Biomass burning data from airborne field campaigns
Samuel Hall
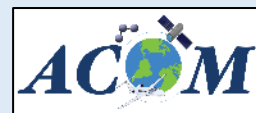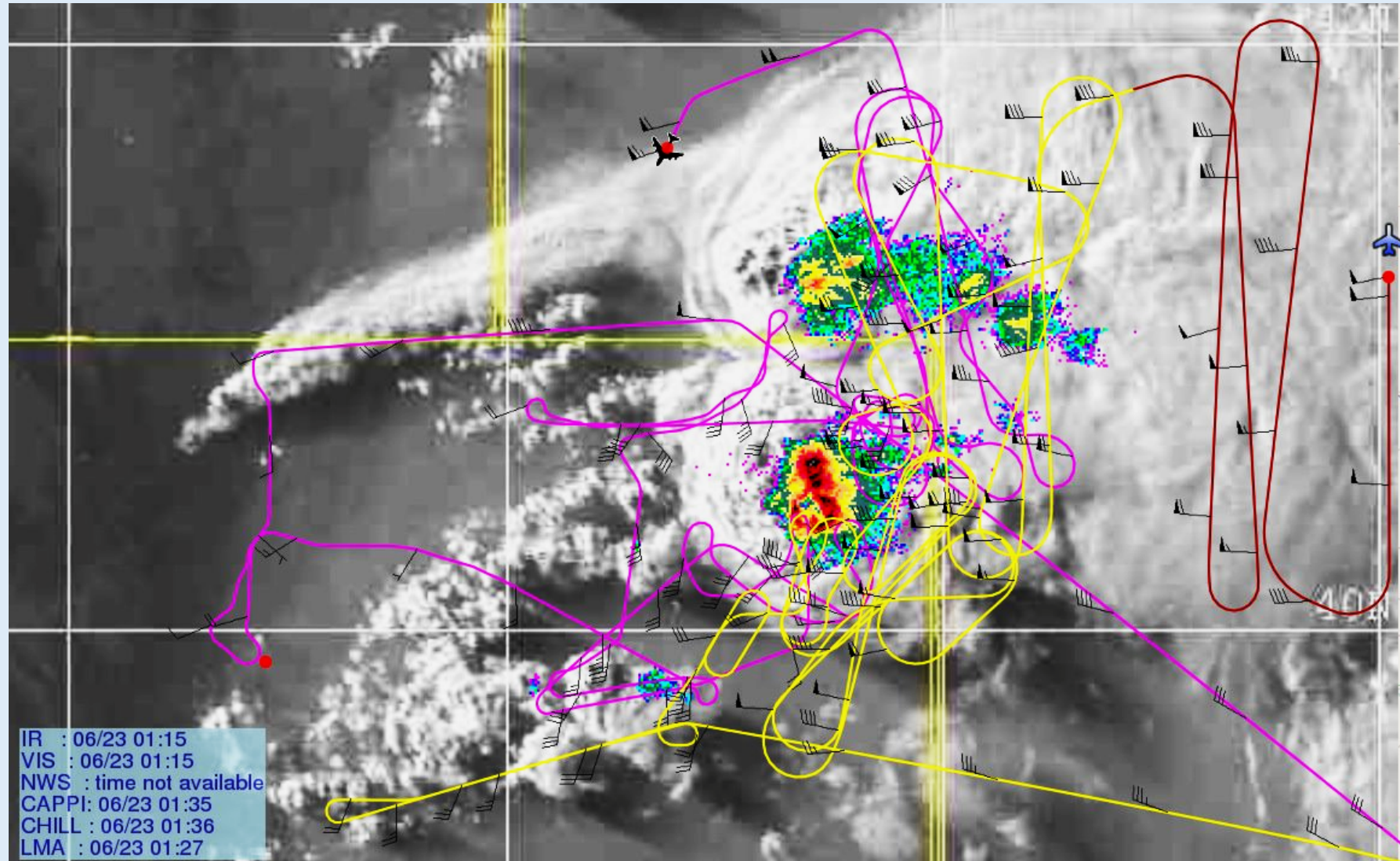
NCAR C-130

NOAA WP-3D

NASA DC-8

DRYDEN FLIGHT RESEARCH CENTER

UNIVERSITY OF NORTH DAKOTA

NASA WB-57

NASA ER-2

N528NA

NASA B200

NCAR GV

NASA P-3B

N426NA

ARIM Campaigns

7/11/2017

Legend: NCAR GV · NCAR C-130 · NASA DC-8 · NASA P3-B · NASA WB-57 · NOAA WP-3D · Ground

43 Completed
2 Ongoing/Funded
4 Proposed

Year	Campaigns (Jan–Dec)
2020	*COALA* (Jan–Feb)
2019	*KAMP* (Jun–Jul); *FIRECHEM* / ACCLIP (Jul–Aug)
2018	ATom (Apr–Jun); WE-CAN (Jul–Aug)
2017	ATom (Jan–Feb); ATom (Sep–Nov)
2016	KORUS-AQ (May–Jun); ATom (Jul–Aug)
2015	WINTER (Jan–Mar); CSET (Jul–Aug)
2014	CONTRAST (Jan–Mar); FRAPPE (Jul–Aug); HCR TFs (Oct–Dec)
2013	NOMADSS (Jun–Jul); SEAC4RS (Aug–Sep)
2012	TORERO (Jan–Feb); DC3 (May–Jul)
2011	BEACHON-ROMBAS (Jul–Aug)
2010	HEFT-10 (Jan–Feb); BEACHON-ROCS (Aug–Sep)
2009	OASIS (Mar–May)
2008	HEFT-08 (Feb); ARCTAS I (Mar–May); CARB/ARCTAS II (Jun–Jul)
2007	PACDEX (Apr–May); TC4 (Jun–Aug)
2006	CR-AVE (Jan); MIRAGE / IMPEX (Feb–May); INTEX-B (Feb–May)
2005	PAVE (Jan); AVE-Houston (Jun–Aug)
2004	Greenland-04 (Mar–May); INTEX-NA (Jun–Aug); AVE-Houston (Oct)
2003	SOLVE II (Jan–Feb); Greenland-03 (Jun–Jul)
2002	
2001	TRACE-P (Feb–May); PROPHET-01 (Jul–Sep)
2000	SOLVE (Jan–Mar); TOPSE (Mar–May); PROPHET-00 (Jun–Aug); TexAQS 2K (Aug–Sep); ISCAT (Nov–Dec)
1999	INDOEX (Jan–Mar); PEM TROPICS B (Mar–Apr); SOS 1999 (Jun–Jul); SOLVE (Nov–Dec)
1998	IPMMI (Jun–Jul); Wallops TFs (Aug–Sep); ISCAT-98 (Dec)
1997	SONEX (Oct–Nov)
1996	PEM Tropics A (Aug–Sep)

