LAUNCH-2005 - International Lindenberg campaign for assessment of humidity and cloud profiling systems and its impact on high-resolution modelling

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Abstract

Within the frame of the European Research Action COST-720, "Integrated Ground-based Remote-Sensing Stations for Atmospheric Profiling" and in connection with the WMO GEWEX Working Group on Cloud and Aerosol Profiling "GEWEX CAP" the Richard-Aßmann Observatory of the German Meteorological Service DWD, in Lindenberg (Germany) had realized the international campaign LAUNCH-2005 in late summer/early fall, last year. LAUNCH-2005 has been designed to accomplish four major scientific objectives:

1. *Assessment of new or improved profiling systems like water-vapor lidars, cloud-radar systems, various microwave profiler systems, a Doppler wind lidar, a new single-photon counting high-range ceilometer, or the re-designed FTIR spectrometer EISAR,*
2. *assessment of various algorithms, combining different techniques for profiling of cloud parameters,*
3. *provision of a data set, designed for validation and comparisons between measurements and NWP output, and*
4. *provision of a data set for data assimilation experiments using high-resolution water-vapor profiling systems in regional NWP modelling.*

The paper gives a brief overview on the campaign itself, and will show selected results to the different scientific objectives. Special emphasis will here be laid on the assessment of new systems in comparison with other remote-sensing and in-situ measuring systems. In particular, the new quasi-operational water-vapour Raman lidar system at Lindenberg Observatory will be shown. A second emphasis is laid on the objective of combining various profiling techniques in integrated algorithms, the so-called "*integrated profiling*". In this respect, we will summarize the LAUNCH-2005 intercomparison of various algorithms for improved liquid-water content profiling, being an highly important variable for forecast-model validation demanded from the NWP community. Final examples will then give an overview on first simulations using the water-vapor profiling network of LAUNCH-2005 in the frame of data assimilation experiments.

1. Assessment of basic techniques and algorithms

Current measurement techniques for atmospheric profiling all have their advantages but also deficits with respect to accuracy, resolution (time and height), all-weather capabilities, cost and/or maintenance. With respect to new or improved techniques, it is therefore important to assess these with regard to their capabilities in those fields. Under this scope, several new profiling systems have been used during LAUNCH-2005. Apart from a number of profiling systems already mentioned in the introduction, the campaign made particular use of various water-vapour lidars and microwave profiler systems, both at simultaneous measurements for independent validation purposes side by side, and by using this technique in the frame of small networks. In this frame, also the new, fully-autonomous water-vapour Raman-lidar system

Table 1: *RAMSES* beamsplitters and filters.

Receiver	near field			far field		
Channel wavelength	354.7 nm	386.5 nm	407.5 nm	354.7 nm	386.5 nm	407.5 nm
Dichroic beamsplitter 1, reflectivity	1.6%	0.7%	>99%	1.6%	0.7%	>99%
Dichroic beamsplitter 2, reflectivity	0.3%	>99%	–	0.3%	>99%	–
Interference filter bandwidth (FWHM)	1.95 nm	2.08 nm	1.78 nm	1.98 nm	2.08 nm	1.74 nm
Interference filter transmission	58%	78%	84%	60%	86%	88%

RAMSES of the German Meteorological Service at the Richard-Aßmann Observatory Lindenberg, Germany, has proven its night-time capabilities in a first campaign. Fig.-1a shows the system, which is housed in a standard 20ft container at the Observatory. The external chillers and heat exchangers for air conditioning and laser cooling are installed in a shed attached to the container. The container's interior is divided into a temperature-stabilized instrument cabin and a room for the operators. In the instrument cabin, the optical bench with the laser and the transmitter optics, the thermally insulated telescope hall, and the optical bench with the lidar receivers are mounted on a single, solid three-leg structure to shield the measurement system from vibrations. The telescope hall is covered with an autonomously-operating hatch which, independently of the system control computer, terminates lidar operation and seals the container in case the redundant environmental sensors signal precipitation or unacceptably high levels of sunlight. This approach ensures that the lidar is protected from adverse ambient conditions even if the computerized system control fails.

Fig.-1a (left): The Raman lidar system RAMSES at the Richard-Aßmann Observatory of the DWD in Lindenberg, Germany

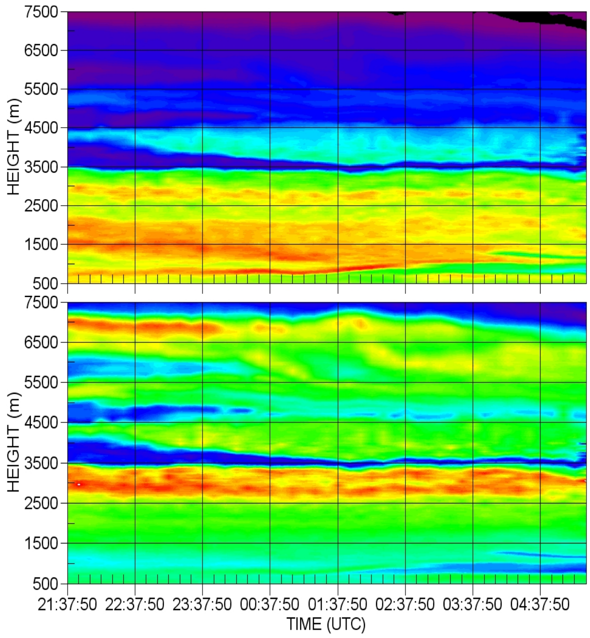

Fig.-1b (right): Time series of mixing ratio (0 –6 g/kg, top) and relative humidity (0 – 85%, bottom) observed over Lindenberg, Germany, in the night of 30–31 October 2005. The time resolution is 10 minutes, the height resolution ranges from 67.5 m to 307.5 m.

Fig.-1b gives a measurement example from LAUNCH-2005, with system-generated time-height cross sections of atmospheric humidity from sunset to sunrise on 30–31 October 2005 as observed with *RAMSES*. During LAUNCH-2005 it turned out that the new lidar system is capable to reliably provide atmospheric humidity profiles in reference quality for validation of other systems, e.g. passive or satellite sensors.

2. Assessment of algorithms for integrated profiling.

Vertical profiling with improved data quality or resolution can be reached by using combinations of single profiling techniques like e.g. microwave profilers, cloud radar or lidar systems. During LAUNCH-2005, special attention in this field was focussed to profiles of the liquid-water content in the atmosphere by an intercomparison and evaluation of methods using a microwave profiler standalone together with an infrared pyrometer, a combination of microwave profiler and ceilometer, an adiabatic approach, a cloud radar - lidar combination, or the so-called "*integrated profiling technique*" (IPT). It resulted that both, cloud radar - lidar and the IPT perform best, in particular when looking at the standard deviation (STD) of the LWC. The STD for this parameter shows a range of about 50-70% of the mean for the LWC, described best by the latter two algorithms.

3. Observation system experiments using networks of water-vapour lidars and conclusions

In order to get an impression on what a small network of stationary, short-period but high-quality, and high time-resolution profiling systems are capable to provide to NWP, two NWP modelling groups made first observation system experiments from LAUNCH-2005 data. First and preliminary results up to now show, that a positive impact on the NWP model output can be seen. The results from comparisons of vertical humidity profiles with or without lidar data assimilation imply that a considerable improvement in model output is achieved. However, more detailed investigations and evaluation of LAUNCH-2005 have still to be done in order to confirm and generalize this preliminary result from very-first OSEs.