Weekly Report – December 20, 2024

Cooperative Institute for Satellite Earth System Studies (CISESS)

NOAA/NESDIS/STAR

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HIGHLIGHTS FOR NESDIS LEADERSHIP

Use-Inspired Science

Methane Retrievals from the JPSS Series VIIRS

NOAA is currently in the process of implementing work highlighted in the United States Greenhouse Gas Measurement, Monitoring, and Information System (US GHGMIS) strategy and developing operational methane-monitoring capabilities. CISESS Scientist Yeseul Cho and colleagues have been developing methane retrievals from the Visible Infrared Imaging Radiometer Suite (VIIRS) flying on Suomi National Polar-orbiting Partnership and Joint Polar Satellite System series satellites in alignment with NOAA's multi-agency US GHGMIS strategy. Recent efforts have focused on implementing the multi-band–multi-pass retrieval method, which calculates methane enhancements using reflectance differences in the M10 and M11 bands (i.e., shortwave infrared wavelengths 1.6 µm and 2.25 µm).

Coordinated control release experiments are being conducted to evaluate the accuracy of their satellite-based methane retrievals. In partnership with the Pipeline Research Council International, on 8 October 2024, a pipeline blowdown was conducted, releasing approximately 536 tons of methane with a mean release rate of eighty-nine tons per hour at each location in the experiment domain. Around 83% of the methane was emitted within the first hour, and the emission rate decreased exponentially afterward. The figure below shows the methane enhancement signal detected by VIIRS on that day at 19:27 UTC. The red boxes highlight areas of significant methane enhancement. Cho and colleagues are in the process of extracting the plume from background noise and quantifying the release rate through comparisons with the reference value. For the first time, they demonstrated VIIRS's capability to provide high-resolution methane retrievals that complement partner agency global monitoring data.

