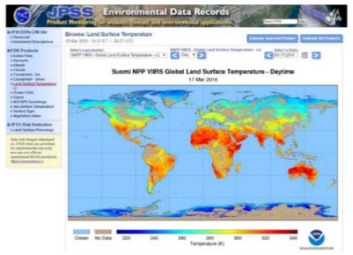
CICS-MD Science Updates

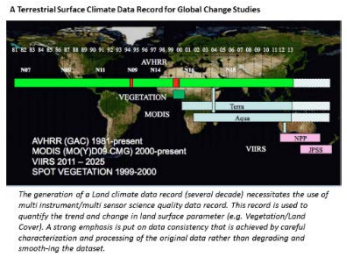
Hugo Berbery

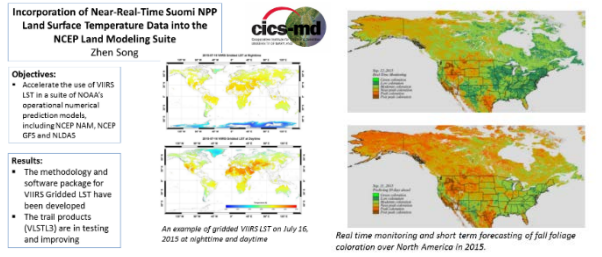
CICS Science Meeting

Nov 29, 2016

cicsmd.umd.edu







Outline

- **CICS Vision**

- **CICS-MD Research**

- **Accomplishments**

  - Research to Operations
  - Publications and Presentations
  - Education and Training

Cooperative Institute for Climate and Satellites

CICS VISION

To perform collaborative research aimed at enhancing NOAA's ability to use satellite observations and earth system models to advance the national climate mission…

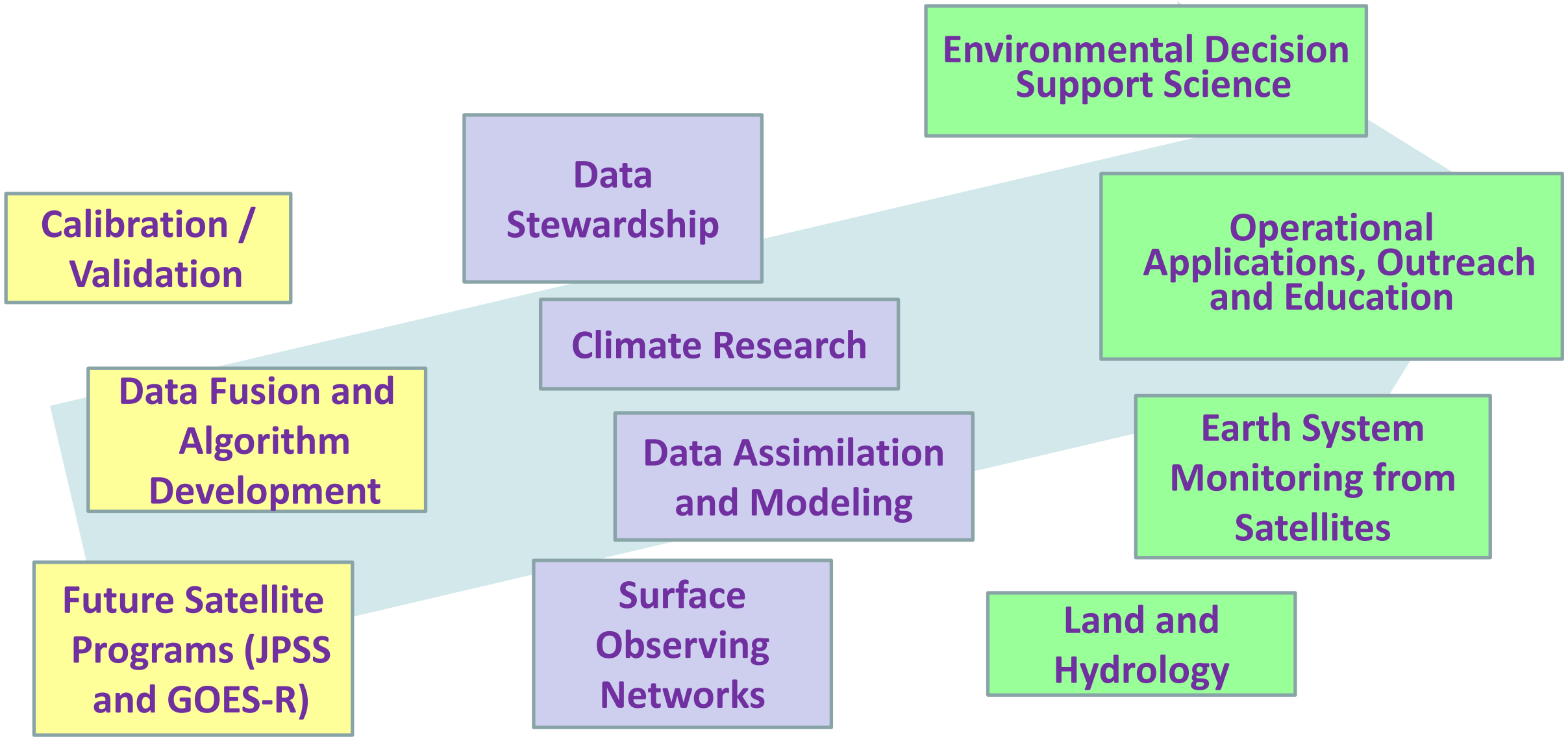
…including understanding, monitoring, predicting and communicating information on climate variability and change.

