**UAS for Meteorological and Atmospheric Studies**

G. Roberts\(^1\), G. Cayez\(^2\), F. Lavie\(^1\), D. Tzanos\(^1\), J.-L. Brenguier\(^1\), C. Ronfle-Nadaud\(^1\), G. Hattenberger\(^3\), M. Bronz\(^3\)

**Abstract**

The National Center for Meteorological Research (CNRM-GAME, Toulouse, France) conducted UAS flights in Southern France on two UAS platforms (mini and mid-size UAS) to demonstrate their feasibility for meteorological and atmospheric studies. The UAS were equipped with meteorological and aerosol sensors as well as a data acquisition system. The meteorological sensors (temperature, relative humidity and pressure) were tested in different housings to assess the optimum design and placement of the sensors. In addition, a standard radiosonde device attached to the aircraft fuselage and balloon launches served as a reference. We found that convective and radiative components generated biases in the meteorological measurements. Aerosol concentrations and particle size distribution were also measured by optical counter and compared for two different inlet designs.

**Introduction**

Introduction (Unmanned Aerial System)

UAS are useful tools to study the atmosphere in places dangerous for aircrafts: hurricanes, fogs, polar research, etc. The COST Action promotes the conception and further development of UAS for use in atmospheric research programs. The networking activities have established a foundation at the European level for the coordination of scientific, technical and legal aspects related to viable operation of UAS.

**COST ES0802**

- UAS starting integration into studies of climate change and sustainable development.
- COST Action coordinates research on using UAS as a cost-efficient, trans-boundary method for the monitoring of the atmospheric boundary layer.
- UAS close observational gaps between ground-based and satellite-based measurements.
- In-situ observations ultimately improve numerical weather models and climate simulation.
- UAS systems come in different sizes, complexity and equipped with different instrumentation.

**VOLTIGE:**

- Cloud microphysics of fog events
- Structure of lower troposphere (inversion height, atmospheric stability).

**UAS at CNRM**

Several types of vectors:

- **UAS Funjet**
  - Total weight: 850 g;
  - Endurance: 20 min, electric; Ceiling: Tested to ~ 2.1 km.

- **UAS EasyStar**
  - Total weight: 1000 g;
  - Endurance: ~ 35 min, electric; Ceiling: Tested to ~ 1.4 km.

- **UAS Avion Jaune**
  - Total weight: 20 kg;
  - Endurance: ~ 4 h, thermal; Ceiling: ~ 4 km.

**UAS navigation**

General principle of an autopilot

The UAS for VOLTIGE are ultra-light model airframes equipped with a Paparazzi autonomous navigation system developed by ENAC.

**Meteorological instrumentation:** Temperature, Pressure, Relative Humidity

**Mesurements artefacts**

Hysteresis:

Problem of hysteresis was noticed on the temperature profile.

Three kinds of temperature probe have been created and tested:

- reverse-flow probe.
- helical probe (with or without double wall).
- open cylindrical probe.

- We have tested the drones under adverse weather conditions (rain, snow, wind) and in clouds.

**Acknowledgments**

- M. Gavart, M. Joanne (Avion Jaune System);
- G. Hattenberger, M. Bronz, M. Goroz, A. Bustico (ENAC);
- F. Lohou et M. Lothon (CRA Lannemezan);
- S. Detty (Meteo-France).