

NSF/NCAR Oceanographic Aviation Developments



Britt Stephens

NCAR Research Aviation Facility





NSF/NCAR Gulfstream (GV)

- Aircraft :: high-altitude jet, modified for research
- Capabilities :: 50,000 feet, 10 hours endurance, and 5,000 nm range
- Areas of Research :: chemistry and climate, chemical cycles, studies of the upper troposphere/lower stratosphere, air quality, and mesoscale weather

NSF/NCAR C-130

- Aircraft :: Turboprop aircraft, Hercules C-130Q
- Capabilities :: 26,000 feet, ~10 hours endurance, and 2,500 nm range
- Areas of Research :: atmospheric chemistry, climate studies, winter storms, aerosols, cloud physics, and air-sea interaction



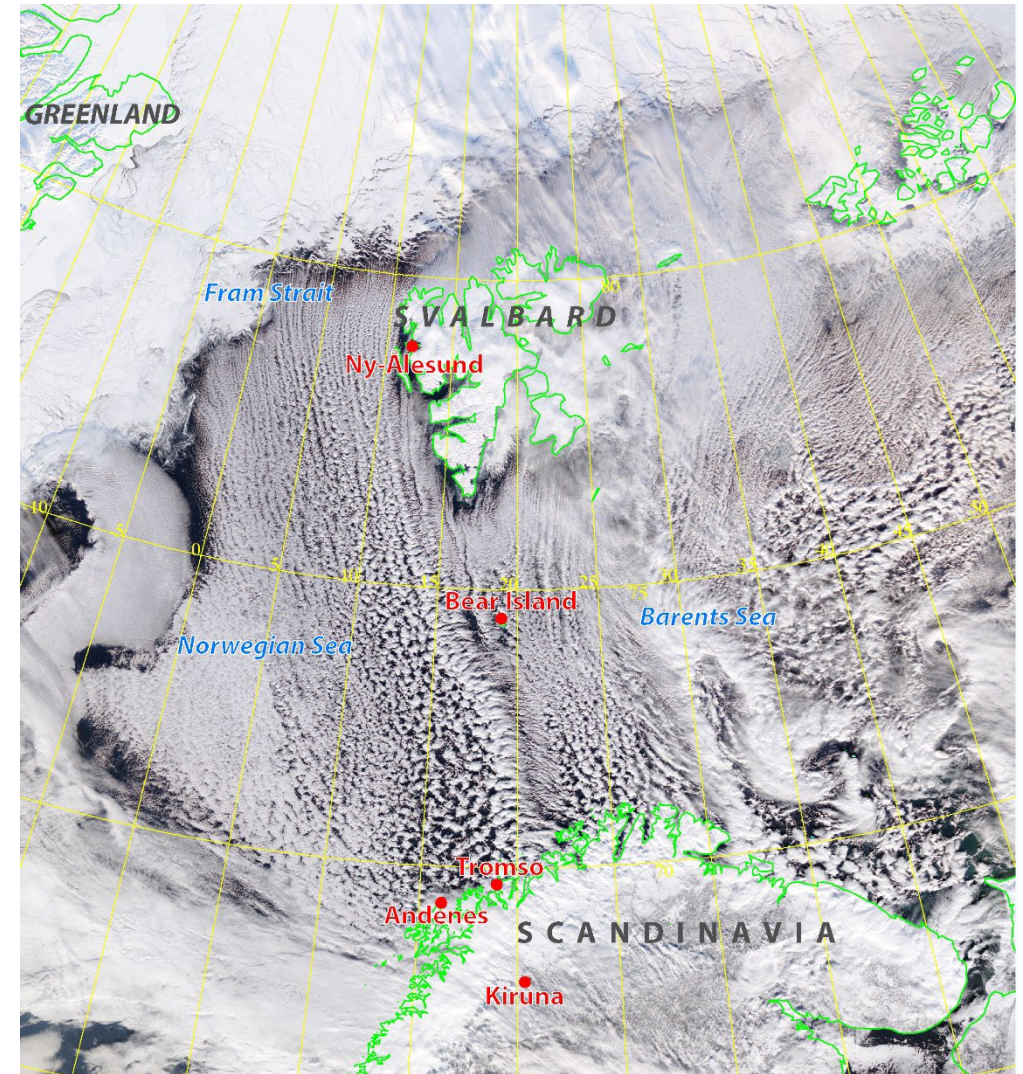
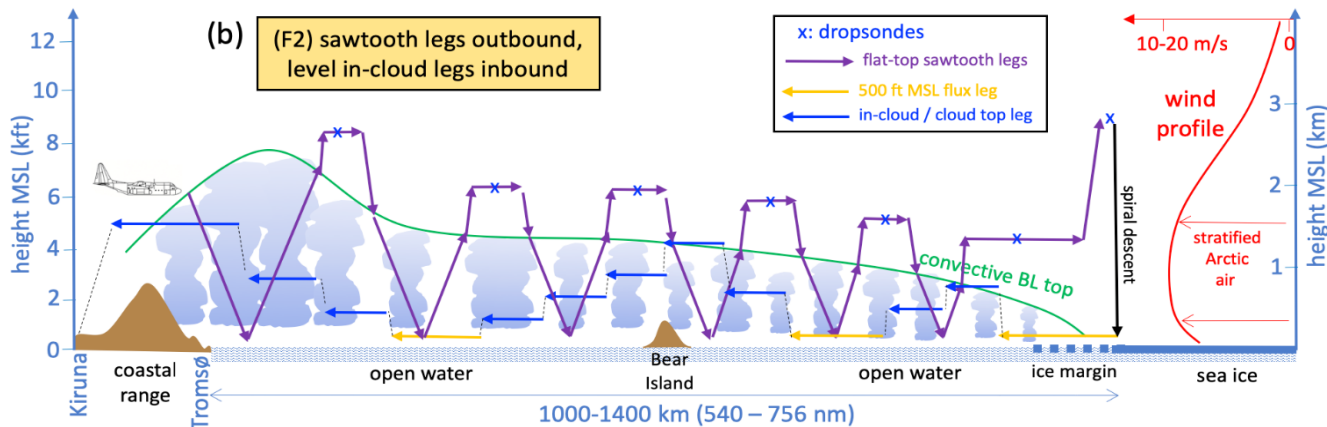


