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Trace Gas Measurements in the Canadian High Arctic using Infrared Emission Spectroscopy

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The High Arctic experiences prolonged periods of total darkness in the winter and continuous daylight in the summer, influencing the atmosphere and its composition in ways that are still not fully understood. Conducting atmospheric measurements in this remote region is challenging, particularly during polar night when solar-viewing instruments are not operational. By using infrared emission spectroscopy, which is independent of sunlight, we are able to document year-round the total column abundances of carbon monoxide (CO), methane (CH4), nitrous oxide (N2O), and ozone (O3). Measurements are made at the Polar Environment Atmospheric Research Laboratory (PEARL, Eureka, Nunavut, Canada, 80.05 N, 86.42 W) using Atmospheric Emitted Radiance Interferometers (AERIs) to measure the absolute downwelling infrared emission from the atmosphere between 500 and 3000 cm-1. The instruments have a moderate resolution of 1 cm-1 and provide total column trace gas measurements with high sensitivity to the lower troposphere. The University of Idaho' s Polar AERI (P-AERI) was installed at PEARL from March 2006 to February 2009 while the second instrument, the E-AERI (Extended-range AERI from 400 cm-1), was installed in October 2008 and is still operating today. The combined measurements allow us to investigate the total column densities of CO, CH4, N2O and O3 at PEARL from 2006 to 2015. These two datasets are compared and validated, during sunlit hours, with measurements made by a high-resolution solar-viewing infrared spectrometer (Bruker 125HR) on-site. Preliminary results indicate that the AERI and Bruker 125HR O3 and CO measurements are highly correlated, with a correlation coefficient of 0.95 and 0.83 respectively (unsmoothed). We present the annual, seasonal and diurnal variability of trace gases in the high Arctic, highlighting ozone depletion events as well as biomass burning events that were observed between 2006 and 2015.

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