



Airborne Reference Temperature System

Precise UAV-based reference temperature data for validation and calibration

The Airborne Reference Temperature System ART features a new method for validating and calibrating thermal satellite data (here: satellite data by constellr). It provides robust reference data on large areas by combining pyrometer measurements and customized flight pattern strategies.

Measuring the temperature of reference surfaces during satellite overflights is highly beneficial for the validation and calibration of thermal satellites or constellations. The Airborne Reference Temperature System ART allows precise and autonomous UAV-based temperature measurements over large reference areas. Designed as a drone-in-the-box solution, the system enables automated remote operation.

Tailored for reference data

The ART system is a state-of-the-art solution designed for precise temperature and emissivity measurements of reference surfaces. It has been developed for the calibration and validation of thermal satellite data and can be used by research institutes, environmental monitoring agencies, and companies where high-resolution thermal measurements are required. Featuring a high-performance pyrometer, the ART system measures temperatures with an accuracy of up to 0.5 K, making it ideal for demanding validation and calibration tasks.

Suitable for various surface types

The ART system is suitable for measuring different surfaces, including water, soil, asphalt,

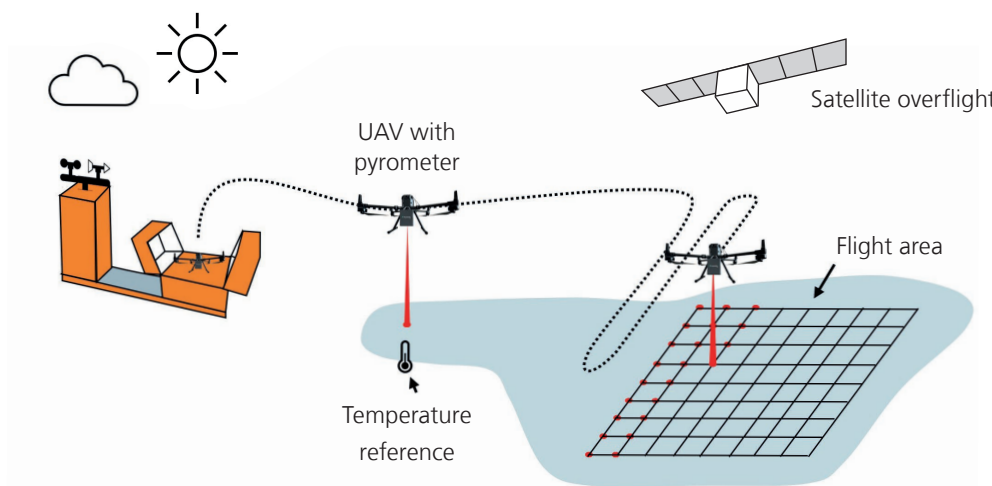
and sand. This makes it adaptable for a wide range of applications in environmental research and satellite calibration. The ART system captures data at a rate of up to 20 Hz, enabling detection of local temperature changes due to surface inhomogeneities. It comes with a tactile temperature measurement system for automated emissivity correction, which reduces drift and detects malfunctions. The integrated software makes it easy to process and analyze data, allowing users to efficiently visualize and interpret the collected data.

Option 1: Integration on your UAV

The ART can be integrated on different types of UAV. With a maximum total weight of 1 kg, it can be carried by a variety of medium-size UAVs with a take-off weight under 25 kg. Fraunhofer IPM supports customers in customizing and integrating the system on different platforms.

Advantages at a glance

- Light-weight airborne reference temperature system
- Temperature accuracy of up to 0.5 K
- Deployable on a wide range of UAVs
- Drone-in-a-box solution for automated remote operation



Adaptive resolution and accuracy: Validating or calibrating a thermal satellite requires reference data of several pixels during overflight. Depending on the thermal satellite's ground sampling distance, the Airborne Reference Temperature System ART optimizes the flight pattern to measure the mean satellite pixel reference temperature as accurately as possible. The system can withstand temporal and spatial temperature change by processing the measurements during the UAV's flight time into the moment of the satellite's data acquisition.

Option 2: Drone-in-a-box

The system is available as a drone-in-a-box solution that enables automated missions during satellite overflights all over the world. It can be deployed either in a stationary or mobile setup, e. g. integrated on a road vehicle or ship. System settings such as area of interest, flight pattern, sensor parameters, and maximum wind speed, as well as data download and remote camera inspection can be controlled via web interface.

The drone-in-a-box solution by Fraunhofer IPM includes:

- **Down-welling hemispherical radiance** measurement
- **Sky camera** for cloud coverage measurement
- **Climate control unit** designed for harsh environmental conditions
- **Weather station** for flight planning and documentation (ambient temperature, wind speed and direction, rainfall, humidity)
- **Automated calibration module** for regular and precise pyrometer calibration, essential for maintaining long-term measurement accuracy and reducing maintenance requirements to a minimum (optional)
- **Sun photometer** to measure the aerosol optical depth, AOD, (optional)
- **Cameras** for both internal and external remote inspection

Technical specifications

Measurement method	UAV-based temperature and emissivity measurement
Reference areas	Homogeneous surfaces: water, soil, asphalt, and sand
Measurement accuracy	up to 0.5 K
Flight time	~ 30 min (dependent on UAV)
Spectral range	8 - 14 μm
Data rate	Maximum acquisition rate of 20 Hz to register rapid temperature changes
Measurement area	Dependent on UAV system and flight pattern > 200 × 200 m
Weather station	Optional, for capturing environmental conditions such as humidity and temperature that could affect measurements
UAV compatibility	Small UAVs under 25 kg maximum take-off weight

All specifications and features are subject to modification without notice.

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