Current and Potential Satellite Data Applications for the Air Resources Laboratory Air Quality, Dispersion, and Deposition Programs

Richard Artz
NOAA Air Resources Laboratory, College Park, Maryland

with contributions from Tianfeng Chai, Alice Crawford, Pius Lee, Ariel Stein, Daniel Tong, …and many others

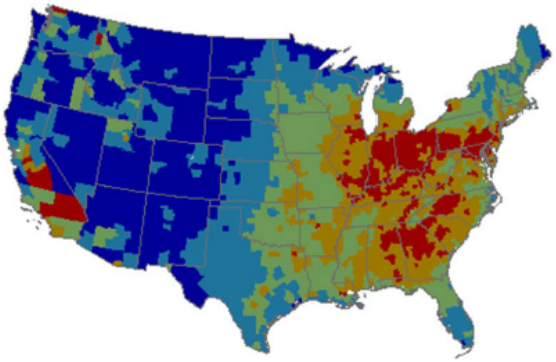
August 25, 2015

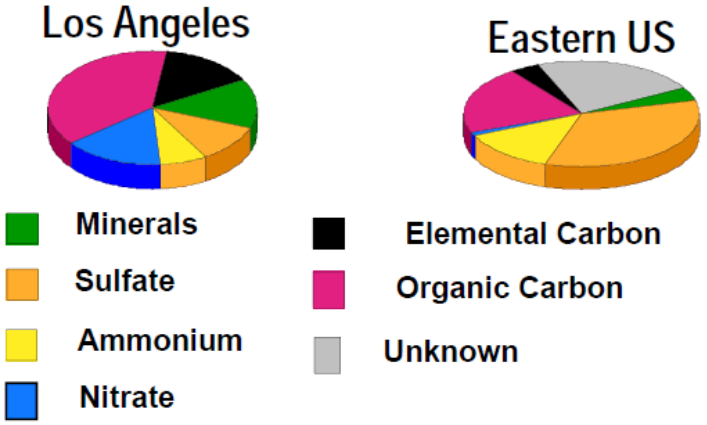
Slide "borrowed" from Dan Costa "New Directions in Air Quality Research at the US EPA"

Public Health Burden of $PM_{2.5}$

(Fann et al., 2011)

Percentage of $PM_{2.5}$ related deaths due to 2005 air quality levels by county



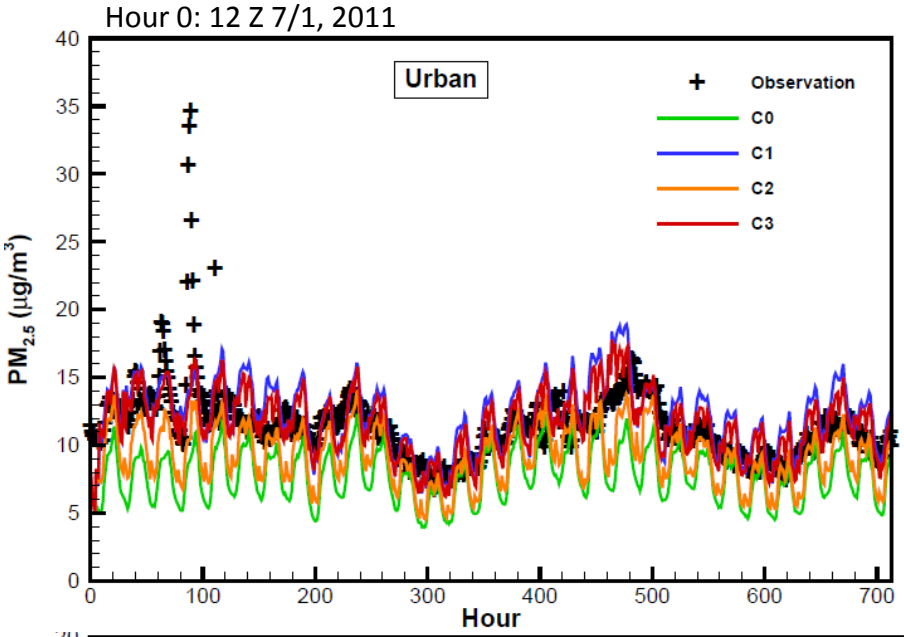


Summary of National $PM_{2.5}$ impacts due to 2005 air quality	
Excess mortalities (adults)[A]	130 to 320,000
Percentage of all deaths due to $PM_{2.5}$[B]	5.4%
Impacts among Children	
ER visits for asthma (<18 yr)	110,000
Acute bronchitis (age 8-12)	200,000
Exacerbation of asthma (age 6-18)	2,500,000

[A] Range reflects use of alternate PM mortality estimates
[B] Population-weighted value using Krewski et al. (2009) PM mortality estimates

NAQFC $PM_{2.5}$ Forecasts with AOD assimilation

Cases	12Z	17Z	18Z	20Z	00Z*	06Z*
C0	-	-	-	-	-	-
C1	-	Terra total AOD	-	Aqua total AOD	-	-
C2	$PM_{2.5}$	-	$PM_{2.5}$	-	$PM_{2.5}$	$PM_{2.5}$
C3	$PM_{2.5}$	Terra total AOD	$PM_{2.5}$	Aqua total AOD	$PM_{2.5}$	$PM_{2.5}$

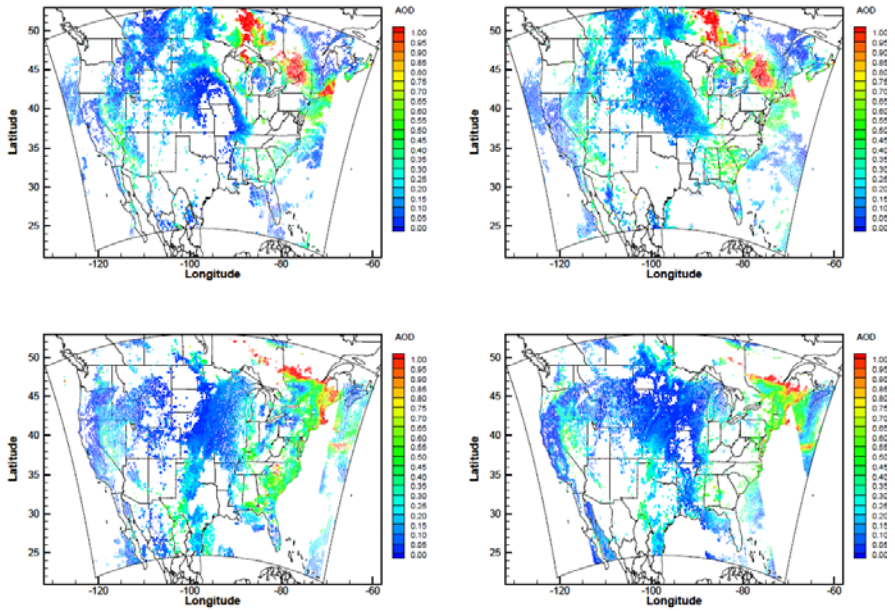


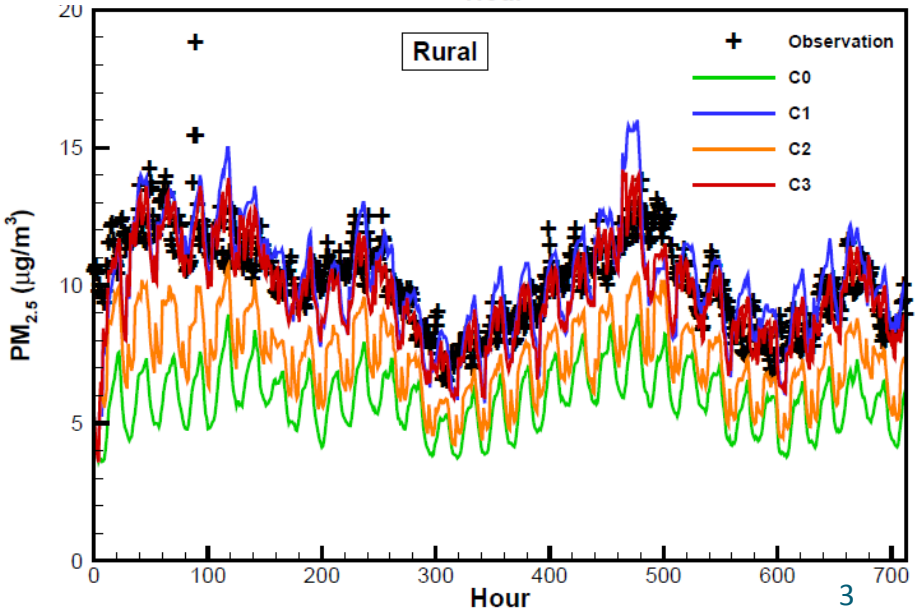
Terra

Aqua

7/19, 2011

7/20, 2011





Ozone Mapping and Profiler Suite (OMPS)

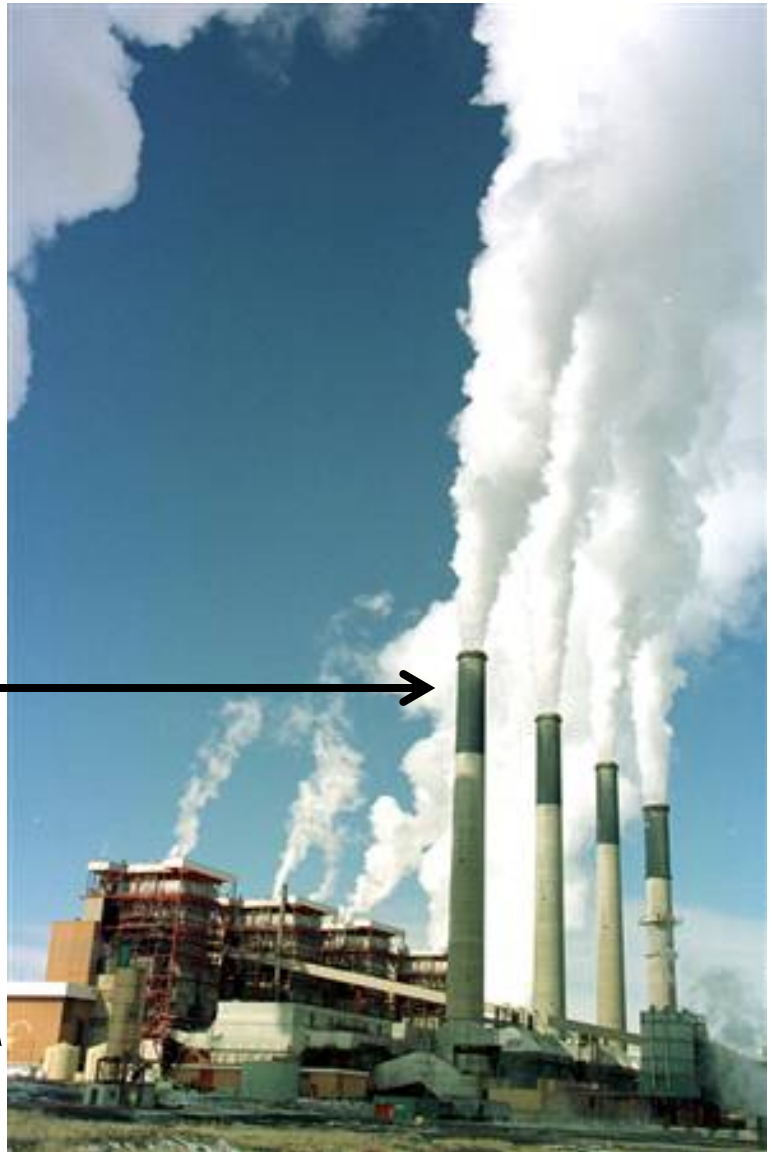
NO_2, SO_2, & HCHO data

OMPS detects pollution in the lower levels of the column

CEMS (Continuous Emission Monitoring System)

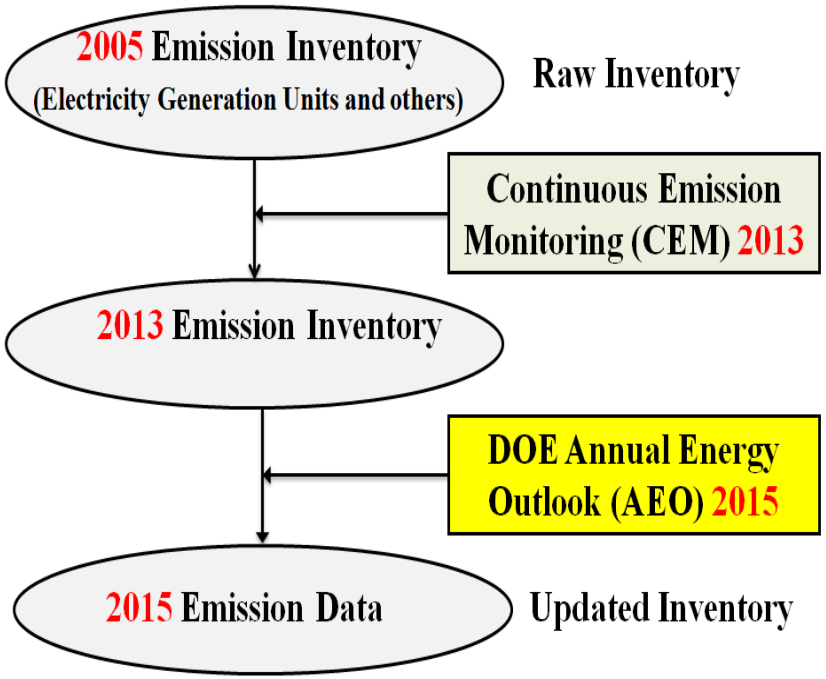
The AQS (Air Quality System) surface sites detect near-surface concentrations

