

Developments of fast-response temperature sensors

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Ultra-Fast-Thermometers UFT's

A family of airborne thermometers developed since 1990's at the University of Warsaw for fast response (better than 1kHz) measurements of temperature fluctuations in clouds and free atmosphere.

Common features:

- resistive (cold wire) thermometers
- fine sensor (1.25 or 2.5 micrometer diameter)
- anti-droplet shield (except for some recent versions)

Most successful deployments:

SZD-45 45 OGAR motor glider - Poland

DLR DO-228 Germany

NCAR C-130 DYCOMS II

CIRPASS Twin Otter POST

ACTOS – helicopter borne platform ACORES

BAS Twin Otter EUREC4A

Modified ultrafast thermometer UFT-M and temperature measurements during Physics of Stratocumulus Top (POST)

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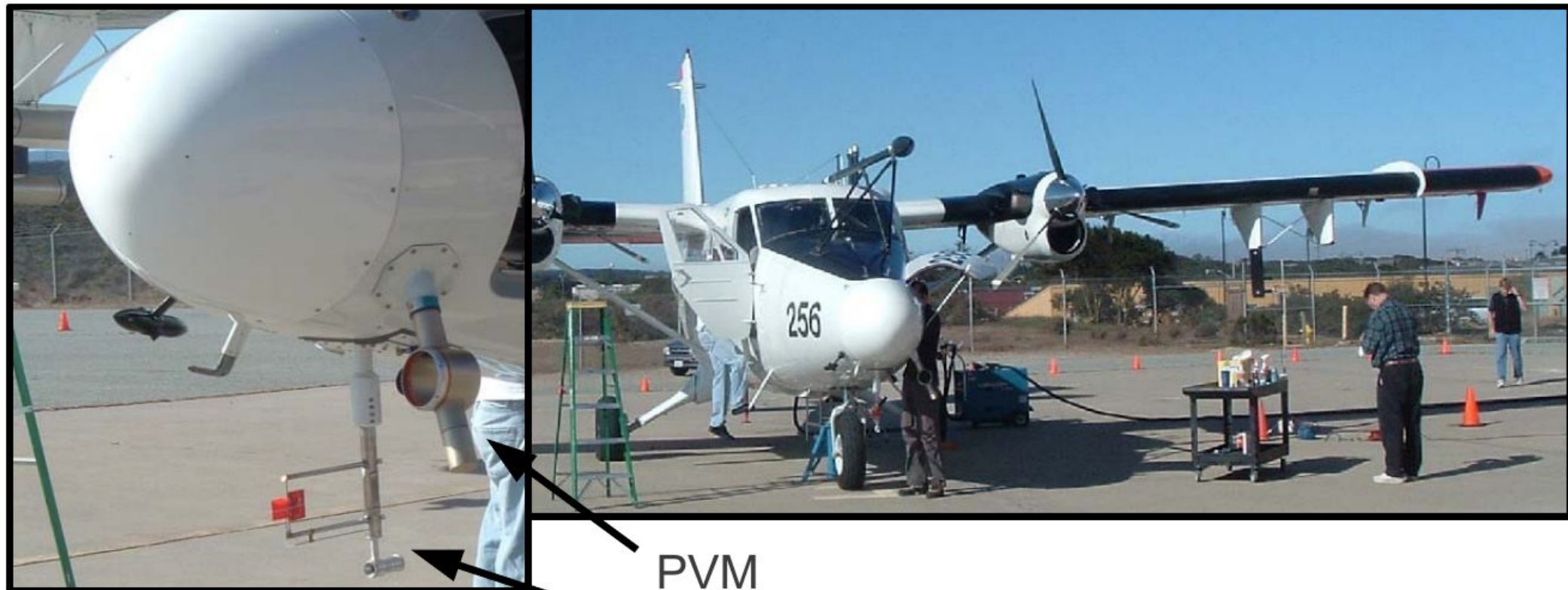
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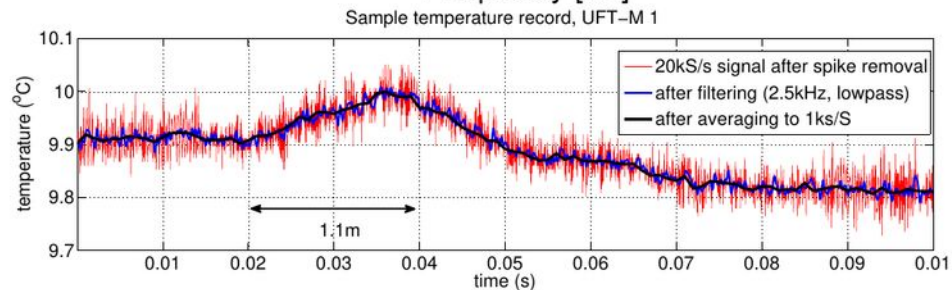
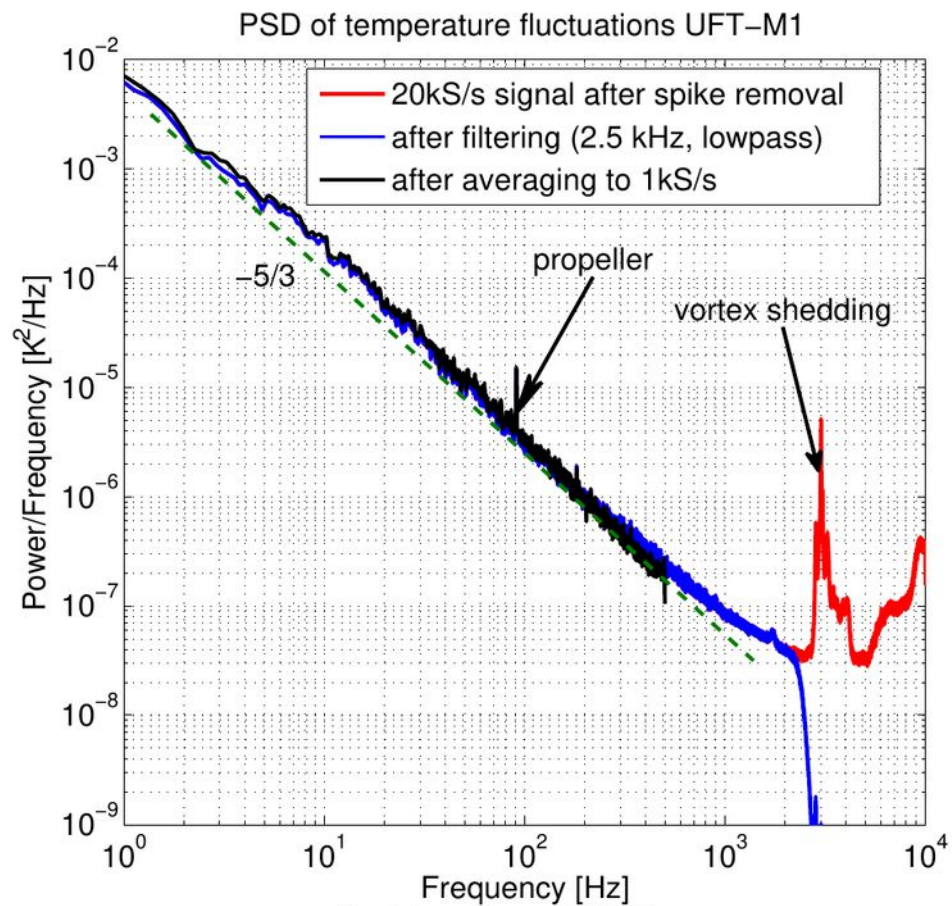
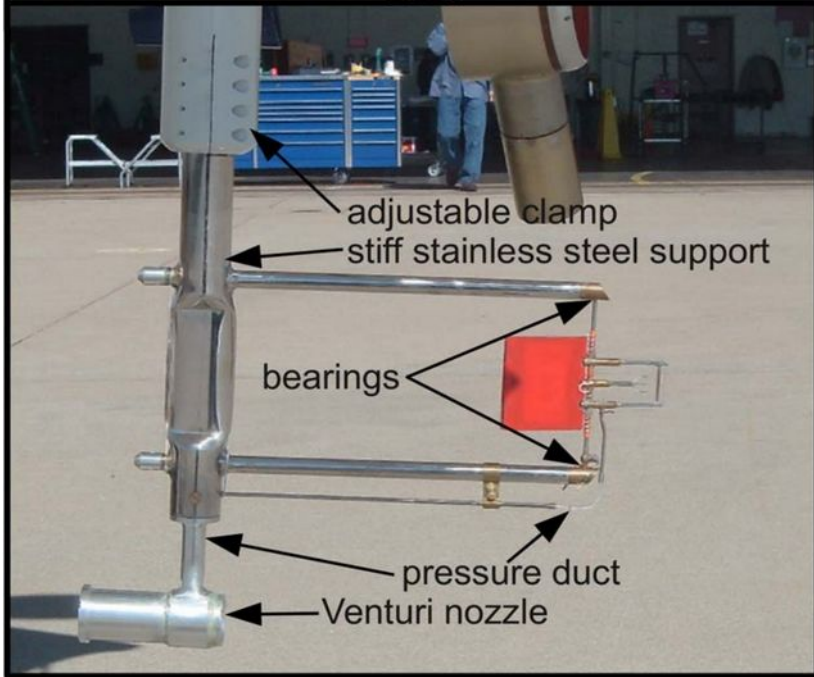
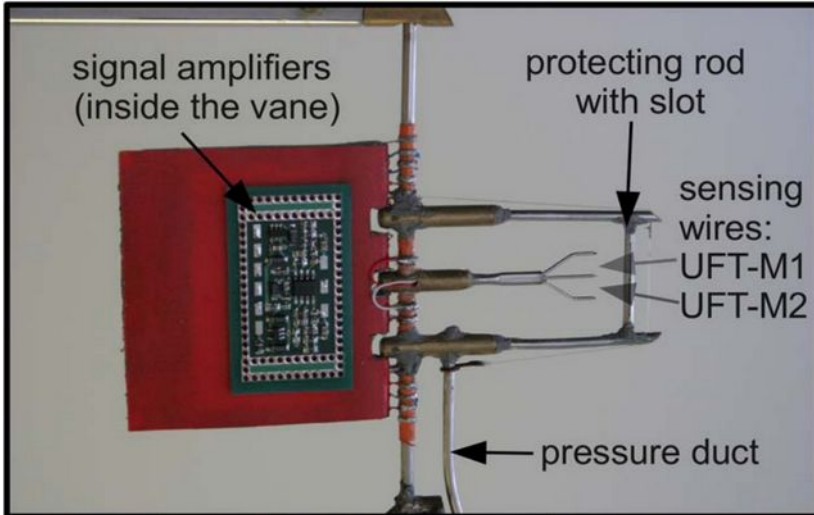
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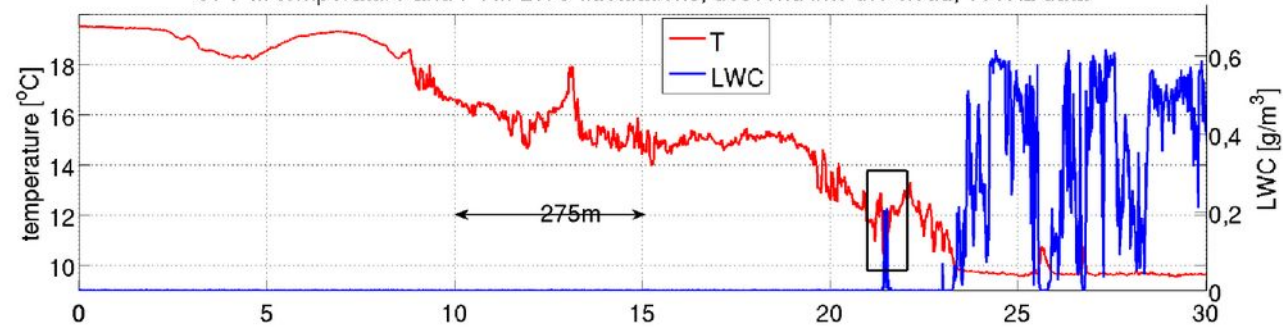


