

National Aeronautics
and
Space Administration

Advancing Suborbital Metadata in the NASA CMR to Facilitate Open and Versatile (re)Discovery and (re)Use of Airborne and Field Observations

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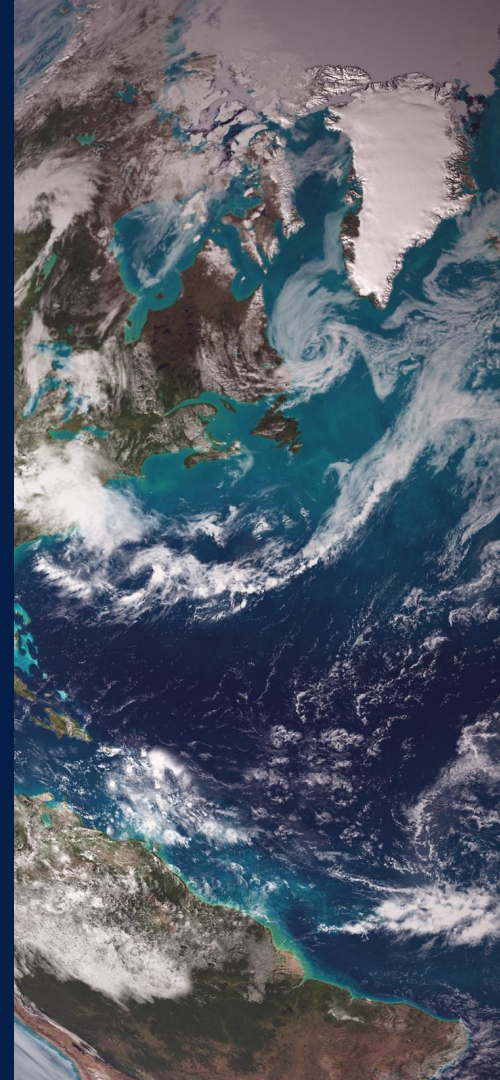


**Atmospheric
Science
Data Center**



Multi-Team Collaboration

- NASA Earth Science Data Systems (ESDS) Program
- Airborne Data Management Group (ADMG)
- Earth Science Data and Information System (ESDIS)
- Distributed Active Archive Centers (DAACs)
- Common Metadata Repository (CMR)

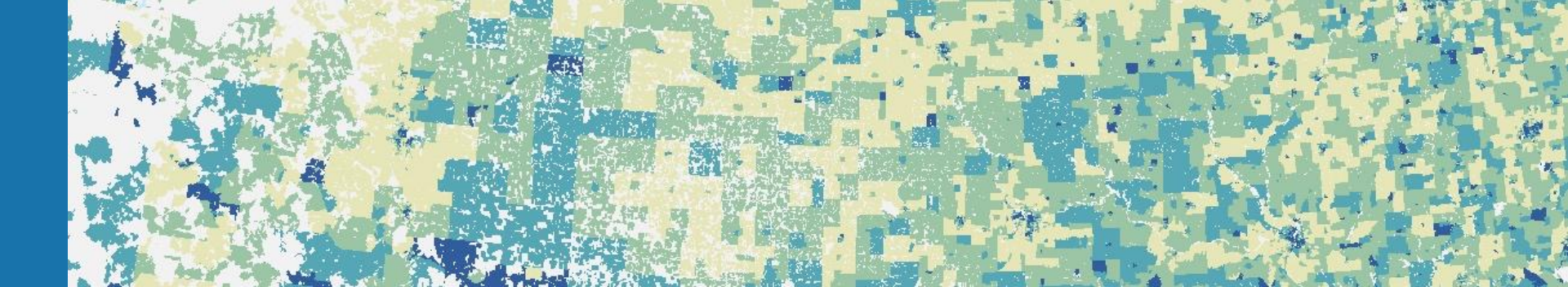


Non-Satellite data for Earth Science

- NASA ESD: 50+ year history of suborbital field observation investigations/campaigns
- Heavily utilized by original science teams
 - Rarely explored beyond initial funding cycle(s)
 - Archived with limited capacity for search/discovery
- Advancing metadata records, data discoverability, and open science priorities
 - Critical juncture for multiple ongoing efforts:
 - CMR, CASEI, SOOT



