ABoVE/ASCENDS: Merged Atmospheric CO2, CH4, and Meteorological Data, 2017

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Documentation Revision Date: 2022-12-02

Dataset Version: 1

Summary

This dataset provides in situ airborne measurements of atmospheric carbon dioxide (CO2), methane (CH4), water vapor concentrations, air temperature, pressure, and wind speed and direction as well as airborne remote sensing measurements of column average CO2 collected during Active Sensing of CO2 Emissions over Nights, Days, and Seasons (ASCENDS) deployments from 2017-07-20 to 2017-08-08 over Alaska, US, and the Yukon and Northwest Territories of Canada. CO2 and CH4 were measured with NASA's Atmospheric Vertical Observations of CO2 in the Earth's Troposphere (AVOCET) instrument. Water vapor and relative humidity were measured with Diode Laser Hydrometer. Measurements were taken onboard a DC-8 aircraft. The ASCENDS flights were coordinated with the 2017 Arctic-Boreal Vulnerability Experiment (ABoVE) campaign. The data are provided in ICARTT format along with an archive of flight videos.

These data are a merge of files from two ABoVE/ASCENDS datasets: Abshire et al. (2022) and Sun et al (2022).

There are four data files in ICARTT (.ict) format and one compressed zip file (.zip) with this dataset; the .ict files contain the data and the .zip file contains flight videos.

