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Supplement of

Atmospheric Radiation Measurement (ARM) airborne field campaign data products between 2013 and 2018

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Supplementary Material

Figure and Tables

Figure S1. Wordcloud of the science themes based on the AAF-supported seven field campaign between 2013-2018.

Table S1. Information about the merged AAF data product.

Variables/ Input file names	Units	Instruments (DOI)
aaf2dsh_c1[aaf2dsh.c1]		2-Dimensional Stereo Probe (2D-S) , H channel (10.5439/1419322)
twodsh_alt(time)	m	
twodsh_lat(time)	degree_N	
twodsh_lon(time)	degree_E	
twodsh_number_concentration(time, aaf2dsh_optical_diameter)	count/L/um	
twodsh_total_number_concentration(time)	count/L	
aaf2dsv_c1[aaf2dsv.c1]		2-Dimensional Stereo Probe (2D-S) , V channel (10.5439/1419322)
twodsv_alt(time)	m	
twodsv_lat(time)	degree_N	
twodsv_lon(time)	degree_E	
twodsv_number_concentration(time, aaf2dsv_optical_diameter)	count/L/um	
twodsv_total_number_concentration(time)	count/L	
aafams_b1[aafams.b1]		High-Resolution Time-of-flight Aeroso Mass Spectrometer (HR-ToF-AMS) (10.5439/1958311)
ams_CVI_enhancement_factor(time)	1	
ams_Chl(time)	ug/m^3	
ams_Chl_err(time)	ug/m^3	
ams_NH4(time)	ug/m^3	
ams_NH4_err(time)	ug/m^3	
ams_NO3(time)	ug/m^3	
ams_NO3_err(time)	ug/m^3	
ams_Org(time)	ug/m^3	
ams_Org_err(time)	ug/m^3	
ams_SO4(time)	ug/m^3	
ams_SO4_err(time)	ug/m^3	
ams_alt(time)	m	
ams_flag(time)	1	
ams_lat(time)	degree_N	
ams_lon(time)	degree_E	
aafccn2cola_b1[aafccn2cola.b1]		Dual-Column Cloud Condensation Nuclei Counter (CCN) , Column A (10.5439/1349242)
ccna_N_CCN(time)	1/cm^3	
ccna_P_sample(time)	hPa	
ccna_T_inlet(time)	degC	
ccna_T_sample(time)	degC	
ccna_alt(time)	m	
ccna_lat(time)	degree_N	
ccna_lon(time)	degree_E	
ccna_supersaturation_calculated(time)	%	

ccna_temp_unstable(time)	unitless	
aafccn2colb_b1[aafccn2colb.b1]		Dual-Column Cloud Condensation Nuclei Counter (CCN) , Column B (10.5439/1349243)
ccnb_N_CCN(time)	1/cm^3	
ccnb_P_sample(time)	hPa	
ccnb_T_inlet(time)	degC	
ccnb_T_sample(time)	degC	
ccnb_alt(time)	m	
ccnb_lat(time)	degree_N	
ccnb_lon(time)	degree_E	
ccnb_supersaturation_calculated(time)	%	
ccnb_temp_unstable(time)	unitless	
aafco_a1[aafco.a1]		
aafco_co(time)	ppmv	Carbon monoxide (CO) mixing ratio calculated with nominal sensitivity correction (co) (10.5439/1244084)
aafcpcfcvi_a1[aafcpcfcvi.a1]		Condensation Particle Counter (CPC), Model 3772, after CVI inlet, a1 level data (10.5439/1361667)
aafcpcfcvi_concentration(time)	1/cm^3	
aafcpcfcvi_b1[aafcpcfcvi.b1]		Condensation Particle Counter (CPC), Model 3772, after CVI inlet, b1 level data (preferred data if available) (10.5439/1559904)
cpcfcvi_alt(time)	m	
cpcfcvi_concentration(time)	1/cm^3	
cpcfcvi_lat(time)	degree_N	
cpcfcvi_lon(time)	degree_E	
aafcpcfiso_a1[aafcpcfiso.a1]		Condensation Particle Counter (CPC), Model 3772, after ISOK inlet, a1 level data (10.5439/1361668)
aafcpcfiso_concentration(time)	1/cm^3	
aafcpcfiso_b1[aafcpcfiso.b1]		Condensation Particle Counter (CPC), Model 3772, after ISOK inlet, b1 level data (preferred data if available) (10.5439/1373109)
cpcfiso_alt(time)	m	
cpcfiso_concentration(time)	1/cm^3	
cpcfiso_lat(time)	degree_N	
cpcfiso_lon(time)	degree_E	
aafcpcu_a1[aafcpcu.a1]		Ultrafine Condensation Particle Counter (UCPC), Model 3025A, after ISOK inlet, a1 level data (10.5439/1240264)
aafcpcu_concentration(time)	1/cm^3	
aafcpcu_b1[aafcpcu.b1]		Ultrafine Condensation Particle Counter (UCPC), Model 3025A, after ISOK inlet, b1 level data (preferred data if available) (10.5439/1349237)
cpcu_alt(time)	m	
cpcu_concentration(time)	1/cm^3	
cpcu_lat(time)	degree_N	
cpcu_lon(time)	degree_E	

