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Modelling the performance of a LIDAR system for the measurement of atmospheric carbon dioxide

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With atmospheric carbon dioxide concentrations rising steadily, investigations into locations and magnitudes of the sources, sinks and net surface fluxes are of increasing importance. Active space-borne measurement systems such as LIDAR offer one potential technique to derive global, near-surface concentrations. However, significant instrumental challenges need to be overcome for such measurements to achieve a useful degree of accuracy and precision. This poster presents the work being carried out at the University of Leicester to accurately model a spaceborne LiDAR system.

The model aims at providing an insight into the performance of a differential absorption LiDAR system (DIAL) based on current and future technology in a realistic environment. This is achieved by accurately modelling the surface footprint of a laser system based on expected orbital parameters, and using atmospheric profiles, topographic information and BRDF's to simulate the laser lights interaction with the environment.

The model readily simulates LiDAR systems operating at 1.57 and 2.05μm wavelengths using Voigt convolved HITRAN line centres to obtain accurate vertical sensitivity to the atmosphere as a result of spectral line broadening. This method allows any spectral line to be selected and any offset from the line centre to be applied to optimize the systems performance. It also offers the potential for investigating multi-spectral LiDAR systems and the benefits that this method has versus the standard duel wavelength DIAL systems.

In order to retrieve near-surface CO2 concentrations of a few ppm the resulting instrument requirements are unquestionably demanding, but provide a benchmark for new technology development initiatives such as A-SCOPE and ASCENDS.