D2.3 Lagrangian measurements with smart balloons

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LIST OF ACRONYMS

ITN-COMPLETE	Innovative Training Network Cloud-MicroPhysics-Turbulence-Telemetry
WP	Work Package
UAV	Unmanned Aerial Vehicles
IMU	Inertial Measurement Unit
GNSS	Global Navigation Satellite System
ISM	Industrial, Scientific and Medical

D2.3 LAGRANGIAN MEASUREMENTS WITH SMART BALLOONS

Within the Horizon 2020 Innovative Training Network Cloud-MicroPhysics-Turbulence-Telemetry (ITN-COMPLETE) [1], the Work Package 2 WP2 foresees the study of the structure of turbulence in clouds and interfacial turbulent phenomena [2]. In order to improve the understanding of the effect of turbulence in cloud processes, information about turbulence velocity fluctuations and structure of thermodynamic fields is being analyzed according to the work assigned to the different project's partners. To characterize the turbulence impact in warm convective clouds, issues such as dynamics of turbulent entrainment of dry environmental air into the cloud, microphysical and dynamical effects of turbulent mixing following the entrainment, measurements in real clouds and, measurements in cloud chambers, are being investigated.

Part of the measurements in real clouds involves the use of innovative atmospheric mini radiosondes aimed at the generation new Lagrangian-based cloud fluctuation datasets to improve the understanding of turbulence and microphysical processes interactions inside warm clouds. Lagrangian measurements consist of following individual fluid particles carried by a flow [3] and its interest has risen significatively during the last decades, nevertheless, Lagrangian measurement techniques are mainly laboratory procedures involving the seeding of the flow with tracer particles to look at their motion [4]. In contrast to most of the traditional approaches, the use of the mini floating radiosondes is an experimental method for measuring in-situ the influence of turbulence in cloud formation. They must be small and light weighted to be apt to passively follow small scale cloud fluctuations.

So far, the design, prototyping and preliminary tests of the ultra-light radioprobes have been carried out. Most of the radioprobe's systems have been tested individually [5, 6, 7] and some of them inter-integrated. The first fully integrated electronic prototype is under production and after some calibration and working tests, the initial collection of atmospheric data will be achieved.

The first Lagrangian-based field experiment will be conducted in the next months at the Environmental Research Station Schneefernerhaus UFS in Germany, which is the highest European research station located approximately at 2650 m a.s.l. This research station offers ideal conditions for the measurement of the cloud properties required for this work. The first fully integrated prototypes of the radioprobes (integrated whole electronic board and external balloon) will be tested, together with the receiving and ground station systems.
The system setup will consist of some dozens of the innovative mini radioprobes and, at least three receiving and ground stations located at known fixed positions on the ground. The radioprobes will be lifted to a known height and then released inside a cloud by an Unmanned aerial vehicle UAV, commonly known as drone. The UAV will be driven from ground.
During the flight, the microcontroller placed inside each radioprobe will control the sensors and the transmission system to acquire, pre-process, store, arrange and transmit the data to the different receiving and ground stations. The last design of the radioprobes includes a set of very light sensors: temperature, pressure, humidity, Inertial Measurement Unit IMU and a Global Navigation Satellite System GNSS receiver to generate a new cloud Lagrangian database. Each device includes also a transmission system that allows the communication with the receiving stations. For this purpose, an Industrial, Scientific and Medical ISM license-free frequency band is being utilized. In order to further reduce energy consumption at the radiosonde side, the number of packets' transmission has been reduced as much as possible. The microcontroller stores and packs the collected data inside the microcontroller's registers and, when they reach

the pre-programmed length, the data is sent to ground using a long-range saving-power transmission technology.
As mentioned before, the receiving and ground stations will be located at known fixed positions on the ground. This will enable the execution of positioning and tracking algorithms to determine the location of the radioprobes. Each ground station will be equipped with a receiving system to capture the transmitted data from the floating devices and, a data acquisition and control system to receive, control and manage the obtained information. In addition, the ground stations will include some additional pre-programmed software tools to store, visualize and post-process the data.

Once the row data has been analyzed and processed, the cloud Lagrangian datasets will be shared with the scientific community through the open access database of the Project COMPLETE. This with the aim of transferring the knowledge acquired during the field measurements for the reduction of the gap present in the cloud microphysics understanding correlated to turbulence.

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