OMPS detects large plumes



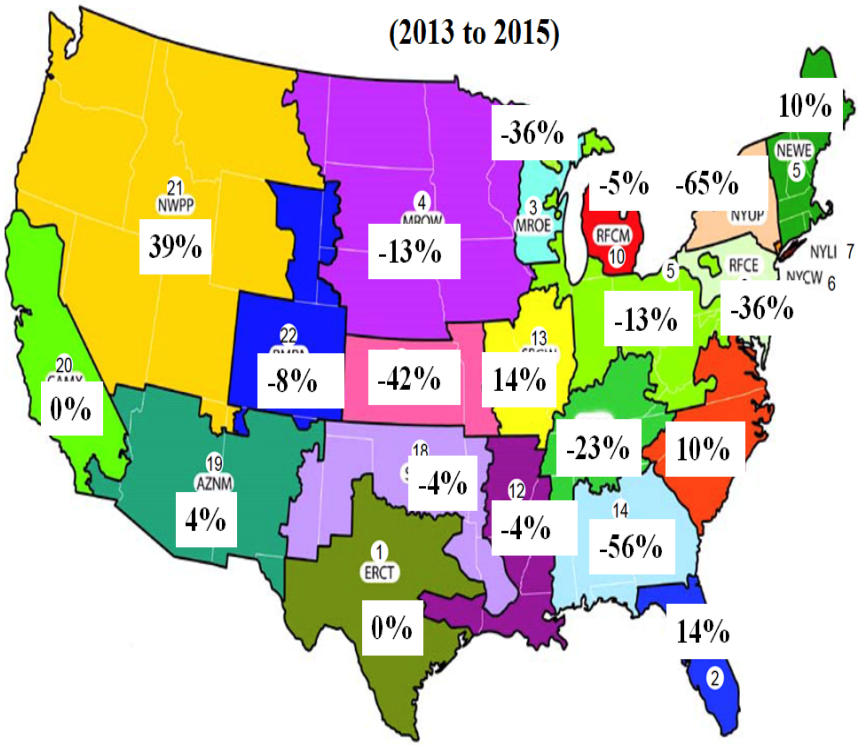
SO2 Emissions from Large Power Plants

NAQFC Point Source Emission Processing

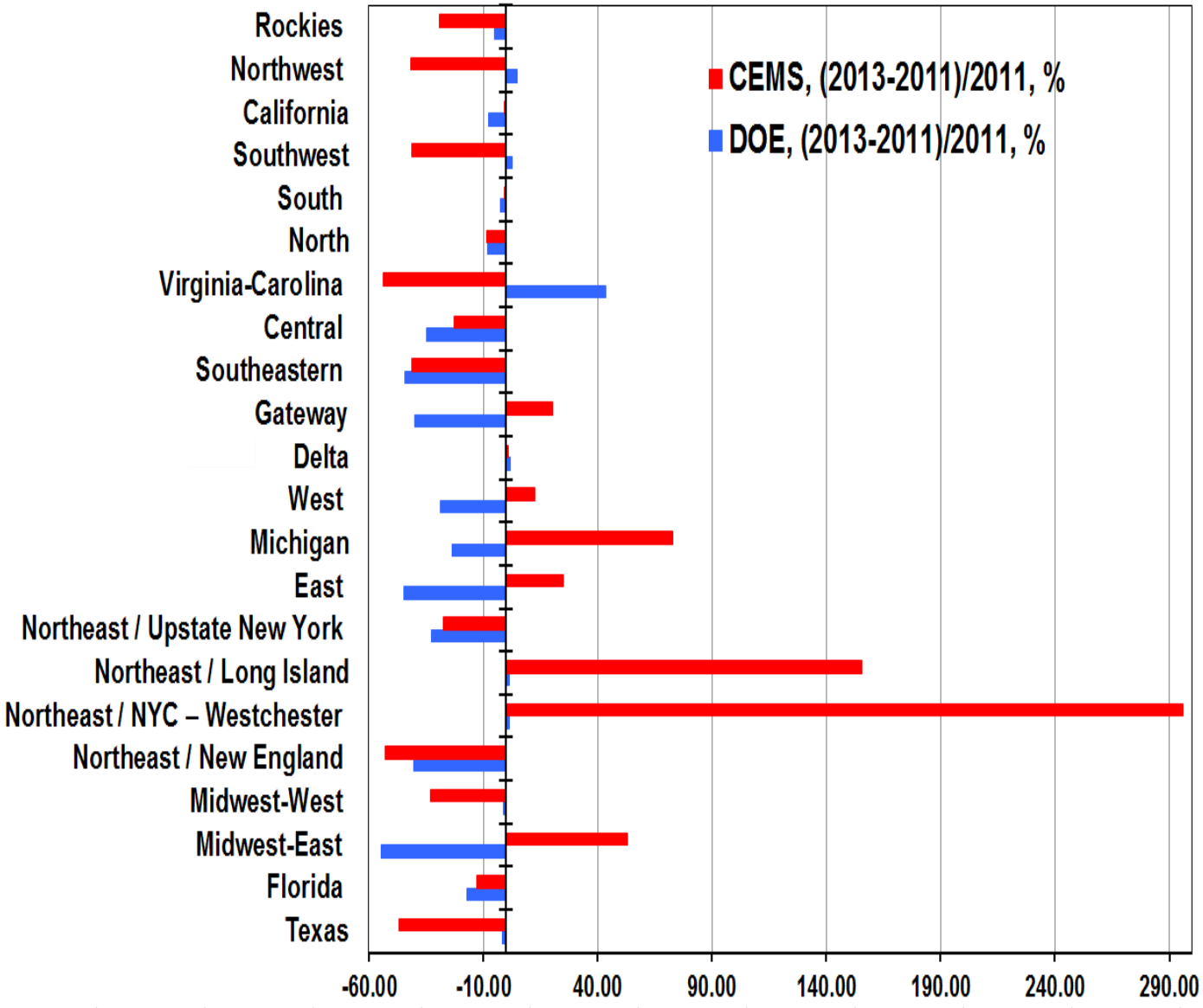


DOE SO2 Emission Projection

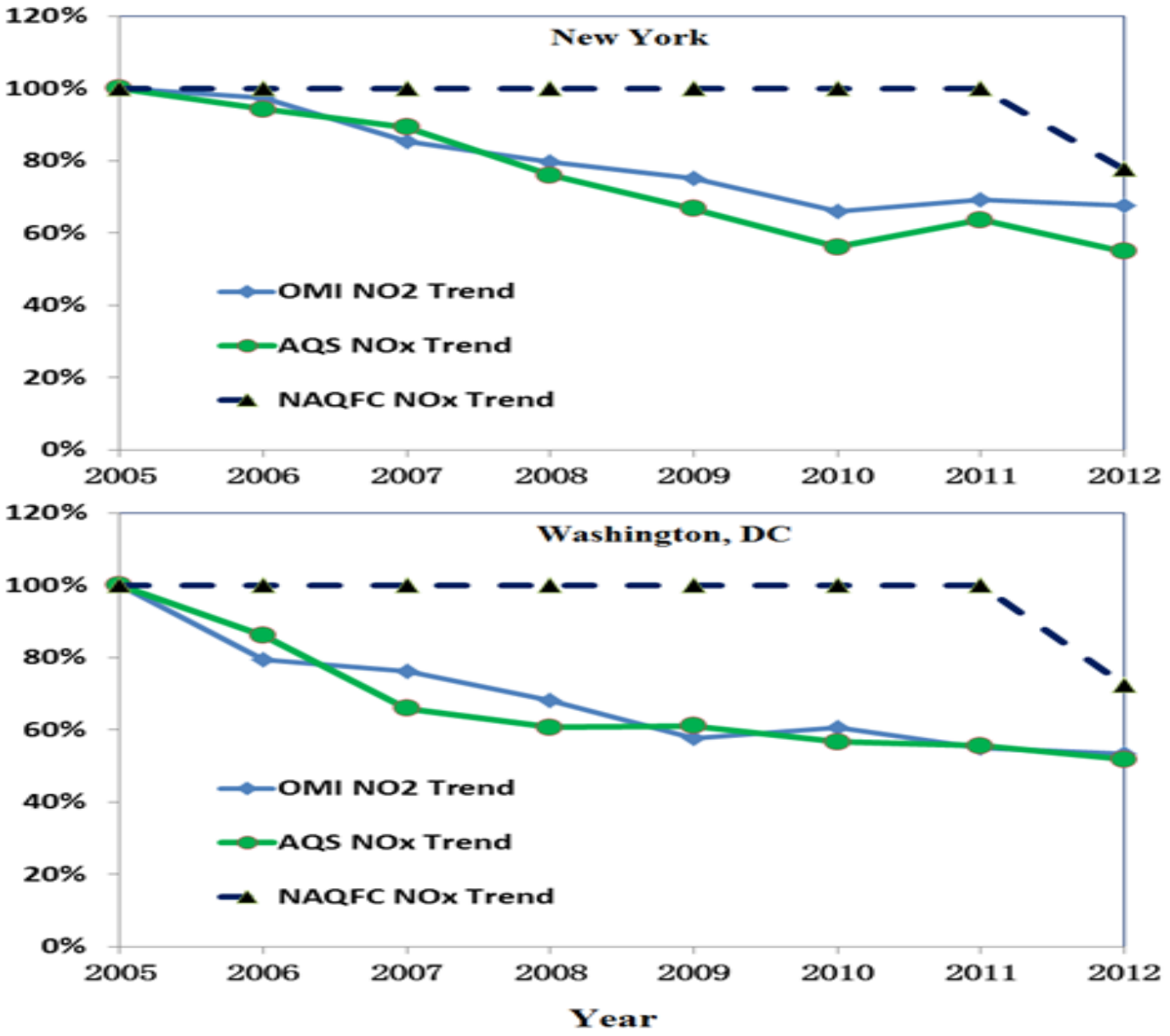
(2013 to 2015)



Comparison of DOE Projections with Measurements

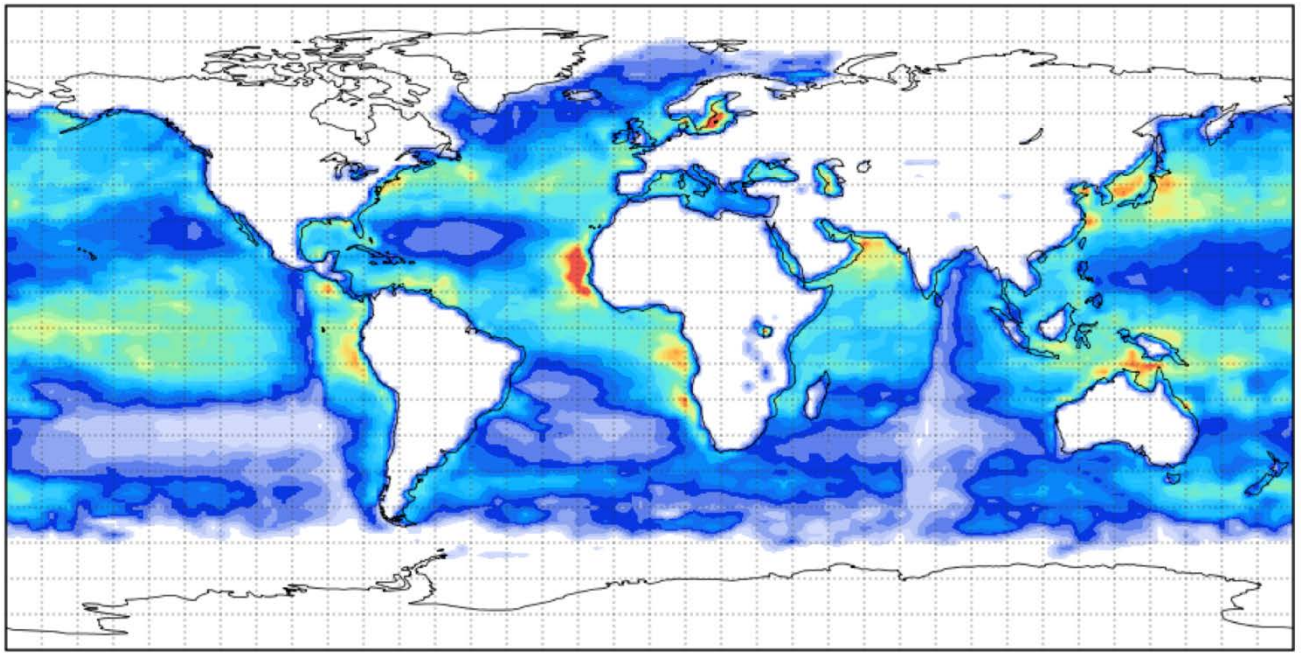


Another Application: OMPS NO2

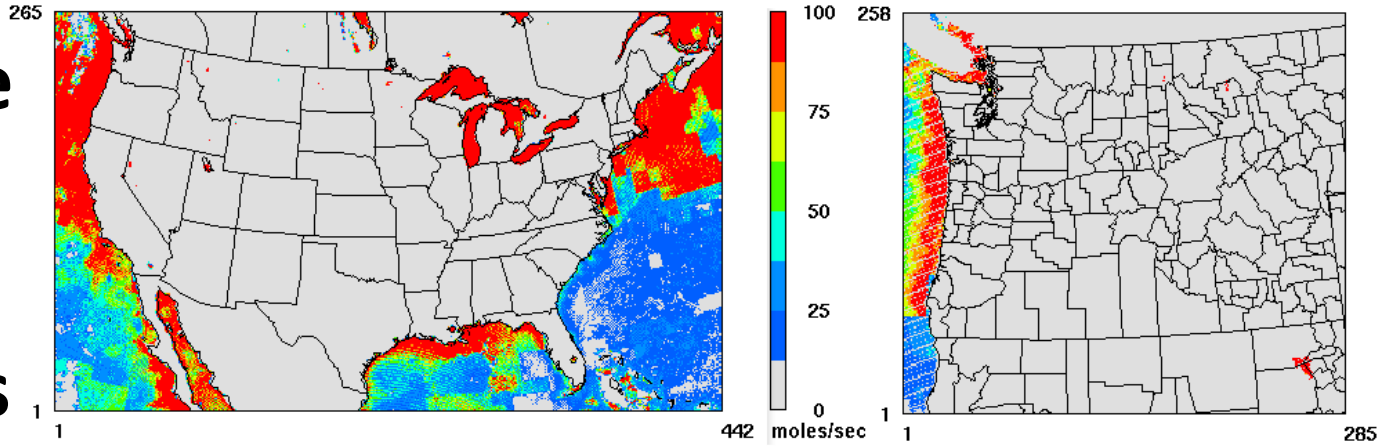


VIIRS Marine Isoprene Emission

Global Isoprene (April 2014)