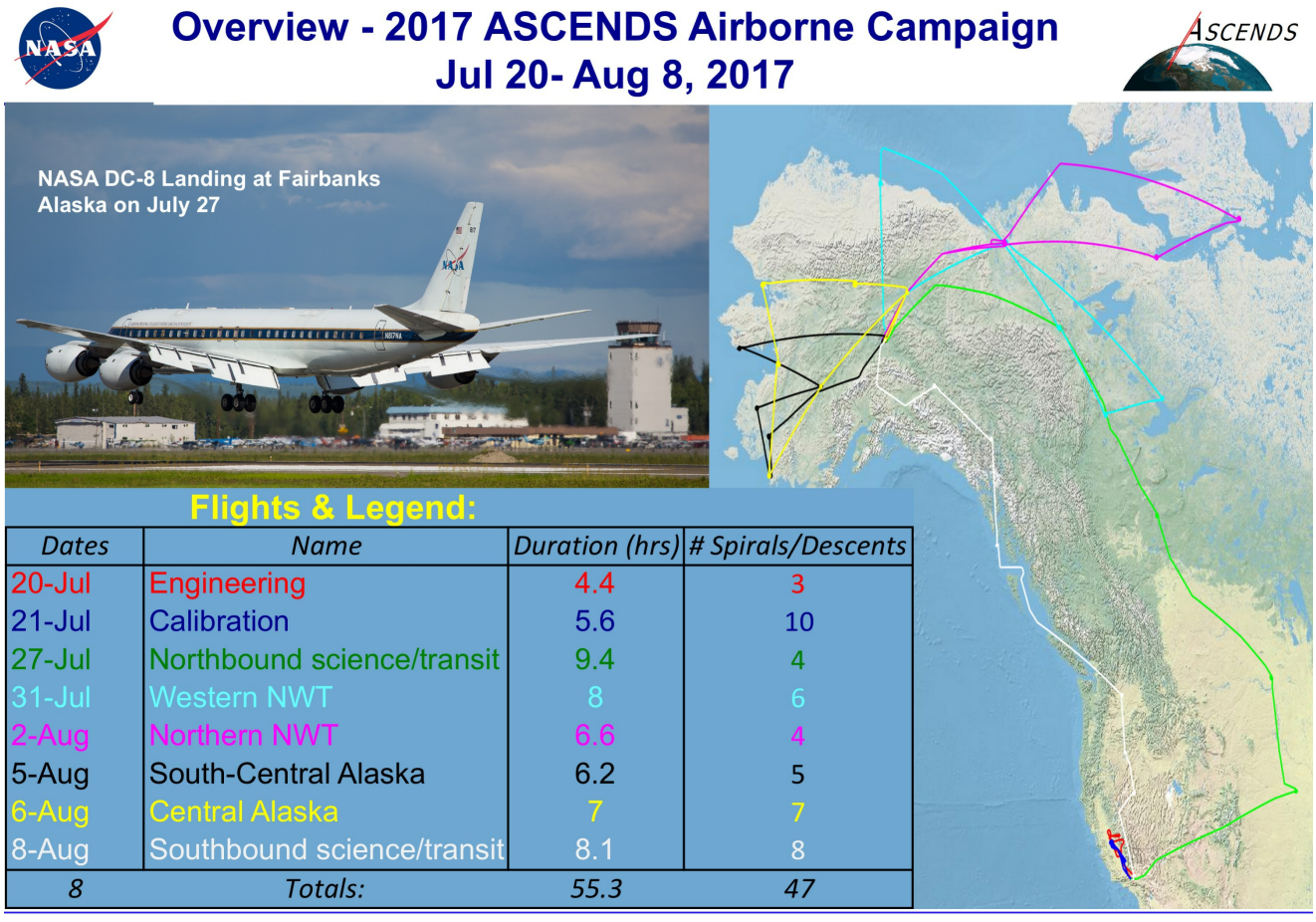

Figure 1. A map showing the ground tracks for the airborne campaign with a table summarizing each flight. The colors in the table match those shown in the ground tracks. Image is from the related dataset Abshire et al. (2022).

Citation

Abshire, J.B., J. Mao, H. Riris, S.R. Kawa, and X. Sun. 2022. ABoVE/ASCENDS: Merged Atmospheric CO2, CH4, and Meteorological Data, 2017. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2114

Table of Contents

1. Dataset Overview

This dataset provides in situ airborne measurements of atmospheric CO_2, CH_4, water vapor concentrations, air temperature, pressure, relative humidity, and wind speed and direction, as well as airborne remote sensing measurements of column averaged CO_2 collected during ASCENDS deployments from 2017-07-20 to 2017-08-08 over Alaska and the Yukon and Northwest Territories of Canada. CO_2 and CH_4 were measured with NASA's Atmospheric Vertical Observations of CO_2 in the Earth's Troposphere (AVOCET) instrument. Water vapor and relative humidity were measured with a Diode Laser Hydrometer. These data are a merge of files in the Related Datasets listed below.

Project: Arctic-Boreal Vulnerability Experiment

The Arctic-Boreal Vulnerability Experiment (ABoVE) is a NASA Terrestrial Ecology Program field campaign based in Alaska and western Canada between 2016 and 2021. Research for ABoVE links field-based, process-level studies with geospatial data products derived from airborne and satellite sensors, providing a foundation for improving the analysis and modeling capabilities needed to understand and predict ecosystem responses and societal implications.

Related Datasets

Abshire, J.B., J. Mao, H. Riris, S.R. Kawa, and X. Sun. 2022. ABoVE/ASCENDS: Active Sensing of CO2, CH4, and Water Vapor, Alaska and Canada, 2017. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2050

- One of the two input datasets used to generate the current merged dataset

Sun, X., P.T. Kolbeck, J.B. Abshire, S.R. Kawa, and J. Mao. 2022. ABoVE/ASCENDS: Atmospheric Backscattering Coefficient Profiles from CO2 Sounder, 2017. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2051

- One of the two input datasets used to generate the current merged dataset

Related Publications

Abshire, J. B., A.K. Ramanathan, H. Riris, G.R. Allan, X. Sun, W.E. Hasselbrack, J. Mao, S. Wu, J. Chen, K. Numata, S.R. Kawa, M.Y.M. Yang, and J. DiGangi. 2018. Airborne measurements of CO_2 column concentrations made with a pulsed IPDA lidar using multiple-wavelength-locked laser and HgCdTe APD detector. Atmospheric Measurement Techniques (AMT) 11:2001-2025. https://doi.org/10.5194/amt-11-2001-2018

Allan, G.R., J.B. Abshire, H. Riris, J. Mao, W.E. Hasselbrack, K. Numata, J. Chen, R. Kawa, M. Rodriguez, and M. Stephen. 2018. Lidar measurements of CO_2 column concentrations in the Arctic region of North America from the ASCENDS 2017 airborne campaign. SPIE Proceedings volume 10779, Lidar Remote Sensing for Environmental Monitoring XVI, 1077906 (24 October 2018). https://doi.org/10.1117/12.2325908

Sun, X., J.B. Abshire, A. Ramanathan, S.R. Kawa, and J. Mao. 2021. Retrieval algorithm for the column CO_2 mixing ratio from pulsed multi-wavelength lidar measurements. Atmospheric Measurement Techniques 14:3909–3922. https://doi.org/10.5194/amt-14-3909-2021

Acknowledgement

This research was funded by the NASA Terrestrial Ecology Program: Arctic-Boreal Vulnerability Experiment.

