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Multicopter Based Ultra Low Latitude vertical profile flights in the Eastern Ebro basin (Catalan): Method inter-comparison

Burkhard Wrenger
Jens Dünnermann
Joan Cuxart
Felipe Molinos
Jose Roselló
Norman Wildmann
Jens Bange

Hochschule Ostwestfalen-Lippe
University of Applied Sciences
Burkhard Wrenger

Overview

- Motivation
- The Lleida/Raimat Campaign
- Multicopter UAV and Flight pattern
- AMOC measurement computer
- Preliminary results
- Comparison with established tools
- Summary and Outlook

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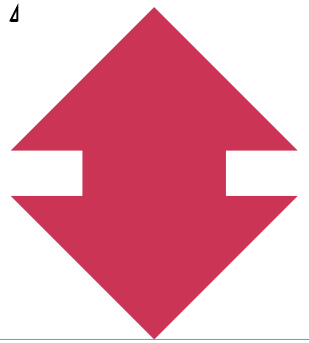
Motivation:
Suitable Altitude Ranges for Experiments

Closing the Gap with Multicopters?



Manned Aerial Vehicle:
200 m – ...

Small Fixed Wing UAV:
30 m – 3000 m

Multicopter:
0 m – 200 m

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Motivation and Reasons for the Raimat Campaign

- ➔ Missing: 0–30 m (Ultra low ABL)
- ➔ Test if multicopter can close the gap.
- Method inter-comparison essential for acceptance of new method. Here: Balloon, WindRASS
- Eastern Ebro valley and Raimat site provide excellent conditions for ABL investigations.
- Experienced organiser (Joan Cuxart)
- Good weather conditions during daytime vs. night and fog during nighttime
- Scientific objectives of the overall campaign ➔ talk given by Joan Cuxart

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The Campaign from the UAV / Multicopter perspective

- Calm and steady weather conditions during the day ➔ ideal for testing purposes.
- Only a few restrictions on UAV operation.
- Scientific objectives required measurements mainly during the night and in the fog
- Main interest: vertical profiles closing the gap from ground level to approx. 40+ m agl (where WindRASS data become available)

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Multicopter

- Oktocopter capable of flying up to 40 min. and max. 1.5 kg payload.
- 14.4 V / 5500 mAh battery pack
- Illumination LED bands
- 2.4 Ghz data link, 35 Mhz safety/remote control
- Simple autopilot
- AMOC measurement computer with ground control station
- Sensor package: p, T, RH (slow and fast)

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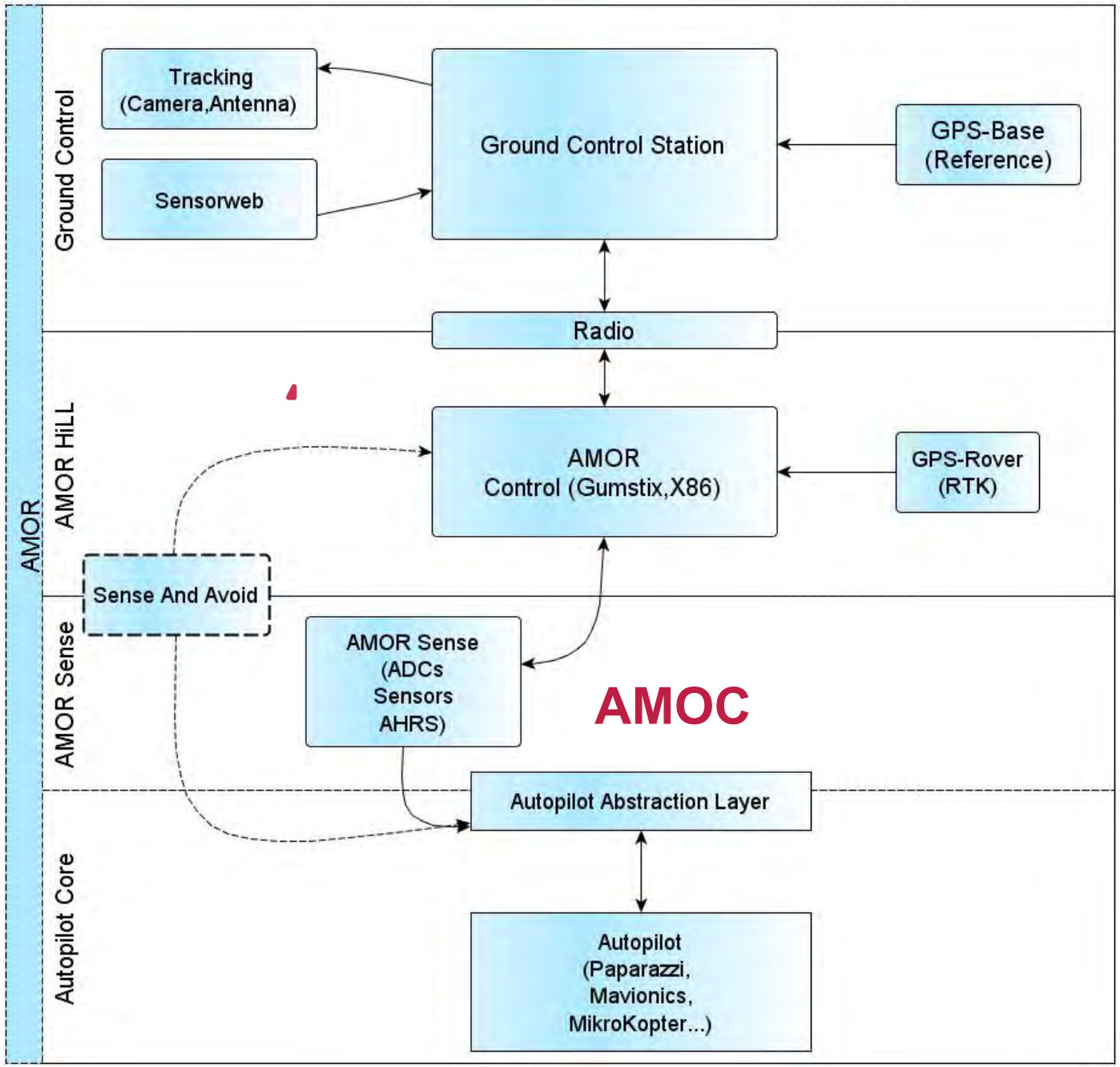
The AMOR platform



