NCICS Highlights

North Carolina Institute for Climate Studies
Inspire. Advance. Engage.

2019–2020

2019–2020 Institute Highlights

Formally approved as an inter-institutional research institute by the University of North Carolina General Administration in January 2011, the North Carolina Institute for Climate Studies (NCICS) is a unique center of excellence showcasing a partnership between universities, the private sector, nonprofit organizations, community groups, and the federal government.

NCICS's primary activity continues to be the operation of the North Carolina location of a National Oceanic and Atmospheric Administration (NOAA) Cooperative Institute. NCICS's mission is facilitated by its co-location with our primary NOAA sponsor, the National Centers for Environmental Information (NCEI), in the Veach-Baley Federal Complex in Asheville, North Carolina.

Institute Vision

- ***Inspire*** cutting-edge research and collaboration
- ***Advance*** understanding of the current and future state of the climate
- ***Engage*** with business, academia, government, and the public to enhance decision-making

Major Accomplishments

Since July 1, 2019, NCICS

- began operating the North Carolina location of NOAA's new Cooperative Institute for Satellite Earth System Studies in partnership with the University of Maryland;
- developed and released a comprehensive climate science report for the state of North Carolina;
- expanded public access to NOAA data in the cloud through the Big Data Project;
- contributed to the development of new climate normals that account for the influences of climate change and El Niño–Southern Oscillation effects, plus a suite of normals for the U.S. Atlantic Coast;
- advanced multiple research and public health efforts in response to the COVID-19 pandemic;
- engaged in research to improve drought monitoring and early warning;
- helped plan and host the 2019 NCEI Users' Conference;
- contributed to major upgrades to NCEI's Optimum Interpolation Sea Surface Temperature and NOAAGlobalTemp datasets;
- continued to enhance NCEI's U.S. Climate Reference Network;
- employed machine learning techniques in a variety of applications, including detecting weather fronts in model data and generating temperature and humidity profiles from satellite observations;
- expanded research at the nexus of climate and health, including the initiation of a new partnership with the Centers for Disease Control and Prevention and studies of extreme heat events; and
- finalized a book chapter on satellite precipitation measurements and extreme rainfall.

From CICS to CISESS

In partnership with the University of Maryland, NCICS hosted the North Carolina location of the NOAA Cooperative Institute for Climate and Satellites (CICS) from 2009 through 2019. In July 2019, CICS was superseded by the new Cooperative Institute for Satellite Earth System Studies (CISESS), with NCICS again serving as the North Carolina host.

The transition from CICS to CISESS required extensive collaboration with our partners at NCEI, other NOAA offices, and the rest of the CISESS Consortium to identify and organize more than 30 new and continuing projects. The Institute also hired several new scientists to support an expanding mission.

CISESS's primary objective is to document the natural atmosphere–ocean–land–biosphere components of the Earth system and how they interact with human activities as a coupled system and to transition these research results into operational applications that produce societal benefits.

COVID-19 Challenges and Responses

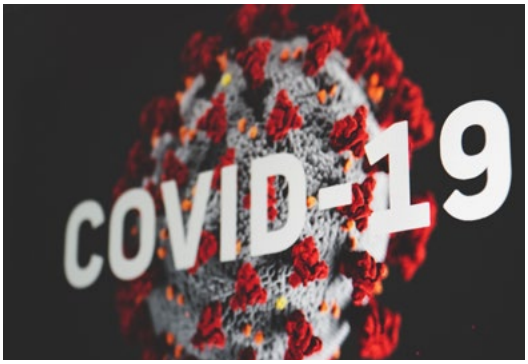


Image by CDC and Martin Sanchez/Unsplash

In mid-March 2020, NCICS transitioned to full-time teleworking as a result of the COVID-19 pandemic. This unexpected change posed a variety of challenges, but Institute staff continued to make significant progress in all research and project tasks.

A well-established team culture and the Institute's robust IT and communications infrastructure helped minimize disruptions. NCICS staff also continue to collaborate with colleagues from NOAA NCEI and other partner organizations, most of whom have also been teleworking since March.

Soon after the emergence of the SARS-CoV-2 virus as a major public health threat, a team of researchers from NCICS and Appalachian State with combined experience in climate and weather data, epidemiology, bioengineering, statistics, and other fields began investigating whether factors such as temperature, humidity, and solar radiation might influence the spread of the COVID-19 cases. Results published in June identified a significant relationship between COVID-19 transmission and humidity in three of eight U.S. cities studied. https://bit.ly/3dh0n2L

Two NCICS scientists—Garrett Graham and Jennifer Runkle—are serving on the scientific advisory committee for the Buncombe County (NC) Department of Health and Human Services' Epidemiology Team. Dr. Graham is spearheading efforts to set up a regional public health COVID-19 testing lab to monitor municipal wastewater for population-wide viral loads.

Dr. Runkle worked with Buncombe County to develop a symptom "self-checker" for county residents, which is designed to help residents assess potential symptoms and make decisions about seeking medical care and to provide county public health experts with better information about the spread of the virus. The tool was made available to the public at the end of April and has already received significant participation, resulting in many referrals to 911 for emergency care for those with severe symptoms and advice to seek COVID-19 testing and medical advice for those with less severe symptoms. See https://ncics.org/cics-news/developing-a-covid-19-self-checker-for-buncombe-county-north-carolina/ for more information.

Dr. Runkle also led a NOAA-wide effort to assemble a new web-based directory of environmental datasets relevant to studying influences of climate and weather factors on COVID-19 and other infectious diseases. https://www.climate.gov/covid

Administration

Institute Information Technology Support Services

NCICS's IT team implemented security and monitoring improvements and network upgrades and transitioned data storage from Gluster to Ceph. The Ceph file systems are faster and more stable, and the Ceph infrastructure allows NCICS researchers to move their code from file systems to on-premises object stores in preparation for cloud deployment.

Institute Communications

External communications this year focused on the transition to CISESS from the predecessor cooperative institute and included updates to the website and social media accounts. In addition, a new partnership with Blue Ridge Public Radio resulted in a series of radio and web stories on climate change and related topics featuring interviews with NCICS and NCEI staff. NCICS also organized a remote media availability event for the release of the North Carolina Climate Science Report.

Access and Services Development

NOAA Big Data Project Support

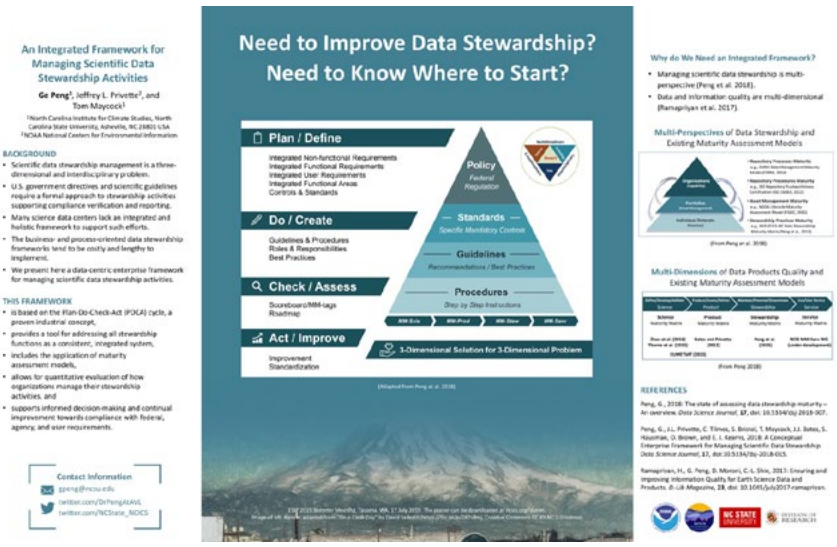
This year, the Big Data Project project team used the NCICS-designed data hub/broker architecture to move additional datasets to the cloud and backfill High-Resolution Rapid Refresh and GOES data from archive sources. Datasets added to the cloud include the Automated Surface Observing System, the Integrated Surface Database, and Global Surface Hourly data; Global Hydro-Estimator, fire/hotspot data; and almost every other Level 2 product for GOES-16 and GOES-17, including the ABI, GLM, and SUVI instruments. https://ncics.org/data/noaa-big-data-project/

Development and Support of NOAA Climate Products and Services

The University of North Carolina Asheville's National Environmental Modeling and Analysis Center (NEMAC), a CISESS Consortium partner, supports NOAA's suite of climate services tools. Key accomplishments included support for climate.gov; development, user testing, and release of version 3.0 of the Climate Explorer; and ongoing work on the U.S. Climate Resilience Toolkit. NEMAC also developed a prototype data visualization sandbox for authors of the upcoming Fifth National Climate Assessment and updated graphics for multiple U.S. Global Change Research Program (USGCRP) climate indicators. Contributions to the North Carolina state climate assessment summary report included developing an all-hazard and resilience database and co-facilitating six workshops.