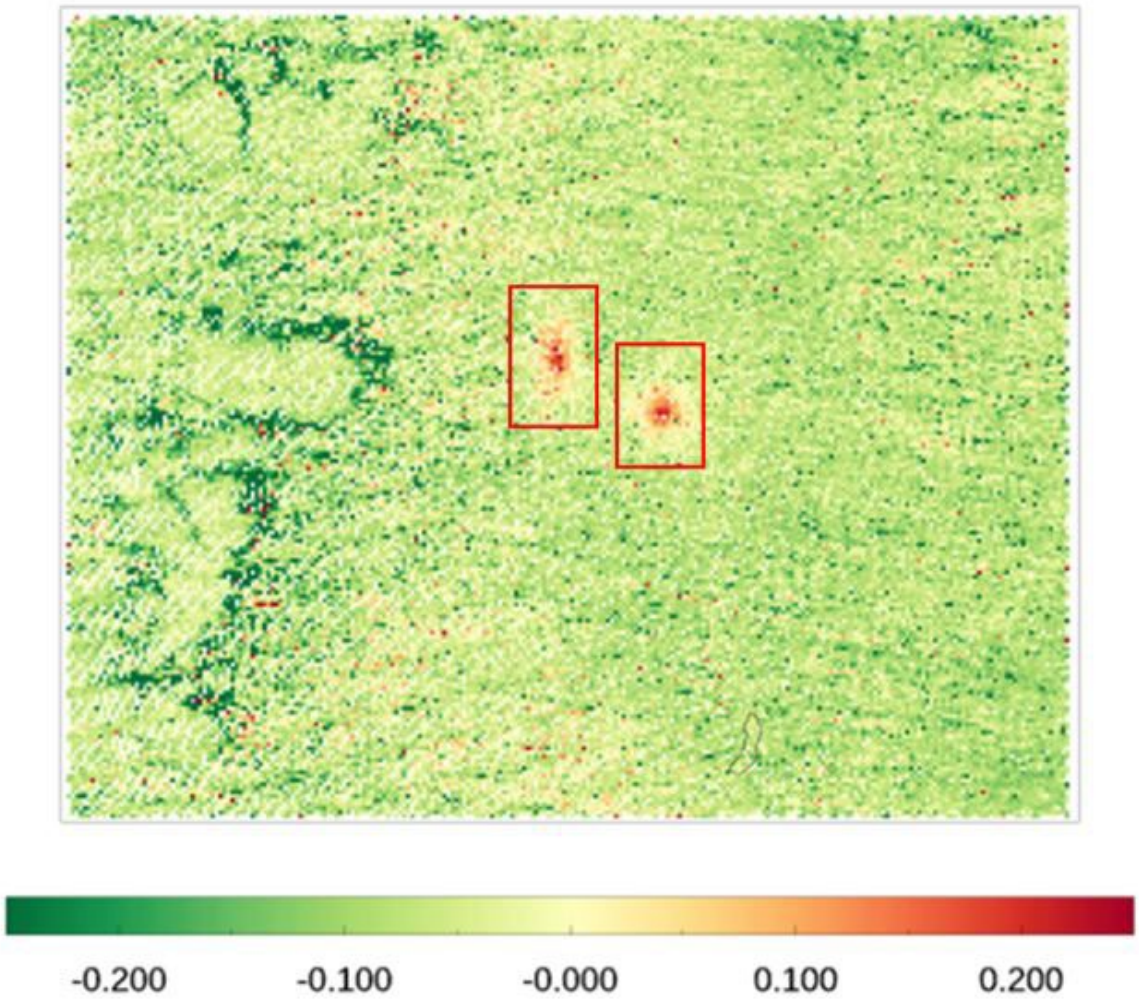


Figure. VIIRS methane enhancement signal (unit: mol/m^2) detected on 8 October 2024 at 19:27 UTC.

(Yeseul Cho, CISESS, yscho@umd.edu; Funding: JPSS PGRR)

TRAVEL AND MEETING REPORTS

CISESS Scientists a Strong Presence at the AGU24 Annual Meeting

The American Geophysical Union's annual meeting took place during the week of December 9 in Washington DC, bringing together Earth and space scientists from around the world. Twenty-nine CISESS Scientists plus a handful of their student research assistants gave talks and presented posters on topics such as using machine learning to retrieve precipitation from satellite sensors, developing a wildfire-centric lightning climatology, and expanding flood

mapping to obscured areas, to name a few. For the students, this was a terrific opportunity to meet and mingle with others in their field, as well as present their interesting findings.