PVM

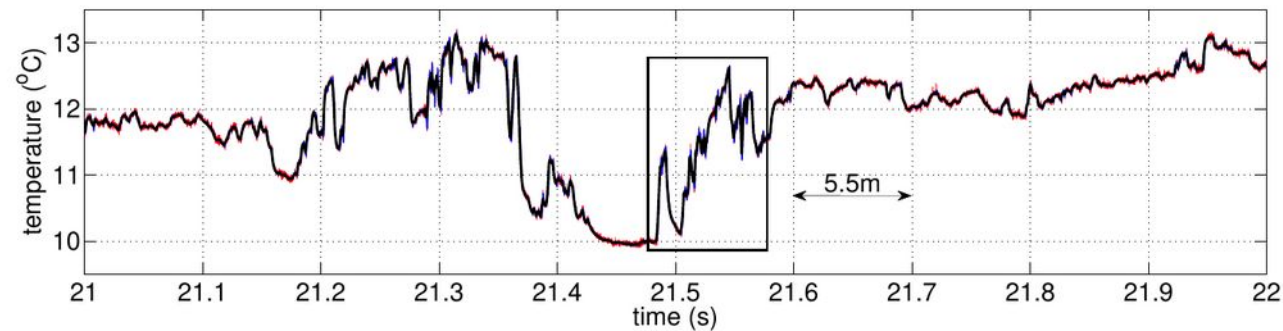
UFTM



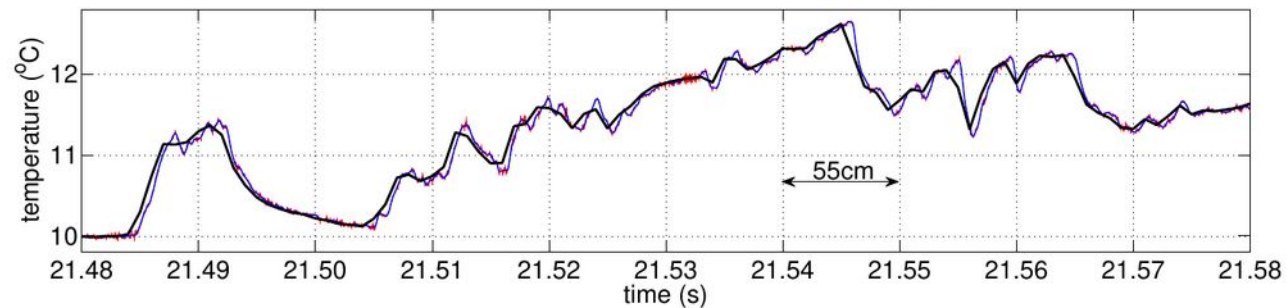
UFT-M temperature and PVM LWC fluctuations, descend into the cloud, 100Hz data



Temperature record: error corrected (red); 2.5kHz LPF (blue); averaged to 1 kS/s (black)



Temperature record: error corrected (red); 2.5kHz LPF (blue); averaged to 1 kS/s (black)



