State of CERES

Norman G. Loeb
NASA Langley Research Center, Hampton, VA



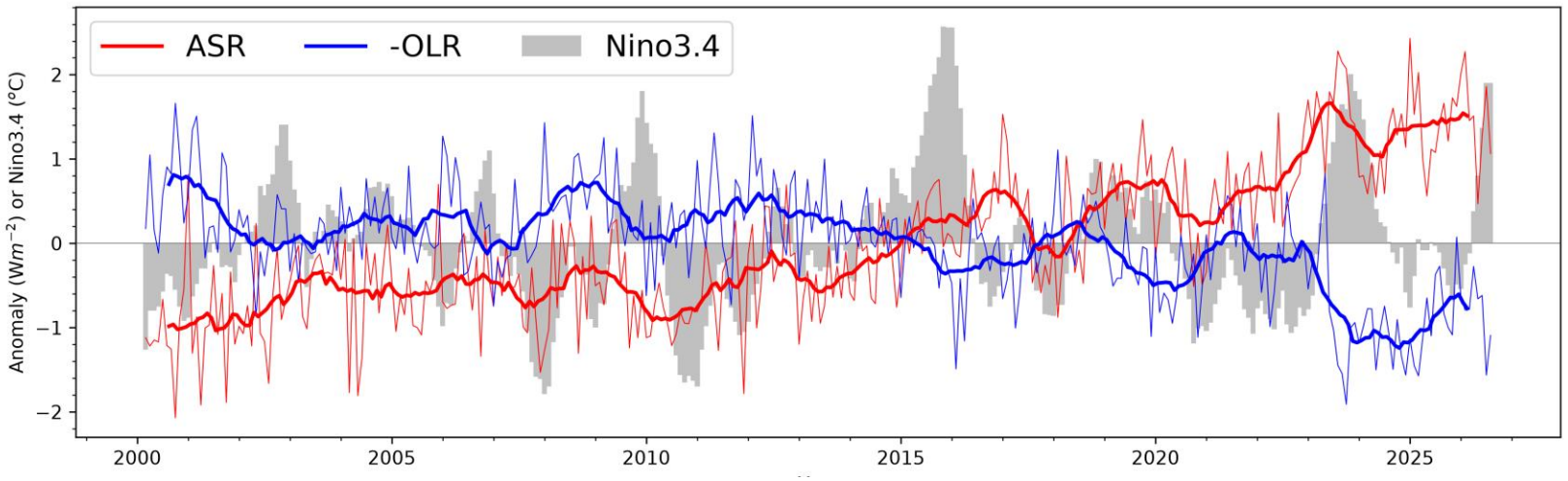
CERES Science Team Meeting, October 27-29, 2026
NASA Langley Research Center, Hampton, VA

