ARM ACME PROJECT

ARM Airborne Carbon Measurements

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ACME-SGP
- Scientific Objectives
- Results and Highlights

ACME-NSA
- Scientific Objectives
- Campaign Overview
- Links with NGEE-Arctic, ARM, and ASR objectives
- Feedback
• Document changes in atmospheric concentrations of GHGs

• Contribute to multi-agency effort for validation of satellite- and ground-based column CO$_2$ estimates

• Close gap in U.S. CH$_4$ emissions estimates
ACME IN THE SGP

- ARM Carbon project starts at SGP
  - 2001: 2-flask sampler installed on aircraft
  - 2002: 12-flask & continuous CO₂ (RM0) installed
  - 2003: RM0 fully operational
  - 2004: continuous CO₂ (RM12) installed
  - 2005: 14CO₂ sampler installed
  - 2006: 14CO₂ sampler removed
  - 2007: continuous CO₂ (RM12) removed
  - 2008: 14CO₂ sampler removed
  - 2009: continuous CO₂ (RM12) installed
  - 2010: continuous CO₂ (RM12) installed
  - 2011: continuous CO₂ (RM12) removed
  - 2012: continuous CO₂ (RM12) removed
  - 2013: continuous CO₂ (RM12) installed
  - 2014: continuous CO₂ (RM12) removed
  - 2015: continuous CO₂ (RM12) removed
  - 2016: continuous CO₂ (RM12) removed
  - 2017: continuous CO₂ (RM12) removed

- Cessna 172-XP (Pilot: B. Fristoe)
- Cessna 206 (Pilot: K. Linville)

- ACME VI (PI: S. Biraud). October 1, 2016 – September 30, 2017?
ACME IN THE SGP - RESULTS

Biraud et al., 2013 (AMT)
ACME IN THE SGP - RESULTS

- CO₂ (ppm)
  - Color scale: 370 to 410

- CH₄ (ppb)
  - Color scale: 1800 to 2100

- CO (ppb)
  - Color scale: 60 to 210

- N₂O (ppb)
  - Color scale: 320 to 330
ACME IN THE SGP - RESULTS

Sweeney et al., 2015 (JGR-Atmosphere)
HIGHLIGHTS (FOR CH4)

- Miller et al., 2013 (PNAS)

- Turner et al., 2015 (ACP)
Established ground sites provide ground truth and temporal context for ACME airborne measurements

- DOE/ARM sites (Barrow and Oliktok)
- DOE/NGEE-Arctic site (Barrow)
- NOAA/GMD operational site (Barrow)
- NSF/LTER Arctic (Toolik Lake)
- San Diego U. Flux towers (Atqasuk and Ivotuk)
Overarching science question: “How does permafrost thaw and processes associated changes in hydrology, soil biogeochemical processes and plant community succession affect feedbacks to the climate systems?”

Period of observations: 2012-2015 (phase 1)

Study Domain: Barrow
CARVE IN THE NSA

Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE)
PI: Charles Miller (NASA/JPL)


Science Payload
• Picarro: continuous CO₂, CH₄, H₂O
• 12-Flask Package: ~50 trace gases
• FTS: Column CO₂, CH₄, and CO
• Other: O₃ and IR temp

Results (Chang et al., 2014)
• Net CO₂ was ~0 in 2012 and represents a small sources in 2013.
• Total CH₄ emissions from Alaska are small compare to global emissions (2 vs. 550 Tg CH₄·yr⁻¹)
Arctic-Boreal Vulnerability Experiment (ABoVE)

**Overarching science question:** “How vulnerable or resilient are ecosystems and society to environmental change in the Arctic and boreal region of western North America?”

**Proposed intensive airborne observations:** 2017 and 2019

**Study Domain:** Alaska and Northwest Canada

**Science Payload:** TBD
• Characterize spatial variability of CO$_2$ and CH$_4$ mixing ratios and link to ecosystem dynamics

• Evaluate representativeness of site measurements at regional scales

• Impact of Oil/gas emissions around Prudhoe Bay
Campaign Dates
June 1 – September 15, 2015

**Strategy:** frequent and sustained flights
(1 flight every 4 days; 25 flights total)

**Science Payload**
- Picarro: continuous CO$_2$, CH$_4$, H$_2$O
- LGR: continuous CO and N$_2$O
- 12-Flask Packages: ~50 trace gases
- Atmospheric state (air temp, presre, dew point,...)
- Cloud microphysics (HVPS-3, 2D-S, F-CDP, CDP-2)
- Aerosols (UCPS, CPC, UHSAS-A, PCASP, PSAP).
- Radiation (SPN1s and MFR)
ACME IN THE NSA

ACME-V Flight Plan #1
- 574 miles total
- Spiral up to 10,000' over AMF, NSA, PATQ, Votuk, Toolik
- Spiral down over the same sites to “500” agl
- Transition between sites at lowest level
- ETE 4.40

ACME-V Flight Plan #3
WP-3 N69 57.44 W148 43.58
WP-4 N69 34.74 W148 38.31
WP-5 N69 11.63 W148 47.10
WP-6 N68 48.10 W148 48.27
Toolik N68 38.00 W149 36.00
Ivotuk N68 59.92 W155 45.42
AMF N70 29.68 W149 53.16

ACME-V Flight Plan #2
- 621 nm enroute
- Spiral up over AMF, NSA, and PATQ to 20,000'
- Spiral down over the sites to “500”
- Transition between sites at lowest level
- ETE 3.08

ACME-V Flight Plan #4
- AMF N70 29.68 W149 53.16
- WP-2 N70 46.20 W154 26.75
- NSA N71 19.36 W156 37.07
- PATQ N70 28.03 W157 26.14
How to be involved?
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