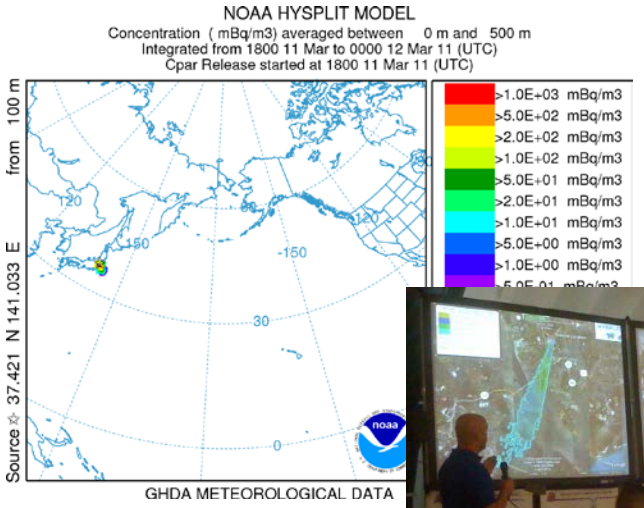


Isoprene into model domains

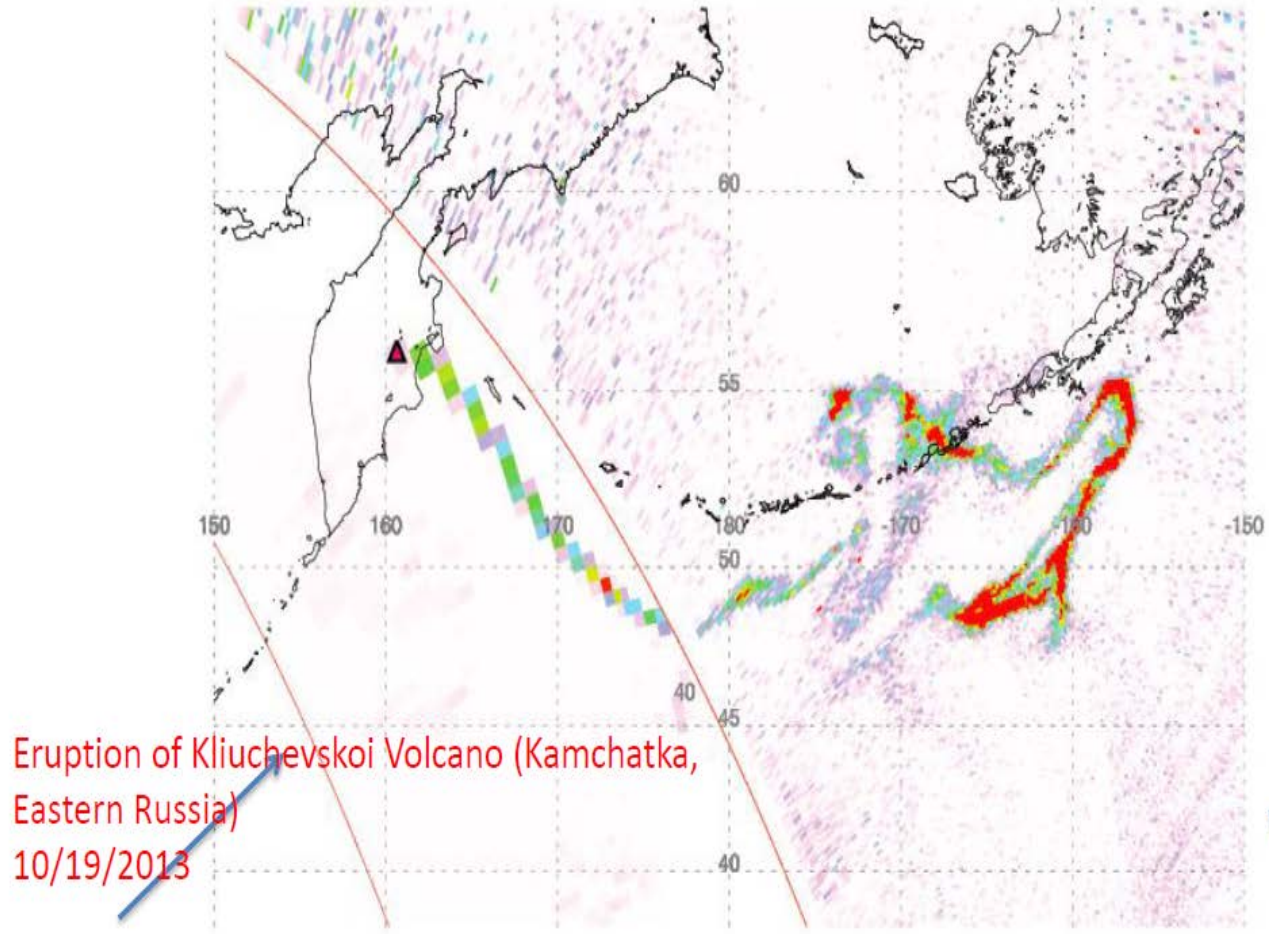


Atmospheric Transport and Dispersion

Dispersion Modeling System



NPP/OMPS Orbits 10253 & 10252 -- 10/19/2013 - 10/20/2013



Volcanic Ash Forecasting for Aviation

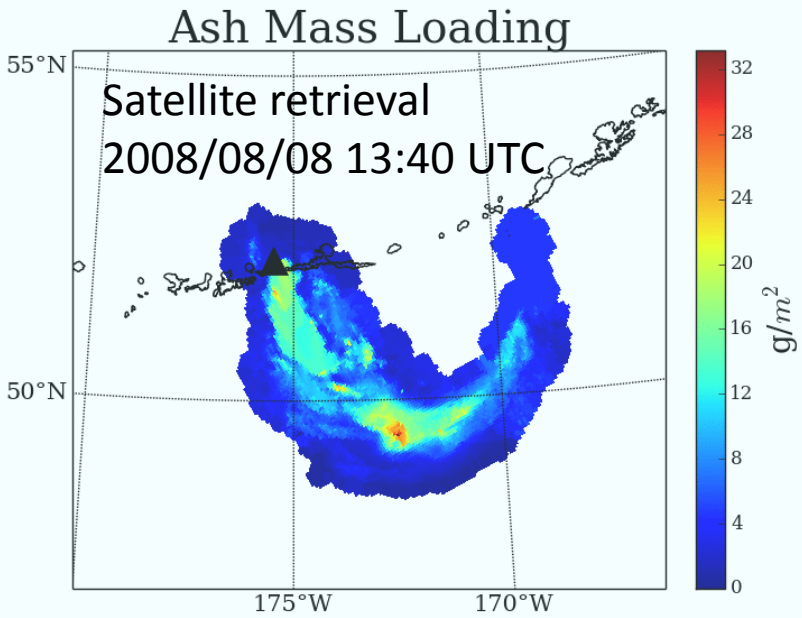
CURRENT: Ash source term subject to large uncertainties (estimate of mass of ash can be off by orders of magnitude). Satellite observations ➡ Human ➡ Model

Satellite based Volcanic Ash Retrieval Algorithm from NOAA/CIMSS

http://volcano.ssec.wisc.edu/.

Quantitative Information

- Mass loading
- Top height
- Effective radius



2008 Eruption of Kasatochi, Aleutian Islands.

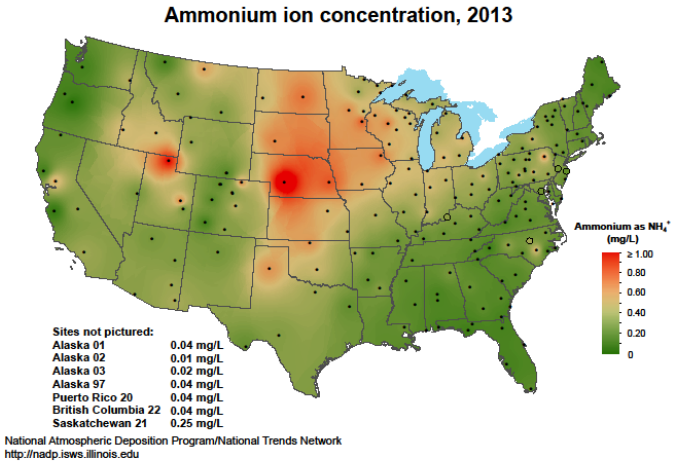
Ash retrievals were provided by Michael Pavolonis and are available at ftp://ftp.ssec.wisc.edu/pub/geocat/noaa_ash_retv/kasatochi

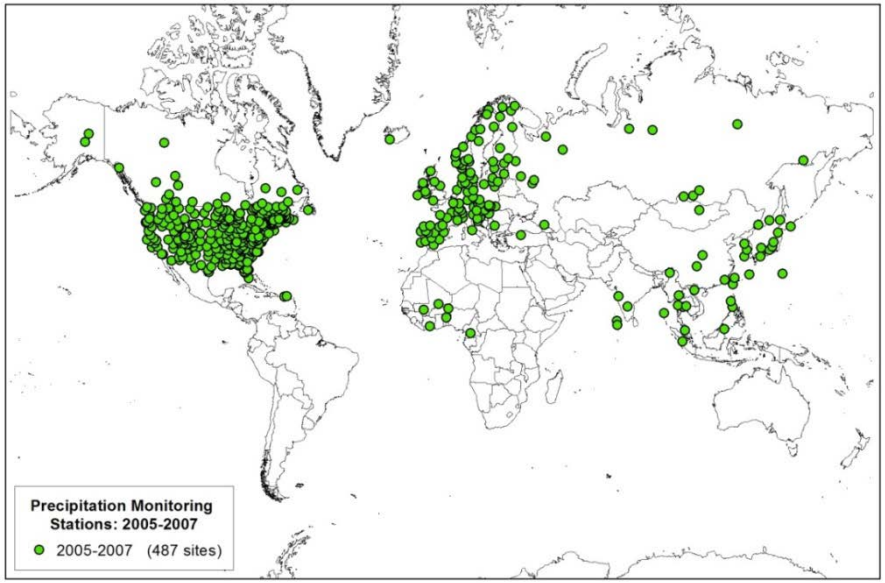
PROPOSED:

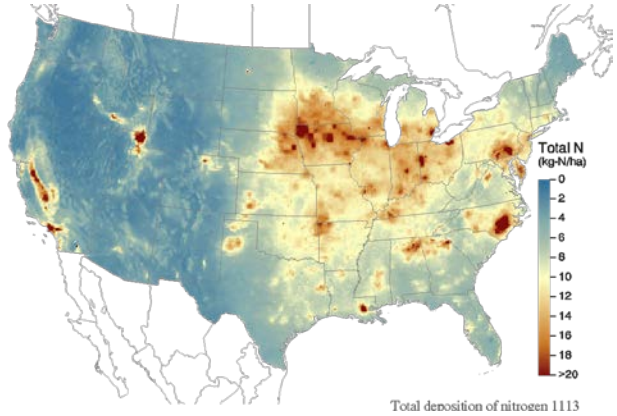
Satellite retrieval ➡ Model

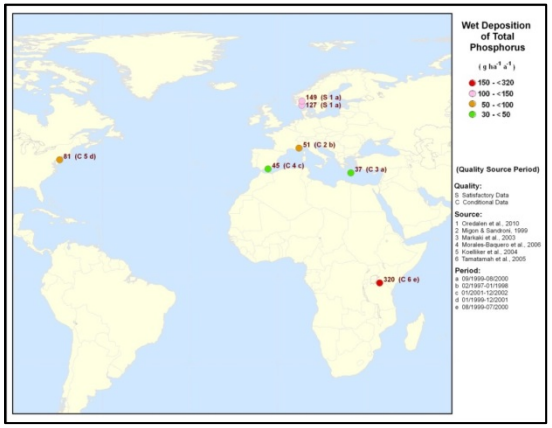
- Improve Source term (3 different approaches):
  - Amount of mass determined by matching HYSPLIT output with measured mass loading.
  - Source constructed from measurement of mass loading, top height and effective radius. Ash initiated at observed position rather than at the volcano vent.
  - Inversion algorithm utilizes satellite measurements to determine likely emission profile at the vent (ash mass as a function of time and height).
- Evaluation of model output using satellite measurements.
  - Evaluation statistics used to direct model development efforts.
  - Provide information to VAAC on model performance as an eruption is unfolding.

Wet and Dry Atmospheric Deposition





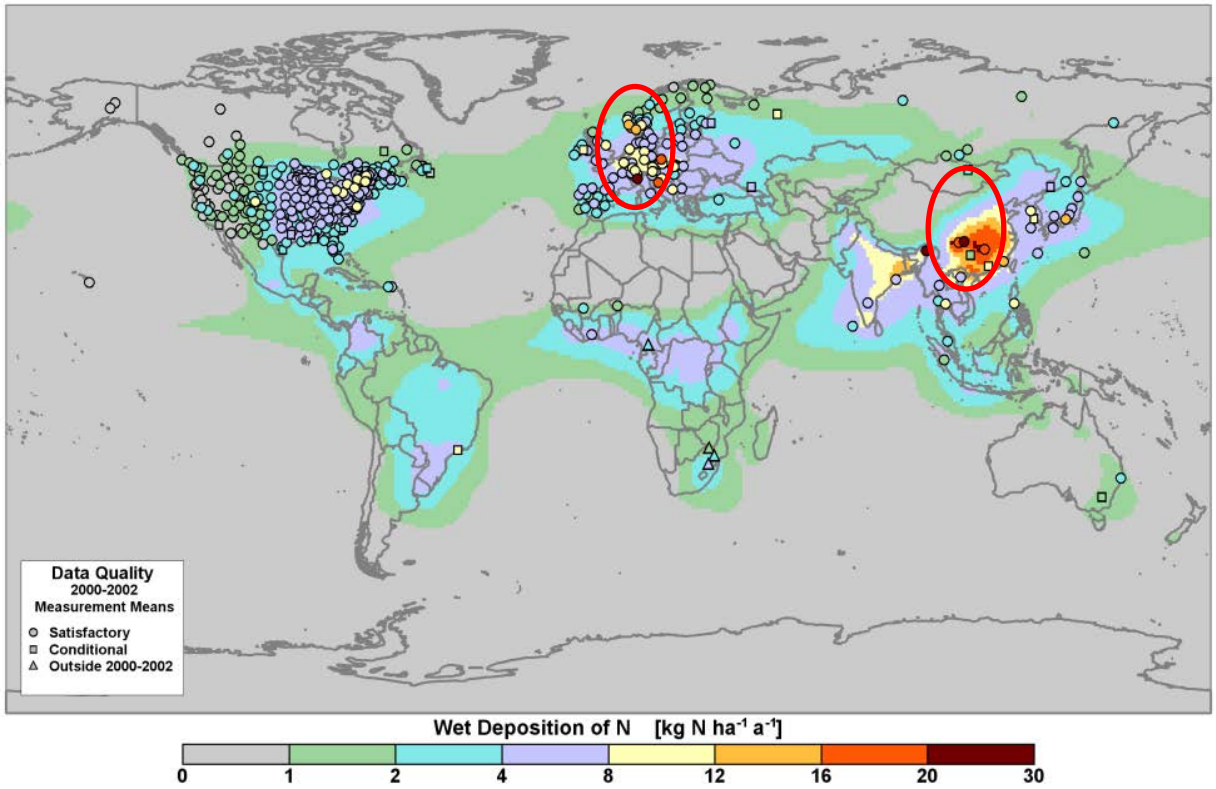




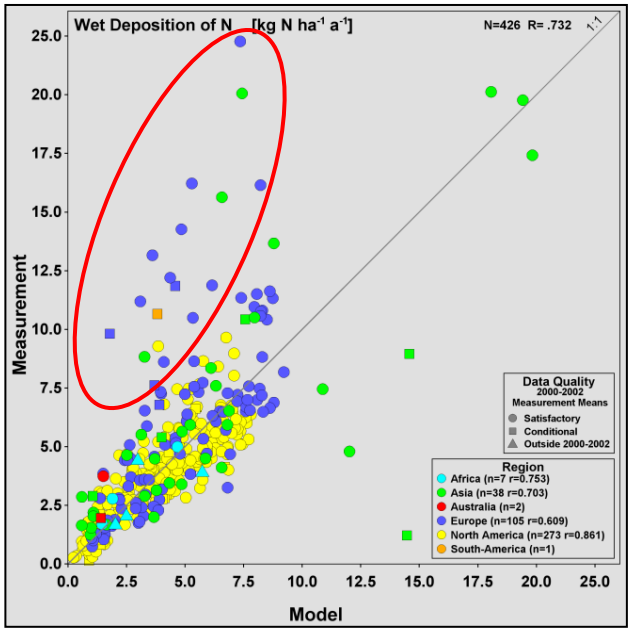
Deposition of Major Ions Nationally and Globally

Nitrogen

Wet deposition of Oxidized + Reduced Nitrogen



Model versus Measurement Results



- High deposition in eastern North America, Europe and Asia
- Reasonable model-measurement comparability except in Europe and parts of Asia

Slide courtesy of R. Vet

AGU PUBLICATIONS

Global Biogeochemical Cycles

RESEARCH ARTICLE
10.1002/2014GB004805

Global dry deposition of nitrogen dioxide and sulfur dioxide inferred from space-based measurements

C. R. Nowlan[1,2], R. V. Martin[1,2], S. Philip[1], L. N. Lamsal[3], N. A. Krotkov[3], E. A. Marais[4], S. Wang[5], and Q. Zhang[6]

[1]Department of Physics and Atmospheric Science, Dalhousie University, Halifax, Nova Scotia, Canada, [2]Atomic and Molecular Physics Division, Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts, USA, [3]NASA Goddard Space Flight Center, Greenbelt, Maryland, USA, [4]Earth and Planetary Sciences, Harvard University, Cambridge, Massachusetts, USA, [5]School of Environment, Tsinghua University, Beijing, China, [6]Center for Earth System Science, Tsinghua University, Beijing, China

Key Points:
- NO_2 and SO_2 dry deposition is derived from space-based measurements
- Global and regional budgets of dry deposition are determined
- NO_2 and SO_2 deposition in urban areas is examined

Correspondence to:
C. R. Nowlan,
cnowlan@cfa.harvard.edu

Citation:
Nowlan, C. R., R. V. Martin, S. Philip, L. N. Lamsal, N. A. Krotkov, E. A. Marais, S. Wang, and Q. Zhang (2014), Global dry deposition of nitrogen dioxide and sulfur dioxide inferred from space-based measurements, *Global Biogeochem. Cycles*, *28*, 1025–1043, doi:10.1002/2014GB004805.

