is turbulent, with eddies that capture and dissect emission plumes; these small-scale motions are not represented in available wind fields. We reduce the effects of these errors by averaging results from many collections.

Small Emission Contributions

MethaneSAT heatmaps sometimes show very small methane emissions (less than 1 kg hr^{-1} km^{-2}) widely spread across some areas, including places remote from known infrastructure. These very small emissions may often result from random fluctuations (“noise”) in the MethaneSAT data, which our algorithms cannot always distinguish from genuine, low-rate emissions. Thus, we cannot completely rule out the possibility that there may actually be such small emissions, even in empty regions. Regions with very low emissions in a heatmap may thus show a slight positive bias and may contribute to a small bias in total regional emissions. We have released a set of scenes where we are confident that this small emission artefact is not significant.