UFT-2 development: FP-5 EUFAR

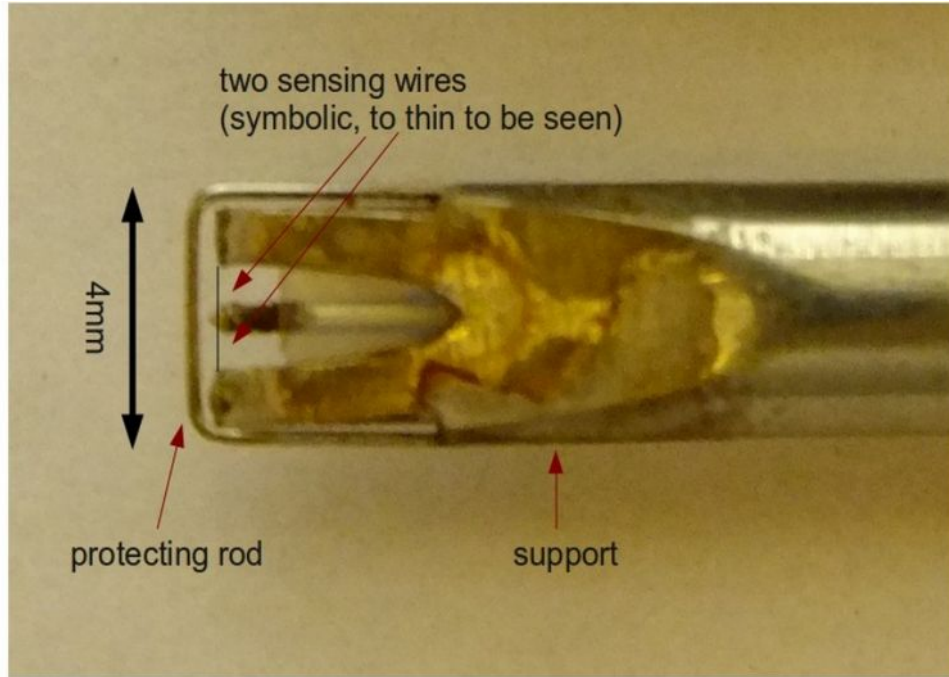


Fig.1. Prototype UFT-II – sensor head.

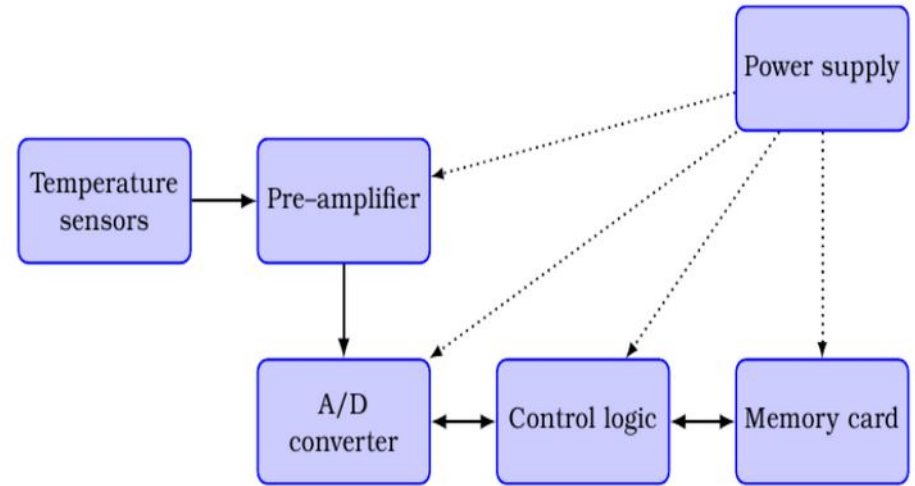


Fig.3. Block diagram of the complete UFT-2: sensing elements, amplifiers and data acquisition system (DAS).



Fig.6. Two UFT-II thermometers with housing designed and built by Enviscope in course of DENCHAR field intercomparison campaign.



Fig.7. UFT-2 in housing attached to the container under the left wing of Learjet aircraft.

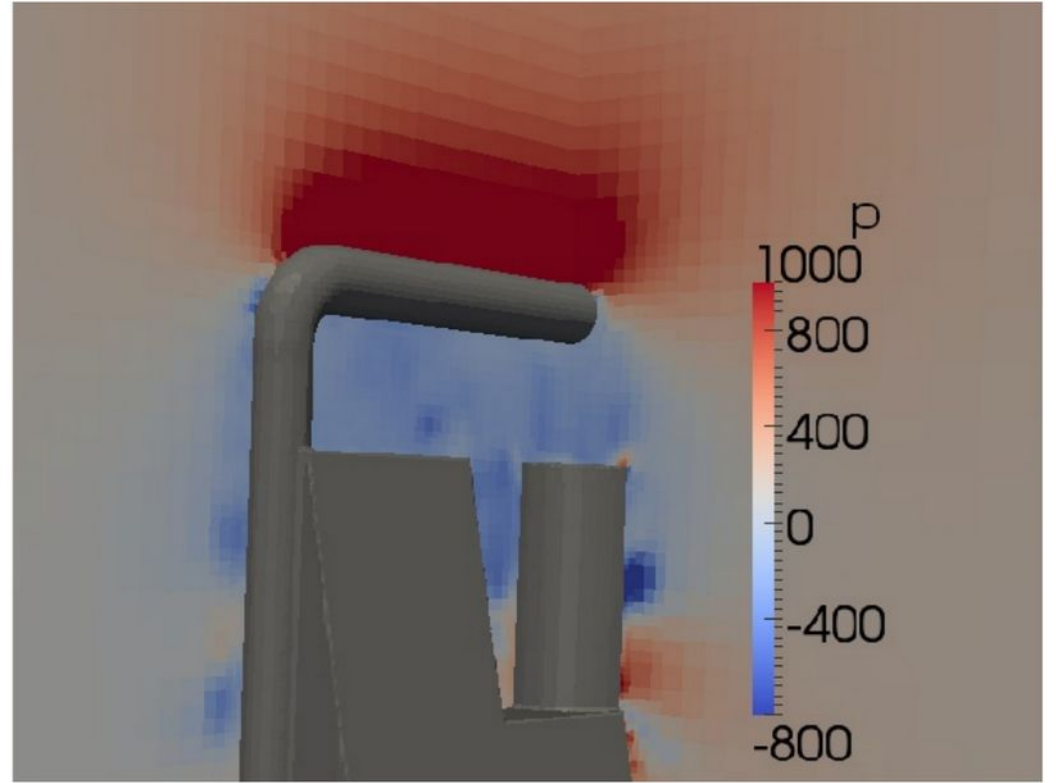
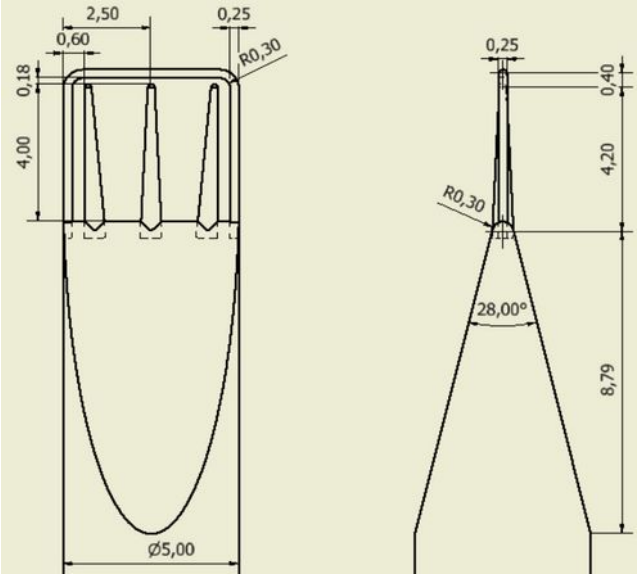
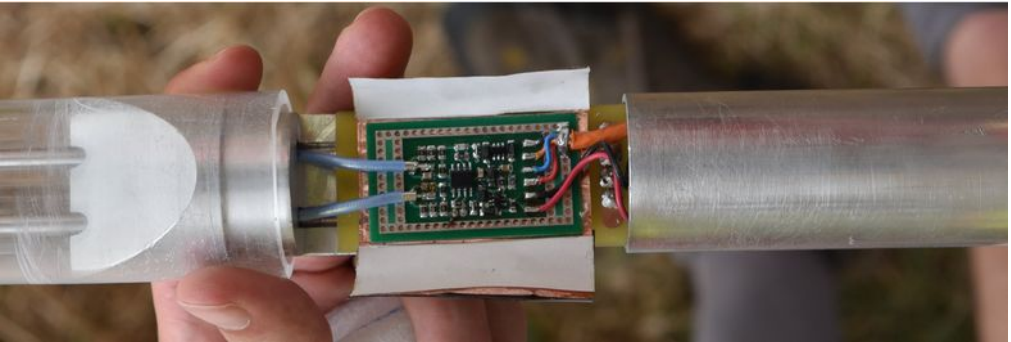
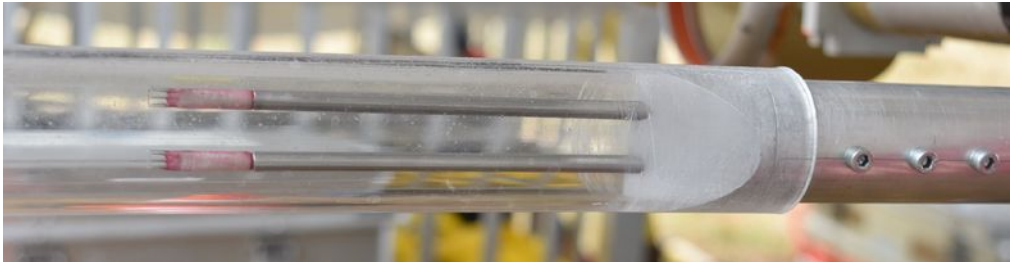
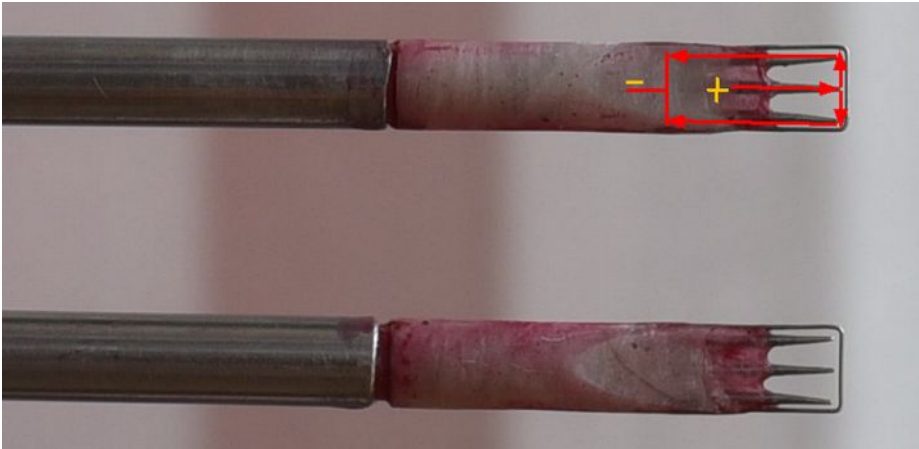


