LEO Products for NWS Pacific and Alaska Regions

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The Basics

- PSAS - “Polar Satellite Antenna Systems”
- U.S. National Weather Service Office of Observations contract
- Provide low-latency LEO products to Pacific & Alaska Regions
  - Currently 126 unique, operational products for Pacific, 170 for Alaska
- In place since September 2022
- Core team
  - UW-SSEC: L. Gumley (PI), D. Schumacher (PM), G. Yoerger, *D. Santek*
  - UAF-GINA: J. Delamere, J. Cable, C. Dierking
- NWS colleagues
  - Office of OBS: B. Gockel, F. Al-Mtwali
  - Many others in the Alaska & Pacific Regions!

The Basics

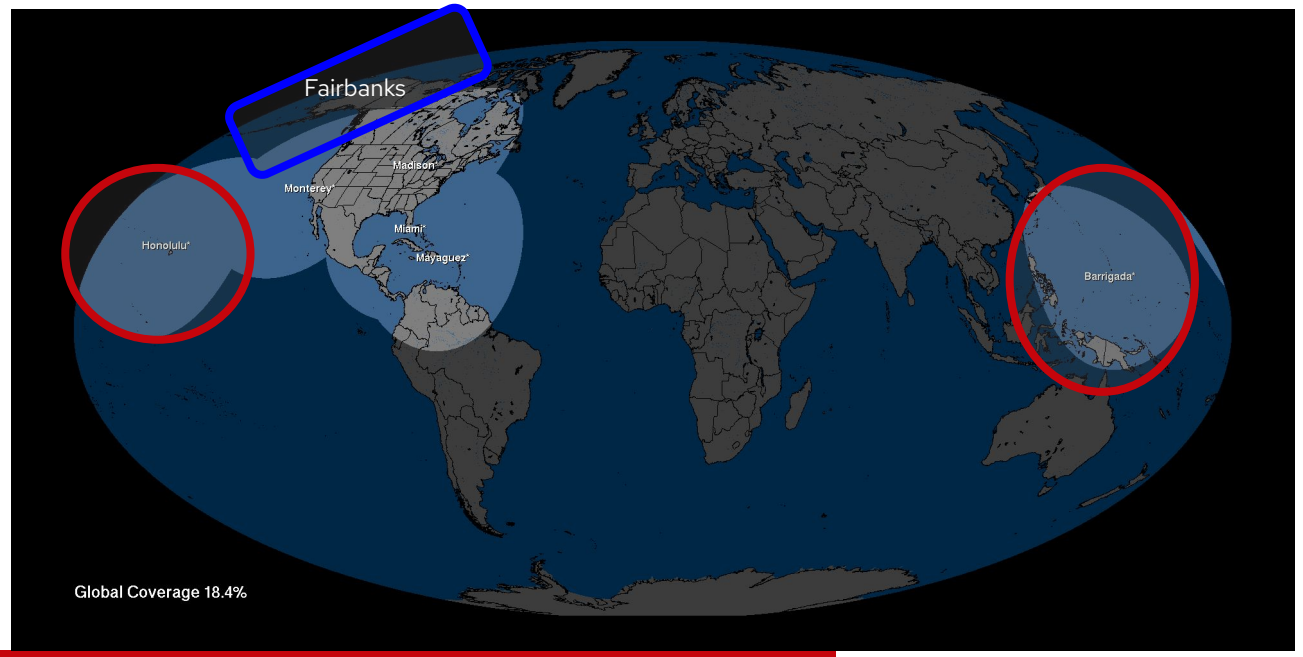
- Collectively, we maintain and operate for NWS use:
  - 5 LEO direct broadcast antenna reception + processing systems
    - 2 in Hawaii
    - 1 in Guam
    - 2 in Alaska
  - **Heavy use of CSPP LEO, EUMETSAT, and JAXA processing software to generate Level 0, Level 1, and Level 2 products and format them for NWS use**

But first, a little history

- In the 2010s, NOAA funded the installation of direct broadcast LEO antennas around the United States, during the early years of the JPSS program.
- 3 main objectives
  - Participation in DBNet for NWP assimilation of MW/IR sounder data
  - Downlink ARGOS Data Collection Service, and send to KINEIS
  - **Deliver low-latency LEO products to regional users, such as the National Weather Service (NWS) local forecast offices**

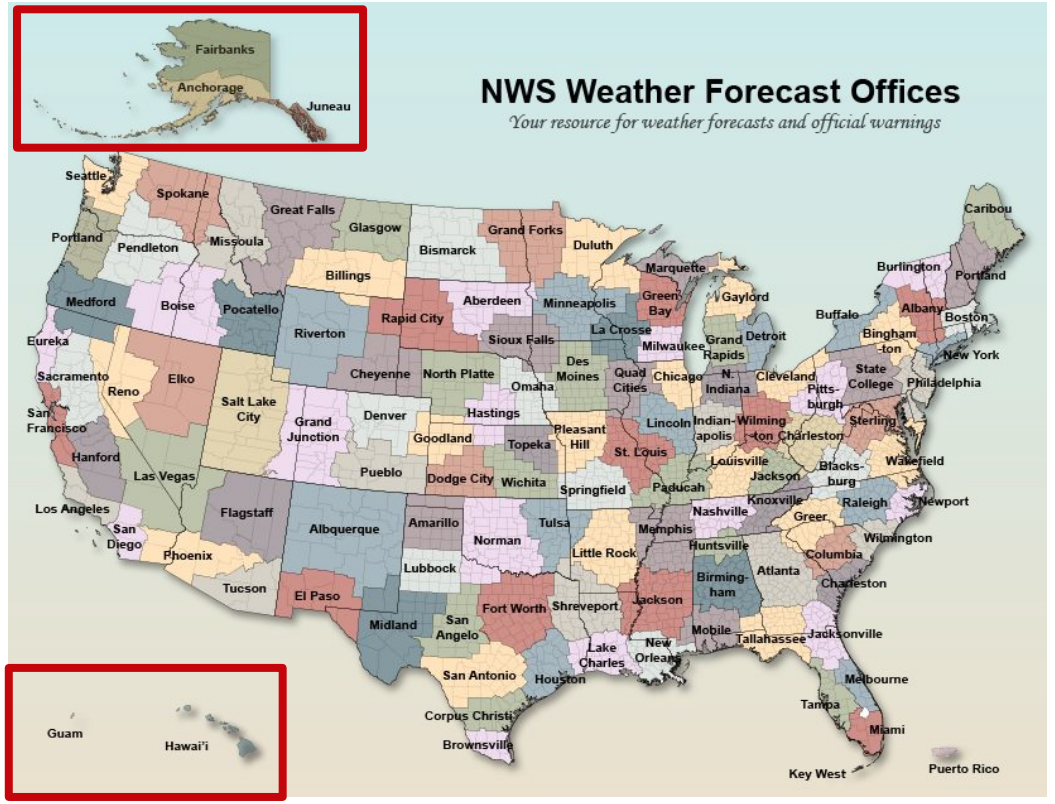
But first, a little history

- Today, there are DB antennas covering nearly all of the US
  - SSEC owns + operates 6 LEO DB antennas
    - Coverage over CONUS, Puerto Rico, Hawaii, and Guam.
    - NOAA owns 1 LEO DB antenna in Hawaii, operated by SSEC.
  - GINA owns + operates 2 LEO DB antennas, covering Alaska.