CICS STRUCTURE

Three main components that work together with NOAA to conduct collaborative research related to the CICS Themes on satellite information and its use for weather and climate applications

- CICS-MD
- CICS-NC
- Consortium Members → CUNY/CREST among them

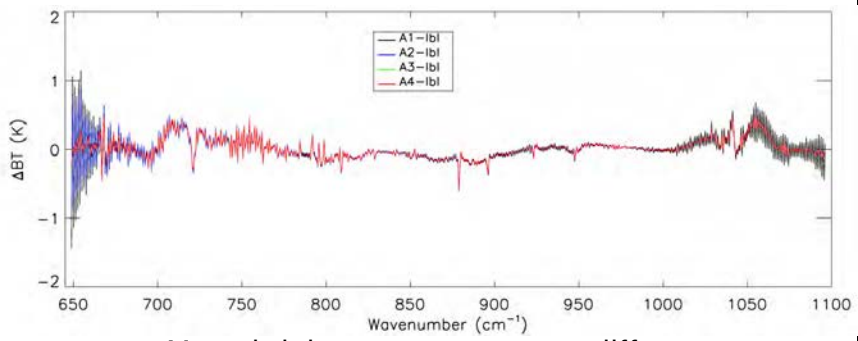
CICS-MD Research Topics



CICS-MD Research Topics

Calibration and Validation

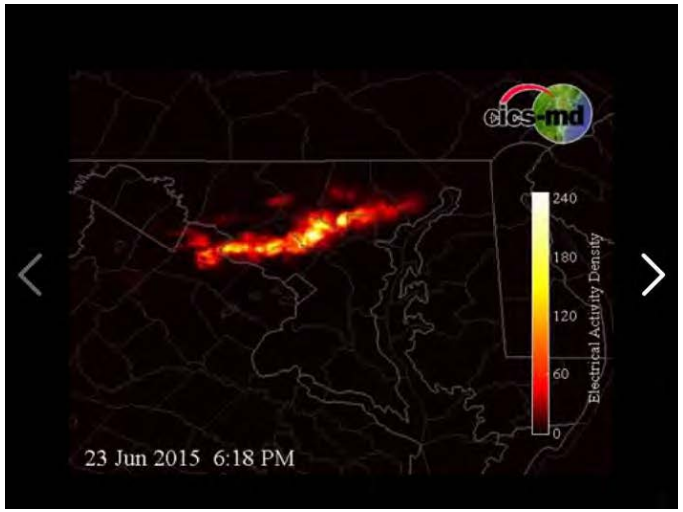
- Assess spectral and radiometric accuracies
- Improve algorithms, including optimization of calibration equations
- Provide prelaunch science support for JPSS-1 VIIRS instrument



Mean brightness temperature difference between different algorithms

Data Fusion and Algorithm Development

- Evaluate and identify algorithm artifacts
- Communicate results to the corresponding development teams
- Improve retrievals of atmospheric temperature, water vapor, land surface temperature, and hydrometeors
- Use of lightning information to improve estimates of near real-time precipitation



CICS-MD Research Topics

Advanced Satellite Programs (JPSS/GOES-R)

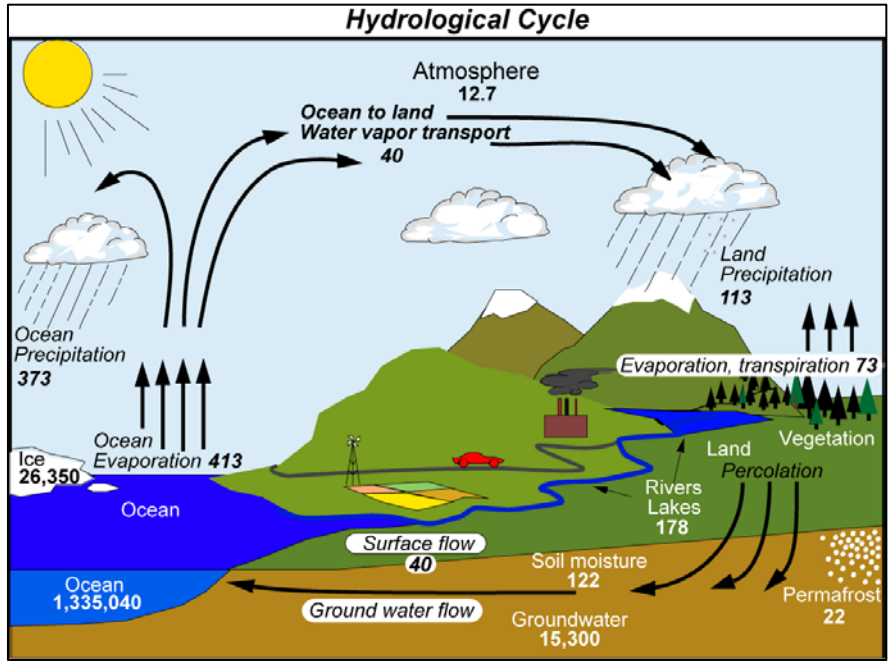
GOES-R: Geostationary Operational Environmental Satellite-R series
JPSS: Joint Polar Satellite System