Fig.9. A snapshot of pressure fluctuations behind the sensing rod at TAS 70m/s. Value of the pressure is given in Pascals divided by the air density.

Item	Specifications	Comments
Version Number	Version #1	
Instrument Name	UFT2	UFT stays for Ultra Fast Thermometer
Technique (Principle of Measurement)	RTD immersed thermometer	Sensing element: 1.27 μ m diameter fine fire, 90%Pt 10%Rh alloy. Resistivity: 50 Ω . Sensitivity: 80m Ω /K .
Airborne Platform	Subsonic Aircraft	Preferred slowly flying aircraft (~60m/s).
Mounting	External, a special housing might be needed.	The present housing constructed by Enviscope is designed for the Learjet aircraft.
Weight in kg	1.6	Mass of the complete UFT2 with electronics, dedicated data acquisition system, power supply and housing, including 2 independent sensing heads for redundancy.
Measuring Units [K]	Temperature fluctuations	Standard output signal in voltage proportional to the temperature.
Response frequency	> 5kHz at 70m/s	Response frequency dependent on the true air speed of the aircraft, at 120m/s documented response up to 8kHz.
Resolution	< 0.1K	Maximum theoretical resolution: 0.03K Practical resolution < 0.1K
Sensitivity	11mV/K	Sensitivity of the amplified signal.
Dedicated data acquisition system	16 bit, 4 channel A/D converter, Maximum sampling rate 200kHz (total)	Total storage capacity: 32GB (San Disk memory card). Practical storage capacity > 20GB.
Power supply	Autonomous.	4 lithium AA batteries.
Transportability/Suitability for Campaign	Transportable.	Fully autonomous, not dependent on the aircraft power supply and data acquisition.

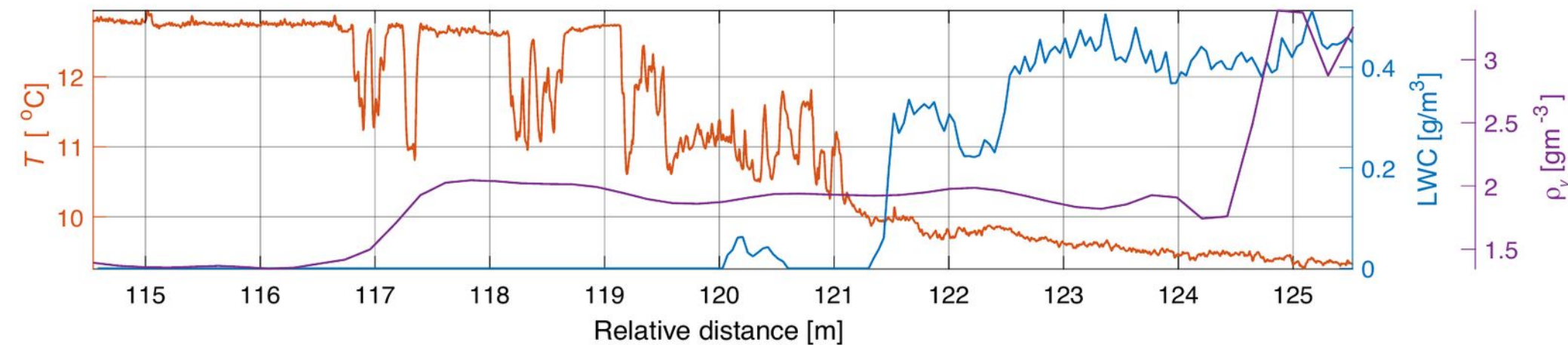
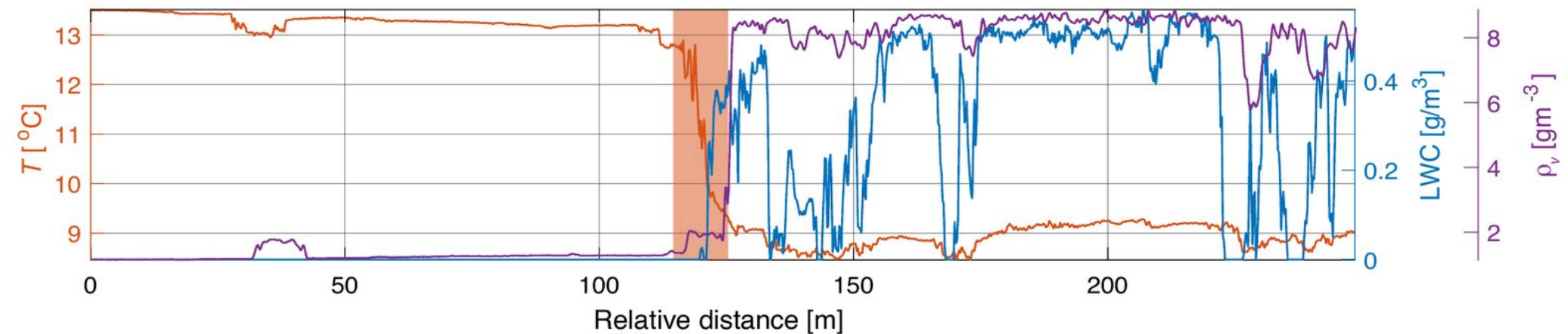
UFT-2 deployment on ACTOS: ACORES



