Preserving NASA Historic and Current Mission Data and Adding Value to These for Future Researchers

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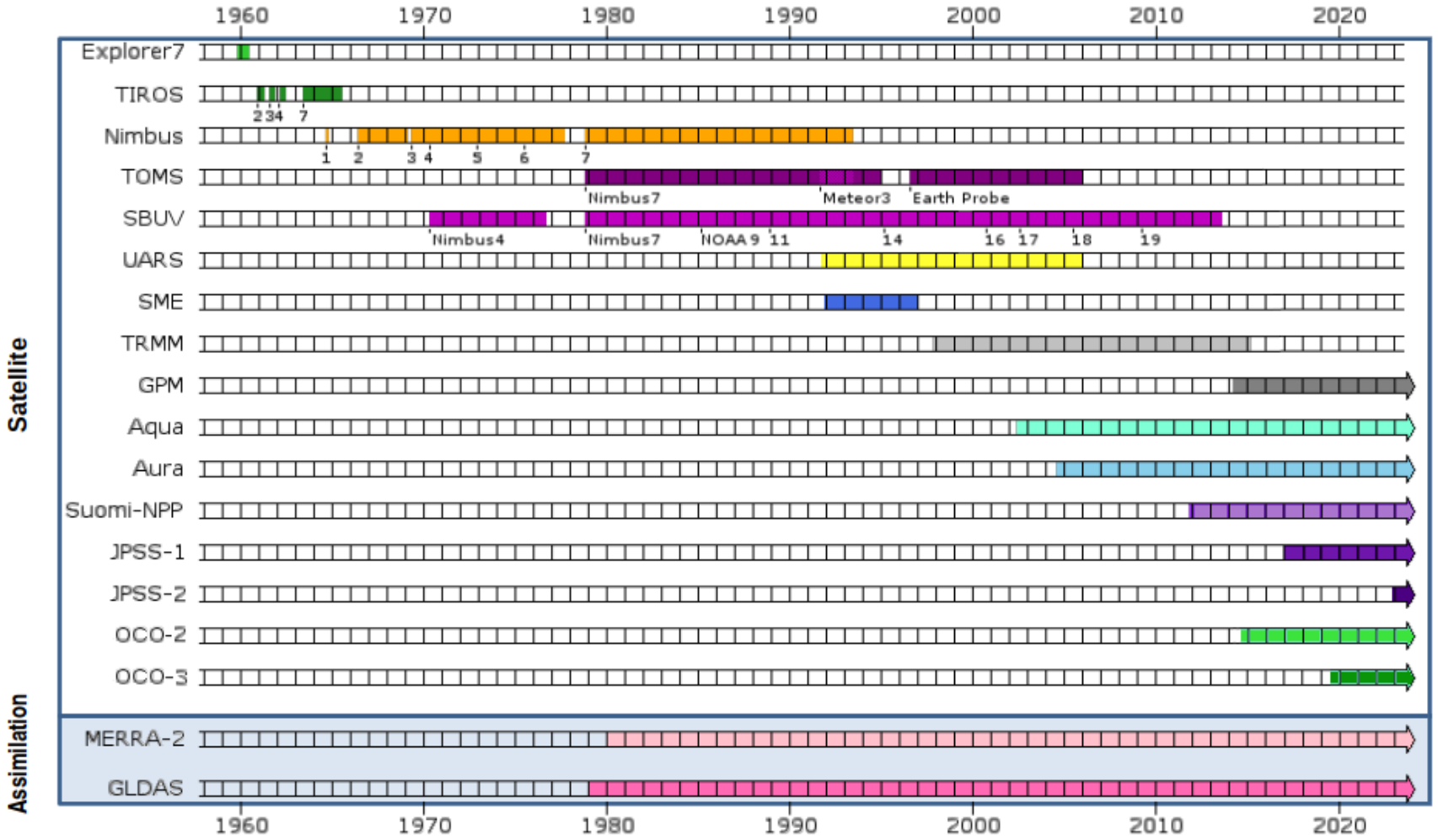
Introduction

The NASA Goddard Earth Sciences Data and Information Services Center (GES DISC) has been actively involved in many aspects of ensuring the long-term preservation of NASA earth science data and knowledge. This involves both the recovery and preservation of early NASA meteorological and other earth observation data, as well as preserving the more recent Earth Observation System (EOS) mission data sets which continue or have reached their end of lifetime.

