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Simulated retrievals of methane total columns in support of future satellite missions: an error sources analysis

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Measuring atmospheric composition is a central objective for monitoring climate change and understanding human impact on the environment. In particular, quantifying natural and anthropogenic sources and sinks of greenhouse gases is a primary target of future Earth observing satellite missions. To this end, upcoming satellites are designed to measure carbon dioxide and/or methane total columns with high accuracy.

Here, our research focuses on investigating and quantifying the main error sources of methane total column retrievals from satellites collecting solar backscatter absorption spectra in the shortwave infrared spectral range. Since errors as small as fractions of a percent can jeopardize the concentration estimates, our study in particular aims at supporting the best selection of instrument properties of new sensors such as Sentinel-5.

To achieve this goal we performed retrieval simulations for a detailed ensemble of synthetic scenarios covering typical geophysical scenes that any future satellite would encounter. The ensemble is based on a range of microphysical aerosol and cirrus properties, Lambertian surface reflection properties and seasonal variations. The use of synthetic scenarios provides insight into the partitioning of several error sources such as forward model approximations, instrument properties, imperfect spectroscopy. Finally, our assessment will point out the most critical aspects to be considered in the design of future satellite missions and their support studies.