

**Cooperative Institute for Climate and Satellites–North Carolina** Inspire. Advance. Engage.

## CICS—NC Overview

## Otis Brown November 29, 2016



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## Introduction

### **Seven Streams of Effort**

- Administration
- Access and Services Development
- Assessments
- Reference Environmental Data Records & Data Stewardship
- Climate Literacy, Outreach, Engagement, & Communications
- Surface Observing Networks
- Workforce Development

**Plus Consortium and Other Projects** 



## Access and Services Development

## Support improvements to access mechanisms for NCEI's data and product holdings

### NOAA Big Data Project (BDP)

- Delivering environmental data via cloud providers (Amazon, Microsoft, Google, IBM, and Open Cloud Consortium)
- High-performance computing infrastructure
- Technical, scientific, data expertise
- NEXRAD Level 2 live on AWS on October 27<sup>th</sup>, 2015
- Led to 2.3 times access with 80% from AWS
- Developing GOES/GOES-R service prototype





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## **Access and Services Development**

### NOAA Big Data Project (BDP) [continued] Changing the paradigm





Ref: Ansari et al., 2016 Unlocking the potential of NEXRAD data through NOAA's Big Data Partnership, *BAMS* (in review)



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## Access and Services Development

### **NCEI Ingest System Software Engineering**

Stood up an *Agile* development team for ingest activities at Asheville NCEI location.

- Installed a proof-of-concept instance of the *Common Ingest System* used at NCEI Boulder location on CICS-NC hardware.
- Created monitoring tools for the ingest system to facilitate proactive problem resolution.





## Assessments

# Support interagency activities for global, national and regional assessments of climate change

### **NOAA Assessments Technical Support Unit**

- US Global Change Research Program (USGCRP) activities
- USGCRP Climate and Health Assessment released April 4, 2016
- 50-state NOAA State Climate Summary project in progress
- Globalchange.gov website support
- Completed and published NOAA NESDIS Technical Report comparing CMIP3 and CMIP5 projections for United States
- ~10 FTE staff



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### **Climate and Health Assessment**

- Project and process management, building on 2014 NCA experience
- Science and modeling support
- Contributing authors
- Editorial support: Communicating science clearly, accurately
- Visual communications: Infographics and improving scientific figures, designing PDF layouts & supplemental materials
- Report released on April 4, 2016
- <u>health2016.globalchange.gov</u>



Life Cycle of Blacklegged Ticks, Ixodes scapularis





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**NC STATE UNIVERSITY** 

### **State Summaries Project**

- Four-page climate summaries for each state
- Observed and projected changes for key climate variables
- Almost 500 primary figures created, along with 1,000 supplemental figures that will be available on the website
- Comments and inputs from Regional Climate Centers, state climatologists
- Currently in final stages of NOAA-led peer-review process and publication
- Release expected late 2016

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### Web Support for US Global Change Research Program

- Took over support US Global Change Research Program websites, including Globalchange.gov, in October 2014
- Developed new site used to solicit nominations and technical inputs
- New author collaboration website released May 2016
- New metadata collection site released August 2016

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### **Sustained Assessment Process**

- Supporting the development of USGCRP Climate Science Special Report
  - Will serve as technical foundation for 4<sup>th</sup> National Climate Assessment
  - First order draft complete
- Planning underway for 4<sup>th</sup> NCA
- Working with the LOCA (Localized Climate Analogs) dataset for NCA 4
  - New statistically-downscaled daily data set
  - based on CMIP5 simulations at 1/16-degree spatial resolution for CONUS
  - 11 Terabytes of data
  - Flexible, scalable analysis code being developed
  - Initial set of 23 derived climate variables calculated



## *Provide quality satellite and in situ climate observing datasets to document the Earth's climate*

- Planning and implementation of large-scale (~300 TB) GOES satellite imagery reprocessing
- Development of a Climate Data Record for the High-Resolution Infrared Radiation Sounder (HIRS) satellite atmospheric temperature and humidity profile
- Manuscript in Bulletin of the American Meteorological Society describing the PERSIANN-CDR precipitation dataset





- Extensive support for the transition of the ISCCP satellite cloud data set to NCEI, including contributions to the next generation H-series ISCCP cloud data satellite products and a paper on visible calibration of ISCCP B1U data
- Spatial-temporal data fusion of land surface albedo products (collaboration with NC State University Statistics Department)







