University of Wisconsin SSEC Satellite Data Services Update

McIDAS Users Group Meeting

September 25-26, 2023

WISCONSIN
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SSEC

SSEC SDS

Current Staff


Jerrold Robaidek


Daniel Forrest


Richard Kohrs


Clayton Suplinski


Douglas Schumacher


Kaba Bah


Rob Lemke


Istvan Bocsi


Erik Olson

Staffed M-F , 8:30 AM - 5:00 pm Central time.

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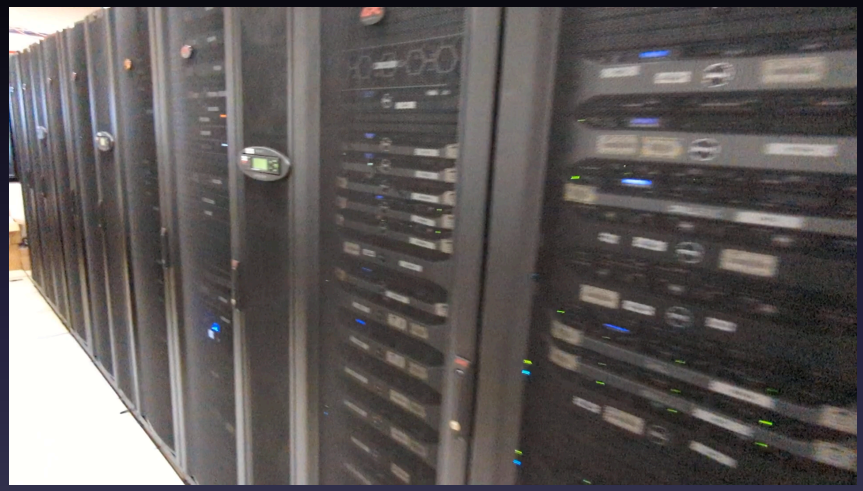
Data Center Facilities

- 2100 sqft
- Backup power provides ~15 minutes uptime
- Campus Chilled water for cooling
- Greater than 20 PBs Storage * (storage numbers out of date)



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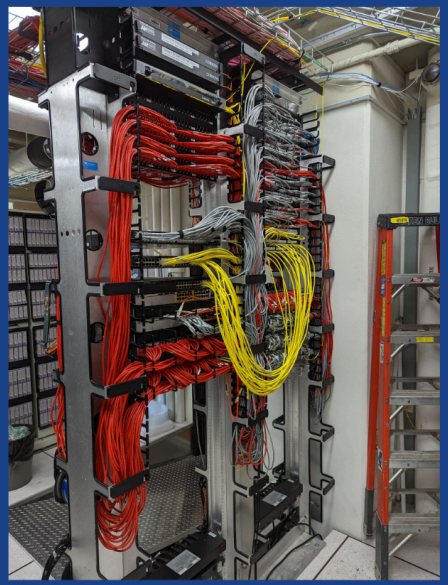
Data Center Facilities

Power, Cooling, and Network



1 & 10 GBit internal connections
50 Gbit infiniband within HPCC

22 In-line coolers

5 - 72 KW UPS

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Data Center Facilities

UW Provisioned Off-site Data Center

- Tier 3, backup power, cooling
- Essential systems
- Ingest, Distribution
- On UW network
- Plans to expand for projects that demand high availability

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High Performance Compute Cluster (HPCC)

2018 Replaced original 2012 HPCC

- 2,560 cores
- 15.3 TB memory
- 4 PB of storage
- 54 Gbit FDR infiniband
- $1.6 milion

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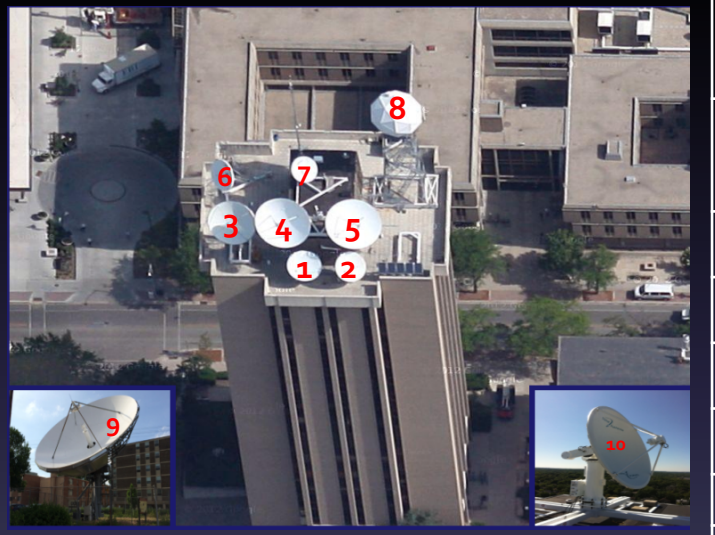
Antennas

UW SSEC Antennas

September 22, 2023



	Name	Type and Band	Datasets	Pointing location Satellite	Antenna Diameter
1	Patriot 1	DVB2 C-Band 4020MHz	Noaaport *note	Galaxy 31 121ºW	4.5 m
2	Patriot 2	GRB/GVAR L-Band (dual feed) GRB 1,686.6 MHz GVAR 1685.7 MHz	-GOES-West backup -GOES-14 -GOES-T checkout	Goes-W/Test GOES-14 108ºW	4.5 m
3	Patriot 3	C-Band EWS 4126.475Mhz Wallops 4117.065MHz 4120MHz center	-EWS-G1 -Wallops Polar Relay	SES-2 87ºW	6.3 m
4	West Harris	GRB L-Band GRB 1,686.6 MHz	GOES-West	GOES-West 137ºW	7.3 m
5	East Harris	GRB L-Band GRB 1,686.6 MHz	GOES-East	GOES-East75ºW	7.3 m
6	Andrew	GVAR L-Band GVAR 1685.7 MHz	idle/backup	128ºW	4.6 m
7	Little Andrew	C-Band 4080 MHz	Geonetcast	58ºW	3.7 m
8	Modis	X-Band	off-line	tracking	4.4 m
9	Orchard St	C-band 3960MHz (center 3951.625MHz)	Gilmore Polar Relay	SES-1 101ºW	11 m
10	Direct Broadcast ERB	X/L Band L-Band 1701.3 MHz	LEO DB	tracking	2.4 m

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SSEC Antennas

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DB Antennas operated by CIMSS/SSEC

SSEC antennas (5)
(Owned and operated by CIMSS/SSEC on behalf of NOAA)
(*Locations part of the NWS PSAS project)
- Honolulu*
- Madison
- Miami
- Mayaguez
- Guam*

NOAA antennas (2)
(Owned and operated by UAF and NOAA NWS, respectively)
- Fairbanks*
- Monterey

Partner antennas (15)
(Owned and operated by other groups)
- JMA
- ECCC
- CLS/KINEIS
- CSIR
- GISTDA
- ATSC
- Hampton Univ.

Madison, Wisconsin

Honolulu, Hawaii

All antennas are Orbital Systems X/L-band

Miami, Florida

Mayaguez, Puerto Rico

Guam, Mariana Islands

Credit Liam Gumley

NOAA DBRTN DBNet

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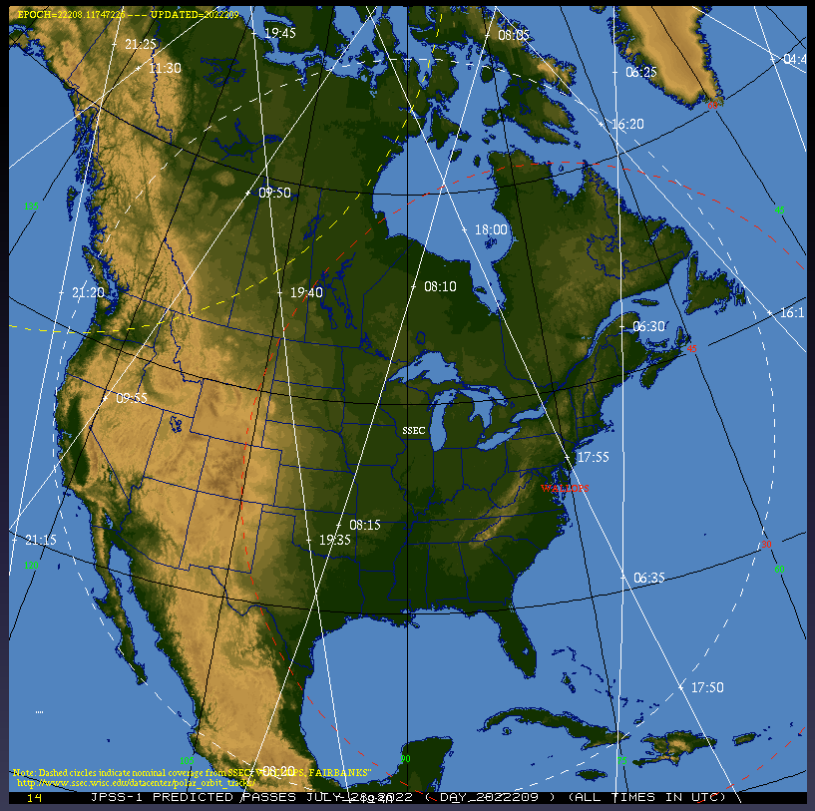
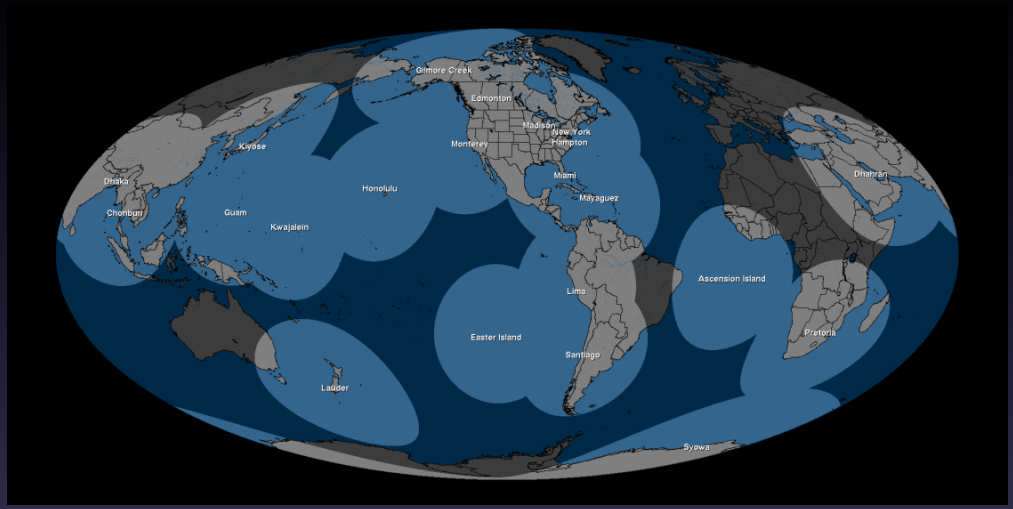
Antenna Coverage of
Direct Broadcast Antennas