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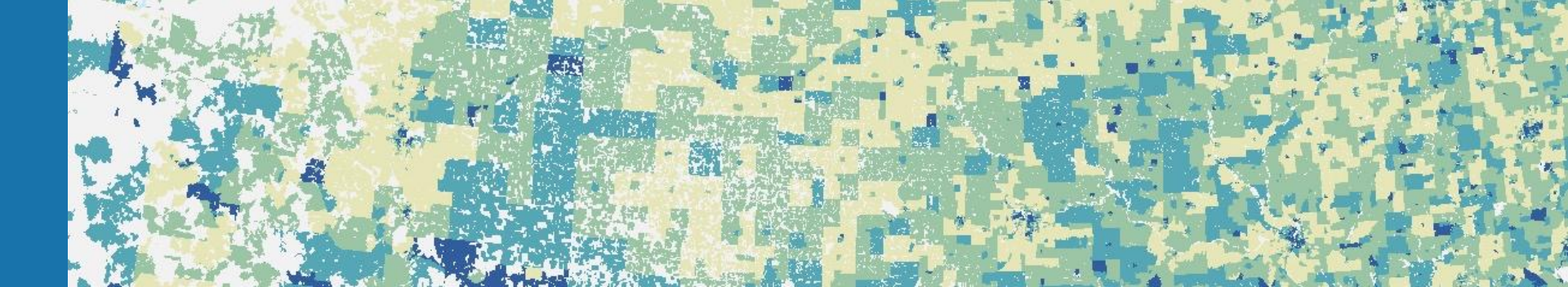


Common Metadata Repository (CMR)

CMR is a highly performant, constantly evolving system cataloging metadata records for Earth Science data, services, tools, and variables. All metadata records are registered, validated, updated, discoverable, and accessible via APIs.

Since NASA is a member of the Committee on Earth Observation Satellite (CEOS), CMR also includes metadata for dozens of other CEOS agencies - and recently NOAA also announced adopting the CMR for NESDIS holdings.

Supports satellite data very, very well... but suborbital data, not so much...



Sub-Orbital Order Tool (SOOT)

One example of many DAAC-developed resources for non-satellite data; developed by the Atmospheric Science Data Center (ASDC) to support complex metadata inquiries based on instruments, variables, data flags, and other criteria far exceeding the current capacity of CMR.

SOOT provides data subsetting as well as a merge service that transforms data products into analysis-ready data.

There are many DAAC-specific tools across ESDIS...but these are only available at single DAACs...

SOOT Resources
General User
Power User

SOOT Storymap
Merge User Guide
ICARTT Standards
Variable Standard Names
Merge Functionality
Q&A Earthdata Forum

Sub-Orbital Order Tool (SOOT) Power User Interface

Welcome to the [Sub-Orbital Order Tool \(SOOT\)](#) which is designed to promote suborbital research and analysis. Here you can discover and access the airborne and field campaign data archived at the Atmospheric Science Data Center (ASDC). The SOOT Power User Interface is intended for experienced airborne data users and airborne science teams.

Select a campaign and deployment: 2



ACEPOL
Support Documentation
2017



ACTIVATE
Support Documentation
2020 2021 2022



Aeolus Cal/Val
Support Documentation
2019



AJAX
Support Documentation
2011 2012 2013 2014
2015 2016 2017 2018



ARISE
Support Documentation
2014



CAMP2EX
2018 2019



CPEX-AW
Support Documentation
2021



DCOTSS
2021 2022



DISCOVER-AQ
Support Documentation
2011-MD 2013-CA
2013-TX 2014-CO



FIREX-AQ
2019



LISTOS
Support Documentation
2017 2018 2019



LMOS 2017
Support Documentation
2017



NAAMES
Support Documentation
2015 2016 2017 2018



ORACLES
2016 2017 2018



OWLETS
2017 2018

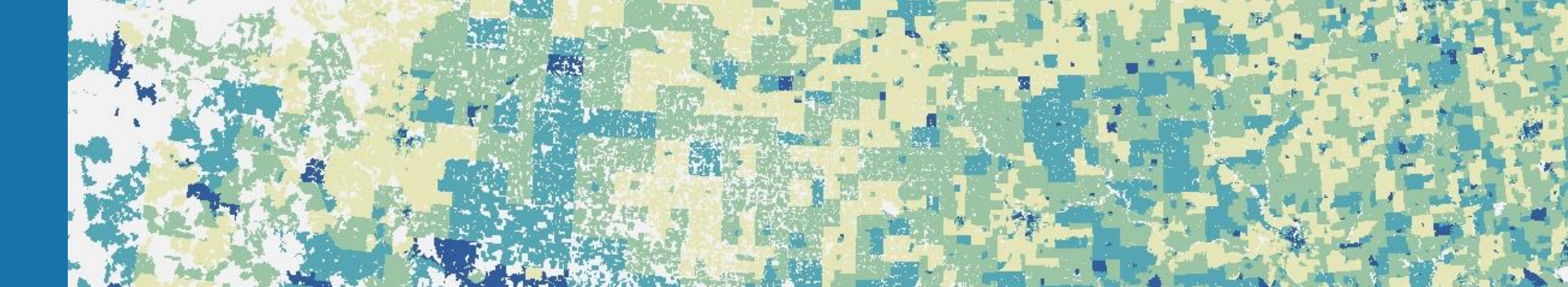


SCOAPE
2019



TRACER-AQ
2021

ASDC SOOT Power User Interface
asdc.larc.nasa.gov/soot/power-user



Catalog of Archived Suborbital Earth Science Investigations (CASEI)

CASEI is a multi-faceted resource for contextual metadata on field campaigns, platforms, instruments, and their relationships to geophysical concepts. The system includes backend database, web-based discovery portal, and fully documented API.