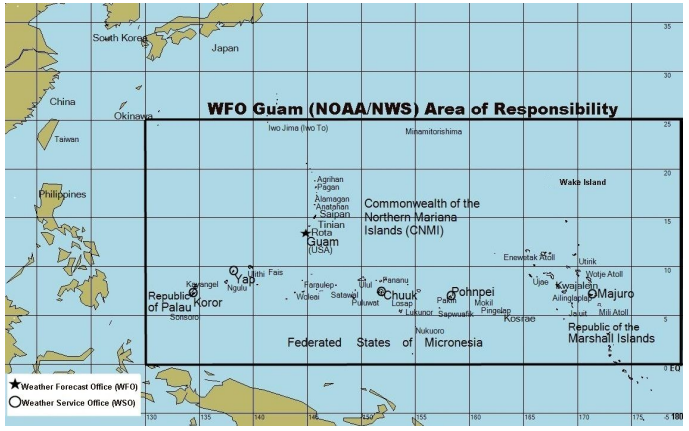
How the NWS operates today

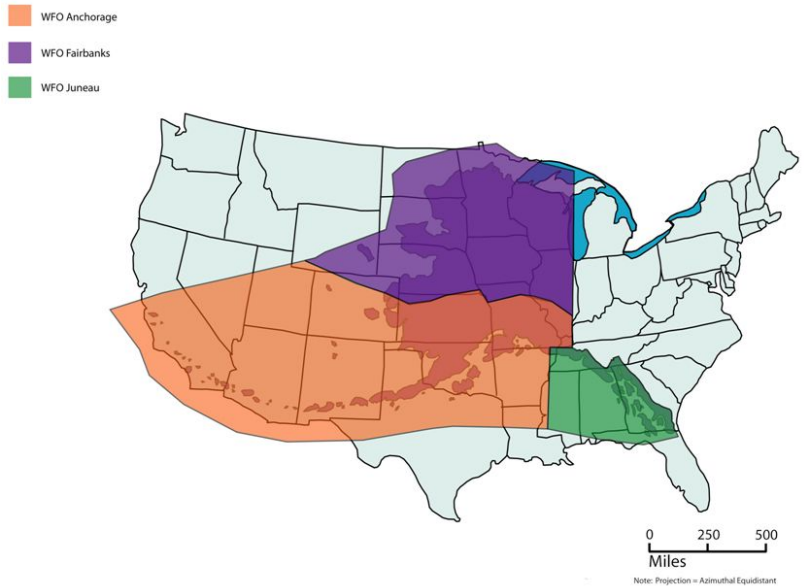
- Since the mid-1990s, the NWS has run 122 "Weather Forecast Offices"
- Each office is responsible for issuing local weather forecasts and warnings
- Organized into 6 "regions"
- Alaska and Pacific Regions collectively known as "OCONUS"

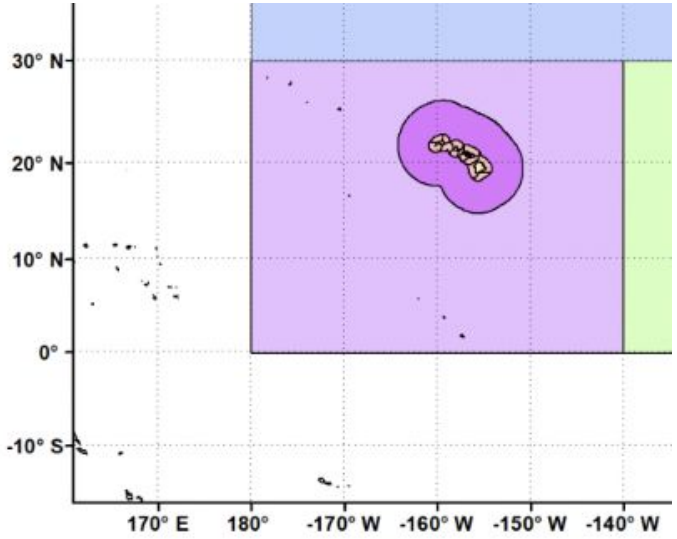


How the NWS operates today

- Both Alaska & Pacific Regions have very large areas of responsibility, with limited radar coverage
- Alaska also has mediocre GEO satellite viewing angles