The data is available after tremendous amounts of effort

SEAC⁴RS Data Flow Overview
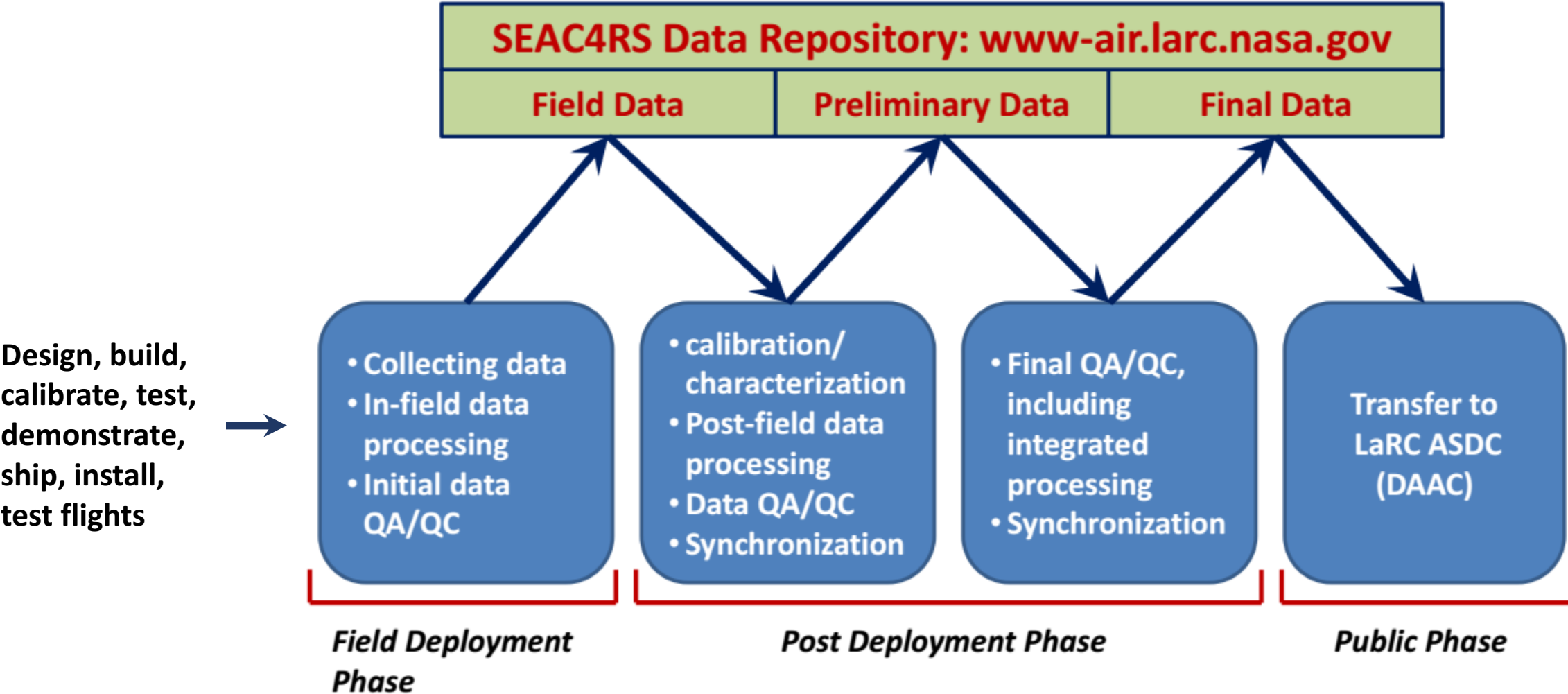
Modified from Gao Chen, NASA LARC

Where are the airborne data repositories?

- NCAR
- NASA
- NOAA
- DOE
- Universities (typically small aircraft)
- Foreign organizations (e.g. DLR, FAAM)

NASA ESPO airborne campaigns
https://espoarchive.nasa.gov/archive/browse

NASA LARC airborne campaigns
https://www-air.larc.nasa.gov/missions.htm

https://www-air.larc.nasa.gov/missions.htm

NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION

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Airborne Science Data
for Atmospheric Composition

Ozone Water-Land Environmental Transition Study

OWLETS will use a unique combination of two ozone lidars, UAV equipped with O3 and surface sensors to characterize the water-land differences in O3.
• One of the lidars(GSFC lidar) will be located in-land, while a second lidar(LaRC) will be located on the Chesapeake Bay Bridge Tunnel, 6-7 miles off-shore to obtain simultaneous "over-water" data.
• UAV/drone with a in-situ O3sensor will allow us to investigate near-range vertical and horizontal gradients.
• O3 sondes, fixed ground sensors, and mobile in-situ will also obtain measurements.

>> more

LMOS campaign provides extensive observational air quality and meteorology datasets through a combination of airborne, ship, mobile lab, and fixed ground-based observational platforms. Additionally, chemical transport models (CTMs) and meteorological forecast tools assist in the planning for day-to-day measurement strategies. The main objectives of LMOS are to better understand the lakeshore ozone gradient and to evaluate and improve CTMs used for regulatory and research purposes in this region. LMOS 2017 is a collaborative effort between LADCO and its member states, NASA, NOAA, EPA, EPRI, Scientific Aviation, and a number of research groups at universities.

>> more

KORUS-AQ offers the opportunity to further advance NASA goals and those of its international partners related to air quality through a targeted field study focused on the South Korean peninsula and surrounding waters. The study would integrate observations from aircraft, ground sites, and satellites with air quality models to understand the factors controlling air quality across urban, rural, and coastal interfaces.

>> more

The Atmospheric Carbon and Transport – America (ACT-America), will conduct five airborne campaigns across three regions in the eastern United States to study the transport of atmospheric carbon.

