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Airborne measurements of HCN, CO_2 and CH_4 associated with emissions from boreal biomass burning

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High resolution measurements of hydrogen cyanide (HCN), carbon dioxide (CO_2) and methane (CH_4) were made over Canada onboard the UK Atmospheric Research Aircraft FAAM BAe-146 from 12 July to 4 August 2011. The observations were made as part of the international BORTAS project which aims to quantify the impact of BOReal forest fires on Tropospheric oxidants over the Atlantic using Aircraft and Satellites. The sorties were aimed at transecting and sampling the outflow from the commonly occurring North American boreal forest fires during the summer months and to investigate and identify the chemical composition and evolution of these plumes.

HCN is a distinctive and useful marker for forest fire emissions and it was detected using chemical ionisation mass spectrometry (CIMS). The ionisation scheme employed I^- ions which form an adduct with HCN and typical sensitivities of 0.6 counts/ppt have been achieved for sampling at 1 Hz. Elevated CO_2 and CH_4 are also commonly associated with forest fire emissions and they were measured using the Fast Greenhouse Gas Analyser (FGGA) by Los Gatos Research. This near-IR off-axis integrated cavity output spectroscopy system allowed detection and sampling at 10 Hz. In-flight calibrations revealed a mean accuracy of -0.02 ppmv $\pm$ 0.57 ppmv (1σ precision) for CO_2 and a mean accuracy of 0.08 ppbv $\pm$ 2.31 ppbv (1σ precision) for CH_4 for 1Hz observations during the BORTAS campaign.

During the 10 flights over the Eastern Canada region (Nova Scotia, New Brunswick, Newfoundland, Ontario and Quebec) several biomass burning plumes were sampled and enhancements in levels of HCN, CO_2 and CH_4 within these plumes were evident.

The observed HCN enhancements inside the plume compared to outside the plume reached up to factor of about 10. For the majority of plumes, a good positive correlation with CO was seen, and in some plumes, CO was observed whilst no HCN was detected, indicating possibly emission sources of anthropogenic activity rather than forest fires. Peak concentrations of CO_2 were also measured nearby a refinery in Halifax. During some flights, elevated CH_4 concentration, likely to be associated with wetland emissions rather than forest fires, were also observed. Maximum concentrations of CO_2 and CH_4 were similar to those observed during the summer ARCTAS campaign in 2008 (Simpson et al., 2011) with maxima of 400 ppmv of CO_2 and 2040 ppbv of CH_4.

Further in-depth analysis and results, such as emission ratios, will be discussed and put in context with other boreal forest fire emission experiments, such as e.g. ARCTAS.

Reference: Simpson et al. Boreal forest fire emissions in fresh Canadian smoke plumes: C1-C10 volatile organic compounds (VOCs), CO_2, CO, NO_2, NO, HCN and CH_3CN, Atmos. Chem. Phys., 11, 6445–6463, 2011