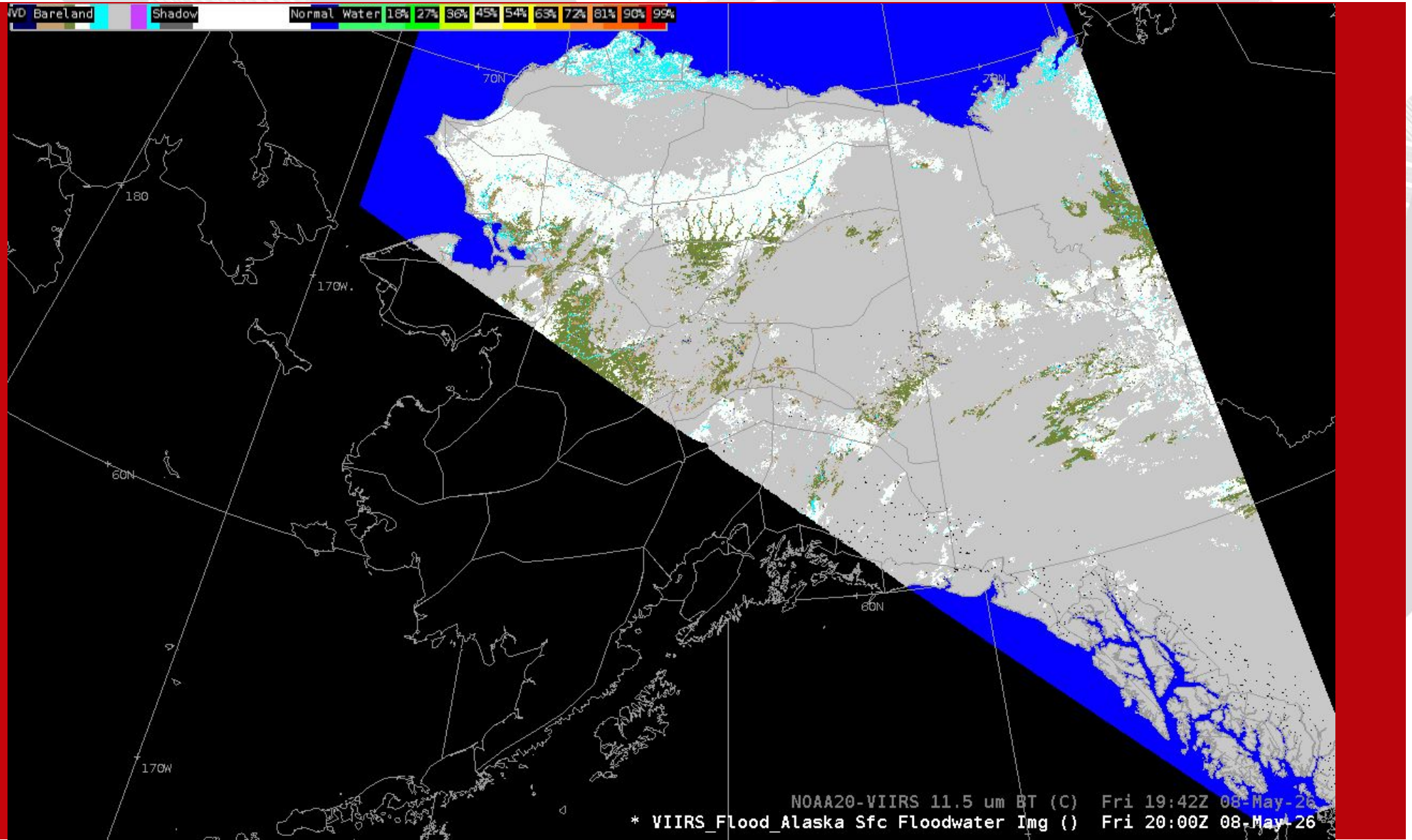






How the NWS operates today

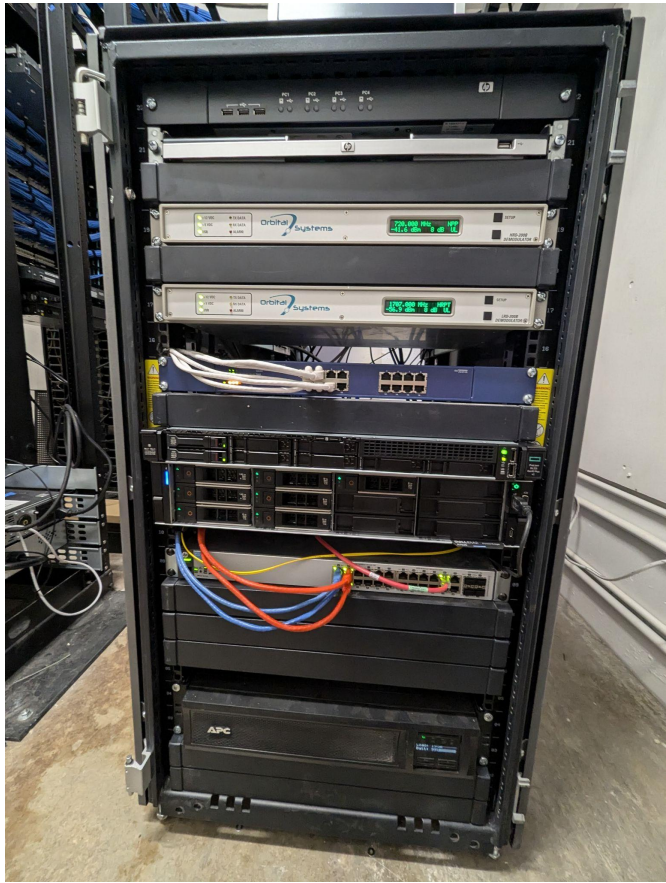
- Since the mid-1990s, the cornerstone software of NWS operations has been AWIPS (Advanced Weather Interactive Processing System)
- **How do satellite datasets arrive to forecaster workstations?**
  - Delivery to the local office can happen in 4 ways:
    - National satellite link called NOAAPort/SBN
      - Only a handful of (high latency) VIIRS DNB, JPSS/MetOp soundings
    - **Terrestrial network link from the regional HQ**
      - Often very bandwidth constrained
      - "Primary way in" for specialty regional products
    - On-site direct broadcast antennas + processing systems
      - A few offices have GOES GRB, HimawariCast (GWSAS)
      - **1 WFO (Guam), has on-site LEO antenna**
  - Ingested by local backend Linux server called EDEX
  - Visualized on local Linux workstations via CAVE


NVD Bareland
Shadow
Normal Water 18% 27% 36% 45% 54% 63% 72% 81% 90% 99%
70N
180
170W.
60N
170W
60N
NOAA20-VIIRS 11.5 um BT (C) Fri 19:42Z 08-May-26
* VIIRS_Flood_Alaska Sfc Floodwater Img () Fri 20:00Z 08-May-26

Hawaii Hardware

Honolulu Community College

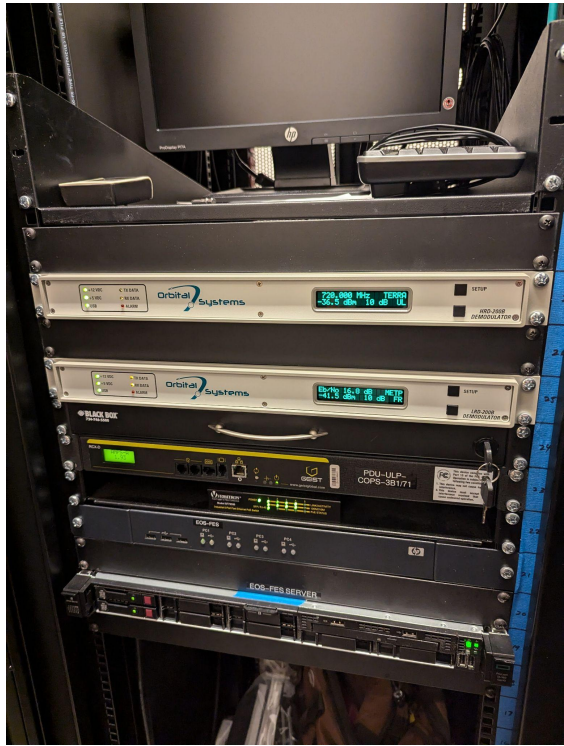
- 2.4m Orbital Systems antenna, installed 2012
- Owned by SSEC
- X/L-band feed
- HRD/LRD-200B demodulators
- Orbital Systems EOS-FES, replaced 2024
- Processing system, replaced 2024
  - 128 CPU cores
  - 512 GB RAM
  - 30 TB RAID-5 storage



Hawaii Hardware

Ford Island - Honolulu, HI

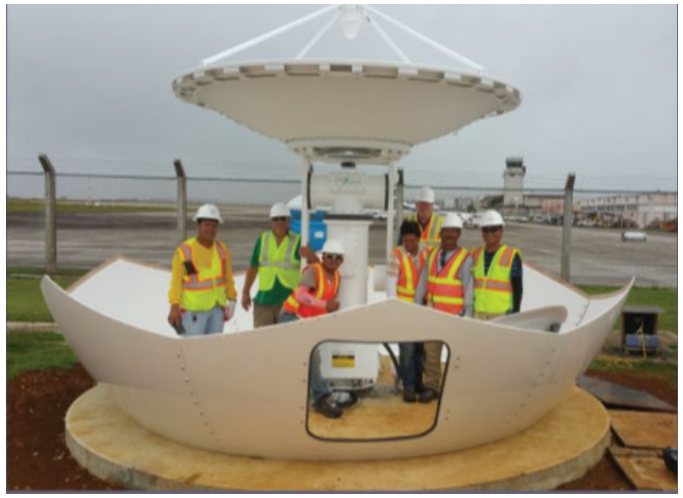
- 2.4m Orbital Systems antenna, installed 2015
- Owned by NOAA
- X/L-band feed
- HRD/LRD-200B demodulators
- Orbital Systems EOS-FES, replaced 2020
- Processing system, replaced 2021
  - 64 CPU cores
  - 256 GB RAM
  - 17 TB RAID-5 storage