UFT-2



Penetration through a sharp inversion capping Sc cloud



UFT-M and UFT2 tests in LACIS-T wind tunnel

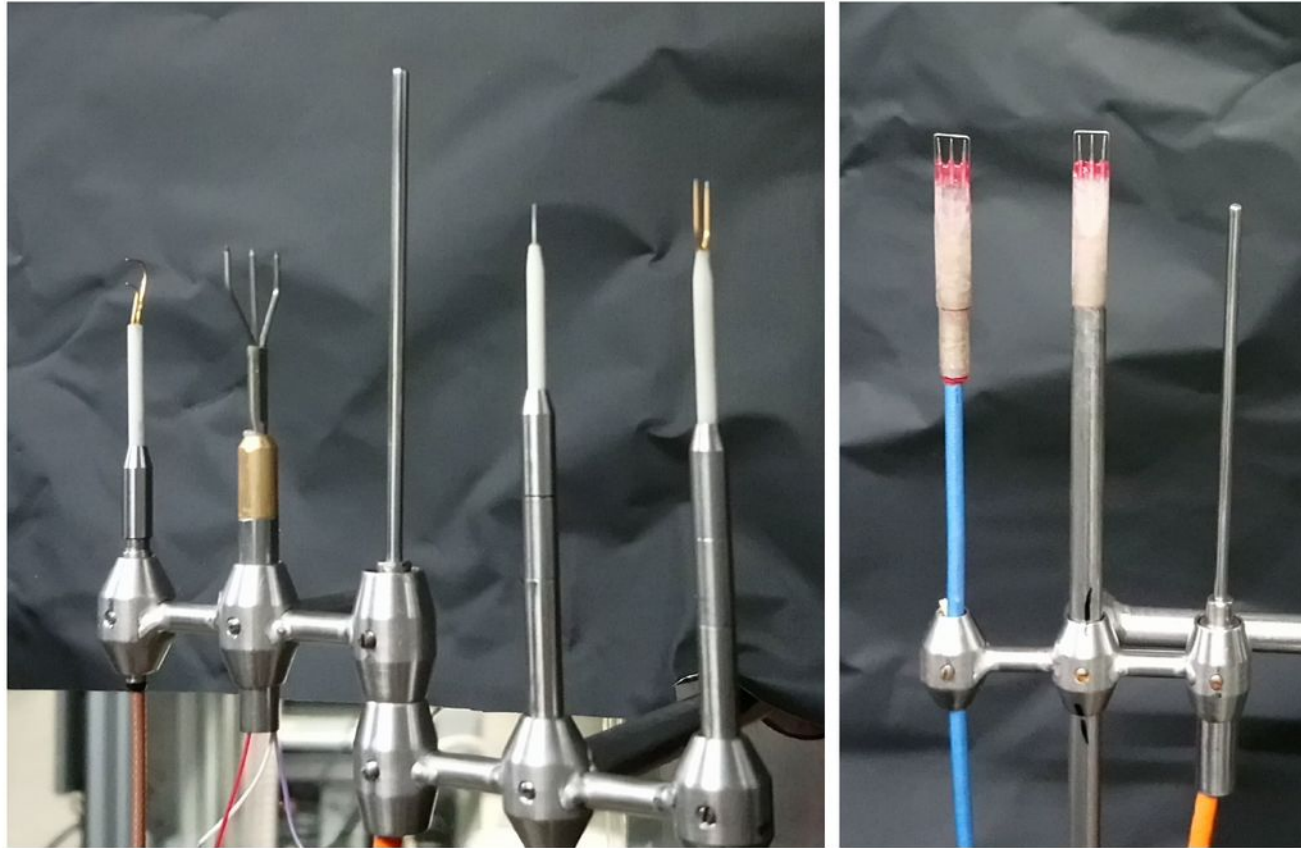
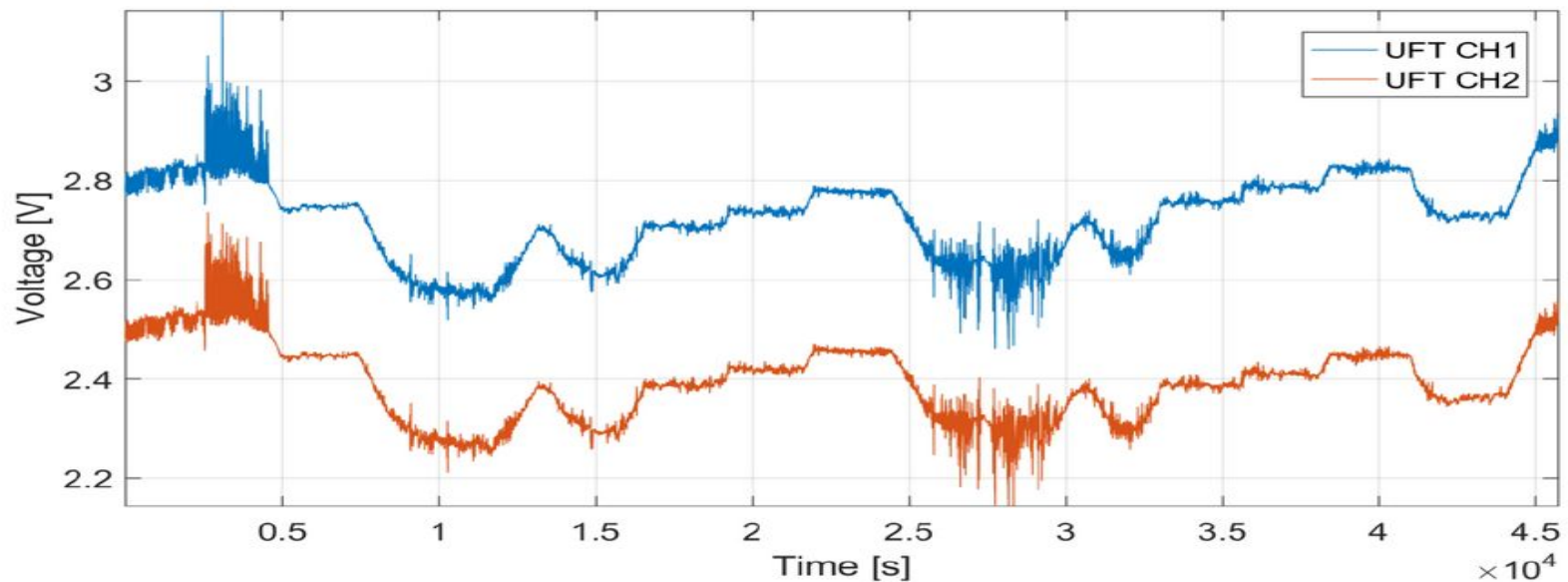
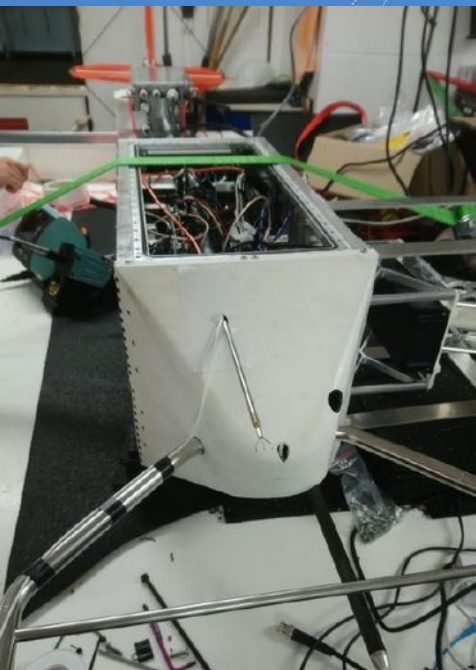
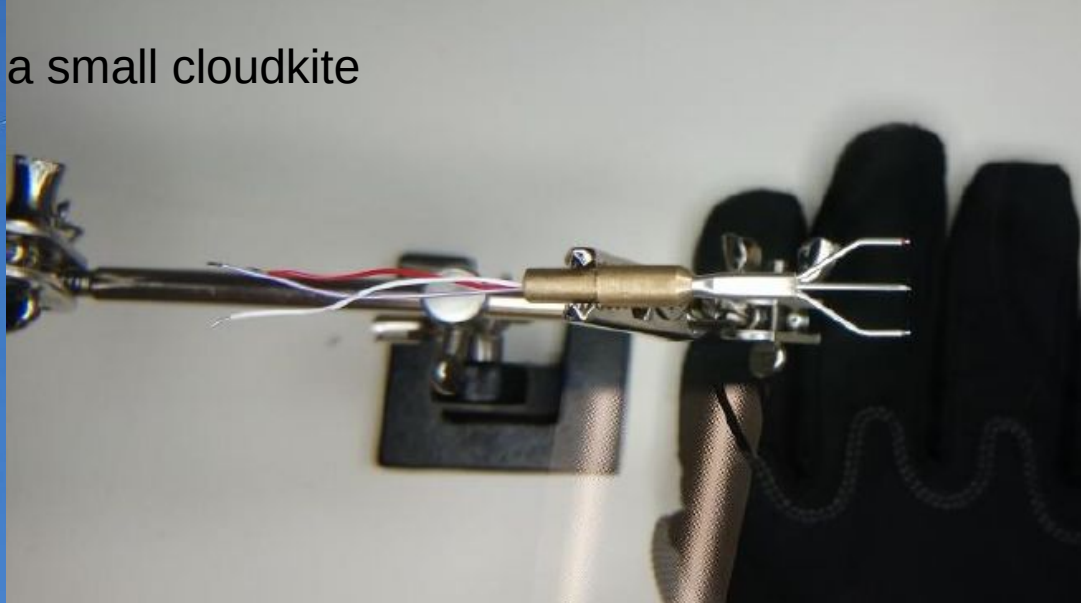
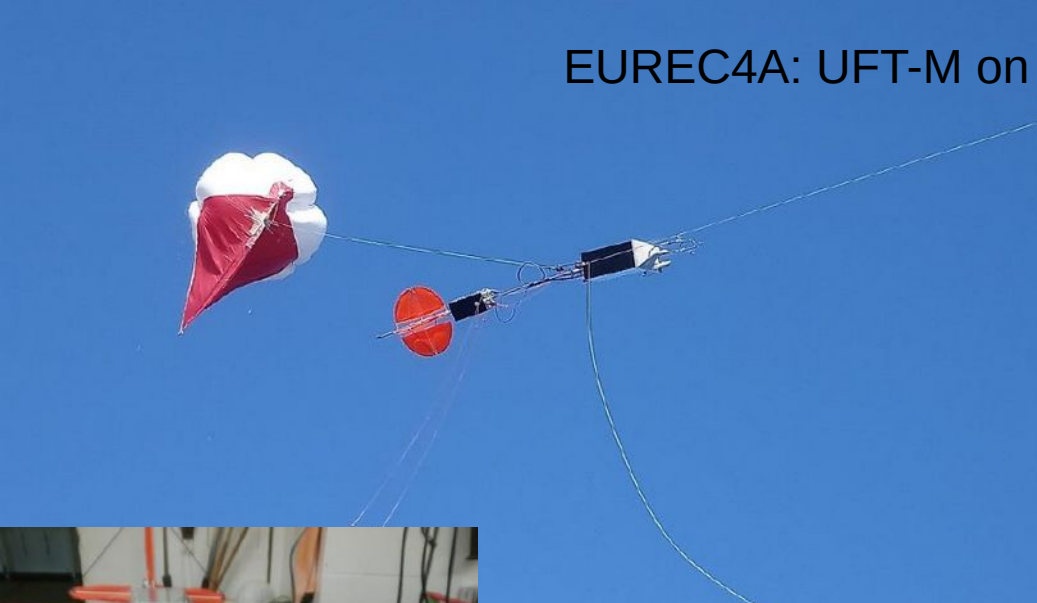