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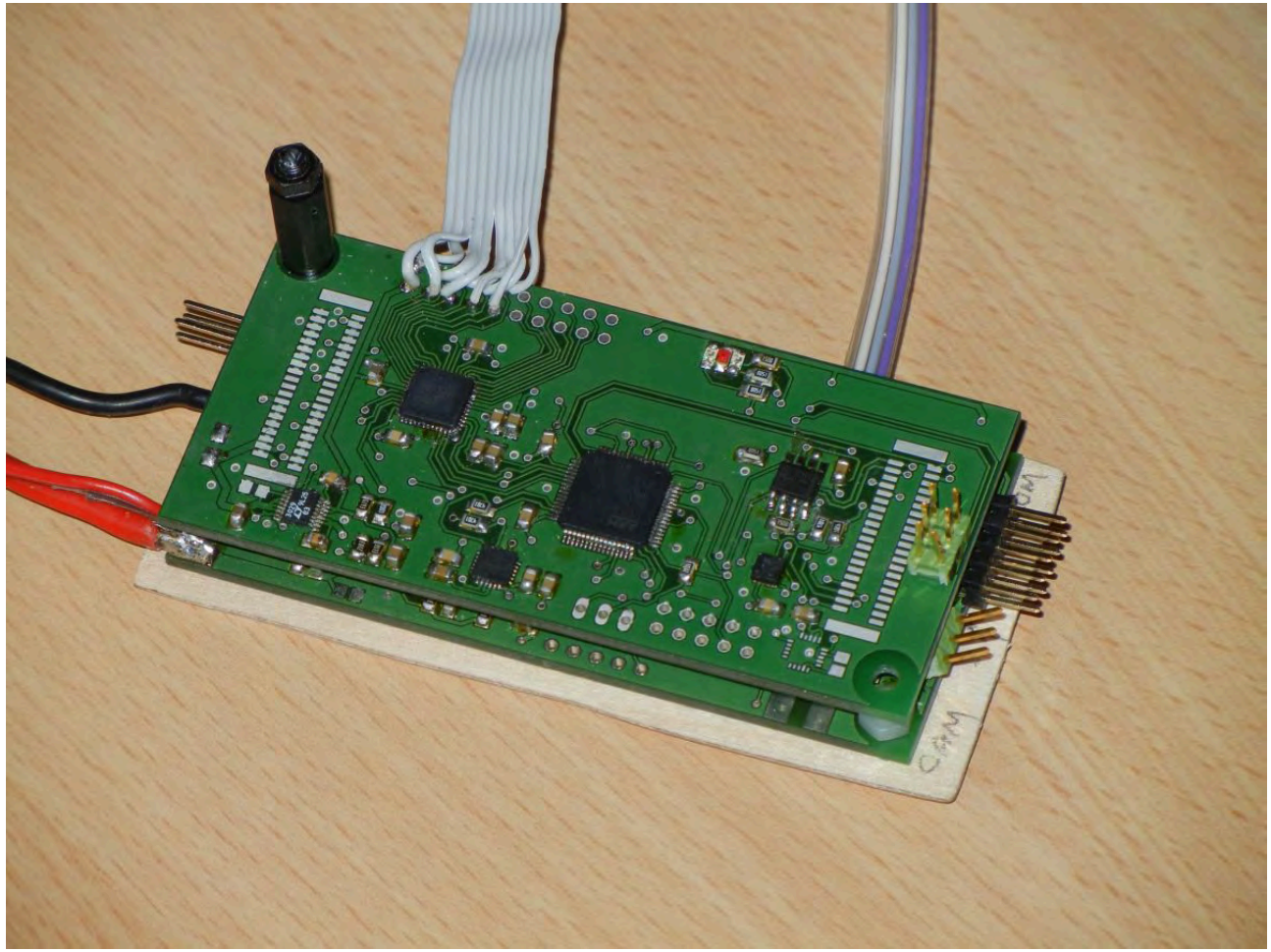
Airborne Meteorological Onboard Computer (AMOC)