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### **NC STATE UNIVERSITY**

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### NEXRAD NMQ/Q2 Reanalysis

- Joint project with the NOAA National Severe Storms Laboratory and the Cooperative Institute for Mesoscale Meteorological Studies in Norman, OK
- Applies National Mosaic and Multisensor Quantitative Precipitation Estimate (NMQ/Q2) algorithms to the entire NEXRAD archive (1997–2011)
- Data from NCEI, processed on NCICS high-performance computing cluster
- Pushing data to cloud providers (e.g., Amazon) as part of NOAA "Big Data" effort
- Working to place in NCEI archive
- Already being used for applied research





- Refactoring production software for High resolution Infrared Radiation Sounder (HIRS) Outgoing Long-wave Radiation (OLR) Monthly CDR in preparation for production operations within NCEI
- Evaluation of the accuracy of the NOAA NCEI High Resolution Infrared Radiation Sounder (HIRS) near-surface air temperatures in the Arctic, using 1-year, QC'd data from Surface Heat Budget of the Arctic Ocean (SHEBA) project





- Generated obs4MIPs datasets from the entire period of record for three different Climate Data Records:
  - HIRS Outgoing Long-wave Radiation CDR
  - Optimum Interpolation Sea Surface Temperature (OISST) CDR
  - Sea Ice Concentration CDR
- Datasets available on ESGF (Earth System Grid Federation: <u>http://esgf.llnl.gov/</u>)
- Analyzed other NCEI holdings for possible use in the obs4MIPs effort



**O** HIRS OLR Monthly

About this data

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### **NC STATE UNIVERSITY**

OISST Monthly
About this data

## Data Stewardship

- Cutting-edge research on the scientific stewardship of individual digital environmental data products
  - New data stewardship maturity matrix for environmental data records
  - Stewardship maturity evaluation of NOAA Climate Data Records
  - Peer-reviewed paper published introducing roles/responsibilities of data, scientific, and tech stewards
  - Currently applied to > 250 NCEI products

Preservability	*	$\star$	$\star$	$\star$	$\stackrel{\frown}{\simeq}$
Accessibility	*	$\star$	$\stackrel{\sim}{\sim}$	$\stackrel{\sim}{\sim}$	$\stackrel{\sim}{\sim}$
Usability	$\star$	$\star$	$\star$	$\stackrel{\sim}{\sim}$	$\frac{1}{2}$
Production Sustainability	$\star$	$\star$	$\star$	$\star$	$\star$
Data Quality Assurance	$\star$	$\star$	$\star$	$\star$	$\stackrel{\wedge}{\simeq}$
Data Quality Control/Monitoring	$\star$	$\star$	$\star$	$\stackrel{\wedge}{\sim}$	$\stackrel{\wedge}{\sim}$
Data Quality Assessment	$\star$	$\star$	$\star$	$\frac{1}{2}$	$\frac{1}{2}$
Transparency/Traceability	*	$\star$	$\star$	$\stackrel{\sim}{\sim}$	$\stackrel{\wedge}{\sim}$
Data Integrity	*	$\star$	$\star$	$\star$	☆
sessment Date: 09/04/2015 SMM Ve	rsion: NCI	DC-CICS-S	MM_000	1 Rev. 1 1	2/09/20



## Surface Observing Networks

# Sustaining and improving the quality of in situ observations and observing networks

Developed a sub-monthly tool for monitoring impacts of temperature extremes in the United States.

- Near-real-time station data is aggregated at various levels (states, NCA regions, and CONUS)
- Data is updated on a daily basis to analyze current temperatures against the period of record
- Deployed experimental web-based visualization tool





## Surface Observing Networks

- Developing next version of NOAA's global temperature product, known as the Global Historical Climatology Network–Monthly (GHCN-M) dataset:
  - Nearly four times as many stations
  - Updated QC and bias corrections
  - Version 4 beta released Oct 2015
- Used USCRN soil climate observations to evaluate the national changes in soil moisture for improved drought monitoring
- Deployed a new precipitation algorithm for the U.S. Climate Reference Network (USCRN), improving the network's capacity to monitor precipitation at a 5-minute frequency





## Surface Observing Networks

- Analyzed changes to USCRN precipitation patterns over the 2012 drought and compared USCRN soil conditions to a commonly used reanalysis model—the North American Regional Reanalysis.
- Research highlighted severity of the 2012 drought and the model's capacity to simulate the evolution of hydrological extremes.
- Developing soil product for the USCRN that can monitor both droughts and floods.