- Provide scientific support for the GOES-R and JPSS Missions
- Validate GOES-R Land Surface … und Campaign and Station Data
- Perform analysis of an Obs… measure the impact of withdrawing data from the…
- Develop JPSS risk reductio… timation algorithm)
- Develop and transition to operations a… the retrieval of Snow Cover, Snow Depth and Snow Water Equivalent; SNPP VIIRS … osol Optical Thickness; Aerosol Particle Size Parameter (APSP), and Suspended Matter (SM)…

Seattle
AMS Short Course:
Experiencing JPSS Capabilities

The Hydrological Cycle

Useful global data sets of the water cycle can be developed from satellite information



Drought and water extremes *create some of the costliest natural hazards can have dramatic impacts …*

… on lives and property, a community's economic well-being …

… and the ability of an ecosystem to provide resources for sustainable consumption.

$$\frac{\partial(SM)}{\partial t} = P - E - R$$

A new CICS-MD initiative: GOES-R Water Cycle Products and Services to support the National Weather Service

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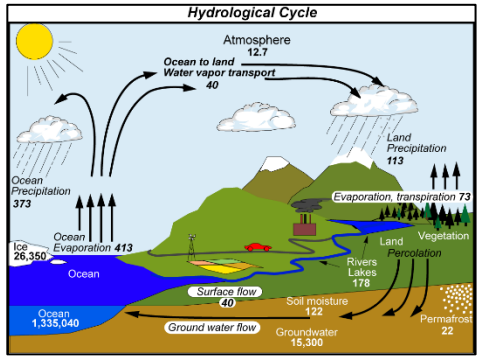
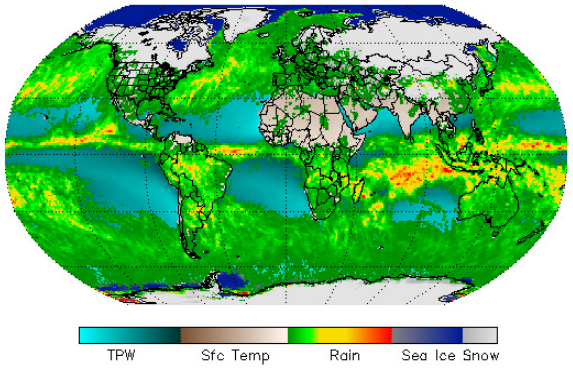


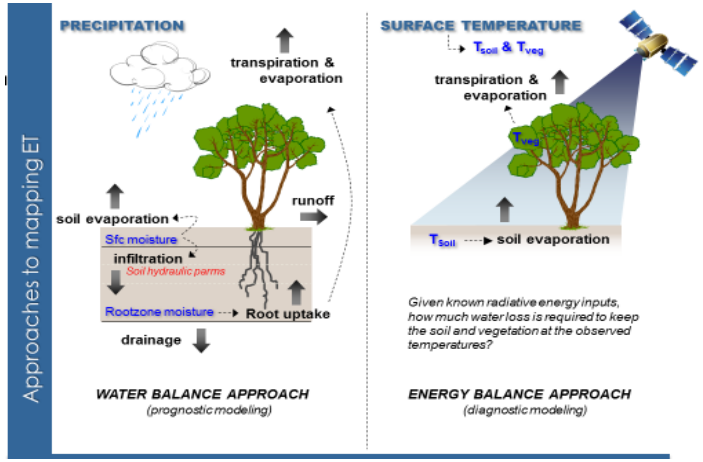
(1) Advancing Precipitation Retrievals



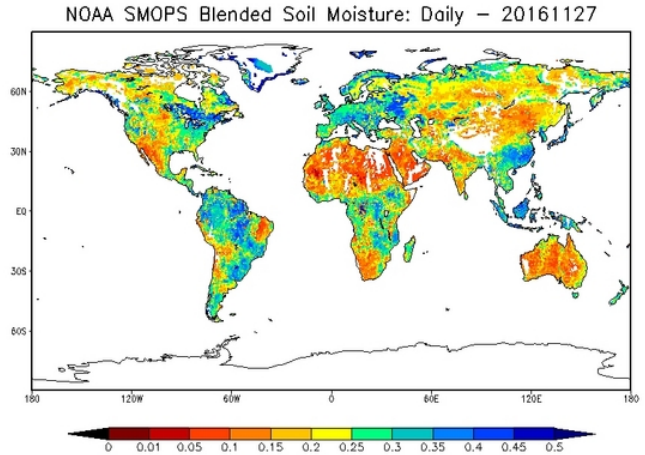
NOAA *polar* orbiting satellites contain the AMSU/MHS sensors which are used to **retrieve hydrological variables (water vapor, clouds, rain, snow, sea-ice)**.

(2) Evapotranspiration and Soil Moisture

Evapotranspiration



Soil moisture



CICS-MD Research Topics

Data Stewardship

- Participate in the continued development, maintenance, and enhancement of the World Ocean Database, the World Ocean Atlas, and Regional Climatology Projects

Surface Observing Networks

- Support of NOAA's commitment to the Global Climate Observing System (GCOS) Reference Upper Air Network (Howard University)
- Generate high-quality emission products to support day-to-day operations of NOAA real-time forecasts of O_3 and $PM_{2.5}$ (fine particles <2.5μm)
- Provide science, engineering and testing support for GOES-R near-surface Unmanned Aircraft System (UAS) feasibility demonstration study

NCEI Center for Coasts, Oceans and Geophysics (CCOG)

Coral Reefs and People in a High CO_2 World

Pendleton, L., A., (including Liqing Jiang)