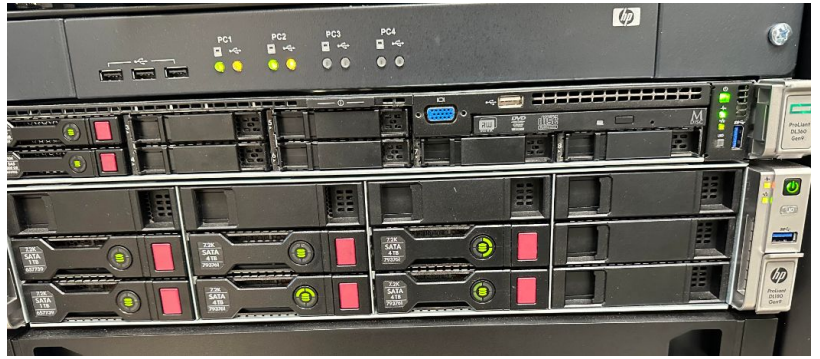


Guam Hardware

WFO Guam

- 3.0m Orbital Systems antenna, installed 2017
- Owned by SSEC
- X/L-band feed
- HRD/LRD-200B demodulators
- Orbital Systems EOS-FES
- Processing system
- Stayed online through multiple typhoons, including Category 4 Mawar in 2023

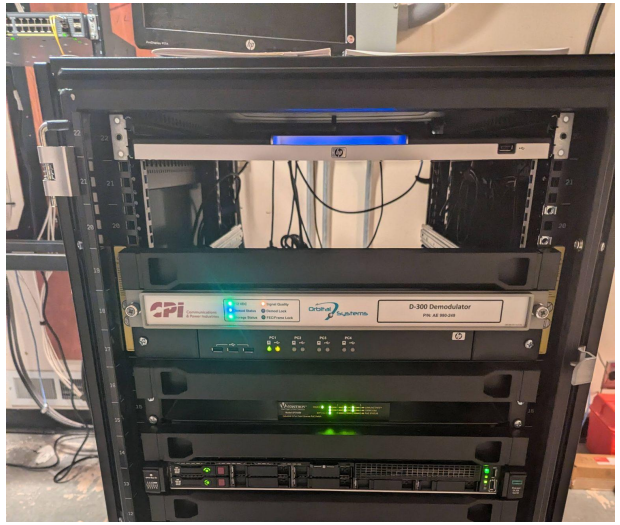




Alaska Hardware

Gilmore - Fairbanks, AK

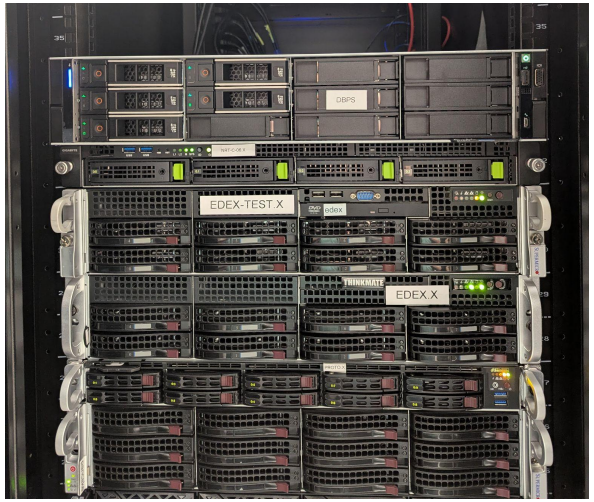
- 3.0m Orbital Systems antenna, installed 2014
- Owned by GINA
- X/L/S-band feed
- D-300 demodulator
- Orbital Systems EOS-FES



Alaska Hardware

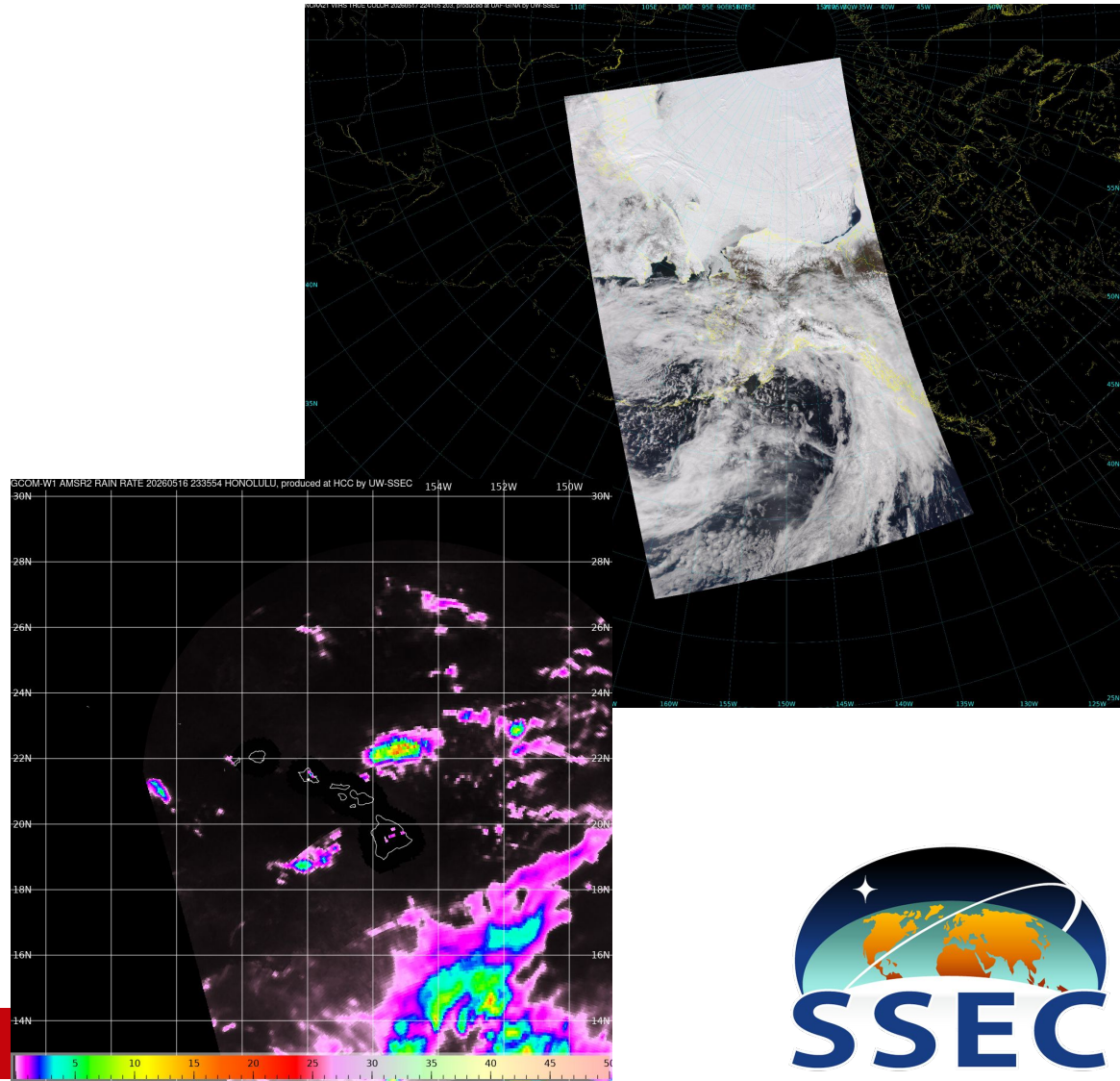
UAF5 - Fairbanks, AK

- 2.4m Orbital Systems antenna, installed 2024
- Owned by GINA
- X/L-band feed
- D-300 demodulator
- Orbital Systems EOS-FES
- Processing system for both antennas, installed 2025
  - 128 CPU cores
  - 768 GB RAM
  - 32 TB RAID-5 storage
- Also use GINA NRT for R2O products



