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Development of an airborne three-channel LED-based broadband cavity enhanced absorption spectrometer: towards an improved understanding of nighttime chemistry of NO_3 and N2O5 in northwest Europe

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A three-channel cavity-enhanced absorption spectrometer capable of covering a broad UV-vis spectrum range has been developed in Cambridge for deployment on board the UK FAAM BAe-146 atmospheric research aircraft for measuring in situ concentrations of important atmospheric absorbers such as NO_3, N2O5, NO_2, IO and H_2O and also aerosol extinction. So far this instrument has been deployed in two aircraft campaigns (the ROle of Nighttime chemistry in controlling the Oxidative Capacity of the atmOsphere, RONOCO, during July 2010 and January 2011; and the Coordinated Airborne Studies in the Tropics, CAST, during February 2014) with focuses on measuring NO_2/NO_3/N2O5 (for RONOCO) and IO (for CAST). In this talk, I will start by briefly presenting the working principle, design consideration, sensitivity test as well as intercomparison results of this novel aircraft instrument. I will then move on to present recent results from the analysis of the RONOCO campaign data, to illustrate the spatial and temporal variability of nighttime chemistry processes revealed by the high-resolution NO_3 and N2O5 data collected. Significant improvements were made towards a better understanding of the oxidation of reactive VOCs by NO_3 and O_3 and the contribution of peroxy radicals (HO_2 and RO_2, of which only HO_2 was successfully measured) to NO_3 direct losses, and towards determining factors (organics and nitrate components of the aerosol particles, and relative humidity) that greatly influence the rate of N2O5 uptake by aerosol particles as well as directly probing the role of cloud, rain and ice scavenging in removing N2O5, in this typical northwest European environment.