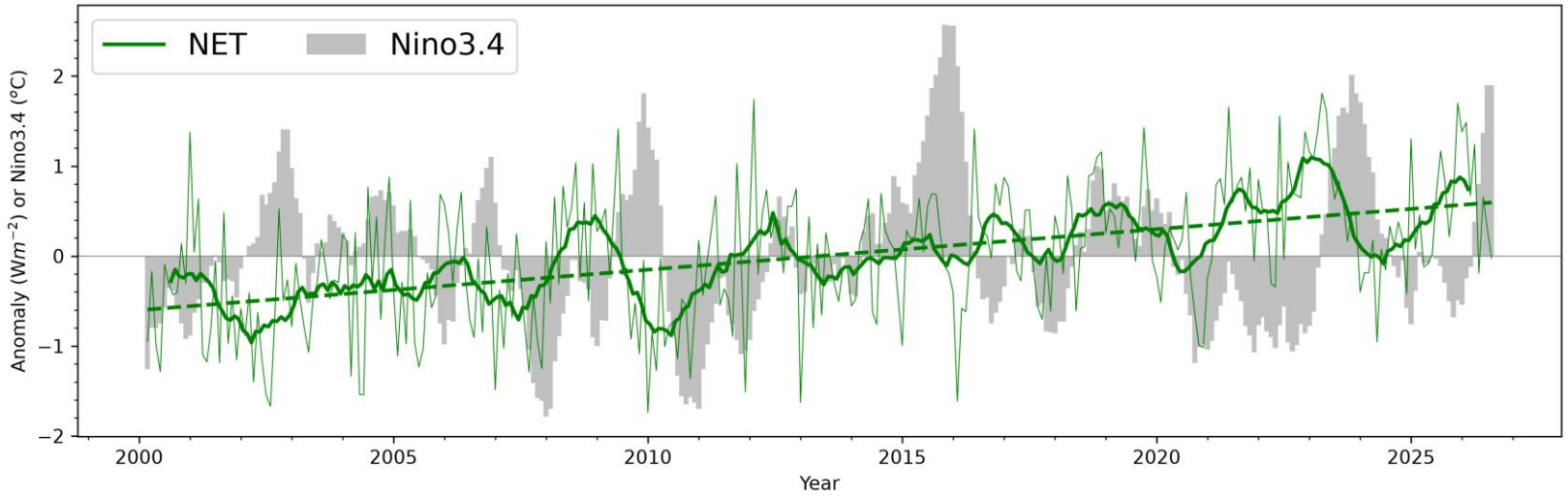
CERES Technical Meeting

Review Status of CERES Instruments and Data Products:

- State of CERES
- CERES Terra, Aqua, S-NPP, NOAA-20 Instrument Calibration Update
- MODIS & VIIRS Cloud Algorithm & Validation Status
- ADM, SARB and TISA Working Group Reports
- FLASHFlux Update
- Data Management Team Update

Global Mean All-Sky TOA Flux Anomalies (CERES EBAF Ed4.2.1; 03/2000–08/2026)





Trends (Wm^{-2} per decade; 2σ)

