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Thermal and near-infrared sounding for weather, air quality and greenhouse gas monitoring in the Arctic from highly elliptical orbits

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The Canadian Space Agency's PCW (Polar Communications and Weather) mission is a dual satellite mission with each satellite in a highly eccentric orbit with apogee ~42,000 km and a period in the 12-24 hour range to deliver continuous (24x7) communications and meteorological data over the Arctic. The baseline meteorological instrument is a 21-channel spectral imager similar to MODIS or ABI. The PHEMOS (Polar Highly Elliptical Molniya Orbital Science) mission is a science complement to the PCW mission to address weather, climate and air quality issues. The instrument package consists of a Fourier transform spectrometer (FTS) to cover the near-infrared and mid-infrared spectral range and an ultraviolet-visible (UVS) spectrometer.

In a phase A study funded by the Canadian Space Agency, we are configuring an FTS instrument for thermal infrared sounding as well as for greenhouse gas monitoring via near-infrared solar reflection. Using imaging detectors allows many measurements in parallel with increased observation time up to 100 s per view. The field-of-regard (FOR) is subdivided into a number of views such that a full measurement of the FOR is completed in about 1 hour. A pointing mirror is used in a step and stare mode. The thermal infrared is covered with two optimized bands; band 1 covers 700 to 1400 cm^{-1} and band 2 covers 1800 to 2500 cm^{-1} for which the scientific focus are temperature and water vapour profiles and air quality species (including CO, O_3, HNO_3, NH_3). The spectral resolution is 0.3 cm^{-1}. The near-infrared spectral bands target absorption signatures of CO_2, CH_4, and O_2. The two relevant spectral ranges are 5990-6450 cm^{-1} and 13060-13168 cm^{-1} (O_2-A band), measured with spectral resolutions of 0.3 and 0.6 cm^{-1}, respectively. The O_2-A band is used to determine surface pressure, albedo, and aerosol optical depth and vertical distribution, the latter of which is critical for CO_2 retrieval. The FTS instrument design will be presented as well as design challenges and expected performance. Retrieval studies examining the feasibility of measuring CO_2, CH_4, and aerosol properties as a function of signal-to-noise ratio, radiometric accuracy, surface albedo, and other factors will be presented as well.