aaffcdp_c1[aaffcdp.c1]		Fast-Cloud Droplet Probe (F-CDP) (10.5439/1417472)
fcdp_alt(time)	m	
fcdp_lat(time)	degree_N	
fcdp_lon(time)	degree_E	
fcdp_number_concentration(time, aaffcdp_optical_diameter)	count/L/um	
fcdp_total_number_concentration(time)	count/L	
aaffims_b1[aaffims.b1]		Fast Integrated Mobility Spectrometer (FIMS) (10.5439/1908565)
fims_alt(time)	m	
fims_geometric_diameter_bounds(fims_geometric_diameter, bound)	nm	
fims_heated_flag(time)	1	
fims_lat(time)	degree_N	
fims_lon(time)	degree_E	
fims_number_concentration(time, fims_geometric_diameter)	1/cm^3	
fims_pressure(time)	hPa	
fims_temperature(time)	degC	
aafhvps_c1[aafhvps.c1]		High Volume Precipitation Spectrometer Version 3 (HVPS-3) (10.5439/1417471)
hvps_alt(time)	m	
hvps_lat(time)	degree_N	
hvps_lon(time)	degree_E	
hvps_number_concentration(time, aafhvps_optical_diameter)	count/L/um	
hvps_total_number_concentration(time)	count/L	
aafinletcvi_c1[aafinletcvi.c1]		Counterflow Virtual Impactor (CVI) Inlet (10.5439/1241543)
inletcvi_alt(time)	m	
inletcvi_cvi_cut_size(time)	um	
inletcvi_enhancement_factor(time)	1	
inletcvi_inlet_dilution_factor(time)	1	
inletcvi_inlet_selector(time)	1	
inletcvi_lat(time)	degree_N	
inletcvi_lon(time)	degree_E	
aafinletisok_a1[aafinletisok.a1]		Aerosol Isokinetic Inlet (10.5439/1241544)
inletisok_cabin_temperature(time)	degC	
inletisok_pressure_isok_inlet(time)	hPa	
inletisok_relative_humidity_isok_inlet(time)	%	
inletisok_temperature_isok_inlet(time)	degC	
aafmergedaerosolsd_c1[aafmergedaerosolsd.c1]		Merged aerosol size distribution (prefered) (10.5439/1905541)
aerosolsd_alt(time)	m	

