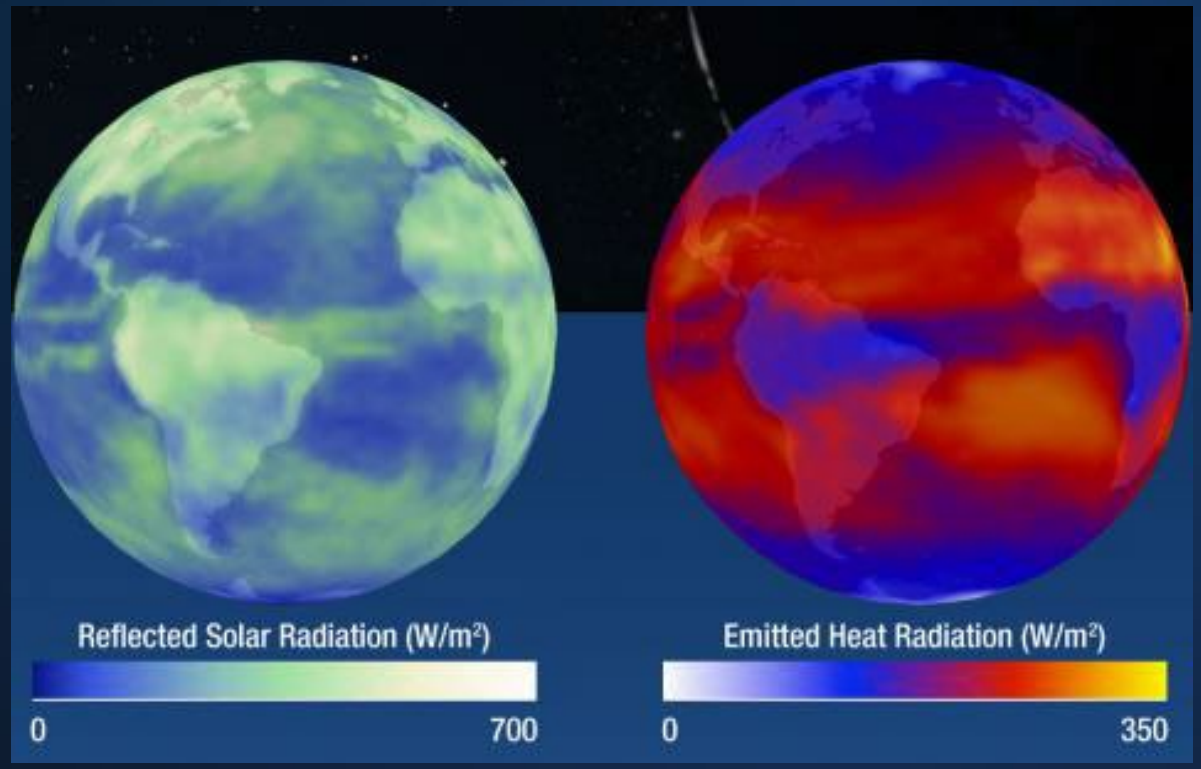
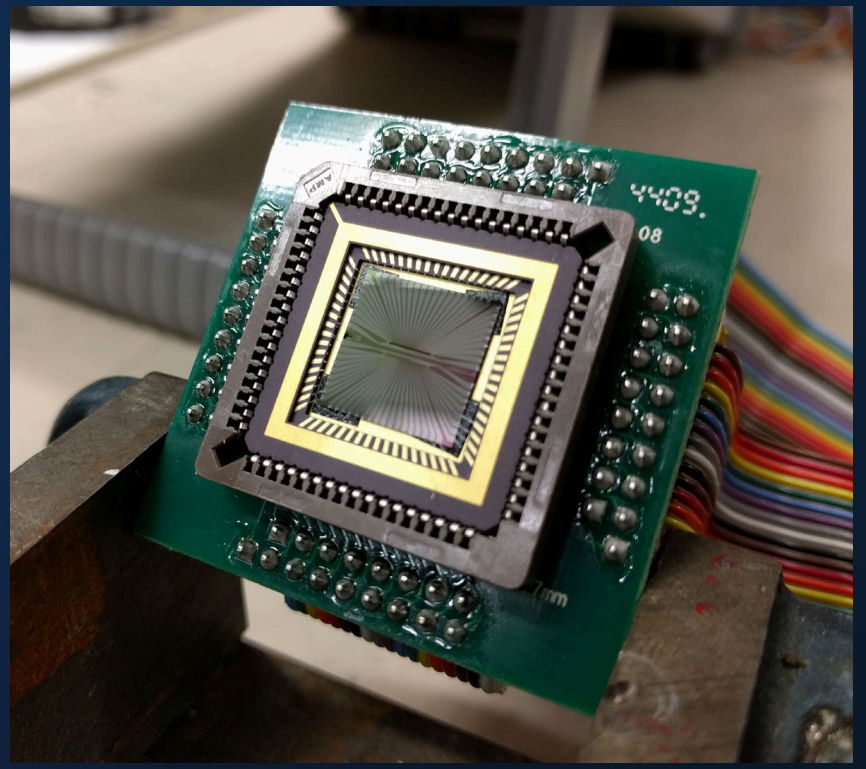
Radiometry for Climate Metrology