Purpose-built response to user needs; independent from, but linked to, NASA's airborne and field data repositories.

DAAC-independent capacity, but presently still a separate entry point...



NASA | CASEI

EXPLORE LEARN ▼ ABOUT CONTACT

Catalog of Archived Suborbital Earth Science Investigations

An inventory of NASA's airborne and field campaigns for Earth Science

Explore CASEI

DATA SHORTCUT

Go directly to a campaign, platform, or instrument →

NASA CASEI Homepage

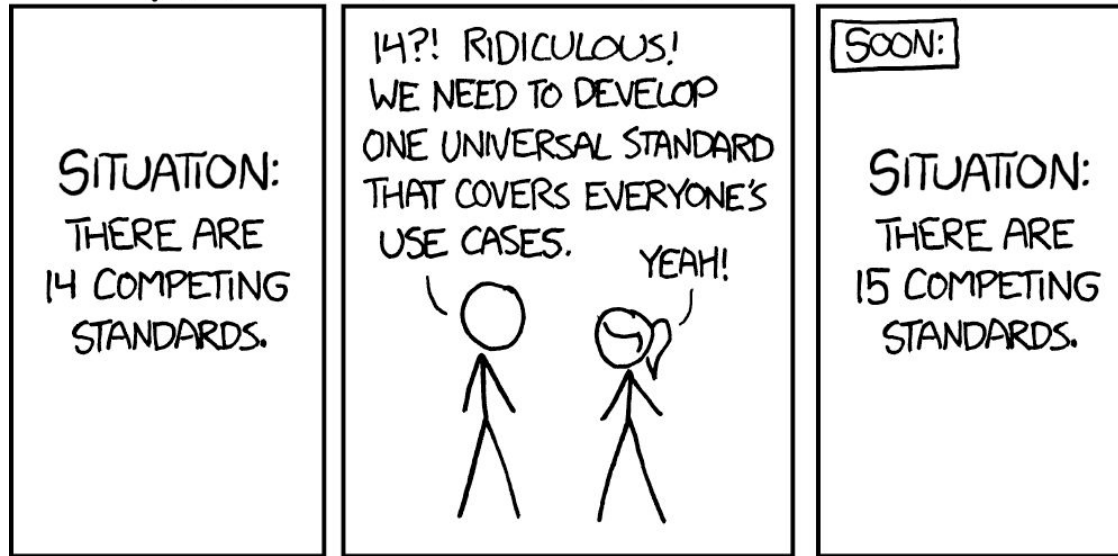
impact.earthdata.nasa.gov/casei/

NASA Suborbital Earth Science Data

	CMR	CASEI	SOOT
Benefit	NASA-wide, well documented, metadata published when data products published	Purpose-built for airborne and field needs, across all DAACs	Specific subsetting, merge services, standardized community variable names and conventions
Challenge	No support for crucial airborne and field data contextual information	Separate resource, curation takes time, not integrated across ESDIS (yet)	Limited number of campaigns, only available at ASDC

Kinda feels like...

HOW STANDARDS PROLIFERATE:
(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC.)



