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A new DOAS instrument on long-distance IAGOS-CARIBIC flights and airborne DOAS applications

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Within the IAGOS-CARIBIC project airborne DOAS (Differential Optical Absorption Spectroscopy) measurements of atmospheric trace gases are performed aboard a commercial long range passenger aircraft from Lufthansa since 2005. They provide a unique dataset for episodic, long-term and seasonal observations. The DOAS instrument is the only remote sensing technique aboard. DOAS is a well-established remote sensing technique to retrieve trace gas columns in the atmosphere from scattered light spectra of the sun. A series of trace gas species can be observed simultaneously, including nitrogen dioxide (NO_2), sulphur dioxide (SO_2), bromine oxide (BrO), nitrous acid (HONO), formaldehyde (HCHO) and ozone (O_3). Since DOAS is a contact-free measurement technique, it is specially well suited for measuring highly reactive trace gases. It is widely used on different platforms and the airborne DOAS measurements are filling the gap between ground-based measurements and satellite data.

The CARIBIC DOAS instrument is divided into an instrument unit within the CARIBIC container in the cargo hold of the aircraft, a telescope unit, which is specially designed for the permanently mounted pylon underneath the aircraft, and fiber optics in between. The instrument unit consists of three temperature stabilized spectrometers and the readout and control electronics. The telescope unit contains three telescopes, which observe scattered sunlight to the right under the elevation angles of +10°, -10° and -82° (nadir) relative to the horizon. This measurement geometry allows the separation of boundary layer, free tropospheric and stratospheric trace gas columns along the flight track. A new DOAS instrument was designed and installed in 2016 (first flights expected from March 2017) to improve the detection limits of NO_2, SO_2, BrO, HCHO, HONO, O_3 and O_4. Furthermore, an extended wavelength range allows to measure in addition iodine monoxide (a potentially important oxidant in the free troposphere) and glyoxal (a tracer for VOCs).

The IAGOS-CARIBIC project and the significant technical improvements of the new DOAS system will be presented. Also, selected examples for possible airborne measurement applications of the CARIBIC DOAS will be shown.