Scientific Data Stewardship for Digital Environmental Data Products

The project team published a peer-reviewed paper describing the application of the Data Stewardship Maturity Matrix to NOAA's OneStop project and gave multiple presentations at national and international conferences. The manual for the World Meteorological Organization's High Quality Global Data Management Framework for Climate was adopted by the Eighteenth World Meteorological Congress and published.



This poster describes an integrated framework for managing scientific data stewardship activities. It was presented at the 2019 ESIP summer meeting. https://doi.org/10.6084/m9.figshare.9171830

Assessment Activities

The North Carolina Climate Science Report

As part of the response to an executive order from North Carolina Governor Cooper, NCICS led the development of the North Carolina Climate Science Report (NCCSR).

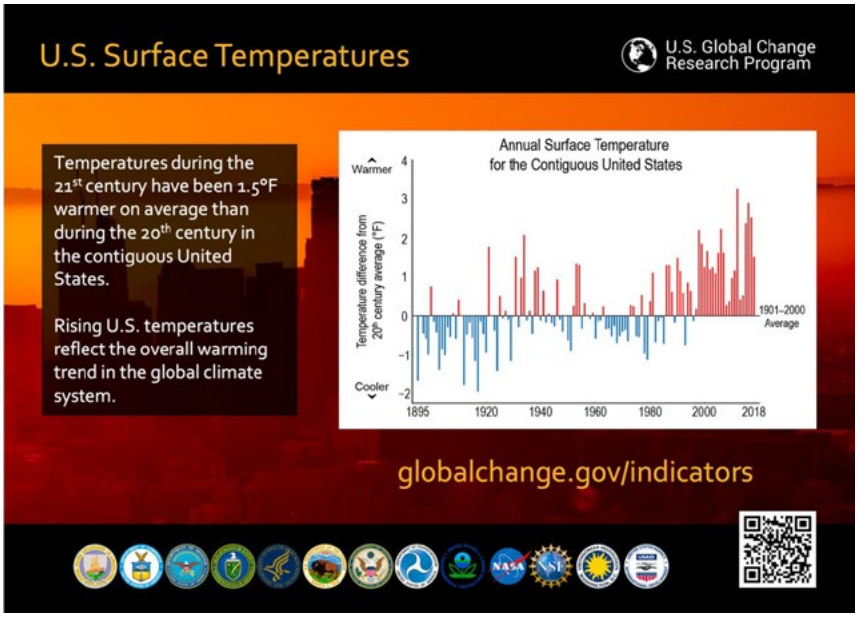
Work began in summer 2019 under the direction of Dr. Kenneth Kunkel. Initial efforts included participating in workshops to assess needs and assembling an author team and an advisory panel comprising NCICS staff and other university and federal research scientists from around the state. NOAA's Assessments Technical Support Unit (TSU), staffed primarily by NCICS, provided significant scientific and technical expertise. Following initial drafting, the report underwent several rounds of review and revision prior to being released on March 11, 2020. It serves as an independent, peer-reviewed scientific contribution to climate change planning efforts at the state level, including the development of a risk assessment and resilience plan. It is also intended to inform the citizens of North Carolina about the state of knowledge on climate change. The report is available at https://ncics.org/programs/nccsr/. Selected examples of media coverage can be found at https://ncics.org/in-the-media/.

National Climate Assessment Activities

The TSU is preparing for the Fifth National Climate Assessment by developing a new online collaboration portal for managing report content, working with NOAA legal advisors and USGCRP to ensure compliance with new federal requirements, and contributing to guidance documents for author teams. The TSU also published updates to the Fourth National Climate Assessment, including alternative text providing descriptions of more than 300 figures for readers who have visual impairments.

Climate Change Indicators

TSU staff provide scientific and technical expertise in support of the USGCRP climate change indicators project. This year, the indicators team completed a comprehensive update of the full indicator suite, planned the development of several new indicators, and worked with NCEI's communications team to publish a web story and social media posts featuring the Heat Waves Indicator (https://www.ncei.noaa.gov/news/ongoing-study-global-change).



One side of the postcard developed for the USGCRP Heat Waves Indicator.

The team also developed postcards for several Indicators as an additional communications tool, and the metadata viewer developed for the National Climate Assessment was incorporated into the Indicators Platform. http://www.globalchange.gov/indicators

U.S.–India Partnership for Climate Resilience (PCR)

NCICS initiated Phase II capacity-building activities for the PCR, working with India-based partner The Energy and Resources Institute (TERI) to co-convene a forestry-related session at TERI's 2020 World Sustainable Development Summit and coordinating a roundtable discussion with India forestry sector stakeholders.

Panelists at the World Sustainable Development Summit participate in a session titled "Forest – A Tool for Adaptation and Mitigation of Climate Change at WSDS 2020."

Information Technology Services

Common Ingest Agile Development Team

The new Common Ingest system at NCEI's Asheville location, which was developed with significant contributions from NCICS software developers, is designed to ingest up to 6.7 terabytes per day of weather and climate data archives—processing more than 150,000 files stored in as many as 13,000 archive information packages. This year, the project team supported the NCEI operations team in completing the migration of datasets from the legacy ingest system, enhancing existing functionality, hardening the system for greater resilience to network errors, and implementing other enhancements to improve operational use.

NCEI Infrastructure Architecture Planning and Implementation

This project team supported the test-tier deployment of Common Data Services, integration with Common Ingest, and the demonstration of its ability to support metadata at NCEI. The team also presented a prototype implementation of NiFi, an open-source, high-performance workflow data processing system; tested scalable cluster processing management via the cloud-ready Argo Workflows tool; and provided training and support to promote adoption of modern tools, including a migration to open-source version control using Git.

Science and Services

Scientific Subject Matter Expertise Support

In support of NCEI's product–portfolio–planning management approach, NCICS staff served as Product Leads for 25 of NCEI's 214 products, Product Area Leads for 3 of 15 product areas, and subject matter experts on six Climate Data Record (CDR) Integrated Product Teams.

Spatial–Temporal Reconstruction of Land Surface Temperature (LST)

Results from a study on the diurnal variation of net surface solar radiation suggest a promising option for filling in spatial and temporal gaps in satellite LST data, even under partially cloud-contaminated conditions. The LST algorithm developed for this project was tested against near-real-time surface solar absorption data from GOES-R, and recent improvements to the algorithm include new constraints for the descending leg of the daily solar cycle based on climatological LST values near sunset.

