Geophysical Research Abstracts
Vol. 20, EGU2018-6753, 2018
EGU General Assembly 2018

Exploitation of an Unmanned Aerial Vehicle to characterize the air-sea interface near glacier fronts in the Arctic region

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The scientific community is increasingly interested in the characterization of tidewater glaciers phenomena in the Arctic region due to the important role they play in understanding climate changes.
The traditionally used remote sensing methods are often unsuitable in this particular application: data provided are insufficient to well characterize polar regions (missing biological and chemical data), have low temporal and spatial resolution and are often influenced by weather conditions (e.g. cloud cover, lighting conditions). Moreover, the tidewater glaciers front is an hostile environment where very often large masses of ice detach from the glacier itself and could endanger the lives of scientists performing local measurements.
The use of autonomous vehicles (aerial and marine) in these dangerous areas allows overcoming some of the limitations typical of traditional surveys. Autonomous vehicles provide high spatial and temporal resolution data, are low cost and allow greater flexibility in data acquisition operations. Obviously, they are not immune to some problems including payload and autonomy limitations, stability and maneuverability, magnetic compass calibration and local flight regulation restrictions.
This paper describes the use of an Unmanned Aerial Vehicle (UAV) during a scientific campaign carried out in June 2017 in the Kongsfjorden, an Arctic glacial fjord located in the Svalbard archipelago. The drone, landing and taking off from a small support boat, was used to acquire environmental data in front of different tidewater glaciers. The UAV was a DJI S1000 octocopter customized by Italdron and CNR-ISSIA. This drone is portable but able to perform high quality missions thanks to the possibility to carry heavy payloads, which can be mounted on board in addition to the video, positioning and data transmission tools necessary for the drone flight operations.
In this mission, a FLIR-A35 thermal camera and a set of low cost and high-resolution sensors used to analyze the column of air (humidity, temperature, CO, CO_2, O_3, NO_2) were installed on board. The thermal images were georeferenced using the drone telemetry and were used to reconstruct a thermal map of the sea/ice in the area surveyed by the UAV.
The features of the AirQino sensor board (measuring the environmental parameters) satisfy UAV operation requirements: high spatial and temporal resolution, low weight and cost and high accuracy. Temperature and humidity sensors were calibrated against the Climate Change Tower in Ny-Alesund, while the chemistry sensors were calibrated against reference high-cost instruments (HORIBA gas analysers). The data collected during the campaign complemented surface data from the camera giving some information on atmospheric chemical composition. For example, the flown profile highlighted an expected decrease in CO_2 with altitude reaching background values consistent with the recent increase of concentration of said gas in the Arctic due to climate changes.
A preliminary data analysis of the different measured quantities shows interesting results and confirms that the use of UAV in hazardous areas, like in the Arctic, allows obtaining effective environmental and sea surface temperature data. Nevertheless further experimental campaigns are required to achieve a deeper characterization of the processes taking place in front of the Arctic glaciers.