Scientific Steering Committee:

Paquita Zuidema, U. Miami
 Bart Geerts, U. Wyoming
 Greg McFarquhar, U. Oklahoma

Operations:

Kiruna, Sweden
 22 February – 7 April, 2024





NSF funded project to measure CO₂ from the LC-130s led by NCAR, CU, and NOAA



SCARGO Goals

The primary science goals of SCARGO are to:

1. Quantify the magnitude and **seasonal evolution (Nov-Feb)** of Southern Ocean air-sea CO₂ exchange.
2. Measure **interannual variability over three years** in Southern Ocean summertime air-sea CO₂ exchange.

In addition, SCARGO seeks to make a valuable methodological advance to:

3. Establish the feasibility and optimal approach to leverage the aircraft already supporting the US Antarctic Program for science.



CARBON CYCLE

Strong Southern Ocean carbon uptake evident in airborne observations

Matthew C. Long^{1*}, Britton B. Stephens¹, Kathryn McKain^{2,3}, Colm Sweeney³, Ralph F. Keeling⁴, Eric A. Kort⁵, Eric J. Morgan⁴, Jonathan D. Bent^{1,4,†}, Naveen Chandra^{6,‡}, Frederic Chevallier⁷, Róisín Commane⁸, Bruce C. Daube⁹, Paul B. Krummel¹⁰, Zoë Loh¹⁰, Ingrid T. Luijkx¹¹, David Munro^{2,3}, Prabir Patra¹², Wouter Peters^{11,13}, Michel Ramonet⁷, Christian Rödenbeck¹⁴, Ann Stavert¹⁰, Pieter Tans³, Steven C. Wofsy^{9,15}

RESEARCH

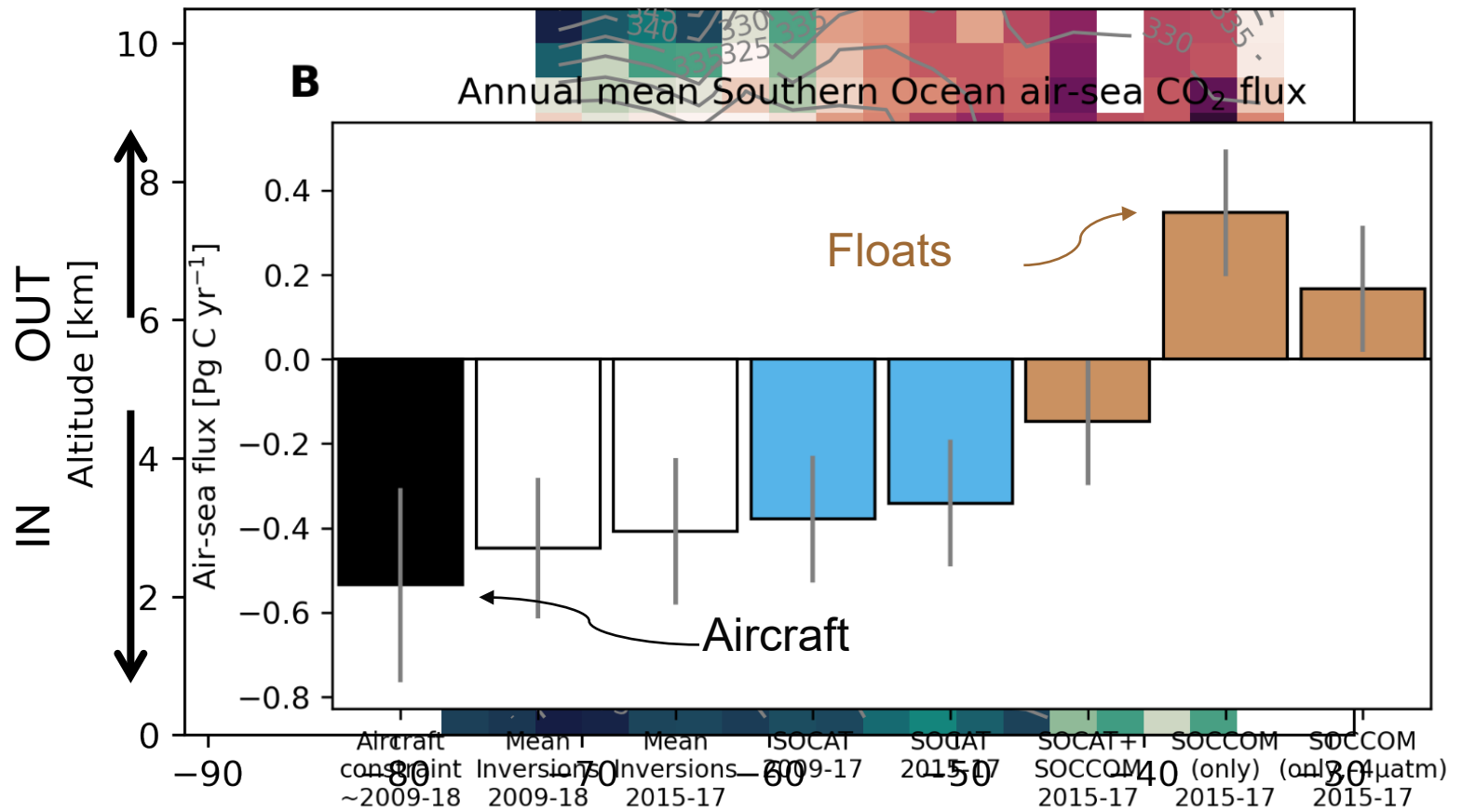
IN SCIENCE JOURNALS

Edited by Michael Funk



Long *et al.*, *Science* **374**, 1275–1280 (2021) 3 December 2021

A Aircraft obs: CO₂ minus 295–305K mean (Jan-Feb 2016)



