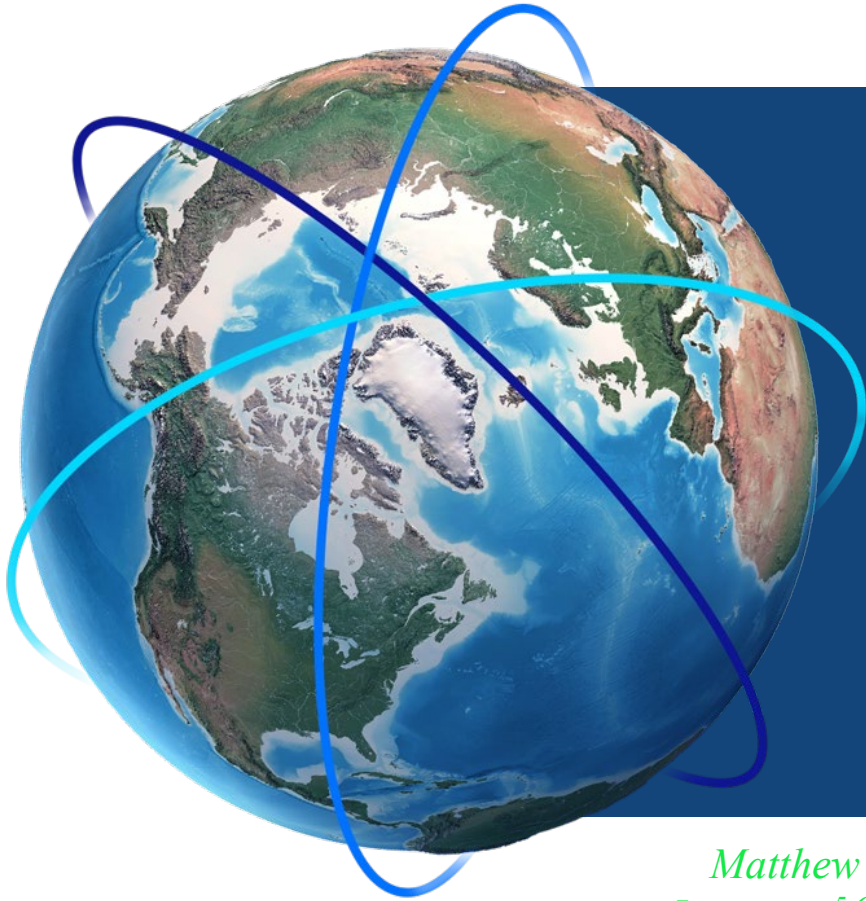




QuickSounder Advanced Technology Microwave Sounder (ATMS)