Satellite & Instrument Support

- Visible/IR imagers
  - MODIS: Aqua
  - AVHRR: MetOp-B, MetOp-C
  - VIIRS: S-NPP, NOAA-20, NOAA-21
  - *METimage: MetOp-SGA1*
- Microwave imagers
  - AMSR2: GCOM-W1
  - *AMSR3: GOSAT-GW*
  - *MWI (& ICI?): MetOp-SGB1*
- Microwave sounders
  - ATMS: S-NPP, NOAA-20, NOAA-21
  - AMSU-A/MHS: MetOp-B, MetOp-C
  - *MWR: Arctic Weather Satellite*
  - *MWS: MetOp-SGA1*
- Infrared sounders
  - CrIS: NOAA-20, NOAA-21
  - IASI: MetOp-B, MetOp-C
  - *IASI-NG: MetOp-SGA1*



Yellow: Support planned / development in progress

Direct Broadcast Processing System (DBPS)

- Software to glue CSPP LEO and other packages together for automated processing
- Rocky Linux 8
- Primarily bash scripts
- Monitor for incoming raw data
- Kick off processing
- Move files to output directories
- Insert products into LDM queue

```
# Site name and location
export DBVM_SITE_NAME="HCC"
export DBVM_CITY_NAME="HONOLULU"
export DBVM_SITE_LAT="21.322"
export DBVM_SITE_LON="-157.871"
export ORGANIZATION=$HOSTNAME

# CSPP version options for install scripts
export CSPP_SDR_VERSION='4.1'
export CSPP_ACSPO_VERSION='3.0'
export CSPP_HEAP_VERSION='3.0'
export CSPP_P2G_VERSION='3.2'

# Level 1 processing options
export DBVM_SDR_VIIRS_CORES='32'
export DBVM_SDR_CRIS_CORES='16'
export DBVM_SDR_ATMS_CORES='16'
export DBVM_SDR_OMPS_CORES='4'
```

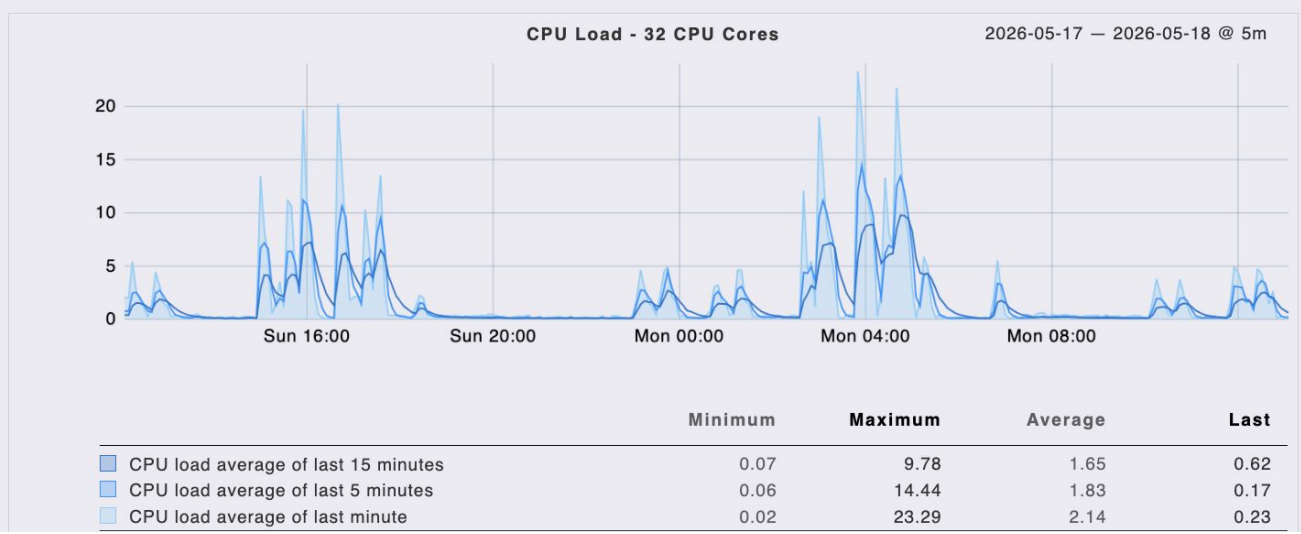
Server & product monitoring

- Processing latency
  - LOS to product sent on LDM
  - Raw transfer time
  - Processing time
- Contract targets
  - Level 1 <25 minutes
  - Level 2 <35 minutes
  - System uptime >99%
- Mean times
  - VIIRS SDR: 4.6 minutes
  - ATMS MiRS: 1.7 minutes
  - CrIS/ATMS HEAP: 4.7 minutes
  - AVHRR L1: 2.9 minutes

Reporting Period	ISO Week	Statistic	*Overall*	
			Level 1	*Level 2*
April 2026	16	Mean	3.2	12.8
		Max	6.3	41.9
		Count	427	1959
	17	Mean	3.3	12.8
		Max	6.6	42.4
		Count	423	1924
	18	Mean	3.4	13.1
		Max	6.9	43.1
		Count	395	1713
	Overall	*Mean*	*3.3*	*12.9*
		Max	*6.9*	*43.1*
		Count	*1245*	*5596*