2. Data Characteristics

Spatial Coverage: Alaska; Yukon; Northwest Territories

ABoVE Reference Locations

Domain: Core and extended
State/Territory: Alaska; Yukon; Northwest Territories
Grid cells: Ah000v000, Ah000v001, Ah001v000, Ah001v001, Ah001v002, Ah002v001, Ah002v002

Spatial Resolution: Point locations. At an aircraft speed of 170 knots (87.5 m/s), one 1-second averaging interval covers a distance of ~87 m. Profiles cover a vertical range from the surface up to 6 km altitude at ~15 m vertical resolution.

Temporal Coverage: 2017-07-20 to 2017-08-08 with 8 single-day flights during the period.

Temporal Resolution: 1, 5, 10, and 60-seconds

Study Areas: Latitude and longitude are given in decimal degrees.

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Alaska and Canada	-165.6848	-98.1479	71.2664	34.5939

Data File Information

There are four data files in ICARTT format (*.ict) and one .zip file with flight videos.

The .ict files are named **ascends-mrgXX-dc8_merge_20170720_R2_thru20170808.ict** where **XX is 01, 05, 10, and 60 (second intervals).** The files used to create this dataset from the two Related Datasets in Section 2 of this document are listed in Table 2**.** These files put all individual measurements on a common time base and coordinates. These co-located measurements will facilitate the analysis of the co-variations of the parameters.

The .zip file is named **flight_videos.zip.**

Table 1. Variables in the merge data files.

User note: A "Unit Conversion" field is provided which shows one unit "to" another unit contained in parentheses (e.g. "(degC to K)") if the units changed between the PI data and the merge file at all, even if just the case differs. If the units of a variable changed but no conversion was necessary, the unit text was changed or clarified from that in the raw file (e.g. to standardize units across a variable/measurement type). Where the field is empty, no unit change was made from the raw file.

If any portion of the averaging period contains a Limit of Detection (LOD) value for a given measurement, the average is marked with an LOD flag: Lower LOD= -888888, Upper LOD= -777777. For the merge period, if all data are missing, the missing flag is set to = -999999.

Variable	Unit Conversion, if changed	Original Name	Description	Data-ID
UTC	("seconds (from midnight UTC)" to "s")	N/A	Mid-time of the interval in seconds since midnight UTC on the flight date	Merge code
JDAY		N/A	Julian day of the flight start date	Merge code
INDEX	1	N/A	Sequential index of the data record starting with the flight number	Merge code
FLIGHT	1	N/A	Flight number	Merge code
LOCAL_SUN_TIME	degrees	N/A	Local sun time at the sampling longitude and time	Merge code
LATITUDE	degrees_north	N/A	Latitude	Ascends-Hskping
LONGITUDE	degrees (0-360)	Longitude	Longitude	Ascends-Hskping
ALTP	("ft" to "km")	Pressure_Altitude	Aircraft pressure altitude derived from air pressure sensor	Ascends-Hskping
PRESSURE	("mb" to "hPa")	Static_Pressure	Static air pressure	Ascends-Hskping
TEMPERATURE	("Celcius" to "K")	Static_Air_Temp	Static air temperature	Ascends-Hskping
THETA	K	N/A	Potential temperature	Merge code
O3COLUMN	Du	N/A	Ozone column	OMI
SZA	1	N/A	Solar zenith angle	Merge code
WNS	("m/s (limited to where Roll_Angle <= 5 degrees)" to "m/s")	Wind_Speed	Wind speed, limited to where Roll_Angle <= 5 degrees	Ascends-Hskping
WND	("deg (0-360" to "deg")	Wind_Direction	Wind direction, 0-360 degrees, clockwise from +y	Ascends-Hskping
DOY	("day beginning January 1" to "DOY")	Day_Of_Year	Fight day of year, beginning January 1	Ascends-Hskping
MSL_GPS_ALT	("m (height above mean sea level)" to "km")	MSL_GPS_Altitude	Aircraft GPS altitude above mean sea level	Ascends-Hskping
HAE_GPS_ALT	("m (height above ellipsoid WGS84)" to "km")	HAE_GPS_Altitude	Aircraft GPS altitude above WGS84 ellipsoid	Ascends-Hskping
RadarAlt	("ft" to "km")	Radar_Altitude	Aircraft radar altitude	Ascends-Hskping
GRD_SPD	("m/s" to "m s-1")	Ground_Speed	Aircraft ground speed	Ascends-Hskping
TAS	("kts" to "m/s")	True_Air_Speed	Aircraft true airspeed	Ascends-Hskping
IAS	("kts" to "m/s")	Indicated_Air_Speed	Aircraft indicated airspeed	Ascends-Hskping

