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# **An Air Quality and Greenhouse Gas Mission focused on Northern Regions**

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# Canadian HEO Mission: Background, History

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- Enormous benefits to GEO + LEO constellation of missions , but neither is well-suited for continuous high latitude coverage
- Two or more satellites in a Highly Elliptical Orbit (HEO) configuration can be used for quasi-geostationary coverage of the high latitudes
- There is potential for a Canadian **HEO** mission focused on the north
- The Polar Communications and Weather (**PCW**) mission was considered as early as 2007, but the partnership is now unlikely
- Canadian Space Agency (CSA) also considered additional instrument enhancements to PCW under the Polar Highly Elliptical Orbit Science (**PHEOS**) program
- The Weather, Climate and Air quality (**WCA**) mission concept was an atmospheric research option that completed Phase 0 and A in 2012 (PCW-PHEOS-WCA PI: Prof Jack McConnell, York U, now deceased)

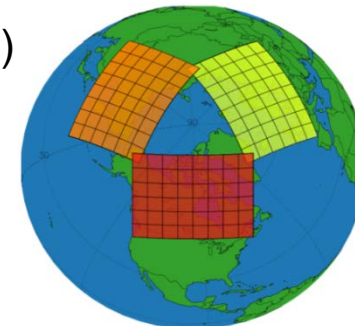


# PCW-PHEOS-WCA Bands, Species, Coverage

Optimal and All-Band (Lite)  
Compliant

	Band ( $\mu\text{m}$ )	Band ( $\text{cm}^{-1}$ )	Resolution	Target species	
<b>FTS</b>	1	6.7 – 14.2	700 - 1500	0.25 $\text{cm}^{-1}$	T, H <sub>2</sub> O, O <sub>3</sub> , CO, CO <sub>2</sub> ,
	2	3.7 – 5.6	1800 - 2700	0.25 $\text{cm}^{-1}$	CH <sub>4</sub> , HNO <sub>3</sub> , CH <sub>3</sub> OH, HCOOH, PAN, HCN, NH <sub>3</sub> , SO <sub>2</sub> ...
	3a	1.66 - 1.67	5990 - 6010	0.25 $\text{cm}^{-1}$	<b>CH<sub>4</sub> columns</b>
	3b	1.60 - 1.67	5990 - 6257	0.25 $\text{cm}^{-1}$	<b>CO<sub>2</sub> and CH<sub>4</sub> columns</b>
	4	0.760-0.766	13060-13168	0.50 $\text{cm}^{-1}$	<b>O<sub>2</sub> A band (<math>p_{\text{surf}}</math>, aerosol)</b>
<b>UVS</b>	0.280-0.650		~ 1 nm	O <sub>3</sub> , NO <sub>2</sub> , aerosol, BrO, HCHO, SO <sub>2</sub> , ...	

Fourier Transform Spectrometer (FTS) / UV-Visible Spectrometer (UVS)



For details see: Nassar, Sioris, Jones, McConnell (2014), Satellite observations of CO<sub>2</sub> from a highly elliptical orbit for studies of the Arctic and boreal carbon cycle, J. Geophys. Res., 119, 2654-2673, doi:10.1002/2013JD020337 and PCW-PHEOS-WCA references therein.



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**Potential PHEOS-WCA-FTS  
Fields of Regard**

# Update on Recent Canadian Activities

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- Continual development of imaging FTS technology (2016-2017) for GEO and HEO applications (by ABB, funded by CSA), with plans for stratospheric balloon testing of an IFTS to measure CO<sub>2</sub> and CH<sub>4</sub> in 2018
- New CSA and Environment and Climate Change Canada (**ECCC**) mission concept study: “Air Quality and GHG mission focused on Northern Regions” (2016-2017) builds off past work. Have enlisted an industry team led by ABB (with Airbus, MDA and other subcontractors) to re-examine:
  - Orbit: HEO remains the baseline, but other possibilities still on the table
  - Bands: GHG and AQ now higher priority than meteorology -> still need TIR?
  - Advantages of FTS vs. grating technology for imaging
  - Full instrument trade studies (bands, spectral/spatial resolution ...)
  - Assess costs – standalone mission, hosted payload, partnerships
- This new **Northern** mission concept has stricter AQ and GHG precision and horizontal resolution requirements than PCW-PHEOS-WCA to increase the value of the observations for estimating northern (~50-90°N) anthropogenic emissions and link to requirements of international LEO/GEO missions



# Summary and Conclusions

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- Ongoing efforts and funding in Canada toward a satellite mission to observe air quality and greenhouse gases in northern regions as demonstrated by continual technology development and a “Concept Study for an AQ and GHG Mission focused on Northern Regions”
- HEO remains the leading option for quasi-geostationary high latitude coverage, giving some mid-lat overlap with GEO missions
- Observing requirements set by ECCC and CSA align with other missions in the CEOS-ACC constellation and proposed missions being discussed as components of a future GHG constellation
- A strong industry team is currently assessing design trade-offs
- Partnerships with other countries/agencies may be needed to make a quasi-geostationary northern AQ and GHG mission a reality
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