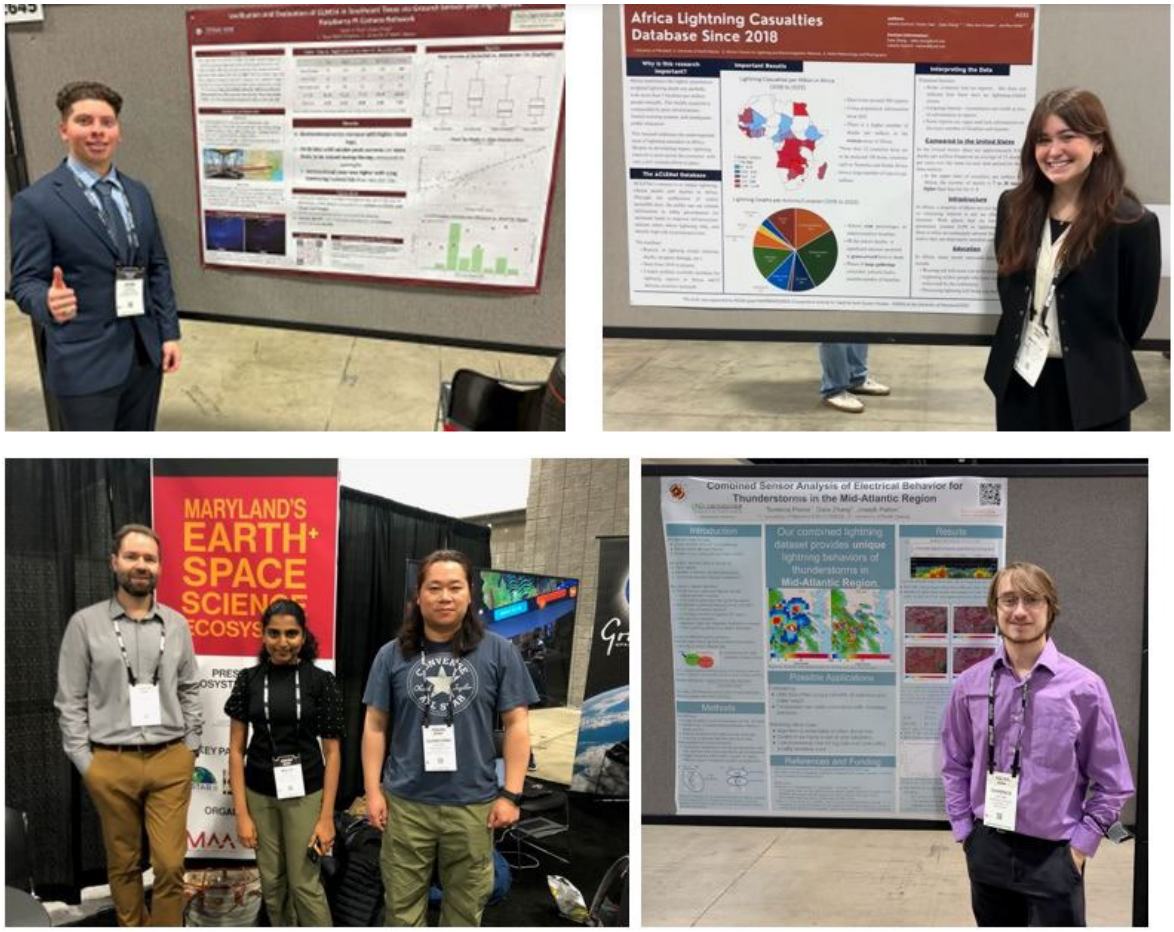


Figure. (Three photos, clockwise from top left) Students Adam Clark, Isabella Stanford, and Terrence Pierce, supervised by Dr. Daile Zhang (now at the University of North Dakota) proudly presenting their research on various aspects of lightning at the AGU24 Annual Meeting. (bottom left) CISESS Scientists Veljko Petkovic, Malarvizhi Arulraj, and Guangyang Fang.

Examples of CISESS's participation at AGU24 include:

- ***Guangyang Fang and His Team Wow the Crowd With Immersive Geoscience Education***

CISESS Scientist Guangyang Fang and his undergraduate research assistants Damian Figueroa and Samuel Wiggins and high school research assistant Mark Rosenbaum highlighted their work conducted at CISESS's Proving Ground and Training Center, featuring an innovative virtual- and mixed-reality application designed for engaging geoscience education. Through interactive educational modules, 3D models of equipment and landmarks, and immersive gameplay, users

explored topics like the Earth's water cycle, lightning and cloud types, and the Faraday cage effect on lightning safety. Combining a museum-like environment with gamified learning, this experience fostered curiosity and deeper understanding of geoscience concepts in a dynamic virtual setting.

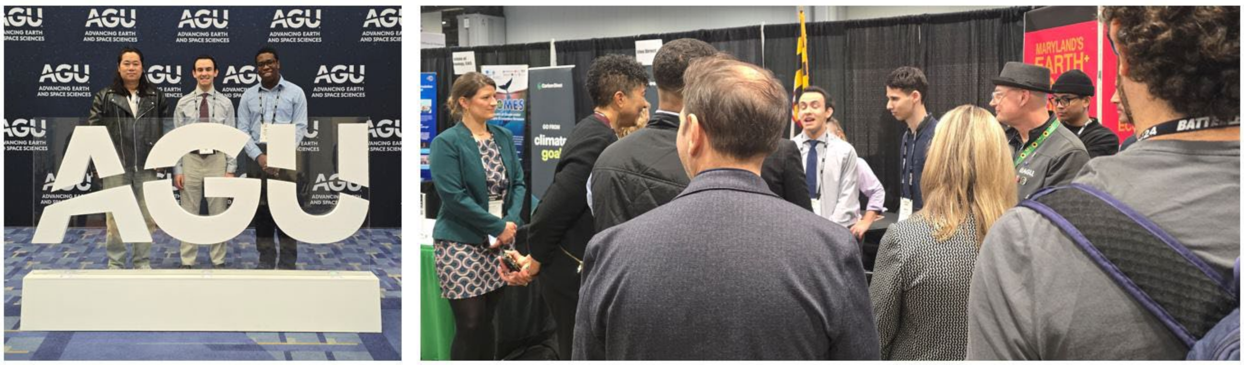


Figure. (left) From left to right, Guangyang Fang, Damian Figueroa, and Samuel Wiggins. (right) Damian Figuero chatting with the audience at the CISESS exhibit booth at AGU24.

(Guangyang Fang, CISESS, gfang@umd.edu; Funding: GOES-R AWG, GOES-R PGRR)

- ***Javier Villegas Bravo and His Student Give a Talk on Wildfire Burned Area Detection***