- Developed jointly by Hochschule Ostwestfalen-Lippe and University of Tübingen



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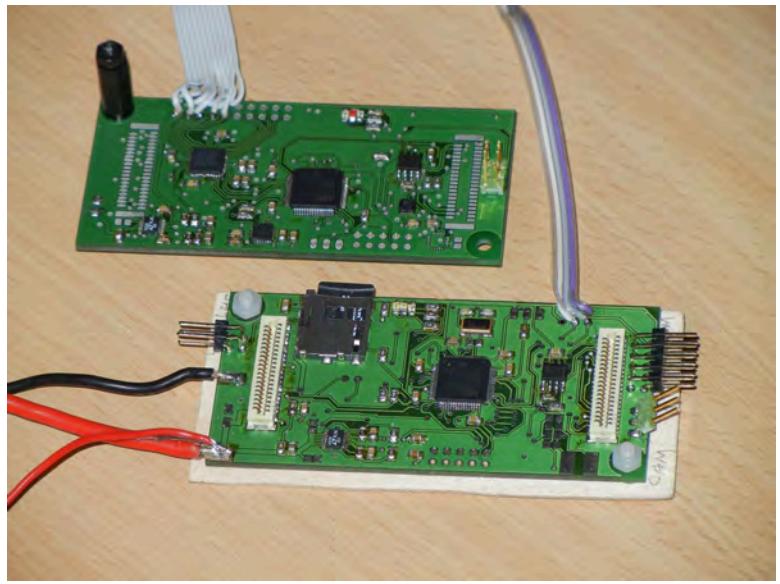
Airborne Meteorological Onboard Computer (AMOC): Key Features

- Data acquisition rate: min. 100 Hz
- 16 AD channels, max. 24 bit resolution
- Data storage (Micro-SD) onboard
- Communication link to ground control station
- Includes GPS, acceleration, gyro, magnetometer
- Stackable interface to AMOR control board
- Dedicated Ground Control station for data acquisition (Java software, runs on MS Windows, Linux,...)
- Very reliable even under very rough conditions
- Small footprint (5x9x3 cm^3, 50 g)