Almost 65 Years of Earth Data at GES DISC



Data Recovery Overview

At end of mission data originally went to NASA's National Space Science Data Center (NSSDC), and from there to the National Archives Federal Record Center (FRC).

Earth Science Data Recovery Task:

- Preserve NASA historic data written on 7-track and 9-track tapes, 3480 cartridges,
- Save film imagery, and supporting documentation
- Data accessible online to the scientific community
- Add metadata to make data discoverable
- Free up space occupied by bulky media and need for climate controlled warehouse
- Funded by the NASA Earth Science Data and Information System (ESDIS) project
- Implemented and coordinated by the GES DISC.

Data Recovery

1) NASA Requests Access of Tapes → 2) NASA Retrieves Tapes → 3) Vendor Recovers Tapes to Digital Files → 4) NASA Validates Digital Copies of Tapes and Evaluates Data Quality

Data Processed

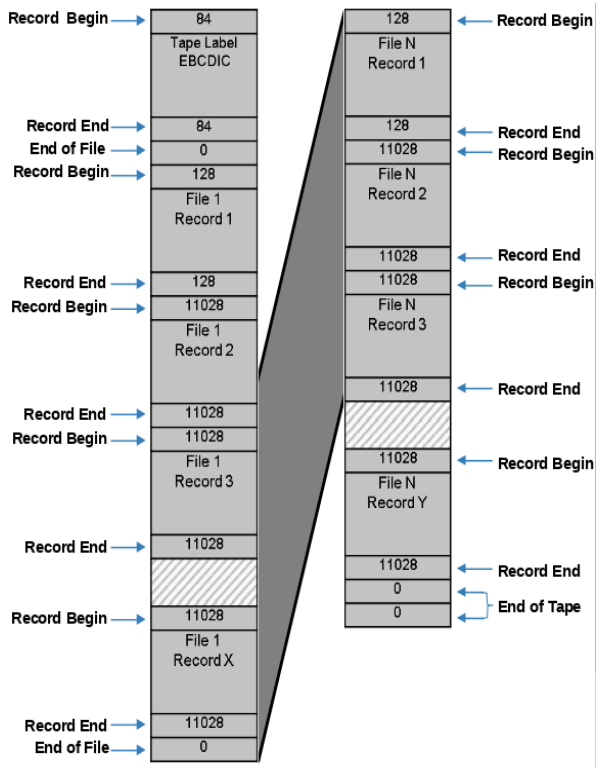
5) NASA Ingests & Archives Files; Makes Data Public → 6) NASA Follows Backup & Recovery Procedures → 7) NASA Asks for Recovered Tapes to be Destroyed