ASR: 0.90 ± 0.21

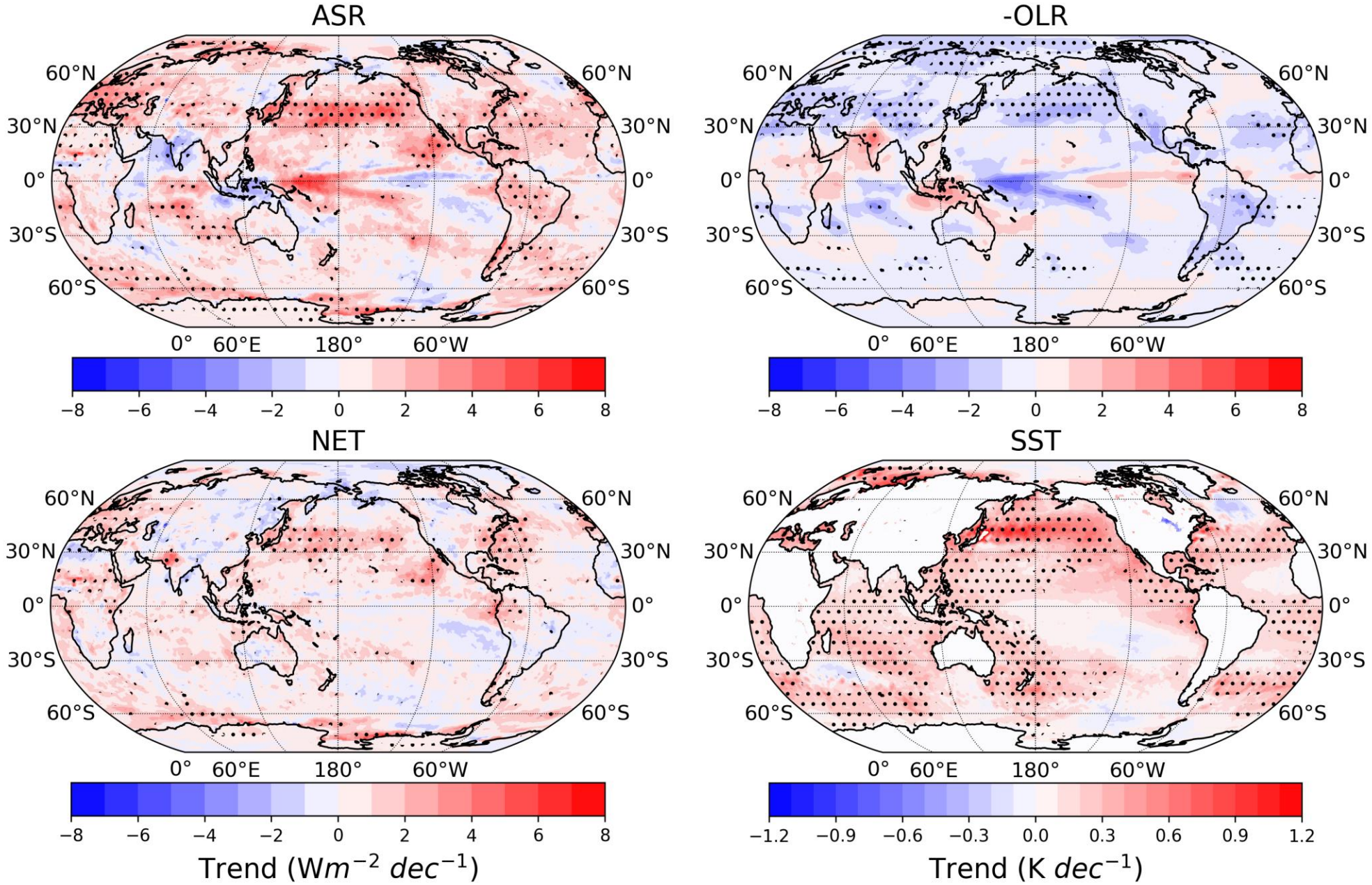
−OLR: −0.45 ± 0.22

NET: 0.45 ± 0.16

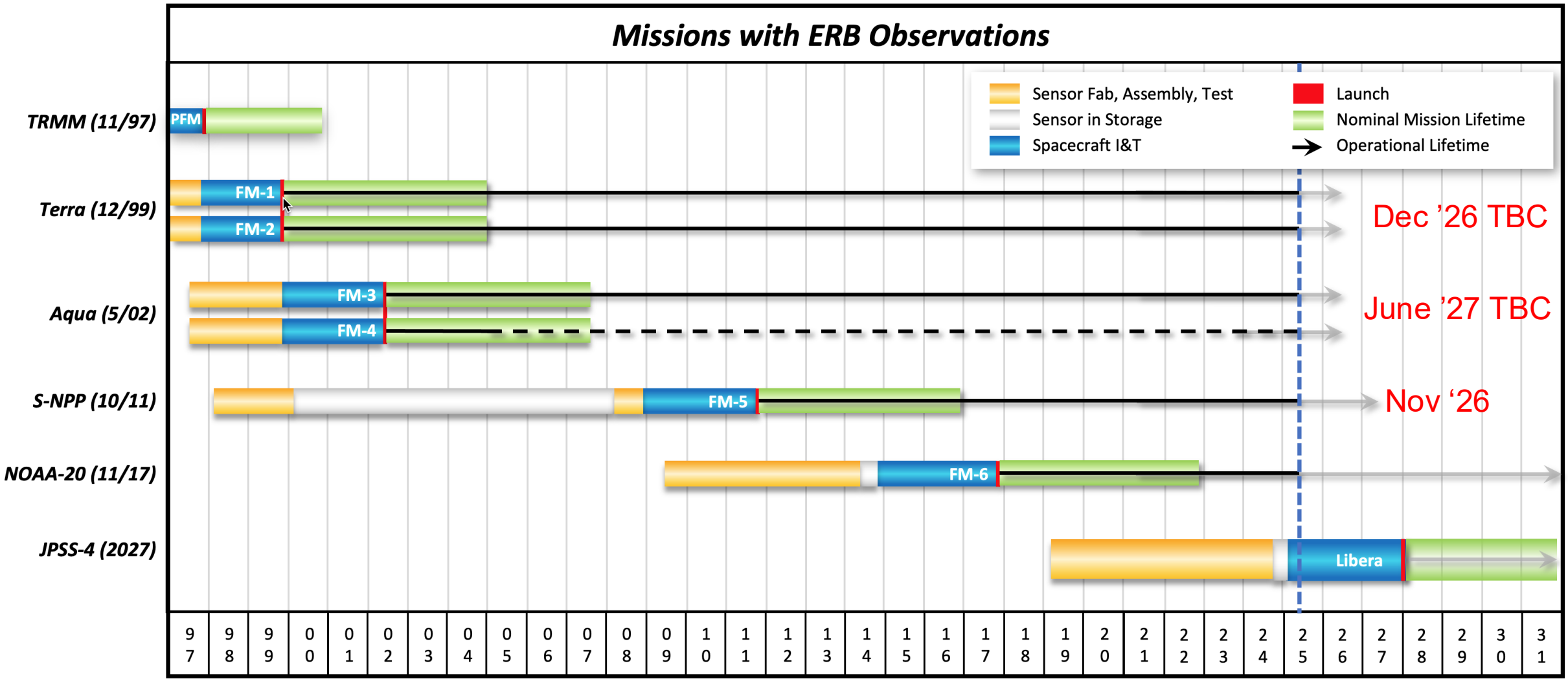
Units: Wm^{-2}	Solar Irradiance	ASR	−OLR	NET
03/2000-02/2010	340.14	240.73	−240.20	0.53
03/2016-02/2026	340.23	242.12	−240.87	1.25
Difference	0.090	1.39	−0.67	0.72

