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Application of DOAS Instruments for Trace Gas Measurements on Unmanned Aerial Systems

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Unmanned Aerial Systems (UAS) are a new powerful tool for observations in the atmospheric boundary layer. Recent developments in measuring technology allow the construction of compact and sensitive active and passive DOAS instruments which can fit the space and weight constraints on Unmanned Aircraft Systems. This opens new possibilities for trace gas measurements in the lower troposphere, especially in areas which are not accessible to manned aviation e.g. volcanic plumes or which should be monitored regularly (e.g. industrial emissions of a stack).

Two DOAS instruments for the APAESO platform of the Energy, Environment and Water Research Centre (EEWRC) at the Cyprus Institute are presented. Our first system is a passive DOAS for remote sensing applications which measures scattered sunlight and light reflected by the surface. It is equipped with telescopes for observations in downward (nadir) and horizontal (limb) viewing direction. Thus it allows determining height profiles and the spatial distribution of trace gases. For this the light is analysed by a compact spectrometer which covers the UV-blue range allowing to measure a broad variety of atmospheric trace gases (e.g. NO_2, SO_2, BrO, IO, H_2O ...) and aerosol properties via O_4 absorption. Additionally, the nadir direction is equipped with a system for the observation of surface properties. It will be used to measure and analyse reflection of different types of vegetation. The spectra will serve as reference spectra for satellite measurements to create global maps. The instrumental setup and the results of first test flights are shown.

The second instrument which is currently under development is a Cavity Enhanced (CE-) DOAS for in situ measurements of NO_3. In contrast to the passive DOAS it is able to perform night time measurements as it uses an active LED light source. This is important for studies of NO_3 since it plays an important role in night time chemistry while it is rapidly photolysed during daytime. The long optical light path of several km which is required for sensitive NO_3 measurements is realized in an optical resonator of 50cm. For the first time such an instrument is constructed within the space and weight limitations of the UAS. The prototype setup and first laboratory measurements are presented.