Transitioning the International Satellite Cloud Climatology Project (ISCCP) Process to NCEI

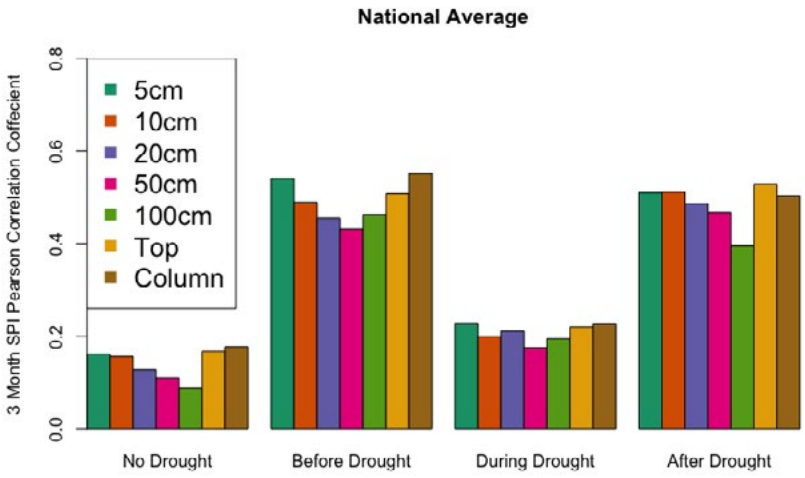
This year, the ISCCP team released an ISCCP H-series cloud product for July 2017 through December 2018 using a climatology derived by applying a neural network algorithm to High-Resolution Infrared Sounder (HIRS) data. More detailed statistics on the impact of using climatological profiles in lieu of the actual profiles have been generated and are provided on the NOAA ISCCP web page (https://www.ncdc.noaa.gov/isccp).

Standardization of U.S. Climate Reference Network (USCRN) Soil Moisture Observations

Research efforts showed that combining USCRN standardized soil moisture conditions with other indicators can provide insight on drought onset and amelioration. Hourly standardized soil moisture observations were also aggregated to provide weekly metrics of soil moisture variability.

Two metrics—the percent of hours below the 30th percentile and anomalous averages—were found to correlate best with U.S. Drought Monitor–based drought evolution, demonstrating that these datasets show some promise as monitoring tools.

https://www.ncei.noaa.gov/news/new-understanding-soil-moisture.



Pearson correlation coefficients between USCRN standardized soil moisture anomalies and the standardized precipitation index (SPI) for months in the categories No Drought, Before Drought (3-month period prior to onset of a drought event), During Drought, and After Drought (3-month period following a drought event).

Drought-Related Health Impacts: Advancing the Science for Public Health Applications

CISESS Consortium partner University of Nebraska Medical Center and the National Integrated Drought Information System conducted two state-level workshops on drought and health and researched the impact of soil moisture and drought on incidences of coccidioidomycosis (Valley fever). They are also evaluating the impact of historical drought events on mortality and morbidity, and preliminary results reflect a greater impact on minority subpopulations.

Strategic Engagement and Outreach

Key accomplishments this year included helping plan and host the 2019 NCEI Users' Conference, improvements to NCEI's use of a customer relationship management tool, multiple engagement activities at the 2020 Annual Meeting of the American Meteorological Society, and new collaborations with the State Climate Office of North Carolina.

NCICS staff also participated in a variety of educational and outreach events in Western North Carolina.

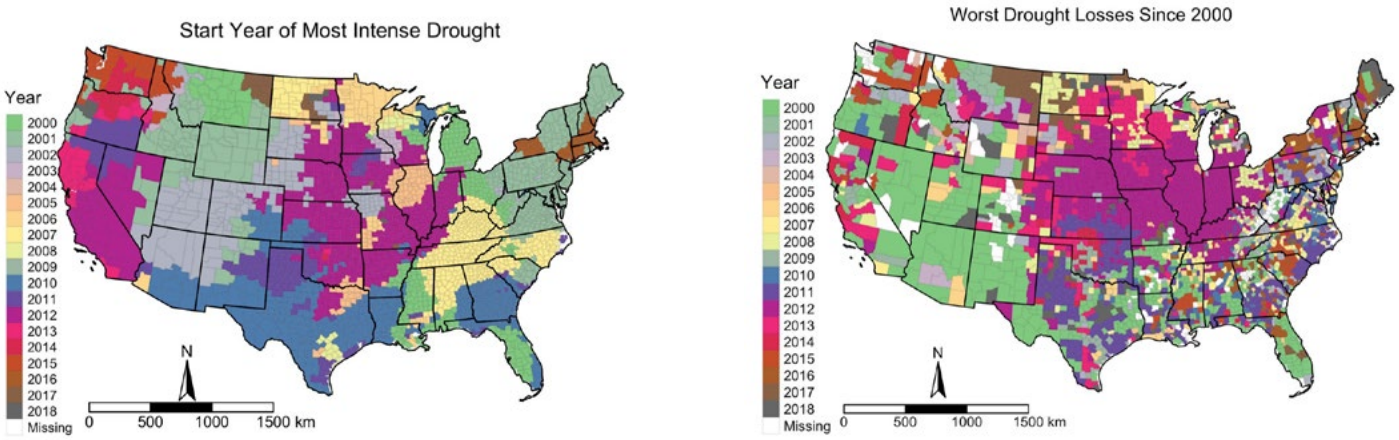
This poster highlighting outcomes from the 2019 NCEI Users' Conference was presented at the 2020 Annual Meeting of the American Meteorological Society.

Optimum Interpolation Sea Surface Temperature (OISST) Algorithm Upgrades

OISST is one of NOAA's oldest continuously offered satellite-based data products, but its quality has degraded in recent years due to a reduction in spatial coverage and an overly large bias correction stemming from improvements in the quality of ship observations. The project team massively increased spatial in situ coverage by switching to a new NCEI database as the source for observations and developed more appropriate bias-correction values for ship observations. OISST version 2.1 became operational in March 2020. https://www.ncei.noaa.gov/news/ncei-improves-analysis-sea-surface-temperatures.

Exploring the Impacts of Drought Events on Society

To facilitate broader explorations of the societal impacts of drought events, data from the U.S. Drought Monitor were intersected with U.S. county data to define unique drought events. Characteristics of these events revealed stark contrasts between the western and eastern United States. Results also showed that county-level economic losses did not always align with measures of drought severity, suggesting that other factors, such as event timing, may influence agricultural losses.



(left) Start year of the worst drought event defined by drought intensity based on the number of weeks exceeding D2 status and (right) economic losses based on insurance payouts from the U.S. Department of Agriculture.

USCRN Applications and Quality Assurance

The USCRN team compared a new soil sensor, the Acclima probe, against the current HydraProbe in both a homogeneous test bed and at 43 USCRN stations. Results showed that the Acclima probe provided more realistic soil moisture conditions at stations with high-clay-content soils. The team is also revising quality control methods for soil moisture and temperature and using machine learning techniques to estimate and constrain the relationship between remotely sensed surface solar absorption and USCRN's hourly land surface temperature data. NOAA Atlas 14 values for precipitation extremes and frequency were updated through 2019 at USCRN stations.

GOES-R-Based Products

Assessments of GOES-16 visible channel calibration were made using the near-real-time Clouds and Earth's Radiant Energy System FLASHFlux data, and a radiative transfer model was deployed for calibrating geostationary visible channels. The algorithm was also tested in producing near-real-time surface solar absorption values from the GOES-16 sensor.