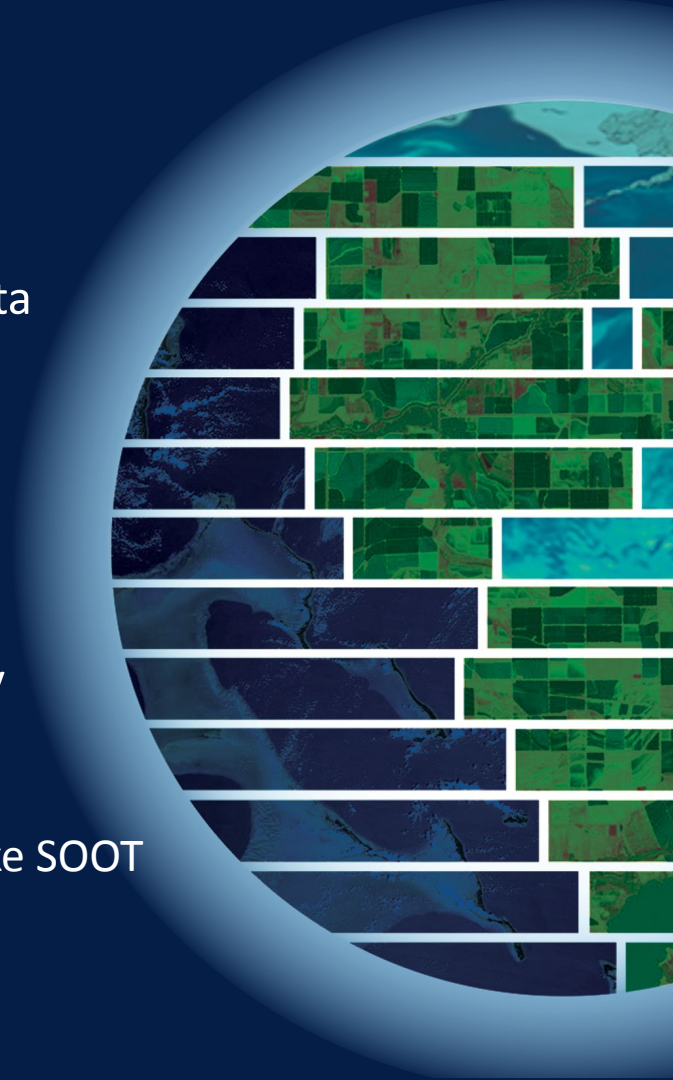
source: <https://xkcd.com/927/>

Earthdata Unification

- Large-scale effort to refine, simply access across data holdings stewarded by NASA ESDIS.
- Tools from individual DAACs would benefit users across ESDIS, but are generally specific for holdings at single repository due to needed metadata beyond CMR
- ESDS recommendation to infuse CASEI functionality across ESDIS
 - Leveraging unification to also support broadening applicability of DAAC-specific tools, like SOOT

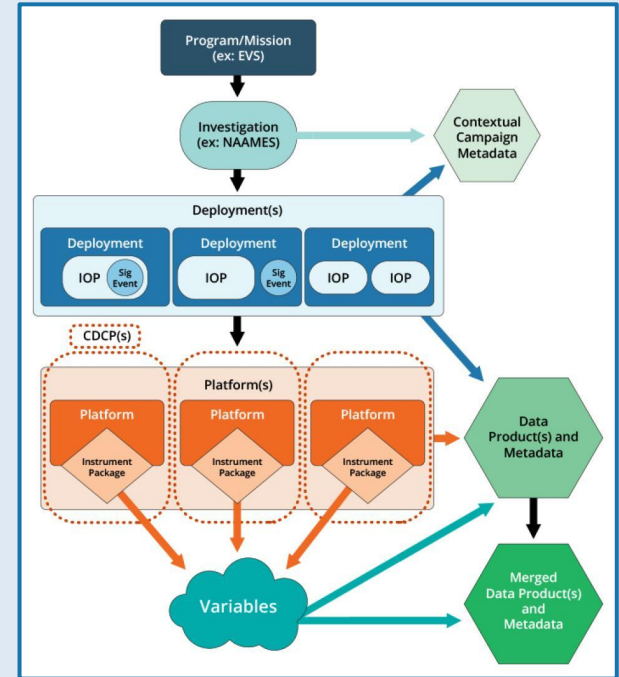


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Metadata Mapping Approach

- CMR needs to be updated (or augmented) to accurately represent contextual information within metadata schema(s)
- Analyze CASEI and SOOT data models/schemas, map each element to any CMR elements corresponding to the same conceptual entity
 - CASEI: Multiple levels of metadata
 - SOOT: Support subsetting, merging
 - CMR: Various UMM profiles
- Details of aligning elements
 - Conditionals/caveats for nearly-aligning elements
- Established a new suborbital schema (draft) for CMR
 - Only includes CASEI campaign level metadata



Simplified schematic of CASEI metadata model

Metadata Mapping Approach

- CMR needs to be updated (or augmented) to accurately metadata

- Analyze C map each correspond

- CASEI:
 - SOOT:
 - CMR:

- Details of
 - Condition

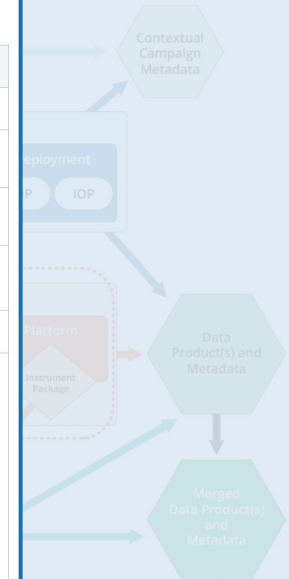
- Established a new sub-section for “Platform” element
 - Only includes CASEI campaign level metadata

Element Specification

Platform is a required element. A minimum of 1 Platform must be provided. Multiple Platforms may also be provided if necessary (Cardinality: 1..*).