aerosolsd_cas_flag(time)	1	
aerosolsd_cloud_flag(time)	1	
aerosolsd_cvi_flag(time)	1	
aerosolsd_fcdp_flag(time)	1	
aerosolsd_fims_flag(time)	1	
aerosolsd_geometric_diameter_bounds(merged_optical_diameter, bound)	nm	
aerosolsd_lat(time)	degree_N	
aerosolsd_lon(time)	degree_E	
aerosolsd_number_concentration(time, merged_geometric_diameter)	1/cm^3	
aerosolsd_optical_diameter_bounds(merged_geometric_diameter, bound)	um	
aerosolsd_pcasp_flag(time)	1	
aafmergedcldsd_c1[aafmergedcldsd.c1]		Merged cloud size distribution (prefered) (10.5439/1897918)
cldsd_alt(time)	m	
cldsd_lat(time)	degree_N	
cldsd_lon(time)	degree_E	
cldsd_number_concentration(time, cldsd_optical_diameter)	count/L/um	
cldsd_optical_diameter_bounds(cldsd_optical_diameter, bound)	um	
cldsd_total_number_concentration(time)	count/L	
aafnaviwg_c1[aafnaviwg.c1]		Multiple sensors from the atmospheric state and aircraft state session in Table 2 (10.5439/1375937)
alt(time)	m	
ambient_temp(time)	degC	
angle_of_attack(time)	degree	
cabin_pressure(time)	hPa	
cabin_temperature(time)	degC	
dewpoint_temperature(time)	degC	
dynamic_pressure(time)	hPa	
ground_speed(time)	m/s	
indicated_airspeed(time)	m/s	
lat(time)	degree_N	
leg_number(time)	unitless	
lon(time)	degree_E	
pitch(time)	degree	
potential_temperature(time)	degC	
press_alt(time)	m	
qc_flag(time)	unitless	
radar_alt(time)	m	

relative_humidity_ice(time)	%	
relative_humidity_water(time)	%	
roll(time)	degree	
side_slip(time)	degree	
solar_zenith_ground(time)	degree	
static_pressure(time)	hPa	
sun_azimuth_aircraft(time)	degree	
sun_azimuth_ground(time)	degree	
sun_elev_aircraft(time)	degree	
total_temp(time)	degC	
true_airspeed(time)	m/s	
true_heading(time)	degree	
vert_wind_speed(time)	m/s	
vertical_velocity(time)	m/s	
wgs_alt(time)	m	
wind_direction(time)	degree	
wind_speed(time)	m/s	
aafneph_b1[aafneph.b1]		3-Wavelength Integrating Nephelometer, Model 3563 (10.5439/1372684)
neph_Bbs_B(time)	1/Mm	
neph_Bbs_G(time)	1/Mm	
neph_Bbs_R(time)	1/Mm	
neph_Bs_B(time)	1/Mm	
neph_Bs_G(time)	1/Mm	
neph_Bs_R(time)	1/Mm	
neph_P_sample(time)	hPa	
neph_RH_sample(time)	%	
neph_T_inlet(time)	degC	
neph_T_sample(time)	degC	
aafo3_c1[aafo3.c1]		Ozone concentration - Model 49i (10.5439/1488851)
o3_alt(time)	m	
o3_lat(time)	degree_N	
o3_lon(time)	degree_E	
o3_o3(time)	ppbv	
aafpcasp_a1[aafpcasp.a1]		Passive Cavity Aerosol Spectrometer-100X (PCASP) (10.5439/1245509)
pcasp_sample_flow_rate(time)	cm^3/s	
pcasp_sheath_flow_rate(time)	cm^3/s	
pcasp_size_distribution(time, aafpcasp_optical_diameter)	count/s	
aafpsap1s_b1[aafpsap1s.b1]		3-Wavelength Particle Soot/Absorption Photometer (PSAP) (10.5439/1494909)
psap_Ba_B_Weiss(time)	1/Mm	
psap_Ba_B_raw(time)	1/Mm	

