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Development of a Fast Solar Tracker Enabling Atmospheric Direct Sun Remote Sensing Applications on Different Moving Platforms

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Spectroscopic direct sun remote sensing of the atmosphere offers an essential tool for the validation of models and satellite observations as well as for the monitoring of emissions. Validation missions for greenhouse gas monitoring satellites are essential to improve the performances of the satellite products, thereby gaining a better understanding of the dynamics between sources and sinks. Furthermore, the monitoring of ozone-depleting substances is a vital contribution to observe the progress in restoring the ozone layer. A high tracking precision is in particular for measuring CO_2 and CH_4 columns required. We aim for an accuracy better than 0.05°.

This work presents the development of a compact and reliable stand-alone sun tracker for mobile applications. The tracking is camera-based and has two modes. In the first mode, image processing using the image of a fish-eye lens with a field of view of 185° monitoring the entire hemisphere above the instrument calculates the coarse position of the sun. On reaching this coarse position, the other camera-based tracking system takes over and centers the projection of the sun with high precision and fast response times (100 Hz control loop). The tracker is compatible with different kinds of spectrometers like grating spectrometers and Fourier transform infrared spectrometers (FTIR). The tracking is also suitable for different mobile platforms like cars, ships, or stratospheric balloons.

During the CoMet (Carbon Dioxide and Methane Misson 2018) campaign, the tracking has performed well in a stop and go manner on a car-mounted setup. On every stop, the tracker was able to autonomously find the sun regardless of the relative position of the vehicle. For the MORE-2 (Measuring Ocean REferences 2) campaign onboard a research vessel over the Pacific ocean, the tracking allowed for using over 99 % of the measuring time for high-precision retrievals of CO_2 and CH_4 using an EM27/SUN FTIR. Based on the lessons learned during the performed campaigns, a further improved version of the tracker for flying on a stratospheric balloon in August 2020 is in development.