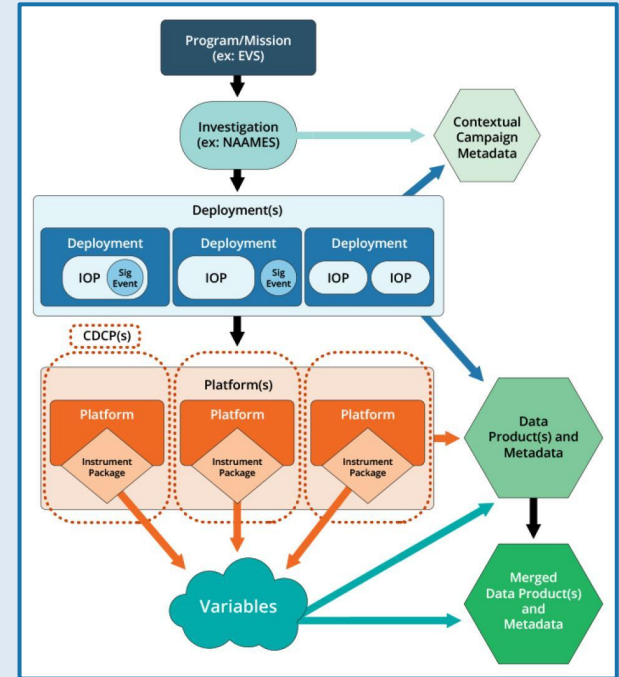
Providing platform **characteristics** is optional. An unlimited amount of platform **characteristics** may be specified for a particular platform (Cardinality: 0..*). If platform **characteristics** are provided, all 5 sub-fields (Name, Description, DataType, Unit, Value) are required.

Model	Element	Type	Usable Valid Values	Constraints	Required?	Cardinality	Notes
UMM-Common	Platforms/Type	String	Platform Category Keywords	KMS controlled	No	0..1	
UMM-Common	Platforms/ShortName	String	Platform Short_Name Keywords	KMS controlled	Yes	1	
UMM-Common	Platforms/LongName	String	Platform Long_Name Keywords	KMS controlled	No	0..1	
UMM-Common	Platforms/Characteristics/Name	String	n/a	1 - 80 characters	Yes, if applicable	1	Only required if a characteristic is listed. Providing characteristics is optional.
UMM-Common	Platforms/Characteristics/Description	String	n/a	1 - 80 characters	Yes, if applicable	1	Only required if a characteristic is listed. Providing characteristics is optional.
UMM-Common	Platforms/Characteristics/DataType	Enumeration	STRING FLOAT INT BOOLEAN DATE TIME DATETIME DATE_STRING TIME_STRING DATETIME_STRING	n/a	Yes, if applicable	1	Only required if a characteristic is listed. Providing characteristics is optional.
UMM-Common	Platforms/Characteristics/Unit	String	n/a	1 - 20 characters	Yes, if applicable	1	Only required if a characteristic is listed. Providing characteristics is optional.



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Sub-Orbital Order Tool (SOOT) BETA Guided Tour

SOOT Resources General User BETA Power User Login

Variable Search Exact Match Variable Selection Total records available: 11

Variable Search:

Filter by Campaign: FIREXQAQ DCOTSS

Filter by Platform: Select option

Filter by Dates: Start Date 07/15/2019 End Date 07/11/2022

Select	PI Variable	Name	Campaign	Platform	Instrument	Description
☐	MM_O3	Gas: O3	FIREXQAQ	MOBILE	AMLGAS	Ozone
☒	O3	Gas: O3	FIREXQAQ	MOBILE	2B Technologies O3	Ozone
☒	O3_CL	Gas: O3	FIREXQAQ	DC8	CL	Ozone
☐	O3_MR	Gas: O3	DCOTSS	SONDES		en-sci ecc ozone mixing ratio
☐	O3_ROZE (10Hz)	Gas: O3	DCOTSS	ER2		ozone mixing ratio
☒	O3_ROZE (1HZ)	Gas: O3	DCOTSS	ER2		ozone mixing ratio
☒	O3_ROZE (1HZ)	Gas: O3	FIREXQAQ	DC8	ROZE	ozone mixing ratio
☒	O3_UCATS	Gas: O3	DCOTSS	ER2		UCATS OZONE MIXING RATIO (PPBV)
☐	O3_ppb	Gas: O3	FIREXQAQ	MOBILE	Photometric Sensor	ozone mixing ratio

Shopping Cart: 4 variables total Clear Cart

Selected Campaigns: FIREXQAQ (2) DCOTSS (2)

Remove	Variable	Platform	Instrument	Investigator	Description
☒	O3	MOBILE	2B Technologies O3	SHANG LIU	Ozone
☒	O3_CL	DC8	CL	THOMAS RYERSON	Ozone

Review & Download

SOOT General User interface: variable search and subsetting functionality

Merge Options SOOT PUI Merge User Guide

Selected Variables:

ACTIVATE-DLH-H2O (3)

ACTIVATE-LARGE-AMS (2)

Select	Variable Name	Type	Units	Description	Standard Name
☒	Org_Ave_IsoK_ST_P	Scale	r	Organic_micrograms_per_standard_cubic_meter	AerComp_OrganicAerosol_InSitu_VacuumAerodynamic_Accu_MassSTP
☐	SO4_Ave_IsoK_ST_P	Scale	r	Sulfate_micrograms_per_standard_cubic_meter	AerComp_Sulfate_InSitu_VacuumAerodynamic_Accu_MassSTP
☒	NO3_Ave_IsoK_ST_P	Scale	r	Nitrate_micrograms_per_standard_cubic_meter	AerComp_Nitrate_InSitu_VacuumAerodynamic_Accu_MassSTP
☐	NH4_Ave_IsoK_ST_P	Scale	r	Ammonium_micrograms_per_standard_cubic_meter	AerComp_Ammonium_InSitu_VacuumAerodynamic_Accu_MassSTP

