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CarbonSat - Quantification of natural and man-made greenhouse gas surface fluxes from satellite observations of atmospheric CO_2 and CH_4 column amounts

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Surprisingly and in spite of their exceptional driving role in climate change, our knowledge about the variable sources and sinks of the greenhouse gases CO_2 and CH_4 is currently inadequate. For example, the ability of the Earth-atmosphere system to buffer increasing anthropogenic emissions into the atmosphere has large uncertainties and emissions from many sources (geologic, anthropogenic, biogenic) are to a large degree uncertain. An adequate knowledge of the sources and sinks of CO_2 and CH_4 and their response to a changing climate is a pre-requisite for the accurate prediction of the regional variation of the climate of our planet. CarbonSat is a new mission concept to quantify and monitor CO_2 and CH_4 sources and sinks at the regional to local scale. The data will allow a better understanding of the processes that control the Carbon Cycle dynamics and an independent estimate of local greenhouse gas emissions (fossil fuel, geological CO_2 and CH_4, etc.). This will be achieved by a unique combination of high spatial resolution passive and active compact remote sensing with inverse modeling techniques. CarbonSat will accurately measure column-averaged mixing ratios of CO_2 and CH_4, i.e., XCO_2 and XCH_4, at a spatial resolution of 2 x 2 km^2 (500 km continuous swath) with 0.5% goal (1%, threshold) single measurement precision and global coverage within 3-6 days. Beside the quantification of sources and sinks on the regional scale, one key and innovative aim of the CarbonSat mission is to go a step forward towards quantifying local emission hot spots (fossil fuel emissions by power plants, gas/oil production, geological sources etc.). The core sensor will be a compact Imaging NIR/SWIR spectrometer (SCIAMACHY, OCO heritage) whose measurements yield global data sets of XCO_2 and XCH_4 with at least one order of magnitude higher number of cloud free measurements than GOSAT and OCO and one order of magnitude better spatial coverage than OCO, due to CarbonSat's 500 km swath continuous across track coverage with 2 x 2 km2 spatial resolution. Ideally, the imaging spectrometer will be accompanied by a compact CH_4 Lidar, to derive complementary accurate XCH_4 - especially in high northern latitudes - as well as information on clouds and vegetation height. The overall mission concept, the expected data quality and selected application areas will be presented.