UAV-REUNION

Deployment of UAVs at Reunion for the Calibration of the TCCON and the mapping of Shipping Emissions

DURATION
01/10/2013 - 31/12/2015

BUDGET
149.973 €

PROJECT DESCRIPTION

It is the aim of this project to demonstrate new and innovative atmospheric measurement techniques using Unmanned Aerial Vehicles (UAVs). Two parallel demonstration activities are envisaged at Reunion Island:

TCCON calibration: As part of the Total Carbon Column Observing Network (TCCON), which retrieves total columns of atmospheric greenhouse gases with high precision and accuracy, the Belgian Institute for Space Aeronomy (BIRA-IASB) operates a high-resolution spectrometer at Reunion Island. To guarantee the accuracy of TCCON measurements, which is crucial for the exploitation of the data, a calibration using in-situ measurements is required. To this end, an AirCore, an innovative lightweight atmospheric sampling system, will be attached to a homing parafoil system, which will be deployed up to 30 km altitude from a balloon.

Test of the newly developed SWING instrument from an UAV: The Small Whiskbroom Imager for atmospheric composition monitorinG (SWING) is a miniaturized payload that has been developed at BIRA-IASB in 2012. Preliminary tests from an ultra-light aircraft have already been performed over Belgium. Its capability to operate from a custom built UAV platform will be demonstrated above the harbour of Reunion Island for the characterization of NO2 and SO2 exhausts from ships.

BIRA-IASB has been studying the atmospheric composition above Reunion Island since 2002. The institute operates two high-resolution Fourier-transform infrared (FTIR) spectrometers at the island. From the measurements of the instruments, the vertical distribution of a variety of atmospheric trace gases above the island can be retrieved. Both spectrometers contribute data to the Network for the Detection of Atmospheric Composition Change and the TCCON.

To assure the accuracy of the TCCON data, the instruments have to be calibrated to the standards of the World Meteorological Organization. In this project we will demonstrate the use an innovative low-cost atmospheric sampling system for this aim. The system is composed of three relatively new separate components, an AirCore, a high-altitude balloon, and a guided parafoil. The capability of this system, to sample the atmosphere up to 30 km, gives it an important advantage over the more conventional aircraft-based calibration systems, which have a maximum altitude of about 13 km. The AirCore will be provided by the Rijksuniversiteit Groningen (The Netherlands), and the homing parafoil system will be designed and built by Reev River Aeropsace (Romania).

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In parallel with the calibration of the TCCON station, and making use of the same Reev River flight infrastructure, the recently developed SWING instrument will be tested above the main harbour of La Reunion Island, to demonstrate the capability of monitoring NO2 and SO2 emissions from ships.

SWING has been developed at BIRA-IASB in the framework of a collaboration with the University of Galati (Romania), and Reev River Aerospace. SWING is a miniaturized instrument dedicated to the mapping of tropospheric gases at high spatial resolution from UAVs. The system is based on a compact ultra-violet visible spectrometer and uses a whiskbroom imaging technique employing a scanning mirror. When mounted on its custom-built UAV, the instrument is able to cover an area of 20x20 km2 in less than one hour. The spectra are analyzed using Differential Optical Absorption Spectroscopy, and several species are detectable, including NO2 and SO2, two atmospheric pollutants emitted in large quantities by ships.

Simulations indicate that the SWING instrument is able to map tropospheric NO2 columns with a ground resolution of approximately 200x200 m2. Such a fine resolution is unreachable from space-based instruments, whose resolution is too coarse to resolve small-scale structures associated to local emissions like e.g. the NO2 horizontal distributions around street canyons, which are important for air quality policies.

Besides their intrinsic scientific value, high resolution maps of NO2 would be useful to estimate the accuracy of the state-of-the-art chemical and transport models. Another straight-forward application of SWING concerns satellite validation. SWING would be able to cover a satellite pixel in less than one hour, and would thus be a very useful validation tool.

Combining the TCCON validation and SWING-UAV tests in a joint field campaign will reduce the overall cost of the two activities, especially since the platforms will be operated by the same operators.

The results of both activities will be published in peer-reviewed scientific papers.

CONTACT INFORMATION

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LINKS

http://uv-vis.aeronomie.be/airborne/swing.php

https://tccon-wiki.caltech.edu/Sites/Reunion_Island