WaSul-Hygro: A diode laser based photoacoustic instrument for airborne measurement of water vapor and total water concentration

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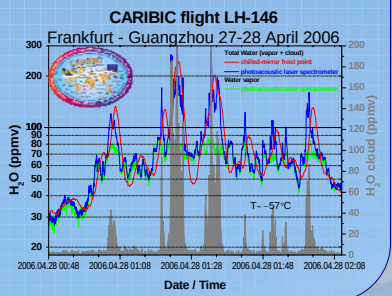
Water vapor is probably the most important trace gas in the atmosphere: it is responsible for ~2/3 of the natural greenhouse effect, and plays an important role in numerous physical and chemical processes. Despite its paramount importance, sensitive and reliable water vapor detection systems for automatic airborne operation were not widely used until recently. However, nowadays there exist several projects for monitoring the concentration and the distribution of trace gases (including water vapor) within the atmosphere where there is a strong need for reliable water vapor detector systems.

WaSul-Hygro is based on a commercially available, room temperature operated telecommunication type diode laser. Using these types of lasers offers several advantages such as an expected operational lifetime exceeding ten years. Our photoacoustic cells offer high sensitivity, small size, fast response time (below 10 seconds), operation under continuous gas flow and large immunity to outside disturbances. Furthermore with one laser light source up to four photoacoustic cells can be illuminated through, so that different gas streams can be measured simultaneously. The electronics is a compact and integrated unit which provides laser driving, signal processing, concentration calculation and long term storage of the calculated concentration or alternatively continuous data transfer to a master computer. Gas handling is a critical part of the system: the direction of the inlet with reference to the flight direction determines whether water vapor or total water is sampled; the sampling line has to be short and preferably heated. Acoustic silencers (filters) are inserted into the sampling line to avoid excessive acoustic flow noise to interfere with the measurement.

Caribic project

A photoacoustic water vapor detector (WaSul-Hygro) for airborne upper tropospheric / lower stratospheric measurements operates on-board a commercial aircraft (Airbus A340-600 of Lufthansa) within the project CARIBIC (www.caribic-atmospheric.com) since May 2005. In this project in one cell water vapor and in the other cell total water is measured, while the third cell is used as a reference cell with fixed water vapor concentration for precise wavelength locking of the laser. The test measurements were demonstrated that the WaSul-Hygro detector characteristics fulfill all the requirements of atmospheric applications: its minimum detectable mixing ratio is as low as 0.3 ppm at 200 hPa air pressure; it measures the water vapor in interference-free mode, so the components existing in the atmosphere do not affect the detector measurement accuracy; it has a wide dynamic range (from 0.2 ppm up to a few thousand ppm); and its response time is <30 sec.

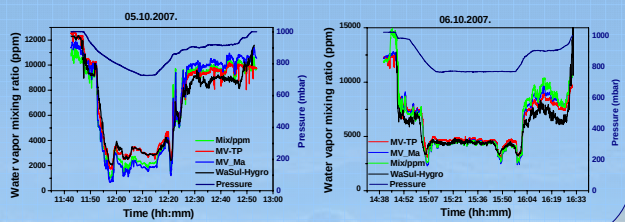


Eufar campaing (Phalcon project)

The main goal of the Phalcon project was to test the WaSul-Hygro in measurements at lower altitudes and high water vapor mixing ratio, and compare its performance with other hygrometers. The field campaign was take over the city of Leipzig in September/October 2007.

The WaSul-Hygro system was located on-board of Enviscope-Partenavia. There was a good overall agreement between the readings of WaSul-Hygro instrument and other water vapor instruments on-board.

MV-TP: Meteolabor Dew Point Mirror TP3-ST
MV-MA: VAISALA HMP 230 with modified sensor assembly (in Rosemount housing)
Mix/ppm: MOZAIC – VAISALA HMP230 in Rosemount housing



Conclusion

Various measurement campaigns justified the applicability of our system for airborne operation in wide concentration and pressure range.

References

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More information

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51. Stand in Exhibition