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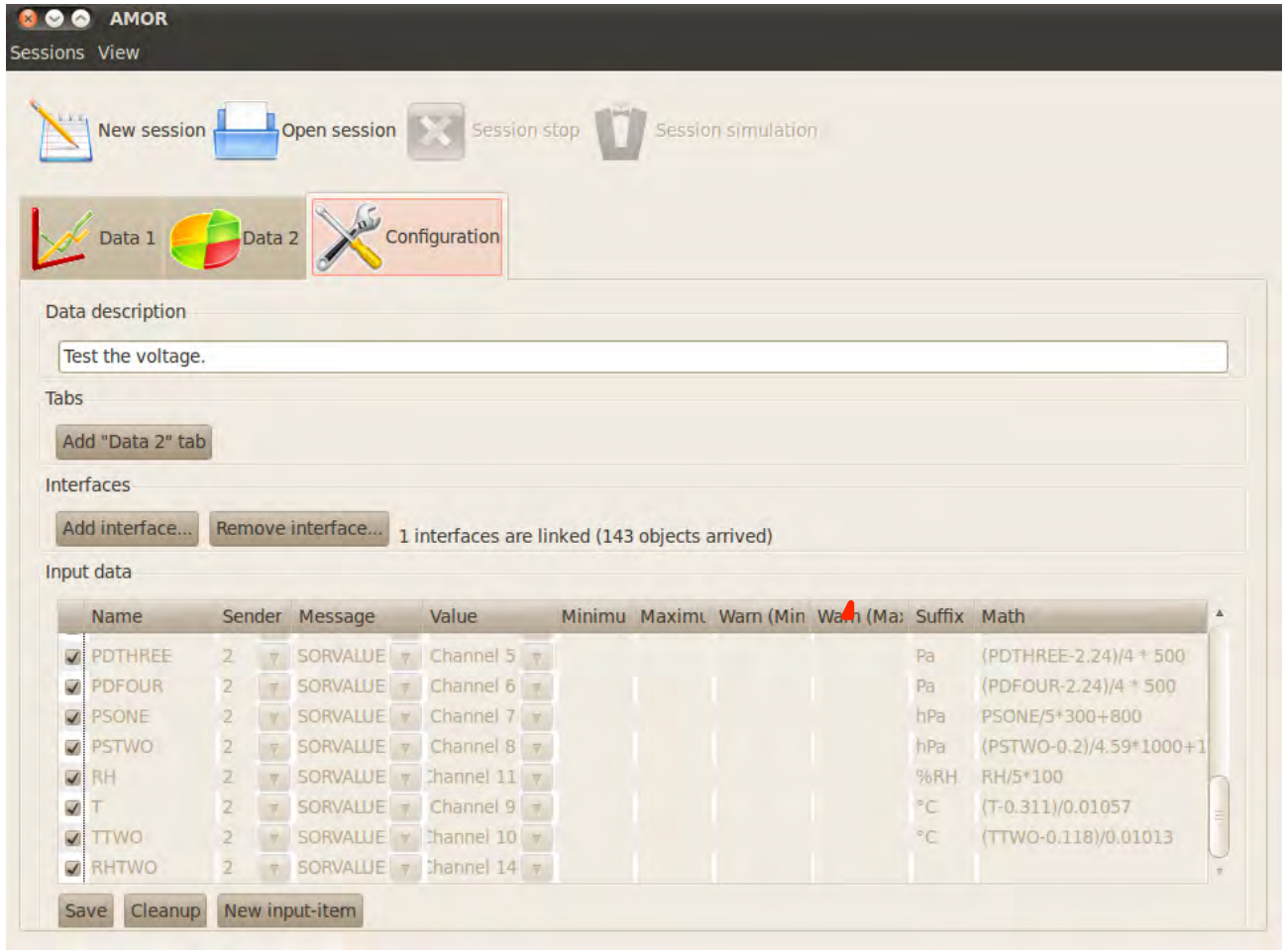
AMOC: The Scientific Groundstation

- Configurable data and sensor Interfaces (onboard and ground station)
- User definable (sensor) values for, e.g., real time plots including temperature compensation,...



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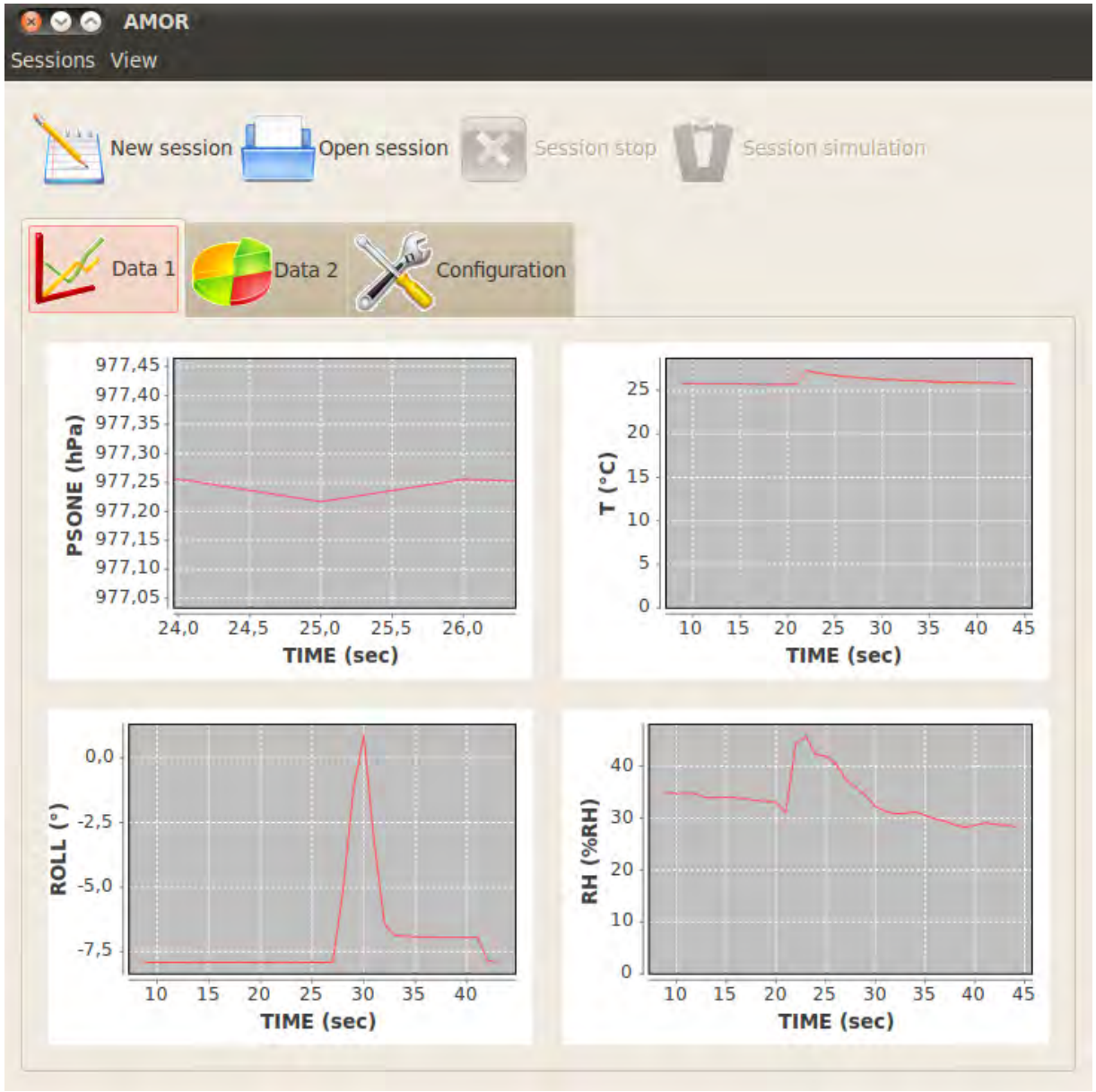
AMOC: The Scientific Groundstation