psap_Ba_G_Weiss(time)	1/Mm	
psap_Ba_G_raw(time)	1/Mm	
psap_Ba_R_Weiss(time)	1/Mm	
psap_Ba_R_raw(time)	1/Mm	
psap_alt(time)	m	
psap_lat(time)	degree_N	
psap_lon(time)	degree_E	
aafso2_c1[aafso2.c1]		Sulfur dioxide (SO_2) mixing ratio calculated with nominal sensitivity correction (so2) (10.5439/1244691)
so2_alt(time)	m	
so2_lat(time)	degree_N	
so2_lon(time)	degree_E	
so2_so2(time)		
aafsp2rbc10s_c1[aafsp2rbc10s.c1]		Single Particle Soot Photometer (SP2) (10.5439/1458760)
sp2_N_dN_rBC(time, diameter_geo)	count/cm^3	
sp2_alt(time)	m	
sp2_diameter_geo_bounds(diameter_geo, bound)	um	
sp2_lat(time)	degree_N	
sp2_lon(time)	degree_E	
sp2_rBC(time)		
aafuhsas_a1[aafuhsas.a1]		Ultra-High Sensitivity Aerosol Spectrometer (UHSAS) (10.5439/1244083)
uhsas_flow(time)	cc/min	
uhsas_lower_size_limit(bin_number)	nm	
uhsas_sample_flow_rate(time)	cc/min	
uhsas_sample_pressure(time)	kPa	
uhsas_sheath_flow(time)	cc/min	
uhsas_size_distribution(time, bin_number)	count	

Table S2. Information of the data availability for each field campaign (green: data available; yellow: N/A).

Measurement	datastream	CACTI	ACE-ENA	HI-SCALE	ACAPEX	ACME-V	GoAmazon	BBOP
Meteorology	aafnaviwg.c1							
	aafdewpoint.a1							
Cloud	aaf2dsh.c1							N/A
	aaf2dsv.c1							N/A
	aaffcdp.c1							N/A
	aafhvps.c1							N/A
	aafmergedaerosolsd.c1				N/A	N/A	N/A	N/A
Aerosol	aafccn2cola.b1							

	aafccn2colb.b1							
	aafinletcvi.c1					N/A	N/A	N/A
	aafinletisok.a1					N/A	N/A	N/A
	aafcpcfcvi.b1							
	aafcpcfiso.b1							
	aafcpcu.b1							
	aafneph.b1			N/A				
	aafpsap.b1			N/A				
	aafuhsas.a1		N/A					
	aafpcasp.a1							
	aaffims.b1							
	aafmergedcldsd.c1				N/A	N/A	N/A	N/A
	aafams.b1				N/A	N/A		N/A
Trace gas	aafso2.c1				N/A	N/A		
	aafco.c1							
	aafo3.c1					N/A		
	aafsp2rbc10s.c1			N/A				

Table S3. List of compared measurement ranges and measurement variances among airborne measurements during the GoAmazon field campaign.

Measurement Variables	Measured Range during the Field Campaign	Measurement Variances between the Two Aircraft
Static Pressure	500 – 1010 hPa	< 1 %
Static air temperature	272 – 310 K	< 1%
Dewpoint temperature	230 -300 K	Without clouds, <1% With clouds, the measurement from the G1 can be up to 5% lower than that of HALO
3-D wind	1-15 m/s	< 40%
Particle number concentration	500 – 15,000 cm-3	< 20% for CPC, <50% for UHSAS (size dependent)
Non-Refractory particle chemical composition	< 10 μg·m-3	< 10% above 2500 m Up to 50% below 2500 m
CCN concentration	SS=0.25%, 100 – 2000 cm-3	< 10% above 2500 m Up to 50% below 2500 m
Gas phase concentration	Ozone: 15-75 ppb CO: 50-200 ppb	Ozone: < 25% CO: < 15%
Cloud droplet number concentration	3- 20 μm	<50 %

Table S4. A reference table of ARM primary measurements conresponding to the CF standard names.