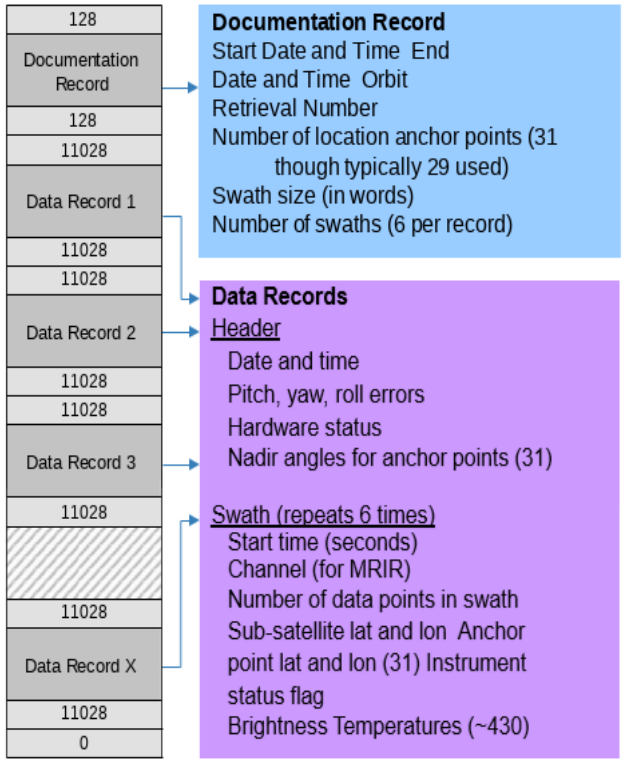
Tape Recovery Process

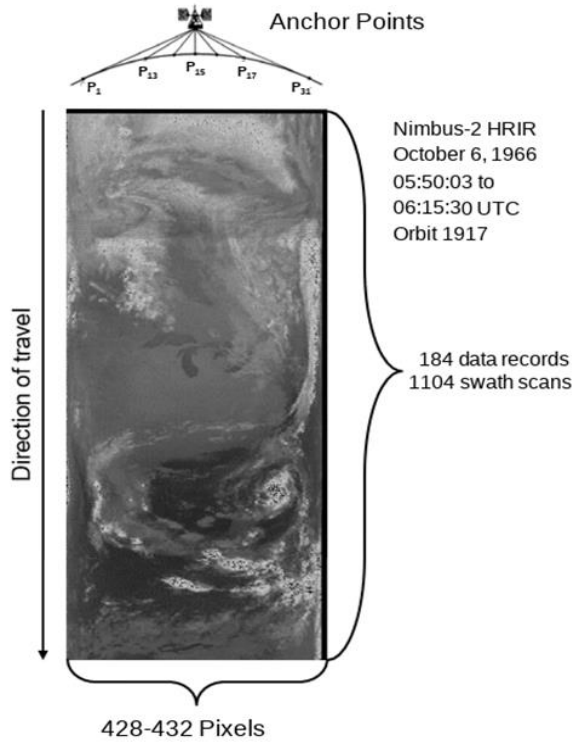
The magnetic tapes are restored with all bits saved in their original format to a digital tape file:

The GES DISC choose to make the individual data files from the digitzed tape available to users rather than the digital tape images. These are then extracted using custom software:

- Each experiment team designed their own unique file format, limits software reuse
- No concept of file-level metadata, needs to be extracted from each data file
- Data originally written on outdated IBM-360 or other machines, e.g.
  - some use 36-bit rather than 32-bit words
  - IBM integer, floats and characters, rather than IEEE values
  - Text in EBCDIC or BCD not ASCII

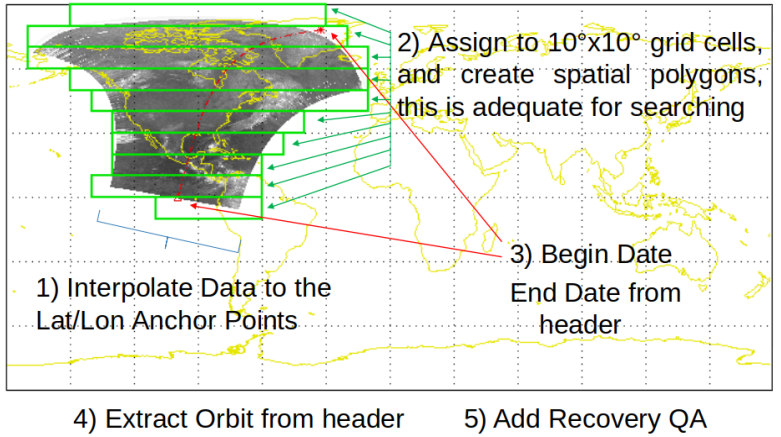

Record Begin
84
Tape Label EBCDIC
Record End
84
End of File
0
Record Begin
128
File 1 Record 1
Record End
128
Record Begin
11028
File 1 Record 2
Record End
11028
Record Begin
11028
File 1 Record 3
Record End
11028
Record Begin
11028
File 1 Record X
Record End
11028
End of File
0
128
File N Record 1
128
11028
File N Record 2
11028
11028
File N Record 3
11028
11028
File N Record Y
11028
0
0
Record Begin
Record End
Record Begin
Record End
Record Begin
Record End
Record Begin
Record End
End of Tape


128
Documentation Record
128
11028
Data Record 1
11028
11028
Data Record 2
11028
11028
Data Record 3
11028
11028
Data Record X
11028
0
Documentation Record
Start Date and Time End
Date and Time Orbit
Retrieval Number
Number of location anchor points (31 though typically 29 used)
Swath size (in words)
Number of swaths (6 per record)
Data Records
Header
Date and time
Pitch, yaw, roll errors
Hardware status
Nadir angles for anchor points (31)
Swath (repeats 6 times)
Start time (seconds)
Channel (for MRIR)
Number of data points in swath
Sub-satellite lat and lon Anchor point lat and lon (31) Instrument status flag
Brightness Temperatures (~430)


Anchor Points
Nimbus-2 HRIR
October 6, 1966
05:50:03 to
06:15:30 UTC
Orbit 1917
184 data records
1104 swath scans
Direction of travel
428-432 Pixels

Metadata Extraction

Obtaining metadata requires reading the data file headers and data records using custom software, as the original tapes do not contain this level of information.