MachNumber		Mach_Number	Aircraft speed in mach number	Ascends-Hskping
VerticalSpeed	("m/s" to "m s-1")	Vertical_Speed	Aircraft vertical speed	Ascends-Hskping
HDG	("deg (0-360" to "degs")	True_Heading	Aircraft true heading, 0-360 degrees, clockwise from +y	Ascends-Hskping
TRK	("deg (0-360" to "degs")	Track_Angle	Aircraft track angle, 0-360 degrees, clockwise from +y	Ascends-Hskping
DriftAngle	("deg (+-180" to "degs")	Drift_Angle	Aircraft drift angle, +/-180 degrees, clockwise from +y	Ascends-Hskping
PITCH	("deg (+-180" to "degs")	Pitch_Angle	Aircraft pitch angle, +/-180 degrees, up+	Ascends-Hskping
ROLL	("deg (+-180" to "degs")	Roll_Angle	Aircraft roll angle, +/-180 degrees, right+	Ascends-Hskping
PotentialTemp	("Kelvin" to "degK")	Potential_Temp	Potential temperature	Ascends-Hskping
Dewpoint	("Celcius" to "K")	Dew_Point	Dew point temperature (data are missing or not included for all files)	Ascends-Hskping
TotalAirTemp	("Celcius" to "K")	Total_Air_Temp	An intermediate product of air temperature measurement, not corrected for air motion	Ascends-Hskping
IR_SurfTemp	("Celcius" to "K")	IR_Surf_Temp	Surface temperature	Ascends-Hskping
CabinPressure	("hpa" to "hPa")	Cabin_Pressure	Aircraft cabin pressure	Ascends-Hskping
SolarZenithAngle	("deg" to "degs")	Solar_Zenith_Angle	Solar zenith angle	Ascends-Hskping
AircraftSunElevation	("deg" to "degs")	Aircraft_Sun_Elevation	Sun elevation angle with respect to aircraft	Ascends-Hskping
SunAzimuth	("deg" to "degs")	Sun_Azimuth	Sun azimuth angle	Ascends-Hskping
AircraftSunAzimuth	("deg" to "degs")	Aircraft_Sun_Azimuth	Sun azimuth angle with respect to aircraft	Ascends-Hskping
MixingRatio	("g/kg" to "g kg-1")	Mixing_Ratio	Atmospheric water mass mixing ratio (data are missing or not included for all files)	Ascends-Hskping
VaporPresWater	("mb" to "hPa")	Part_Press_Water_Vapor	Partial pressure of water vapor (data are missing or not included for all files)	Ascends-Hskping
SatVaporPresWater	("mb" to "hPa")	Sat_Vapor_Press_H2O	Saturated vapor pressure over liquid water	Ascends-Hskping
SatVaporPresIce	("mb" to "hPa")	Sat_Vapor_Press_Ice	Saturated vapor pressure over ice	Ascends-Hskping
RelativeHumidity	("percent (with respect to water)" to "%")	Relative_Humidity	Relative humidity (data are missing or not included for all files)	Ascends-Hskping
CH4_ppmv	("ppmv" to "ppbv")	CH4_ppmv	Measurements of dry methane (CH4) in volumetric mixing ratio (from the AVOCET instrument)	ASCENDS-AVOCET-CH4
CO2_MixingRatio	ppmv	CO2_ppmv	Measurements of dry carbon dioxide (CO2) in volumetric mixing ratio (from the AVOCET instrument)	ASCENDS-AVOCET-CO2
XCO2_Sounder	ppm	XCO2_Sounder	Measurements of column-averaged dry-air mole fraction (XCO2) (from the CO_2 Sounder Lidar instrument)	ASCENDS-CO2SOUNDER-XCO2
Aircraft_Altitude	("m" to "km")	Aircraft_Altitude	GPS height above mean sea level	ASCENDS-CO2SOUNDER-XCO2
H2O_vapor_DLH	ppmv	H2O_ppmv	Water vapor mixing ratio	ASCENDS-DLH
RHi_pct_DLH	%	RHi_pct	Relative humidity with respect to ice	ASCENDS-DLH