ACTIVATE-LARGE-INLETFLAG (1)

ACTIVATE-LARGE-MICROPHYSICAL (3)

ACTIVATE-LEGFLAGS (3)

Time Base Mode: Generic

Choose a generic time base interval: 60 sec 30 sec 15 sec 10 sec 5 sec 1 sec

Processing Option: Average Only

Mergeable:

Filename	Why are these files able to be merged?
ACTIVATE-DLH-H2O_HU25_20200215_R0.ict	Merge is available for ICARTT (Ict) file formats from the same campaign, target date, launch, and platform.
ACTIVATE-LEGFLAGS_HU25_20200215_R3.ict	
ACTIVATE-LARGE-AMS_HU25_20200215_R2.ict	
ACTIVATE-LARGE-INLETFLAG_HU25_20200215_R1.ict	
ACTIVATE-LARGE-MICROPHYSICAL_HU25_20200215_R3.ict	

☐ Include Input Files in Download? Return to Selected Files Merge and Download Cancel

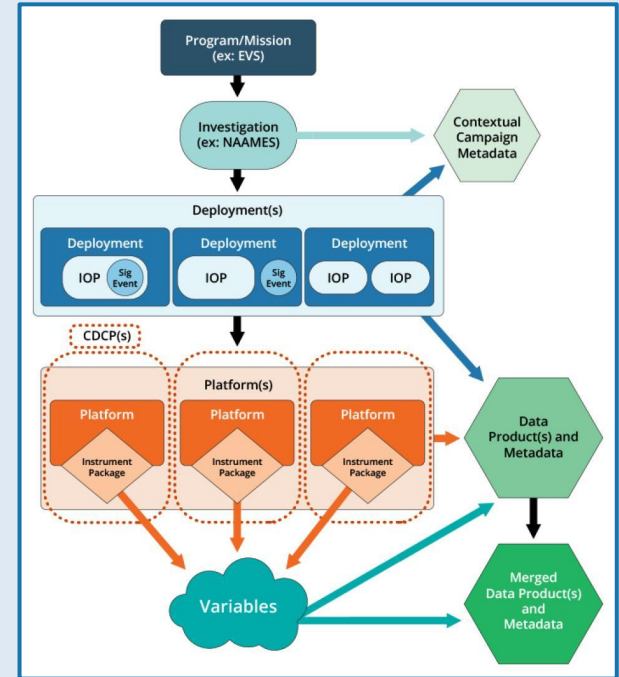
SOOT Power User interface: merge service

SOOT Element	CMR (UMM) Element
DataCollection/ProjectAcronym	UMM-C: Project/ShortName
VariableExtendedMap/VariableName	UMM-V: Variable/Name

Only includes CASEI campaign level metadata

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Simplified schematic of CASEI metadata model