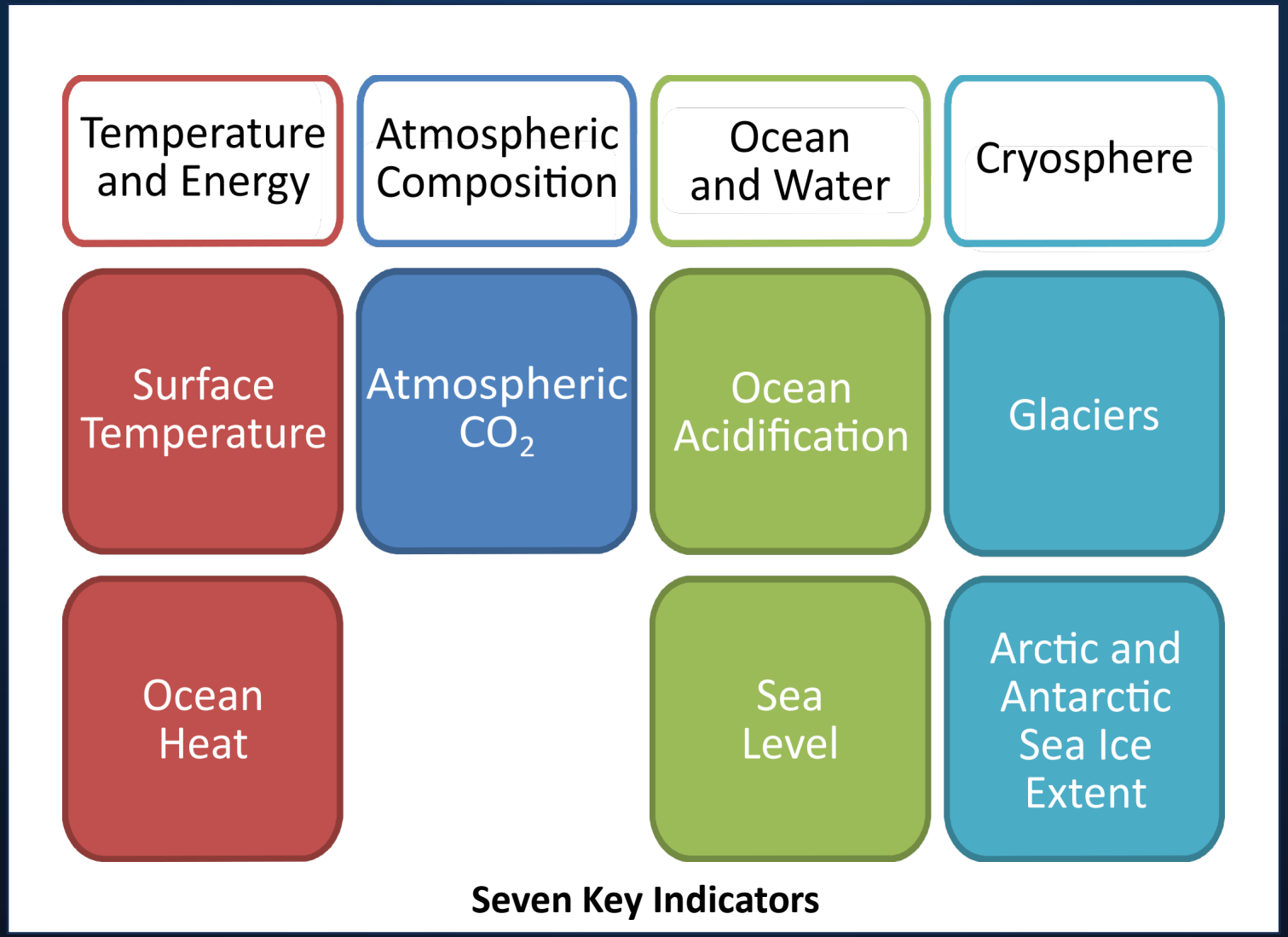


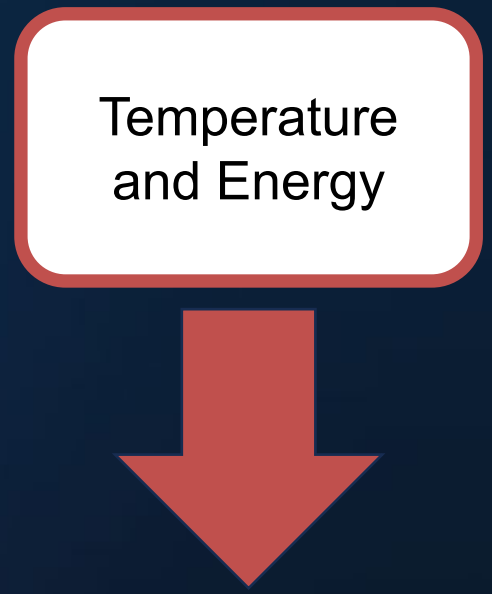
Credit: NASA/Goddard Space Flight Center Scientific Visualization Studio