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CIMSS & SSEC at the UW-Madison

SSEC Data Center Incoming Data

August, 2023

1+ TB/day via Satellite
(C-band. L-band, X-band)

8+ TBs/day via Internet*
(ftp, LDM, ADDE, http, rsync, AWS)

CIMSS = Cooperative Institute for Meteorological Satellite Studies

SSEC = Space Science &Engineering Center

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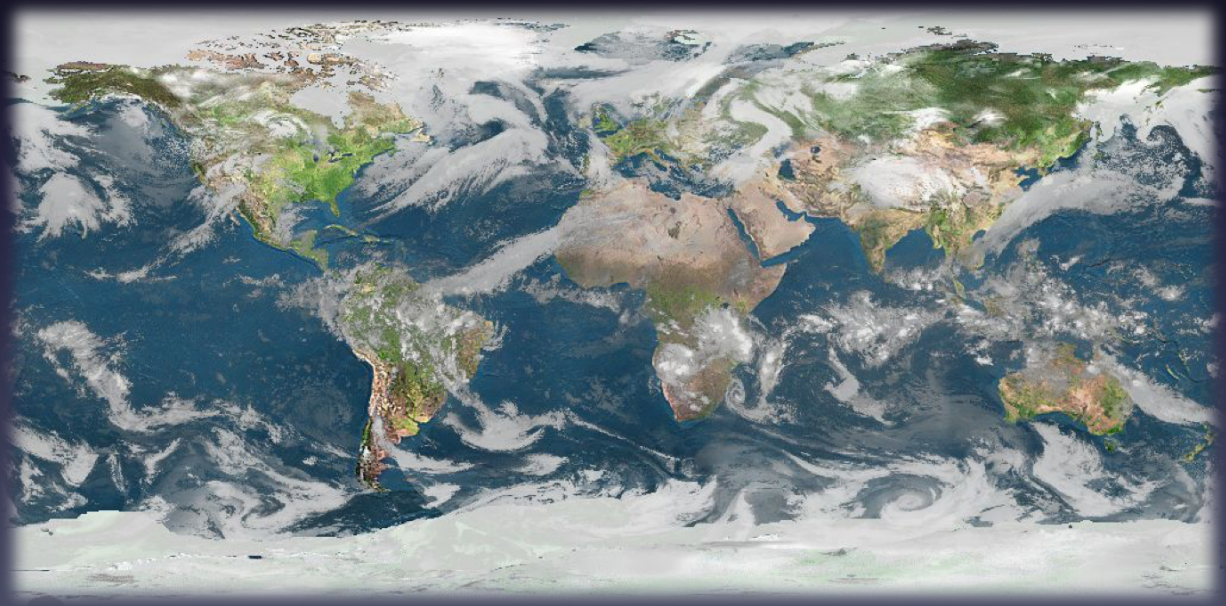
Real-time Data

The SSEC Data Center receives data from 10+ different geostationary satellites and 13+ different polar orbiting satellites. Most data are available in near real-time via ADDE. Other methods of data access are available upon request.



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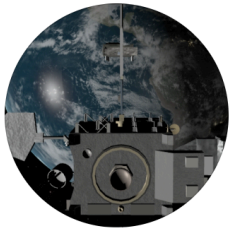
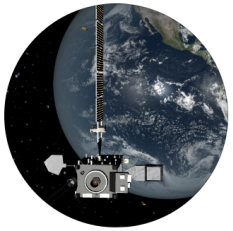
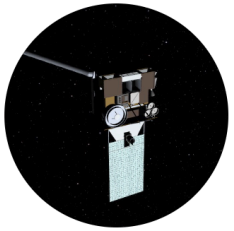
Satellites Ingested

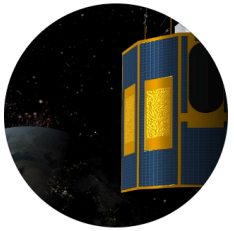
12 geostationary satellites (varies from 8-12)

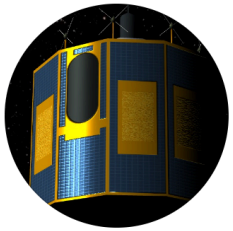

GOES-16

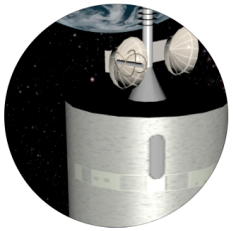

GOES-18

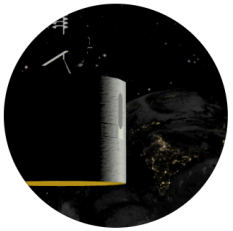

GOES-14

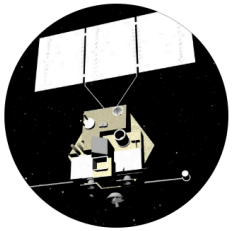

EWS-G1

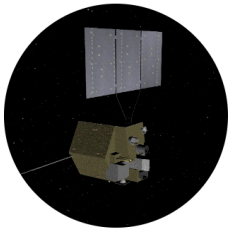

Meteosat-9

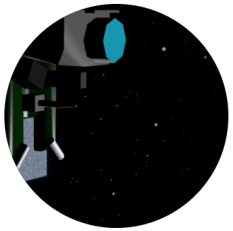

Meteosat-10

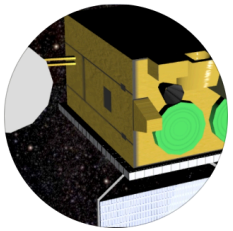

FY-2G


FY-2H


FY-4A


FY-4B


Himawari-9


GEO-KOMPSAT-2A

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Geostationary Satellites Received at UW SSEC in 2023

	Sub-Point	Reception Method	Source	Latency	Daily Volume
GOES-16	75.2° West	L-Band	DB	<10 seconds	130-400 GB
GOES-14 (backup)	104° West	L-Band	DB	<2 minutes	23 GB
GOES-13/EWS-G1	61.5°East	C-Band & internet relay	DB	<2 minutes	23 GB
GOES-15/EWS-G2	103.3°E -Drifting to 61.5°East	L-Band	DB	<2 minutes	23 GB
GOES-17 (backup)	104.7° West	L-Band	DB	<2 minutes	23 GB
GOES-18	137°West	L-Band	DB	<10 seconds	130-400 GB
Meteosat-10	0° East	Network Relay	NOAA STAR *Terrestrial Eumetcast Geonetcast*	~30 minutes	24 GB
Meteosat-9	41.5° East	Network Relay	NOAA STAR	~30 minutes	24 GB
Himawari-9	140° East	Network Relay	NOAA STAR AWS (backup)	~ 10 minutes	300 GB
Himawari-9	140° East	Himawari Cast Network Relay	Hawaii NWS	~ 10 minutes	62 GB
FY2H	79° East	Network Relay	ABOM	15-30 minutes	4.7 GB
FY2G	99.5° East	Network Relay	ABOM	15-30 minutes	4.7 GB
GK2A	128° East	Network Relay	KMA	9-24 minutes	11 GB
FY-4A (AGRI & GIIRS)	105° East	Terrestrial Eumetcast	Eumetsat	10-15 minutes	~5 – 13 GB
FY-4B (GIIRS only)	133° East	Terrestrial Eumetcast	Eumetsat	10-15 minutes	~5 – 13 GB

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Meteosat-9	41.5° East	Network Relay	NOAA STAR	~30 minutes	24 GB
Himawari-9	140° East	Network Relay	NOAA STAR AWS (backup)	~ 10 minutes	300 GB
Himawari-9	140° East	Himawari Cast Network Relay	Hawaii NWS	~ 10 minutes	62 GB
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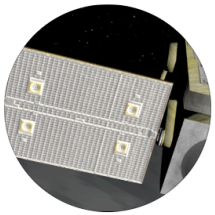
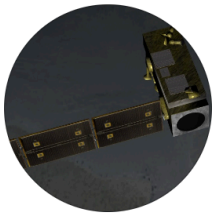
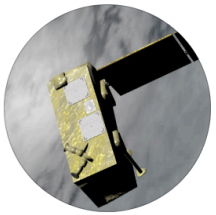
FY-4B (GIIRS only)	133° East	Terrestrial Eumetcast	Eumetsat	10-15 minutes	~5 – 13 GB

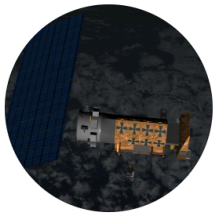
Satellites Ingested

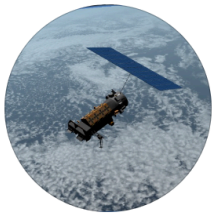
18 polar satellites (varies from 11-18)


Suomi NPP

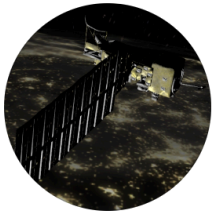

NOAA-21

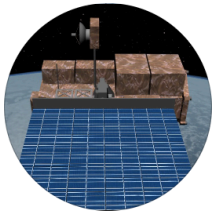

NOAA-20

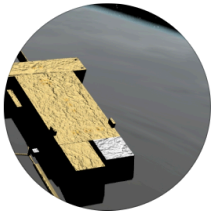

NOAA-19

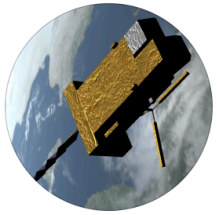

NOAA-18


NOAA-15


Aqua

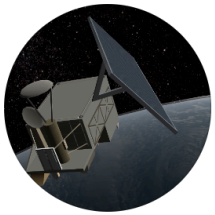

Terra

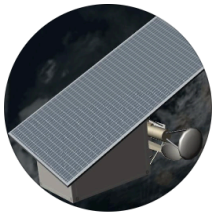

MetOp-B

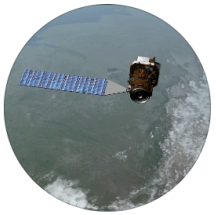

MetOp-C

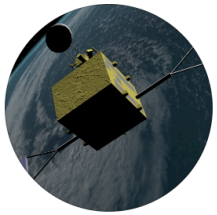

Sentinel-3A

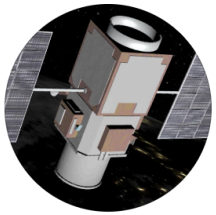

Sentinel-3B


FY-3A


FY-3B


Landsat-8


GCOM-W1


Calipso


SARAL

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Polar Satellites Received at UW SSEC in 2023