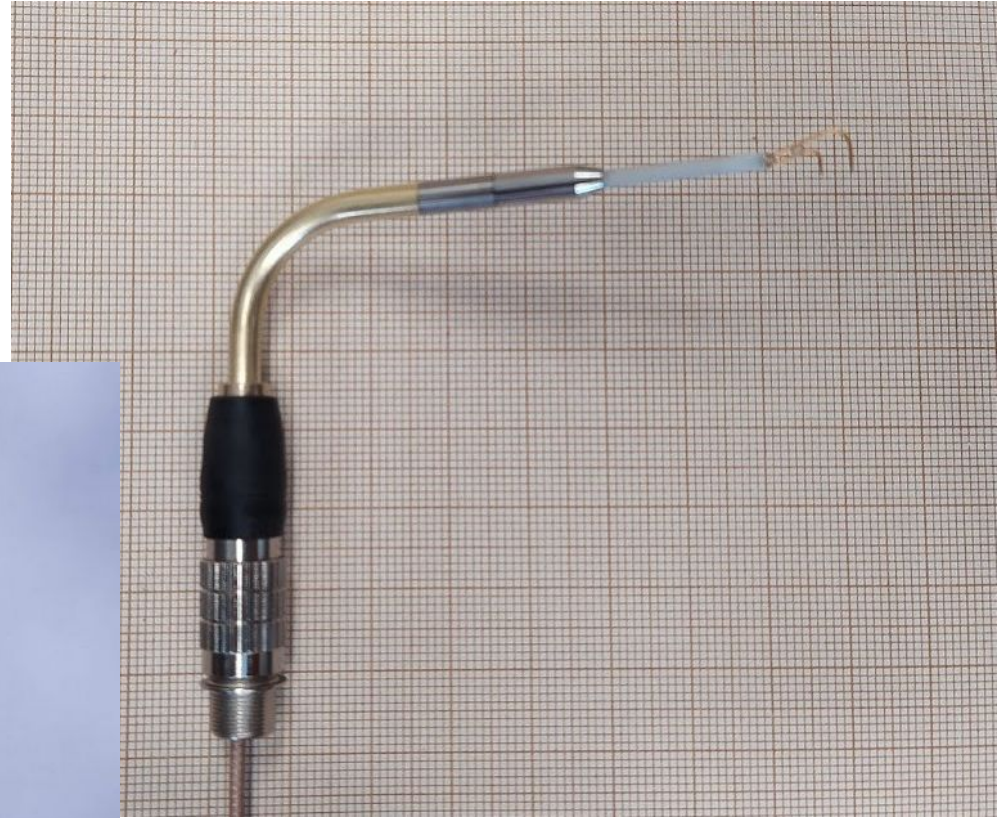
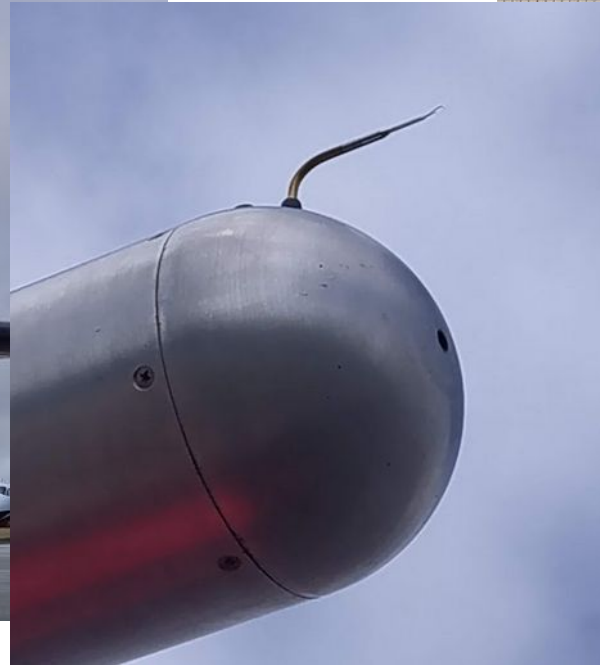
Figure 1. Fast temperature sensors (from left to right): UFT-2-B, UFT-M, PT100, ColdWire (Dantec Dynamics 55P71), UFT-2-A, UFT-2-0, UFT-2-0, PT100