SCARGO Project Timeline

May 2018: Proposal submitted for three full field seasons (2019/20, 2020/21, 2021/22)

March 2019: Proposal awarded

May 2019: AF1067 submitted

Oct 2021: Certification basis signatures

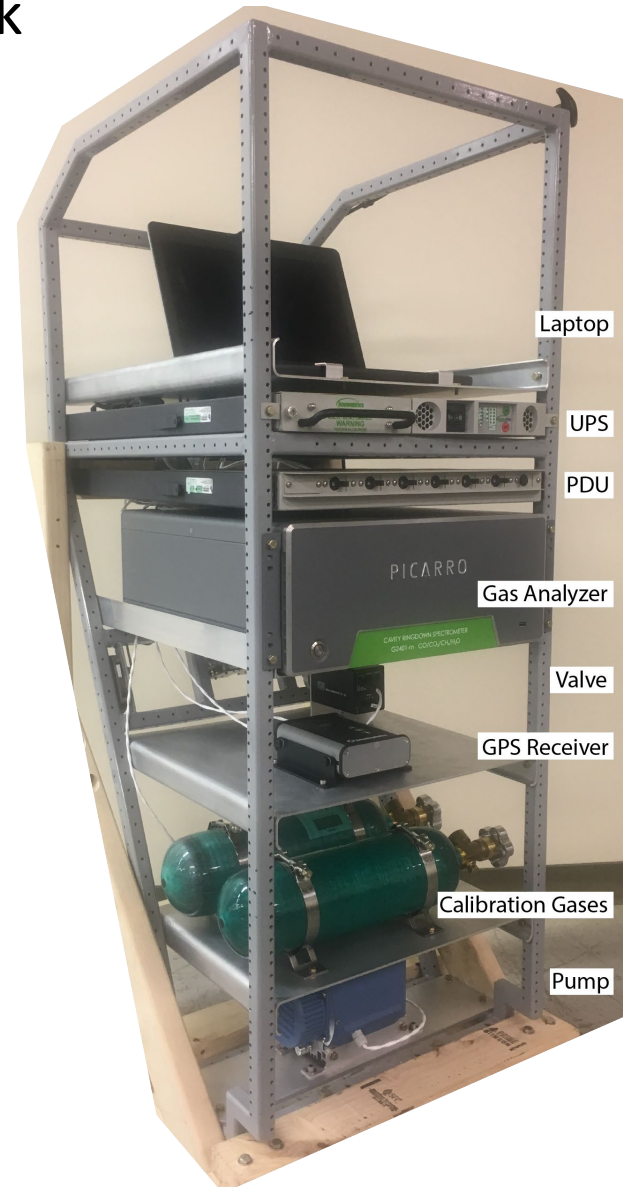
March 2022: Test phase in Schenectady, NY

Aug 2022: Approved for flight

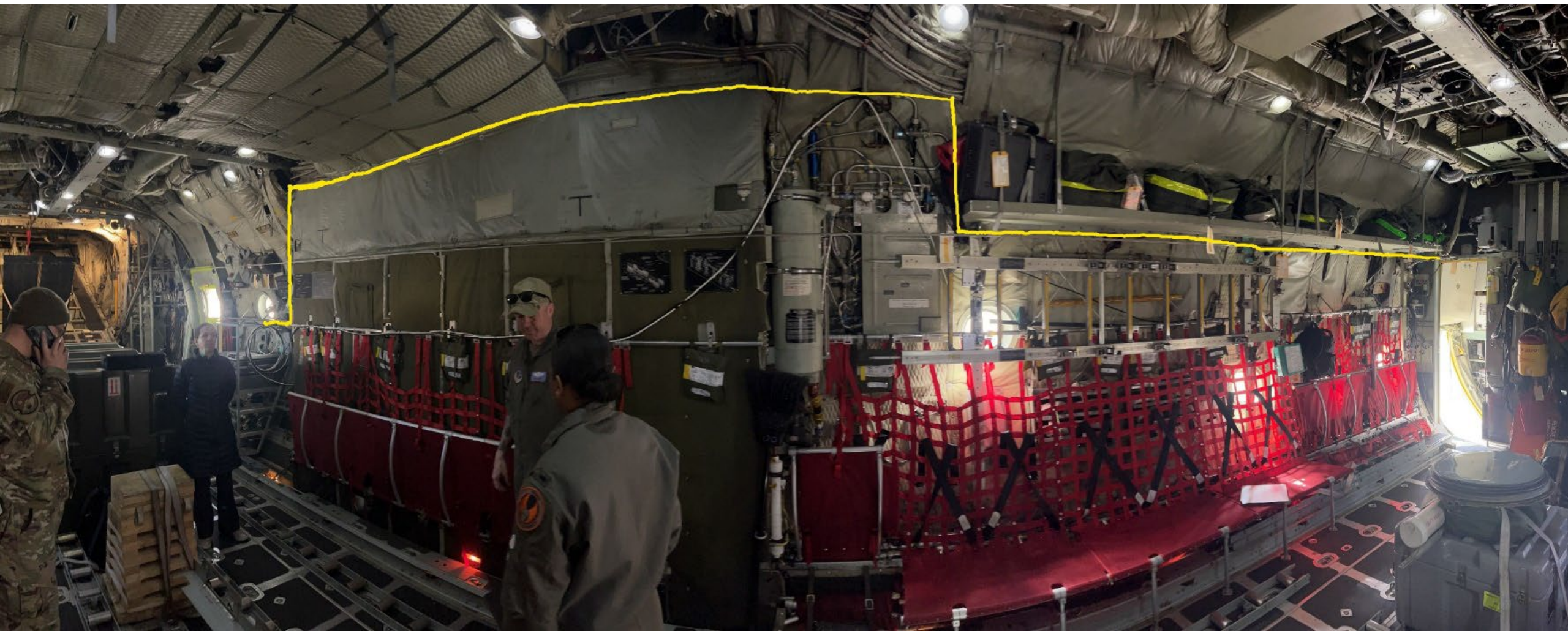
Nov-Dec 2022: Test deployment to McMurdo