	Reception Method	Domain	ADDE Latency	Instruments	Access
NOAA-15	C-Band relay, NOAA-STAR	DB CONUS Global	DB <1 minutes after pass	AVHRR, AMSU, DCS->level-1	**ADDE**
				All other instruments Level-0	NA
NOAA-18	DB L-Band, C-Band relay, NOAA STAR	DB CONUS Global	DB <1 minutes after pass	AVHRR->level-1	**ADDE**
				All other instruments Level-0	NA
NOAA-19	DB L-Band, C-Band relay, NOAA STAR	DB CONUS Global	DB <1 minutes after pass	AVHRR->level-1	**ADDE**
				All other instruments Level-0	NA
NOAA-20	DB XL-Band, NOAA STAR, CLASS	DB CONUS Global	DB <1 minutes after pass Global network relay ~45 min	VIIRS>level-1	**ADDE**
				VIIRS,ATMS, CrIS	DB ftp (sips)
Metop-B/C	DB L-Band, NOAA STAR Relay	DB CONUS Global	CONUS <15 minutes after pass	AVHRR ->level-1	**ADDE**
				AVHRR, IASI	DB ftp (sips)
Suomi-NPP	DB X/L Band, NOAA STAR, CLASS	DB CONUS Global	CONUS <15 minutes after pass Global network relay ~45 min	VIIRS	**ADDE**
				VIIRS,ATMS, CrIS	DB ftp (sips)
NOAA-20	DB X/L Band, NOAA STAR, CLASS	DB CONUS Global	CONUS <15 minutes after pass Global network relay ~45 min	VIIRS	**ADDE**
				VIIRS,ATMS, CrIS	DB ftp (sips)
NOAA-21	DB X/L Band, NOAA STAR, CLASS	DB CONUS Global	CONUS <15 minutes after pass Global network relay ~45 min	VIIRS	**ADDE**
				VIIRS,ATMS, CrIS	DB ftp (sips)
Aqua	DB X-Band, NASA Relay	DB CONUS Global	DB <15 minutes after pass	AIRS, MODIS -> Level-1	**ADDE**
				AIRS, MODIS	DB ftp (sips)
Terra	DB X-Band, NASA Relay	DB CONUS Global	DB <15 minutes after pass	MODIS -> Level-1	**ADDE**
				MODIS	DB ftp (sips)
Landsat-8	Network Relay (USGS)	CONUS	<24 hours	Level-1	WMS
Shizuku GCOM-W1, FY-B/C, Calipso, Saral	DB X-Band	CONUS	DB <1 min after pass	Level-0	SSEC ftp

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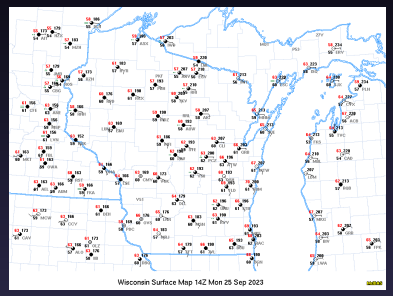
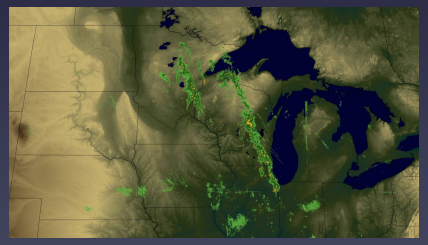
NOAA-15	C-Band relay, NOAA-STAR	DB CONUS Global	DB <1 minutes after pass	AVHRR, AMSU, DCS->level-1	**ADDE**
				All other instruments Level-0	NA
NOAA-18	DB L-Band, C-Band relay, NOAA STAR	DB CONUS Global	DB <1 minutes after pass	AVHRR->level-1	**ADDE**
				All other instruments Level-0	NA
NOAA-19	DB L-Band, C-Band relay, NOAA STAR	DB CONUS Global	DB <1 minutes after pass	AVHRR->level-1	**ADDE**
				All other instruments Level-0	NA
NOAA-20	DB XL-Band, NOAA STAR, CLASS	DB CONUS Global	DB <1 minutes after pass Global network relay ~45 min	VIIRS>level-1	**ADDE**
				VIIRS,ATMS, CrIS	DB ftp (sips)
Metop-B/C	DB L-Band, NOAA STAR Relay	DB CONUS Global	CONUS <15 minutes after pass	AVHRR ->level-1	**ADDE**
				AVHRR, IASI	DB ftp (sips)
Suomi-NPP	DB X/L Band, NOAA STAR, CLASS	DB CONUS Global	CONUS <15 minutes after pass Global network relay ~45 min	VIIRS	**ADDE**
				VIIRS,ATMS, CrIS	DB ftp (sips)
NOAA-20	DB X/L Band, NOAA STAR, CLASS	DB CONUS Global	CONUS <15 minutes after pass Global network relay ~45 min	VIIRS	**ADDE**
				VIIRS,ATMS, CrIS	DB ftp (sips)
NOAA-21	DB X/L Band, NOAA STAR, CLASS	DB CONUS Global	CONUS <15 minutes after pass Global network relay ~45 min	VIIRS	**ADDE**
				VIIRS,ATMS, CrIS	DB ftp (sips)
Aqua	DB X-Band, NASA Relay	DB CONUS Global	DB <15 minutes after pass	AIRS, MODIS -> Level-1	**ADDE**
				AIRS, MODIS	DB ftp (sips)
Terra	DB X-Band, NASA Relay	DB CONUS Global	DB <15 minutes after pass	MODIS -> Level-1	**ADDE**
				MODIS	DB ftp (sips)
Landsat-8	Network Relay (USGS)	CONUS	<24 hours	Level-1	WMS
Shizuku GCOM-W1, FY-B/C, Calipso, Saral	DB X-Band	CONUS	DB <1 min after pass	Level-0	SSEC ftp

Non-Satellite data

- NOAAport (500+GB/day)
  - Text/Point
  - Model Grids
  - Radar





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Future ADDE real-time datasets

- GOES-U
- MTG
- GK2A (ADDE)
- FY-4A/B AGRI (ADDE)

Data Distribution

- Realtime
  - McIDAS ADDE (Abstract Data Distribution Environment)
  - ftp (being phased out)
  - http(s)
  - LDM
  - Direct access via mount (in-house only)
  - WMS (Web map service)
- Archive
  - ADDE
  - Direct Access (in-house only)
  - WMS (experimental)
  - McFETCH
  - THREDDS (being expanded)

Archive

Early SSEC Satellite Archive History

(Before 1978)

7.3 Meter Antennas for
SMS-1 and SMS-2
1974

9 - Track tapes
Before 1978

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National Archive

1979 - 2004

Routine Archiving Begins

1978

(FGGE)

Umatic Tapes

(3 tapes/day per/satellite)

1978-1996

3590 Tapes

(1 tape/day per/satellite)

1996 - 2004

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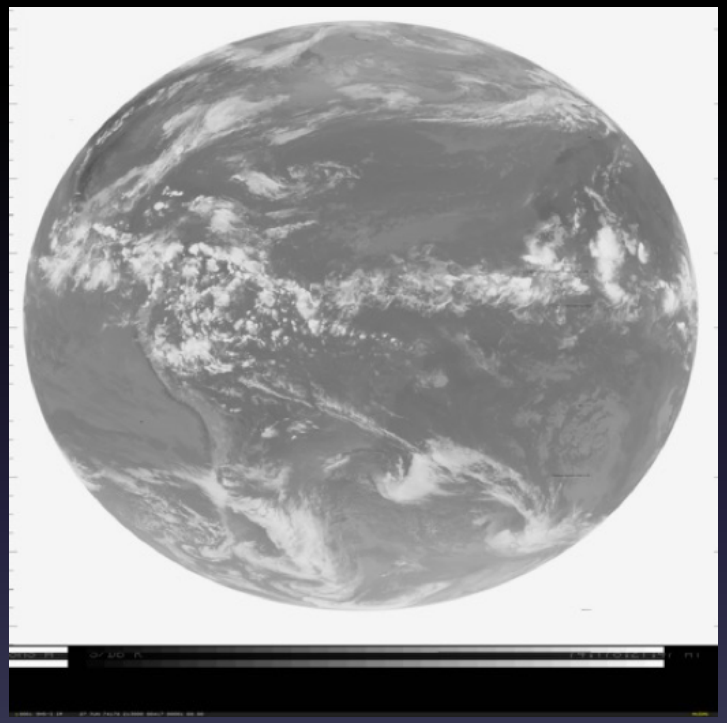
First SMS/GOES
Images in the Archive

