National Aeronautics and Space Administration

FY24 Strategic Initiatives Research and Technology Development (SRTD)

Earth System Explorer - Greenhouse gases

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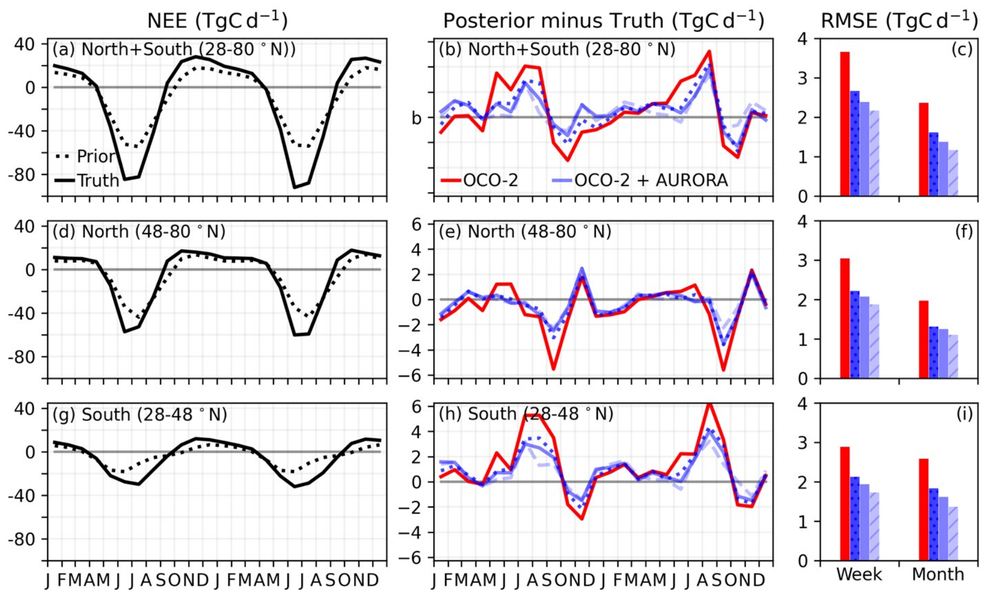
**Jet Propulsion Laboratory, California Institute of Technology*

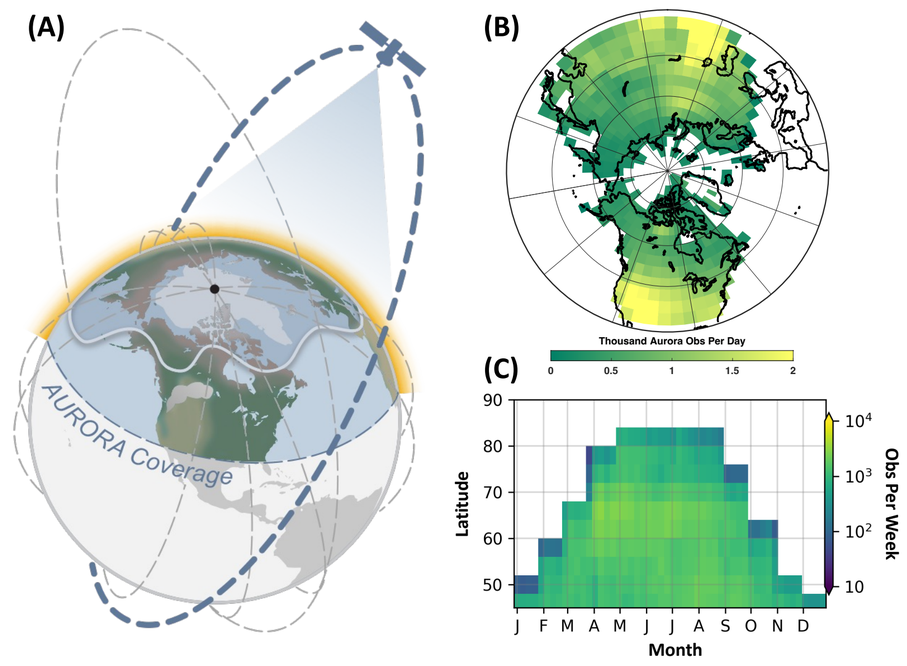
Strategic Focus Area: Earth System Explorer – Science Definition and Technology Maturation **| Strategic Initiative Leader:** Sabrina M Feldman

Background and Objectives: This proposal focuses on concept and technology maturation for ESE and EV class missions focusing on GHGs. Our concept considers panFTS in different orbits (HEO, GEO, MEO) to optimize C cycle science return at regional- to global- scale. Our GHG ESE concept maturation objectives aim to resolve long-standing questions about C emissions resulting from emerging tipping points in critical ecosystems in Arctic and tropical regions. We address these critical questions using retrieval and flux OSSEs, leveraging PanFTS multi-spectral (SWIR + TIR) retrievals of multiple species (CO2, CH4, CO, SIF, wind), and sub-daily to daily spatially resolved mapping. Our objectives are to: (1) Quantify grid scale flux uncertainty reduction, (2) Determine the detectability of abrupt GHG emissions, and (3) Optimize PanFTS instrument design to achieve pan-Arctic and global GHG science.