ACT-America will deploy two aircraft, a C-130 and UC-12, instrumented with remote and in situ sensors, to observe how mid-latitude weather systems interact with CO2 and CH4 sources and sinks to create atmospheric CO2/CH4 distributions.

>> more

GTE: Aircraft-Based Missions

MERGED DATA SETS

CHEMICAL DATA PLOTS

MISSION (Locale)	OBJECTIVES	AIRCRAFT	STATUS	DATA
CITE-1A Wallops Island	Ground Based Instrument Intercomparisons	Ground Based	Completed July 1983	Available
CITE-1B Tropics	Airborne Instrumentation Intercomparisons	CV-990	Completed Nov. 1983	Available
CITE-1C Trop Fold	Airborne Instrumentation Intercomparisons	CV-990	Completed Apr. 1984	Available
ABLE-1 Barbados	Boundary Layer Chemistry and Dynamics-Precursor	Electra	Completed June 1984	Available
ABLE-2A Brazil	Boundary Layer Study of $CO/O_3/NO_x$ - Dry Season	Electra	Completed Aug. 1985	Available
CITE-2 West Coast-U.S.	Test and Intercomparisons: Nitrogen Budget Experiments	Electra	Completed Aug. 1986	Available
ABLE-2B	Boundary Layer Study of $CO/O_3/NO_x$ - Wet	Electra	Completed	Available

U.S. Department of Commerce | National Oceanic & Atmospheric Administration | NOAA Research

Earth System Research Laboratory
Chemical Sciences Division

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Group Home   Research Groups   Staff   Publications   Projects   Measurements   Instruments   Research Platforms
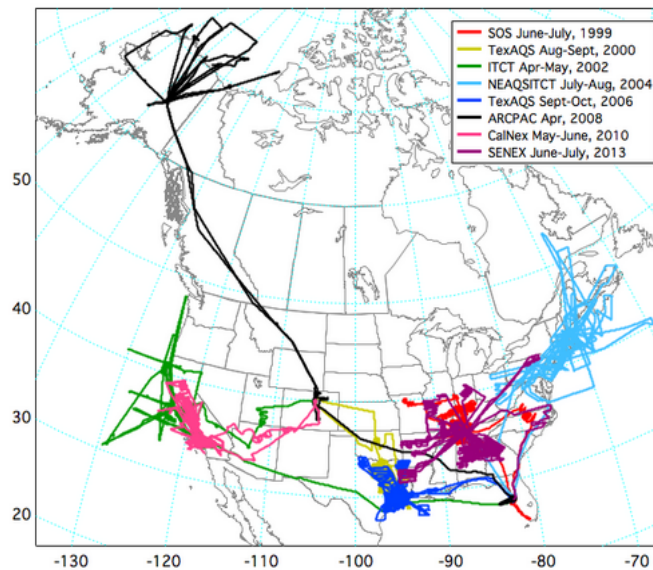
Tropospheric Chemistry: Datasets for Modellers

Created to improve the ability to incorporate NOAA WP-3D airborne chemistry data sets into large-scale models. Provided ICARTT-formatted data files from all the major chemically-instrumented NOAA WP-3D aircraft field projects since 1999. There are three data files for each flight day:

1. First file contains one-minute averages of faster-response (typically 1Hz) meteorological, gas-phase, and particulate-phase data for a given flight.
2. Second file contains these faster-response data averaged over the whole air sampler (WAS) open/close times for a given flight.
3. Third file contains the WAS data on hydrocarbons, halocarbons, and other trace species.

Each project website contains more information and details of the specific measurements. As a convenience, each of the file types are put together into a single .tar file and embedded in the 'Modellers data download'. Additional data files (IGOR format, individual data files - not specifically for modellers) are available from the specific experiment websites.

SOS June-July, 1999
TexAQS Aug-Sept, 2000
ITCT Apr-May, 2002
NEAQSITCT July-Aug, 2004
TexAQS Sept-Oct, 2006
ARCPAC Apr, 2008
CalNex May-June, 2010
SENEX June-July, 2013

Major aircraft field missions:

2010 CalNex (California Nexus Research at the Nexus of Air Quality and Climate Change) based in Ontario, California during May - June, 2010.

- CalNex 2010 Modellers data download

NCAR EOL airborne campaigns
https://www.eol.ucar.edu/all-field-projects-and-deployments

All Field Projects and Depl...

https://www.eol.ucar.edu/all-field-projects-and-deployments

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NCAR UCAR | **EOL** Earth Observing Laboratory

development • deployment • data services • discovery

Search

All Field Projects and Deployments

Below is a comprehensive list of all of EOL's field projects and deployments. Please see the Computing, Data and Software Facility home page for contact information.

Name	Full Name	Date	Data Access	Field Catalog
SOCRATES	Southern Ocean Clouds, Radiation, Aerosol Transport Experimental Study	01/15/2018 to 02/26/2018		Field Catalog
LAFE	Land-Atmosphere Feedback Experiment	08/01/2017 to 08/31/2017		
WE-CAN	Western wildfire Experiment for Cloud chemistry, Aerosol absorption and Nitrogen	08/01/2017 to 09/30/2017		
ACE-ENA	Aerosol and Cloud Experiment - Eastern North Atlantic	06/15/2017 to 02/28/2018		
VORTEX-SE_2017	Verification of the Origins of Rotation in Tornadoes Experiment Southeast 2017	03/08/2017 to 05/08/2017	Data Access	Field Catalog
ARISTO-2017	Airborne Research Instrumentation Testing Opportunity	02/20/2017 to	Data	Field

NCAR ACOM airborne campaigns
https://www2.acom.ucar.edu/campaigns

FIELD CAMPAIGNS

Field campaigns with ACOM participation. See also proposed campaigns in the planning stages.