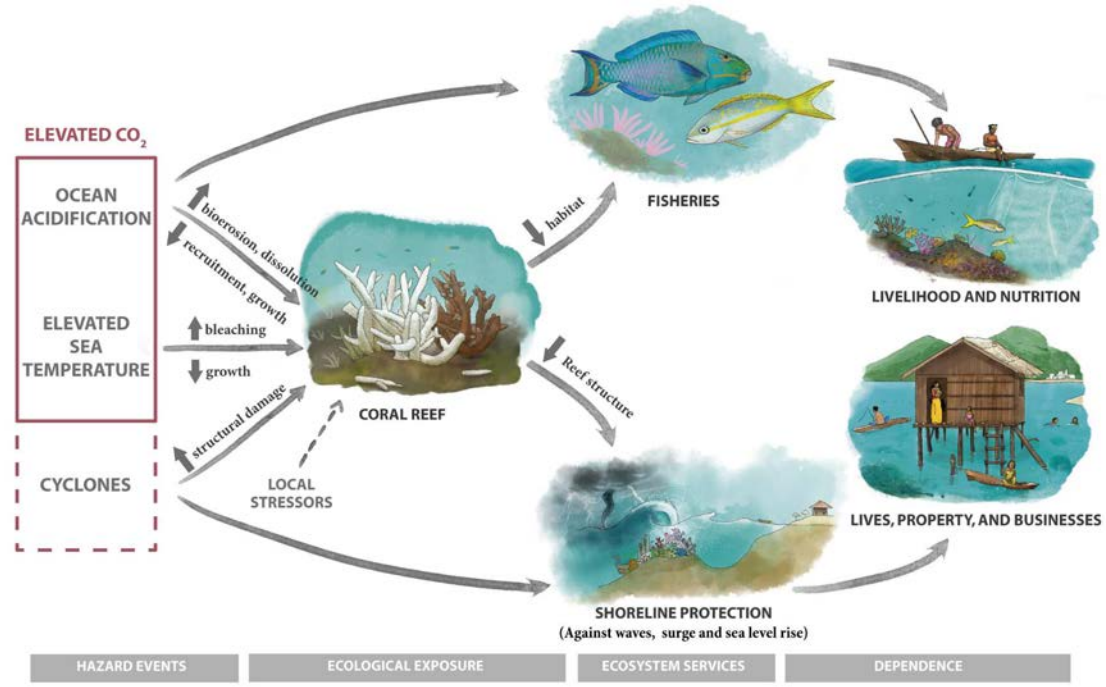
Increasing levels of carbon dioxide in the atmosphere put shallow, warm-water coral reef ecosystems, and the people who depend upon them at risk from two key global environmental stresses:

1) elevated sea surface temperature (that can cause coral bleaching and related mortality), and

2) ocean acidification.

Impacts to people will be most grave where:

a) human dependence on coral reef ecosystems is high,
b) sea surface temperature reaches critical levels soonest, and
c) ocean acidification levels are most severe.



Where these elements align, swift action will be needed to protect people's lives and livelihoods, but such action must be informed by data and science.

ARL
Air Resources Laboratory
Conducting research and development in the fields of air quality, atmospheric dispersion, and climate

Brown Carbon from Biomass Burning in the Amazon

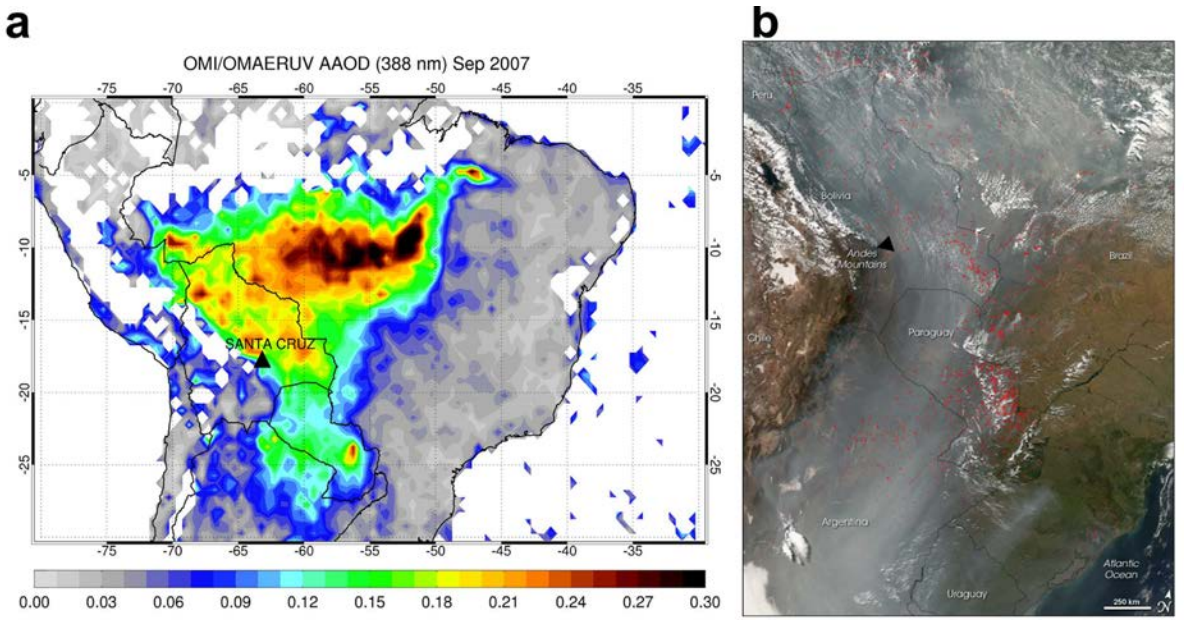
Zhanqing Li, Russ Dickerson, and Xinrong Ren

The "brown carbon," is organic carbon released into the atmosphere from burning trees and plants.