Implementation of Geostationary Surface Albedo Algorithm with GOES Data

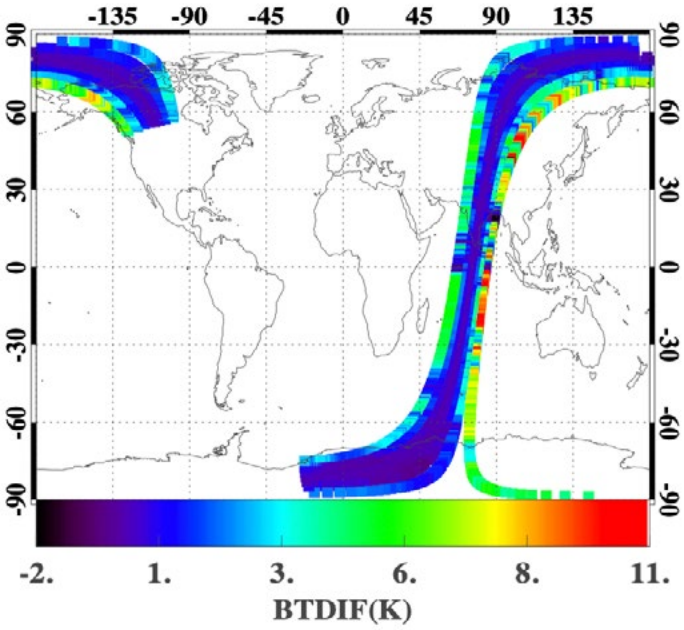
The cloud mask developed by MeteoSwiss was installed, configured, compiled, and successfully executed with test METEOSAT data on NCICS servers. In the current phase, each agency is focused on producing Level 2 data from their own satellites. In preparation for merging data from five different organizations, the NCICS team is collaborating with statisticians from University of California, Santa Cruz, to create a framework leveraging spatial statistics methods.

Calibration of HIRS Brightness Temperatures

HIRS measurements of brightness temperature (BT) must be calibrated in order to provide a consistent dataset for use as a climate data record. Preliminary work on this project identified a subset of the data that can be used for calibration of HIRS BT between satellites. While some calibration had been performed previously, preliminary comparison of intersatellite BTs has shown that some channels may still have large intersatellite biases (over 1 K), especially toward the edges of the temperature range.

HIRS-Like Data from New-Generation Sensors

Profiles of atmospheric temperature and humidity obtained from a neural network analysis of HIRS data form an important ancillary input to ISSCP processing. The HIRS instrument is experiencing increasing degradation and will not be flown on future satellite missions, necessitating a change in ISCCP processing and/or the production of HIRS-like data from other sensors. The team is exploring the use of measurements from the Infrared Atmospheric Sounding Interferometer on board the MetOp-series satellites to continue ISCCP processing with a HIRS-like product.

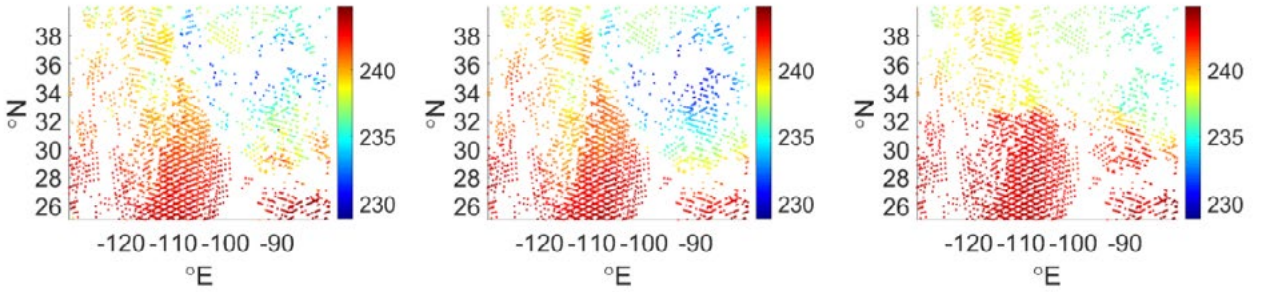


Difference in brightness temperature (BT) after applying limb correction to HIRS all-sky data for August 26, 2019. Note the increase in limb-corrected BT towards the scan edge.

HIRS Temperature and Humidity Profiles

This effort to derive atmospheric temperature and humidity profiles focused on improving intersatellite calibration of raw HIRS brightness temperatures and on leveraging surface and 2-meter temperatures to create a blended product along with in situ observations, where the HIRS-based data can be especially useful for improving spatial coverage.

Through a collaboration with the University of Cincinnati's Statistics Department, hierarchical Bayesian nearest-neighbor co-kriging Gaussian process (NNCGP) models are applied to address the intersatellite calibration problem. These models can account for cross-dependencies among overlapping satellite observations with varying fidelity. The proposed method reduces computational complexity and enables filling in gaps in the large, irregularly spaced datasets that result from the presence of clouds.



(a) NOAA-15 testing data-set (b) Prediction means by NNCGP model (c) Prediction means by single level NNGP model

(a) March 1, 2001, NOAA-15 Channel 5 brightness temperatures, compared to (b) using NOAA-14 data and the newly developed NNCGP model versus (c) the same NOAA-14 data with a traditional nearest-neighbor Gaussian process model.

Regional Variability of Sea Ice Coverage

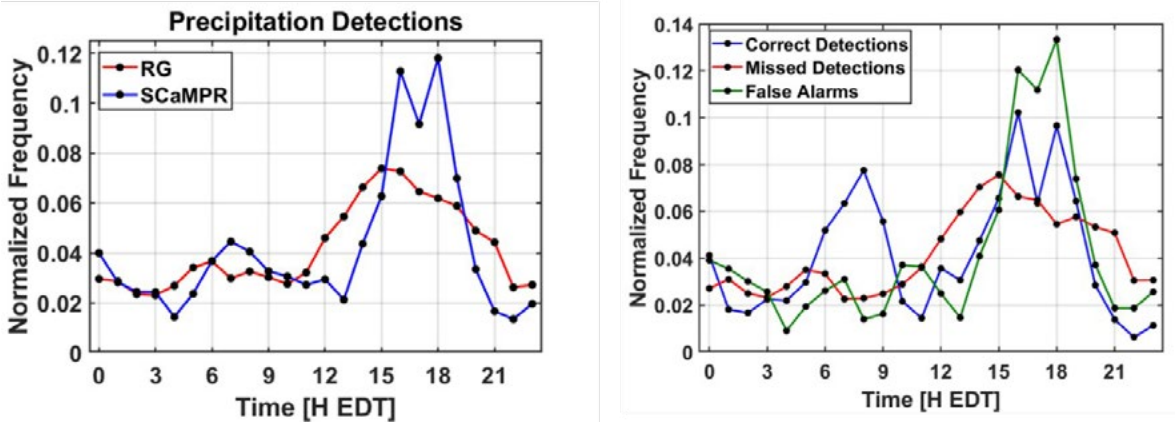
Several papers were published this year related to the sea ice extent CDR, including one examining when Arctic summers will be largely ice free based on global climate model projections and another reporting on the impact of different choices of sea ice concentration thresholds on computations of Arctic sea ice extent trends. In addition, climate normals for sea ice concentration, area, and extent for the Arctic and sub-Arctic were evaluated and transitioned to NOAA.

Developing and Validating Heat Exposure Products Using the USCRN

Heat exposure indices, including heat index, apparent temperature, and wet-bulb globe temperature (WBGT), are being developed and validated using hourly and sub-hourly data from the USCRN. These derived products will be used to address heat health by combining the climate data with socioeconomic and hospital data. A comparison with data from North Carolina's ECONet showed that WBGT values can be used to derive black-globe temperature and WBGT at USCRN sites.

Evaluation and Elucidation of SCaMPR Performance in Complex Terrain Leveraging GOES-R Observations and Ground-Based Precipitation Measurements

Teams from the University of North Carolina Asheville and Duke University are collaborating on ongoing maintenance of the Great Smoky Mountains National Park Rain Gauge Network in the southern Appalachians, error analysis and evaluation of the Self-Calibrating Multivariate Precipitation Retrieval (SCaMPR) quantitative precipitation estimation (QPE), forensic analysis of SCaMPR retrievals to identify error sources, and development and verification of the IPCDC algorithm. Gauge visitation and maintenance continues, and recent research shows that SCaMPR QPE errors exhibit a strong diurnal cycle and a spatial structure that can be tied to orographic precipitation regimes.