Campaign	Dates	Base of Operations	Field catalog	Data archive
WE-CAN	Jul 2018 to Aug 2018	Broomfield, CO		
ATom-4	Apr 2018 to May 2018	Palmdale, CA		
ATom-3	Sep 2017 to Oct 2017	Palmdale, CA		
ATom-2	Jan 2017 to Feb 2017	Palmdale, CA		
ATom-1	Jul 2016 to Aug 2016	Palmdale, CA		
PROPHET	Jul 2016	Michigan		
KORUS-AQ	Apr 2016 to Jun 2016	Osan Air Base, South Korea		
ORCAS	Jan 2016 to Feb 2016	Punta Arenas, Chile	Field Catalog	
CSET	Jun 2015 to Aug 2015	California, Hawaii	Field Catalog	EOL Archive
WINTER	Feb 2015 to Mar 2015	Northeast U.S.	Field Catalog	EOL Archive
FRAPPÉ	Jul 2014 to Aug 2014	Broomfield, CO	EOL Catalog	NASA Archive
DISCOVER-AQ Colorado	Jul 2014 to Aug 2014	Broomfield, CO	NASA Catalog	NASA Archive

# But how do I find the airborne <u>biomass burning</u> data

- No easy solution
- Some recent campaigns (DC3, SEAC4RS, NOMADSS, ARCTAS)
- Dataset DOI's
- NCAR Data Stewardship Engineering Team (DSET)
  - Digital Asset Services Hub (DASH)
  - Digital assets easily discoverable through one portal
    - Searchable metadata for NCAR digital assets
      - e.g. "CO measurements during DC3"
      - e.g. "ozone measurements in Colorado"
      - e.g. "TOGA instrument acetonitrile"
    - Built to provide for smaller projects as well
- Photolysis frequency focused database

What data are available within a campaign?

Each mission has a different payload

- Housekeeping (lat, lon, alt, p, T, pitch, roll, ...)

- Flight videos (forward, nadir)

- Chemical (CO, acetonitrile, HCN, ozone, ...)

- Aerosol (size, chemistry, optical properties, ...)

- Radiation (actinic Flux, irradiance, radiance, ...)

- LIDAR (ozone, aerosol, ...)

- Imagers (hyperspectral, ...)
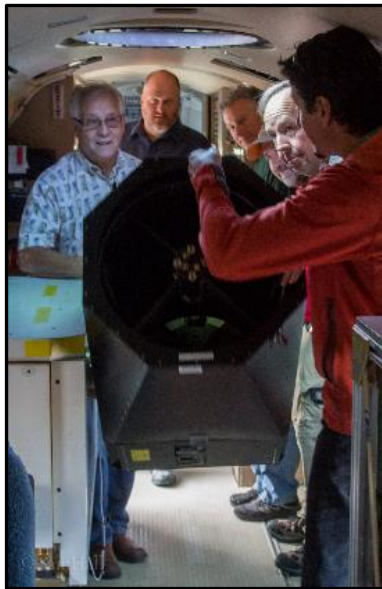
Additional data also vary

- Presentations/Publications

- Flight summaries

- Surface data (ground sites, ships, mobile vans, aeronet, etc.)

- Chemical models

- Box models

- Weather models

- Back trajectories

- Satellite images

- Satellite retrievals (AOD, columns, fire locations, etc)

- Radar

- Sondes

- Emissions

- Vegetation mapping

- Lightning mapping

- ...

G-V   C-130   DC-8
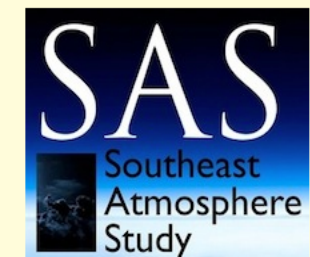
SAS Data Sets

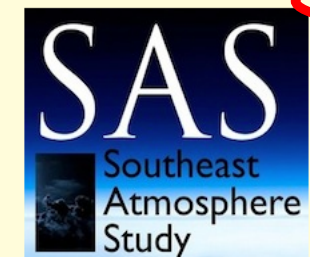| Data Set Name (Responsible Group/PIs shown in parentheses)	Date Posted	Info
Accompanying Archives		
EPA STORET Data Warehouse [(EPA)]	2013-11-07	READ ME
SOAS and SENEX NOAA Data (SENEX password required) [Aikin, Ken (NOAA)]	**Updated 2014-03-13**	READ ME
Southeastern Aerosol Research and Characterization (SEARCH) Study Data Archive [(ARA)]	2014-03-03	READ ME
Aircraft		
Aircraft: NOAA P-3 (N42)		
SOAS and SENEX NOAA Data (SENEX password required) [Aikin, Ken (NOAA)]	**Updated 2014-03-13**	READ ME
Vertical Wind Data from NCAR C-130 and NOAA P-3 Comparison Flight [Damiano, Barry (NOAA-AOC)]	2013-12-23	READ ME
Aircraft: NSF/NCAR C-130		
AeroLaser Vacuum Ultra Violet (VUV) Fluorescence In Situ Carbon monoxide (CO) mixing ratio [Campos, Teresa, Frank Flocke, Michael Reeves, Daniel Stechman, and Meghan Stell (NCAR-ESSL-CARI, NCAR-EOL)]	**Updated 2015-01-12**	
CU CIMS HO2, HO2+RO2 [Cantrell, Chris (CU-ATOC)]	**Updated 2014-10-27**	READ ME
CU CIMS OH, H2SO4, sCIs [Mauldin, Roy Lee (CU-ATOC)]	2014-02-04	READ ME
CU Fluorescence SO2 [Mauldin, Roy Lee (CU-ATOC)]	2014-02-04	READ ME
Detector for Oxidized Hg Species (DOHGS) Data [Ambrose, Jesse L., Lynne Gratz, and Dan Jaffe (Univ. of Wash-Bothell)]	**Updated 2014-07-18**	READ ME

File Edit View History Bookmarks Tools Help

DATA BY CATEGORY

- **Accompanying Archives**
- **Aircraft**
- **Ancillary**
- **Flux**
- **Forecast Text Products**
- **Land Based**
- **Model**
- **Photography**
- **Radar**
- **Satellite**
- **Upper Air**