EUREC4A: UFT-M on a small cloudkite

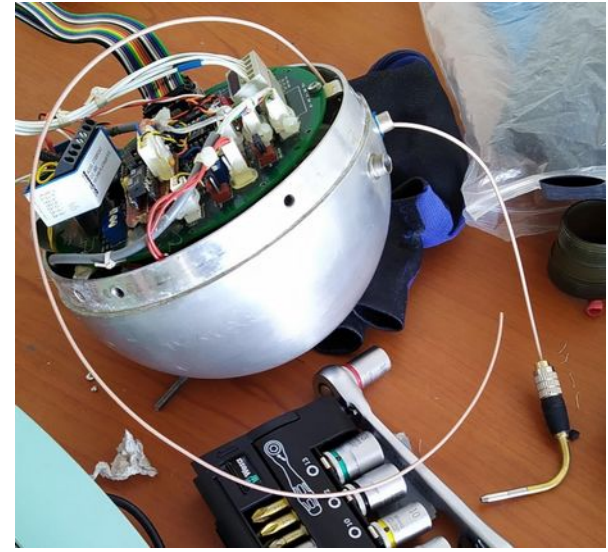
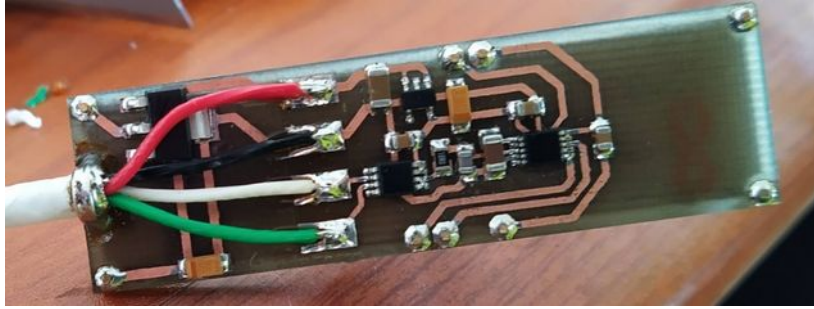


Mounting of the UFT2B on BAS Twin Otter

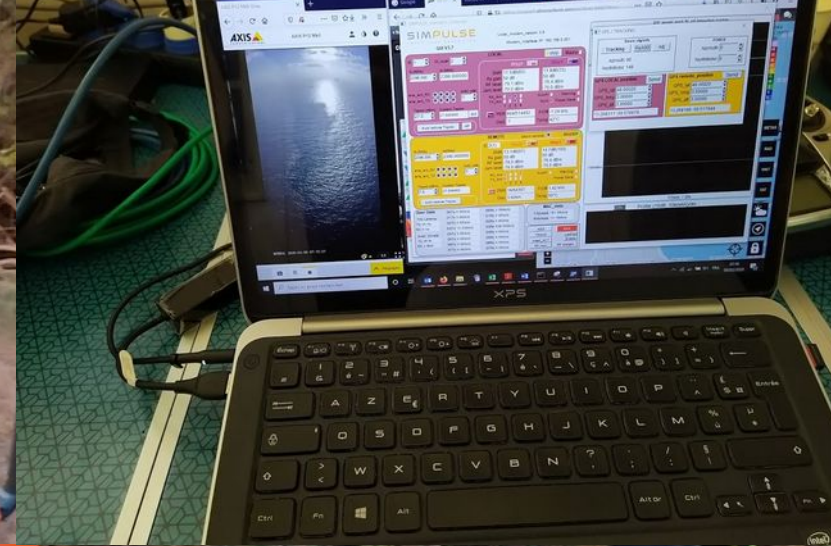




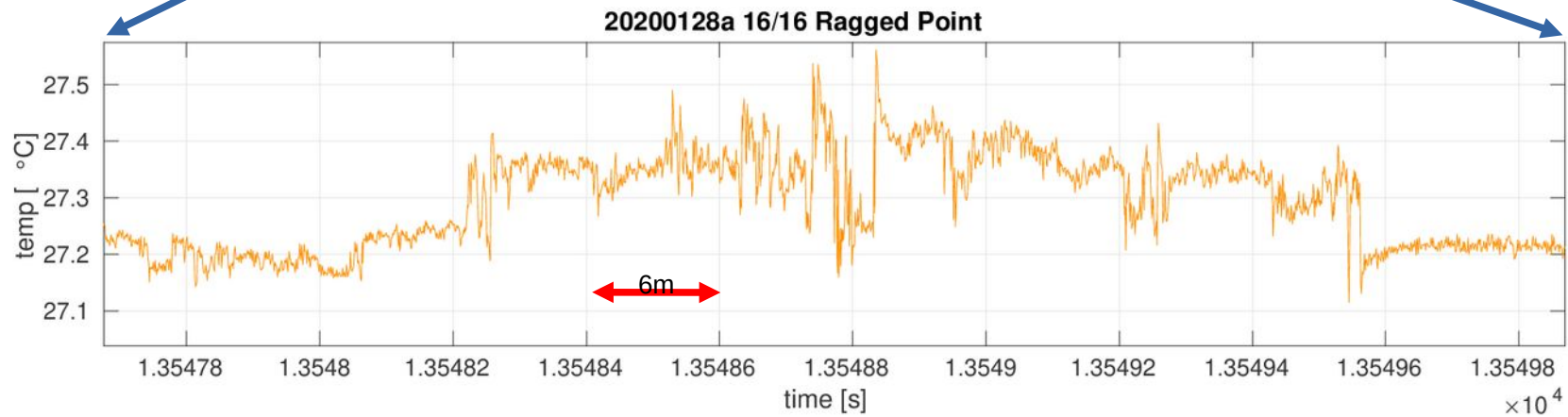
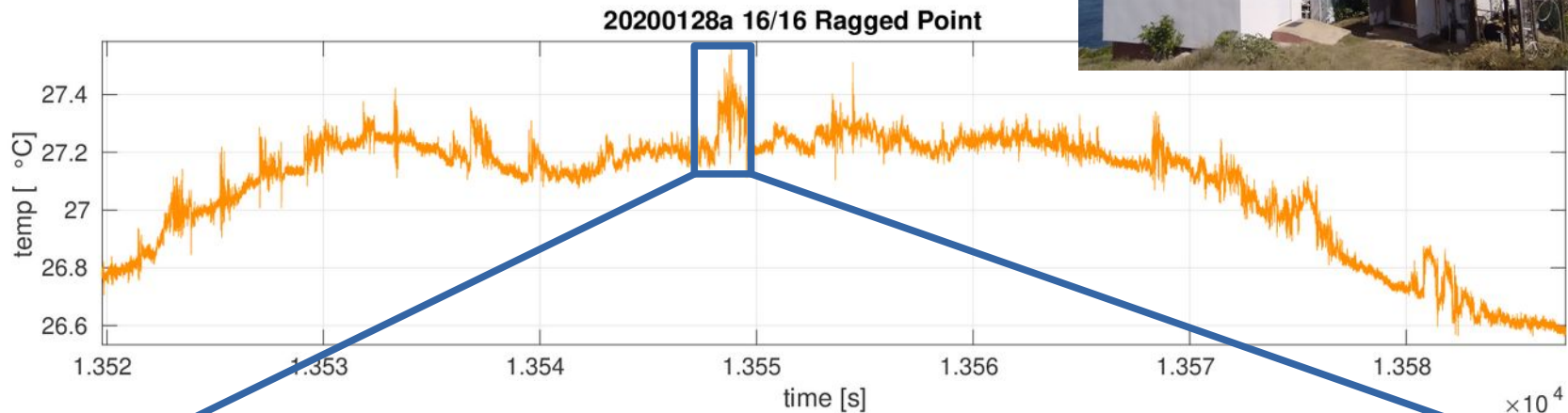
A special hold of the UFT2B
mounted on the turbulence
probe of BAS Twin Otter