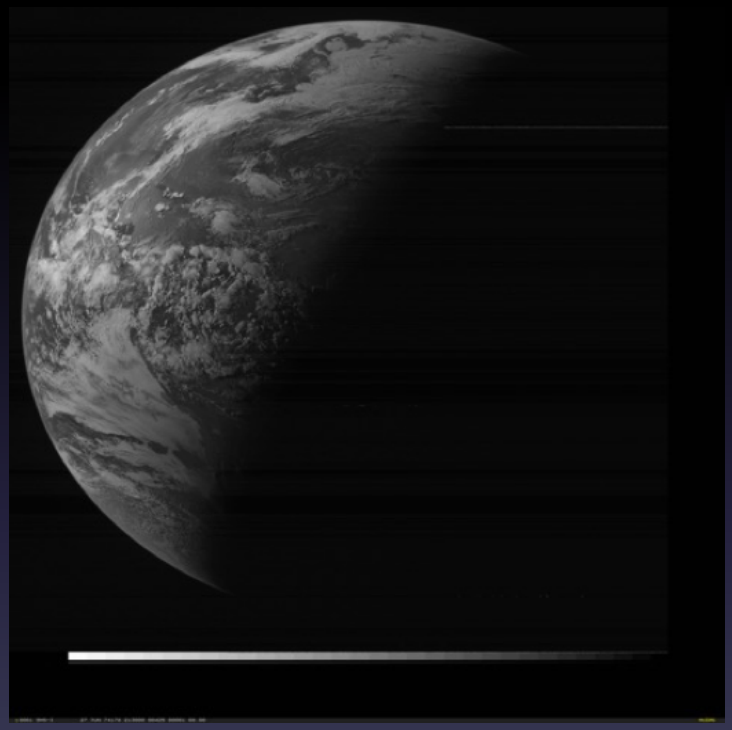


Infrared

SMS-1

1974 - June 27

21:30 UTC



Visible

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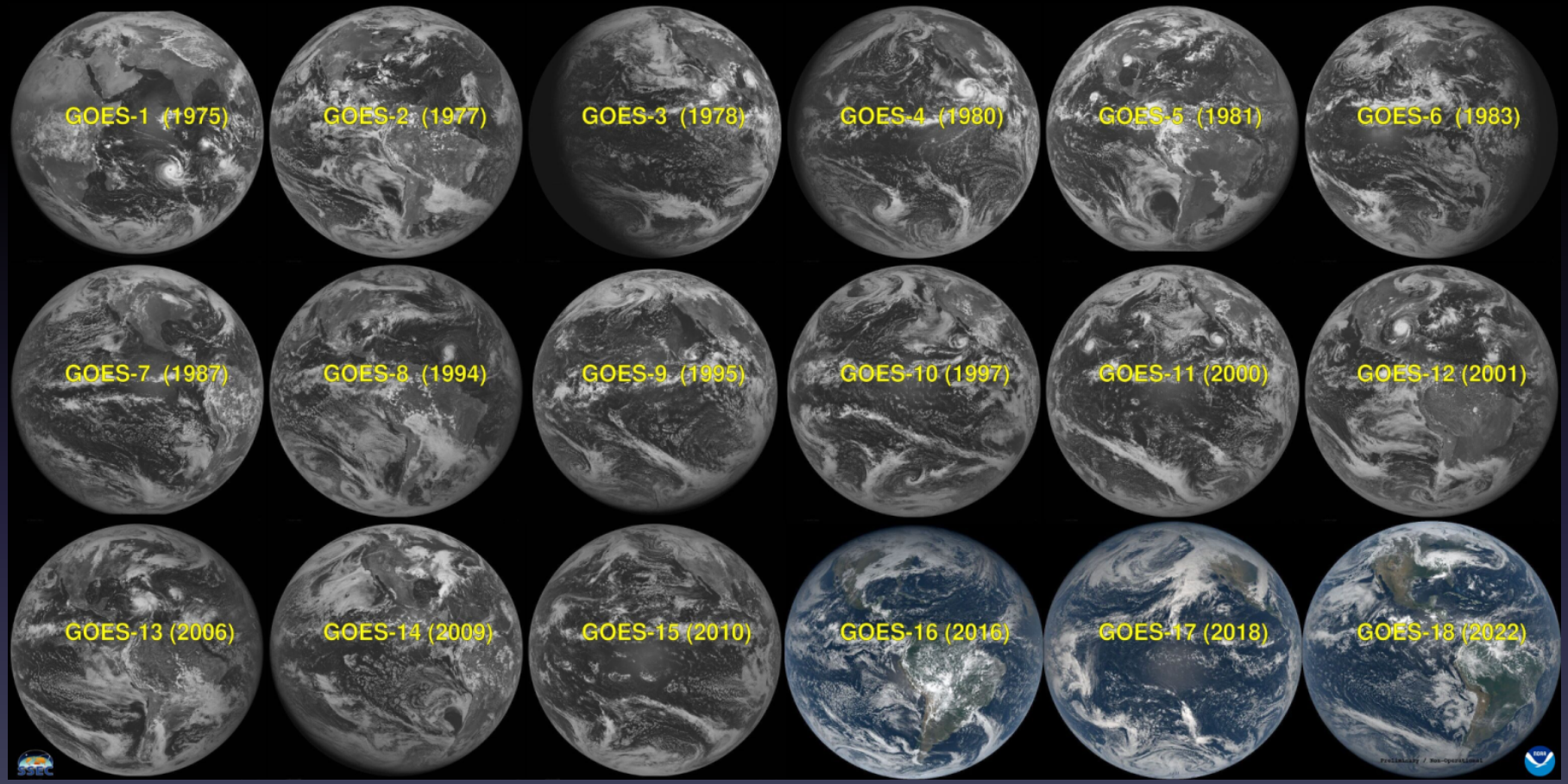
GOES-1 through GOES-18



Credit Tim Schmit

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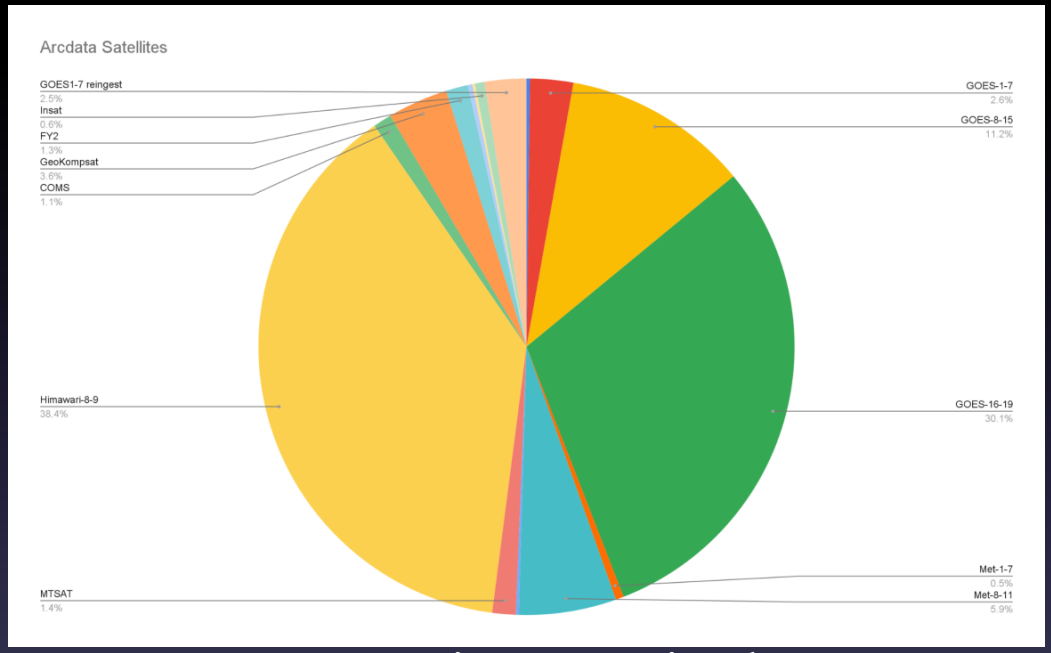
Online Archive

Currently over 3 PB in size!

Online Archive Begins in 2005

(Funded by commercial data user)

Data backed up to LTO 5 (being moved to LTO-8)



Routine International Satellite Archive Begins in 1998

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Archive Data

As of Summer 2023, over 3 PBs online.

Grows approximately about ~350+ TB/year

US Geostationary Satellites

- GOES-8 through GOES-18 ***(1994-Present)*** (East, West , South America and test)
  - *G16 and G18 L1 ABI and L2 GLM in Netcdf*
  - *G16 and G18 CADUs (essential for SDS and CSPP-GEO debugging)*
- GOES-1 through GOES-7 ***(1978-1996)***
- SMS-1&2 *(1974, 1978-1981)*

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Archive Data

International Geostationary Satellites

- GMS/MTSAT ***(1998-2015)***
- Meteosat/Meteosat IODC ***(1998-Present)***
- Meteosat-1 FGGE (1978-1979)
- FY2 (2004-Present)
- Kalpana ***(2005-2017)***
- Insat-3D ***(June 2014-2017)***
- COMS (June 2012 – 2022) (not archiving GK2A)
- Himawari-8/9 (March 2015 – Present)

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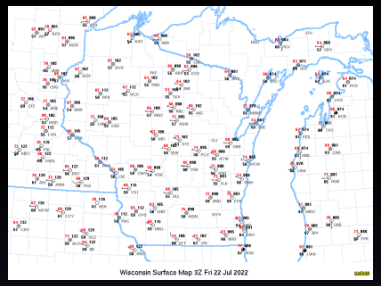
Other Archives