Back to SAS

Email comments & questions to
codiac@ucar.edu

DOHGS Merged Data Files containing all C-130 Observations [Emmons, Louisa (NCAR/ACOM)]	2016-08-02
Downward and Forward Looking Digital Camera Movies - Final (with data) [(NCAR-EOL-RAF)]	2013-11-15
Downward and Forward Looking Digital Camera Movies - Preliminary [(NCAR-EOL-RAF)]	2013-08-22
Downward-Looking Digital Camera Imagery [Beaton (NCAR-EOL-RAF)]	2013-07-29
Flight Tracks (Google Earth .kml files) [(NCAR-EOL)]	2013-10-04
Forward-Looking Digital Camera Imagery [Beaton (NCAR-EOL-RAF)]	2013-07-29
In Situ Chemiluminescence NO, NO2, O3 Data [Weinheimer, A.J., D.J. Knapp, D.D. Montzka, F.M. Flocke, T.L. Campos (NCAR)]	Updated 2015-01-05
Merged Data Files containing all C-130 1 Minute Observations [Emmons, Louisa (NCAR/ACOM)]	2016-08-02
Merged Data Files containing all C-130 1 Second Observations [Emmons, Louisa (NCAR/ACOM)]	2016-08-02
NSF/NCAR C-130 High Rate Navigation, State Parameter, and Microphysics Flight-Level Data [(NCAR-EOL-RAF)]	2013-10-04
NSF/NCAR C-130 HONO Particulate Nitrate and Nitric Acid Data [Xianliang Zhou/Wadsworth Center NY/SUNY Albany]	Updated 2014-09-12
NSF/NCAR C-130 Low Rate Navigation, State Parameter, and Microphysics Flight-Level Data [(NCAR-EOL-RAF)]	Updated 2016-04-15
NSF/NCAR C-130 Low Rate Navigation, State Parameter, and Microphysics Flight-Level Data - ICARTT format (subset of NetCDF files) [(NCAR-EOL-RAF)]	2013-12-06
NSF/NCAR GV HIAPER Atmospheric Radiation Package (HARP) CCD Actinic Flux Spectrometers Photolysis Frequencies [Hall, Samuel (NCAR-ACD)]	Updated 2014-11-20
PICARRO G1301-f In Situ Carbon dioxide (CO2) mixing ratio and Methane (CH4) [Flocke, F. , T. Campos, M. Reeves, D. Stechman, and M. Stell (NCAR)]	Updated 2015-01-12
PICARRO G1301-f In Situ Carbon dioxide (CO2) mixing ratio and Methane (CH4) High Rate Data [Flocke, F. , T. Campos, M. Reeves, D. Stechman, and M. Stell (NCAR)]	Updated 2015-01-12
Proton Transfer Reaction Mass Spectrometer (PTR-MS) Data [Kaser, Lisa, Bin Yuan (NCAR)]	Updated 2014-11-04
Scanning Mobility Particle Sizer (SMPS) Particle Size Distributions [Ortega/Smith (NCAR-ESL)]	2013-12-06
TOGA Merged Data Files containing all C-130 Observations [Emmons, Louisa (NCAR/ACOM)]	2016-08-02
Trace Organic Gas Analyzer (TOGA) VOC Analyzer Data [Apel, Eric, Rebecca Hornbrook (NCAR-ACD)]	Updated 2014-07-17

Data formats

- **ICARTT**
  <http://www-air.larc.nasa.gov/missions/etc/IcarttDataFormat.htm>
- HDF
- NETCDF
- Images
- Other formats (especially for older data)

- Separate sites for LIDAR, weather, models, etc
- NASA LARC has tools at https://www-air.larc.nasa.gov/tools.htm

Sample ICARTT format

37, 1001
Diskin, Glenn S.
NASA Langley Research Center
DACOM: Diode laser spectrometer measurements of CO
SEAC4RS
1, 1
2013, 08, 27, 2015, 02, 11
1
Time_UTC_mid, Time, seconds since midnight UTC
2
1, 1
-9999, -9999
CO_ppbv_DACOM, ppbv, Carbon Monoxide mixing ratio
CO_Flag_DACOM, unitless, CO data source (see Other Comments)
1
These data are FINAL
20
PI_CONTACT_INFO: NASA LaRC, MS 483, Hampton, VA 23681; 757-864-6268; glenn.s.diskin@nasa.gov
PLATFORM: NASA DC-8 Aircraft
LOCATION: Latitude, Longitude, and Altitude included in project navigation data records
ASSOCIATED_DATA: N/A
INSTRUMENT_INFO: Diode laser Spectrometer measurements of CO
DATA_INFO: These data are final.
UNCERTAINTY: 5% or 5 ppbv (DACOM; CO_Flag==0); 10% (LGR; CO_Flag==1)
ULOD_FLAG: -7777
ULOD_VALUE: n/a;
LLOD_FLAG: -8888
LLOD_VALUE: n/a;
DM_CONTACT_INFO: Josh DiGangi; 757-864-8789; joshua.p.digangi@nasa.gov
PROJECT_INFO: N/A
STIPULATIONS_ON_USE: Data available without restriction; consult PI for more information
OTHER_COMMENTS: Gaps in DACOM data coverage (> 5 min) filled using data from an LGR Model 907-0029
CO/CO2 Analyzer
Data are flagged under the CO_Flag_DACOM variable as "0" when reporting DACOM data and "1" when reporting
LGR data.
A DACOM-based calibration has been applied to the reported LGR data.
REVISION: R0
R0: No comments for this revision.
Time_UTC_mid, CO_ppbv_DACOM, CO_Flag_DACOM
65015,151.121,0
65016,150.421,0