IEEE MicroRad 2024

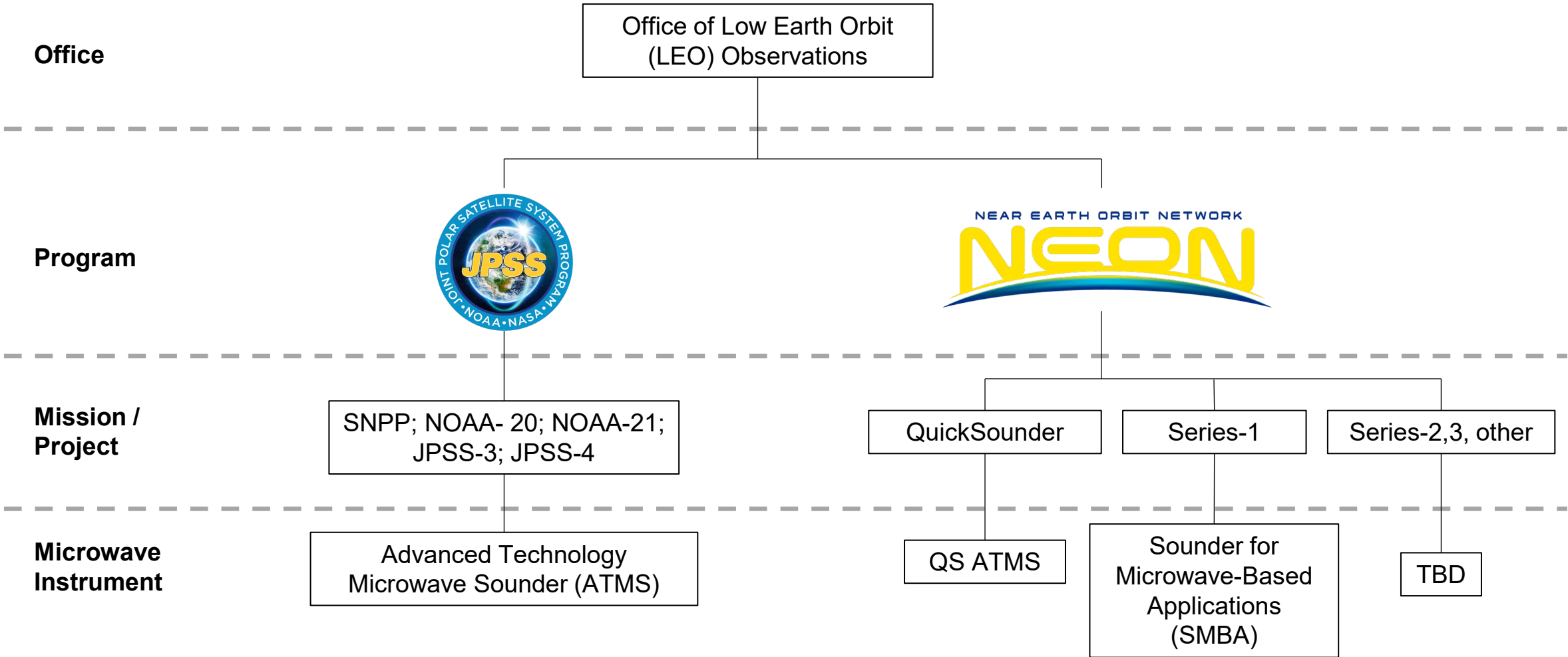
Matthew Sammons^{1,2} (presenting), Joel Amato³, Alexandra Bringer^{1,4}, James Fuentes³, Siena Iacovazzi^{5,6}, Flavio Iturbide-Sanchez⁵, James Kam³, Edward Kim¹, Fabian Rodriguez-Gutierrez³, Ninghai Sun^{5,6}, Hu Yang^{5,7}

¹NASA Goddard Space Flight Center, ²Fibertek Inc., ³Northrop Grumman, ⁴KBR Wyle,, ⁵NOAA,
⁶Global Science and Technology, ⁷University of Maryland

Overview and Outline

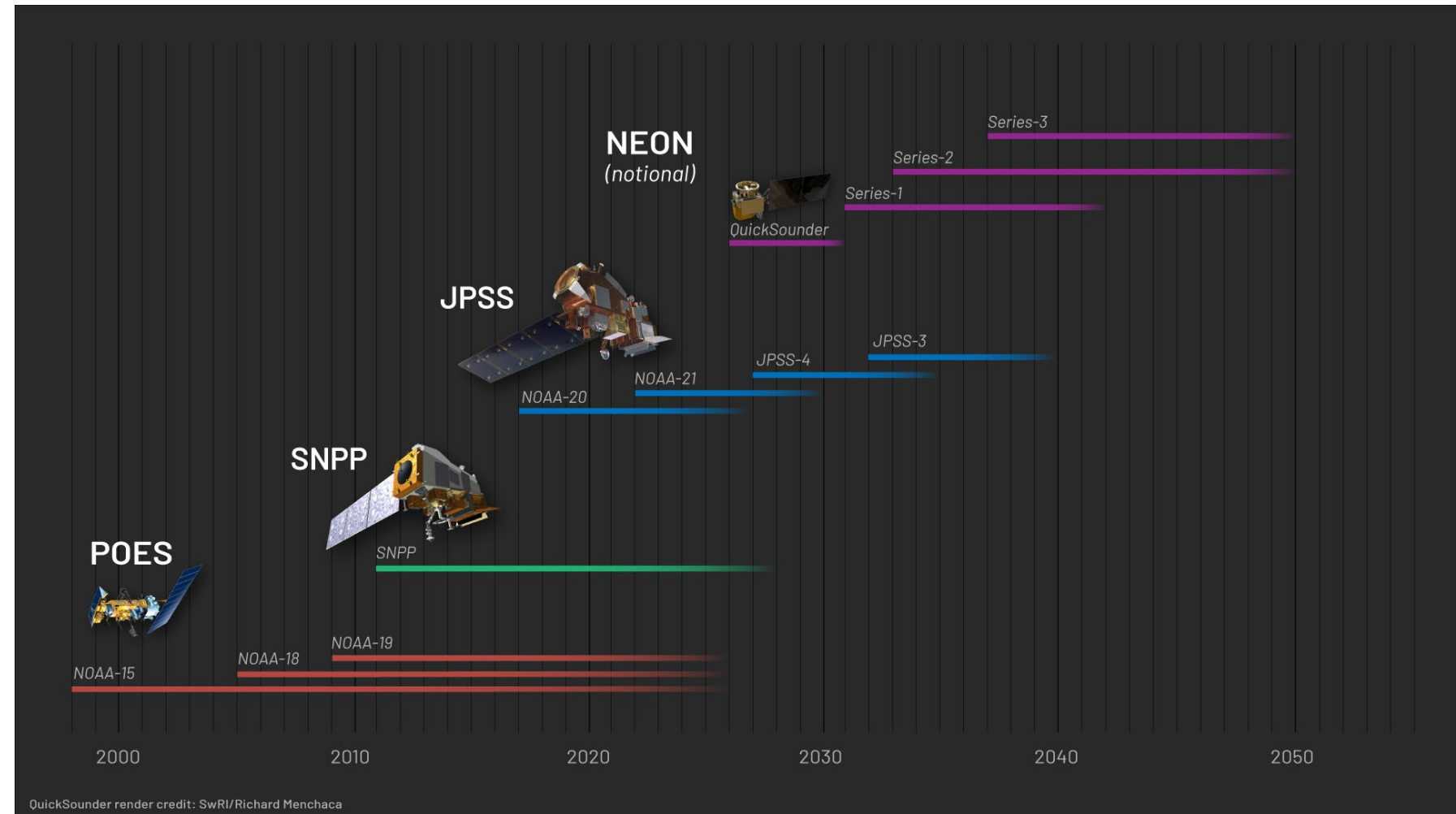
- Purpose:
 - Overview of the QuickSounder (QS) mission and onboard microwave radiometer
 - NOAA and NASA collaborative mission
 - Launch in 2026
 - QS Advanced Technology Microwave Sounder (ATMS) instrument
- Outline
 - Office of Low Earth Orbit (LEO) observations
 - LEO Mission Timeline
 - QuickSounder Mission Overview
 - QS ATMS