Credit: Chris Yung, NIST

World Meterological Organization Global Climate Indicators





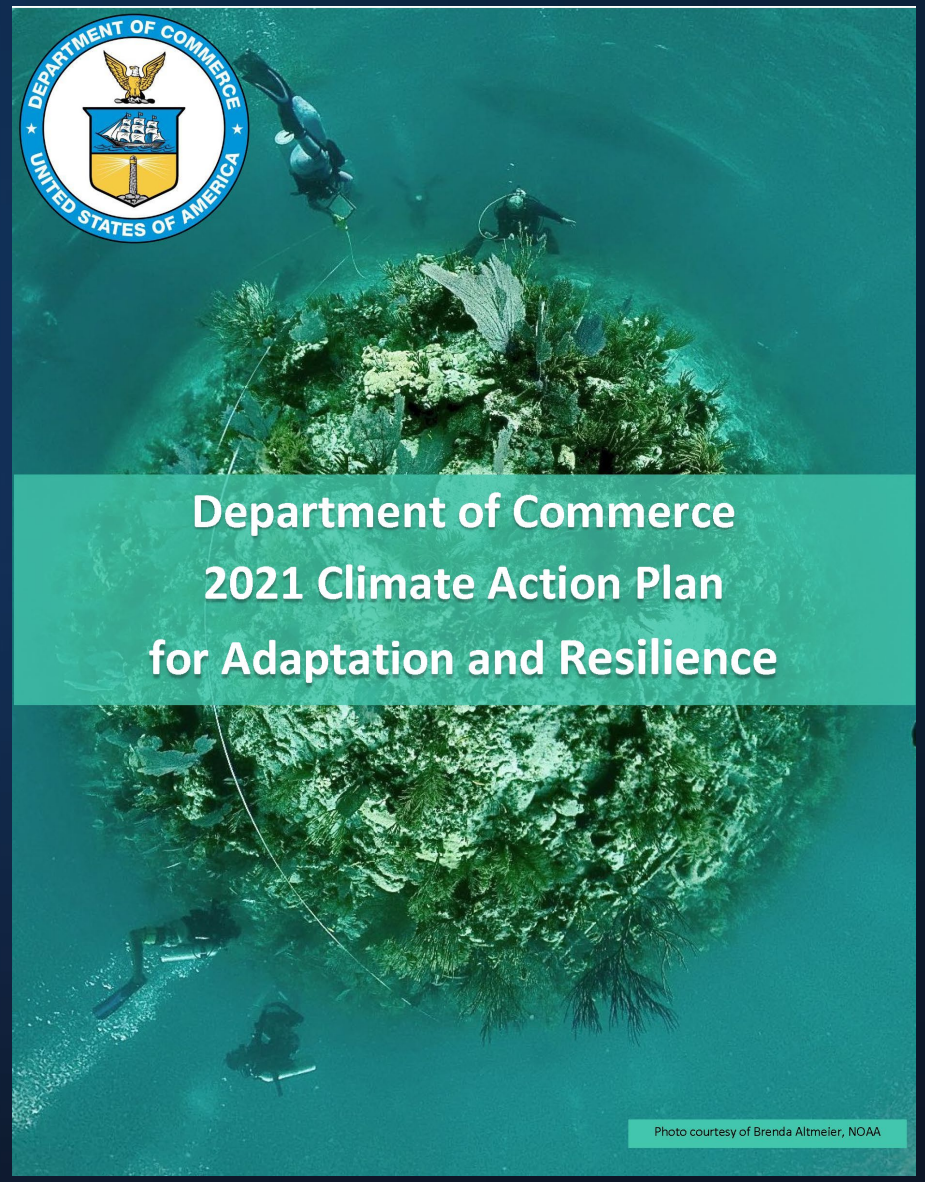
Earth Radiation Budget

55 Essential Climate Variables

Credit: World Meteorological Association (WMO), https://gcos.wmo.int/en/global-climate-indicators

Policymakers depend upon "reliable and timely climate information" to make critical