- Configurable graphical user interface including vertical profiles,...
- More details in WG 2 meeting on Thursday



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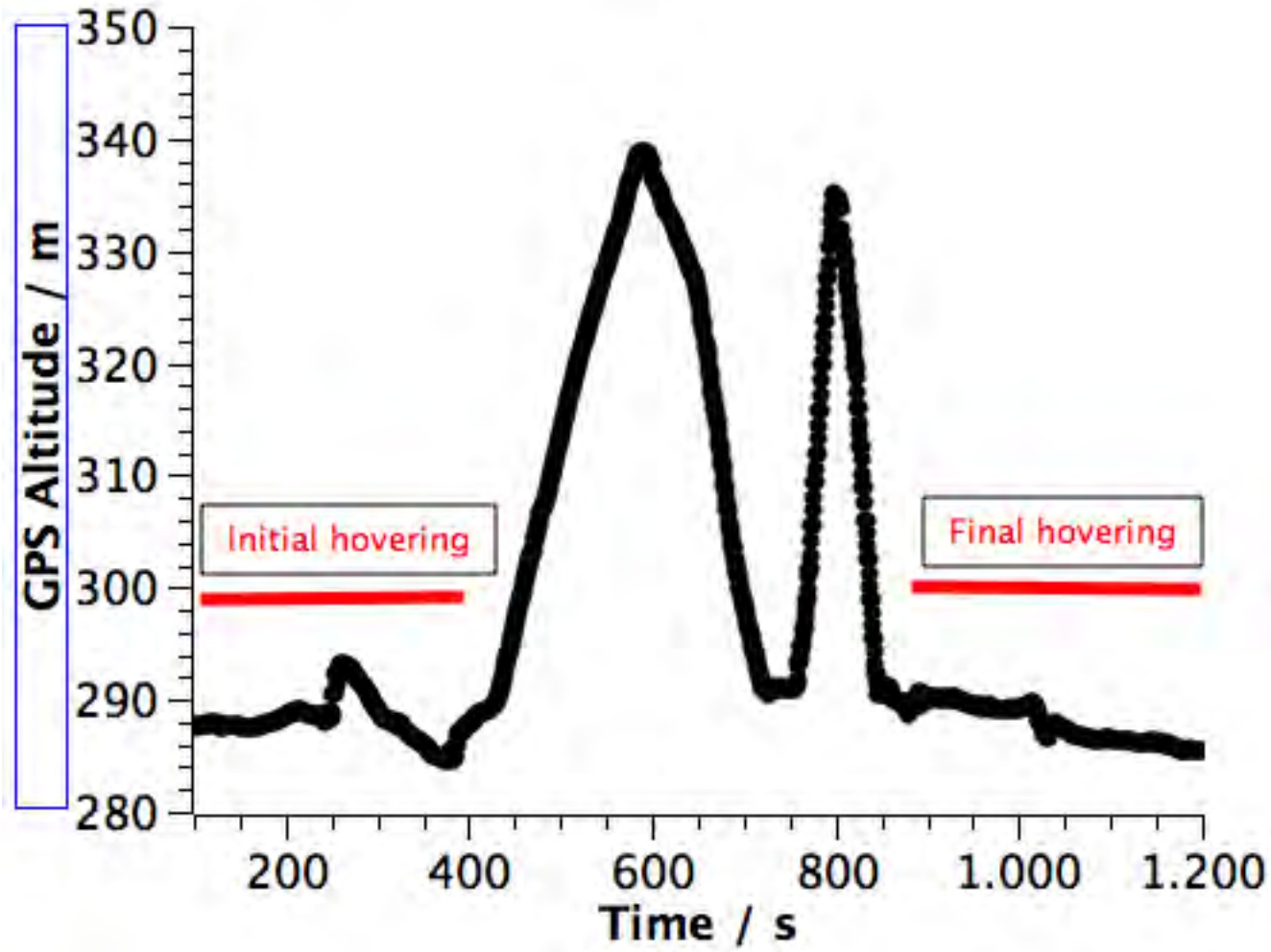
Flight patterns