Links to Element ID	Element ID	Cardinality (CASEI)	Data Type	CASEI Element Name	Element Description	Enumerated By	CMR Element Name (UMM-C Schema / UMM-G Schema)	Notes or Conditions for UMM to apply / be consistent w/ CASEI	GCMD Note
	C.1	1	String	Campaign Short Name	Abbreviation for field investigation name (typically an acronym)		UMM-C: Project UMM-C: Project/Campaigns UMM-C: Project/ShortName UMM-C: Short Name	If acronym (or the community-used non-acronym name for the investigation, eg: BigFoot) is used, then the CMR elements will correspond exactly to CASEI's element. If the CMR element is a non-acronym alias for the campaign then it does NOT correspond to the CASEI element	Typically, the value for the Project keyword is the (or a) GCMD project keyword for the campaign - this should correspond to the GCMD Project Keyword that is assigned in CASEI as well as in CMR (see notes on Element ID C.20)
	C.2	1	String	Campaign Long Name	Full name of field investigation (typically the acronym fully spelled out)		UMM-C: Project UMM-C: Project/Campaigns UMM-C: Project/LongName UMM-C: EntryTitle UMM-C: Short Name	It is possible that any of these CMR elements will be provided as the expanded acronym, full name for the campaign.	
	C.3	0*	String	Campaign Alias	Any additional names and/or acronyms used to refer to this field investigation		UMM-C: Project UMM-C: Project/Campaigns UMM-C: Project/LongName UMM-C: Short Name	If any of these CMR elements do not correspond to the CASEI Campaign Short Name or CASEI Campaign Long Name element, then they are to be considered Campaign Aliases.	
	C.4	0*	String	Notes Public	Free text additional notes on the field investigation		UMM-C: Abstract	This CASEI element is used to provide any campaign-specific information curators wish to convey to the public. If there is no content in this element as provided by CASEI curators, it is acceptable to use the CMR Abstract element ONLY if the CMR record the metadata element is describing is for the entire field campaign and not a single data product from that campaign.	
	C.5	1	String	Admin Description	Free text description of the field investigation, including items such as the science or research objectives, regional location, supported mission(s), and equipment used			This follows a specific template - CMR items currently can not produce this.	
D.6 (first deployment)	C.6	1	Date	Start Date	Start date of first deployment of the field investigation		UMM-C: Temporal Extents UMM-C: TemporalExtents/SingleDateTime UMM-C: TemporalExtents/RangeDateTime/BeginningDateTime UMM-C: TemporalExtents/PeriodicDateTime/StartDate	If the dates in the CMR Temporal Extent element correspond to the start and end of all of the campaign's DEPLOYMENTS (per CASEI definitions of campaign and deployment), then the most appropriate element for the start of the duration should be used here -- most likely the RangeDateTime/BeginningDateTime or SingleDateTime elements. If the dates in the CMR Temporal Extent element correspond only to a <i>specific data product</i> , then it is possible but unlikely the CMR element corresponds to this CASEI element.	
D.7 (last deployment)	C.7	0..1	Date	End Date	End date of last deployment of the field investigation		UMM-C: Temporal Extents UMM-C: TemporalExtents/SingleDateTime UMM-C: TemporalExtents/RangeDateTime/EndingDateTime UMM-C: TemporalExtents/PeriodicDateTime/EndDate	If the dates in the CMR Temporal Extent element correspond to the start and end of all of the campaign's DEPLOYMENTS (per CASEI definitions of campaign and deployment), then the most appropriate element for the end of the duration should be used here -- most likely the RangeDateTime/EndingDateTime or SingleDateTime elements. If the dates in the CMR Temporal Extent element correspond only to a <i>specific data product</i> , then it is possible but unlikely the CMR element corresponds to this CASEI element.	
	C.8	1*	String	Campaign Region Description	Free text words identifying the region of field investigation domain		UMM-C: Location Keywords	CASEI element uses curator-entered text to describe the region; CMR element uses GCMD keywords of varying specificity for the region. Either is suitable -- However, if the CMR element is provided only to a Continent level (GCMD hierarchy Category or Topic level), the CASEI element is likely more helpful to data users. If the CMR Location Keyword element is valid only for a specific data product, then the aggregate of CMR Location Keyword elements for <i>all data products produced by the field campaign</i> should be used for this CASEI element.	
	C.9	1*	Enumeration	Season(s) of Study	Season(s) of field investigation data collection	Limited Fields: Seasons List		Items composing the CASEI element could partly be inferred based on the dates of deployments and their locations. There is no CMR element directly mapping to this CASEI element.	
	C.10	1*	String	Focus Phenomena	Free text words identifying focus of the investigation's science or research objectives		UMM-C: Ancillary Keywords UMM-C: ISO Topic Category	Though not exactly the same, CMR's Ancillary Keywords element could be used for CASEI's Focus Phenomena element. Note that the CMR element is not required and thus may often not be populated. CMR's ISOTopicCategories element is quite a bit more broad than the CASEI element, but generally could map to this same item if the Ancillary Keyword element is empty. Note that CMR requires neither element. If the CMR element(s) are valid only for a specific data product, then the aggregate of	

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Draft CMR Suborbital Schema:

- Campaign Short Name
- Campaign Long Name
- Campaign Alias
- Description
- Temporal Extent
- Location Keywords
- Seasons of Study
- Focus Area
- Geophysical Concepts
- Mission
- Campaign DOI
- Campaign Progress
- Total Data Volume

metadata model

Levels of Metadata

CASEI includes detailed metadata not only at Campaign Level, but also:

- Deployment Level
- Intensive Operation Period (IOP) Level
- Significant Event (SE) Level
- Platform Level
- Instrument Level
- Relationship Level (links Campaign-Deployment-Platform-Instrument)





Ongoing Efforts & Challenges

Earth Science Data Systems' Web Unification Initiative

- Large-scale effort to unify, refine, and simplify access across holdings stewarded by the DAACs within ESDIS
- Earthdata web unification project
 - Assessment, deduplication of tools and services
- New NASA Earthdata web presence
 - Consolidated landing pages: datasets, field campaigns, platforms, instruments
 - Less-visible refinements to underlying metadata



Content from all Earth science data sites are migrating into this site from now until end of 2026. Not all NASA Earth science data will appear across the site until then. Thank you for your patience as we make this transition. [Read about the Web Unification Project](#)



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Your Gateway to NASA Earth Observation Data

The Earth Science Data Systems (ESDS) Program provides open access to NASA's archive of Earth science data, empowering researchers and decision makers to better understand and protect our home planet.



Search for keywords, datasets, topics, and more...

Search

Data Catalog



Explore more than 110 petabytes of unrestricted Earth science data.

Data Tools



From discovery to visualization, our data tools simplify and streamline Earth science research.