Diurnal cycle of rainfall from the rain gauge and (left) SCaMPR data and (right) detection errors.

Development of Climate Data Records for Precipitation: Global Evaluation of Satellite-Based Quantitative Precipitation Estimates

The project team conducted a long-term assessment of the different satellite-based precipitation products from four climate data records (PERSIANN-CDR, GPCP, CMORPH-CDR, AMSU A-B Hydro-bundle) and derived long-term global precipitation characteristics at fine spatial and temporal resolution. A book chapter incorporating project results was finalized.

Earlier Drought Detection Using Remotely Sensed Precipitation Data from the CMORPH Climate Data Record

Monthly and daily standardized precipitation indices (SPIs) were implemented using precipitation satellite data from the CMORPH and PERSIANN CDRs as tools for detecting and monitoring drought. Comparisons with an in situ drought index showed comparable patterns for drought events around the globe but with important differences over areas where precipitation is limited.

Developing Blended In Situ and Satellite Global Temperature Datasets

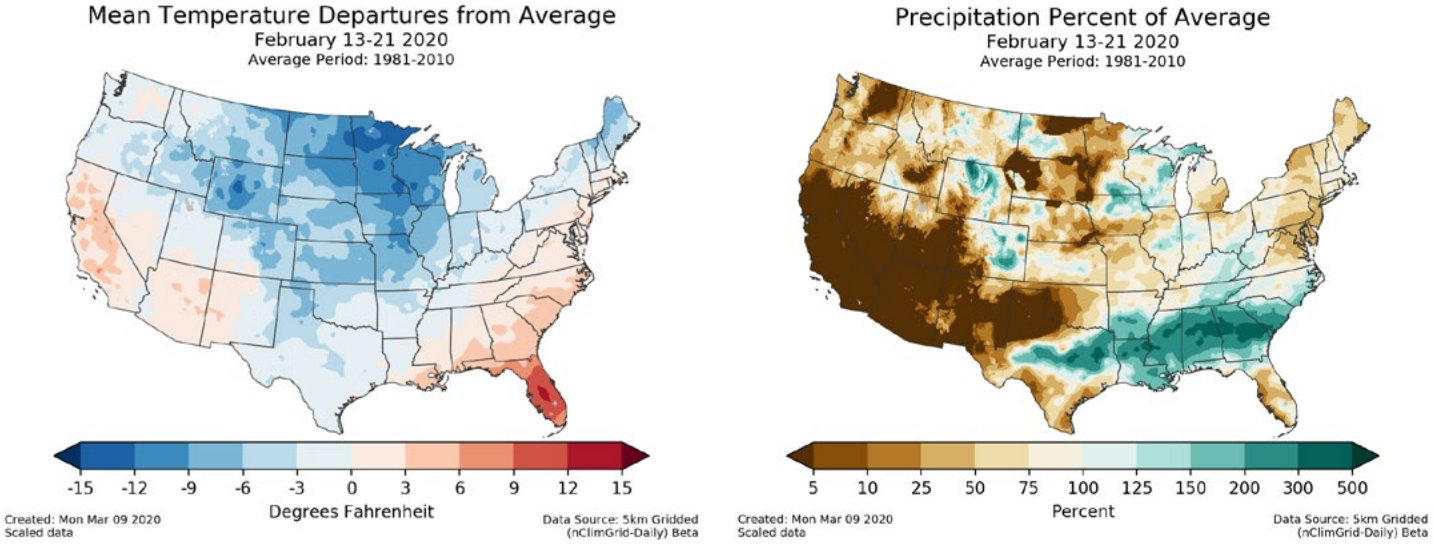
This project explores the use of machine learning to integrate in situ measurements and satellite-derived surface temperature from HIRS instruments to create a sub-daily gridded temperature dataset. The team completed most of the HIRS temperature reprocessing and will be using advanced machine learning tools to create a blended global gridded surface temperature dataset.

Development of Satellite Alternative Precipitation Normals

A prior evaluation of three satellite precipitation CDRs is being used to develop alternative precipitation normals. In addition to the monthly averages that routinely constitute climate precipitation normals, other quantities such as standard deviations, maximum precipitation, conditional means, percentiles, and percentage of rainy days are being computed. Those satellite precipitation normals are compared to in situ normals over the contiguous United States, and the different products are evaluated.

Gridded In Situ USCON Temperature and Precipitation Normals

Thirty-year averages of daily, monthly, and annual gridded USCON (continental United States) temperature and precipitation data are being computed using NCEI's gridded dataset. The team examined day-to-day variability in daily average temperatures, produced maps of extreme event days and a comparison with PRISM data, and incorporated results in NCEI's monthly State of the Climate reports.



Maps of (left) average daily temperature anomalies and (right) percent of normal precipitation. Both plots are for February 13–21, 2020, and are calculated relative to the daily climatologies for 1981–2010.

Maintenance and Streamlining of the Global Historical Climatology Network–Monthly (GHCNm) Dataset

The GHCNm global land surface temperature dataset has now been incorporated into the new version 5 of NOAA's primary global surface temperature product, NOAAGlobalTemp (NGT). A paper describing NGTv5 was published, and NGTv5 is now being used in monthly monitoring reports by NCEI.

Development of a Homogenized Sub-monthly Temperature Monitoring Tool

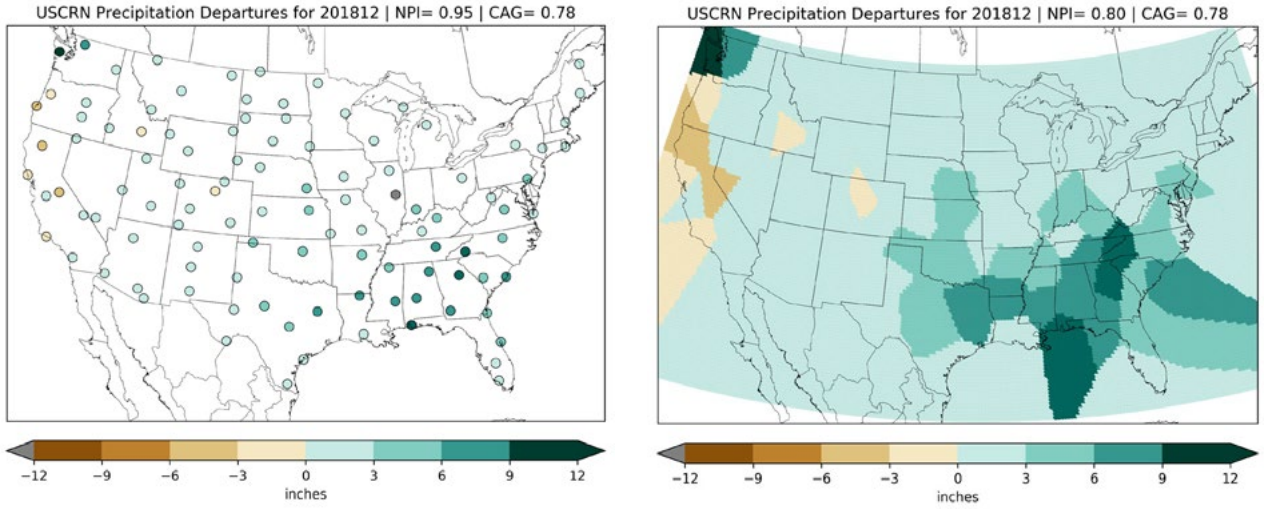
A new sub-monthly tool for monitoring impacts of temperature extremes in the United States was described in a journal article and used to analyze extreme heat events. The results showed that while the 1930s Dust Bowl period saw many heat events, the number and length of these events has been increasing since 1951. Overnight extreme minimum temperature events are increasing more than daytime maximum temperature events, and heat events are becoming more prevalent in the western and southeastern United States.