The maps to the right show

(a) aerosol absorption optical depth from the Ozone Monitoring Instrument (OMI) on the Aura Satellite and

(b) a MODIS image showing smoke and active fires in the same region.



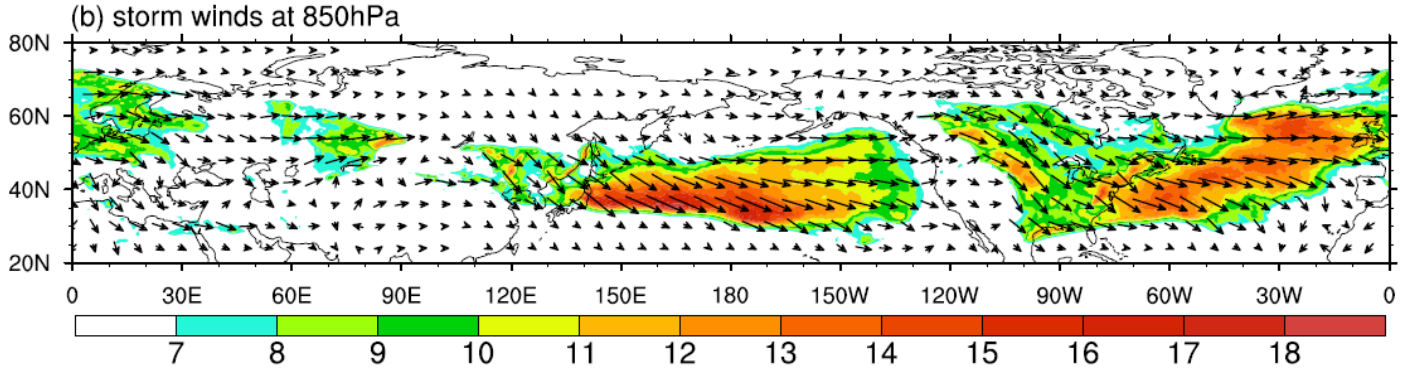
While "black carbon," also emitted from these fires, has been shown to absorb heat and contribute to global climate change, the effects of "brown carbon" are less well understood.

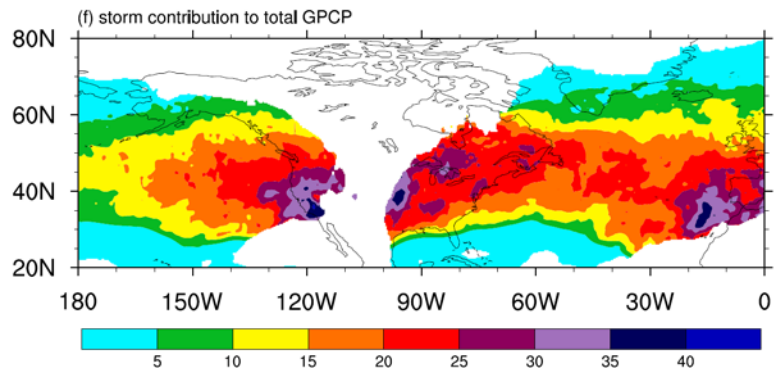
This study found that "brown carbon" did not absorb visible light but did absorb some ultraviolet radiation. As a result, it reduces UV sunburn and plant damage and also slowed the production of ozone.

CICS-MD Research Topics

Climate Research

- Evaluate precipitation and temperature forecasts in the North American Multi-Model Ensemble (NMME)
- Design, develop, and use real-time applications at CPC; refine a Subseasonal Excessive Heat Outlook System
- Explore the potential of a combined set of satellite altimeters to understand the variable circulation of the ocean and its contribution to the changing Arctic Ocean
- Investigate Storm Track contributions to high impact weather in the CFS system





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CICS-MD Research Topics

Data Assimilation and Modeling

- Improve modeling and prediction of high impact weather by assimilating GOES IR cloudy radiance data
- Evaluation of 4DVAR and LETKF in Assimilating JPSS-Derived SST in the Chesapeake Bay Operational Forecasting System
- Enhance NCEP-NAM Weather Forecasts via Assimilating Real-time GOES-R Observations of Land Surface Temperature and Green Vegetation Fraction

Incorporation of Near-Real-Time Suomi NPP Land Surface Temperature Data into the NCEP Land Modeling Suite