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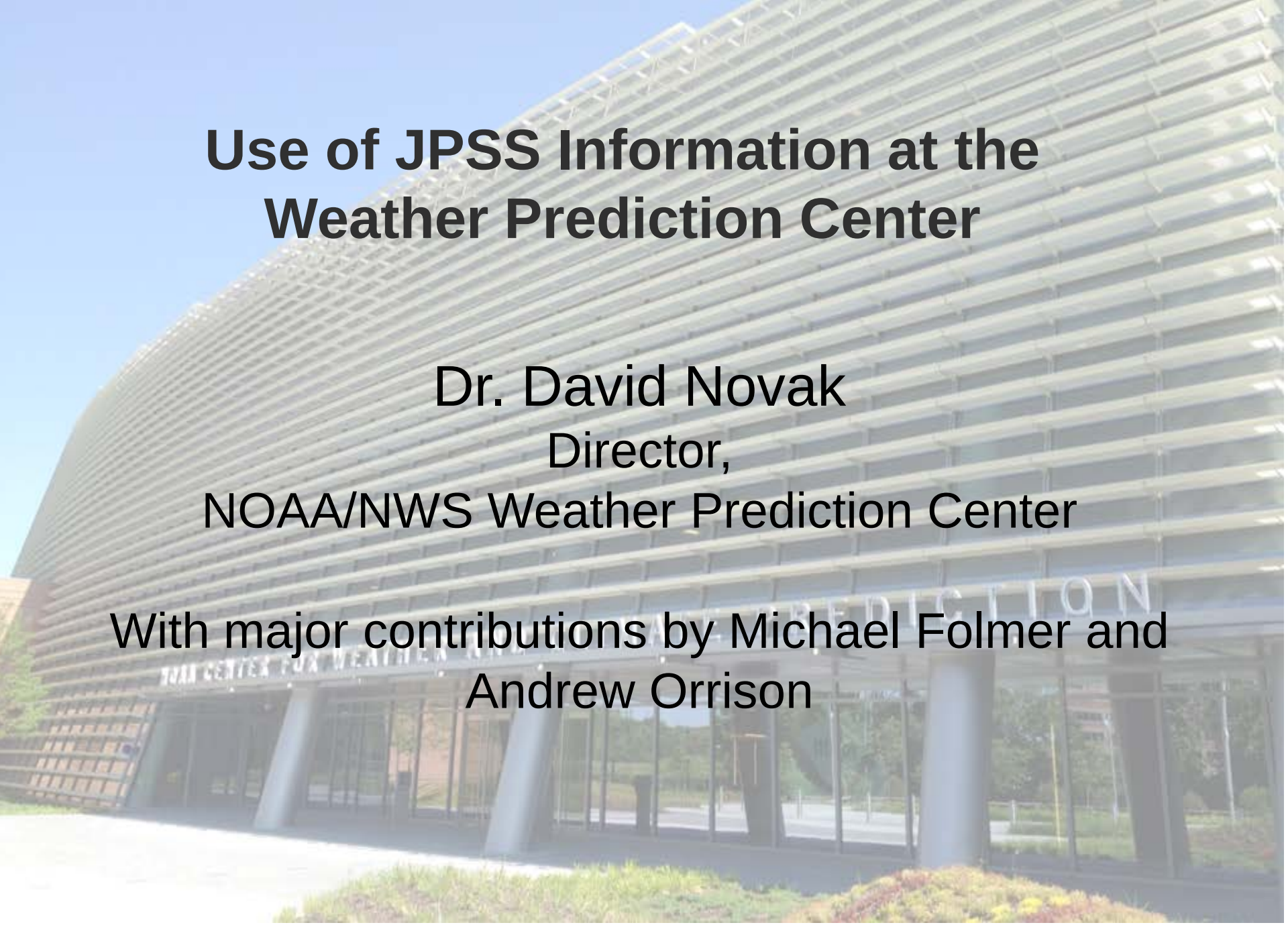
Abstract A method is developed to estimate global NO_2 and SO_2 dry deposition fluxes at high spatial resolution (0.1° × 0.1°) using satellite measurements from the Ozone Monitoring Instrument (OMI) on the Aura satellite, in combination with simulations from the Goddard Earth Observing System chemical transport model (GEOS-Chem). These global maps for 2005–2007 provide a data set for use in examining global and regional budgets of deposition. In order to properly assess SO_2 on a global scale, a method is developed to account for the geospatial character of background offsets in retrieved satellite columns. Globally, annual dry deposition to land estimated from OMI as NO_2 contributes 1.5 ± 0.5 Tg of nitrogen and as SO_2 contributes 13.7 ± 4.0 Tg of sulfur. Differences between OMI-inferred NO_2 dry deposition fluxes and those of other models and observations vary from excellent agreement to an order of magnitude difference, with OMI typically on the low end of estimates. SO_2 dry deposition fluxes compare well with in situ Clear Air Status and Trends Network-inferred flux over North America (slope = 0.98, r = 0.71). The most significant NO_2 dry deposition flux to land per area occurs in the Pearl River Delta, China, at 13.9 kg N ha^{-1} yr^{-1}, while SO_2 dry deposition has a global maximum rate of 72.0 kg S ha^{-1} yr^{-1} to the east of Jinan in China's Shandong province. Dry deposition fluxes are explored in several urban areas, where NO_2 contributes on average 9–36% and as much as 85% of total NO_y dry deposition.



Use of JPSS Information at the Weather Prediction Center

Dr. David Novak

Director,

NOAA/NWS Weather Prediction Center

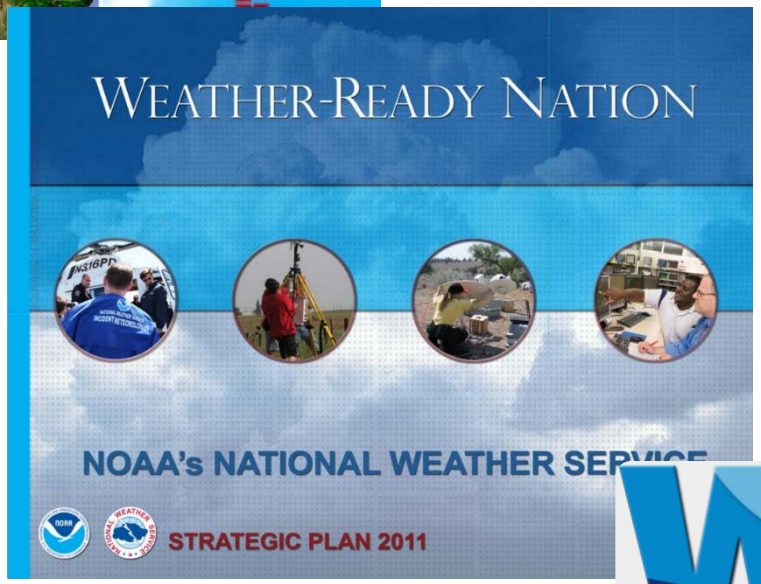
With major contributions by Michael Folmer and Andrew Orrison

Building a Weather-Ready-Nation

Users need and demand:

- **Accuracy**
- **Consistency**
- **Understandable Messaging**

Just one missing link can result in bad decisions

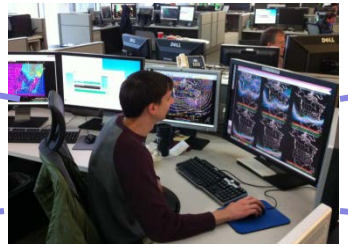


WRN

Weather Prediction Center

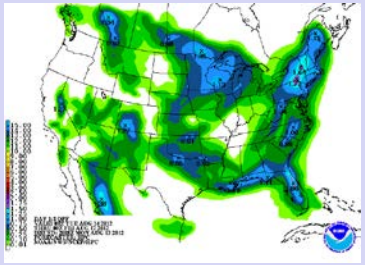
WPC Products and Services

International Model Guidance Suite
NCEP, MDL, CMC, NAEFS, ECMWF, UKMET, FNMOC

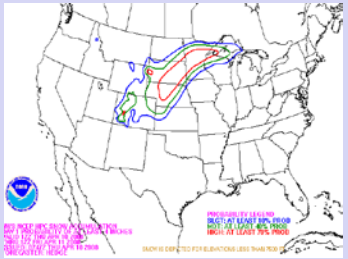


~500 products a day

Medium Range

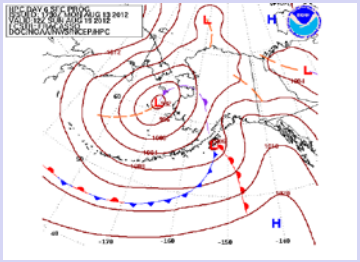


QPF

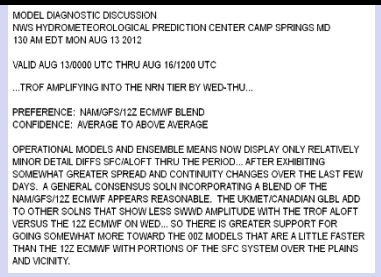


Winter Weather

Met Watch



Alaska



MODEL DIAGNOSTIC DISCUSSION
NWS HYDROMETEOROLOGICAL PREDICTION CENTER CAMP SPRINGS MD
130 AM EDT MON AUG 13 2012

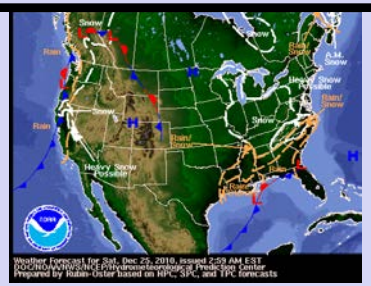
VALID AUG 13/0000 UTC THRU AUG 16/1200 UTC

...TROF AMPLIFYING INTO THE NRN TIER BY WED-THU...

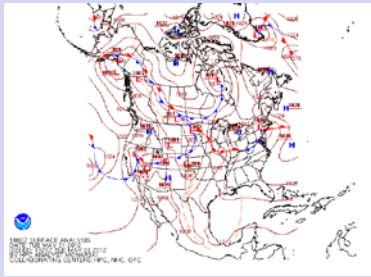
PREFERENCE: NAM/GFS/12Z ECMWF BLEND
CONFIDENCE: AVERAGE TO ABOVE AVERAGE

OPERATIONAL MODELS AND ENSEMBLE MEANS NOW DISPLAY ONLY RELATIVELY MINOR DETAIL DIFFS SFC/ALOFT THRU THE PERIOD... AFTER EXHIBITING SOMEWHAT GREATER SPREAD AND CONTINUITY CHANGES OVER THE LAST FEW DAYS. A GENERAL CONSENSUS SOLN INCORPORATING A BLEND OF THE NAM/GFS/12Z ECMWF APPEARS REASONABLE. THE UKMET/CANADIAN GLBL ADD TO OTHER SOLNS THAT SHOW LESS SWWD AMPLITUDE WITH THE TROF ALOFT VERSUS THE 12Z ECMWF ON WED... SO THERE IS GREATER SUPPORT FOR GOING SOMEWHAT MORE TOWARD THE 00Z MODELS THAT ARE A LITTLE FASTER THAN THE 12Z ECMWF WITH PORTIONS OF THE SFC SYSTEM OVER THE PLAINS AND VICINITY.

Model Diagnostics



Short Range



Analysis

7 Days ——— forecast lead time ———→ hours

Operational Use of LEO information

Key Operational Uses

-Higher resolution data improves situational awareness

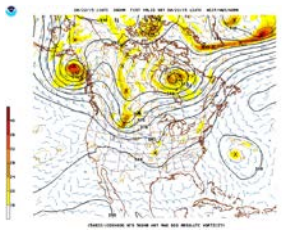
-Provides information to validate model initializations

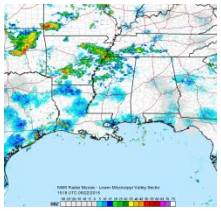
Key Operational Limitation

Getting a pass to overlap area of highest interest

GRAND CHALLENGE: Integration of LEO and GEO information

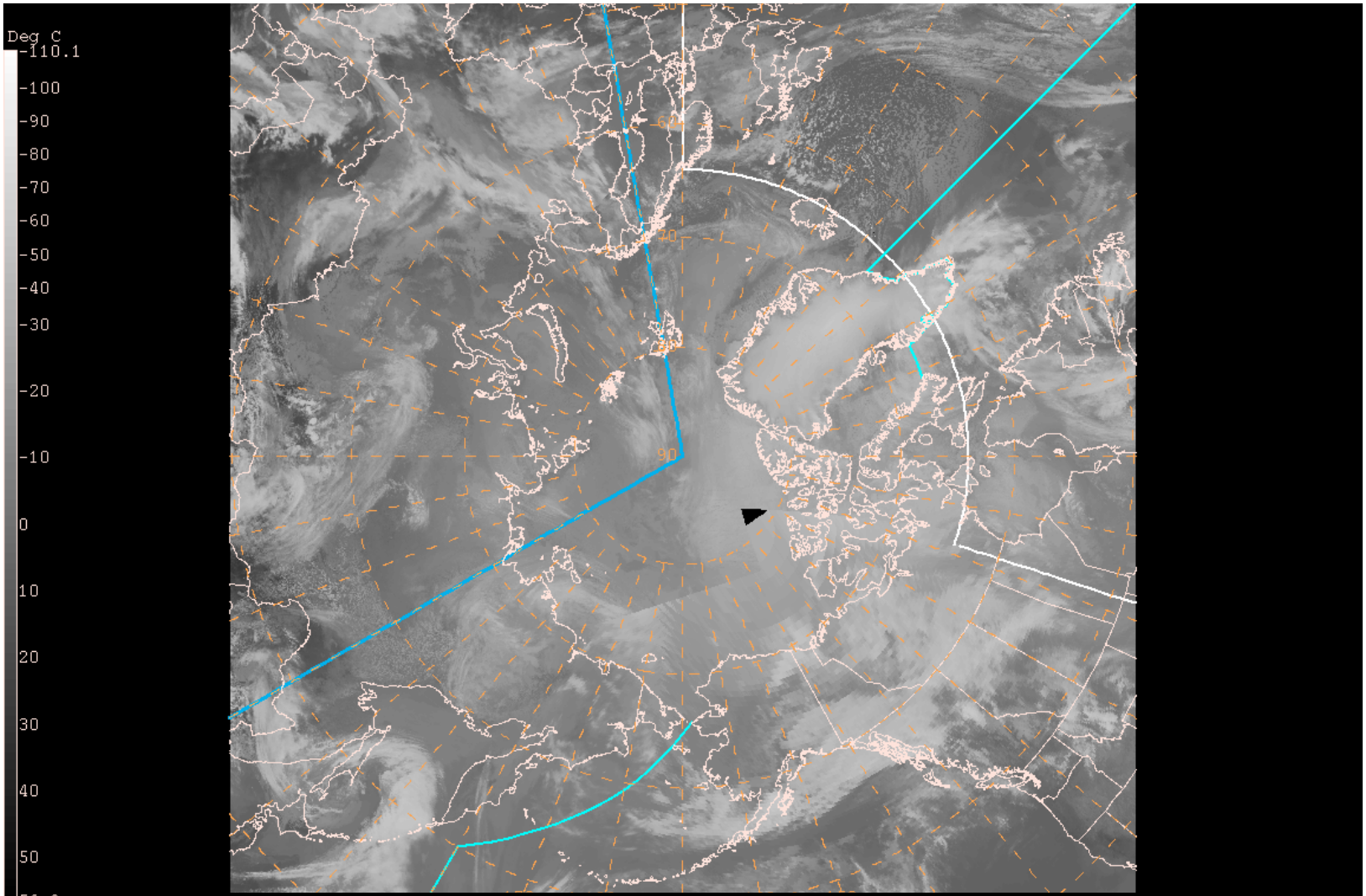
Traditional View	Emerging View
LEO just for the models GEO just for the forecasters	LEO & GEO for ***both*** the models and forecasters