Global Historical Climatology Network–Hourly (GHCN–H)

The project team is working to add global, standardized hourly data to the GHCN–H dataset for use in climate applications. Networks are being added to the data flow, processes are being developed to standardize their format, and an initial survey of existing hourly quality control checks is taking place.

Development of the USCRN National Precipitation Index (NPI)

An algorithm to build an NPI using 100+ USCRN stations has been developed, and a white paper has been completed. The team is working to make the NPI operational at NCEI. Next steps will include porting over the code base to NCEI monitoring systems, updating figures when new data become available, and initiating an operational readiness review.



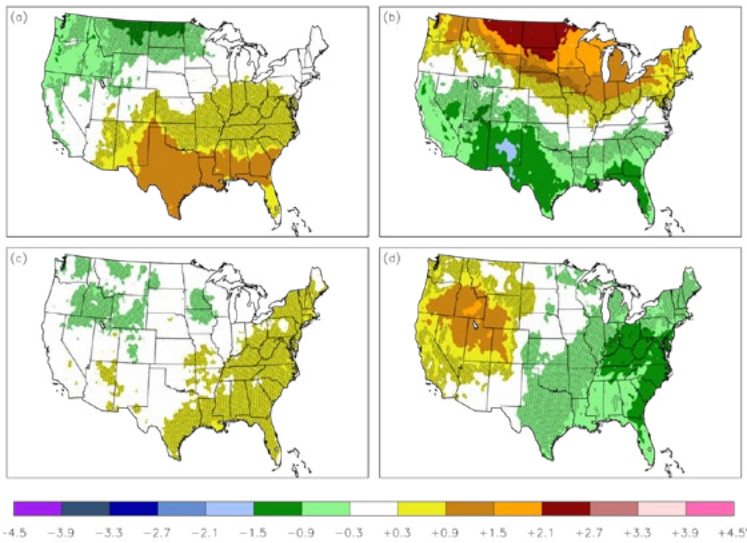
Prototype of the monthly USCRN National Precipitation Index for December 2018: (left) values of NPI at individual USCRN stations and (right) gridded values after interpolation scheme applied.

Identifying Tropical Variability with CDRs

This project resulted in several publications on monitoring and prediction of tropical cyclones using the Outgoing Longwave Radiation–Daily CDR and the International Best Track Archive for Climate Stewardship (IBTrACS). The new IBTrACS version 4 is now being used to produce the "Hurricanes and Tropical Storms" report for NCEI's monthly State of the Climate reports. In addition, two undergraduate interns uncovered the history of wind–pressure relationships identified by the U.S. Joint Typhoon Warning Center and, building on this discovery, used historical pressure data from NCEI to develop a new, more temporally homogeneous wind record.

El Niño–Southern Oscillation (ENSO) Normals

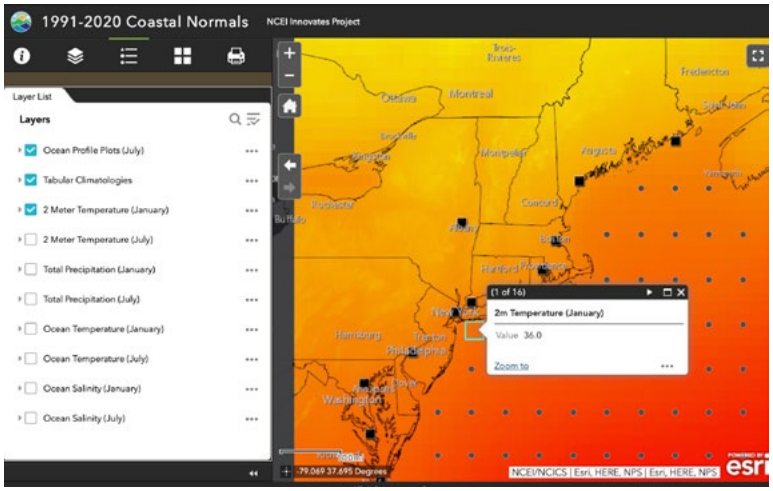
Climate normals have traditionally been calculated as averages of climate variables over long periods—typically 30 years. This approach assumes a stationary climate, so several so-called alternative normals have been introduced recently to account for trends associated with global climate change. A paper was published documenting a unique methodology for developing U.S. normals from nClimGrid–Monthly accounting for both climate change and the phase of ENSO.



ENSO composites of December–January–February mean monthly maximum temperature for (a) strong La Niña, (b) strong El Niño, (c) weak La Niña, and (d) weak El Niño.

NCEI Innovates: Developing 1991–2020 Normals Along the Northeast and Mid-Atlantic Coasts

Conventional climate normals provide the average conditions expected at a given time and place for a given hour, day, or month of the year. This pilot project, which was funded under the new NCEI Innovates program, aims to meet the needs of coastal stakeholders by producing normals for atmospheric and oceanic conditions along the U.S. Mid-Atlantic/Northeast coastline.



The project team calculated climatologies for 1991–2019 for all datasets and developed a prototype interactive mapping tool. They are working with NCEI to make this product operational on the NOAA Geoportal page.

Prototype of the ArcGIS Online interactive tool for the Coastal Normals project. Users can toggle layers on and off, and the map is interactive, displaying relevant normals data and images.

International Comprehensive Ocean–Atmosphere Data Set (ICOADS)

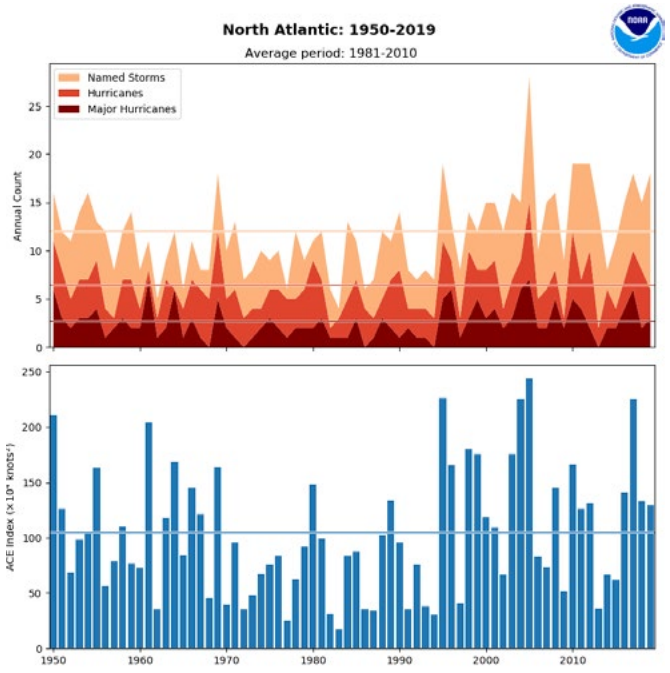
ICOADS is the most complete and heterogeneous collection of surface marine data in existence. The high-impact scripts and workflow used to retrieve and process this data were migrated to a new, more robust computation environment. The data flow has been greatly simplified and now uses native applications that will run on any Linux platform. Several data issues have also been resolved.

Climate Monitoring

NCEI products are the gold standard for climate monitoring, which includes producing monthly and annual reports on climate anomalies, ranks, and extremes. However, several emerging NCEI datasets like IBTrACS and nClimGrid–Daily have yet to be fully tapped in these monitoring activities. Under this project, nClimGrid–Daily and IBTrACSv4 are being incorporated into NCEI's monthly State of the Climate reports to improve tracking of sub-monthly weather patterns and tropical cyclones.