Header

Column headers

Data

Fact: Not everyone reads data headers

Advice: READ THE DATA HEADERS

- Data descriptions

- Uncertainties

- Data quality info

- Stipulations on use

- **Contact info**

Find more detailed info at mission websites and instrument publications
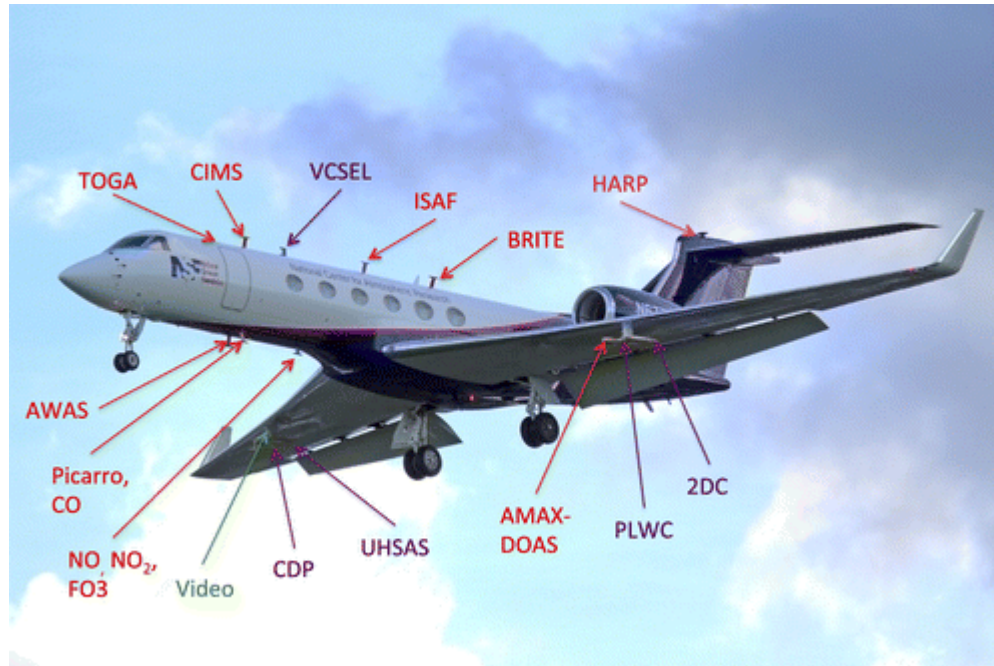
Potential data issues

Where is "my favorite quantity"?

Determine if it was measured

- Look for a merge file
- Examine mission publications
- Examine mission website
- Decipher the payload acronyms

L. Pan, S. Honomichl, NCAR

Potential data issues

Too much of "my favorite quantity"!
e.g. dataset contains 4 ozone measurements and none agree

Determine which is best

- Mission publications and supporting documents
- Consult the mission PI
- Consult the instrument PIs
- Intercomparison review documents (rare)

But why?
- Redundant critical measurement
- Test experimental technique
- Conditional accuracy (altitude, clouds, interferences, etc)
- Instruments measure multiple quantities and sometimes overlap
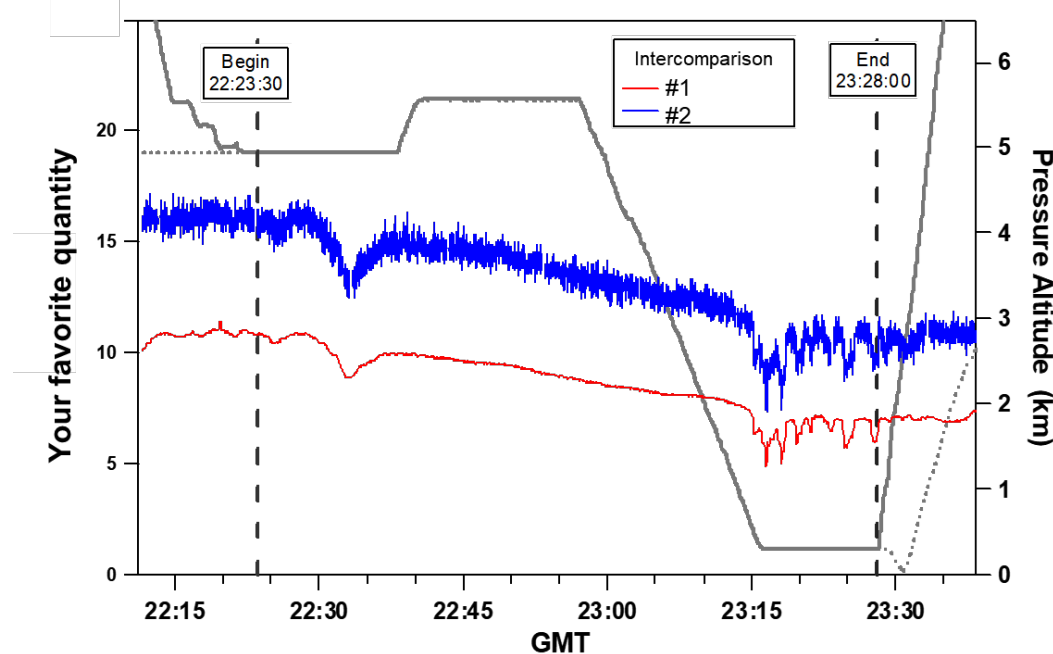
Potential data issues

Does the measurement meet the specs for your study?
(uncertainty, limit of detection, time resolution, etc)

- Examine instrument descriptions on the website
- Examine instrument publications
- Read the datafile headers
- Average, smooth, interpolate with care