Primary measurements	**CF standard name**
twodsh_total_number_concentration	number_concentration_of_cloud_liquid_water_particles_in_air
twodsv_total_number_concentration	number_concentration_of_cloud_liquid_water_particles_in_air

ams_Chl	mass_concentration_of_chlorine_dry_aerosol_particles_in_air
ams_NH4	mass_concentration_of_ammonium_dry_aerosol_particles_in_air
ams_Org	mass_concentration_of_particulate_organic_matter_dry_aerosol_particles_in_air
ams_SO4	mass_concentration_of_sulfate_ambient_aerosol_particles_in_air
ams_NO3	mass_concentration_of_nitrate_dry_aerosol_particles_in_air
ccna_N_CCN	number_concentration_of_cloud_condensation_nuclei_in_air
ccnb_N_CCN	number_concentration_of_cloud_condensation_nuclei_in_air
cpcfcvi_concentration	number_concentration_of_aerosol_particles_in_air
cpcfiso_concentration	number_concentration_of_aerosol_particles_in_air
cpcu_concentration	number_concentration_of_aerosol_particles_in_air
fcdp_total)number_concentration	number_concentration_of_cloud_liquid_water_particles_in_air
fims_number_concentration	number_size_distribution_of_aerosol_particles_in_air
hvps_total_number_concentration	number_concentration_of_cloud_liquid_water_particles_in_air
aerosolsd_number_concentration	atmosphere_number_content_of_aerosol_particles
cldsd_number_concentration	number_concentration_of_cloud_liquid_water_particles_in_air
alt	altitude
ambient_temp	air_temperature
dewpoint_temperature	dew_point_temperature
lat	latitude
lon	longitude
pitch	platform_pitch
press_alt	barometric_altitude
relative_humidity_water	relative_humidity
roll	platform_roll
static_pressure	air_pressure
vert_wind_speed	wind_speed
wind_direction	wind_from_direction
wind_speed	wind_speed
neph_Bbs_B	volume_backwards_scattering_coefficient_in_air_due_to_dried_aerosol_particles
neph_Bbs_G	volume_backwards_scattering_coefficient_in_air_due_to_dried_aerosol_particles
neph_Bbs_R	volume_backwards_scattering_coefficient_in_air_due_to_dried_aerosol_particles
neph_Bs_B	volume_scattering_coefficient_of_radiative_flux_in_air_due_to_ambient_aerosol_particles
neph_Bs_G	volume_scattering_coefficient_of_radiative_flux_in_air_due_to_ambient_aerosol_particles
neph_Bs_R	volume_scattering_coefficient_of_radiative_flux_in_air_due_to_ambient_aerosol_particles

o3	atmosphere_mass_content_of_ozone
psap_Ba_B_Weiss	mass_concentration_of_absorption_equivalent_black_carbon_of_dry_aerosol_particles_in_air
psap_Ba_G_Weiss	mass_concentration_of_absorption_equivalent_black_carbon_of_dry_aerosol_particles_in_air
psap_Ba_R_Weiss	mass_concentration_of_absorption_equivalent_black_carbon_of_dry_aerosol_particles_in_air
so2	atmosphere_mass_content_of_sulfur_dioxide
sp2_rBC	mass_concentration_of_absorption_equivalent_black_carbon_of_dry_aerosol_particles_in_air
uhsas_size_distribution	number_size_distribution_of_aerosol_particles_in_air

Description of a quickplot script

Users can open and review the data using Panoply, as show in Figure S2.