Zhen Song

Cooperative Institute for Climate & Satellites
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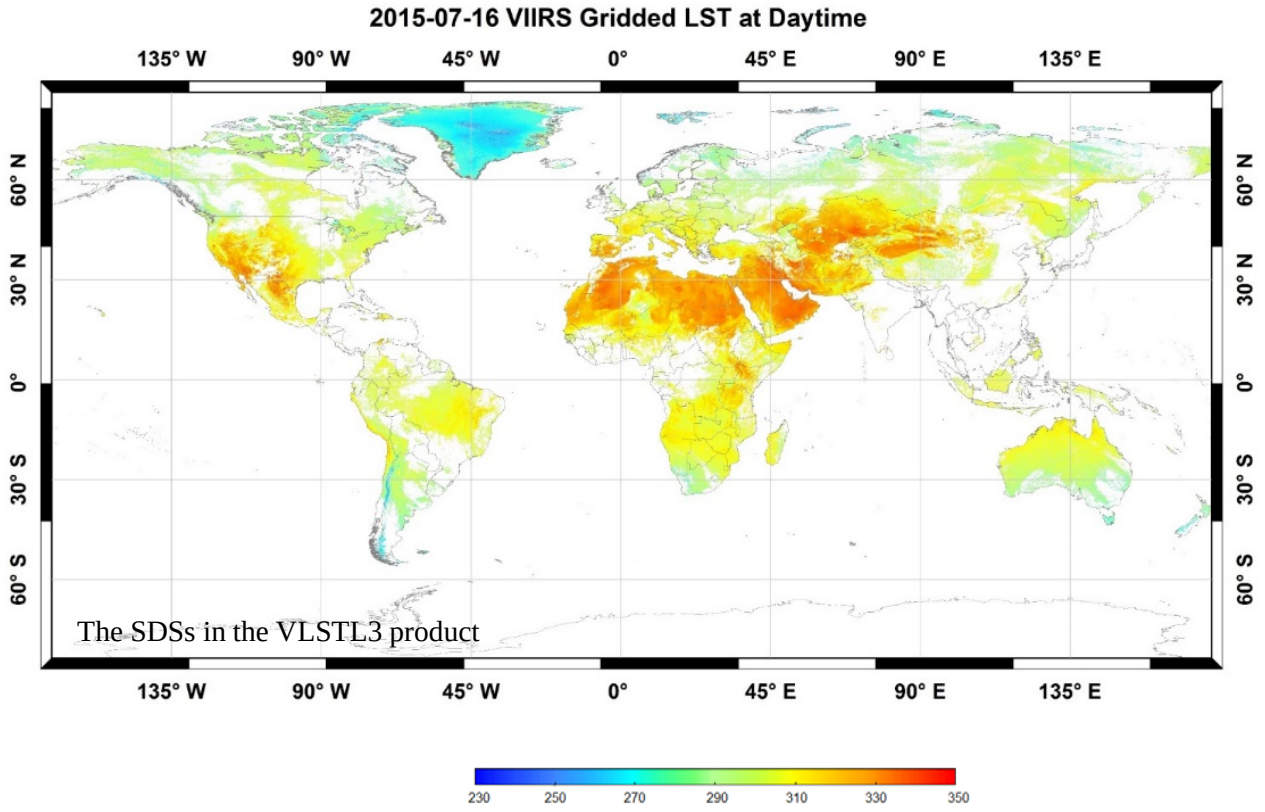
Objectives:

- Accelerate the use of VIIRS LST in a suite of NOAA's operational numerical prediction models, including NCEP NAM, NCEP GFS and NLDAS

Results:

- The methodology and software package for VIIRS Gridded LST have been developed
- The products (VLSTL3) are in testing mode and being improving



The SDSs in the VLSTL3 product

CICS-MD Research Topics

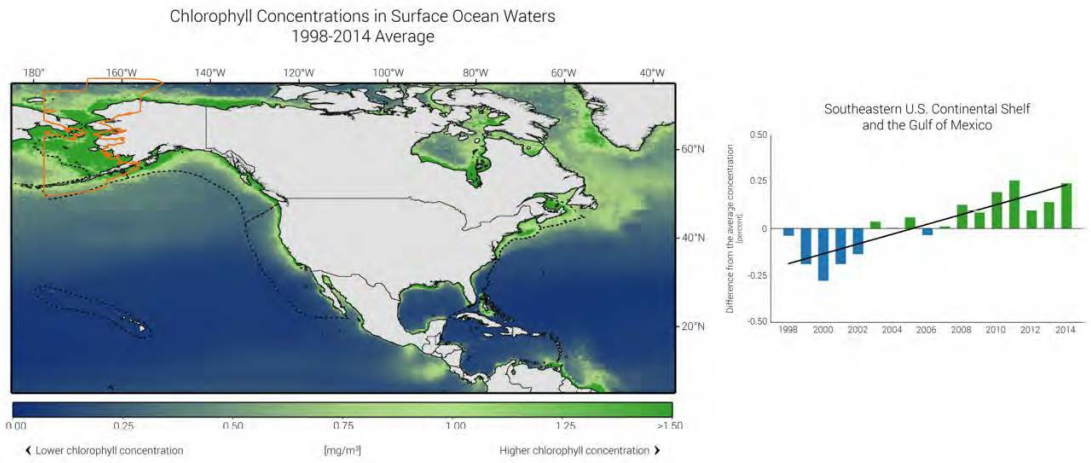
Environmental Decision Support Science

- Research, Development and Implementation of National and Regional Physical, Ecological, and Societal Climate Indicators to bring together data, observations, and indicator products to assess climate changes, impacts, vulnerabilities, and preparedness