CDC Climate and Human Health Activities

NCEI and the Centers for Disease Control and Prevention (CDC) formalized a five-year interagency agreement recognizing a "One Health" approach that applies atmospheric, environmental, oceanographic, and ocean health knowledge, expertise, and methods to understand, assess, predict, communicate, and reduce public health impacts of climate change. Initial project efforts focused on meetings to assess environmental data needs.



(top) Atlantic tropical cyclone counts and (bottom) accumulated cyclone energy (ACE) for 1950–2019. Horizontal lines denote climatological values for 1981–2010.

Understanding Future Changes in Cold and Shoulder-Season Precipitation

The task leader contributed to studies of hydrological cycle changes in high-latitude regions around the world. One project developed an algorithm for identifying weather conditions conducive to freezing rain (WCCFR) using in situ and upper-air observations and reanalysis data. The algorithm was used to build a WCCFR climatology for North America and Northern Eurasia and estimate changes in WCCFR.

Workforce Development

NCICS actively works to identify and train the next generation of scientifically and technically skilled climate scientists. Junior and/or aspiring scientists, including post-doctoral researchers and students, play an important role in the conduct of research at NCICS. High school, undergraduate, and graduate students, as well as recent post-docs support projects across our task streams.

Post-Docs

Andrew Ballinger (PhD, Atmospheric and Ocean Sciences, Princeton University) finished 3 years at NCICS. This year, Ballinger worked with Kenneth Kunkel and Jenny Dissen in support of the U.S.–India Partnership for Climate Resilience efforts.

Douglas Rao (PhD, Geographical Sciences, University of Maryland) began his first year as a post-doc at NCICS working with Jessica Matthews and developing global blended temperature data using in situ and satellite data.

NASA and NOAA Internships

Institute scientists mentored three NOAA Hollings Scholars this year. Their projects involved studying connections between USCRN standardized soil moisture and drought, building a heat vulnerability index, and working on a typhoon reanalysis project.

NCICS staff also mentored three NASA DEVELOP teams. Their research projects included evaluating drought indicators for a September 2019 flash drought event over the Ohio River basin, assessing the correlation between tree cover and land surface temperature in Asheville and identifying vulnerable communities, and studying the area of severe and extreme drought during El Niño events in the Central American dry corridor.

A NASA DEVELOP team mentored by Scott Stevens studied the impact of tree cover on urban heat in Asheville, NC. Team members Darcy Gray, Amiya Kalra, and Amy Kennedy used Landsat data to calculate land surface temperature (LST) changes from 1984 to 2018 and combined this information with census-block socioeconomic data to create a heat vulnerability index. They found a significant correlation between tree cover and LST and identified vulnerable communities. The team presented their results to several hundred attendees at a public event organized by Asheville Greenworks titled "Climate Change and Asheville's Urban Forest." https://develop.larc.nasa.gov/2019/fall/AshevilleUrban.html

Other

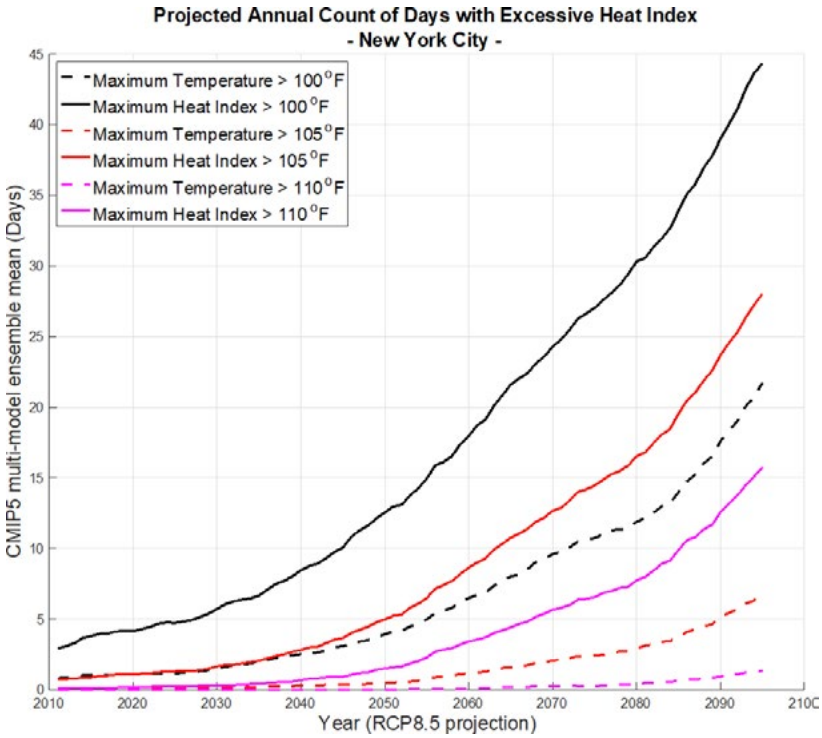
NCICS scientists mentored seven graduate students, including one who successfully defended a PhD dissertation this year, and three undergraduate students. Charlie Wallin, a member of the faculty at Asheville–Buncombe Technical Community College, collaborated with Linda Copley and Jonathan Brannock on cloud operationalization using Docker and GitLab.

Other Institute Projects

Funding sources are indicated in brackets.

The Urban Resilience to Extremes Sustainability Research Network

The NCICS team conducted studies using the Weather Research and Forecasting model to successfully simulate extreme precipitation amounts. A new method was also developed to create the pseudo-global-warming scenarios, and the team used downscaled temperature and humidity data to study projected changes in the number of days with excessively high heat index values. [Arizona State University/NSF]



The multimodel ensemble-mean projected numbers of days exceeding thresholds of 100°, 105°, and 110°F for daily maximum temperature and daily maximum heat index for New York City.

Multiscale Convection and the Maritime Continent

Project results show that the Madden–Julian Oscillation (MJO) modulates rainfall over the Maritime Continent during the afternoon peak of the diurnal cycle but has little impact on the morning minimum. Results exploring the skill of a novel Fourier filtering of combined observations and model hindcasts in the region were published and presented at two seminars. [NASA] ncics.org/mjo

Operational Transition of Novel Statistical-Dynamical Forecasts for Tropical Subseasonal to Seasonal Drivers

Metrics developed for the NCICS MJO monitoring page highlight the most predictable signals for NOAA's Climate Prediction Center (CPC). The operational transition of the existing products to CPC continued, and the project team is training CPC forecasters on tool usage, as well as publishing a paper detailing the skill of the product. [NOAA OAR/CPO]

Climate Indicators to Track the Seasonal Evolution of the Arctic Sea Ice Cover

This project examined the long-term average and temporal variability of the new sea ice climate indicators, including snow melt onset and sea ice retreat, advance, and freeze-up dates. A dataset was released by the National Snow and Ice Data Center. [NASA]

Synthesis of Observed and Simulated Rain Microphysics to Inform a New Bayesian Statistical Framework for Microphysical Parameterization in Climate Models

The team developed an innovative Bayesian statistical framework that combines the extensive radar and ground-based data from the Department of Energy Atmospheric Radiation Measurement field campaigns, bin microphysical modeling, and a new bulk parameterization. [Columbia University/DOE]