Office of Low Earth Orbit Observations



LEO Observations Timeline

- NEON will supplement and eventually replace JPSS
- First NEON mission is QuickSounder
 - Pathfinder mission
 - Launch: 2026
 - QS ATMS instrument



Source: <https://www.nesdis.noaa.gov/our-satellites/future-programs/near-earth-orbit-network-neon>

QuickSounder Overview

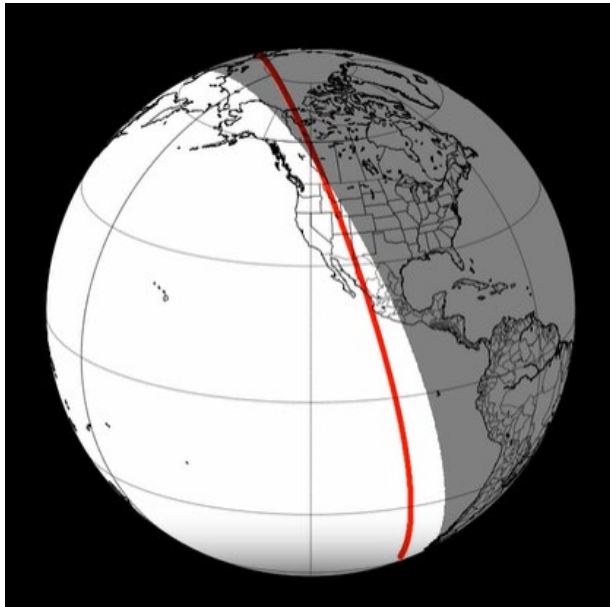
- QuickSounder is a pathfinder for NEON
 - Risk-reduction mission
 - Goals are to “...evaluate streamlined acquisition processes and determine the utility of commercial small satellites, launch services, mission operations and data routing in a disaggregated constellation for the next generation of LEO weather satellites.” [1]
 - Science performance is not the primary focus
 - Three years from beginning to launch
 - Southwest Research Institute (SwRI) spacecraft bus and mission operations provider
 - Northrop Grumman instrument provider
- Launch ~mid 2026
 - 3-year mission life
- Only science instrument is QS ATMS
 - The QS ATMS is the refurbished JPSS ATMS EDU (Engineering Development Unit)

References:

[1] <https://www.nasa.gov/press-release/nasa-awards-modification-to-refurbish-instrument-for-noaa-s-jpss/>