Server & product monitoring

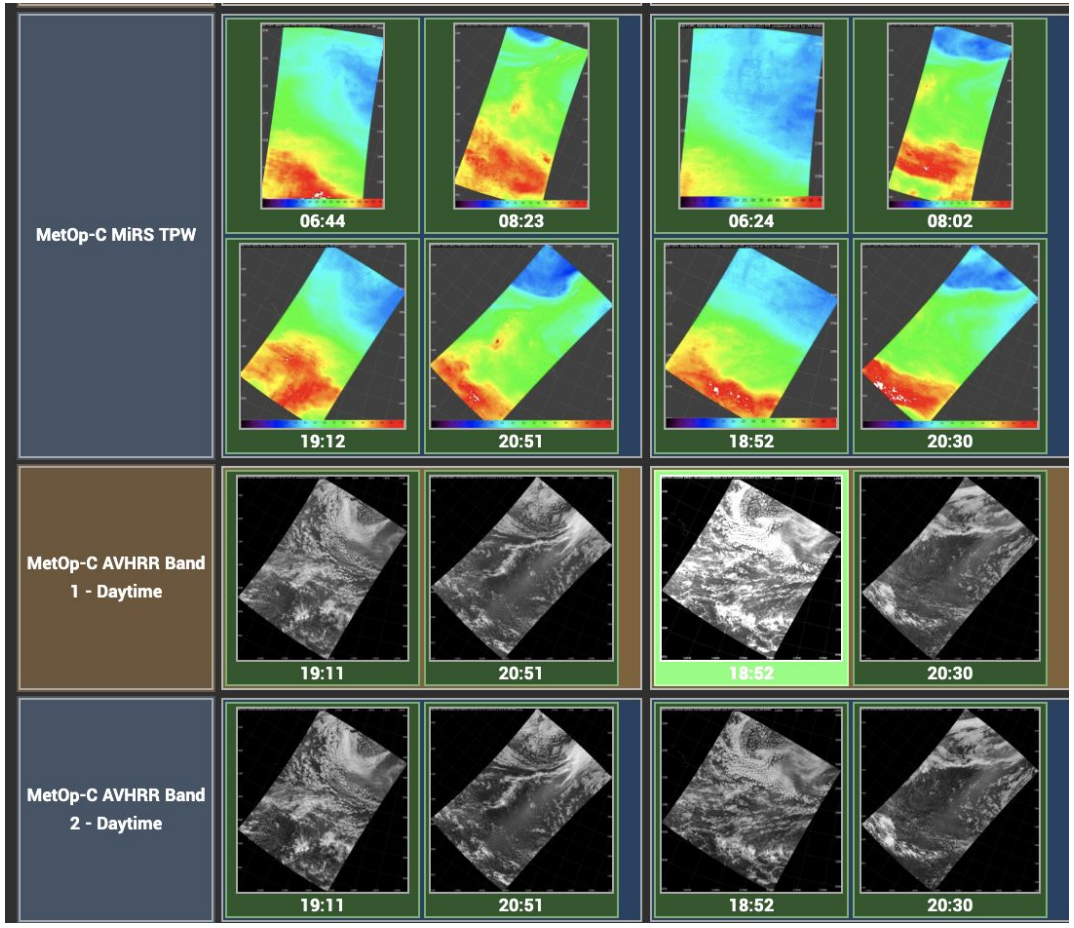
Checkmk



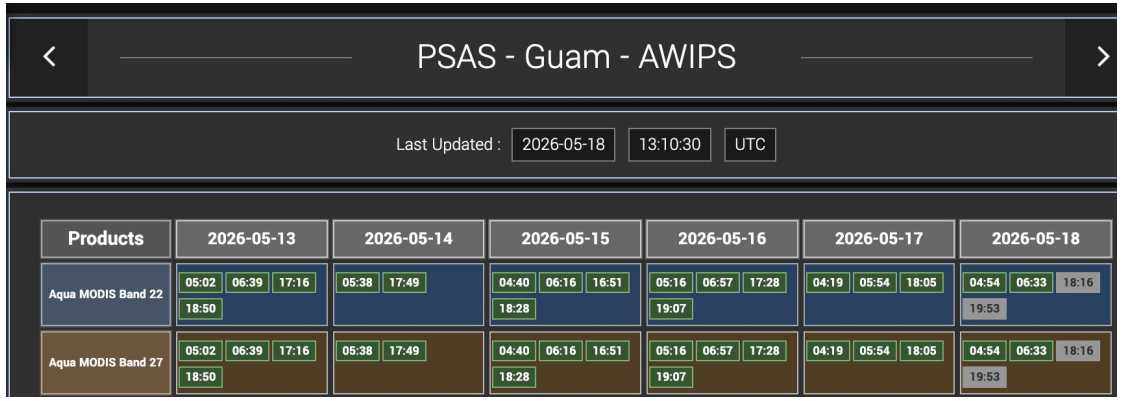
State	Host	Icons	OK	Wa	Un	Cr	Pd
DOWN	dbps.cas.hamptonu.edu		32	0	0	1	0
UP	dbps.ece.uprm.edu		28	0	0	0	0
UP	dbps.gina.alaska.edu		28	0	0	2	0
UP	erb-acs1.ssec.wisc.edu		27	0	0	2	0
UP	erb-acs2.ssec.wisc.edu		30	0	0	2	0
UP	erb-dbps		33	0	0	2	0
UP	guam-dbps		28	0	0	0	0
UP	guam-eosfes		25	0	0	0	0
DOWN	hampton-eosfes		26	0	0	1	0
UP	hcc-eosfes		28	0	0	0	0
UP	irc-dbps		38	0	0	0	0
UP	irc-eosfes		28	0	0	0	0
UP	soest-hcc1.hcc.hawaii.edu		33	0	0	1	0
UP	uprm-eosfes		22	0	0	0	0

Centralized hardware uptime, system resource monitoring with alerts

Server & product monitoring



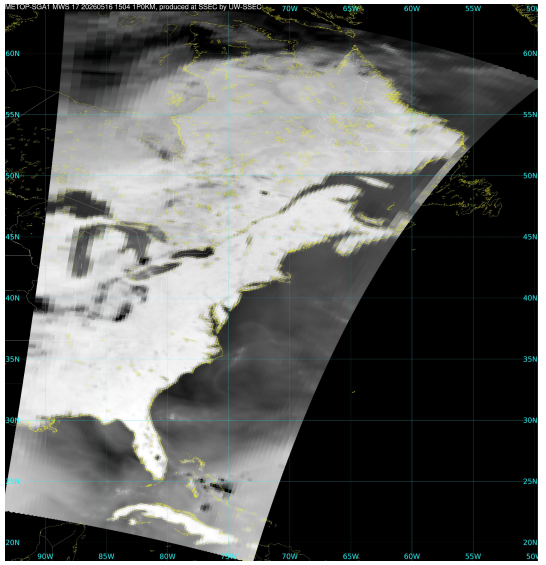
SDS Data Statuses

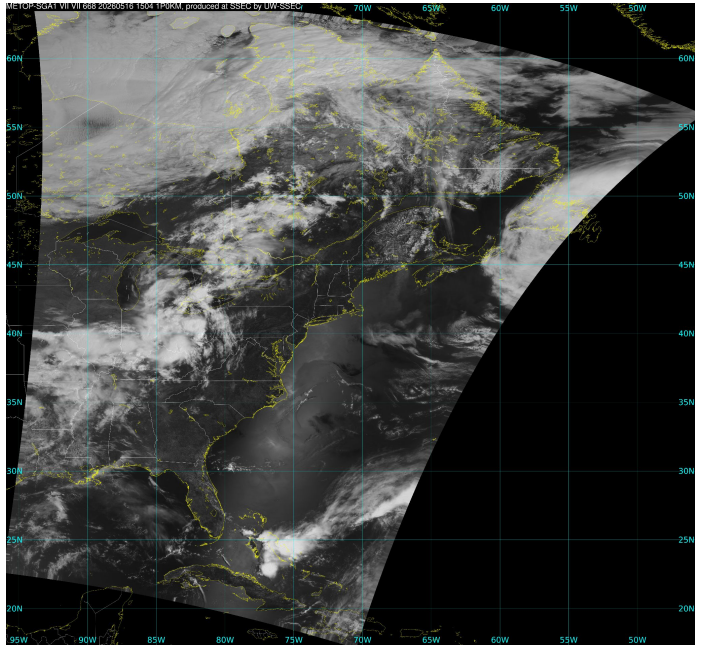


Centralized product availability and quicklooks, plus manual QC checks

Software Packages Used

- Decoding
  - **RT-STPS v6.0 - v8.0** (pre-release)
  - **Dexter** (pre-release)
- Level 1
  - **CSPP SDR v4.1.1**
    - VIIRS, ATMS, CrIS, OMPS
  - **IMAPP MODISL1DB v1.0**
    - MODIS
  - **Metopizer + AAPP v8.10**
    - AVHRR, AMSU-A/MHS, IASI
  - **JAXA L0/L1 v1.0**
    - AMSR2
  - **AWS L0/L1**
    - MWR
  - **MetOp-SG L0/L1**
    - METimage, MWS