- Simple vertical profiles
- Acclimatisation phase (hovering) before and after the vertical profile flight
- Max. 150 m above ground level (visibility limit in the fog)
- GPS hold mode with altitude change controlled by safety pilot („Lift“-mode)
- 27 profiles in total
- Disturbances caused by Multicopter flights?



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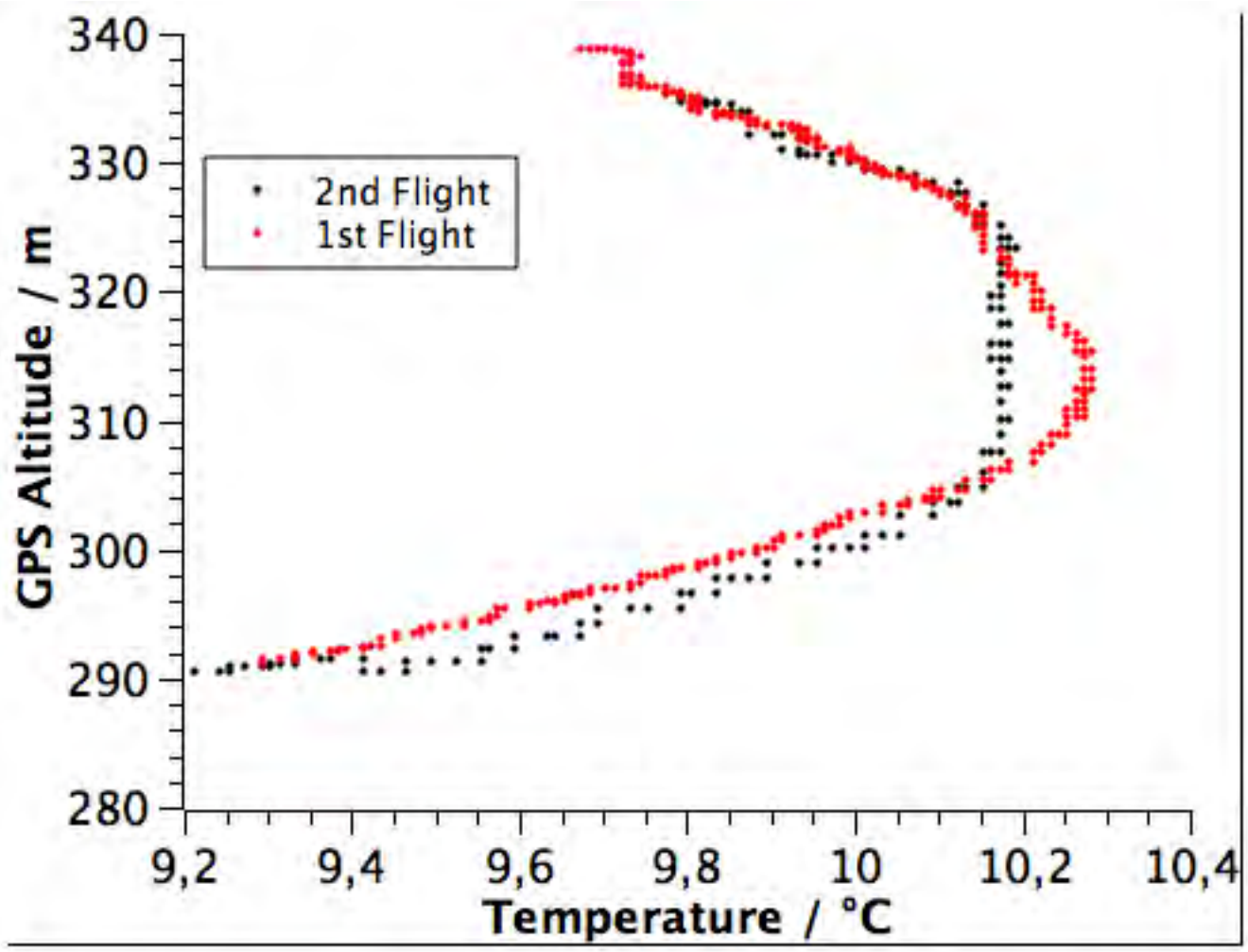
Preliminary Results: Multicopter data

- 2 flights starting at t=0 s and t=200 s showing strong inversion
- Difference within sensor error (approx. 0.1 °C)



Inversion close to the ground (below 40 m!)