LEO Archive

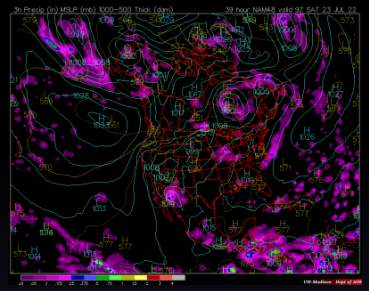
1978 - Present

- NOAA-5 through NOAA-19
- METOP-A/B/C
- AVHRR
- HIRS



Insitu data Archive

1976 - Present



Model Output Grids Archive

1996 - Present

ATS-1 and 3

1966 - 1974

66,000 images scanned
to be available
online in 2023

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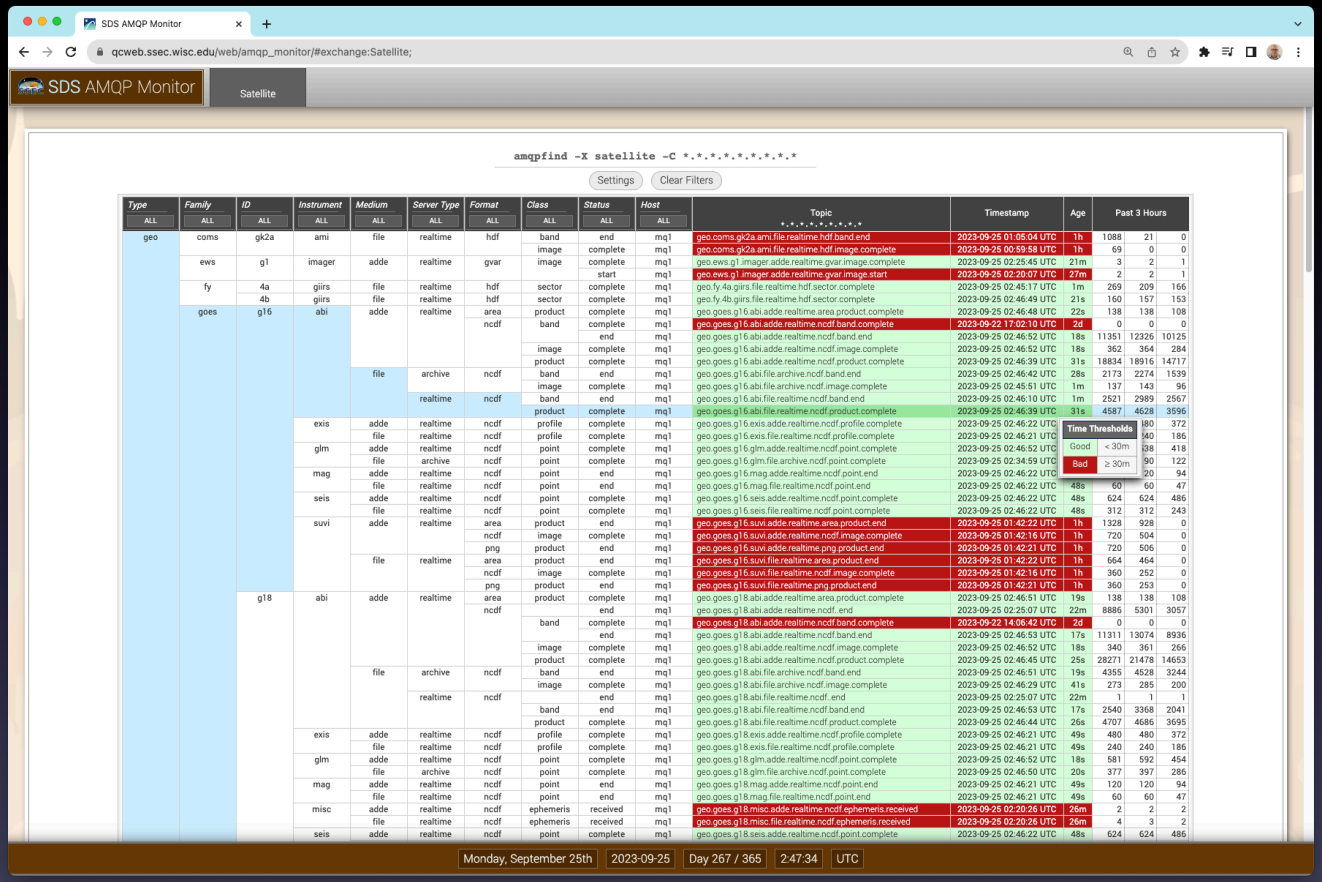
SDS related initiatives

- AMQP Events
- Satellite QC API
- GRB Fanout/Mixer
- Local Noon
- ATS recovery
- SUVI
- AMRDC/WxSaTS development

AMQP



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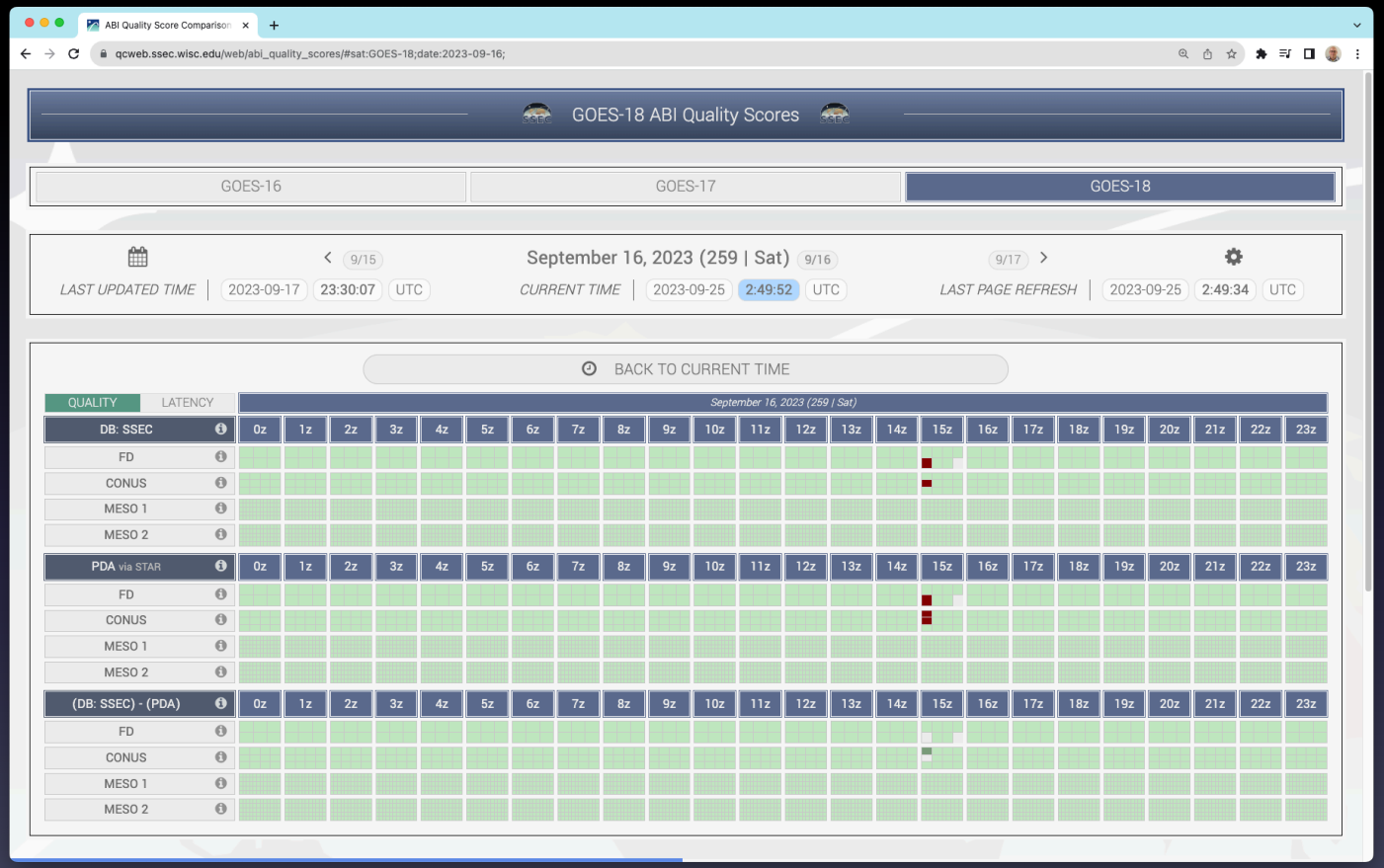
Satellite QC API



https://qcweb.ssec.wisc.edu/web/abi_quality_scores/

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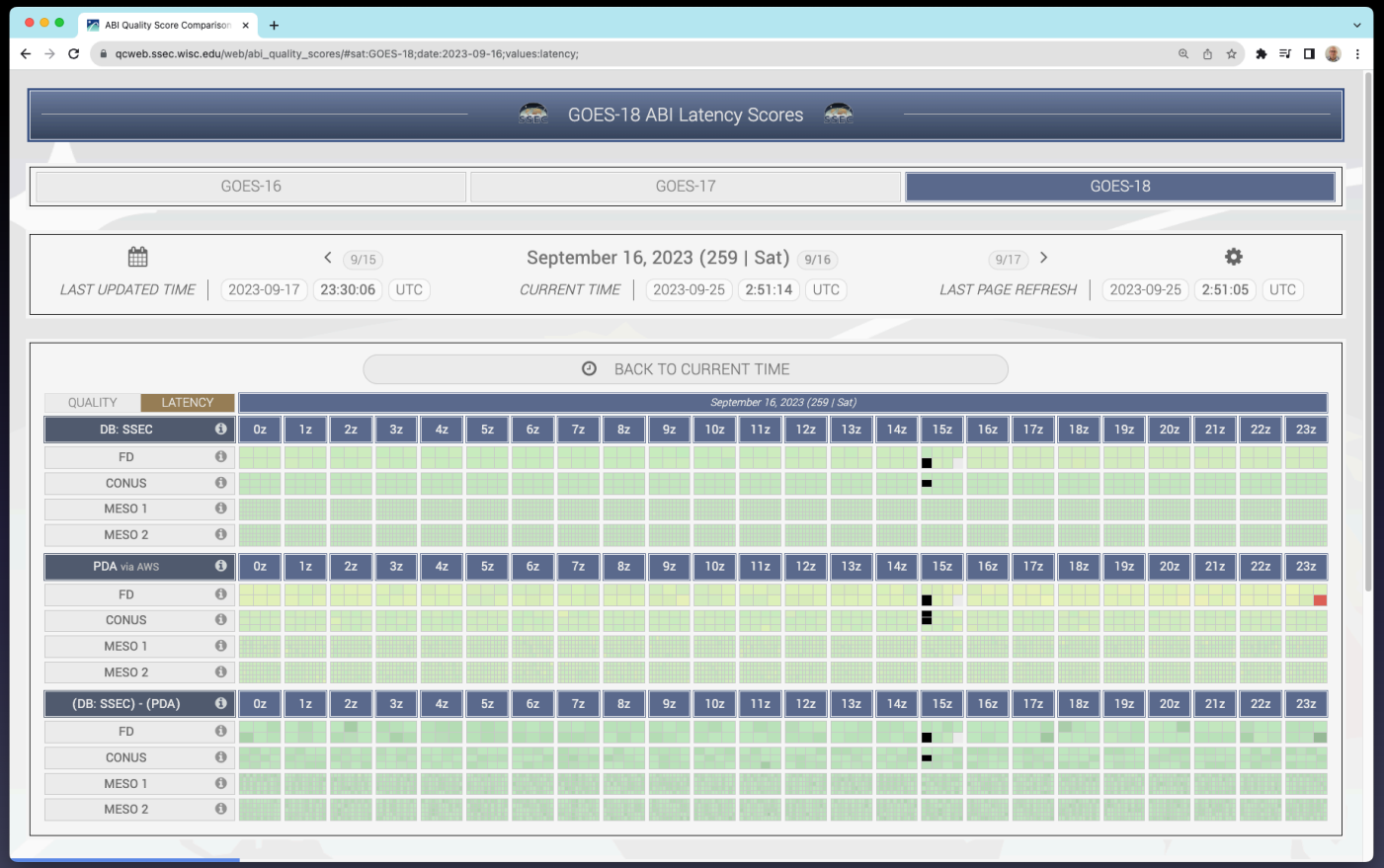
Satellite QC API



https://qcweb.ssec.wisc.edu/web/abi_quality_scores/#values:latency;