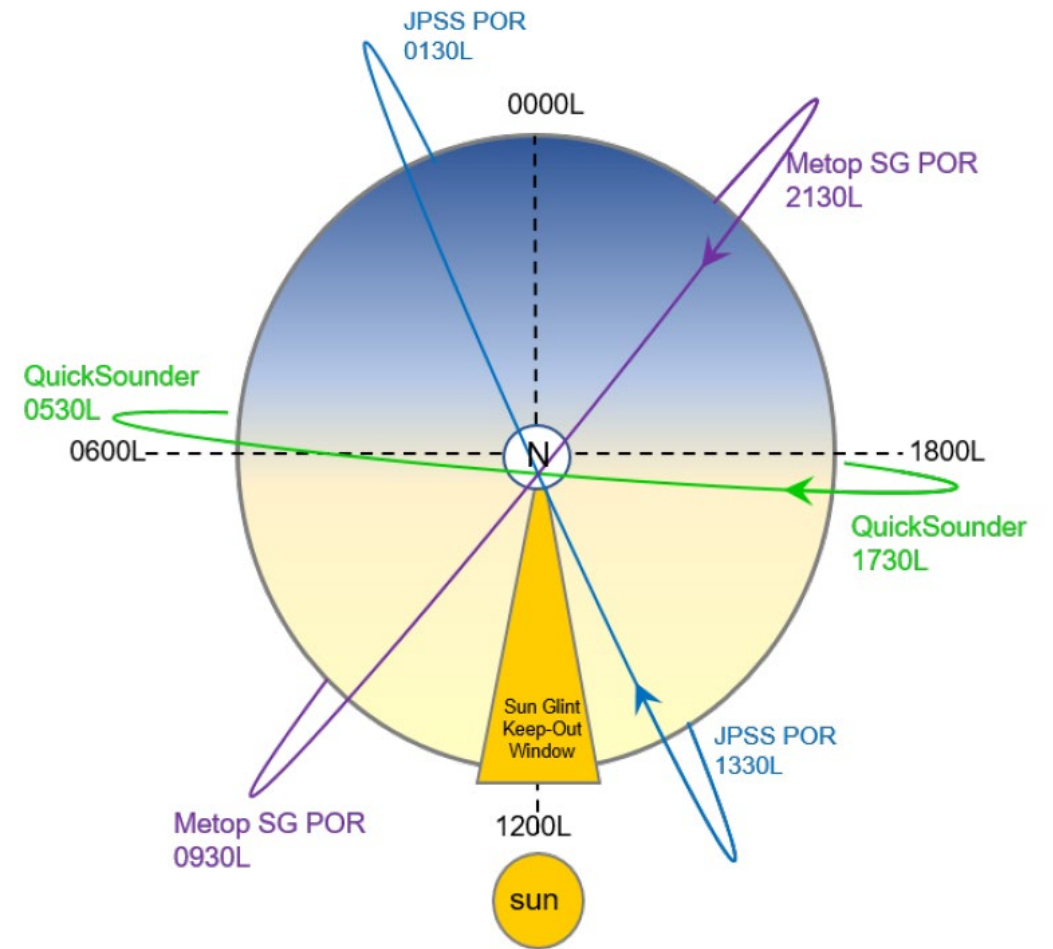
Orbit

- Polar sun-synchronous orbit
 - 824 km altitude
 - 98.71 deg inclination
 - 17:30 local time of the ascending node (LTAN)