Doubling in EEI!

Trends in TOA Radiation and SST (03/2000–08/2026)

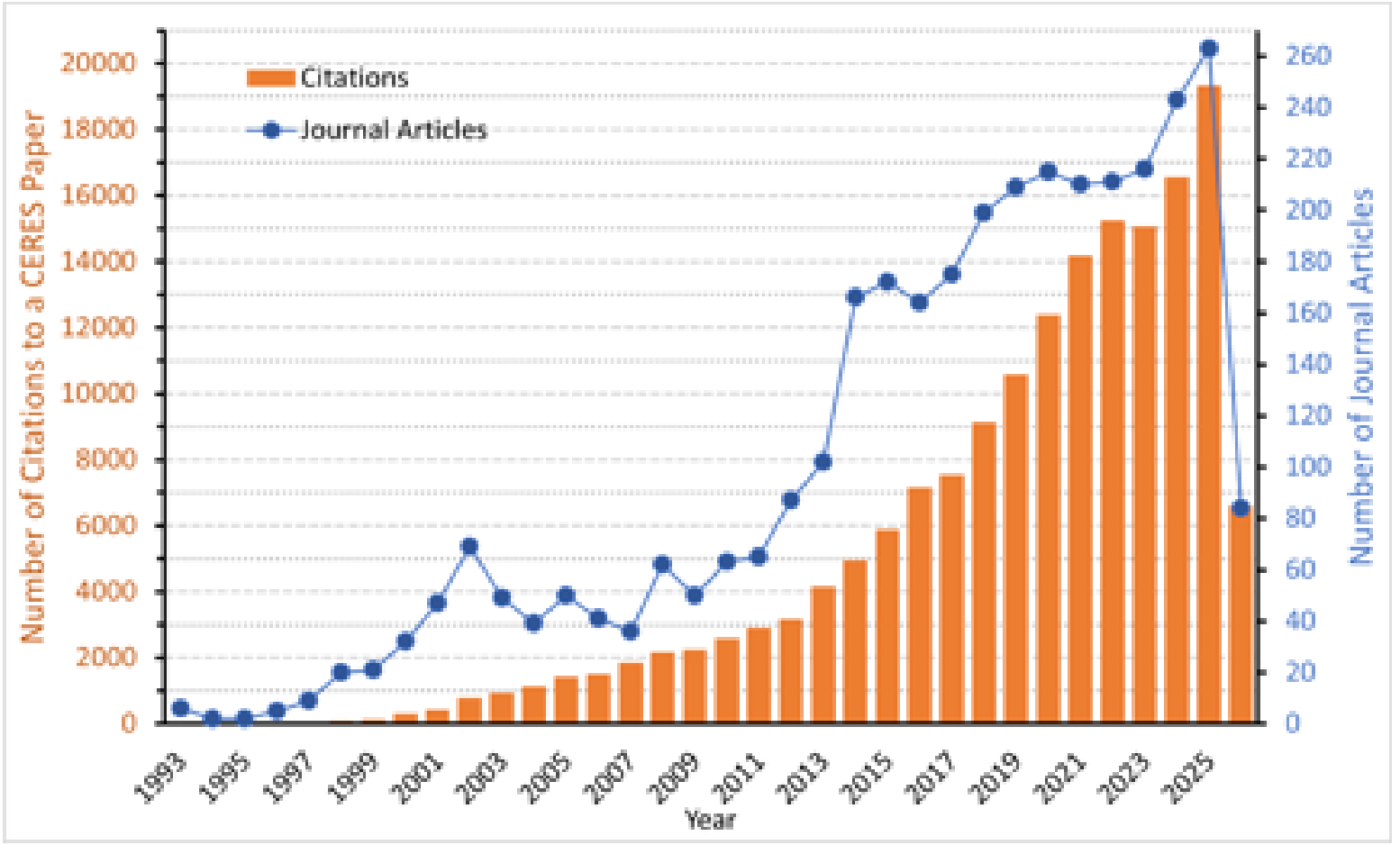


Flight Schedules



- Currently, 6 CERES instruments fly on 4 satellites: Terra (L1999), Aqua (L2002), SNPP(L2011), NOAA-20 (L2017)
- Libera scheduled for launch in 2027 on JPSS-4

CERES Journal Publications and Citation Counts
(For Papers Between 1993-2026; Updated May 7, 2026)



- Total number of peer-reviewed journal articles: 3,384
- Total number of citations to CERES papers: 170,585

(Compiled by Dennis Keyes)

Number of Unique Users by CERES Data Product

(through September 30, 2026)

Level	Product	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
1b	BDS	14	10	12	23	19	30	19	30	44	26
2	SSF	327	235	251	245	246	273	288	436	476	355
	FLASH_SSF	68	101	92	103	101	124	72	71	64	49
	CCCM	49	49	36	45	53	62	78	58	62	59
	ES8	15	10	8	11	8	14	8	37	61	24
	SSF-MISR	3	1	1	4	3	7	0	13	10	7
	CRS				2	1	4	20	37	60	55
3 & 3b	EBAF	935	928	995	1041	994	1196	1589	1747	2010	1743
	SYN1deg	607	639	754	854	858	918	984	1118	1299	1253
	SSF1deg	190	159	221	213	208	255	188	228	249	168
	CldTypHist	86	87	79	86	84	83	119	114	124	62
	FluxByCldTyp				50	62	67	94	65	96	125
	ES4	17	17	17	11	14	15	19	13	14	13
	ES9	8	6	6	8	5	8	6	7	11	8
	FLASH_TISA	52	65	81	131	107	116	95	90	118	80
	CRS1deg								61	42	28

CERES Edition 5 Status

1) Atmospheric reanalysis system

- ECMWF ERA-5 T_s, T and q for standard CERES products
- GMAO GEOS-IT aerosols for Fu-Liou based surface radiative fluxes in SSF (L2)
- GMAO GEOS-IT for FLASHFlux

2) MODIS Collection 7 Level-1b

3) CERES algorithm improvements (particularly those enabling a seamless transition across satellite platforms).

⇒ CERES team MODIS cloud properties: In production. ~8 years processed so far

⇒ Anticipate public release of new CLDPIX product in early 2027

⇒ Anticipate public release of Level-2 CERES SSF in fall of 2027

Planning for Libera

1) Bi-weekly meetings with Libera team, NASA HQ, ESSPO
2) Calibration WG meetings
3) DMT WG meetings
4) Periodic on-site visits at LASP by CERES Instrument WG
   - CERES and Libera instrument teams held multiple Technical Interchange Meetings (virtual and in-person)
   - CERES members participated in Libera pre-launch calibration and data reviews
5) Intercalibration of CERES FM6 and Libera
6) New approach for inferring split SW fluxes from Libera measurements