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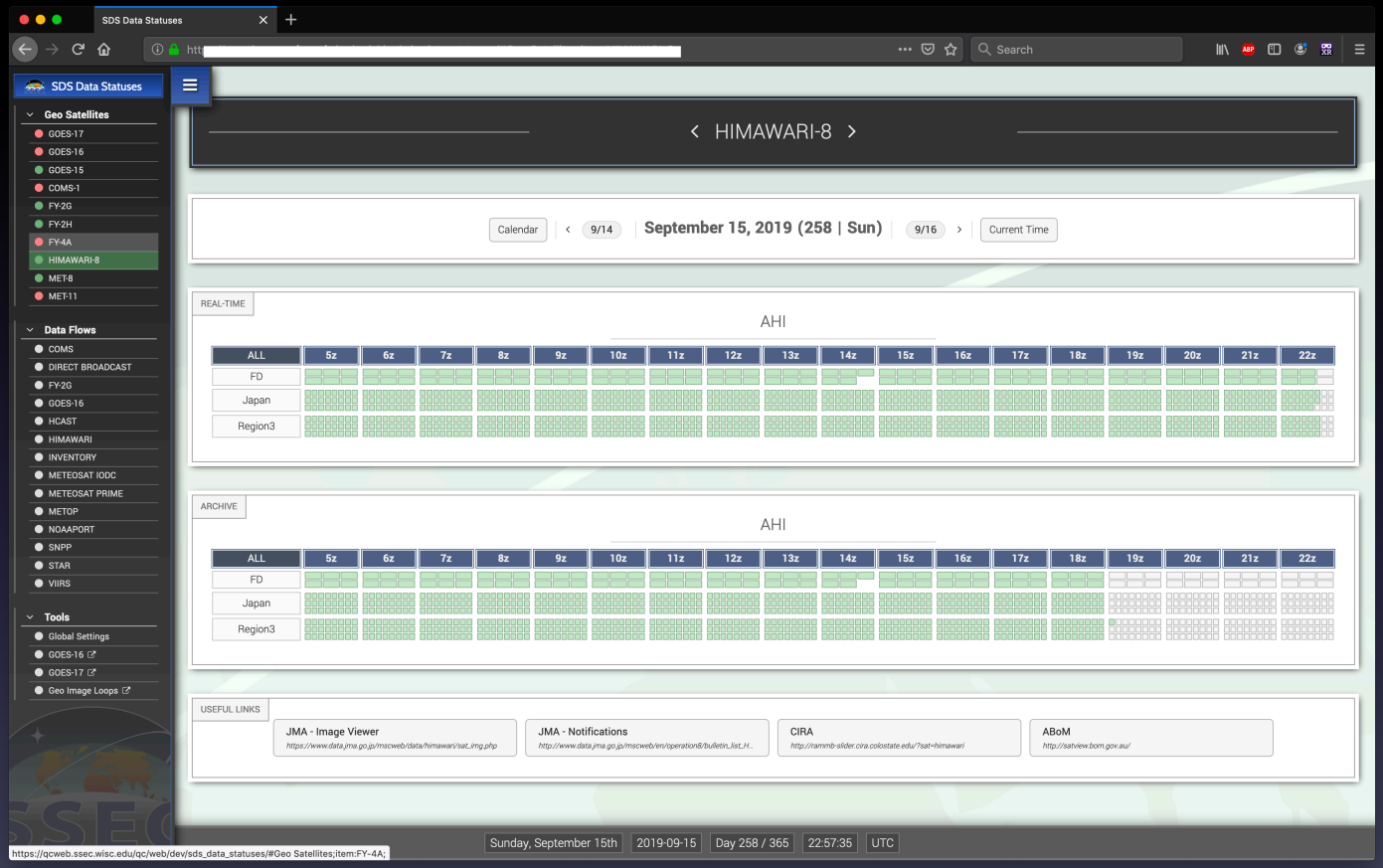
Satellite QC API



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Satellite QC API

Polar Satellite	Source	Instrument	Storage	1 Hr	6 Hrs	24 Hrs	48 Hrs	Last Updated
METOP-B	ALL	AVHRR	ARCHIVE	✓	✓	✓	1 ⚠	2023-09-25 14:04:36 UTC
	ALL	HIRS	ARCHIVE	✓	✓	✓	✓	2023-09-25 14:04:36 UTC
METOP-C	ALL	AVHRR	ARCHIVE	✓	✓	✓	1 ⚠	2023-09-25 14:04:36 UTC
NOAA-15	ALL	AVHRR	ARCHIVE	✓	✓	✓	1 ⚠	2023-09-25 14:04:36 UTC
	ALL	HIRS	ARCHIVE	✓	✓	✓	✓	2023-09-25 14:04:36 UTC
NOAA-18	ALL	AVHRR	ARCHIVE	✓	✓	✓	1 ⚠	2023-09-25 14:04:37 UTC
	ALL	HIRS	ARCHIVE	✓	✓	✓	1 ⚠	2023-09-25 14:04:37 UTC
NOAA-19	ALL	AVHRR	ARCHIVE	✓	✓	✓	1 ⚠	2023-09-25 14:04:37 UTC
	ALL	HIRS	ARCHIVE	✓	✓	✓	✓	2023-09-25 14:04:37 UTC
NOAA-20	ALL	VIIRS	REAL-TIME	✓	✓	✓	✓	2023-09-25 14:04:45 UTC
NOAA-21	ALL	VIIRS	REAL-TIME	✓	✓	✓	✓	2023-09-25 14:04:48 UTC
Suomi NPP	ALL	VIIRS	REAL-TIME	✓	✓	✓	✓	2023-09-25 14:04:55 UTC

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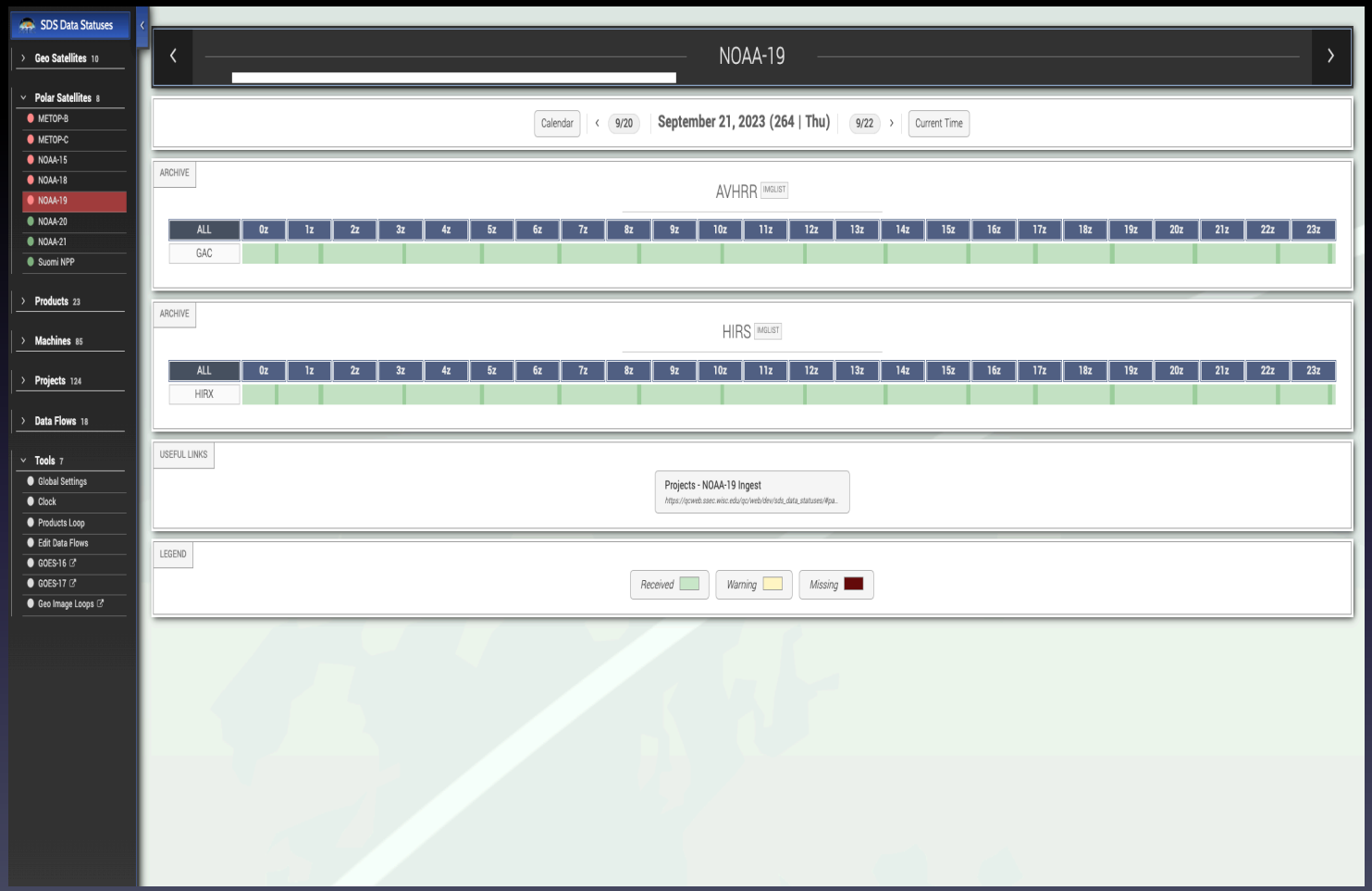
Satellite QC API



