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TI: MERLIN Performance Simulation of Global CH4

AU: *Ehret, G
EM: gerhard.ehret@dlr.de
AF: Institut für Physik der Atmosphäre, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Oberpfaffenhofen, Germany
AU: Flamant, P
EM: flamant@lmd.polytechnique.fr
AF: Institute Pierre Simon Laplace, École Polytechnique, Palaiseau, France
AU: Kiemle, C
EM: christoph.kiemle@dlr.de
AF: Institut für Physik der Atmosphäre, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Oberpfaffenhofen, Germany
AU: Quatrevalet, M
EM: Mathieu.Quatrevalet@dlr.de
AF: Institut für Physik der Atmosphäre, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Oberpfaffenhofen, Germany
AU: Amediek, A
EM: axel.amediek@dlr.de
AF: Institut für Physik der Atmosphäre, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Oberpfaffenhofen, Germany

AB: Atmospheric methane (CH4) is the second most important anthropogenic greenhouse gas after carbon dioxide that will contribute to global warming, significantly. Large uncertainties exist for example in the estimation of tropical and boreal wetlands which provide a large natural source of atmospheric methane. Particularly sensitive are the northern high latitude regions where permafrost melting and gas hydrate instabilities in ice shelves may drive tomorrow's climate. The overall goal of MERLIN (Methane Remote Lidar Mission) which is the joint Franco-German climate monitoring initiative is to provide better information on methane sources on a global basis during all seasons. This will be achieved by means of inverse modelling using space-based lidar measurements of the column-weighted dry-air mixing ratio of CH4, commonly referred to as XCH4, as input data. The latter is a function of the measured differential-absorption optical depth (DAOD) on one hand, and the calculated path-integrated differential-absorption cross section of the selected on-/off-line wavelengths, commonly referred to as integrated weighting function (IWF), on the other hand. To model the MERLIN measurement precision we assumed statistically independent error sources for both parameters. Based on careful selection of the sounding wavelengths in the near IR around 1.64 µm it is found that the random errors in IWF which stem from uncertainties in the geophysical parameters like surface pressure error or errors in the temperature and humidity profiles remain small compared to those from measurement of DAOD. A total of 177 shot-pairs are averaged, which corresponds to a horizontal resolution of 50 km for each observation, in order to obtain a measurement precision of about 1 %. The surface reflectance in nadir direction, which is a key parameter in the precision analysis, is modelled using MODIS data over land and surface wind speed data over water. Cloud coverage and aerosol/cloud extinction of optically thin layers which also impact on the measurement performance are derived from CALIOP measurements for selected scenes. Global error maps for all four seasons are generated in order to demonstrate the CH4 flux error reduction potential by use of hypothetical MERLIN observations in observation simulation system experiments (OSSEs).