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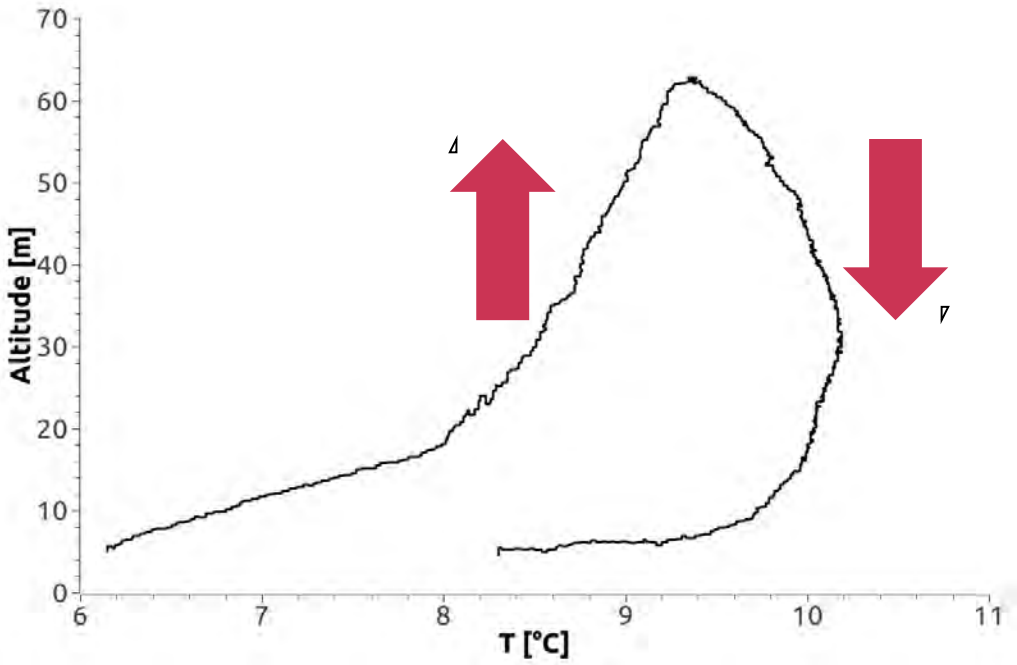
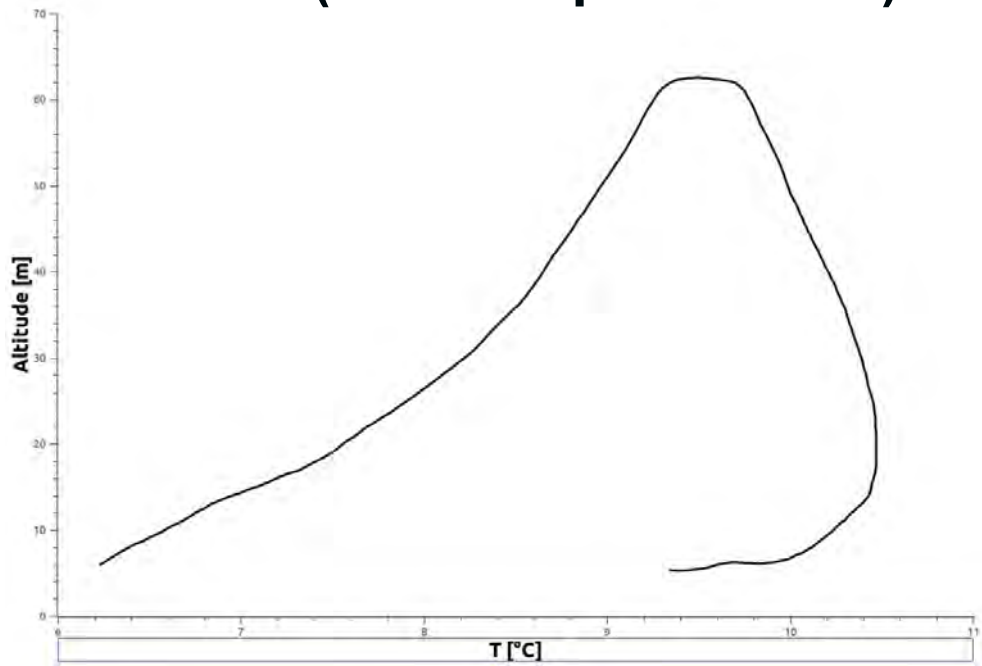
Preliminary Results: Ascent and Descent

Raw Data



Simulation (Slow response time)