decisions, balance economic risk and opportunity, and support growth in a substantial portion of the US gross domestic product.

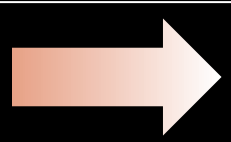
[DOC Climate Action Plan for Adaptation and Resilience 2021]

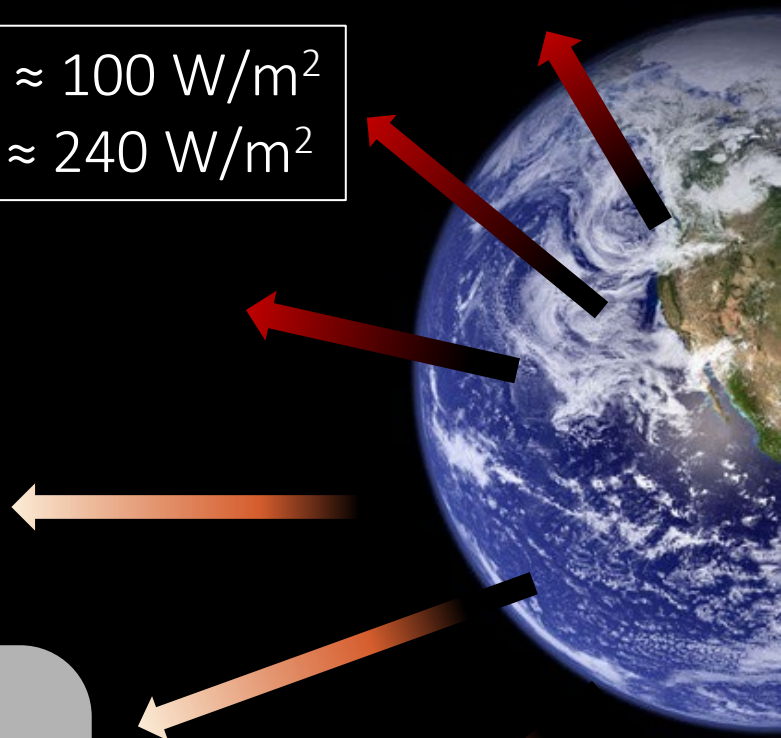


https://www.sustainability.gov/pdfs/doc-2021-cap.pdf

Earth Radiation Budget (Earth Energy Imbalance)