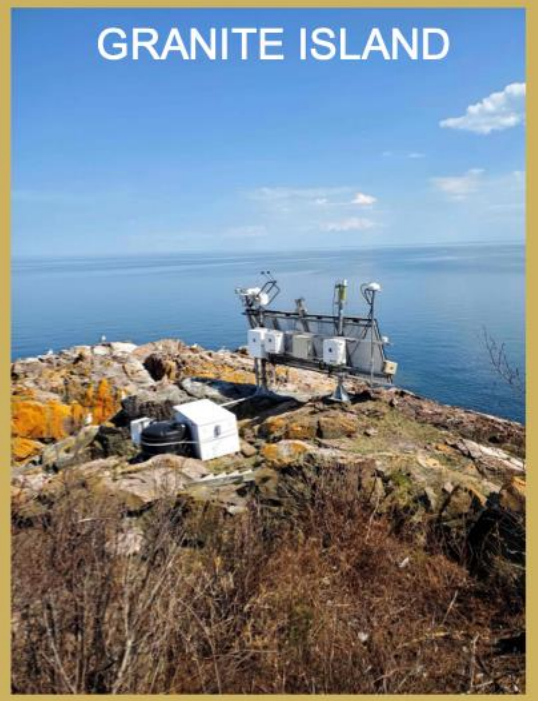
Intercalibration of CERES FM6 and Libera

- ERB CDR requires overlap between successive instruments on different satellites
  - Ideally, this is achieved using measurements coincident in time, location, and viewing geometry (e.g., simultaneous nadir overpass (SNO) method)
- While NOAA satellites are in the same 1:30PM orbit and altitude, they are phased such that time-matched measurements are not possible
- An alternate approach is to use geostationary (GEO) imagers as "transfer radiometers" between ERB instruments on different NOAA satellites (e.g., FM6 and Libera)
- Place ERB instruments in GEOscan mode
  - Enables angle-matched ERB and GEO measurements
  - See Presentation by Dave Doelling on Thursday morning
- **CLARREO-PF**: CERES and Libera teams have also requested intercalibration campaigns between CLARREO-PF and both CERES FM6 and Libera (SW only).
  - Provides an independent check on GEOscan SW intercalibration

Other News

- **Decadal Survey for Earth Science and Applications from Space 2028-2037 (ESAS 2028)**
  - "*Will develop a comprehensive strategy that builds on the 2018 decadal survey and identifies an innovative, fiscally realistic path for addressing the highest priority Earth science and applications challenges that can be advanced in the coming decade through space-based and ancillary observations*"
  - White papers on EEI and ERB were submitted
  - Steering Committee Selected
  - Sub-committees: "Atmosphere", "Cryosphere", "Geosphere", "Biosphere", "Hydrosphere", "State of the Profession"
- **CERESMIP**
  - Workshop in Vancouver, BC. December 2-4, 2026
  - Fall AGU session: GC43G: Progress Toward Understanding the Growing Earth's Energy
    - Poster: Thursday, December 10
    - Oral: Friday, December 11
  - Data coming soon:
    - Data being prepped for the Earth System Grid Federation (ESGF), but the process is slow

CRAVE — CERES RAdiation Validation Experiment
https://science.larc.nasa.gov/CRAVE/



- Normal operations since May visit.
- Prepared site for winter (last week).
- Presented CRAVE and Granite Island to Northern Michigan University students and faculty.
- Data availability: 2018 Jul – 2026 Sep.



- Normal operations.
- NMU summer internship completed its 8th year.
- Intern created CRAVE vs CERES comparisons and available on the CRAVE website.
- Data availability: 2014 Dec – 2026 Sep.