RHw_pct_DLH	%	RHw_pct	Relative humidity with respect to liquid	ASCENDS-DLH

Table 2. These data are a merge of files from the two datasets listed in the Overview Section of this document under **Related Datasets.** Files used to create this dataset are listed below.

AVOCET CH2 Files
ASCENDS-AVOCET-CH4_DC8_20170720_R0.ict,2018-04-26
ASCENDS-AVOCET-CH4_DC8_20170721_R0.ict,2018-04-26
ASCENDS-AVOCET-CH4_DC8_20170727_R0.ict,2018-04-26
ASCENDS-AVOCET-CH4_DC8_20170731_R0.ict,2018-04-26
ASCENDS-AVOCET-CH4_DC8_20170803_R0.ict,2018-04-26
ASCENDS-AVOCET-CH4_DC8_20170805_R0.ict,2018-04-26
ASCENDS-AVOCET-CH4_DC8_20170806_R0.ict,2018-04-26
ASCENDS-AVOCET-CH4_DC8_20170808_R0.ict,2018-04-26
AVOCET CO2 Files
ASCENDS-AVOCET-CO2_DC8_20170720_R0.ict,2018-04-26
ASCENDS-AVOCET-CO2_DC8_20170721_R0.ict,2018-04-26
ASCENDS-AVOCET-CO2_DC8_20170727_R0.ict,2018-04-26
ASCENDS-AVOCET-CO2_DC8_20170731_R0.ict,2018-04-26
ASCENDS-AVOCET-CO2_DC8_20170803_R0.ict,2018-04-26
ASCENDS-AVOCET-CO2_DC8_20170805_R0.ict,2018-04-26
ASCENDS-AVOCET-CO2_DC8_20170806_R0.ict,2018-04-26
ASCENDS-AVOCET-CO2_DC8_20170808_R0.ict,2018-04-26
CO2SOUNDER-XCO2 Files
ASCENDS-CO2SOUNDER-XCO2_DC8_20170720_R0.ict,2019-08-30
ASCENDS-CO2SOUNDER-XCO2_DC8_20170721_R0.ict,2019-09-10
ASCENDS-CO2SOUNDER-XCO2_DC8_20170727_R0.ict,2019-09-10
ASCENDS-CO2SOUNDER-XCO2_DC8_20170731_R0.ict,2019-09-10
ASCENDS-CO2SOUNDER-XCO2_DC8_20170803_R0.ict,2019-09-10
ASCENDS-CO2SOUNDER-XCO2_DC8_20170805_R0.ict,2019-09-10
ASCENDS-CO2SOUNDER-XCO2_DC8_20170806_R0.ict,2019-09-10
ASCENDS-CO2SOUNDER-XCO2_DC8_20170808_R0.ict,2019-09-10
DLH Files
ASCENDS-DLH_DC8_20170720_R0.ict,2018-07-23
ASCENDS-DLH_DC8_20170721_R0.ict,2018-07-26
ASCENDS-DLH_DC8_20170727_R0.ict,2021-11-05
ASCENDS-DLH_DC8_20170731_R0.ict,2018-07-09
ASCENDS-DLH_DC8_20170803_R0.ict,2018-07-09
ASCENDS-DLH_DC8_20170805_R0.ict,2018-07-09
ASCENDS-DLH_DC8_20170806_R0.ict,2018-07-09
ASCENDS-DLH_DC8_20170808_R0.ict,2018-07-09
HSKPING Files
Ascends-Hskping_DC8_20170720_R1.ict,2019-07-16
Ascends-Hskping_DC8_20170721_R1.ict,2019-07-16
Ascends-Hskping_DC8_20170727_R2.ict,2019-07-15
Ascends-Hskping_DC8_20170731_R1.ict,2019-07-16
Ascends-Hskping_DC8_20170803_R1.ict,2019-07-16

Ascends-Hskping_DC8_20170805_R1.ict,2019-07-16
Ascends-Hskping_DC8_20170806_R1.ict,2019-07-16
Ascends-Hskping_DC8_20170808_R1.ict,2019-07-16

3. Application and Derivation

These data contribute to our understanding and predictive capabilities for modeling the land-atmospheric exchange of CO_2 and CH_4 in the ABoVE study region.