Total Solar Irradiance (TSI) ≈ 1360 W/m^2
Incoming Solar Irradiance = TSI/4 ≈ 340 W/m^2





Shortwave$_{outgoing}$ ≈ 100 W/m^2
Longwave$_{outgoing}$ ≈ 240 W/m^2

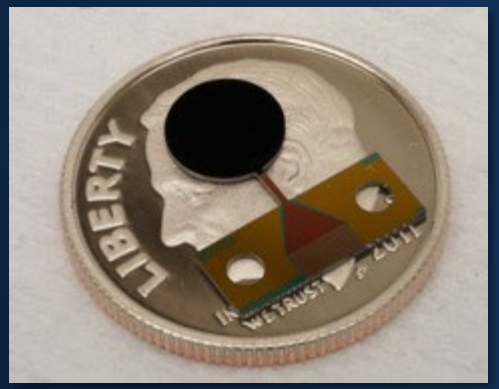
Earth Energy Imbalance (EEI)
EEI = TSI/4 – (SW+LW)$_{outgoing}$

From 2006 to 2020, EEI increased at a rate of
0.76 ± 0.20 W/m^2.*

*von Schuckmann, K. et al, Earth Syst. Sci. Data 15, 1675-1709, https://doi.org/10.5194/essd-15-1675-2023 , 2023

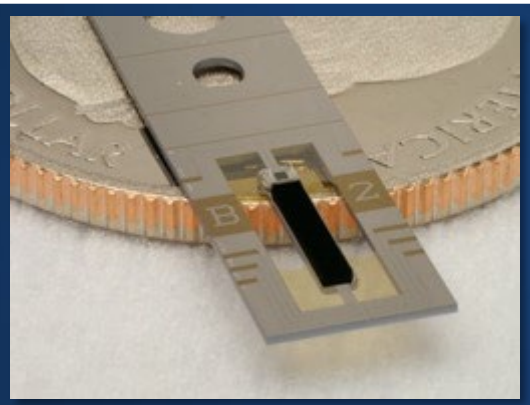
Microfabricated Broadband Radiometers

2017 → 2024



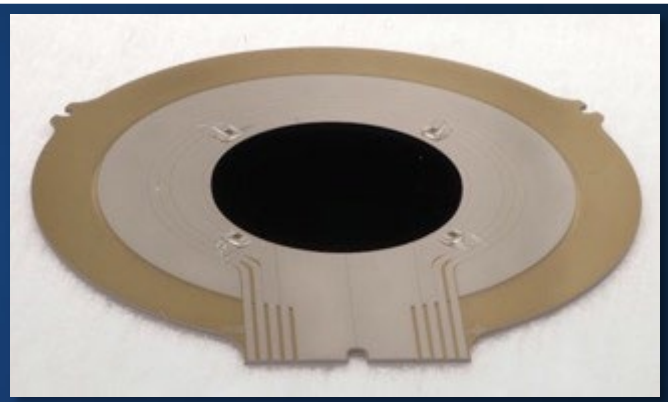
Credit: Nathan Tomlin, NIST

cryogenic fiber optic radiometer (NIST-on-a-CHIP)



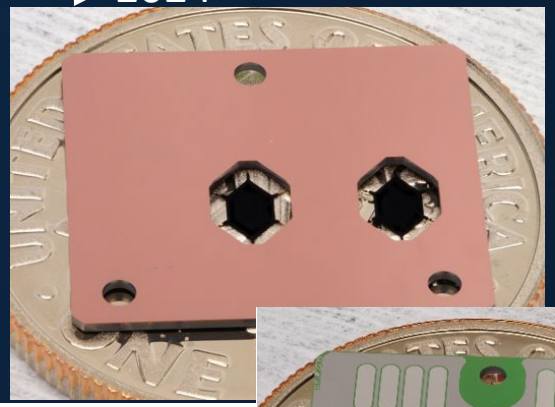
Credit: Nathan Tomlin, NIST

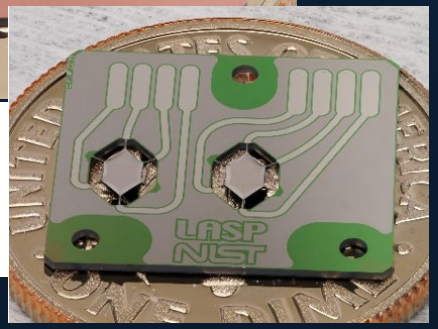
Compact Spectral Irradiance Monitor (Solar) 2019-2022