Metadata attributes needed are

- spatial extent
- start/end time
- orbit number (when applicable)
- QA recovery stats
- original tape info (lineage)

The metadata are then added to NASA's Common Metadata Repository (CMR) which allows users to search for the data through either the local GES DISC web search or the ESDIS search client.

More complicated is the extraction of metadata from scanned images. These often have no information, sometimes only the source of the image.

As a last step, data products are assigned a Digital Object Identifier (DOI) which allows one to cite the data, as well as provide a permanent means to locate and discover the data.

Preservation

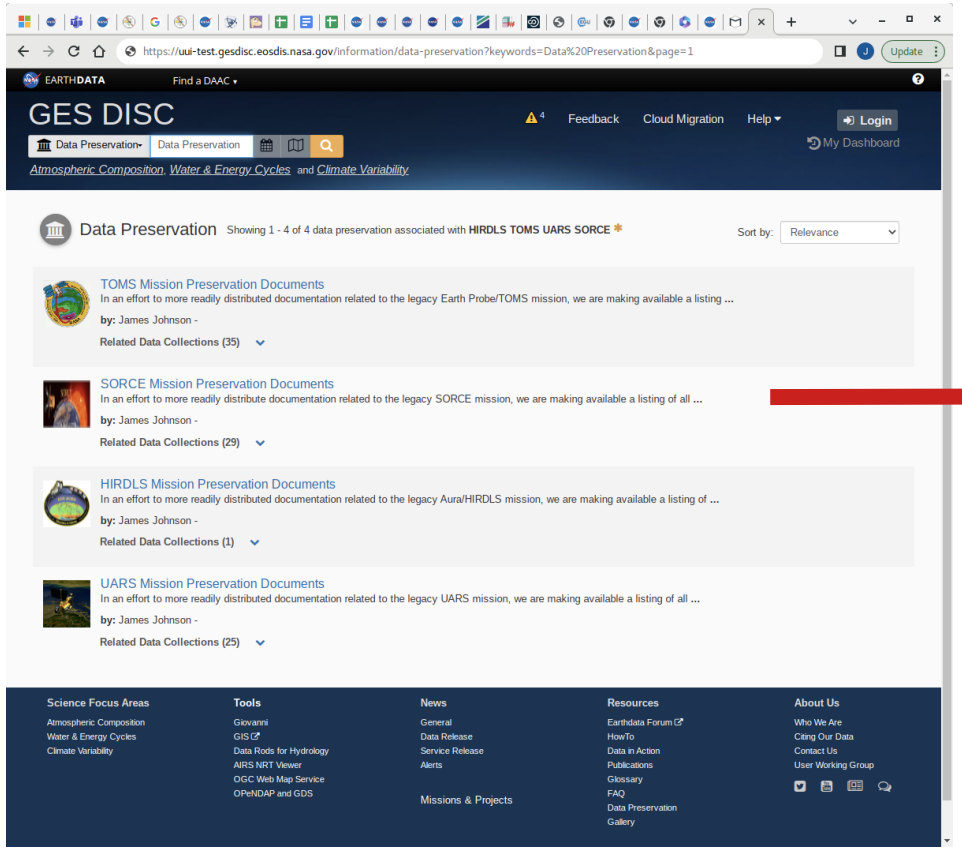
GES DISC follows the guidelines developed for the preservation of data as specified in the NASA EOS Data and Information System (EOSDIS) Earth Science Data Preservation Content Specification (423-SPEC-001) document. Preservation documents are maintained on the GES DISC docserver for public access (except any ITAR or proprietary documents which are stored offline according to NASA and US federal regulations). Access is through the GES DISC Homepage.

