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Performance Simulations for the Space-based Methane Lidar Mission MERLIN

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The space-based Methane Remote Lidar Mission (MERLIN) on global observations of atmospheric methane is a French-German climate monitoring initiative, currently undergoing Phase A studies. Methane is, after carbon dioxide, the second most important greenhouse gas, with however more uncertain anthropogenic emissions. In addition, climate change may cause important feedbacks of yet unknown intensity by release of methane from melting permafrost soils and ocean sediments. The current observational network is not able to monitor these sources with sufficient density and accuracy: While the ground-based in-situ network is too sparse, existing passive remote sensors on spacecraft are not accurate enough and not sensitive at high latitudes over the permafrost regions. Performance simulations show that a differential absorption lidar with moderate average laser power (0.5 W at 1.6 μm wavelength) and telescope size (0.6 m diameter), installed on a small satellite with low earth orbit (500 km), has the potential to fill the observational gap by measuring methane columns with a precision of around 1 % and a spatial along-track resolution of 50 - 100 km, thus satisfying major requirements for inverse modelling of the methane sources. The main instrument and platform characteristics needed to fulfil the requirements will be addressed, and parameters critical to the measurement precision, such as instrument noise and surface reflectivity, will be highlighted. Variations of parameters in the simulations indicate the impact of each individual parameter on the instrument performance. Global maps of the simulated methane measurement precision provide an overview of the expected performance of MERLIN.