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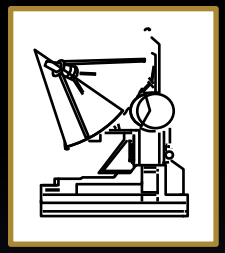
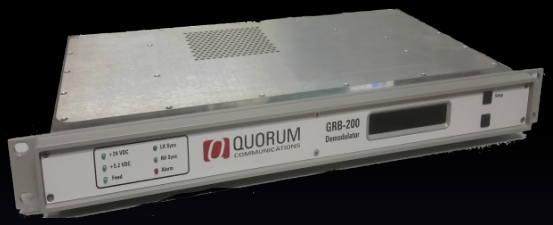
Satellite QC API

- Integrated with inventory
- Public accessible interface

Fanout/Mixer Server





- Fanout allows:
  - Transmission of GRB CADU/CCSDS packets via TCP/IP
  - Distribution of GRB via internet
  - Feed multiple ingestors without using multicast

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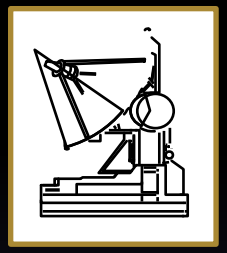
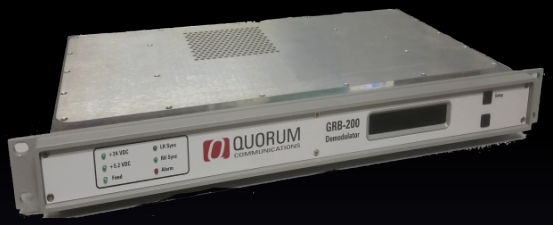
Fanout/Mixer Server





- Mixer allows:
  - Multiple antenna inputs
  - Mix feeds at the "CADU" level
  - Can allow selective data distribution
  - Great for RF interference mitigation
  - Automatic redundancy

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Fanout Mixer

- Multiple Antennas used
- 3 local antennas
- 2 antennas at UCAR in Boulder

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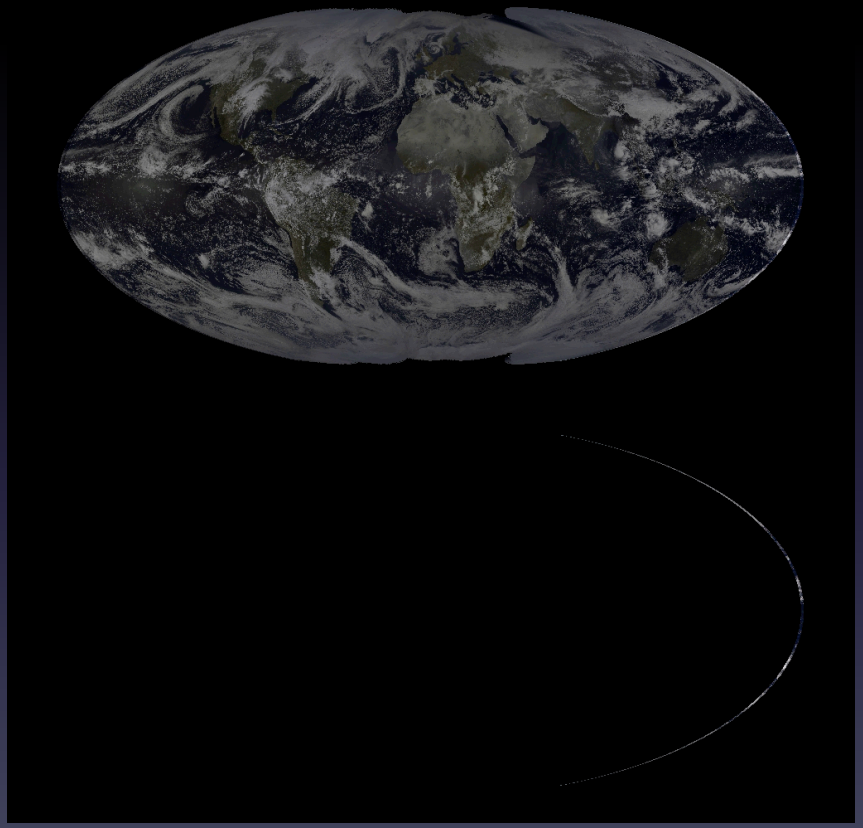
Local Noon

- Created by Rick Kohrs
- Uses local noon visible pixels from global geostationary satellites



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ATS 1 & 3 Recovery

- Digitizing 66,000+ ATS1&3 images
- Jean Phillips, Dave Santek, Tim Schmit, Jerry Robaidek, Max Drexler, Sophia Reiner

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ATS 1 & 3 Recovery

- Determine dates, and times
- Navigate and register image navigation

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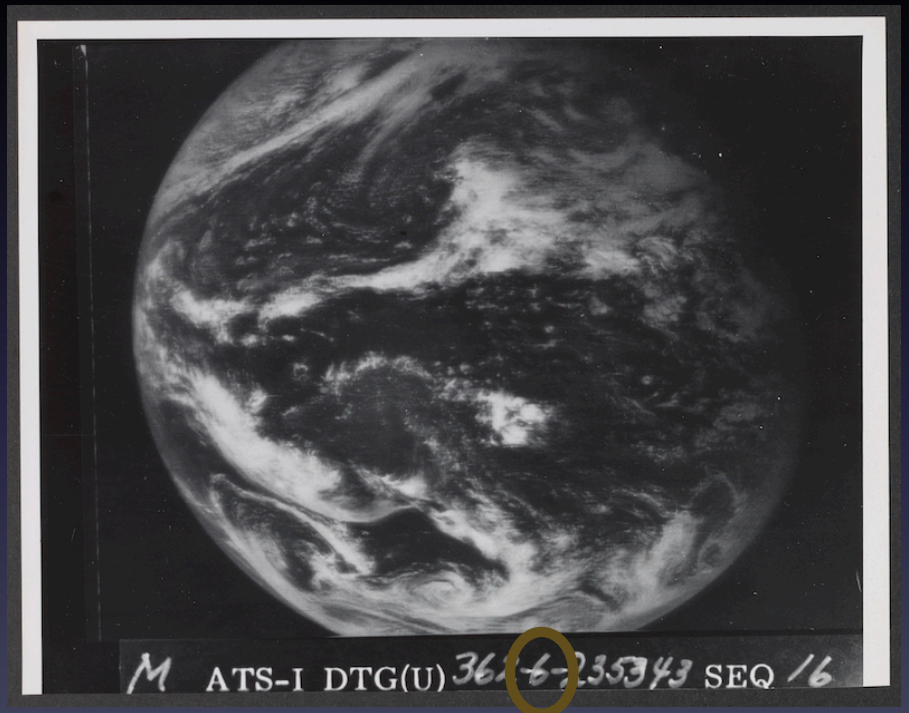
ATS 1 & 3 Recovery

- Does not have a Y2K problem
- It has a "Y" problem
- Or a "just Y" problem
- Or "Just Why?!"



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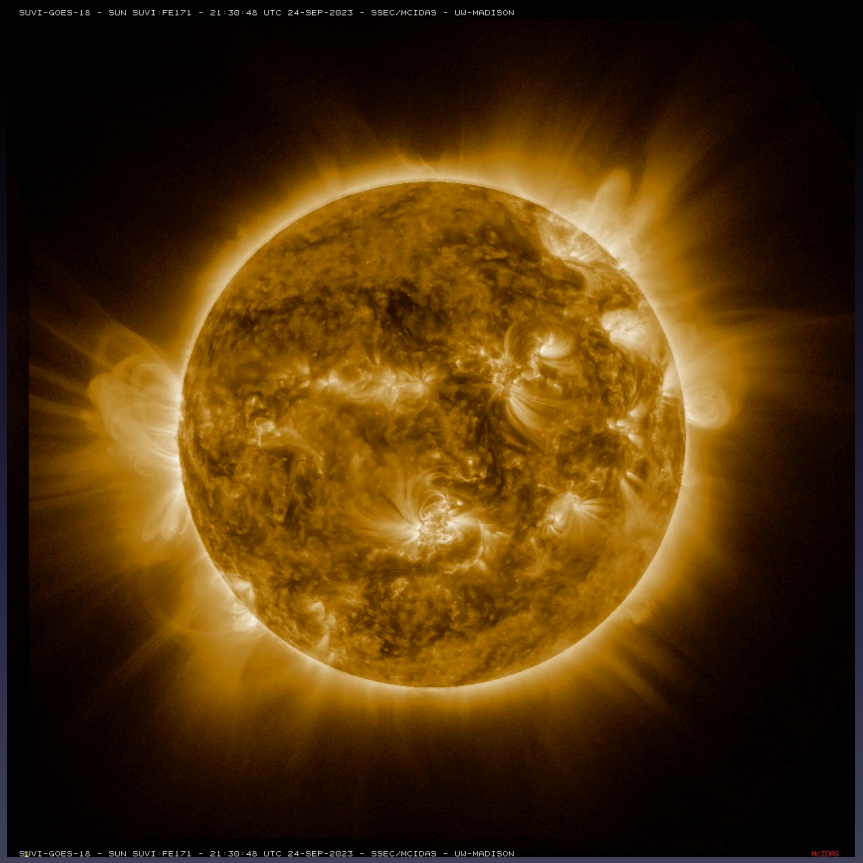
GOES SUVI

- Thanks to Kaba Bah and Rick Kohrs
- Decoding into pngs, and then into AREAs
- Internally available as netcdf, png and AREAs
- Externally available via ADDE