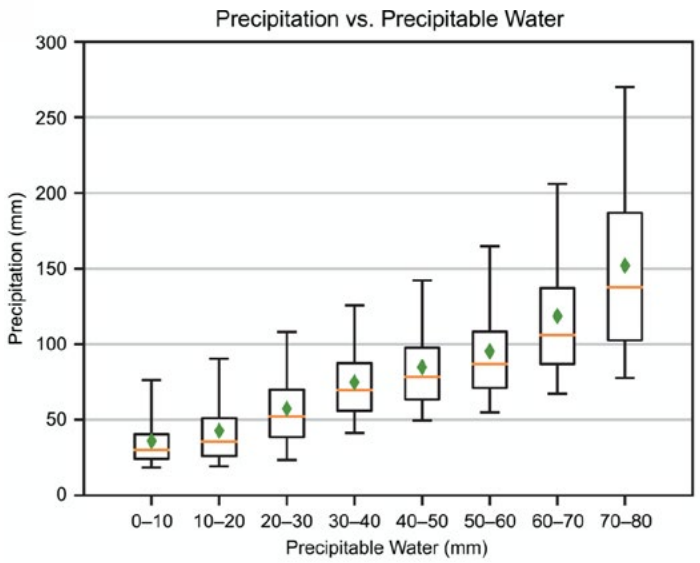
Kelvin Waves and Easterly Waves in NASA's Cyclone Global Navigation Satellite System

Atmospheric Kelvin waves enhance the strength of easterly waves through barotropic energy conversion related to an increase in the meridional gradient of zonal winds. A manuscript is in preparation examining how the eddy kinetic energy budget varies for African easterly waves, between those that occur within the convective phase of a Kelvin wave and those that happen during the suppressed phase. [NASA]

Incorporation of Climate Change into Intensity–Duration–Frequency (IDF) Design Values

The Strategic Environmental Research and Development Program (SERDP) project team completed the majority of the work on this five-year project in June 2020. The primary goal was to incorporate the potential impact of future climate change into estimates of heavy precipitation IDF design values. The results will help the Department of Defense increase the resilience of facilities to heavy precipitation and flooding.

Key outcomes included 1) improved understanding of the meteorological drivers of heavy precipitation events, 2) a website that provides easy access to updated IDF design values accounting for expected increases in heavy precipitation events due to climate change, and 3) a neural network–based software tool that automatically identifies weather fronts in datasets of historical observations or climate model outputs.

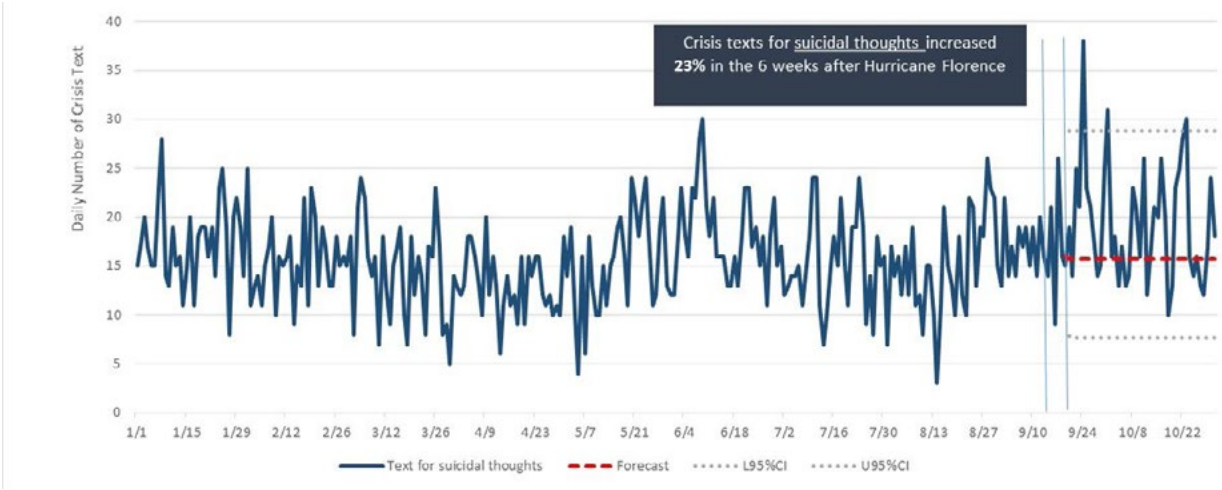


There is a strong and consistent relationship between extreme precipitation totals and precipitable water.

The team also published several papers this year, including one showing that water vapor is the primary determinant of the amount of precipitation falling in extreme events and that future changes in IDF values will be mainly dependent on changes in water vapor. [Army Corps of Engineers/SERDP]

Climate Change Impacts on Human Health

Exploratory research and pilot studies were conducted to examine the impact of climate change—a known environmental determinant—on health risks for vulnerable persons (e.g., pregnant women, persons with a mental health condition). [Mountain Area Health Education Center, Medical University of South Carolina; in-kind partnerships]



Crisis text volume for "suicidal thoughts" over time in youth for North and South Carolina following Hurricane Florence. Data source: Crisis Text Line data, 2018.

2020 By the Numbers

Research

- 50 journal articles, reports, and book chapters
- More than 80 invited presentations and posters

Outreach and Engagement

Spring is normally the busiest time of year for educational outreach events, so COVID-19 cancellations had a significant effect on outreach activities. Nonetheless, NCICS was involved in 11 outreach and engagement presentations and panel discussions and 13 other community outreach events, ranging from science fairs to professional development for local educators. We reached approximately 800 people through these events.

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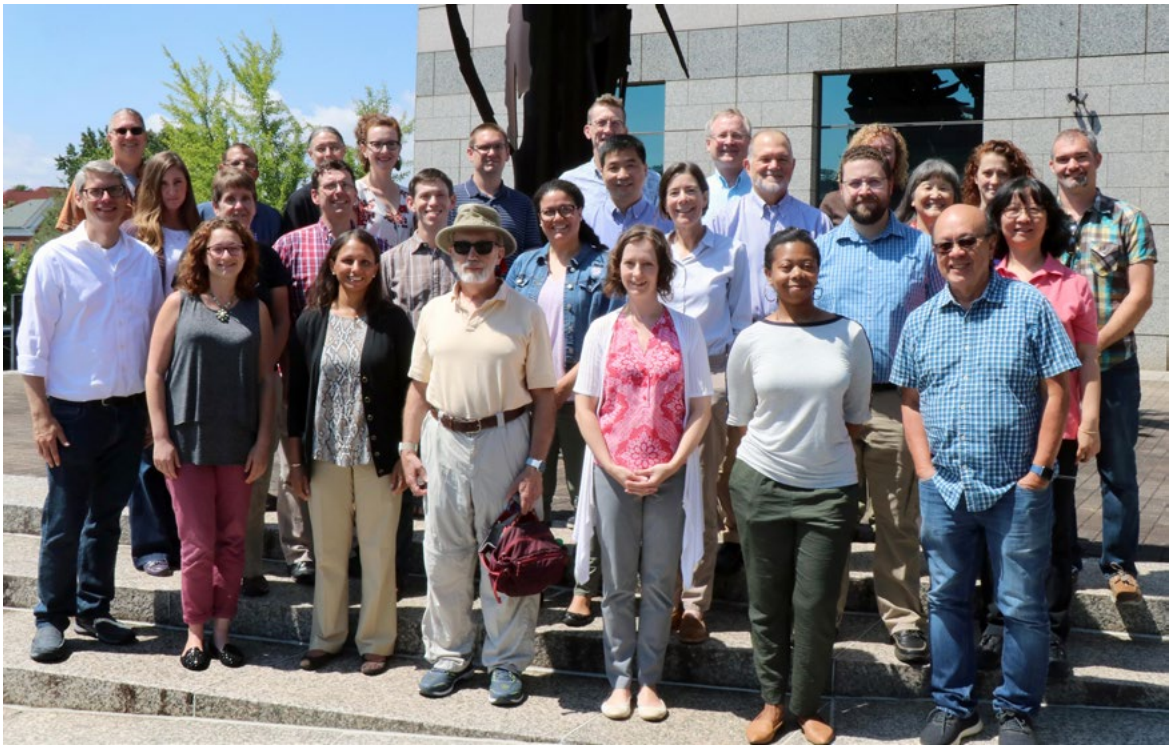

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