4. Quality Assessment

The AVOCET measurements of CO_2 and CH_4 were calibrated using the WMO X2007 scale (https://gml.noaa.gov/ccl/co2_scale.html) and WMO X2004A scale (https://gml.noaa.gov/ccl/ch4_scale.html), respectively. Please refer to user guides of the two input ABoVE/ASCENDS datasets, Abshire et al. (2022) and Sun et al (2022), for more details on calibration process and quality assessment.

5. Data Acquisition, Materials, and Methods

ASCENDS deployments were from 2017-07-20 to 2017-08-08 over Alaska, US, and the Yukon and Northwest Territories of Canada. The flights were designed to assess the accuracy of airborne lidar measurements of column-averaged dry-air CO_2 mixing ratio (XCO2) and to extend lidar measurements to the ABoVE study area in the Arctic. Eight flights with a NASA DC-8 aircraft were conducted with XCO2 measurements from the lidar along with in-situ CO_2 measurements made at the aircraft. Forty-seven spiral-down maneuvers were conducted in locations over California, the Northwest Territories Canada, the Arctic Ocean, and Alaska, along with the transit flights from California to Alaska and return. Each spiral maneuver allowed comparing the XCO2 retrievals from the lidar against those computed from CO_2 measured at the aircraft. In addition to the XCO2 measurement, the lidar receiver also recorded the time-resolved atmospheric backscatter signal strength continuously as the laser pulses propagated through the atmosphere.

In situ concentrations of atmospheric carbon dioxide and methane were measured with an infrared absorption spectrometer on NASA's Atmospheric Vertical Observations of CO_2 in the Earth's Troposphere (AVOCET) instrument. Water vapor and relative humidity were measured with Diode Laser Hydrometer. Column-averaged dry-air CO_2 mixing ratio (XCO2) measurements were taken with the CO_2 Sounder Lidar instrument (Abshire et al., 2017). Sounder is a pulsed, multi-wavelength Integrated Path Differential Absorption (IPDA) lidar that estimates XCO2 in the nadir path from the aircraft to the scattering surface by measuring the shape of the 1572.33 nm CO_2 absorption line (Abshire et al., 2018). The XCO2 observations are available in the related dataset Abshire et al. (2022). The meteorological data are available in the related dataset Sun et al (2022).

For additional details refer to the publications listed in the Overview Section of this document.

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

ABoVE/ASCENDS: Merged Atmospheric CO2, CH4, and Meteorological Data, 2017

Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

7. References

Abshire, J.B., J. Mao, H. Riris, S.R. Kawa, and X. Sun. 2022. ABoVE/ASCENDS: Active Sensing of CO2, CH4, and Water Vapor, Alaska and Canada, 2017. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2050

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Allan, G.R., J.B. Abshire, H. Riris, J. Mao, W.E. Hasselbrack, K. Numata, J. Chen, R. Kawa, M. Rodriguez, and M. Stephen. 2018. Lidar measurements of CO_2 column concentrations in the Arctic region of North America from the ASCENDS 2017 airborne campaign. SPIE Proceedings volume 10779, Lidar Remote Sensing for Environmental Monitoring XVI, 1077906 (24 October 2018). https://doi.org/10.1117/12.2325908

Sun, X., P.T. Kolbeck, J.B. Abshire, S.R. Kawa, and J. Mao. 2022. ABoVE/ASCENDS: Atmospheric Backscattering Coefficient Profiles from CO2 Sounder, 2017. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2051

Sun, X., J.B. Abshire, A. Ramanathan, S.R. Kawa, and J. Mao. 2021. Retrieval algorithm for the column CO_2 mixing ratio from pulsed multi-wavelength lidar measurements. Atmospheric Measurement Techniques 14:3909–3922. https://doi.org/10.5194/amt-14-3909-2021