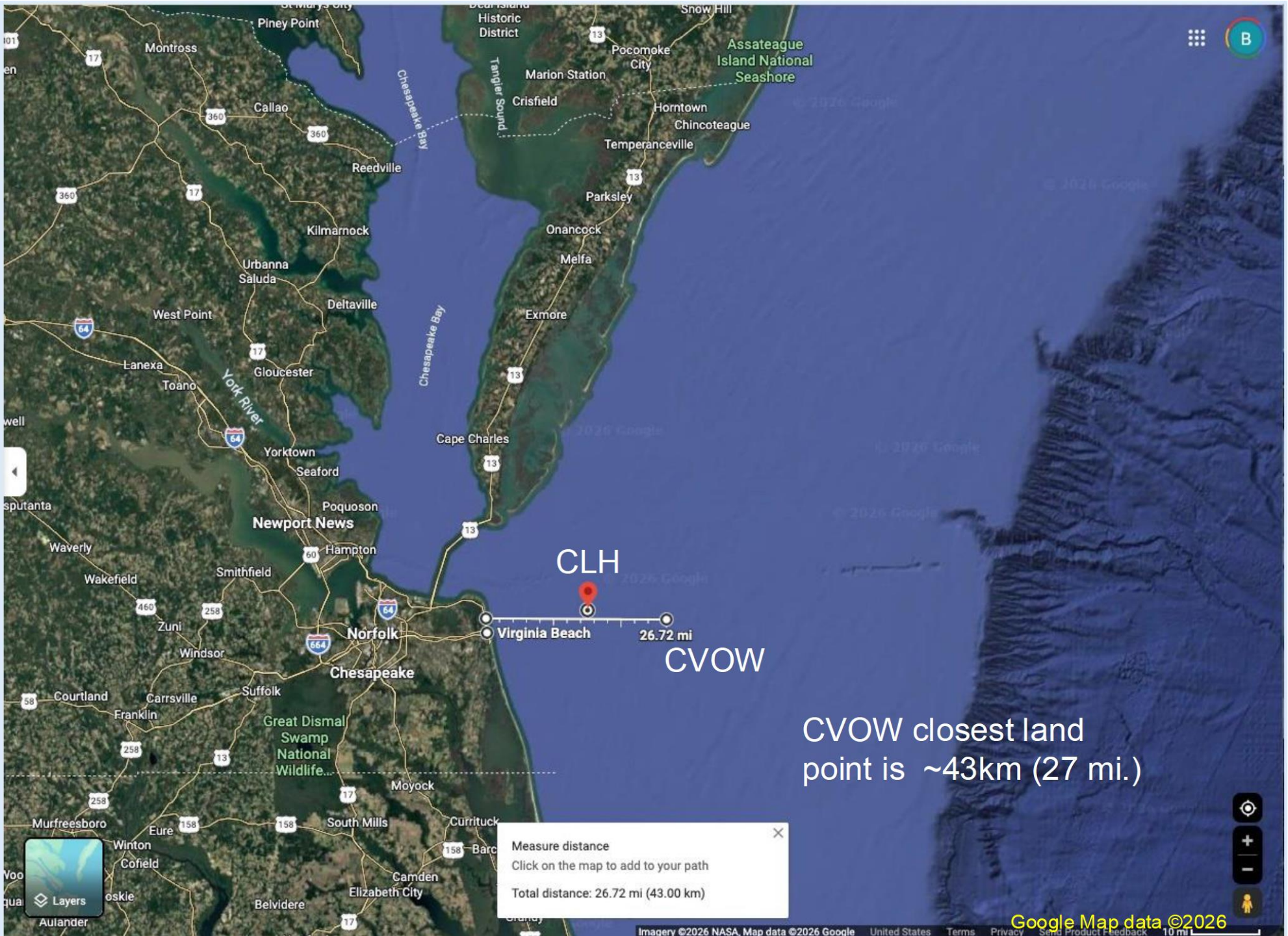


- Coastal Virginia Offshore Wind substation. Owned by Dominion Energy.
- Future over ocean measurement site.
- White Paper in progress.
- Earliest presence: Summer '27.
- Closest land point: 43 km (near COVE)



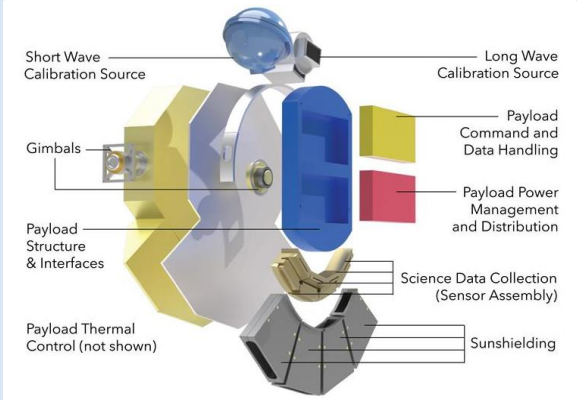
- Data availability: 2000 May – 2016 Nov.