AirDyne Aerospace AS-20S Avionics Rack







Nov/Dec 2022 SCARGO Test Season

Initially planned for Nov-Feb

Descoped in Oct to remove Jan following cargo ops input

Integrated in Christchurch following COVID pause

8 flights over 5.5 weeks (11/20-12/27)

- 3 CHC-MCM and 2 MCM-CHC
- 3 MCM-Pole roundtrips including 1 dip

Further descoped mid-Dec to end Dec 27th

Successful test of operations

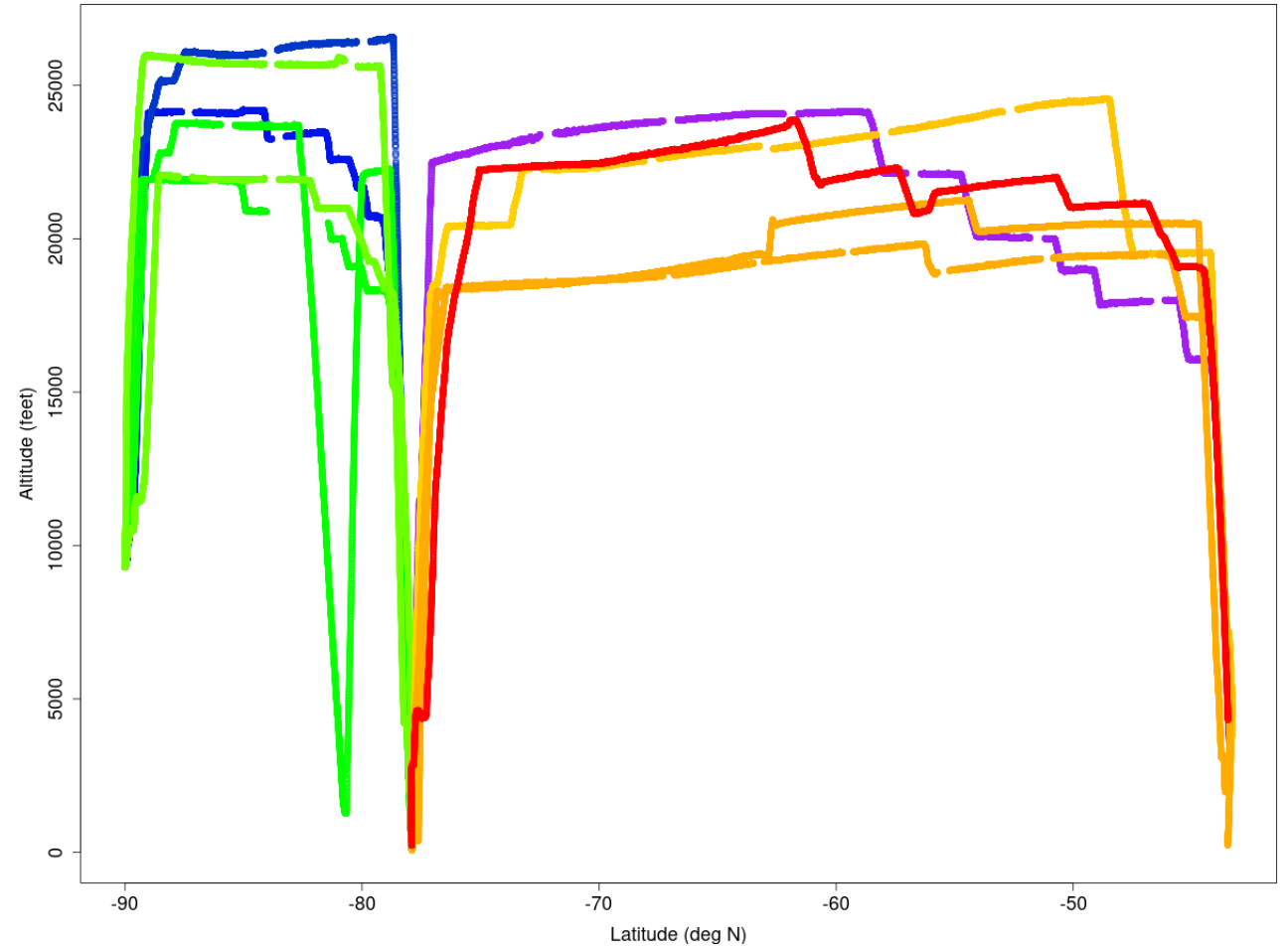
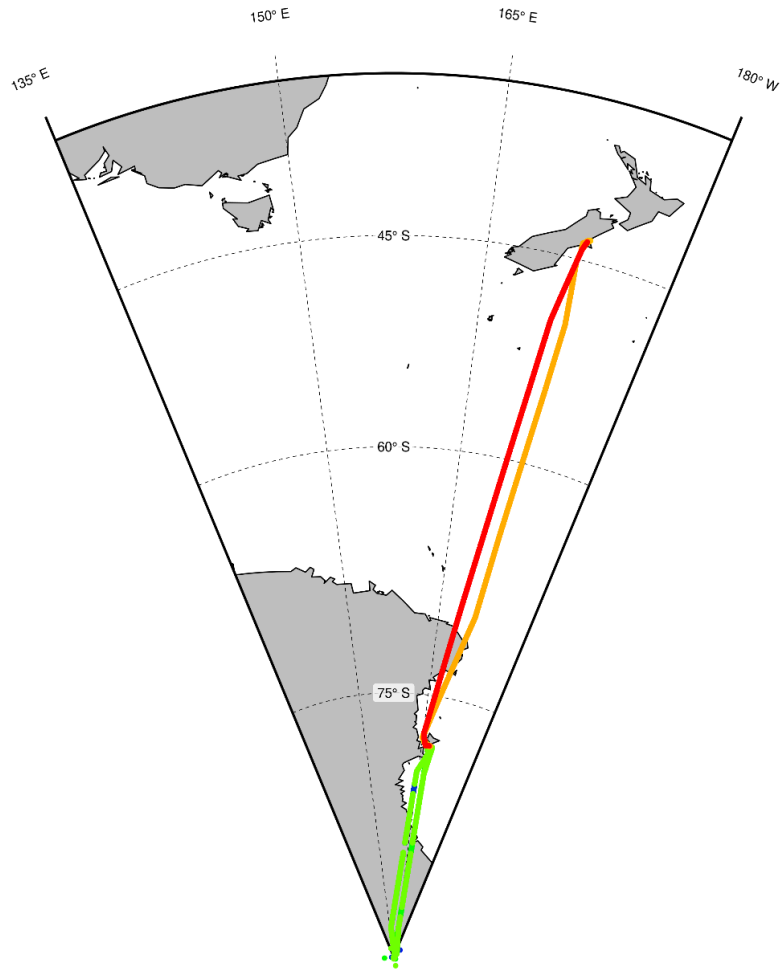
Stresses to ASC cargo planning system identified