Credit: Nathan Tomlin, NIST

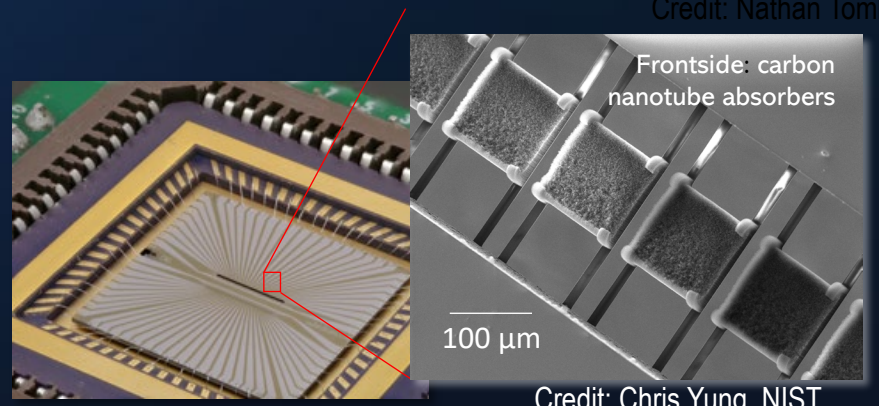
Compact Total Irradiance Monitor (Solar), 2022 - 2023





Credit: Nathan Tomlin, NIST

Libera (Earth Radiance) 2027 launch



Credit: Chris Yung, NIST

Microbolometer Array for Far-Infrared Imaging (Earth Cloud Radiance)

NASA

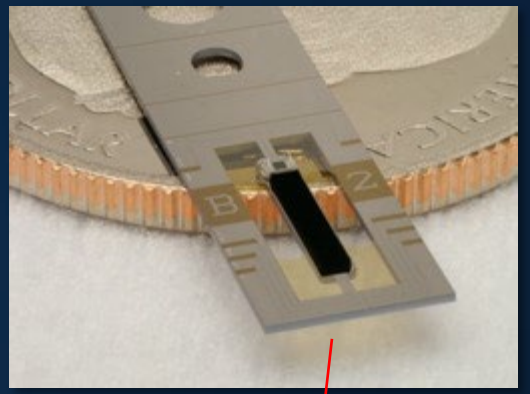
LASP
Laboratory for Atmospheric and Space Physics
University of Colorado Boulder

The TSIS-1 Hybrid Solar Reference Spectrum

O. M. Coddington[1], E. C. Richard[1], D. Harber[1], P. Pilewskie[1,2], T. N. Woods[1], K. Chance[3], X. Liu[3], and K. Sun[4,5]

[1]Laboratory for Atmospheric and Space Physics, University of Colorado Boulder, Boulder, CO, USA, [2]Department for Atmospheric and Oceanic Science, University of Colorado Boulder, Boulder, CO, USA, [3]Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, USA, [4]Department of Civil, Structural and Environmental Engineering, University at Buffalo, Buffalo, NY, USA, [5]Research and Education in ENergy, Environment and Water (RENEW) Institute, University at Buffalo, Buffalo, NY, USA

Abstract We present a new solar irradiance reference spectrum representative of solar minimum conditions between solar cycles 24 and 25. The Total and Spectral Solar Irradiance Sensor-1 (TSIS-1) Hybrid Solar Reference Spectrum (HSRS) is developed by applying a modified spectral ratio method to normalize very high spectral resolution solar line data to the absolute irradiance scale of the TSIS-1 Spectral Irradiance Monitor (SIM) and the CubeSat Compact SIM (CSIM). The high spectral resolution solar line data are the Air Force Geophysical Laboratory ultraviolet solar irradiance balloon observations, the ground-based Quality Assurance of Spectral Ultraviolet Measurements In Europe Fourier transform spectrometer solar irradiance observations, the Kitt Peak National Observatory solar transmittance atlas, and the semi-emp
at 0.01 to ~0.001
wavelengths outs