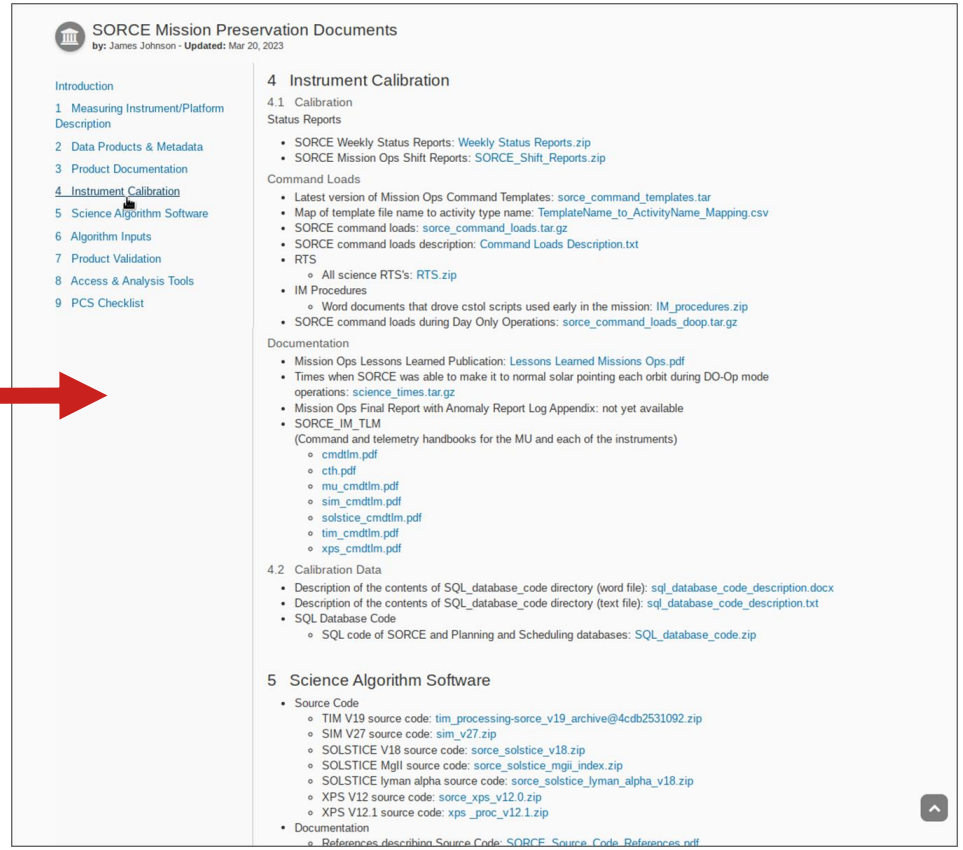
To date, the GES DISC has consulted with the data science teams from the following completed missions: UARS, Earth Probe TOMS, Aura HIRDLS, and SORCE, in order to properly preserve their data and accompanying documentation.

The GES DISC is also currently working with the EOS science teams from TRMM, AIRS, MLS, OMI and additional missions prior to mission end to ensure that the relevant documents and data sets are properly archived for future researchers.

For the next step, the GES DISC is moving the data in its archive into the ‘cloud’. Users can access the data directly using cloud services via AWS us-west-2 region.

Finding Data Preservation Items at the GES DISC





Data Recovered From Tapes and Film

(italics = not yet split into individual files, available upon request)