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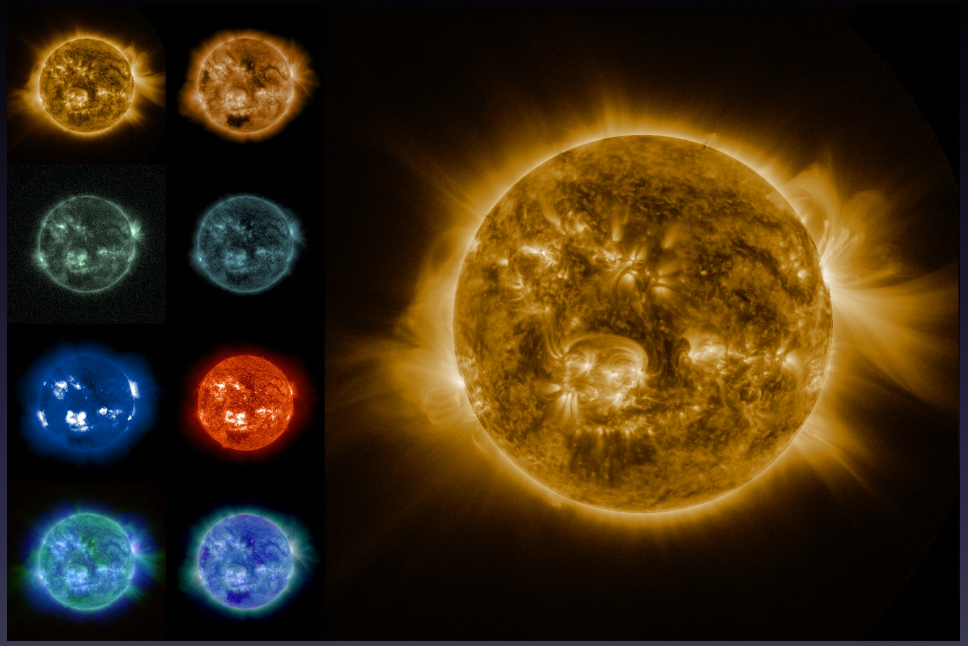

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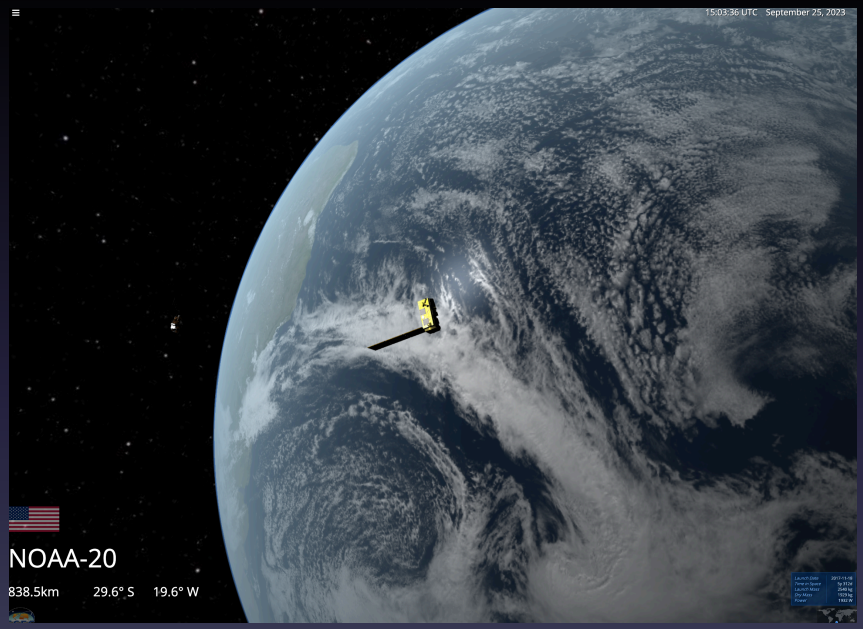
WxSaTS

W X S A T S



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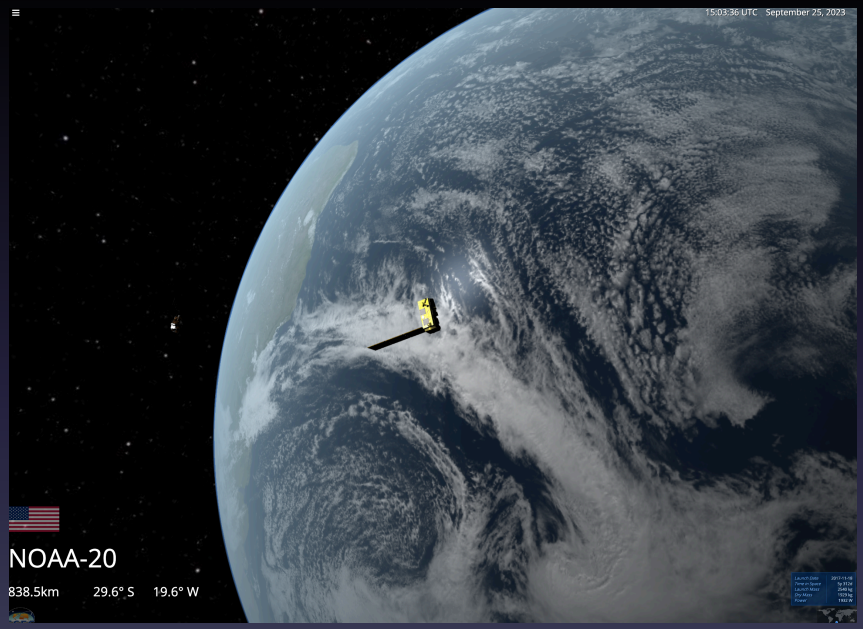
WxSaTS

Current Features

- Weather satellites we receive data from
- Earth with real-time clouds
- Able to display fields-of-vision for ground stations
- Paths, swaths, instrument labels for satellites
- Render cloud-top heights in 3D
- Wind vectors



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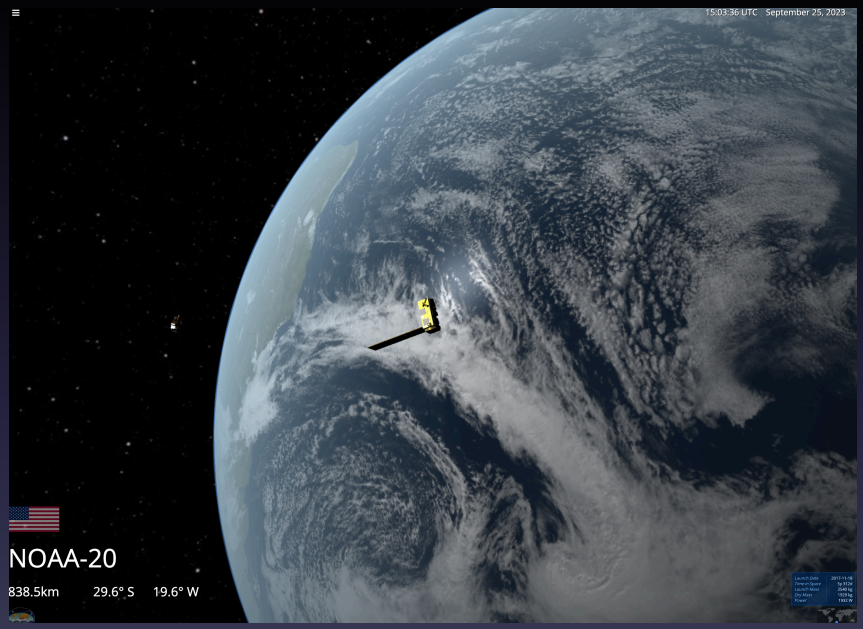
WxSaTS

Current Features

- Display data on a sphere
- All Satellites demo
- View satellites drawn to scale
- Rotating SSEC building with antenna labels
- Other planets / moons / asteroids / stars / exoplanets
- VR support (Meta Quest 1)



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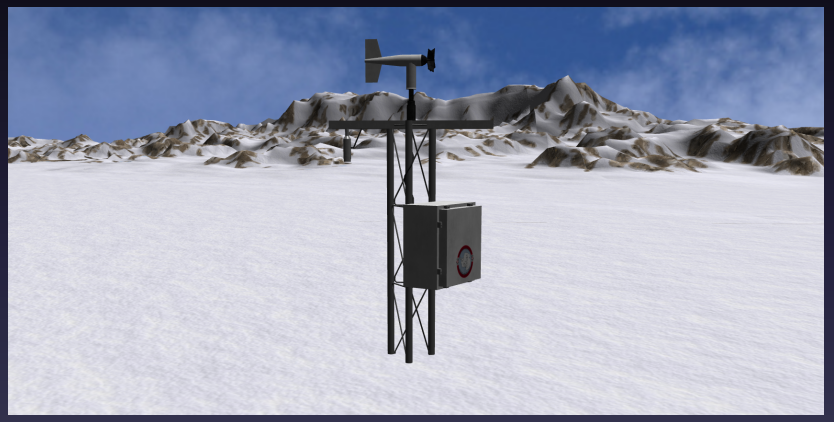
AMRDC

- Will test on:
  - Quest 3
  - Apple Vision Pro
- Turning a lot of the underlying code into a reusable series of libraries.
- Antarctic Simulation



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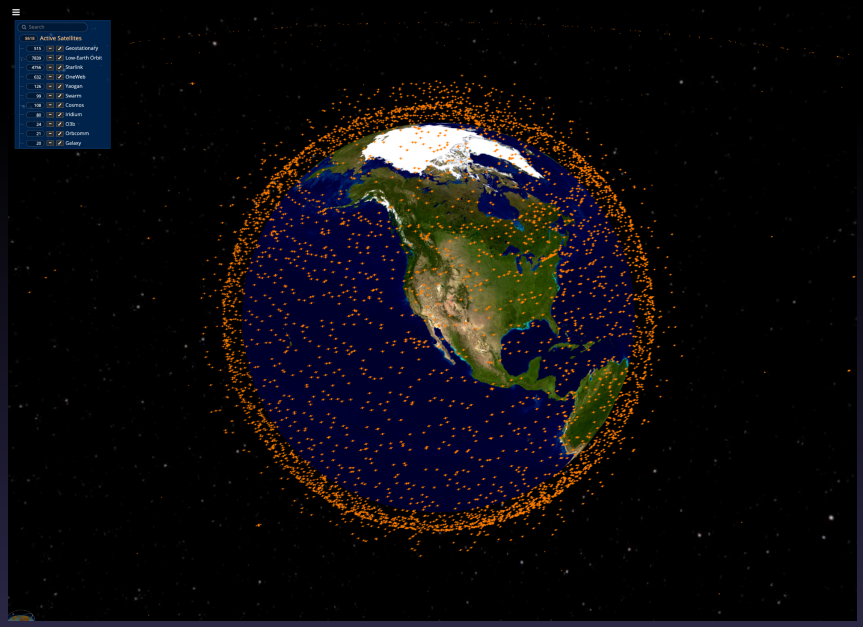
All Sats

- Displays all active satellites
- Interactive
- https://qcweb.ssec.wisc.edu/web/wxsats/#environment:Environments,Custom,All%20Satellites;



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Thanks!

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