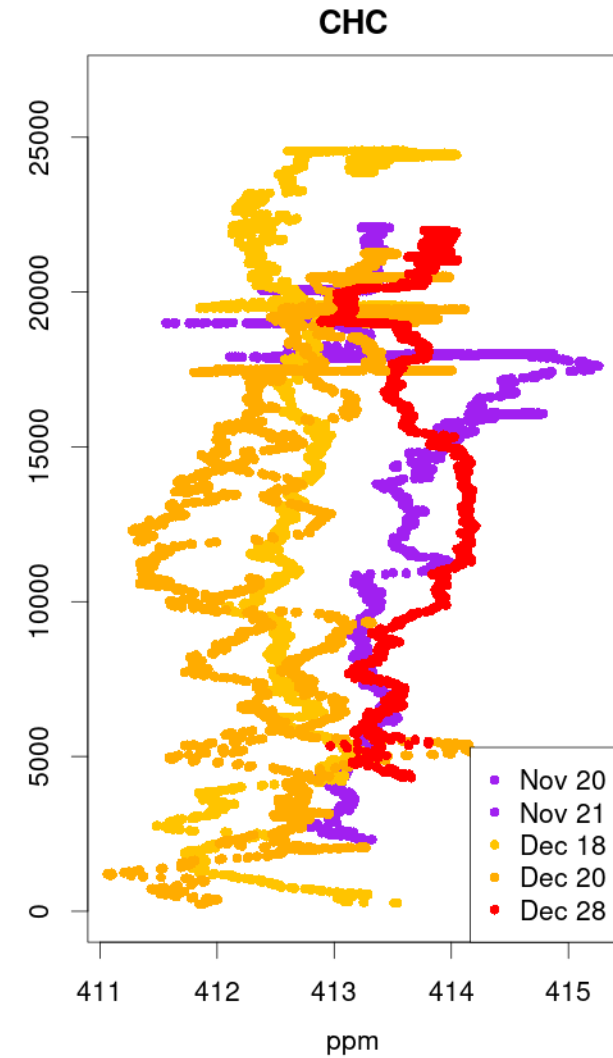
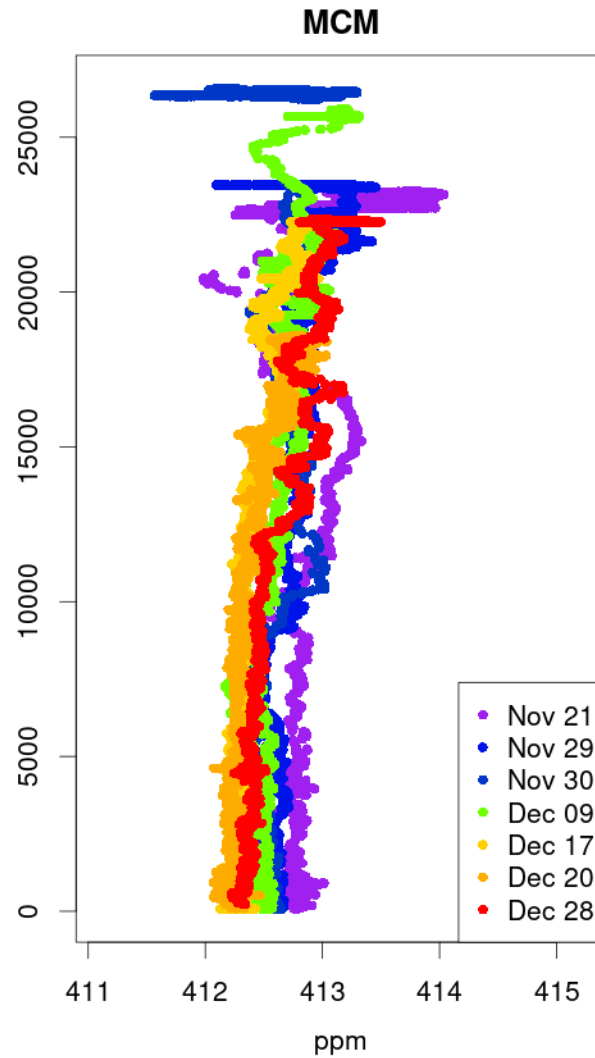
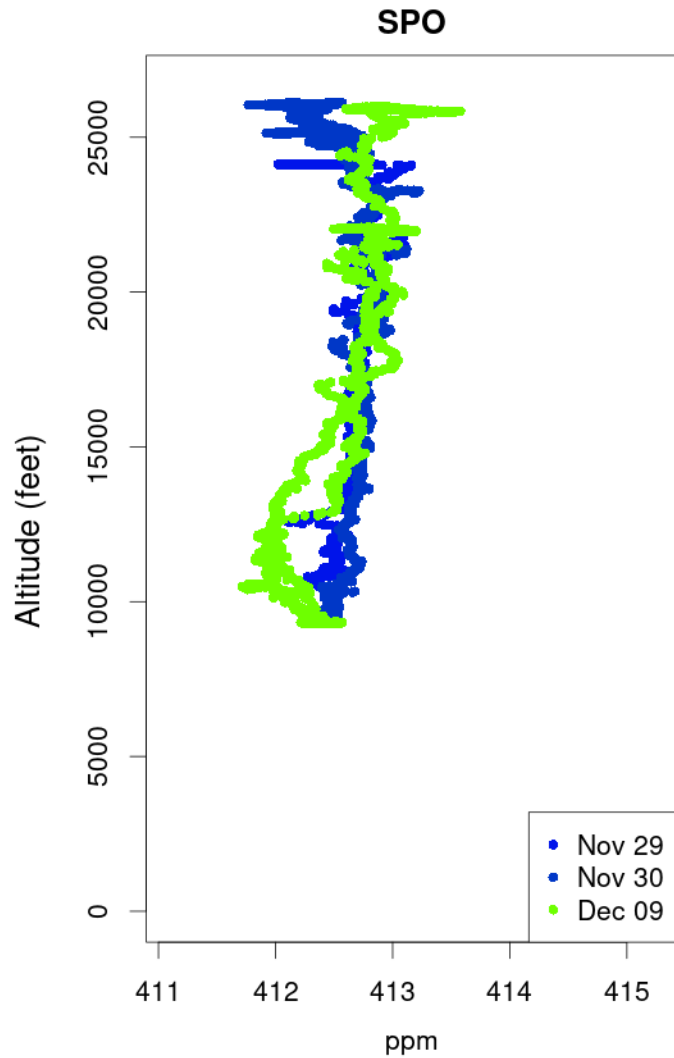
C. Martin