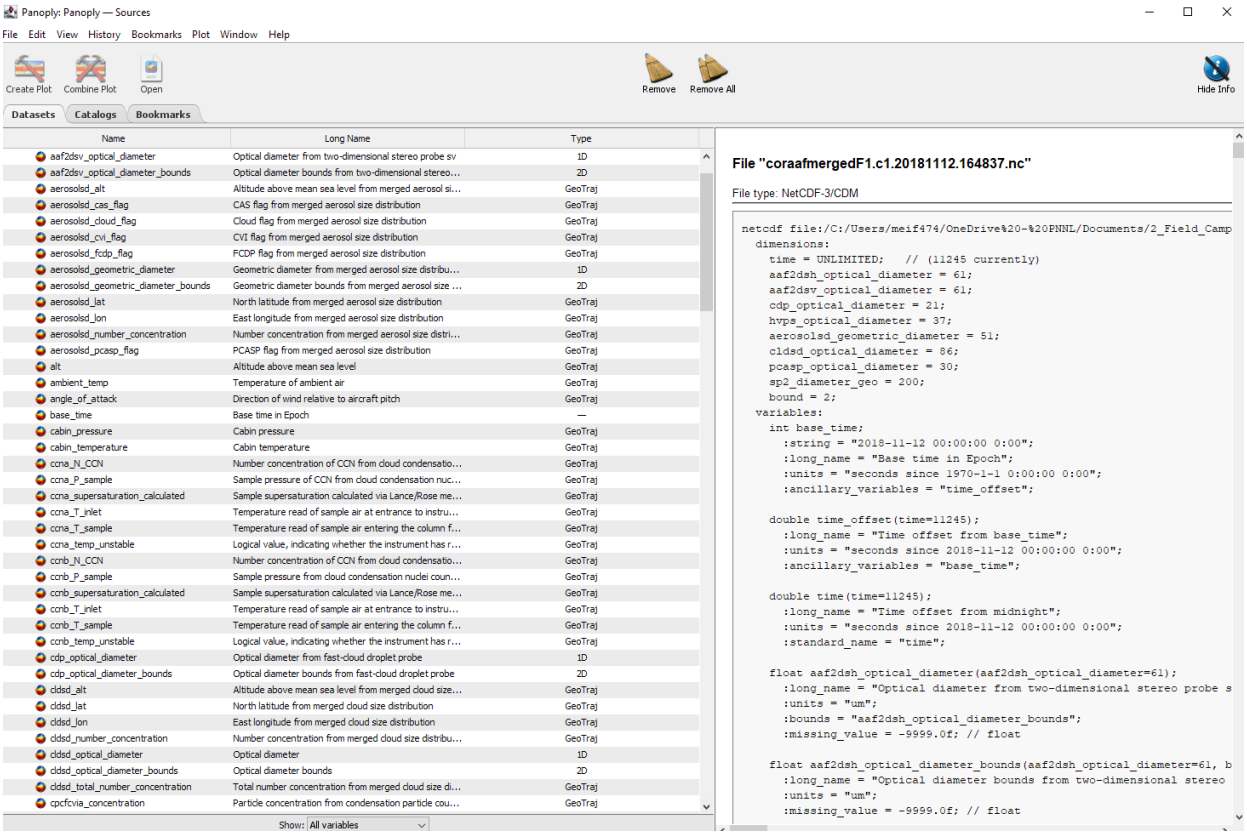

Figure S2. A screenshot of using Panoply to open this netCDF data.

A plotting script has been developed to create quicklook plots (as shown in Fig. S3) for 1D variables. User can request that script by contacting the authors. This script requires 3 input arguments: the directory where input files are located, the name of the input file or a substring to pattern match to identify more than one input file, and a list of all variables to plot.

One example for plotting the variables “twodsv_total_number_concentration and vert_wind_speed” for all files in 2018 is below. It assumes the user has setup and activated the aafmerged_plot conda environment. Please contact authors if you need help to set up conda environment.

python3 plot_aafmerged.py -d /data/vap/gaustad/aafmerged/datastream/cor/coraafmergedF1.c1/ -f coraafmergedF1.c1.20181 -v twodsv_total_number_concentration vert_wind_speed

