

FINAL REPORT PROGRAM LEFE

FAMOUS: Fast Measure Of hUmidity Sensor

Program LEFE/ IMAGO	Project Title FAMOUS	Years 2018 -- 2021
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<p>The 20Hz humidity under tethered balloon</p> <p>Turbulent processes and in particular sensible and latent heat fluxes are mainly responsible for energy transfers between the surface and the atmosphere within the atmospheric boundary layer (ABL). It is in this context that vertical observation of turbulent parameters is of interest. The probe shown in figure 1 was developed by the CNRM in 2010 in order to measure the thermodynamic parameters at very high frequencies (20Hz) and the sensible heat flux in order to know the heat exchanges within the ABL.</p> <p>This lightweight instrument, weighing less than 3 kilograms, measures the thermodynamic parameters during vertical profiles carried out under a tethered balloon between the ground and 800m altitude. These measurements are complementary to the measurements on mast and/or research aircraft during field campaigns dedicated to ABL.</p> <p>In order to increase our knowledge on moisture exchanges within the boundary layer, in cooperation with the GSMA laboratory in Reims, an expert in laser diode measurement, the CNRM has associated to the existing fast sensor a mini spectrometer with a laser diode weighing less than one kilogram in order to measure moisture fluctuations to calculate the latent heat flux. This LEFE project called FAMOUS concerned the integration of this sensor on the existing probe. The two laboratories worked together to have a prototype of this new probe for the end of 2019.</p> <p>During the experimental campaign of the SOFOG3D project in winter 2019/2020, this probe was used to carry out tests. Since then, corrections have been necessary such as the position of the mirrors in relation to the orientation of the probe and the sun. Other tests were made during the project, notably in a calibration chamber, to ensure that the humidity measurement with the FAMOUS instrument is comparable to conventional measurements.</p> <p>In July 2021, the final probe has been deployed during the LIAISE field campaign in Spain to complement the measurements provided on a 50m mast and those on an aircraft. The deployment of this probe represents a strong asset in this measurement campaign for which understanding the impact of irrigation on the redistribution of humidity on the vertical is essential. In order to evaluate the performance of this sensor, we have 20 hours of measurements of the FAMOUS probe at the 50m level to be compared to the licor data. We also have more than 100 hours of data between 50 and 600m altitude to obtain latent heat flux profiles and to compare them with numerical weather predictions models. Six months after this field campaign, a first analyze of the rapid humidity measurements shows the great quality of the data during the day dedicated to the validation of the sensor. The analyze is ongoing for the other days.</p>		

Tether
FAMO
Sonic ane



Figure 1 : picture of the FAMOUS sensor

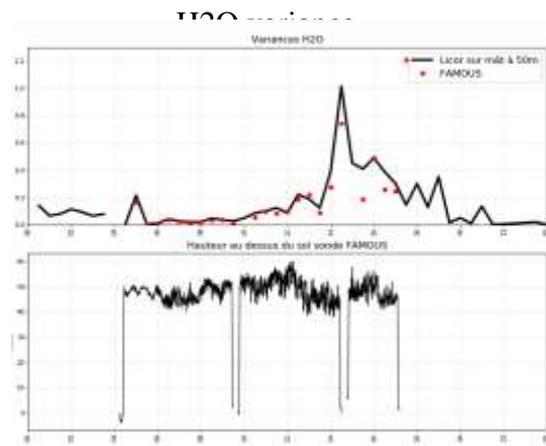


Figure 2 : (top) temporal evolution of the humidity variance mesured by FAMOUS (red) and a Licor(black); (below) altitude of FAMOUS

Figure 1 shows the turbulence probe built by combining a sonic anemometer and an inertial motion sensor, and deployed above a tethered balloon. On one arm of the sonic anemometer we find the FAMOUS sensor which allows us to sample the humidity at a very high frequency. During one day of the LIAISE campaign and in order to validate the sensor, we left the probe at 50m altitude. Figure 2 shows a focus on this day. A licor sensor was positioned at the same altitude on a mast, and provided us a reference measurement. The licor is a reference sensor for fast humidity (20hz) measurement but it has the disadvantage of being heavy. We can see a very good agreement between the measurements of humidity variance from the licor and from FAMOUS.

Future of the project :

This instrument should allow us to quantify moisture exchange in the boundary layer in the LIAISE campaign. This campaign was supposed to take place in 2020, but due to the COVID pandemic it has been postponed to 2021. We have therefore been delayed in exploiting the data. This year will be dedicated to the continuation of the data analysis. Our ambition is to submit a paper with this analysis to demonstrate the contribution of this new instrument. A PhD thesis that will use the data of the LIAISE campaign has been submitted for a start in September 2022, if selected.

The GSMA team has also started collaborating with the CNRS/SAFIRE unit, which deploys aircraft for exploration dedicated to meteorological processes, in order to install the same sensor on the aircraft to replace the current one which does not give satisfaction at high frequency.

Nombre de publications, de communications et de thèses

An article is in preparation for submission to AMT to show the validation of this new sensor with data from the LIAISE campaign

