Weekly Report – May 31, 2024
Cooperative Institute for Satellite Earth System Studies (CISESS)
NOAA/NESDIS/STAR

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HIGHLIGHTS FOR NESDIS LEADERSHIP

Use-Inspired Science

Continued Development of a New Maximum Monthly Mean Climatology and Degree Heating Week Product

CISESS Scientist William Skirving and colleagues at the NOAA Coral Reef Watch (CRW) continue researching an appropriate methodology to derive a prototype v4.0 Maximum Monthly Mean (MMM) and Degree Heating Week (DHW) product, using the prototype v4.0 *CoralTemp* sea surface temperature (SST) dataset. The v4.0 *CoralTemp* SST dataset was previously prototyped, spanning 1981 to the present, to include additional years of available satellite data and to correct for a cool bias identified in the early years of CRW's operational v3.1 *CoralTemp* SST dataset. Each methodology tested produced different MMM and DHW values. These were compared with CRW's in-situ global coral bleaching dataset and operational daily global 5-km satellite DHW product. Also compared were various DHW thresholds to CRW's in-situ global bleaching dataset by applying the Pierce skill score and a Bayesian method for measuring skill to evaluate false positives, false negatives, true positives, and true negatives. These methods did not work well because they require fairly even amounts of data for each state, which typically do not exist during a coral bleaching event. So, with input from multiple weather forecasters, two more simplistic methodologies were developed: Method A identified the percentage of prototype satellite-based v4.0 DHW measurements (spanning 1981-present) that matched in-situ observations, regardless of coral bleaching state; Method B (an example analysis is displayed below) counted v4.0 DHW measurements that matched in-situ coral bleaching observations. As the fourth global coral bleaching event on record continues, Skirving and colleagues continue researching the highest accuracy and highest-performing satellite-based products to address the needs of its extensive and diverse user community worldwide.

Year	Accuracy
2016	93%
2017	95%
2020	79%
2022	91%

Figure: Example methodology (Method B) comparing the v3.1 DHW threshold of 4 (risk of reef-wide bleaching) with aerial observations of coral bleaching on the Great Barrier Reef (Australia) in 2016, 2017, 2020, and 2022. Aerial observations provided data for between 645 and 1,134 reefs, depending on the year.

(William Skirving, CISESS, william.skirving@noaa.gov; Funding: NOS)
This item (in its original form, lightly edited here) was submitted in the SOCD Weekly Report.

TRAINING AND EDUCATION

CISESS Scientist Participates in the National Weather Service Hazardous Weather Testbed Spring Experiment

CISESS Scientist Joseph Patton traveled to Norman, Oklahoma to observe and help with one of the week-long (20–24 May 2024) Hazardous Weather Testbed (HWT) sessions exploring experimental products with National Weather Service (NWS) forecasters. Among the group were four forecasters from various areas of the United States, from Tucson, Arizona to Burlington, Vermont and between. In addition, several developers of the new products being tested were in attendance. This spring, the HWT was testing two new products related to the Geostationary Lightning Mapper (GLM), a space-based instrument used to observe lightning onboard the GOES-R series of weather satellites. These new products are the grayscale background imagery, which GLM takes every two and a half minutes to compare against bright flashes of light it determines to be lightning, and the GLM data quality product, which determines a likely detection efficiency of the instrument at each pixel based on a lightning climatology from the Tropical Rainfall Measuring Mission/International Space Station – Lightning Imaging Sensor in low-earth orbit. The data quality product also includes different colors for flags of pixels, which may not be showing accurate lightning information for a variety of reasons.

The bulk of Patton's work involves creating training for and introducing forecasters to GLM lightning observations, helping them incorporate space-based lightning information into their warning decision-making processes. As part of participating in this HWT session, he offered guidance as a subject matter expert on GLM lightning observations and listened to forecaster feedback concerning the two new GLM products. The information and experiences learned from this HWT session will help Patton create better training modules for forecasters from the NWS and across other weather agencies so that they can more effectively incorporate GLM lightning information into their forecasts and decisions.