Seeing the Arctic

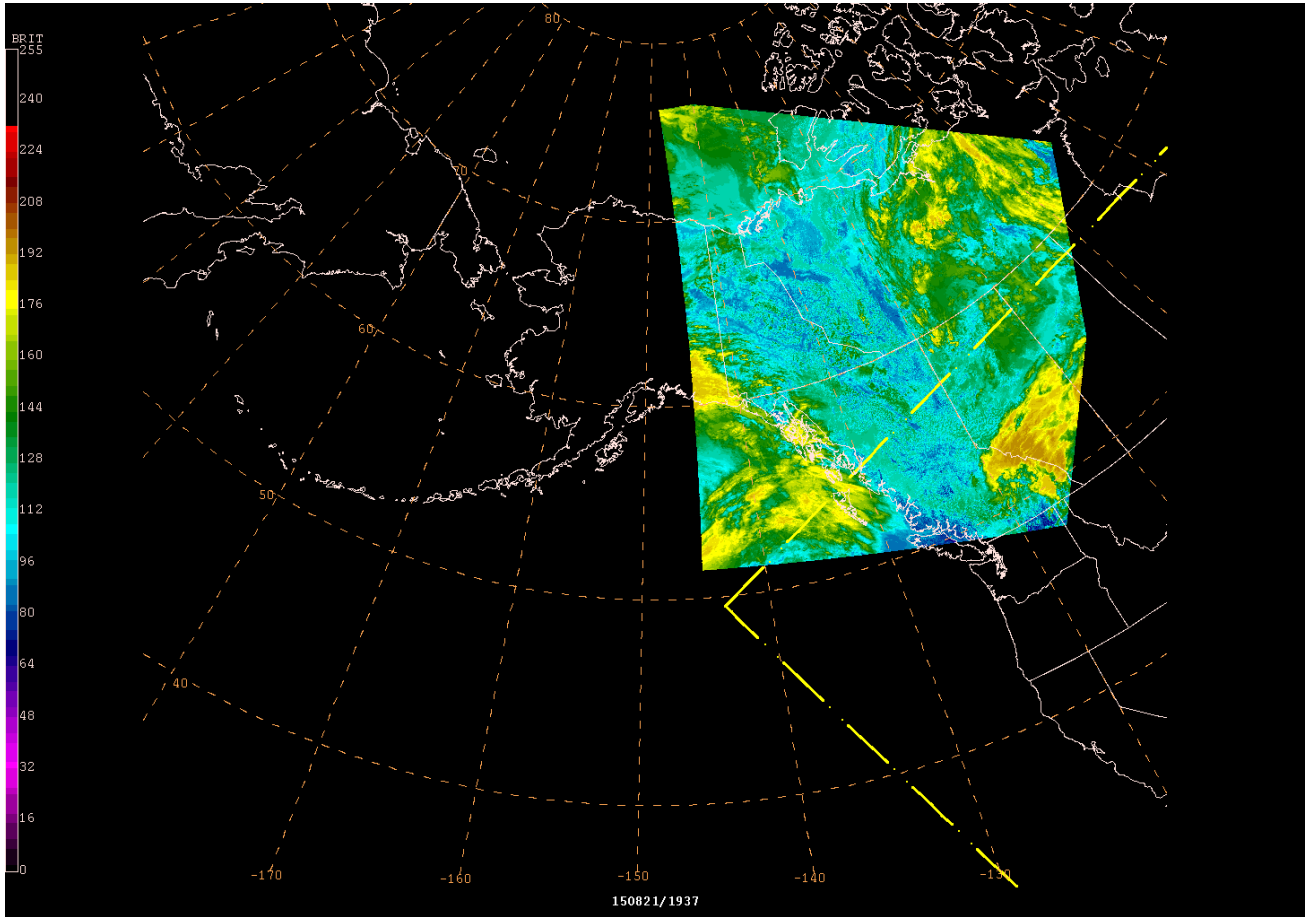
Infrared Geo/Leo Blend



Courtesy of Matthew Lazarra (CIMSS/SSEC)

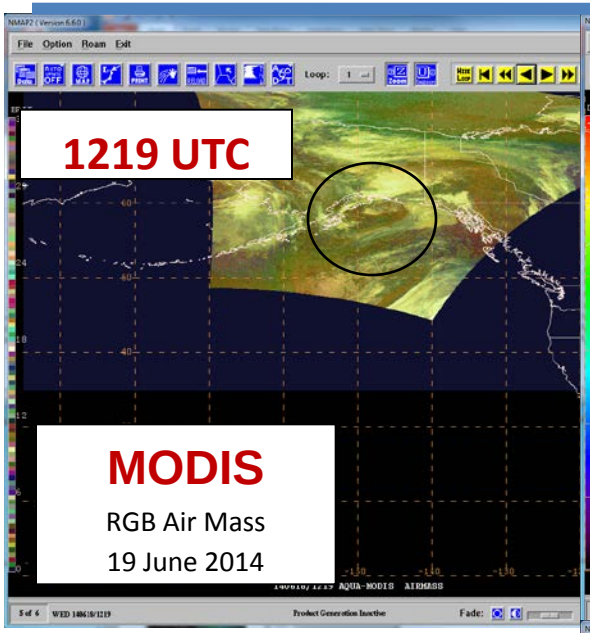
Seeing the Arctic

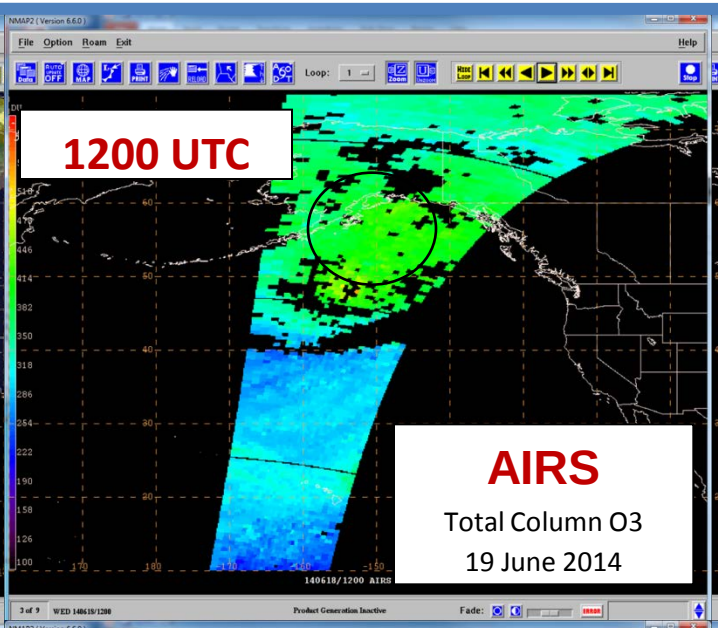
Combining MODIS and VIIRS in One Display

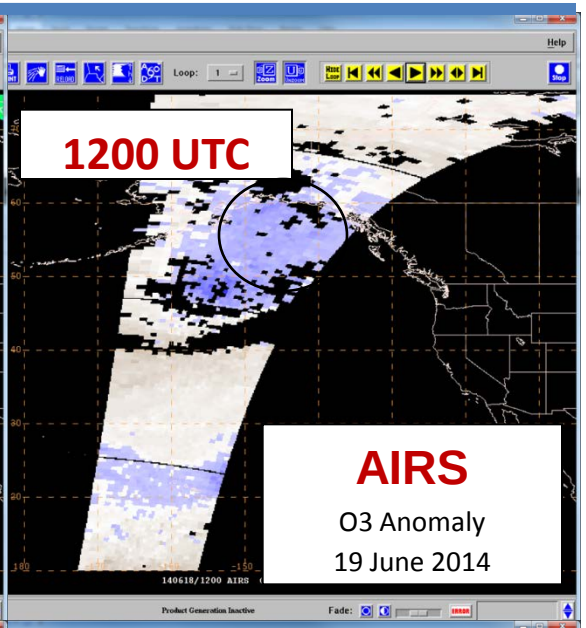


Courtesy of NASA SPoRT

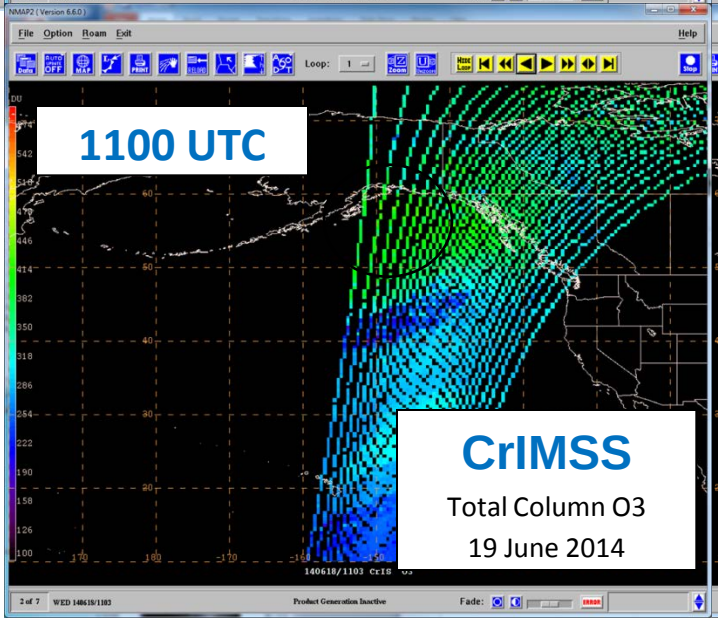
Assessing Short Waves

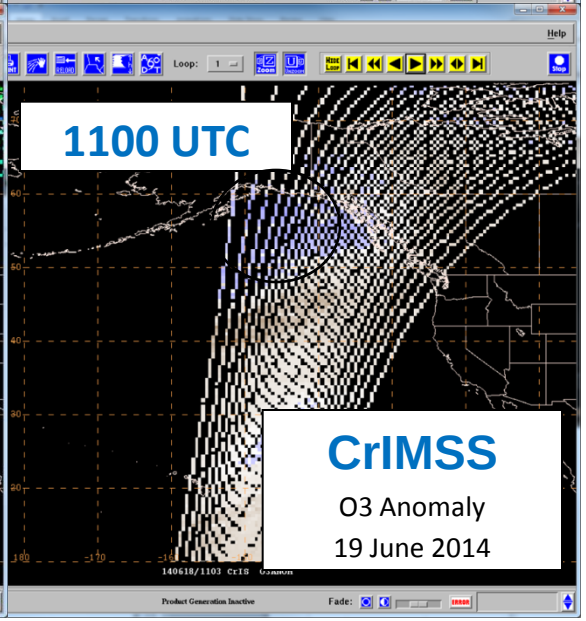






- Forecasters use ozone products to identify short waves and compare with model initializations

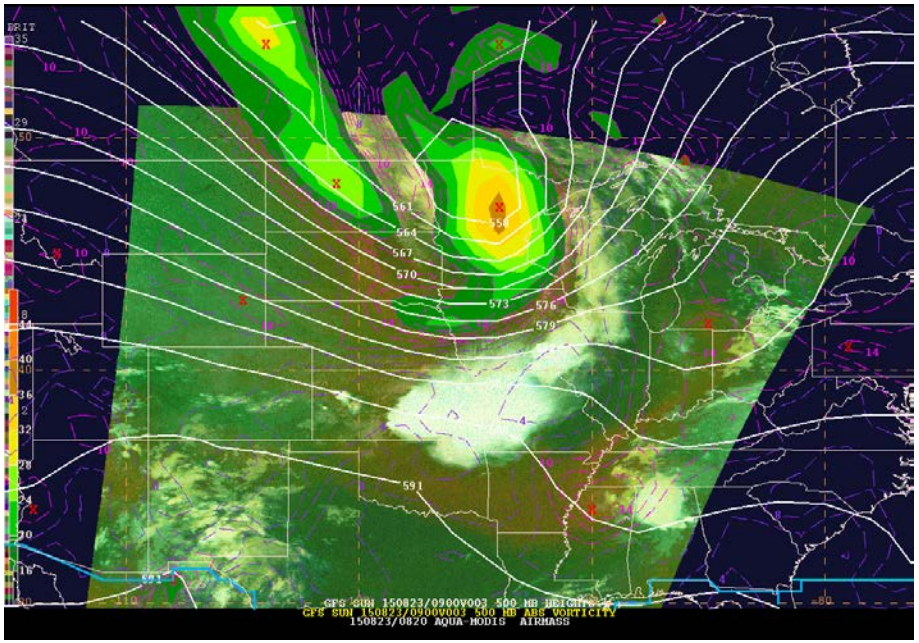




Assessing Short Waves

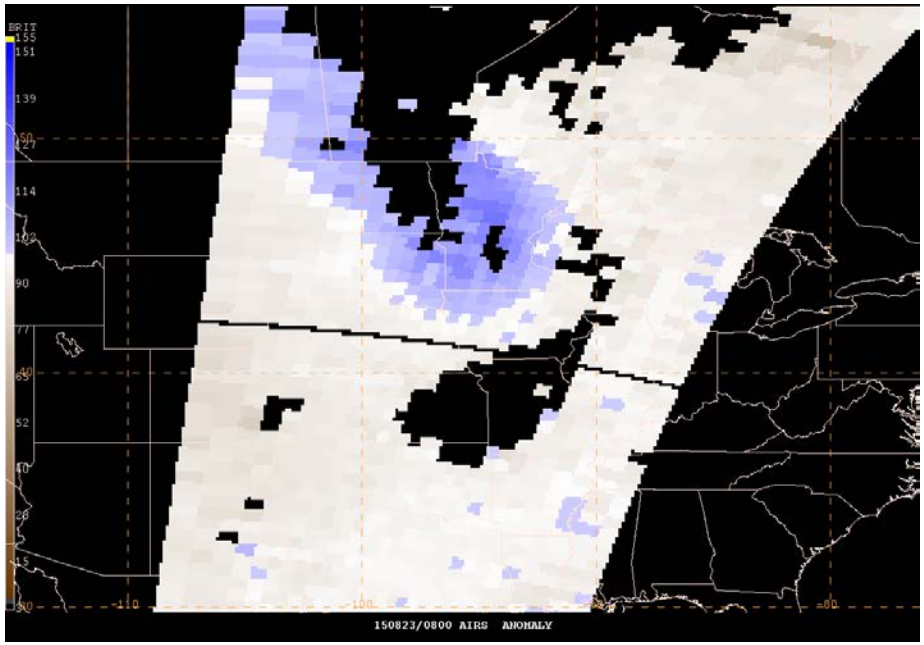
Integrating satellite and model data

Air Mass RGB with GFS 500 mb Z and Abs. Vorticity



Courtesy of NASA SPoRT

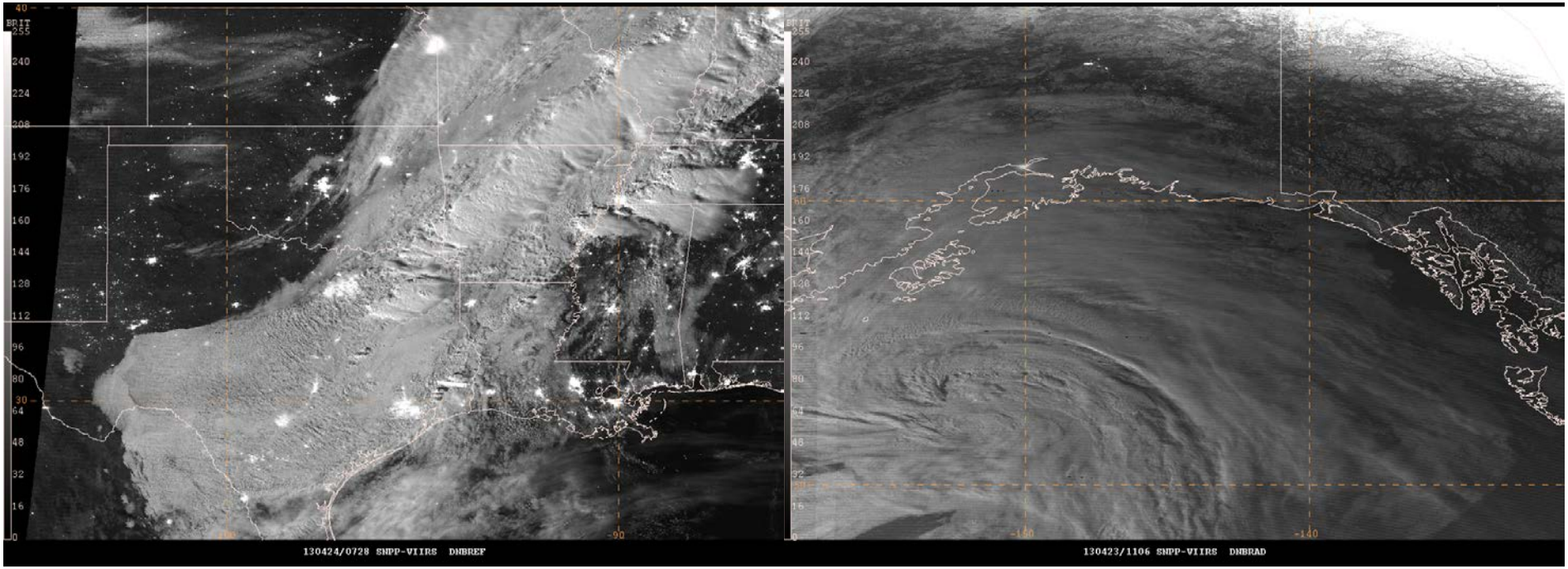
AIRS Ozone Anomaly



Spatial and Vertical Resolution

Day-Night Band used to monitor cold front and storms at night with moonlight!