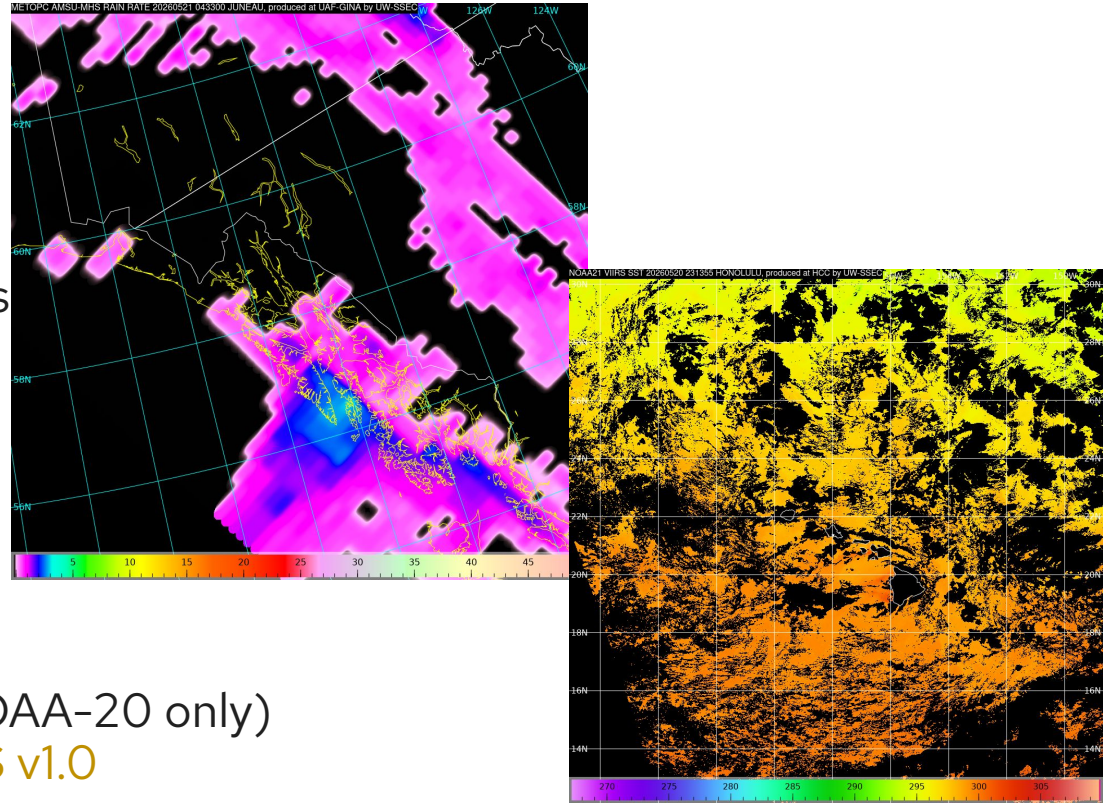




Yellow: Development in progress

Software Packages Used

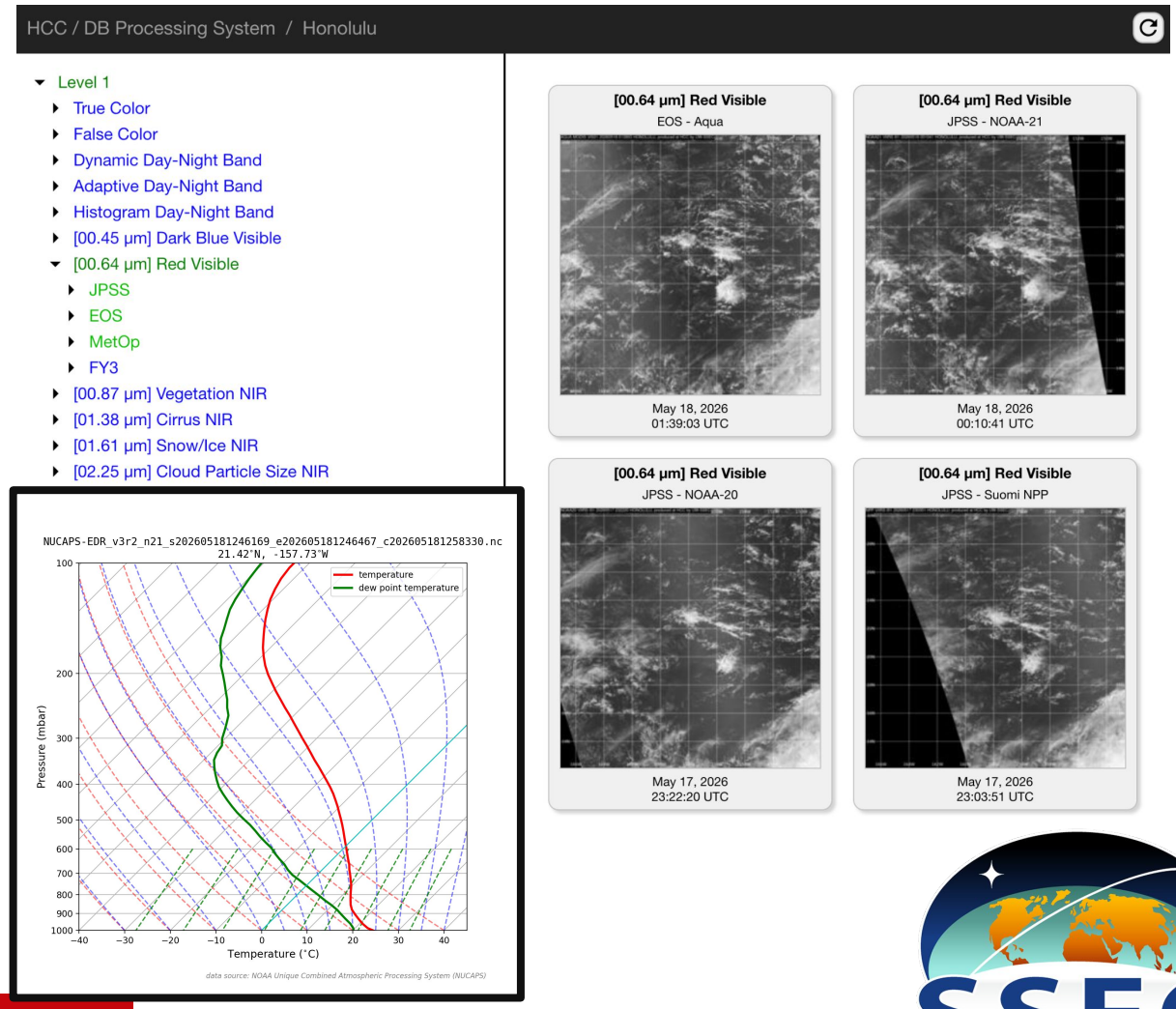
- Level 2
  - **CSPP HEAP v3.0** - Atmospheric profiles
    - CrIS/ATMS, IASI/AMSU-A/MHS
  - **CSPP MiRS v4.0** - Microwave retrievals
    - ATMS, AMSU-A/MHS
  - **CSPP GAASP v1.0.2** - Microwave retrievals
    - AMSR2
  - **CSPP ACSPO v3.0**- VIIRS SSTs
    - v2.0: MODIS, AVHRR
  - Alaska Region Only
    - **CSPP Active Fire v2.1**
      - VIIRS
    - **CSPP CLAVR-x v3.0**
      - MODIS, AVHRR, VIIRS (S-NPP, NOAA-20 only)
      - Supplementing with CSPP ATMOS v1.0
    - **CSPP Flood v2.0**
      - VIIRS
    - CSPP packages being evaluated: OMPS L2, CRYO, LSR, and more



Yellow: Development in progress

Software Packages Used

- Visualization
  - **CSPP Polar2Grid v3.2**
    - AWIPS tiled NetCDFs
    - GeoTIFFs, annotated PNGs
  - **CSPP SounderQL v1.3**
- Front-end
  - **Storm Browser v2.0**
  - Developed by G. Yoerger
  - Sorts by geographic coverage, product type, and source
  - Pacific Region uses to preview products before loading into AWIPS



