KITsonde – A novel modular Multi-Sensor Dropsonde System for High Resolution Measurements

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Abstract

KIT is developing a new modular multi-sensor dropsonde system for high resolution measurements together with the industrial partners *enviscope GmbH*, Frankfurt/M., Germany and GRAW Radiosondes GmbH & Co. KG, Nuremberg, Germany. Its modular design combines the strengths of existing dropsonde systems, such as the widespread AVAPS and the “Karlsruhe Dropsonde”. The main goal of the new system is the use of up to 30 sounding sondes measuring profiles with very high spatial resolution which is of great benefit in inhomogeneous regions such as convective cells and cyclones. High resolution sounding data of temperature and moisture will improve the understanding of the evolution of such atmospheric systems and lead to improved forecasts.
The first operational use of KITsonde will be during the HALO campaigns POLSTRACC and WISE.
KIT is collaborating with two industrial partners in the development of this cutting-edge sounding system. GRAW developed and produces the meteorological sonde which is similar to their latest radiosonde DFM-09. *enviscope* worked on the release container, aircraft installation units and system software as well as aircraft certification.

KITsonde Design Goals

- High resolution measurements with up to 30 sondes
- Launch of up to 4 sondes at the same time
- Direct telemetry link to the aircraft (400 MHz)
- Satellite telemetry as optional data link (Iridium)
- Compatible to widely-used launching systems
- Economically priced and modular design
- Easy adaption to future sensor developments
- Free combinations of sondes and sensors

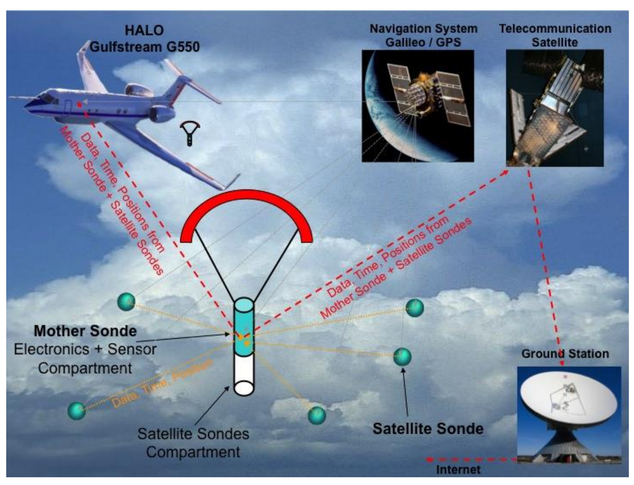

Fig. 1: Initial concept of the KITsonde system.

KITsonde Development

The system contains of 3 major parts:

- Multipurpose release container
- Meteorological sonde
- Aircraft receiver and data acquisition units

The dimension of the release container is compatible to the widespread AVAPS which makes KITsonde easily adaptable to a wide variety of research aircraft. Using the release container different sensors can be deployed at the same time. New sensor developments can be integrated with minimum efforts since the release container protects its payload from mechanical load during the release (Fig. 6). Future probes could include sensors for liquid water, particles (aerosol, droplets), volcanic ash and radioactivity. During test flights in August 2013 sensors for particles from the University of Hertfordshire were successfully installed and tested (Ulanowski et al., DUST 2014).

The standard meteorological sonde is equivalent to the DFM-09 Radiosonde by GRAW Radiosondes. Unique features for dropsonde use are:

- 400 MHz transmitter frequency stabilization
- 400 MHz transmitter output stage switch (jumper)
- New power switch mechanism
- Transmission of time and sonde ID
- Interface for additional external sensors
- Data link for satellite modem interface
- Software for initialization, decoding and calibration

Meteorological Sonde Specifications

Temperature sensor:	Thermistor
Temperature resolution:	0.1 K
Temperature accuracy:	< 0.2 K
Humidity sensor:	Thin film capacitive sensor
Humidity resolution:	0.1 % RH
Humidity accuracy:	< 5 % RH
Geopot. height accuracy:	< 10 m
Wind speed accuracy:	< 0.2 m s^{-1}
Position accuracy (hor.):	< 5 m
Size, Weight:	309 x 24 mm , 75 g

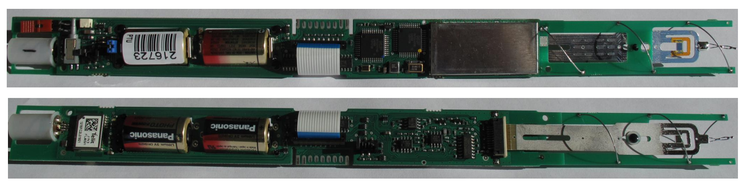

Fig. 2: Sonde circuit board.