## **Other Projects**

### **Other Research**

- Developed and deployed an approach to create ensemble average extratropical cyclone (ETC) tracks from the 20<sup>th</sup> Century Reanalysis
- Interactive web tool (<u>etcsrv.cicsnc.org/ETCv8</u>) to showcase and provide access to the dataset



• Produced CMIP5 data with resolution of 5 km over the United States for analyses of climate change in each of the 50 states in the United States



## **Other Projects**

- Launched an improved version of website for monitoring and prediction of the Madden–Julian Oscillation and other tropical variability
- Serves ~800 unique users each month
- <a href="http://monitor.cicsnc.org/mjo/">http://monitor.cicsnc.org/mjo/</a>





## **Other Projects**

#### DoD — Strategic Environmental Research and Development Program (SERDP)

- Ken Kunkel, lead PI, with Tom Karl & David Easterling (NOAA)
- 5-year, \$2.8 million (\$1.53 million to NCSU)
- Incorporation of effects of climate change into rainfall design values

#### NSF — Urban resilience to climate change-driven extreme events

- Ken Kunkel, Co-PI
- 5-year, \$400K
- Multi-institution collaborative project, ASU lead

## NASA— Multi-scale interactions Between the MJO, Equatorial Waves, and the Diurnal Cycle Over the Maritime Continent

- •Carl Schreck, Lead PI
- •3-year, \$385K

•Multi-institution collaborative project (NCICS/NCSU, MEAS/NCSU, NCAT)



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## Improving public knowledge and understanding of climate change, its impacts, and options for adaptation and mitigation

### **Educational Outreach**

- Participated in more than a dozen regional climate literacy outreach events, including K-12 STEM programs, Career Day activities, and adult continuing education programs, including:
  - NC Science Festival activities, including the Mountain Science Expo at the NC Arboretum
  - Middle school summer camp at Purchase Knob in Smoky Mountain National Park
  - Video chat teaching middle-school students about scientific computer programming



Teaching computer programming to students in Waynesville, NC



### Climate Literacy, Outreach, Engagement and Communications

### Supporting NCEI Engagement, and Communications

- Leading development of a robust customer information and engagement management solution for NCEI
- Working with NCEI to develop sector-based prioritization plan
- Science writing/editing support for NCEI
- Uncertainty quantification for NCEI's database of billion-dollar climate/weather disaster events
- Support for January 2016 NCEI Engagement event on "Moving from Environmental Data to Resilience: Forging Public-Private Partnerships in the Energy Sector" at AMS Annual Meeting





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## **Other Engagement Activities**

 Worked with Asheville–Buncombe Sustainable Community Initiative to develop The Collider — an event and business center in downtown Asheville intended to advance climate/environmental literacy and development of climate services business.

The Collider's office/co-working space opened for business in early 2016

• Working with the *Asheville Museum of Science* to broaden use and membership and to improve exhibit space





### Climate Literacy, Outreach, Engagement and Communications

### **CICS-NC Communications**

- Developed various CICS-NC/NCICS communications materials, including a new institute brochure and latest issue of the CICS-NC newsletter Trends
- Promoted research results and other activities via press releases and social media
- Coordinated communication efforts with NCEI for joint projects
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## Workforce Development

# Prepare the next generation of climate scientists, engineers and technicians

- Student interns (high school and university) and post-docs
- Estimation of topographic variables at high resolution (1 km) for the contiguous U.S. using Global 30 Arc-Second DEM (GTOPO 30) for a project using high-resolution radar reanalysis (NEXRAD)
- Evaluation of new spatial interpolator based on topography, using cross-validation against other methods
- Collocated and analyzed HIRS surface temperature to USCRN station data from 2006–2013. Constructed a best-fit equation to bias correct the HIRS surface temperatures





## IT Infrastructure

### Supporting research, development and computational demands

### **IT Infrastructure**

- High speed networking
  - 802.11 AC WIFI
  - Video Communications
  - 10 Gigabit Ethernet
- High-performance computing
  - 45 Nodes
  - 528Cores / 3.2TB RAM
- Virtual Machine Platform
  - 6 Hosts / 72 Cores / 640GB RAM
  - >30 virtualized systems
- Data services
  - Over 1.2 PB on disk
  - Over 2.25 PB on Tape
  - 8 Gigabit Fiber Channel







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