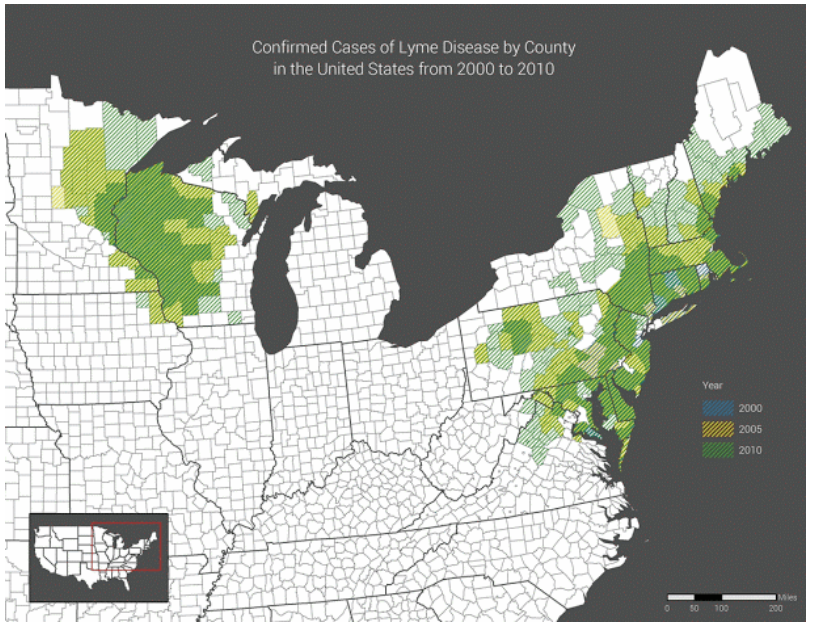
- Strengthening Coastal Community Resilience in the face of Climate Change: Science to Better Understand, Measure, and Value Coastal Ecosystem Services

- International Decision Support Systems for Food Security. Produce weather and climate hazards outlooks over Africa, Central America, and Central Asia and disseminate these climate information documents to the Famine Early Warning Systems Network partners and users

Research, Development and Implementation of
National and Regional Physical, Ecological, and Societal Climate Indicators for the NOAA and the USGCRP National Climate Assessment
Melissa Kenney



Ocean Chlorophyll Concentrations. Designed as an interactive indicator

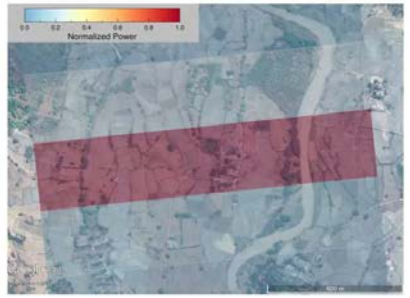


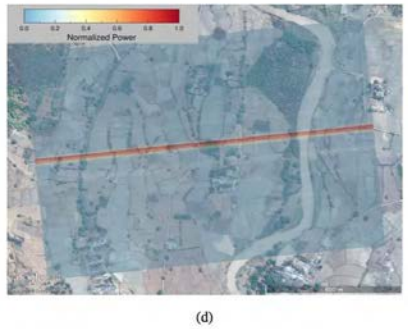
Spread of Lyme disease over time, a new indicator developed in collaboration with researchers from Centers of Disease Control.

CICS-MD Research Topics

Earth System Monitoring from Satellites

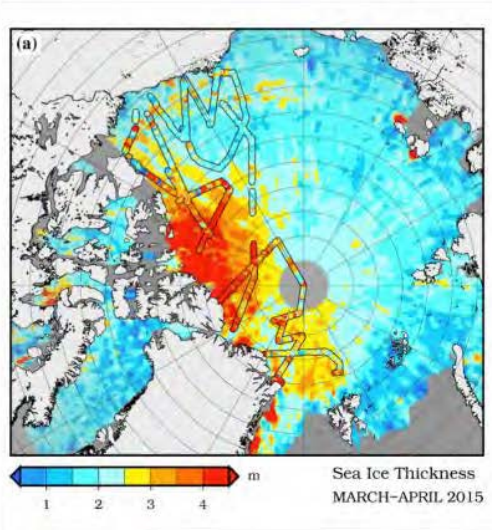
- Enhance Agricultural Drought Monitoring Using NPP/JPSS Land Environmental Data Records for NIDIS
- Research and Development Towards Operational Arctic Snow and Sea ice Thickness Products
- Improve the precision and along-track resolution of satellite altimeters by advanced synthetic aperture radar (SAR) processing techniques



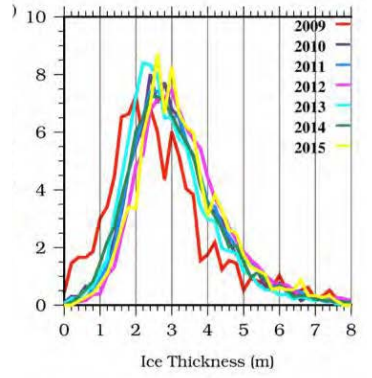


(d)

Google Earth image showing the delay/ Doppler response and the fully focused SAR response after deconvolution.