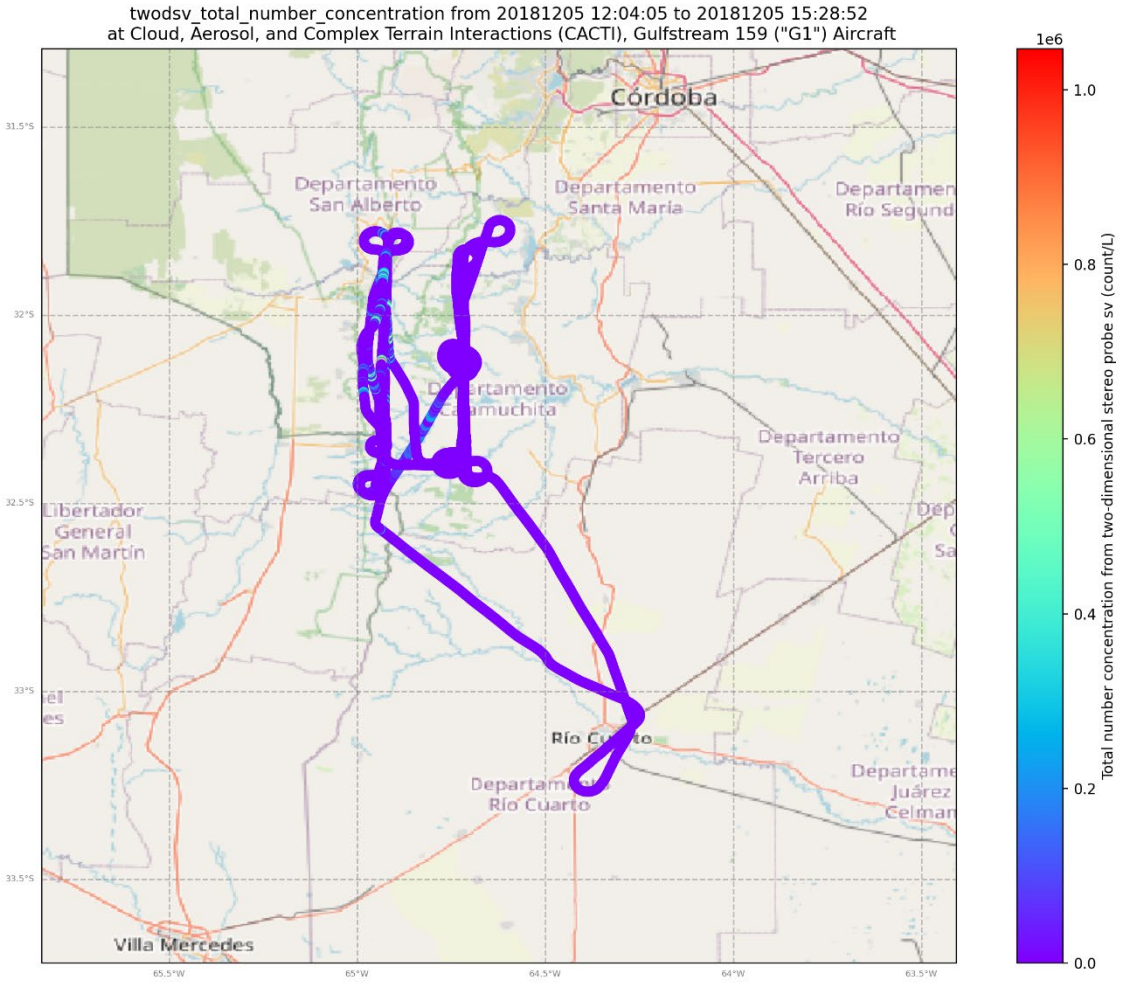

Figure S3. An example quicklook plot using ARM Atmospheric data Community Toolkit developed using Python (https://github.com/ARM-DOE/ACT).

The map is based on Cartopy. Cartopy was originally developed at the UK Met Office to allow scientists to visualize their data on maps quickly, easily and most importantly, accurately. Cartopy has been made freely available under the terms of the BSD 3-Clause License.