Completed Efforts

- Hardware
  - Upgrades of DBPS servers from CentOS 7 to Rocky Linux 8
  - Replacing failed RAID card battery in Guam DBPS causing system crashes
  - Replacing ~12-year-old servers at Honolulu Community College site in 2024
  - Standing up a full PSAS test environment in Madison in 2024/25
  - Installation of dedicated DBPS in Fairbanks, AK in 2025
- Software
  - Moved to RAMdisk work spaces
  - Moved to a event-based LDM insertion model
  - Upgrading many CSPP LEO packages
  - Moving DBPS code into GitLab for version control
  - Work with CPI on EOS-FES AWS, MetOp-SGA1 reception support
- External
  - Resolving 2 multi-month cases of severe X-band RFI in Guam and Hawaii

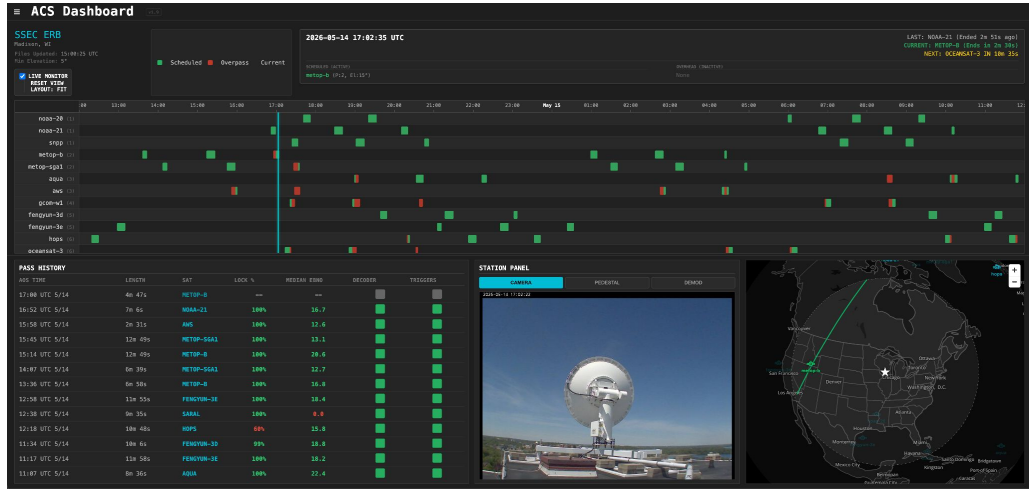
It takes resources to sustain LEO DB collection and product generation!

Ongoing Efforts

- Hardware needs
  - Procurement of new D-300 demodulators for Pacific Region sites
    - Needed for AWS, MetOp-SG, and other future missions
  - Possible procurement of X/L/S-feeds for select Pacific Region sites
    - Loss of GCOM-W1 AMSR2 will be significant to NWS users
    - GOSAT-GW AMSR3 downlink is S-band only
- New missions
  - Arctic Weather Satellite
    - Level 1 software integrated, including P2G support for AWIPS, GeoTIFFs
  - MetOp-SGA1
    - Level 1 software integrated
  - MetOp-SGB1
  - NOAA-22 (currently JPSS-4)
- Interact with NOAA RFIMS on L-band interference tracking

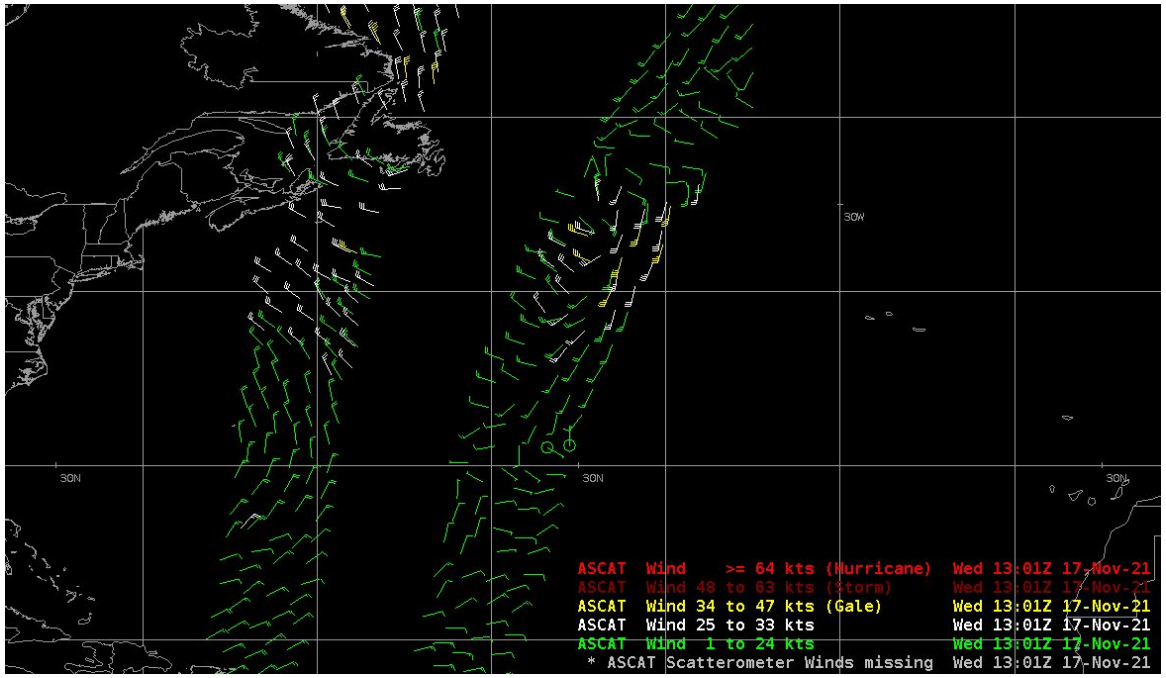
Future Efforts

- Replacement of EOS-FES with SSEC's Antenna Control System (ACS)
  - Lower compute + more flexible
  - Better cybersecurity posture
  - Running our Madison antenna today - see poster P.1
- Multi-antenna merging of raw data before Level 1 generation
  - 1 stream resilient to RFI, network outages, antenna downtime
  - Lower compute requirements for Level 1 & 2 products
  - Even lower latency possible - see presentation 3.4
- Better communication of LEO data availability and daily schedules



Future Efforts

- Continue multi-platform Level 2 algorithms
  - Forecasters care more about the product use case, not source sensor
  - Higher temporal frequency of same LEO products = easier to use
- Inclusion of scatterometer products
  - NWS makes frequent use of ocean surface wind vectors from “global” scatterometer (with high latency) for marine and tropical forecasting
  - Could DB, with the right software available, help them out?
- Prepare to support the NWS future operations model



NWS Future Operations Post-AWIPS

- AWIPS software suite is nearing the end of its ~30-year life
- Development ongoing for replacement, called HIVE/CIRRUS
  - CIRRUS: The back-end data repository is centralized cloud storage
  - HIVE: The front-end visualization interface will be browser-based
- The new system is scheduled to replace AWIPS in 2028
- Local offices and the regions will phase out local data processing
  - DB antennas remain fastest pathway to produce LEO products
  - Where should the processing live?
  - What APIs, data formats are expected for providers?

QUESTIONS?
THANK YOU!