Satellite	Instrument	Start Date	End Date
Explorer 7	Thermal Radiation Experiment	1959-10-19	1960-06-04
TIROS 2	Medium Resolution Scanning Radiometer	1960-11-23	1961-04-13
TIROS 3	Medium Resolution Scanning Radiometer	1961-07-12	1961-10-20
	Low Resolution Omnidirectional Radiometer	1961-07-12	1961-09-30
TIROS 4	Medium Resolution Scanning Radiometer	1962-02-08	1962-06-28
	Low Resolution Omnidirectional Radiometer	1962-02-08	1962-06-30
TIROS 7	Medium Resolution Scanning Radiometer	1963-06-19	1965-06-19
	Low Resolution Omnidirectional Radiometer	*1963-06-19*	*1963-08-29*
Nimbus 1	High Resolution Infrared Radiometer	1964-08-29	1964-09-22
Nimbus 2	High Resolution Infrared Radiometer	1966-05-16	1966-11-15
	Medium Resolution Infrared Radiometer	1966-05-15	1966-07-28
Nimbus 3	High Resolution Infrared Radiometer	1969-04-17	1970-03-21
	Medium Resolution Infrared Radiometer	1969-04-17	1970-03-21
	Satellite Infrared Spectrometer	1969-04-14	1970-06-19
Nimbus 4	Temperature-Humidity Infrared Radiometer	1970-04-13	1971-04-01
	Infrared Interferometer Spectrometer	1970-04-09	1971-01-30
	Satellite Infrared Spectrometer	1970-04-08	1971-04-08
	Selective Chopper Radiometer	1970-07-27	1973-02-20
	Backscatter Ultraviolet Spectrometer	1970-04-10	1977-05-06
Nimbus 5	Temperature-Humidity Infrared Radiometer	1972-12-19	1975-03-01
	Surface Composition Mapping Radiometer	1972-12-11	1972-12-30
	Electrically Scanning Microwave Radiometer	1972-12-11	1977-05-16
	Infrared Temperature Profile Radiometer	1975-02-14	1976-09-30
	Selective Chopper Radiometer	1974-12-12	1978-04-20
	Nimbus-E Microwave Spectrometer	1972-12-17	1973-10-31
Nimbus 6	Temperature-Humidity Infrared Radiometer	1975-06-18	1977-08-11
	High Resolution Infrared Radiation Sounder	1975-06-13	1976-05-26
	Scanning Microwave Spectrometer	1975-06-15	1976-05-31
	Electrically Scanning Microwave Radiometer	1975-06-22	1977-08-11
	Limb Radiance Inversion Radiometer	1975-06-20	1976-01-06
	Pressure Modulator Radiometer	1975-06-16	1978-06-24
Nimbus 7	Temperature-Humidity Infrared Radiometer	1978-10-30	1985-05-13
	Limb Infrared Monitor of the Stratosphere	1978-10-25	1979-05-30
	Stratospheric and Mesospheric Sounder	1978-10-26	1983-06-10
	Solar Backscattered Ultraviolet	1978-10-31	1990-06-21
	Total Ozone Mapping Spectrometer	1978-11-01	1993-05-06

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ATS 6	*Geosynchronous Very High Resolution Radiometer*	*1974-06-17*	*1974-08-30*
SMS 1	Visible Infrared Spin-Scan Radiometer	1974-07-01	1979-04-19
SMS 2	Visible Infrared Spin-Scan Radiometer	1975-02-17	1980-08-22
GOES 1	Visible Infrared Spin-Scan Radiometer	1976-01-27	1976-10-28
GOES 2	Visible Infrared Spin-Scan Radiometer	1977-08-29	1979-01-03
GOES 3	Visible Infrared Spin-Scan Radiometer	1979-05-02	1979-06-08
STS-2 / OSTA 1	*Ocean Color Experiment, Shuttle Multispectral Infrared Radiometer, Measurement of Air Pollution from Satellites*	*1981-11-12*	*1981-11-14*
STS-41G / OSTA 3	*Shuttle Imaging Radar B, Large Format Camera, Measurement of Air Pollution from Satellites*	*1984-10-05*	*1984-10-13*
STS-51B / Spacelab 3	Atmospheric Trace Molecule Spectroscopy	1985-04-30	1985-05-01
GEOS 2	*Optical Beacon System*	*1968-03-18*	*1968-07-25*
GEOS 3	*Satellite-to-Satellite Tracking*	*1975-04-09*	*1975-12-23*
EOLE 1 (CAS 1)	*Upper Atmosphere Winds and Weather Data Relay System*	*1971-08-27*	*1972-07-04*
DMSP 5D-1 / F01	*Multichannel Filter Radiometer (Special Sensor H)*	*1977-03-25*	*1977-07-23*
DMSP 5D-1 / F02	*Multichannel Filter Radiometer (Special Sensor H)*	*1977-03-25*	*1977-07-23*
DMSP 5D-1 / F03	*Multichannel Filter Radiometer (Special Sensor H)*	*1977-03-25*	*1977-07-23*
DMSP 5D-1 / F04	*Multichannel Filter Radiometer (Special Sensor H)*	*1977-03-25*	*1977-07-23*
SME	*Ultraviolet Ozone Experiment*	*1981-12-15*	*1986-12-18*
	Visible Nitrogen Dioxide Experiment	*1982-01-01*	*1986-12-18*

For more information

GES DISC Homepage https://disc.gsfc.nasa.gov

Ramapriyan, H.K., Moses, J.F., & Smith, D. (2022b). Preservation Content Implementation Guidance, Version 1.0. NASA Earth Science Data and Information System Standards Coordination Office, 25 January 2022. doi:10.5067/DOC/ESO/RFC-042