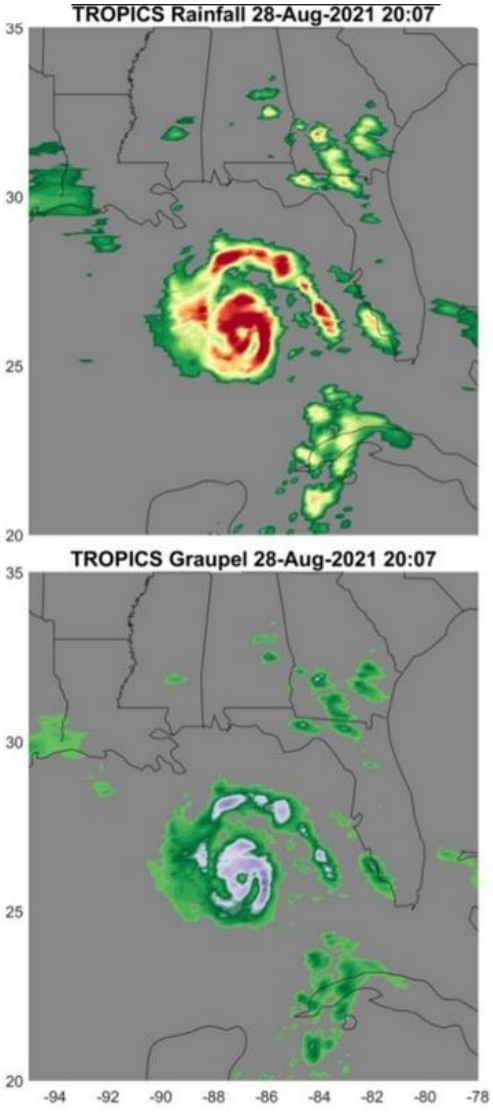
CISESS Scientist Javier Villegas Bravo and his student, Ainsley Giles, an undergraduate student at the University of Maryland's Department of Atmospheric and Oceanic Science, co-presented on their project to classify burned areas from passive satellite imagers. They showed two masks, including a U-Net convolutional neural network, to produce daily updated cloud-free composites of burned areas from the NOAA-20 Visible Infrared Imaging Radiometer Suite. This work will help the NOAA Weather Prediction Center issue flash flood warnings and help other agencies and the public track burned areas for land management and fire-fighting applications.

(Javier Villegas Bravo, CISESS, vllgsbr2@umd.edu; Funding: GOES-R PGRR)

PUBLICATIONS

High-resolution Rainfall and Graupel Retrievals

Citation: Yang, John Xun, **Yong-Keun Lee**, Shuyan Liu**, Christopher Grassotti**, Mark Quanhua Liu, William Blackwell, Robert Vincent Leslie, Tom Greenwald, Ralf Bennartz, and Scott Braun, 2024: Evaluating rainfall and graupel retrieval performance of the NASA TROPICS pathfinder through the NOAA MiRS system. Remote Sens. Environ., 318, 114570, https://doi.org/10.1016/j.rse.2024.114570.



Summary: CISESS Scientists John Yang, Yong-Keun Lee, and Chris Grassotti, affiliated with the NOAA Microwave Integrated Retrieval System (MiRS) group, are involved with the NASA Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of SmallSats (TROPICS) CubeSat mission and have built an algorithm to retrieve hydrometeors. In their recent paper published in *Remote Sensing of Environment*, they used TROPICS data to retrieve global rainfall and graupel, capturing hurricane structures, including hurricane rainbands. The NASA TROPICS mission leverages a constellation of CubeSats with advanced microwave radiometers, introducing novel frequencies at 118 GHz and 205 GHz to study tropical meteorology, precipitation, and storm dynamics. Enhanced through the NOAA MiRS, TROPICS data offers new insights into rainfall and graupel retrievals, highlighting a strong ability to capture hurricane structures, such as the eyewall replacement cycle of Super Typhoon Mindulle (2021) and Hurricane Ida (2021) rainbands, as well as global precipitation. Comparative analyses revealed that both TROPICS and conventional sensors like the Advanced Technology Microwave Sounder are sensitive to precipitation features. The high-frequency channels of TROPICS demonstrated a pronounced sensitivity to hydrometeors, offering a finer resolution than lower-frequency counterparts. Preliminary findings affirm TROPICS' potential for robust precipitation retrievals,

Figure. MiRS-TROPICS-retrieved rainfall and graupel of Hurricane Ida on 28 August 2021. The hurricane eye and rainbands are clearly seen.

comparable to established sensors, with further enhancements expected through continued MiRS tuning. Future work will integrate ground-based observations and expand datasets, enhancing weather and environmental applications.

(John Xun Yang, CISESS, jxyang@umd.edu; Funding: JPPSS PGRR, JSTAR; Yong-Keun Lee, CISESS, yong-keun.lee@noaa.gov; Funding: JPPSS PGRR, JSTAR, LEO; Christopher Grassotti, CISESS, christopher.grassotti@noaa.gov; Funding: JPPSS PGRR, JSTAR, LEO)

(Maureen Cribb, CISESS, mcribb@umd.edu, Funding: CISESS Task I)