CONUS **ALASKA**

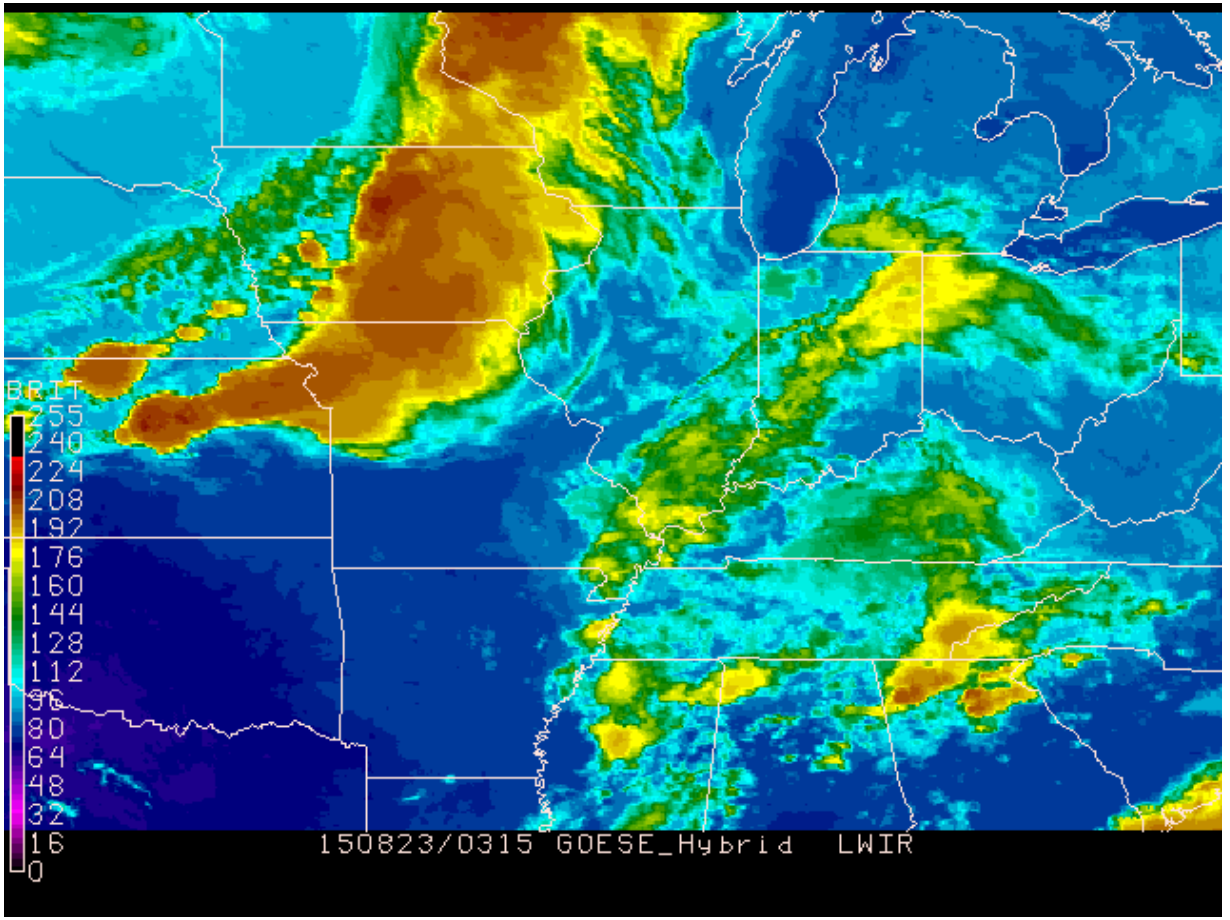


Courtesy of CIMSS and NASA SPoRT

Spatial and Vertical Resolution

SPoRT GOES-13 Hybrid Product

GOES-13
&
VIIRS
&
MODIS

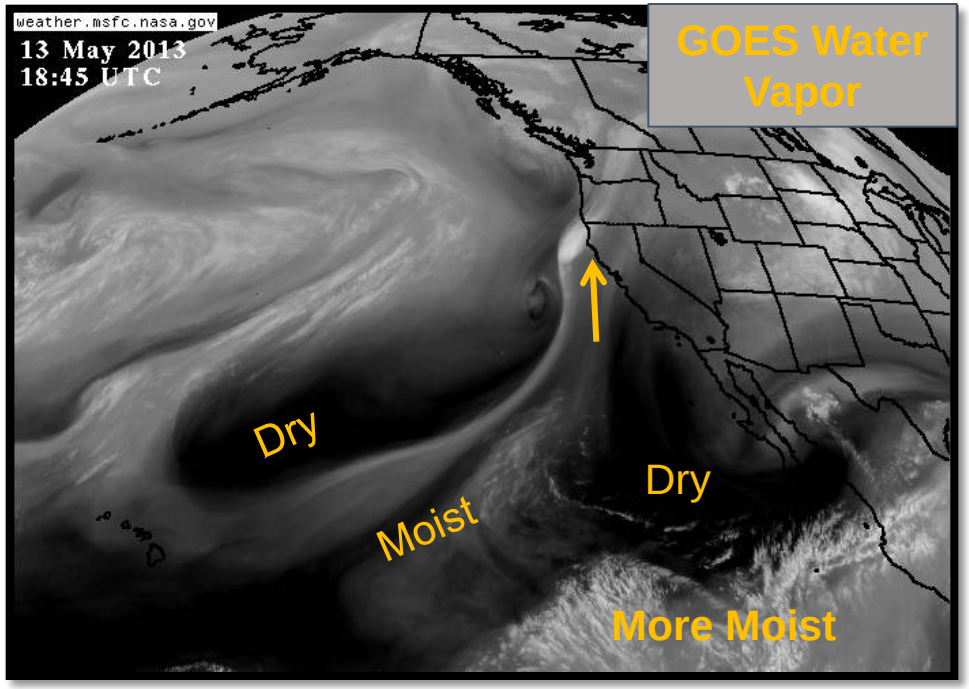


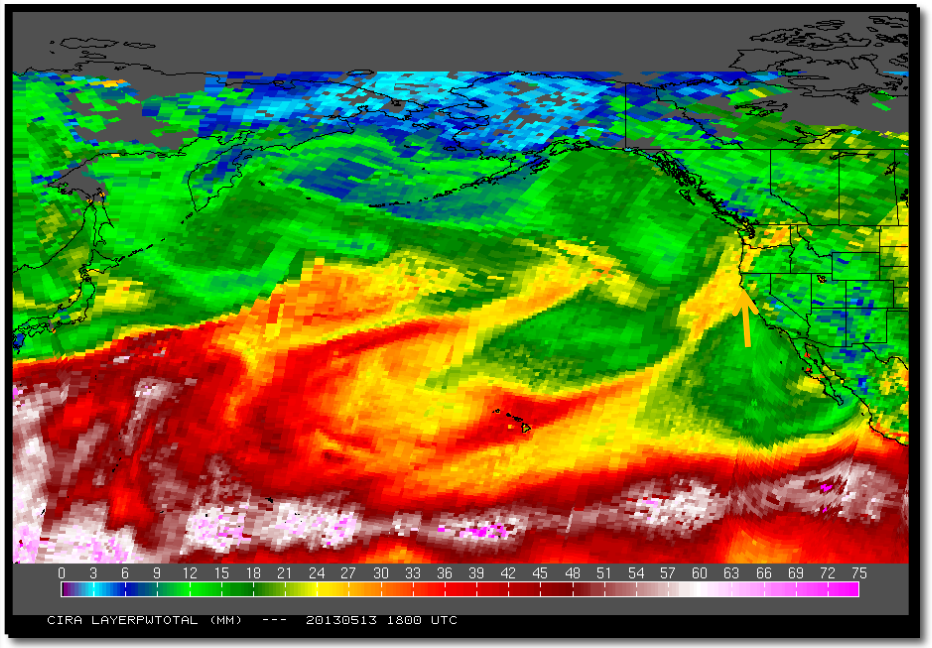
Courtesy of Matt Smith (SPoRT)

Spatial and Vertical Resolution

Discriminate level of moisture.

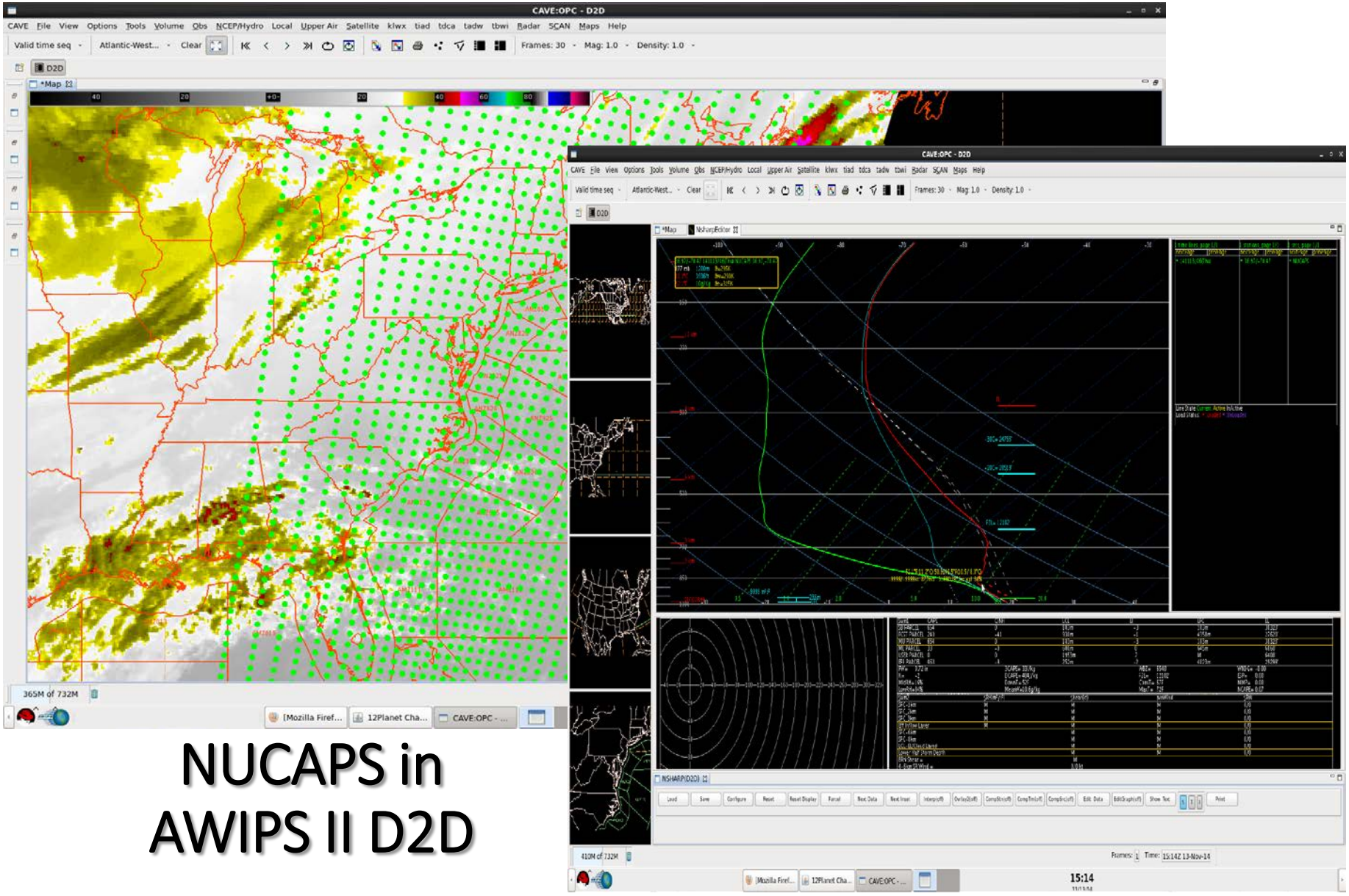
See Lower levels than traditional WV.





CIRA Layered Precipitable Water

Spatial and Vertical Resolution



NUCAPS in AWIPS II D2D

A R2O Challenge

Needed and received

Imagery
VIIRS Imagery Channel 1
VIIRS Imagery Channel 2
VIIRS Imagery Channel 3
VIIRS Imagery Channel 4
VIIRS Imagery Channel 5
VIIRS Imagery Moderate Channel 1
VIIRS Imagery Moderate Channel 9
VIIRS Imagery Moderate Channel 16
VIIRS Imager Near Constant Contrast
Atmospheric
Atmospheric Temperature Profile

Needed but not received

Imagery
VIIRS Imagery Moderate Channel 5
VIIRS Imagery Moderate Channel 13
VIIRS Imagery Moderate Channel 14
Snow, Ice and Hydrology
Snow Water Equivalent (ATMS)
Ice Surface Temperature [New]
Blended Total Precipitable Water (ATMS)
Blended Total Precipitable Water (GCOM)
Blended Total Precipitable Water Anomaly
Blended Total Precipitable Water Anomaly (GCOM)
Blended Rainrate (ATMS)
Blended Rain Rate (GCOM)
Mapped MIRS Profiles
MIRS Global RR Composite
Clouds
Cloud Cover/Layers (VIIRS)
Cloud Mask (VIIRS)
Cloud Top Temperature (VIIRS)
Cloud Top Pressure (VIIRS)
Cloud Top Height (VIIRS)
Cloud Base Height (VIIRS)
Land
Land Surface Temperature (VIIRS)
Vegetation Moisture
Mapped MIRS Surface Products
Ozone
Blended Ozone

Netcdf4 not compatible with NAWIPS

Summary

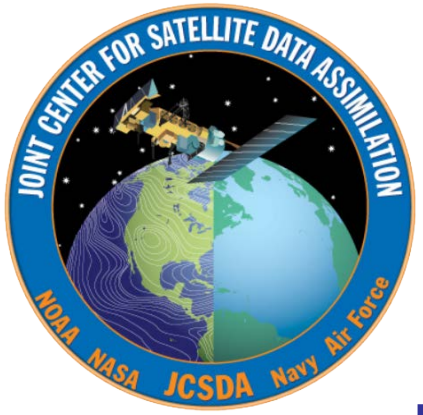
WPC using JPSS products

- Seeing the Arctic for the first time
- Assessing short waves
- Utilizing vertical and spatial resolution

Need integration of satellite, in-situ, and model data to support forecaster decisions

Need Improved R2O

- Operational infrastructure ready to match capability on ‘Day 1’



Data Assimilation for Numerical Weather Prediction

Presented by James G. (Jim) Yoe

Joint Center for Satellite Assimilation

and NWS/NCEP

Overview

- Background
- Assimilation of Suomi NPP
  - Data Impacts
- Planning for JPSS-1 in NWP
- Summary