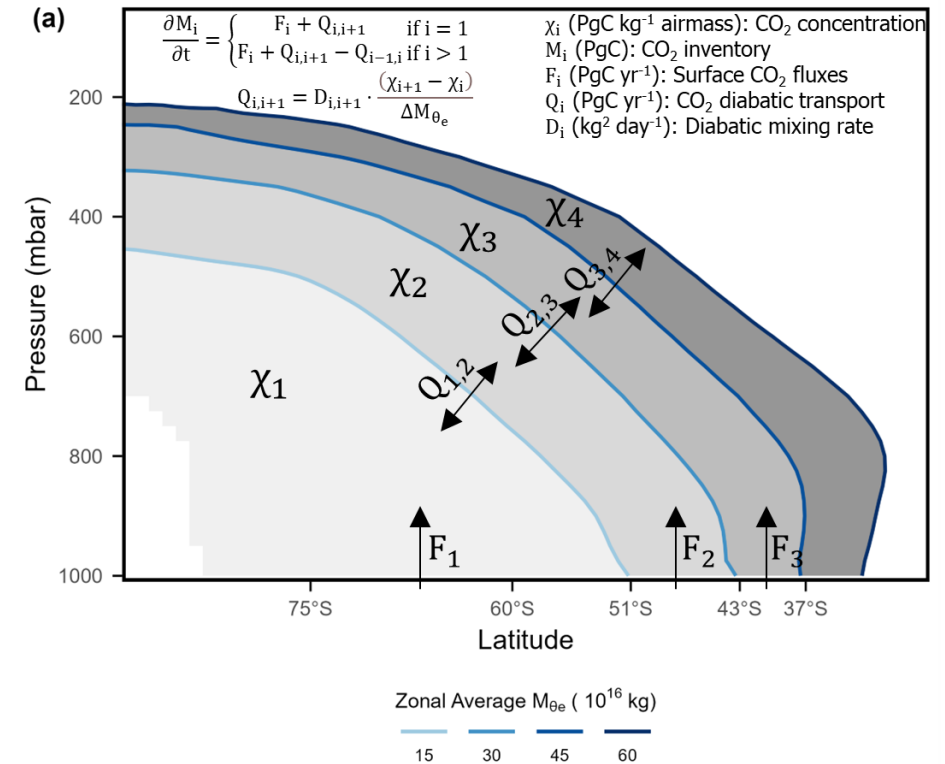
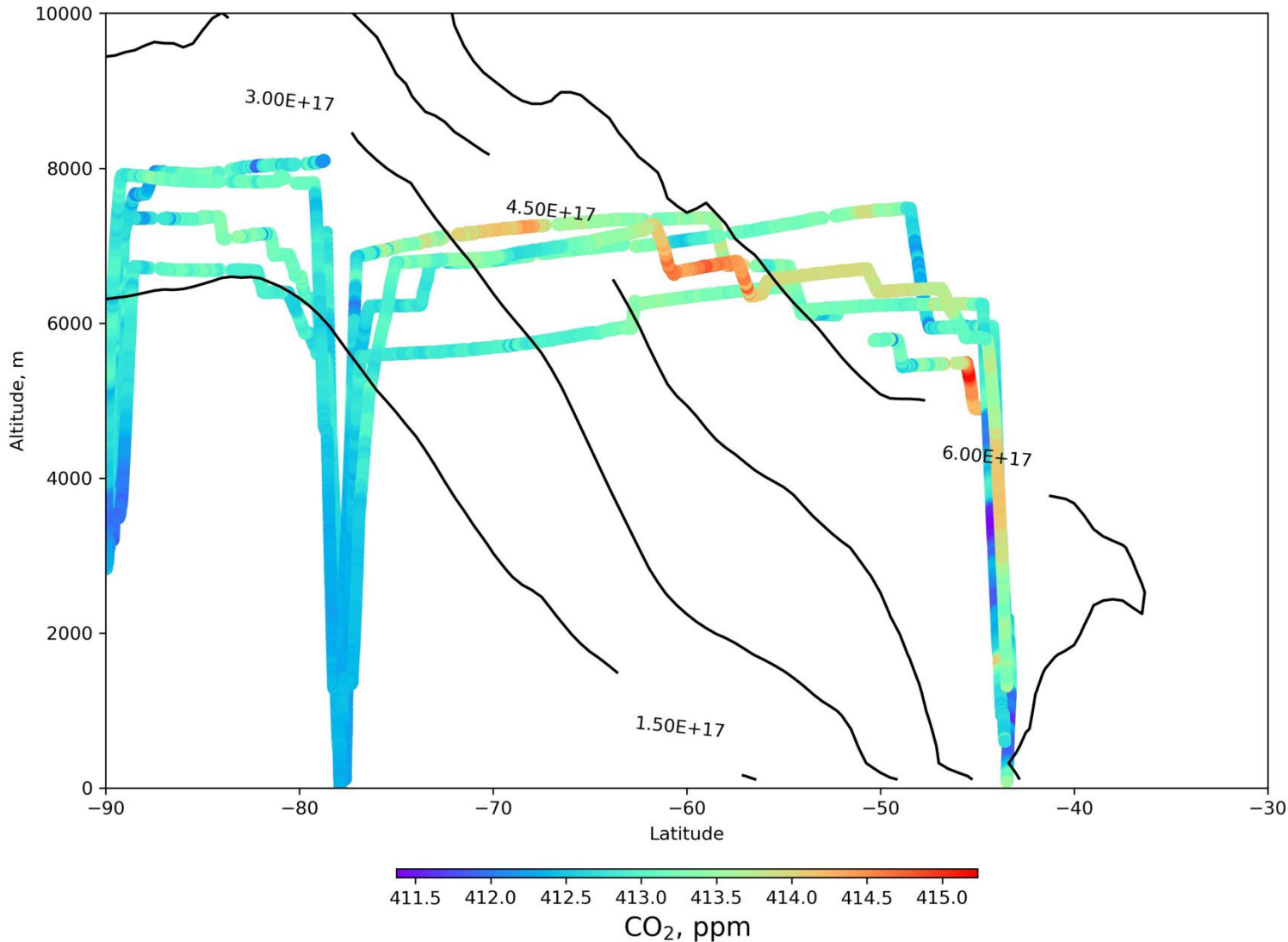
Nov/Dec 2022 SCARGO Test Season – flight tracks