UFT2B on BOREAL drone

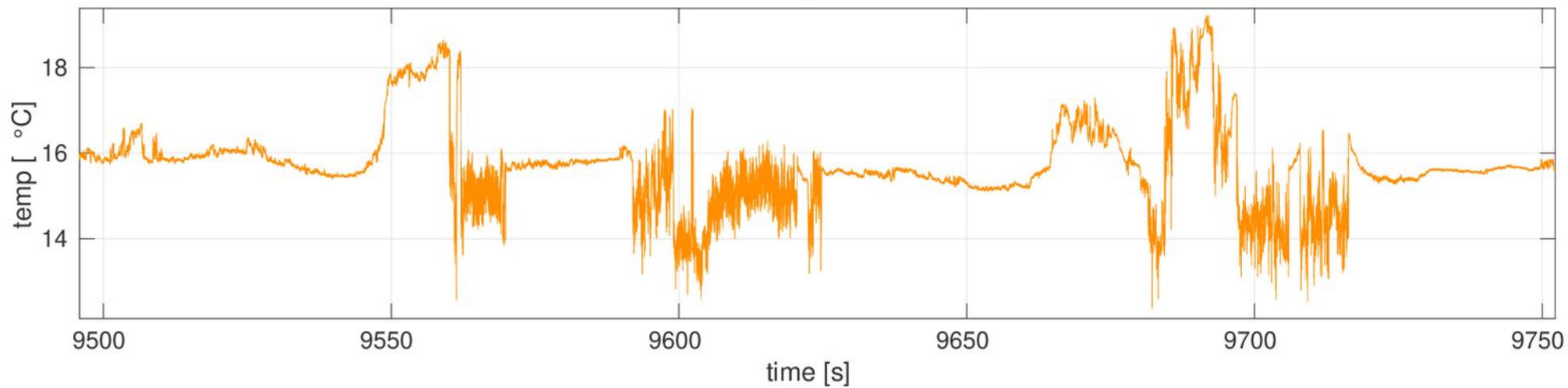


UFT2B, BAS Twin Otter, 30 m above the sea next to Ragged Point / BCO observatories

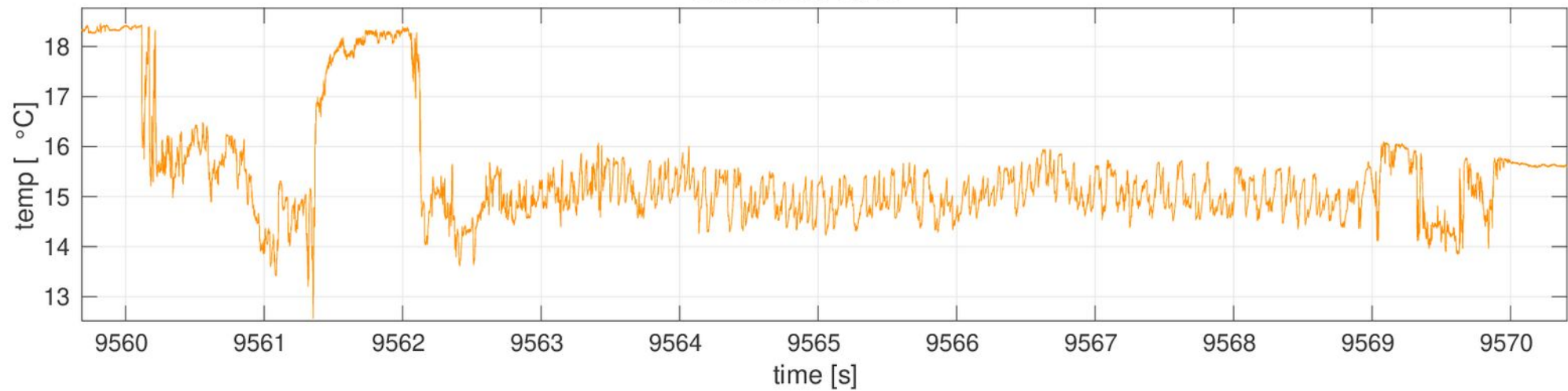


UFT2B, BAS Twin Otter, penetration of successive clouds (upper panel) and blow-up (lower panel)

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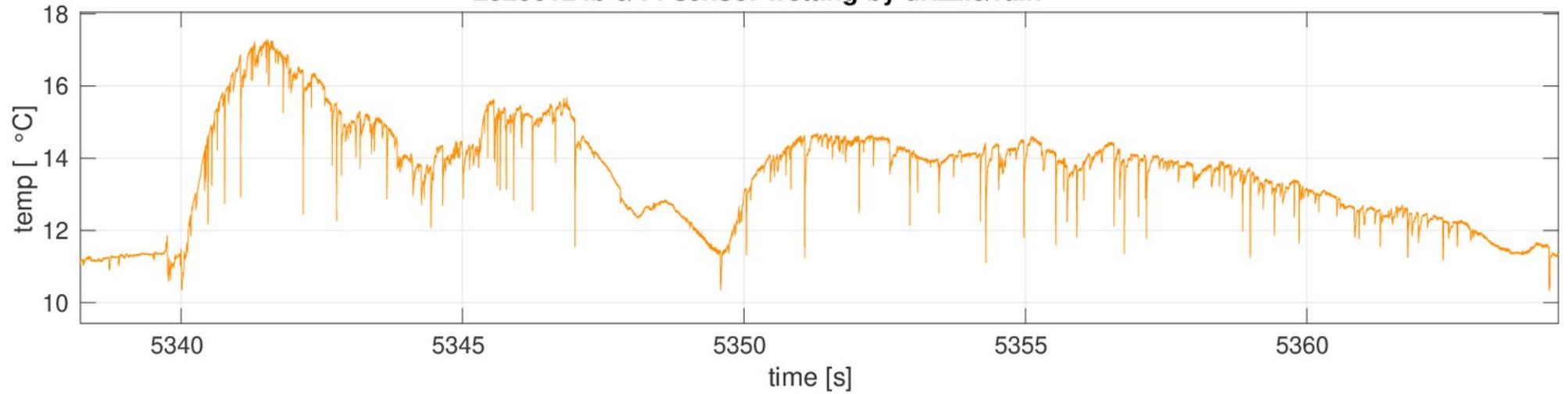


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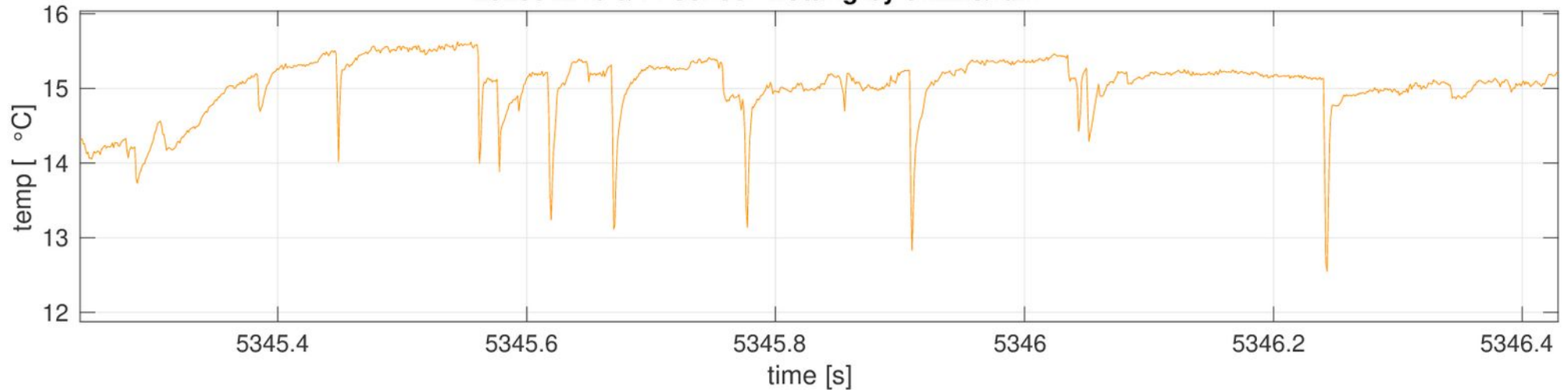


UFT2B, BAS Twin Otter, in rain clouds

20200124b 6/14 sensor wetting by drizzle/rain



20200124b 6/14 sensor wetting by drizzle/rain



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