BACKGROUND: NOAA Operational Numerical Guidance Supports the Agency Mission

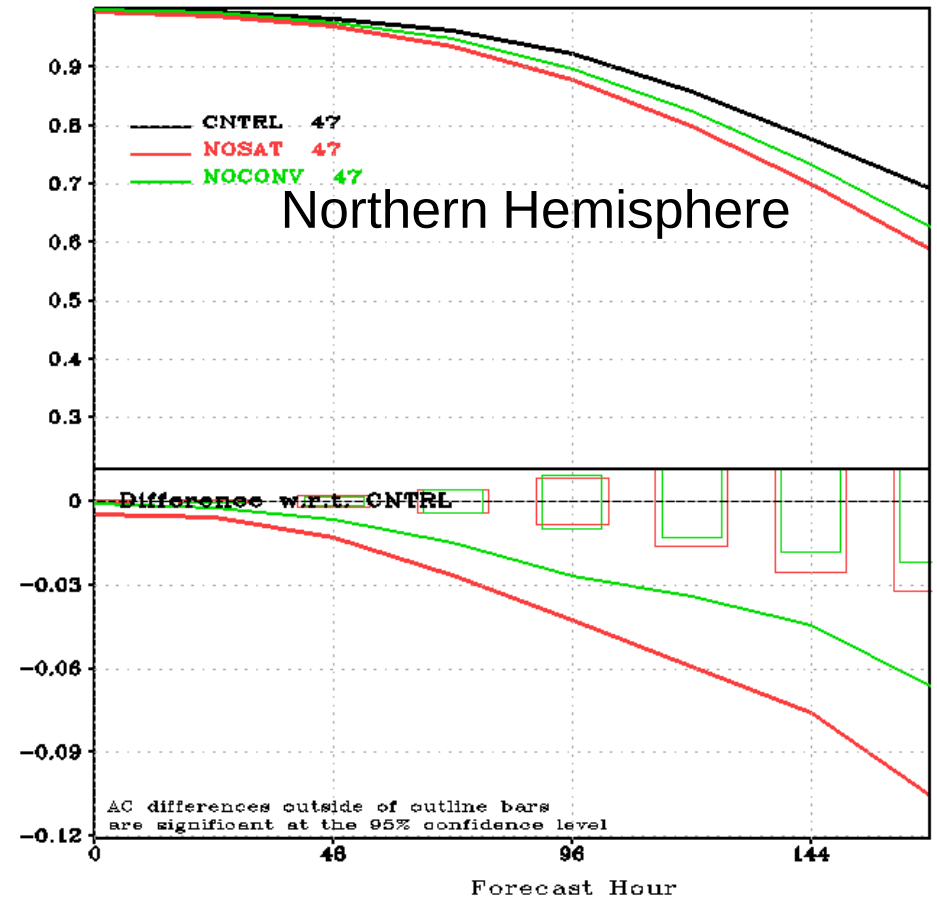
- **Numerical Weather Prediction (NWP) at NOAA**
  - Required for agency to meet service-based metrics
- **National Weather Service GPRA* Metrics**
  - Hurricane Track and Intensity
  - Winter Storm Warning
  - Precipitation Threat
  - Flood Warning
  - Marine Wind Speed and Wave Height

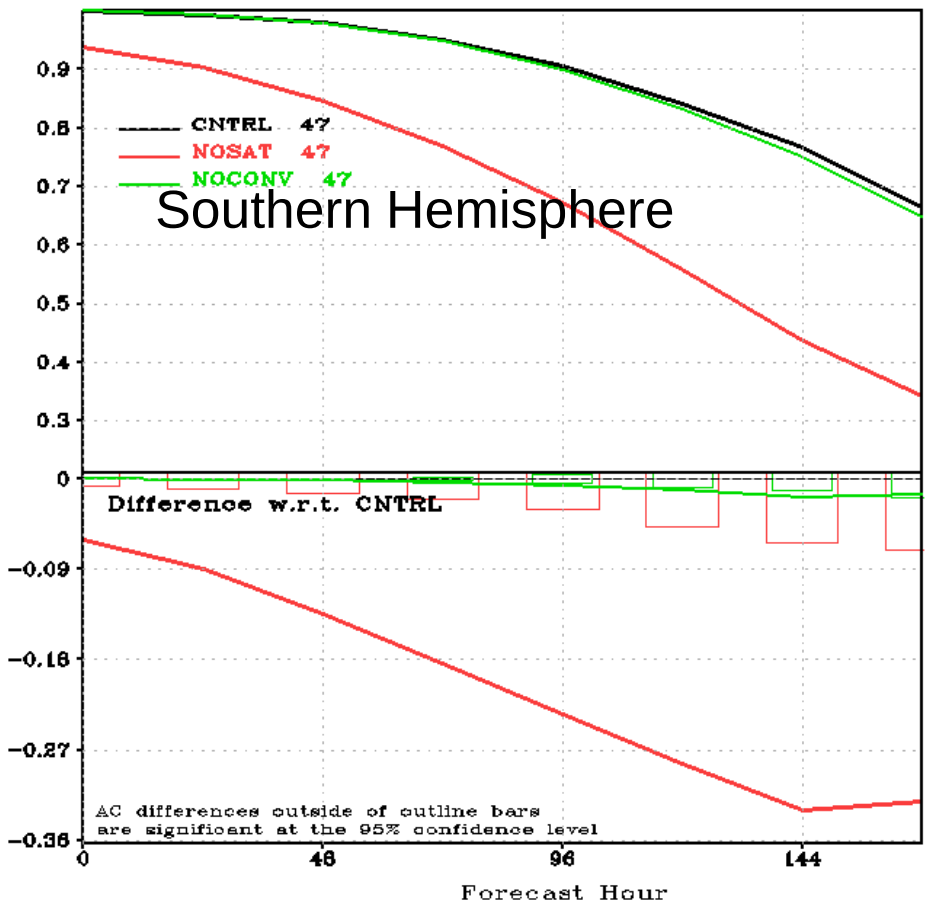
Lead Time and Accuracy!

- **Operational numerical guidance:**
  - Foundational tools used by government, public and private industry to improve public safety, quality of life and make business decisions that drive U.S. economic growth

Background:
Satellite Data Crucial in the GFS

No Satellite / No Conventional Data



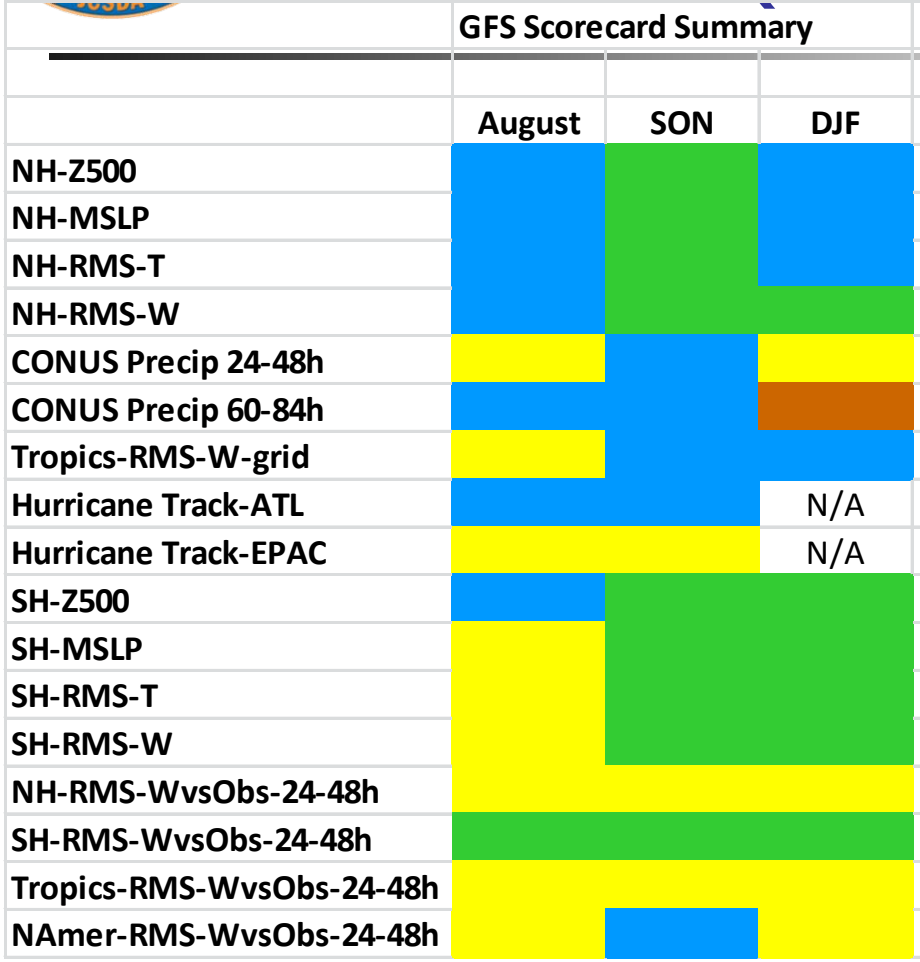


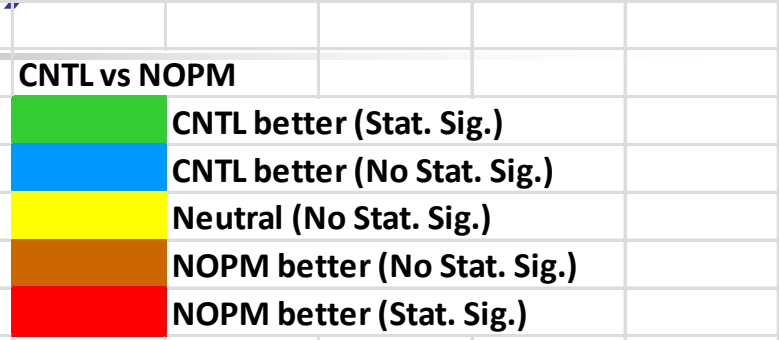
500 hPa Anomaly Correlations
15 Aug – 30 Sep 2010

Assimilation of Suomi NPP Data

- Pre-Launch
  - Working Group – NDE, EMC, NCO, STAR, JCSDA
    - Prioritized data requirements; generated/shared formatted test data; tested data paths, tanks, and decoders; prepared and adapted DA (channel selection, radiative transfer, etc.)
- Post-Launch
  - Data Monitored, evaluated in global NWP)
    - ATMS SDRs (Operational in GDAS/GFS 5/22/2012)
    - CrIS SDRs (Operational in GDAS/GFS 8/20/2013)
      - 399 channels received of 1305
    - OMPS EDRs used in CPC analysis (10/1/2013), monitoring, ozone hole assessment
    - VIIRS EDRs (SST) development for testing underway

Data Impact: JPSS (CNTL) Scorecard





From G. Gayno and S. Lord, 2014

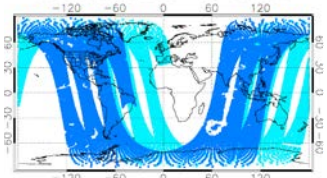
More Recent Impact Experiment Design

Remove quasi-redundant satellite data.

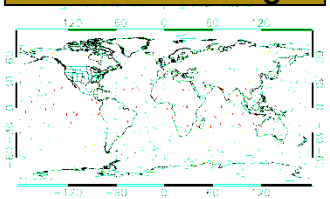
Remove GPSRO data with no future mission or uncertain funding.

Current Operational	Type	Orbit	3polar	2polar (PM Gap)	3pgps (Expected RO)
F16 (SSMI/S)	MW	Early-AM			
F17 (SSMI/S)	MW	Early-AM			
F18 (SSMI/S)	MW	Early-AM			
N15 (AMSU)	MW	Late PM			
N18 (AMSU/MHS)	MW	PM			
N19 (AMSU/MHS)	MW	PM			
SNPP (ATMS/CrIS)	MW/IR	PM			
Metop-A (AMSU/MHS/IASI/HIRS)	MW/IR	Mid-AM			
Metop-B (AMSU/MHS/IASI)	MW/IR	Mid-AM			
Aqua MODIS IR Winds	IR	PM			
Aqua AIRS	IR	PM			
Aqua MODIS WV Winds	IR	PM			
Terra MODIS IR/WV Winds	IR	AM			
WindSat		Early-AM			
GOES Sounder, AMVs	IR	GEO			
JMA AMVs	IR	GEO			
METEOSAT AMVs	IR	GEO			
COSMIC	RO	n/a			Poleward 24° Latitude
Metop-A (GRAS)	RO	n/a			Poleward 24° Latitude
Metop-B (GRAS)	RO	n/a			
TerraSAR-X	RO	n/a			
GRACE	RO	n/a			
C/NOFS	RO	n/a			Poleward 24° Latitude
SAC-D	RO	n/a			Poleward 24° Latitude

Polar Coverage



GPSRO Coverage

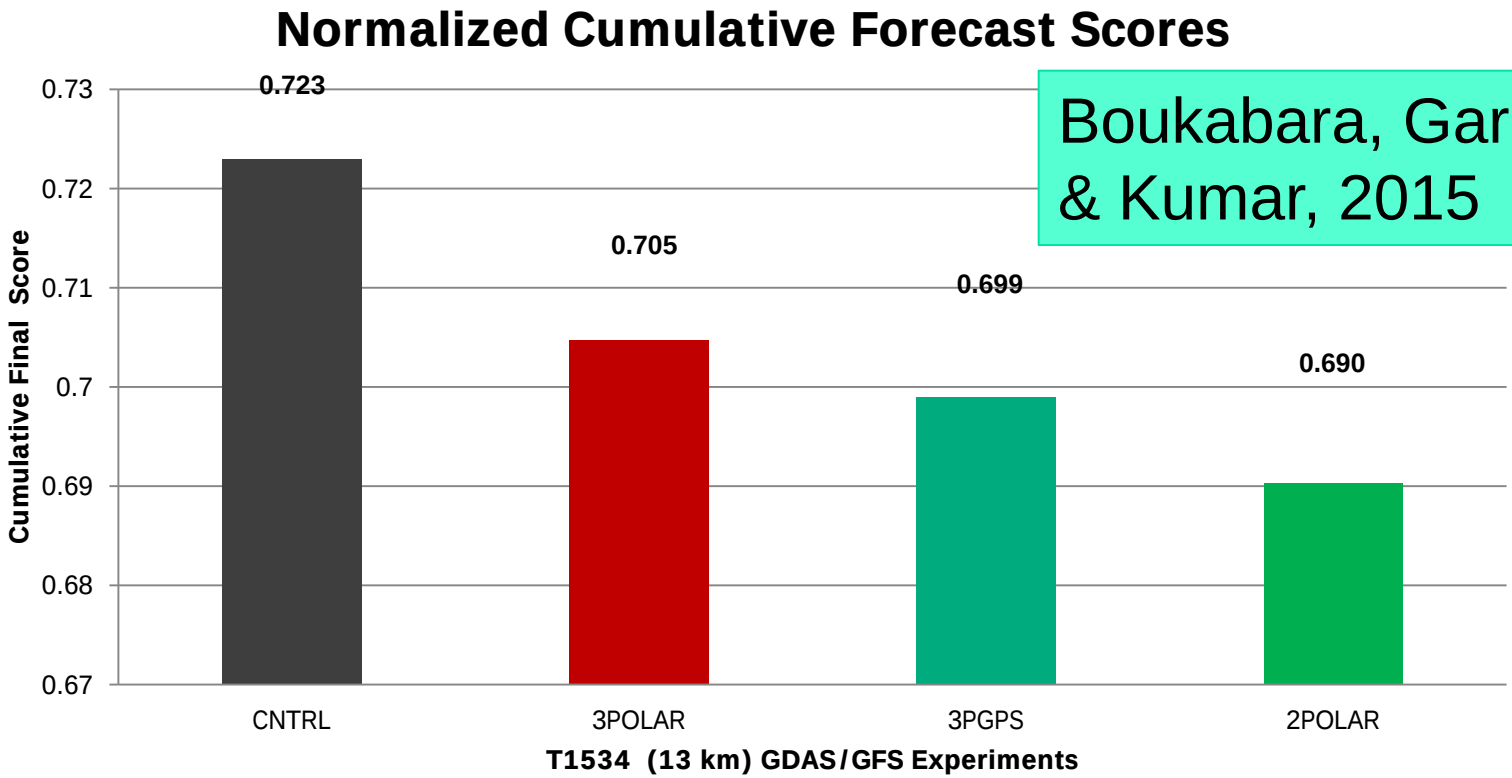


***MODIS IR winds are a proxy for SNPP VIIRS**

Assimila

Denied

More Recent Impact Experiment Results



Boukabara, Garrett, & Kumar, 2015

Cumulative Forecast Scores

1). The loss of a quasi-redundant polar satellite constellation results in a significant degradation of overall forecast quality.
2). The further loss of the Primary PM polar data (S-NPP) further degrades forecast quality

Preparing for JPSS-1 in NWP

- Leverage infrastructure, lessons learned from NPP
  - Plan for rapid readiness for sounder implementation
  - Contingency planning for readiness at commissioning for “gap mitigation”
- VIIRS
  - Incorporate SST EDR, Land Surface Data
- OMPS
  - Assimilate OMPS ozone to adjust CrIS channels for T, moisture
- Improved CrIS assimilation
  - Make use of cloudy radiances
  - Make use of full-spectral resolution radiances
- Synergy with Improved
  - GFS Model Resolution
  - 4D Hybrid Data Assimilation System (DAS)
  - Low-latency JPSS data