Terminator orbit

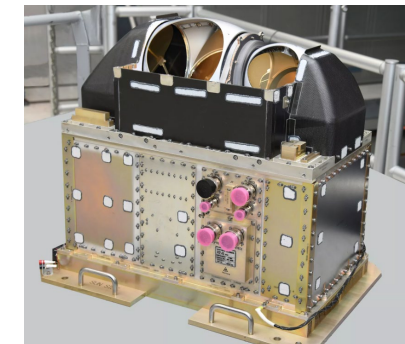
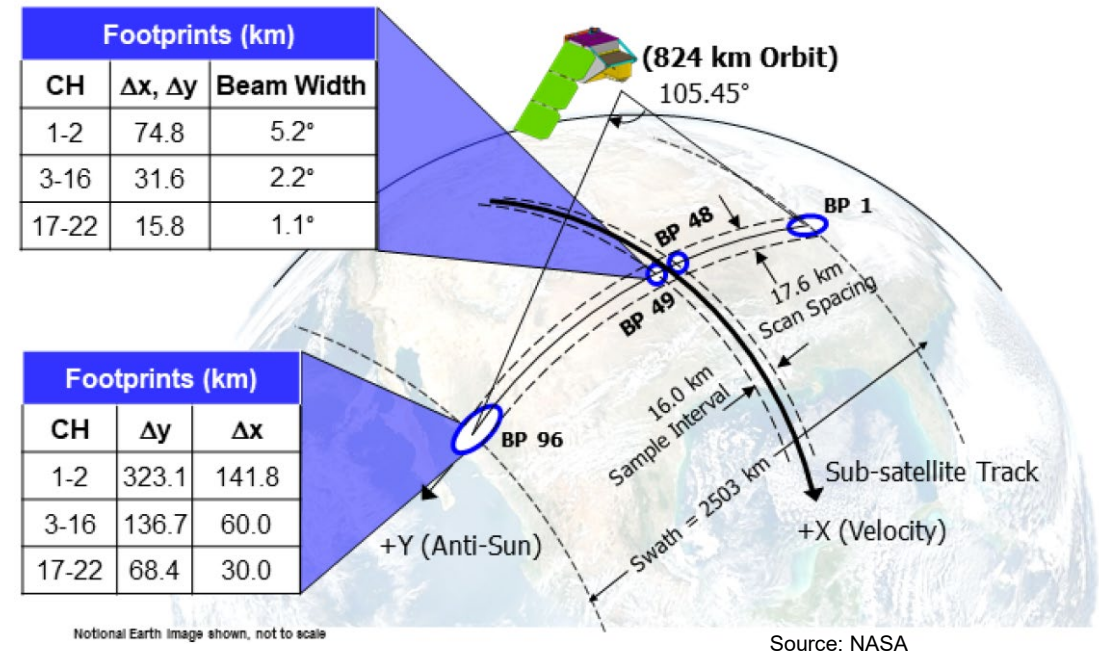
Courtesy of Hu Yang/NOAA STAR



Source: NOAA

QS ATMS (1 of 2)

- QS ATMS is the refurbished JPSS ATMS EDU
 - Total power radiometer, two-point external calibration
 - Cross-track scanning
 - 22 channels at 23-183 GHz for temperature and water vapor sounding
- Goals of refurbishment
 - Return all the ATMS science channels to an operational configuration
 - Ensure that the hardware is space-qualified
 - Address risks that would prevent the ATMS EDU from meeting a 3-year mission life
- Original build around SNPP ATMS timeframe (~2005)
 - Receiver hardware is from the same production lots as SNPP ATMS



JPSS ATMS

ATMS image source: <https://www.nesdis.noaa.gov/our-satellites/currently-flying/joint-polar-satellite-system/advanced-technology-microwave-sounder-atms>

QS ATMS (2 of 2)

- Focus of the QS mission is to identify risks in the non-sensor mission elements
 - Pathfinder for the NEON paradigm
 - Focus: rapid development, commercial bus, downlink, mission operations, etc.
 - Therefore mission will utilize a well-known sensor
- Performance will be fully characterized same as JPSS-3 and JPSS-4 ATMS
 - QS ATMS does not have science performance requirements
- JPSS ATMS specifications shown
 - Gray rows indicate no AMSU equivalent

