



## Progress on the development of innovative, floating, biodegradable radio- probes for atmospheric monitoring inside warm clouds

Miryam Paredes<sup>2,3</sup>, Shahbozbek Abdunabiev<sup>1</sup>, Marco Allegretti<sup>2,3</sup>, Giovanni Perona<sup>3</sup>, Daniela Tordella<sup>1</sup>, Eros Pasero<sup>2</sup>, Flavio Canavero<sup>2</sup>, Andrea Merlone<sup>4</sup>, and Chiara Musacchio<sup>4</sup>

<sup>1</sup>Department of Applied Science and Technology, Politecnico di Torino

<sup>2</sup>Department of Electronics and Telecommunications, Politecnico di Torino

<sup>3</sup>Envisens Technologies s.r.l.

<sup>4</sup>Istituto Nazionale di Ricerca Metrologica di Torino

Characterization of clouds is still a challenging task for weather forecasting and climate modeling. This is because clouds depend on interdisciplinary natural processes, ranging from the micrometer scale, where particles and droplets collide, to the thousand-of-meters scale of airflow dynamics. Turbulence has an important role in cloud formation and rain initiation since it helps rain droplets to evolve through coalescence and collision processes. Unfortunately, the effects of turbulence mechanisms are not yet well understood and there remains a need for further clarification.

In an attempt to address these knowledge gaps, this work presents the advances of an experimental method for measuring in-situ the influence of turbulence in cloud formation and producing an infield cloud Lagrangian dataset by means of the development of ultra-light bio-compatible radio-probes. With a target weight of less than 20 grams, these innovative devices are carefully designed to float and passively track small-scale turbulence fluctuations in warm clouds and neighboring air. Each mini radio-probe embeds a set of compact size microprocessors, controllers and sensors for the measurement of atmospheric parameters inside clouds (e.g. velocity, acceleration, vorticity, pressure, temperature, humidity) after been released into the atmosphere. To reach a buoyancy force equal to the weight of the system, the bio balloons containing the electronics are appropriately filled with a mixture of helium gas and air. During the flight, the smart radio-probes acquire, pre-process, store, arrange and transmit the obtained data to different receiving and ground stations located on earth through a dedicated radio transmission link. Due to the radio-probes' physical constrains and the environmental conditions that can be found inside warm clouds, a power-saving and long-range wireless communication technology has been selected and tested.

The development of the first operational prototypes for both, the radio-probes and the receiving

stations, are presented together with results of the first measurement experiments both, in laboratory and field campaign.