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Investigation of the ground reflectance for spaceborne IPDA lidar measurements of greenhouse gases

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Active remote sensing using lidar shows high potential for the measurement of atmospheric greenhouse gases like carbon dioxide or methane from spaceborne platforms. Due to the weak atmospheric backscatter in the near IR the IPDA lidar (Integrating Path Differential Absorption Lidar) technique is preferred over the range resolving DIAL method. IPDA shows much better performance with respect to systems of comparable size. Sensitivity studies reveal, that this technique promises to match the stringent sensitivity requirements. The earth´s surface reflectance becomes an important issue, since an IPDA lidar uses the laser return of the ground. Gradients of the ground reflectance could introduce noticeable retrieval errors in the column content of the measured gas. Therefore airborne lidar measurements at 1.6 μm wavelength were performed to investigate this type of error source. A lidar system was deployed on the DLR research aircraft Cessna Caravan to measure the variations of the ground return. Data from different regions and various terrains across Europe were collected including sea surfaces. In order to simulate a satellite system the data were upscaled to a larger ground spot corresponding to a conceivable spaceborne setup. The focus of the analyses was on the small-scale reflectance variability as well as the overall dynamic range. Comparisons to MODIS reflectances are performed additionally. It is shown that the impact of this error source is on the order of 0.3 ppm.