- **Two absolute cavity pyrheliometers participated in the National Pyrheliometer Comparison, maintaining traceability to the World Radiation Reference.**
- **Attended 19th BSRN Scientific Review and Workshop. Presented CRAVE operations and potential new Dominion CVOW site.**


CLH
CVOW
26.72 mi
Virginia Beach
Norfolk
Chesapeake
Newport News
Hampton
Yorktown
Seaford
Poquoson
Gloucester
Cape Charles
Onancock
Parksley
Temperanceville
Chincoteague
Assateague Island National Seashore
Pocomoke City
Marion Station
Crisfield
Tangier Sound
Chesapeake Bay
York River
Great Dismal Swamp National Wildlife...
Measure distance
Click on the map to add to your path
Total distance: 26.72 mi (43.00 km)
CVOW closest land point is ~43km (27 mi.)
Google Map data ©2026

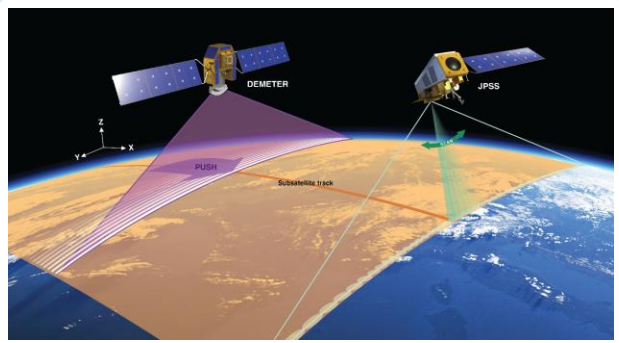
DEMETER: Next Generation of Earth Radiation Budget

- **DEMETER** is designed to deliver CERES equivalent measurements, while pivoting to a smallsat free-flyer platform – ***reducing size, weight, power, development costs, and reliance on a large spacecraft bus***



- **DEMETER** is a ***non-scanner pushbroom*** with thermopile microarray detector with ***shortwave, longwave, and total broadband spectral channels***

<u>Current DEMETER efforts:</u>



- Completion of IIP-23 **Multispectral Radiometric Test (MRT)** in collaboration with **JPL** and **Quartus Engineering**
- Refinement of DEMETER ***Science Traceability Matrix***, ***Concept of Operations (ConOps)***, and ***Instrument Design***
- Continuation of trade studies initiated under Mission Study
- Exploration of ***partnerships*** for the next generation Earth Radiation Budget Mission

MISSION STUDY (COMPLETE)

- **Goal:** Assess **mission architecture** and **operational concepts** to provide the technical baseline and foundational reference required to advance the mission concept toward the next phases of the project lifecycle
- Defined and evaluated feasibility of a preliminary mission concept and preliminary mission architecture, identified and initiated trade studies, and identify preliminary risks

IIP-23 (ECD: April 2027)

- **Goal:** Mature the Technology Readiness Level of DEMETER technology for measuring outgoing Earth Radiation from 0.2 µm to >50 µm to support fundamental earth radiation budget data records
- **MRT** is planned for early 2027 to evaluate the on-orbit calibration sequence in vacuum environment, refine accuracy and precision tree inputs, and validate the **ConOps**

Upcoming Conferences & Meetings of Interest

Fall AGU
- December 7-11, 2026, San Francisco, CA

AMS Annual Meeting
- January 10-14, 2027, Denver, CO

ESA Workshop on the Earth Radiation Budget (Invitation Only)
- February 23-26, 2027, Harwell, UK

EGU General Assembly
- April 4-9, 2027, Vienna, Austria

Spring CERES Science Team Meeting
- May 18-20, 2027, NASA LaRC

29th IUGG General Assembly (IUGG2027)
- July 16-22, 2027, Incheon, South Korea

Gordon Conference
- July 18-23, 2027, Bates College, Lewiston, ME