Potential data issues

Why doesn't the chemistry data line up?
Instrument synchronization

- All instruments sync to official time on aircraft (usually via GPS)
- Instrument response time: function of sampling line length, flow rates and measurement duration
- Also inlet location
- Post-mission: All instruments synced to a fast, variable reference that is correlated with other measurements (e.g. water vapor)
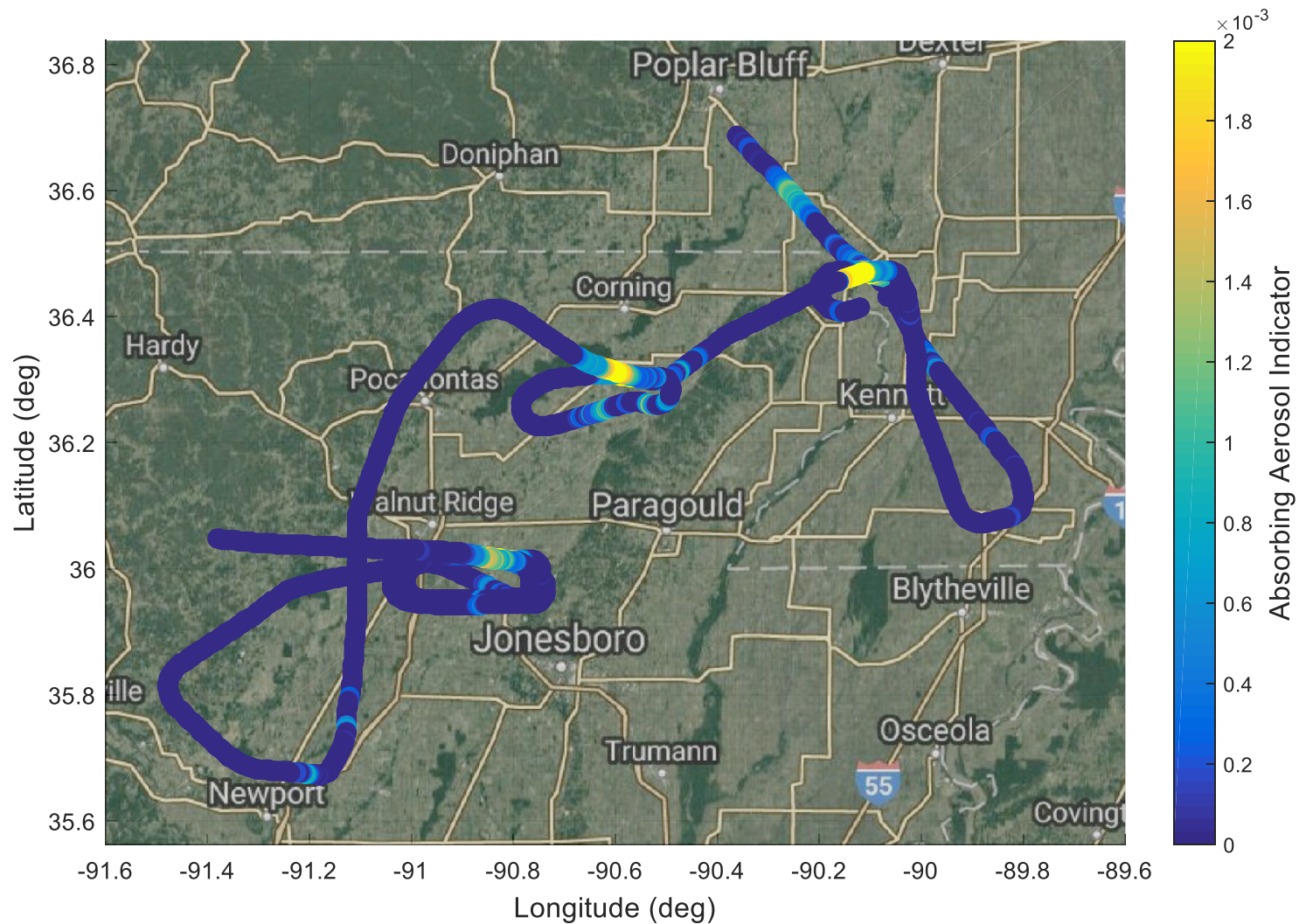- Final data and merges have synchronized times (typically)
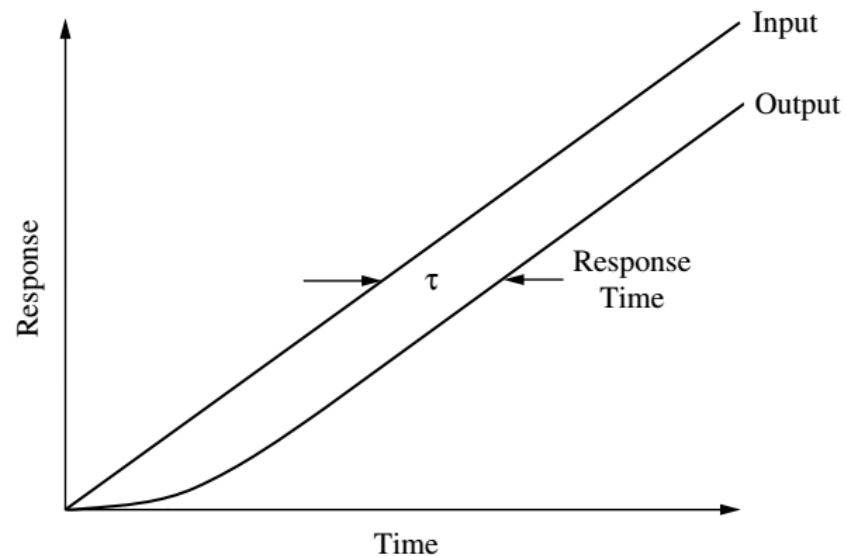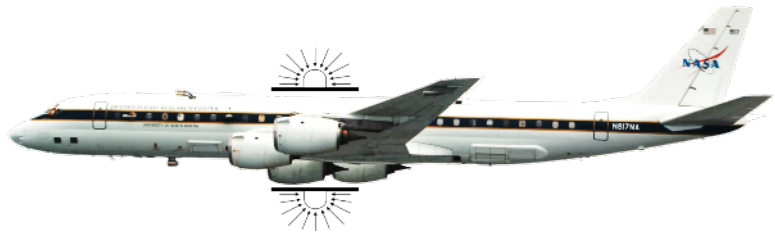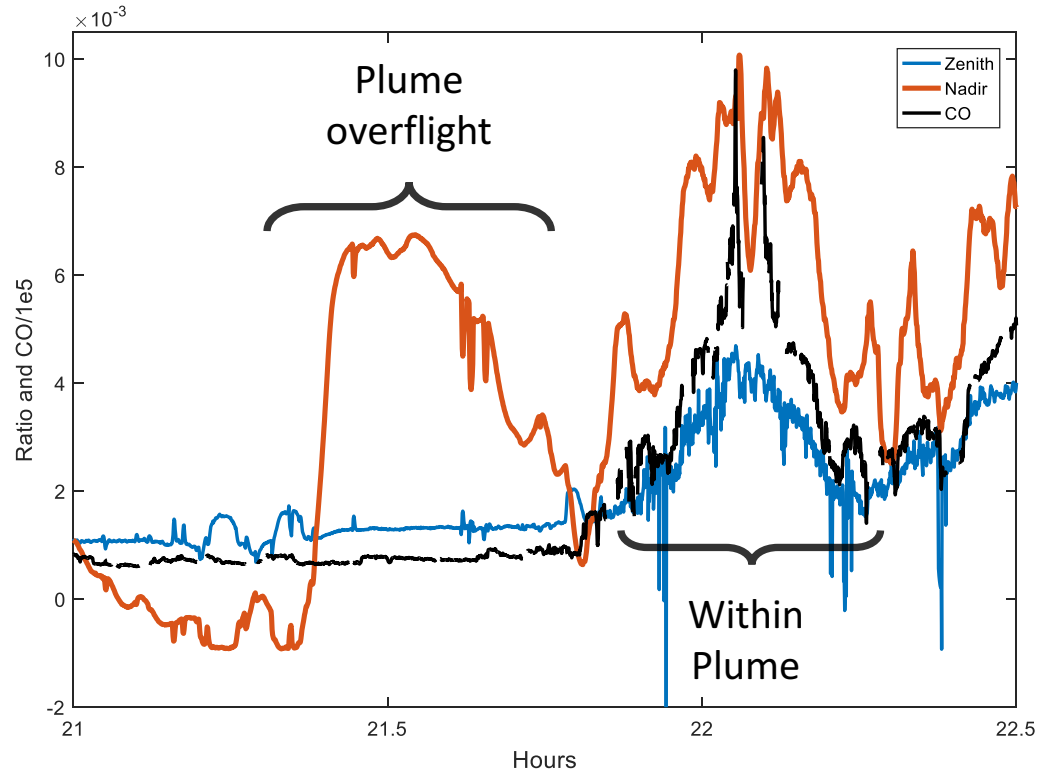
20130923 SEAC4RS Agricultural Fires