ATMS Channels Specifications; Compare to AMSU/MHS

Channel	Channel Center Freq. (MHz)	Polarization	Bandwidth Max. (MHz)	Frequency Stability (MHz)	Calibration Accuracy (K)	NEAT (K)	3-dB Beamwidth (deg)	Remarks	Characterization at Nadir
1	23800	QV	270	≤10	1.0	0.70	5.2	AMSU-A2	Window-water vapor 100 mm
2	31400	QV	180	≤10	1.0	0.80	5.2	AMSU-A2	Window-water vapor 500 mm
3	50300	QH	180	≤10	0.75	0.90	2.2	AMSU-A1-2	Window-surface emissivity
4	51760	QH	400	≤5	0.75	0.70	2.2		Window-surface emissivity
5	52800	QH	400	≤5	0.75	0.70	2.2	AMSU-A1-2	Surface air
6	53596±115	QH	170	≤5	0.75	0.70	2.2	AMSU-A1-2	4 km ~ 700 mb
7	54400	QH	400	≤5	0.75	0.70	2.2	AMSU-A1-1	9 km ~ 400 mb
8	54940	QH	400	≤10	0.75	0.70	2.2	AMSU-A1-1	11 km ~ 250 mb
9	55500	QH	330	≤10	0.75	0.70	2.2	AMSU-A1-2	13 km ~ 180 mb
10	57290.344(f ₀)	QH	330	≤0.5	0.75	0.75	2.2	AMSU-A1-1	17 km ~ 90 mb
11	f ₀ ± 217	QH	78	≤0.5	0.75	1.20	2.2	AMSU-A1-1	19 km ~ 50 mb
12	f ₀ ±322.2±48	QH	36	≤1.2	0.75	1.20	2.2	AMSU-A1-1	25 km ~ 25 mb
13	f ₀ ±322.2±22	QH	16	≤1.6	0.75	1.50	2.2	AMSU-A1-1	29 km ~ 10 mb
14	f ₀ ±322.2±10	QH	8	≤0.5	0.75	2.40	2.2	AMSU-A1-1	32 km ~ 6 mb
15	f ₀ ±322.2±4.5	QH	3	≤0.5	0.75	3.60	2.2	AMSU-A1-1	37 km ~ 3 mb
16	88200	QV	2000	≤200	1.0	0.50	2.2	AMSU-A AMSU-B MHS	Window H ₂ O 150 mm
17	165500	QH	3000	≤200	1.0	0.60	1.1	AMSU-B MHS	H ₂ O 18 mm
18	183310±7000	QH	2000	≤30	1.0	0.80	1.1	AMSU-B MHS	H ₂ O 8 mm
19	183310±4500	QH	2000	≤30	1.0	0.80	1.1		H ₂ O 4.5 mm
20	183310±3000	QH	1000	≤30	1.0	0.80	1.1	AMSU-B MHS	H ₂ O 2.5 mm
21	183310±1800	QH	1000	≤30	1.0	0.80	1.1		H ₂ O 1.2 mm
22	183310±1000	QH	500	≤30	1.0	0.90	1.1	AMSU-B MHS	H ₂ O 0.5 mm

From: NOAA Technical Report NESDIS 158 Joint Polar Satellite System (JPSS) Advance Technology Microwave Sounder (ATMS) Sensor Data Record (SDR) User's Guide Version 1.0 Rev 1.0

QS ATMS vs. JPSS ATMS

- Will characterize performance to JPSS ATMS and AMSU-A
 - QS ATMS in similar orbit as AMSU-A on NOAA-18
- QS ATMS is the only science instrument
 - Analyses that utilize concurrent measurements from other instruments may not be viable
 - Possible changes to post-launch test maneuvers and timing
 - Discussions on expected timing of algorithm validated maturity
- Different orbit than JPSS
 - Orbit is a terminator orbit
 - Evaluation of stray light differences into ATMS
- TVAC testing, Post-launch testing
- Data Downlink
 - No direct broadcast data

QS ATMS vs. JPSS ATMS Attributes/Plans

Attribute/Plan	QS ATMS	JPSS ATMS
Free-flyer	Yes	No
Scanning Type	Cross-track	Cross-track
Frequency range	23-183 GHz	23-183 GHz
No. of channels	22	22
Orbit altitude	824 km	824 km
LTAN	17:30	13:30
TVAC Calibration	Yes	Yes
Post Launch Tests	Yes	Yes
Data Format	HDF5	HDF5
Direct Broadcast Data	No	Yes

Cal/Val Planning

- Same as JPSS ATMS
- Pre-Launch
 - Component (such as calibration targets) and subsystem (such as antenna) data
 - Existing data to be evaluated for use
 - Instrument-level thermal vacuum (TVAC) calibration
 - Uses same ground calibration targets as JPSS ATMS
 - Observatory-level integration and testing
 - Ex: Electromagnetic Interference (EMI)/Electromagnetic Compatibility (EMC); instrument alignment
- Post-Launch
 - Post-Launch Tests (PLTs)
 - Algorithm maturity Reviews
- Assessing algorithm updates
 - Includes updated parameters for processing coefficient table (PCT)
- Public release of documentation
 - Spectral Response Functions (SRFs)
 - Algorithm Theoretical Basis Document (ATBD)
 - Operational Algorithm Description (OAD)
 - Data Book

Summary and Forward Work

- Summary
 - QuickSounder is the pathfinder mission for the NEON program
 - NEON: NOAA and NASA collaboration; supplement and replace JPSS
 - Launch 2026
 - QS instrument is QS ATMS
 - Refurbished JPSS ATMS EDU
 - QS ATMS will be characterized the same as JPSS ATMS
- Forward Work Schedule Highlights
 - Mid-2024: Instrument-level Thermal Vacuum (TVAC) Calibration
 - 2025: Observatory-level I&T
 - Mid-2026: Launch and commissioning