HOME | CU CAREERS | NEWS | LASP'S HYBRID SOLAR REFERENCE SPECTRUM NAMED NEW INTERNATIONAL STANDARD FOR CLIMATE RESEARCH

April 27, 2022

LASP's Hybrid Solar Reference Spectrum named new international standard for climate research

https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2020GL091709

https://lasp.colorado.edu/2022/04/20/lasps-hybrid-solar-reference-spectrum-named-new-international-standard-for-climate-research/

SI-traceability for Global Climate Metrology

2009 → 2023

Comparison of the Total Solar Irradiance Radiometer Facility Cryogenic Radiometer against the NIST Primary Optical Watt Radiometer
CalCon 2009

https://www.nist.gov/programs-projects/primary-optical-watt-radiometer-powr

NIST Primary optical watt radiometer (POWR)

OPEN ACCESS
IOP Publishing | Bureau International des Poids et Mesures
Metrologia
Metrologia 59 (2022) 065006 (19pp)
https://doi.org/10.1088/1681-7575/ac89f5

Decadal validation of the LASP TRF cryogenic radiometer by NIST, and establishment of a replacement room temperature standard*

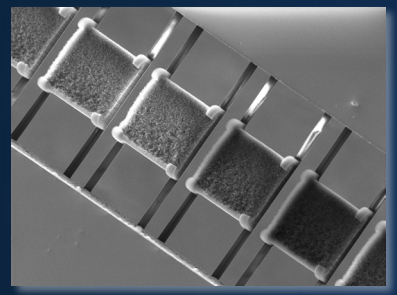
M G White[1,2,**], K Heuerman[3], P S Shaw[4], M S Stephens[2], N A Tomlin[2], C Yung[2], J H Lehman[2], J Rice[4], J Rutkowski[3], C Straatsma[3], P Pilewskie[3], E Richard[3] and D Harber[3]

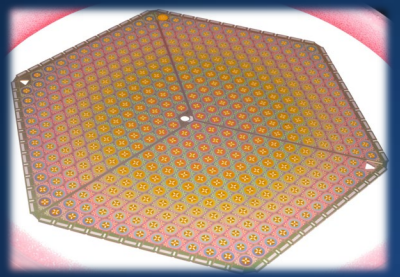
[1] Department of Physics, University of Colorado, Boulder, CO 80309, United States of America
[2] National Institute of Standards and Technology, Boulder, CO 80305 United States of America
[3] Laboratory for Atmospheric and Space Physics, Boulder, CO 80303 United States of America
[4] National Institute of Standards and Technology, Gaithersburg, MD 20899, United States of America

"We present the results of a recent, extensive measurement campaign validating the traceability of the solar irradiance record and Earth radiation budget data. The campaign also established future traceability, thus ensuring confidence in the continuing climate-data record..."

Far-infrared Virtually Imaged Radiometry for (FIRVIR) Climate Metrology

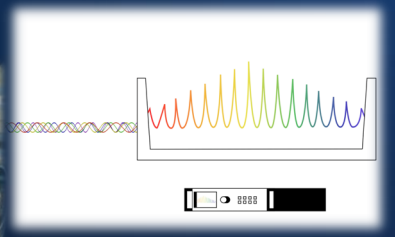
2024 → 2029



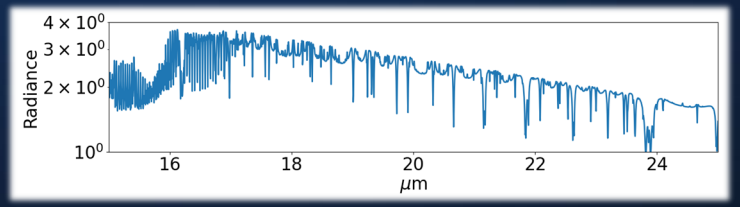


NIST FIR detector and 2-D array technology

A laboratory basis for SI traceability in Far-Infrared (FIR) irradiance, enabled by a new tool kit for FIR spectroscopy and radiometry.



NIST SI-traceable blackbody and frequency comb expertise



NIST IR spectroscopy expertise