Actinic Flux Spectra Ratio (CAFS/TUV) Slope (350-400 nm)
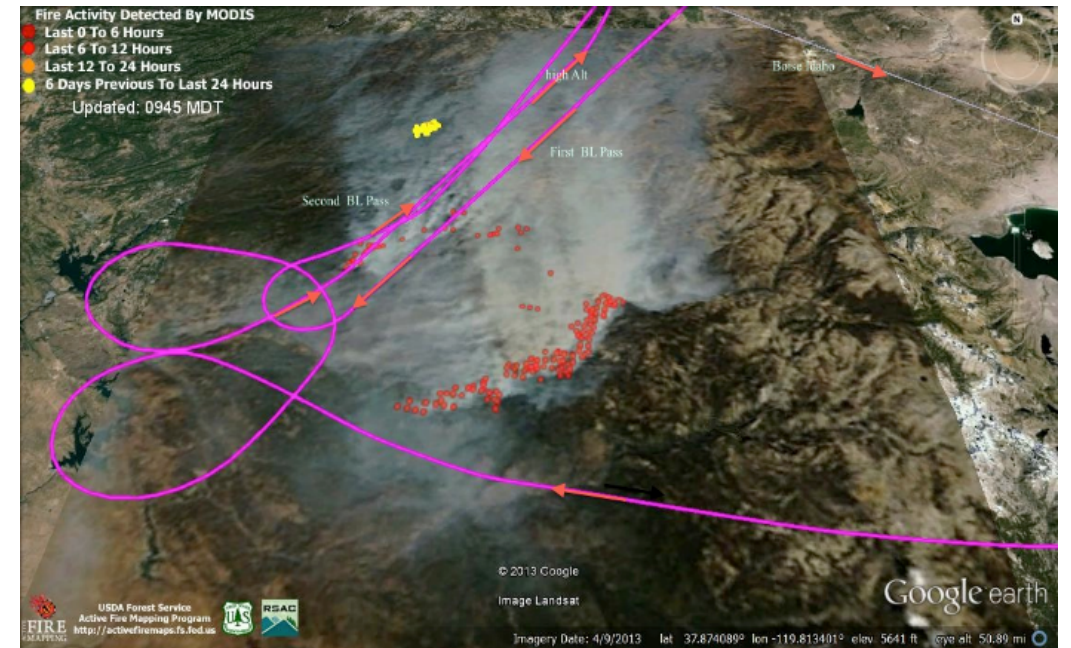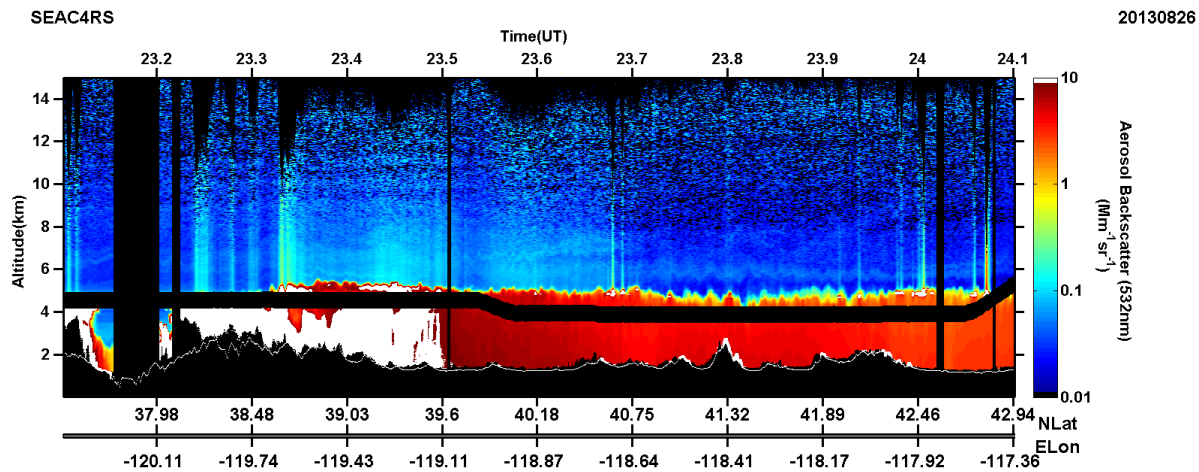UltraViolet Spectral Slope Trend (UVSST)
Smoke Detector

SEAC4RS Rim Fire from the NASA DC-8
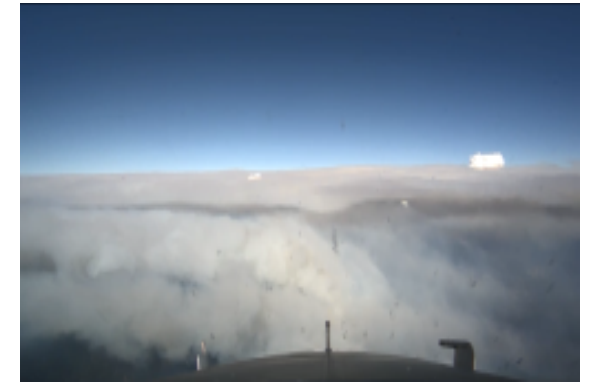
Summary

- Finding data takes some effort

- Retrieving data takes some effort

- Learn about the measurements and pitfalls

- Read data headers

- Data merges are your friend

- Always contact the PI

Sunshine Fire, Boulder, CO, 2017