Nov/Dec 2022 SCARGO Test Season – CO₂ profiles



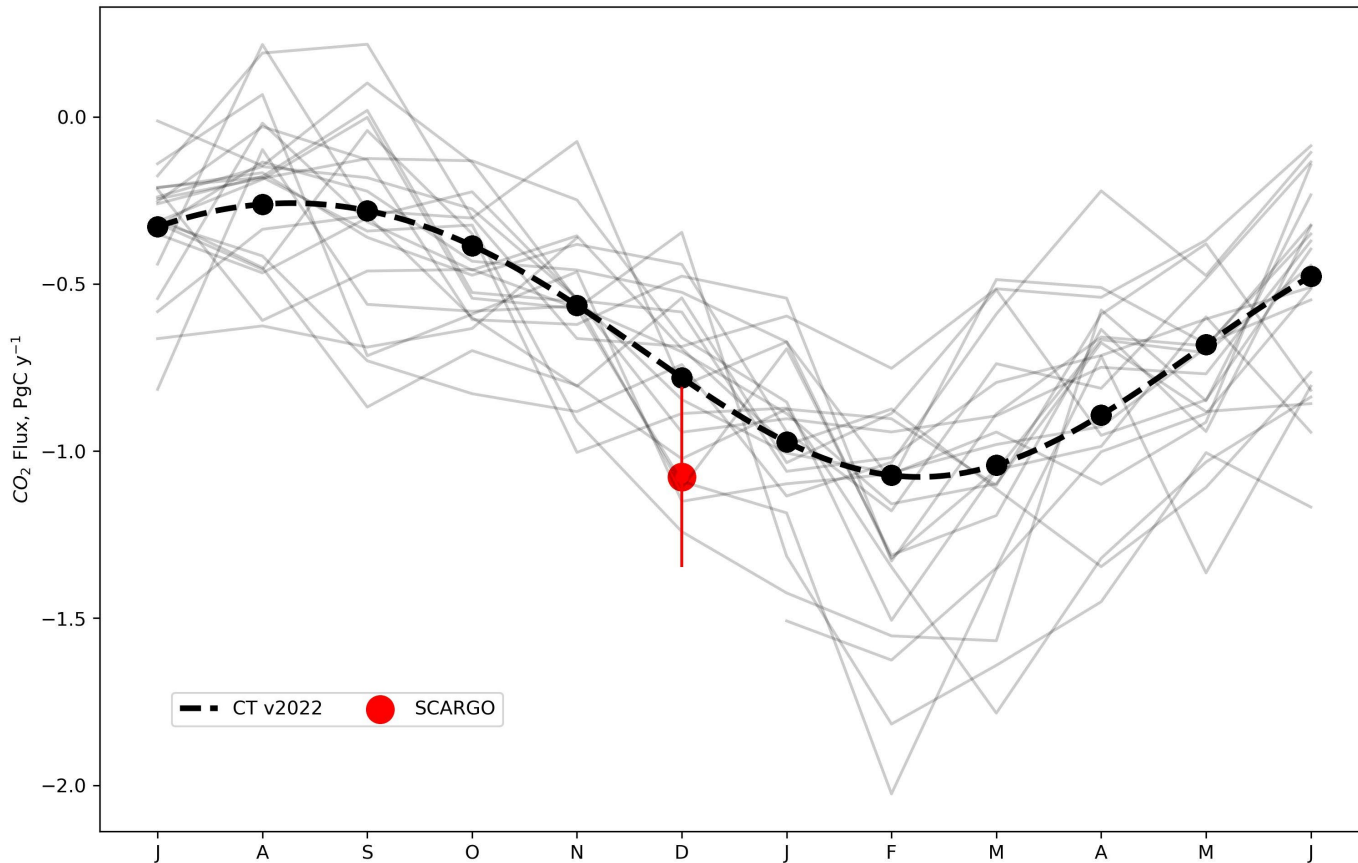
Nov/Dec 2022 SCARGO Test Season – CO₂ cross-section and potential temperature