Figure: (Foreground) HWT organizer Kevin Thiel discusses new satellite products with NWS forecasters. (Background) Joseph Patton (UMD/ESSIC/CISESS) discusses GLM intricacies with developer Dr. Eric Bruning (Texas Tech). Photo credit: Dan Lindsey (NOAA/NESDIS)

(Joseph Patton, CISESS, jpatton4@umd.edu; Funding: GOES-R AWG, GOES-R PGRR)

PUBLICATIONS

Using Machine Learning to Improve Microwave-Based Precipitation Estimates
Citation: Liu, Shuyan, **Christopher Grassotti**, and **Quanhua Liu** (2024): Warm-season Microwave Integrated Retrieval System (MiRS) precipitation improvement using machine learning methods. *IEEE J. Sel. Top. Appl. Earth Obs. Remote Sens.*, early access publication, doi: 10.1109/JSTARS.2024.3405651.
Summary: CISESS Scientist Christopher Grassotti and NOAA Scientist Quanhua (Mark) Liu, along with their colleague at the Cooperative Institute for Research in the Atmosphere, recently published a paper in the *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*. The study compared the performance of five selected machine-learning models regarding precipitation climatology during the warm season in 2022 and 2023 over the

Continental U.S. Input features included retrieved products from the Microwave Integrated Retrieval System (MiRS) based on NOAA-20 Advanced Technology Microwave Sounder data. Among the models, three used a U-Net architecture, and two used a Deep Neural Network (DNN) architecture. The U-Net models all significantly outperformed the DNN models for the evaluated metrics. While the DNN architecture can only learn from local inputs, the U-Net also has the capability to learn from neighborhood spatial patterns. As such, the DNN overcorrected the precipitation amounts that MiRS had overestimated, leading to net underestimation, but also failed to improve the overall performance relative to the original MiRS estimates. The U-Net not only corrected MiRS overestimation in the central U.S. but also improved the MiRS dry bias over the Southeast. Of the five experiments, that which used the MiRS-retrieved column-integrated hydrometeors of graupel water path, rain water path, cloud liquid water, total precipitable water, and geolocation information demonstrated the best performance, improving the MiRS spatial correlation coefficient from 0.75 to 0.89 and reducing the mean bias percentage from 11.95% to -6.33% for 2022 accumulated precipitation. This suggests that applying an appropriate architecture and appropriate input features provides an opportunity to determine more accurate physical and statistical relationships, which can include spatial and regional dependence, leading to improved microwave-based precipitation estimates.

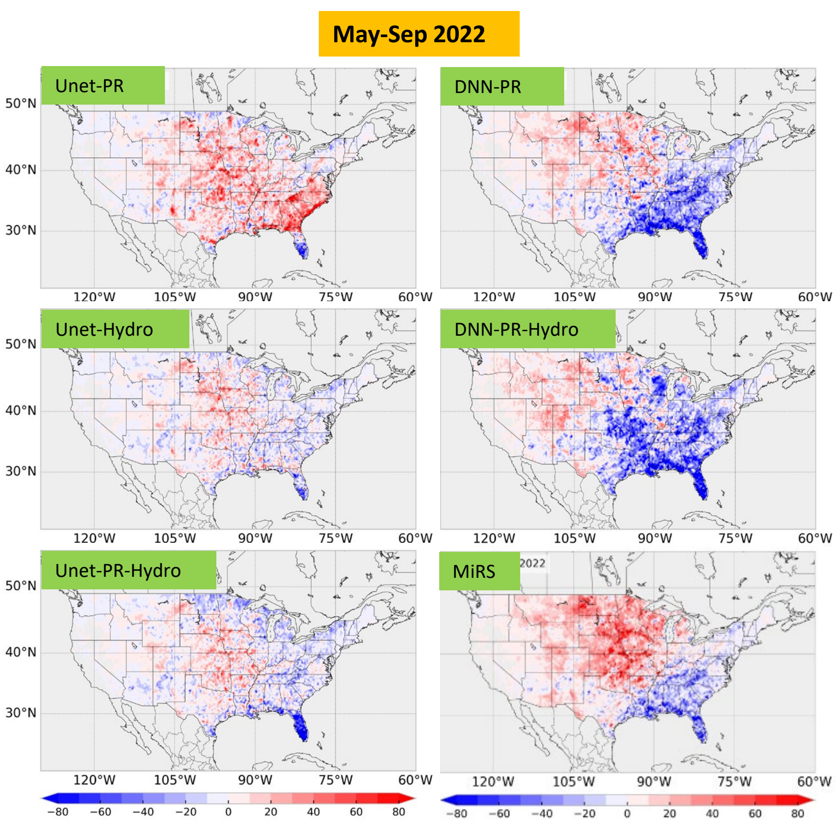

Figure: Biases of accumulated precipitation (mm) relative to the Multi-Radar/Multi-Sensor system ground-based analysis of the five machine-learning models studied during the period of

1 May to 30 September 2022. Biases of the operational MiRS algorithm are also shown in the bottom right panel.

(Christopher Grassotti, CISESS, christopher.grassotti@noaa.gov; Funding: DACS, JPSS PGRR, JSTAR, METOP-SG)

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