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A Novel UAS Rapid Deployment Platform for Targeted Gas Sampling and Meteorological Soundings at Altitudes up to 2,700 masl

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This research project has developed Unmanned Aerial System (UAS) technologies for intelligent targeting and collection of atmospheric gas samples to investigate the so-called Southern Tropical Methane Anomaly, for which it is necessary to sample air below and above the trade-wind inversion. Air parcels above and below the South Atlantic trade-wind inversion can have markedly different trajectories and, hence, encounter very different methane source regions. The system is intelligent in that high resolution temperature and humidity sensors linked to the ground station characterise the atmospheric profile on the upward flight to ensure the platform targets the appropriate sample elevations on the downward trajectory. This capability has been proven to an altitude of 2,700 metres above sea level (masl; ca. 700 mb) at Ascension Island in the South Atlantic and shown that rapid and repeat deployment and sample collection is achievable. Three novel eight motor multirotor UAS (or octocopter) platforms were developed at Bristol Robotics Laboratory (BRL) using primarily off –the-shelf components with a custom-built main fuselage. Gas sampling and atmospheric sensor systems were designed by the University of Birmingham. Our paper explores the capability of this UAS and provides some initial results from the air sampling campaign conducted in September 2014.

Thirty-eight sampling flights were conducted over 12 days and the resulting 47 samples analysed for their CH_4 concentration using the high-precision Picarro Cavity Ring Down Spectrometer already installed at Ascension Island. A subset of samples were sent for $\delta^{13}C_{CH4}$ analysis in Egham, UK. The flights were conducted up to an altitude of 2,700m with 2,000m being typical. There were no major incidents although variable zero and high wind situations above the trade wind inversion (typically at 1,800m) both presented unique challenges and required careful flight planning strategies and in flight trajectory changes. As a result algorithms were developed to estimate in-flight wind speed and direction from aircraft attitude data.

The results from the meteorological samples compared favourably with modelled data from the local Met Office station and we also show comparisons with wind speed and direction as well as insights gained from the CH_4 analysis. Finally, system improvements and further measurements planned for our return to the island in mid-2015 are presented.

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