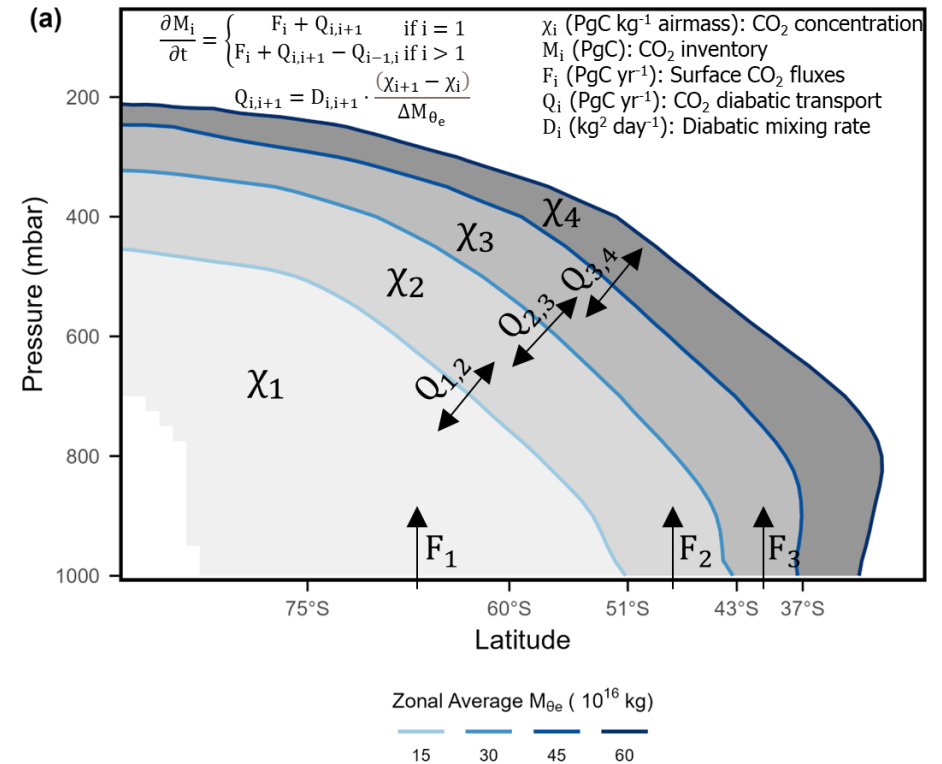
Jin et al., ACP, 2021
Jin et al., PNAS, in review
Vance et al., in prep

Nov/Dec 2022 SCARGO Test Season – CO₂ cross-section and potential temperature

Preliminary flux estimate (> 43 S) compared to NOAA CarbonTracker



Calculation and figure by Jesse Vance (NCAR)



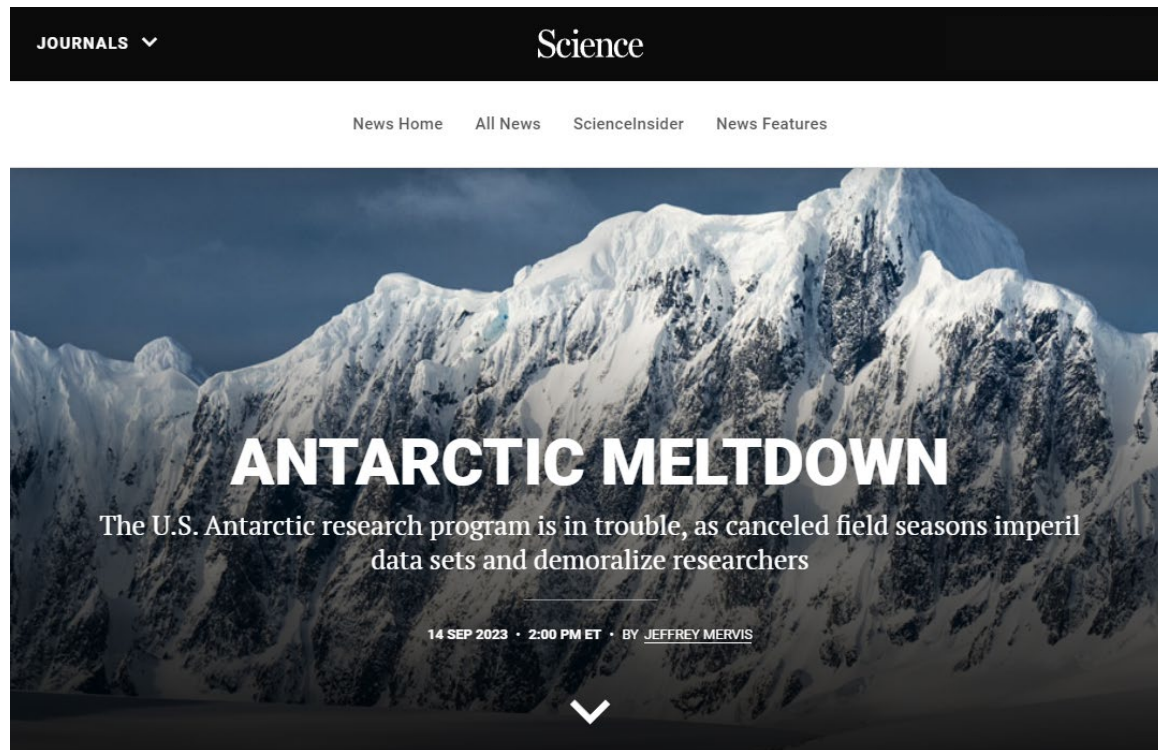
Jin et al., ACP, 2021
 Jin et al., PNAS, in review
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SCARGO Outlook

2023/24 season deferred owing to USAP resource constraints

Moving to a standalone rack crate forward in the cabin

Now planning for full field seasons in 24/25, 25/26, and 26/27



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