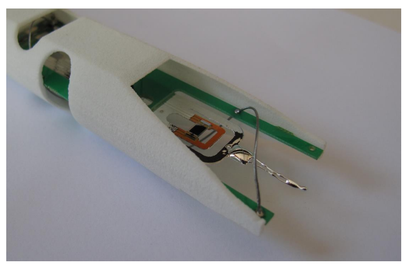

Fig. 3: Sensor plate in dropsonde housing.

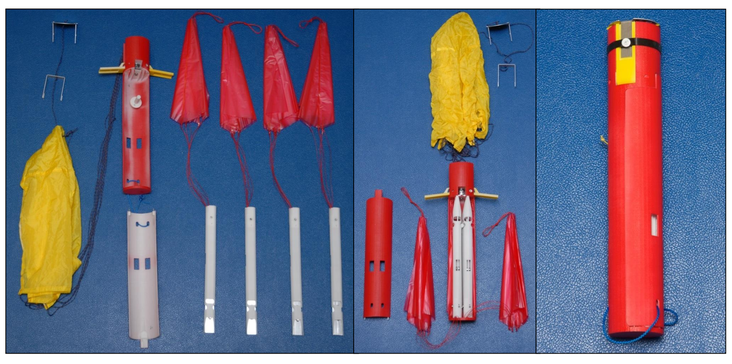

Fig 4: Release Container with dummy sondes (left), during packing (middle) and ready for mission (right). Diameter: 70 mm, Length: 404 mm, Weight: ~780 g

The aircraft receiver is based on Superhet design which provides best performance, small size, and low power consumption. The receiver unit includes 32 receivers: one for frequency band scanning, one for sonde prelaunch test and 30 to receive data streams from active sondes. Data acquisition features real-time data decoding and storage. The system can be operated by only one user. Configuration and real time data visualization is provided by a GUI accessible at the aircraft rack or via network on any computer aboard the aircraft (Fig. 5). The receiver box design allows the use of AVAPS next to KITsonde.

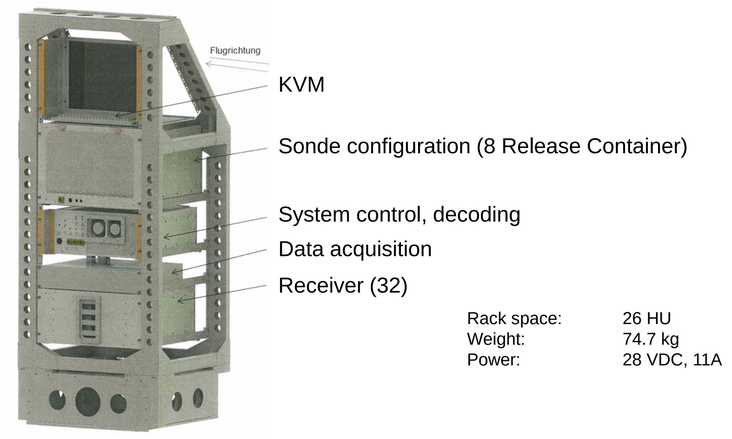

Fig. 5: KITsonde cabin installations.

Test Flights and Data Quality

Test flights with the release container and a basic KITsonde system were successful. Multiple flights and launches have been performed and measurement data was analyzed and compared to different radiosondes (DFM-06, DFM-09, Vaisala RS92, Karlsruhe Dropsonde) and aircraft in situ measurements of Dornier 128 D-IBUF of TU Braunschweig. Laboratory and field testing proved the good data quality of the new sonde (Fig. 7).

Fig. 6: Test launch of KITsonde.

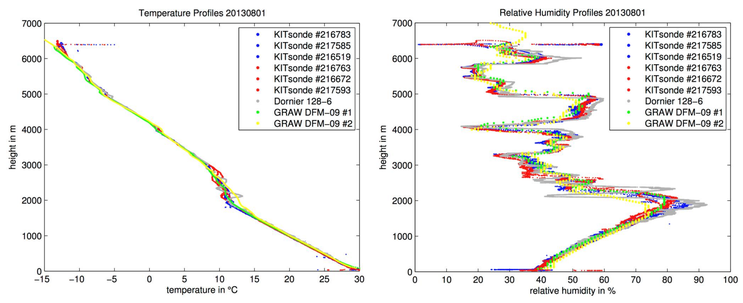

Fig. 7: Profiles of temperature (left) and relative humidity (right) show good data quality of the dropsonde during a test sounding.

Outlook

The satellite telemetry option is laboratory tested and also field tested with the D-IBUF. In May 2014 the KITsonde system will be certified for the HALO research aircraft and tested under high altitude (FL 450) and high speed conditions. KITsonde will be used operationally during the HALO campaigns POLSTRACC and WISE.