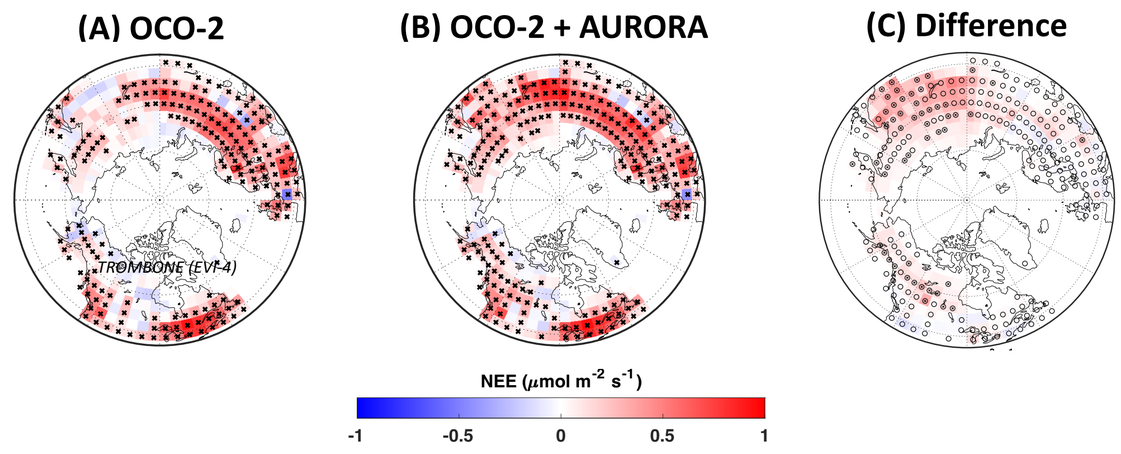
Paper Highlight 1: Our team demonstrates improved observations of Arctic GHG sources and sinks <u>via reduction of flux retrieval uncertainty</u> across the entire annual cycle relative to the state-of-the-art (OCO-2)



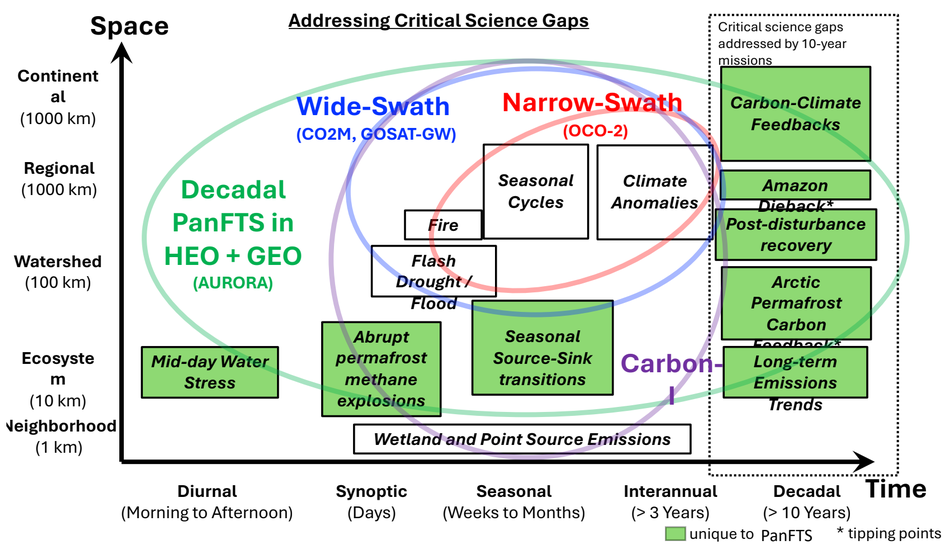
The Arctic Fourier Transform Spectrometer Investigation (AURORA) mission concept addresses (B) spatial and (C) temporal GHG sampling limitations in the Arctic



Paper Highlight 2: We demonstrate that AURORA + OCO-2 improves grid accuracy by increasing sampling frequency

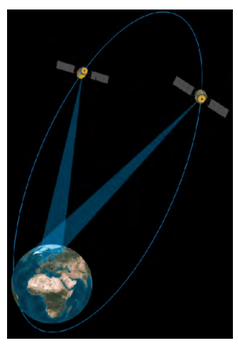


Undiscovered Country: Multi-decadal, sub-daily, regional sampling address critical GHG Science gaps



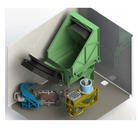
- **Explored Partnership Opportunities** with Canadian Space Agency (CSA) Arctic Observing Mission (AOM) and NOAA GeoXO to Reduce Cost and Increase Science Return.
- **A-Team Study** Demonstrating Science Value of Multi-Decadal GHG Partnership

Potential Partners Enable Critically Important Benefits at Greatly Reduced Cost



2 S/C in HEO in 2034 for 10-year missions to image **Arctic and boreal regions**

GHG + SIF



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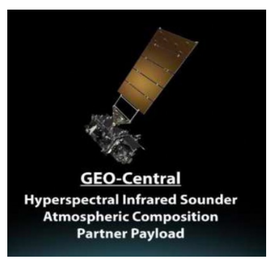
- CSA and NOAA Offer Partner Payload Opportunities with target launch in mid-2030s
- CSA focus on Arctic Boreal Region (HEO)
- NOAA focus on Amazon and CONUS (GEO)
- JPL contributes GHG and Ecology focused PanFTS, providing continuous sub-daily climate mitigation focus
- Partnership Benefits: Synergy with other Targeted Observables, Free Spacecraft, Launch, Operations, Downlink, potential CSA hardware contributions



2 S/C in GEO in 2035, 2041 for 10-year missions to image **Amazon and CONUS**

Significance/Benefits to JPL and NASA: Retrieval OSSE's demonstrate the potential of the JPL designed multi-spectral panFTS to retrieve sub-daily maps of CO2 and CH4 vertical profiles (2+ DOFs) at sub-daily frequency in the tropics and Arctic. This offers advanced GHG spectral, spatial, and temporal sampling relative to PoR. Increased sampling of the pan-Arctic improves C flux detectability, reducing uncertainty in carbon-climate feedback.

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