Data Alerts and Outages



Track interruptions in data availability and view historic outages for specific instruments and platforms.

earthdata.nasa.gov



Ongoing Efforts & Challenges

NASA's Airborne & Field Data Resource Center

- ESDS Airborne and Field Data Workshops (2022, 2024)
 - Common feedback: overwhelming entry points, sprawling nature of information and resources
- Airborne and Field Data Resource Center (AFDRC) streamline access to tools & resources
- Siloed practices, tools, and resources have ***great potential to serve wider communities***, if the broader ecosystem of NASA's CMR and Earthdata infrastructure can leverage DAAC-specific capabilities



AFDRC

Airborne and Field Data Resource Center

A key component of NASA's Earth Observing System is its field experiments, for intensive observation of particular phenomena such as hurricanes, or for ground validation of satellite observations. These field experiments collect many datasets from a wide variety of satellite, airborne, and ground-based instruments, on different spatial and temporal scales, often in unique formats.

Such diverse environmental observations are important for physical process studies, disaster assessment and response, as well as for the validation of environmental satellite observations and atmospheric models, which can improve weather forecasts and representations of Earth's past and future climate.

Founded
2023

earthdata.nasa.gov/centers/afdrc

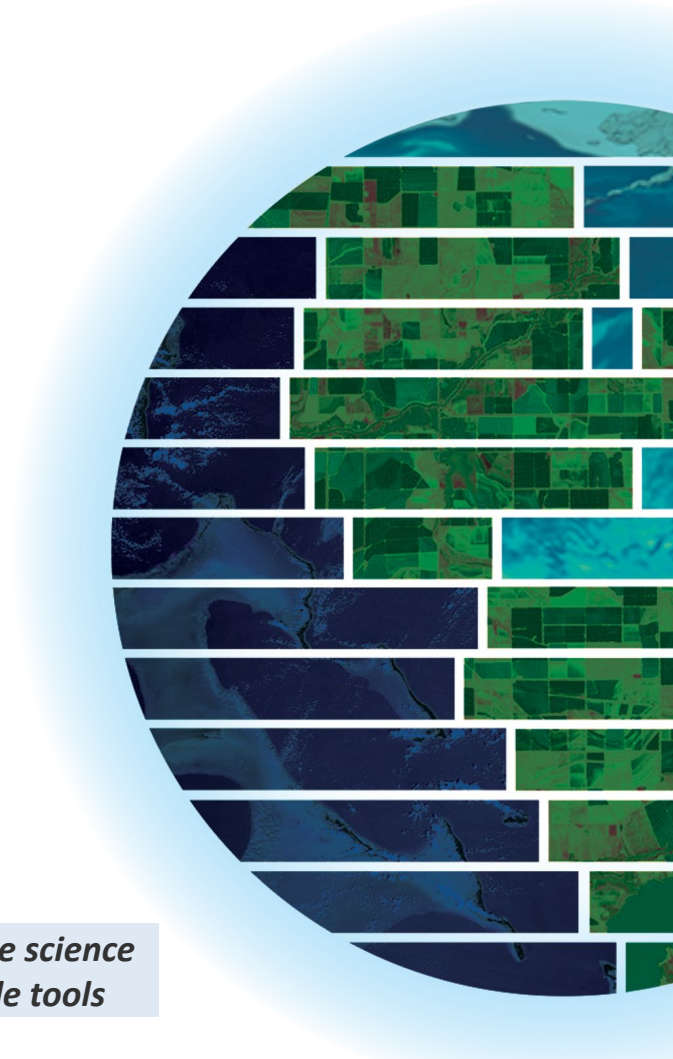
Center Overview

NASA's Airborne and Field Data Resource Center (AFDRC) is designed to help you find information about NASA's airborne and field campaign suborbital measurements and instruments; provides tools and services to help you find, access, visualize and work with the data; and points you to learning resources for working with these unique data products. The term suborbital pertains to any data products and resources that were not derived from platforms that are orbiting Earth. Therefore, suborbital includes measurements made in the air, on land, and on or within water.

Next Steps + Vision

- CASEI formal transition to ESDIS
 - ADMG created as SNWG solution; ESDS: infuse CASEI functionality into ESDIS operations
 - Goal: eliminate need for multiple entry points
- Support SOOT and other DAAC-specific tools
 - Airborne Data Visualizer at ORNL DAAC
 - Field Campaign eXplorer (FCX) at GHRC
 - AppEARS at LP DAAC
 - Vertex at ASF DAAC
- Simplifying virtual collections of data products across repositories and cloud-based archives
 - Collected by a single Facility Instrument
 - Originating from a single field investigation
 - Collected via particular NASA funding vehicles

Melding the metadata will enable greater utility for more science users and lessen the burden of developing generalizable tools





Thank you!

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suborbital@lists.nasa.gov

CASEI

impact.earthdata.nasa.gov/casei/

EARTHDATA

earthdata.nasa.gov

SOOT

asdc.larc.nasa.gov/soot/power-user

AFDRC

earthdata.nasa.gov/centers/afdr