Simulation based on balloon data

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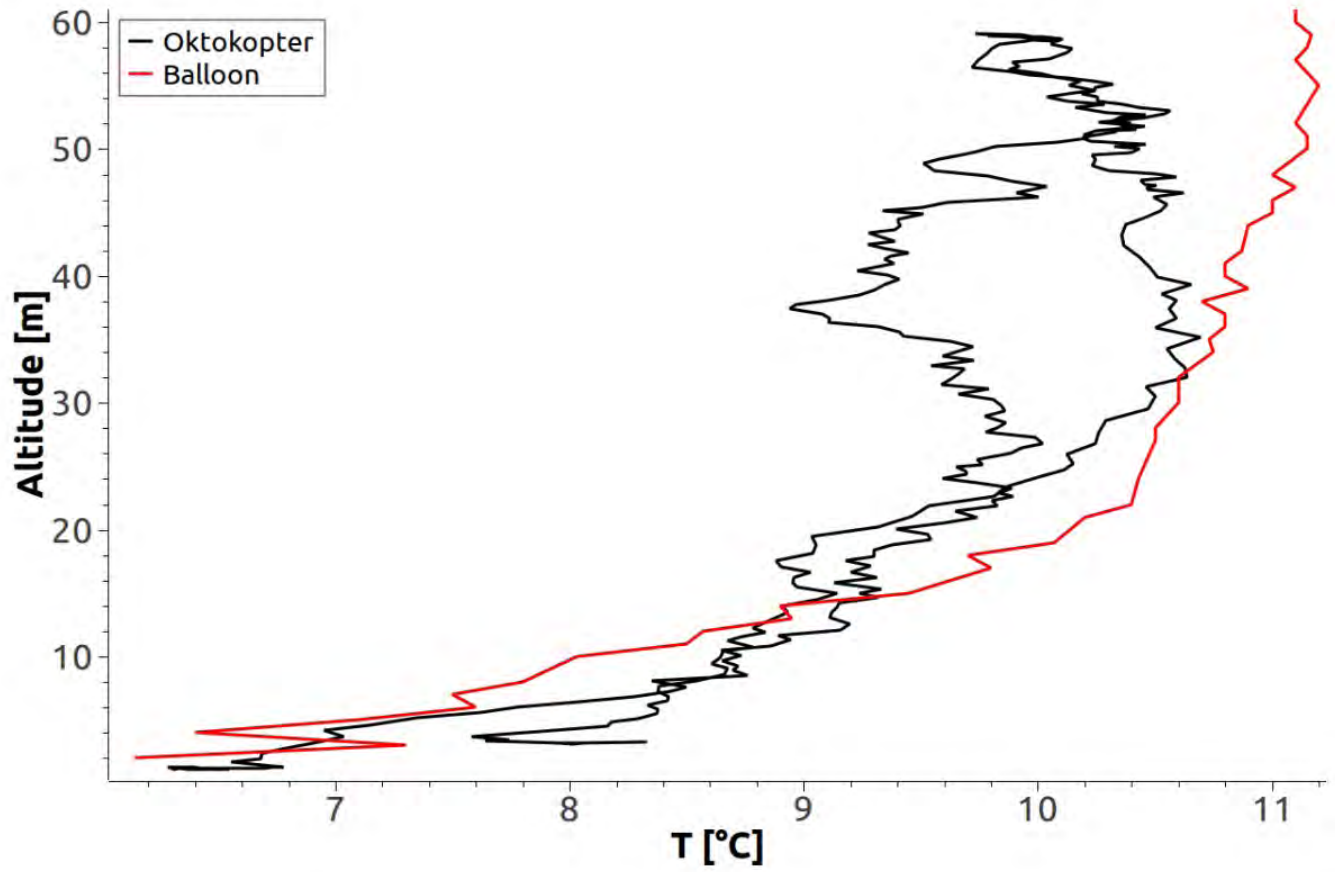
Preliminary Results: slow response time compensated data

- Data with applied compensation reproduce balloon and WindRASS data fairly well.
- Future experiments will use faster sensors.



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Summary and Outlook

- Multicopter flights suitable tool to close the gap from ground level to at least approx. 150 m
- Data can be well reproduced.
- Good agreement with balloon and WindRASS data.
- Slow sensors will be replaced by faster ones.
- Flight patterns will be optimised
- Multicopter is a reliable tool even under fog/night time conditions
- Jens Dünnermann greatly acknowledges the COST STSM funding.

Daytime flight

Flight in the fog

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Thank you for your attention. Questions?

Burkhard Wrenger
Jens Dünnermann
Joan Cuxart
Felipe Molinos
Jose Roselló
Norman Wildmann
Jens Bange

Correspondence:
Phone 0049 5271 – 678 122
burkhard.wrenger@hs-owl.de