Winter Arctic sea ice thickness from the OIB Quick Look product spanning 19 March - 3 April, 2015



Sea ice thickness distributions for ice in the central Arctic

CICS-MD Accomplishments

Training, Outreach and Education

- The CICS-MD Summer Initiative series, hosting 15-25 students each year, provides training and outreach opportunities for both graduate and undergraduate students.
- CICS-MD Proving Ground and Training Center to support from GOES-R and JPSS Programs
- Maintain the Washington D.C. Lightning Mapping Array and monitor in real time the Lightning Detection Network Performance
- Routine product Tele-Training for NWSFO Forecasters
- About 14 students formally advised
- About 9 graduate students supported by a CICS task

Research to Operations

GOES Evapotranspiration (ET) and Drought Product System (GET-D)

Christopher Hain, Li Fang, Xiwu Zhan

This project aims to build the GOES ET and drought product system (GET-D) to **operationally generate ET and drought monitoring products at the NOAA Office of Satellite and Product Operations (OSPO)**

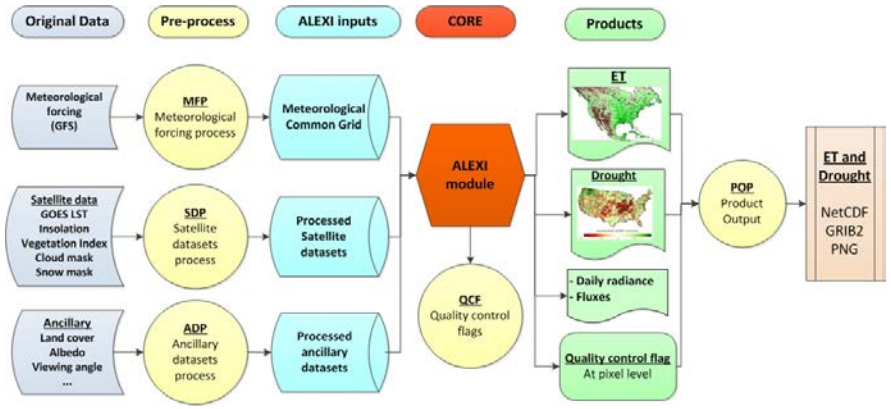


Figure 1. GOES Evapotranspiration and Drought Product (GET-D) system design

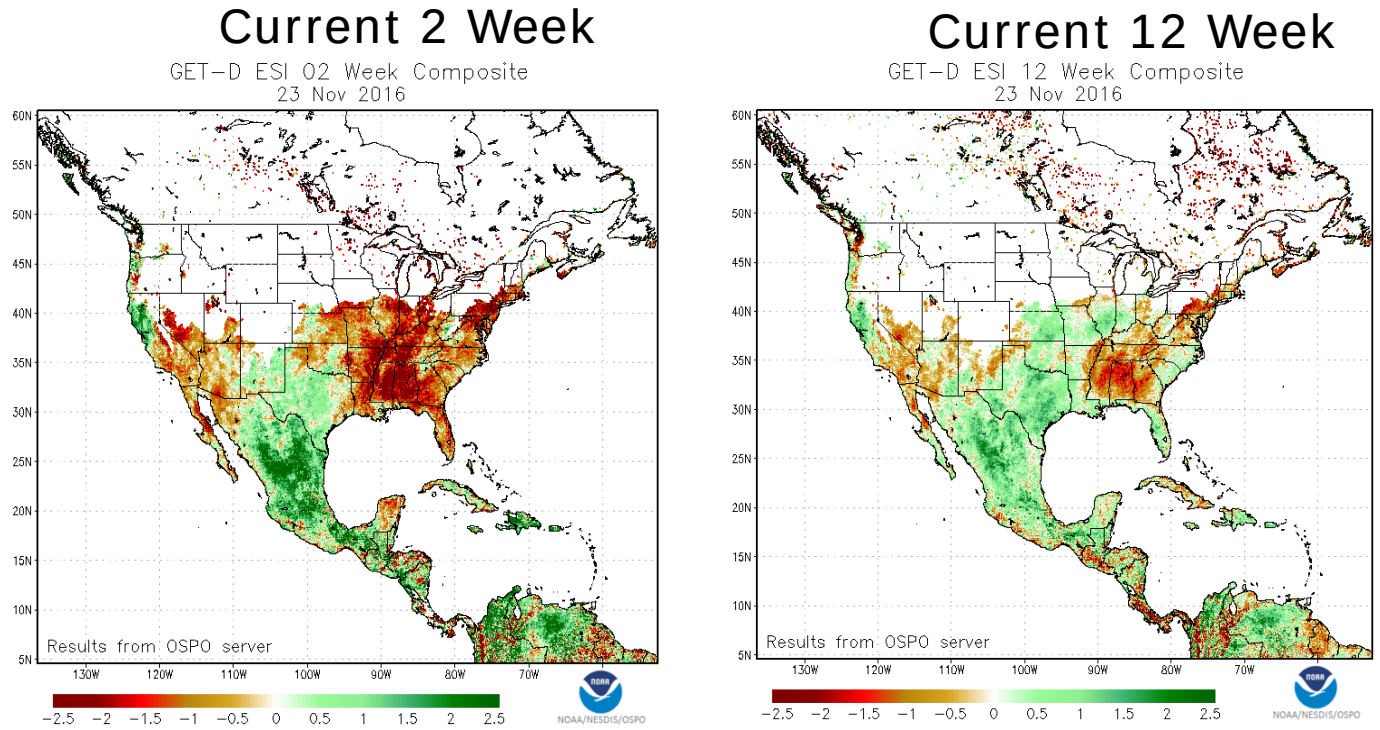


Figure 2. Examples of ESI composites from the GET-D system

CICS-MD Accomplishments

2015 Accomplishments

- Participation in International Conferences, AGU, AMS
  - *AGU: ~80 presentations 34 talks (11 were invited) and 45 posters.*
  - *AMS: ~70 presentations 36 talks (2 were invited) and 27 posters.*
- *Publications*
  - *137 Peer reviewed papers*
- *Research to Operations*
  - *109 new or improved products developed*
  - *66 products/techniques submitted for consideration in operations use at NOAA*

Thanks