NWP Summary and Path Forward

- NWS assimilates S-NPP in operational NWP
  - Early access to S-NPP ATMS, CrIS contributed to calibration and validation of SDRs
  - JPSS, NESDIS, NWS and JCSDA preparing to extend and transition to use of JPSS-1 observations
- JPSS will be foundational stone for NWS' NWP
  - ATMS and CrIS especially as POES, Aqua retired
- Advancements in Data Assimilation System, Models, will yield significant NWP improvement in the JPSS era in conjunction with the advancement in the observations

JPSS Satellite Products Applications at The Climate Prediction Center

Pingping Xie

For David DeWitt, the director of

NOAA Climate Prediction Center

August 25, 2015

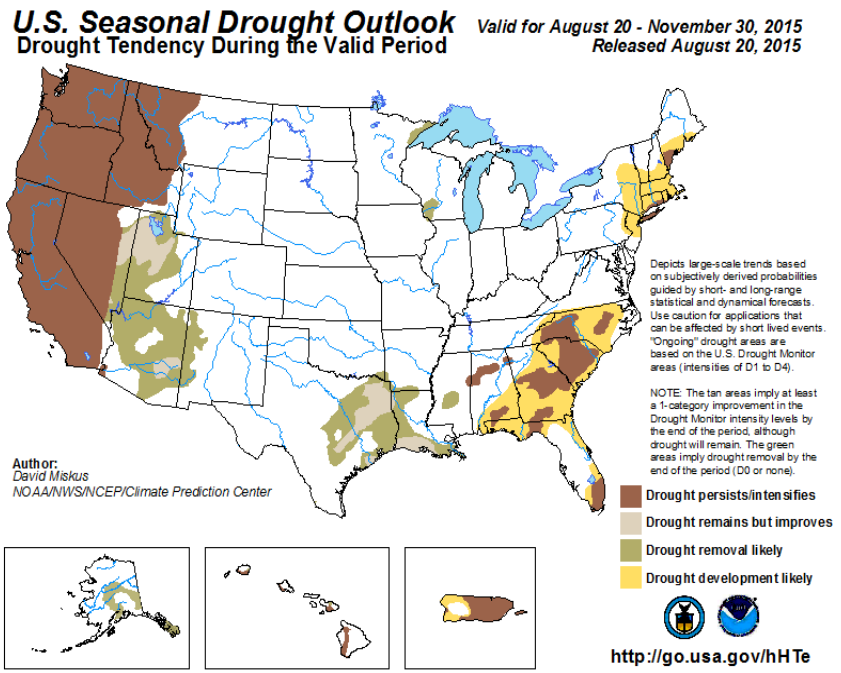
Acknowledgments: C. Long, M. Rosencrans, S.-K. Yang

CPC Mission

We deliver climate prediction, monitoring, and diagnostic products for timescales from weeks to years to the Nation and the global community for the protection of life and property and the enhancement of the economy.

Operational Requirements:

- Deliver national outlook products: temperature, precipitation, drought, hurricanes,..
- Span weeks, months, seasons, years
- Embrace collaborative forecasting with other NCEP Service Centers, NOAA line offices, other agencies and labs
- Ensure real-time, on-time, all the time (since '79)
- Real-time monitoring (satellite applications)



CPC is a Pioneer in Climate Applications of Satellite Data

- Areas of Satellite Data Applications at CPC
  - *Climate monitoring (atmospheric, oceanic, extreme events)*
  - *Forecasts / model verifications*
  - *Climate diagnostics*

- Two basic types of satellite data applications
  - *Direct use of satellite data from NESDIS and other satellite agencies*
  - *Integrating individual satellite data into climate analyses*

  - *Over the past three decades, CPC developed several satellite-based global analyses for climate applications, including its widely used SST, OLR, and precipitation analyses*

JPSS Applications at CPC

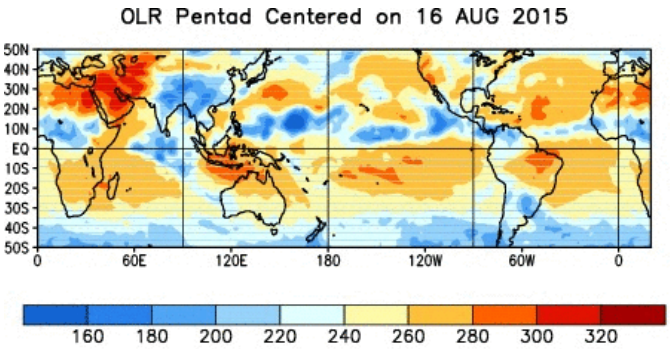
- Currently CPC is already using or plans to use the following JPSS products
  - *Hyperspectral OLR*
  - *Precipitation and snowfall rate*
  - *Ozone*
  - *Atmospheric temperature profiles*
  - *VHI*
- Applications of these JPSS products are expected to enhance CPC's capacity in:
  - *Monitoring ENSO, MJO and tropical convection and verifications of associated forecasts*
  - *Monitoring drought*
  - *Monitoring ozone*
  - *Monitoring climate change*

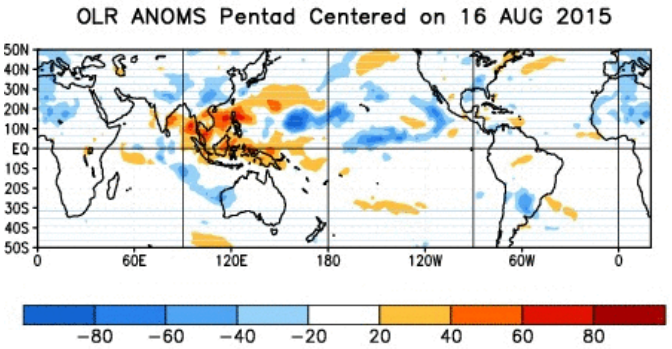
Monitoring the Atmosphere

Outgoing Longwave Radiation

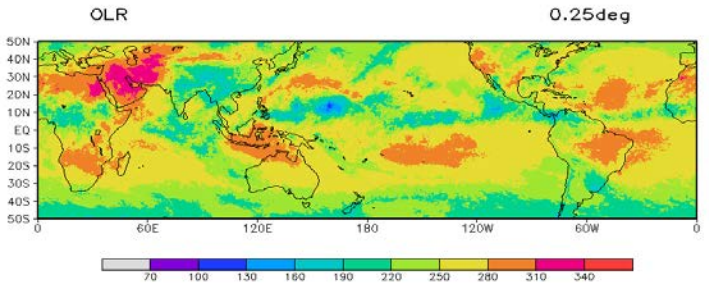
- OLR is widely used to monitor global climate and its variations such as ENSO and MJO
- Currently operational OLR data set is derived from the AVHRR using an old technique
- Hyspectral OLR from IASI aboard MetOp and CrIS from SNPP provide much improved quality
- Hyspectral OLR from all satellites need to be reprocessed and integrated for climate applications

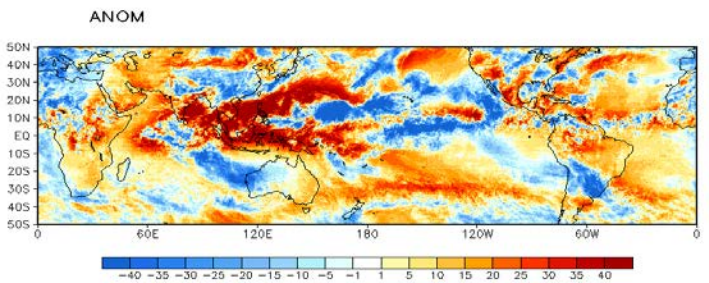
Operational OLR





Hyperspectral (IASI) OLR

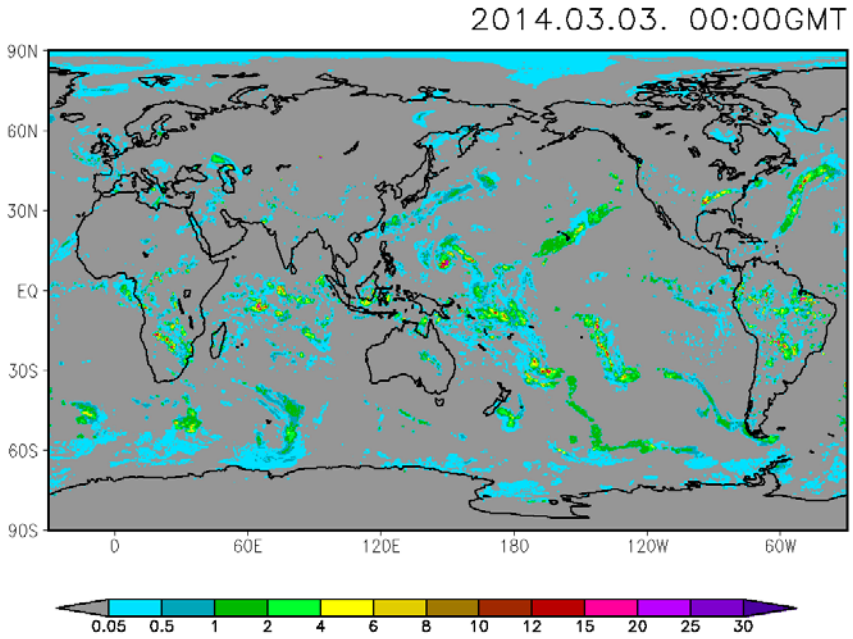




Monitoring the Atmosphere

Precipitation

Pole-to-pole Global CMORPH



- At CPC, we integrate information from all satellite data into a global product (CMORPH)
- CMORPH is improved through infusing rainfall and snowfall rate retrievals from SNPP/ATMS
- CMORPH data domain is expanded to cover the entire globe

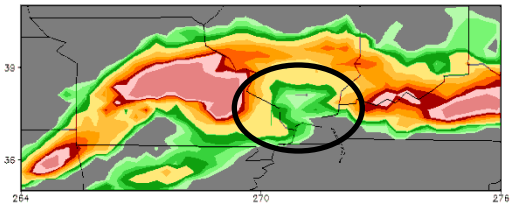
Monitoring the Atmosphere

Precipitation

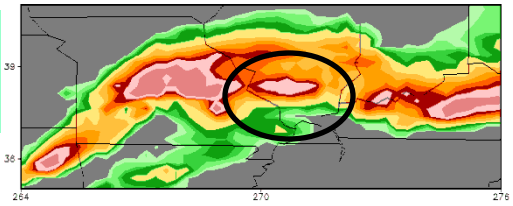
CMORPH Improved with Infusion from JPSS

18-24 UTC, 3 April 2014

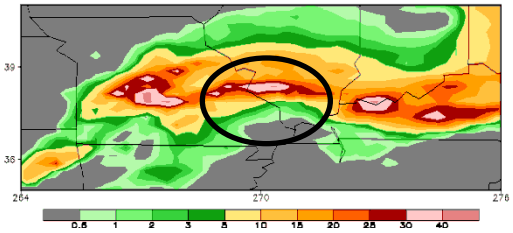
CMORPH w/o SNPP



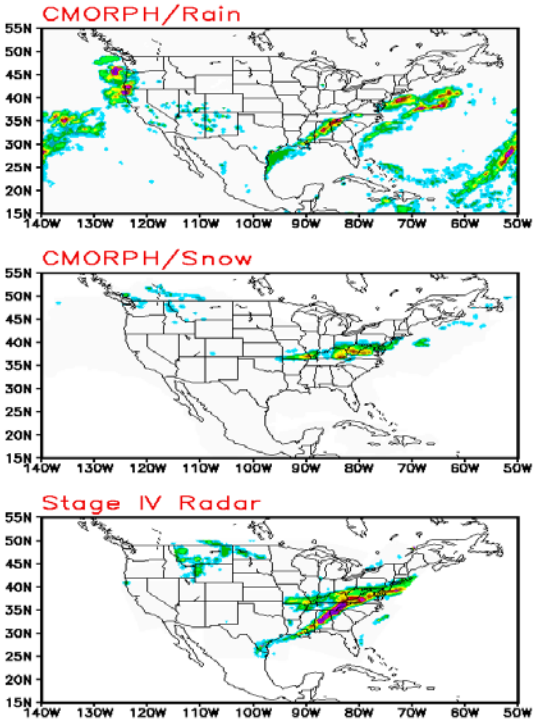
CMORPH with SNPP



Stage IV Radar Est



2014–03–03 10:00–11:00UTC



CMORPH w/o snow

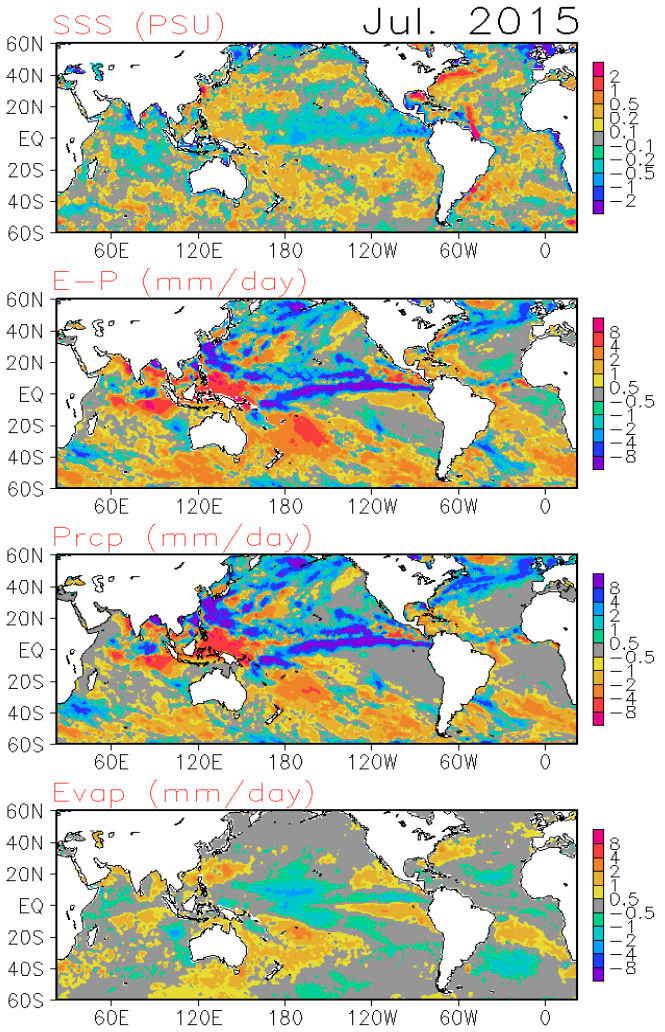
CMORPH with snow

Stage IV Radar Est

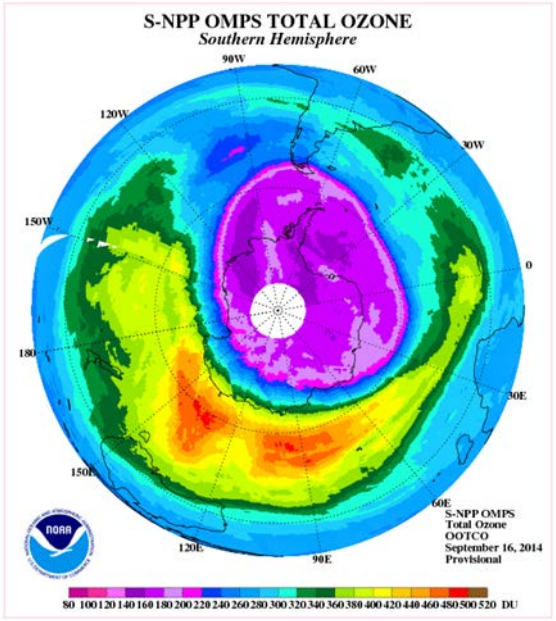
Monitoring the Ocean

Salinity and Oceanic Fresh Water Flux

- **Anomaly for July 2015**
- The oceanic salinity and fresh water flux package is updated monthly and used by CPC in its Monthly Ocean Briefing
- JPSS infused CMORPH is used to define the oceanic fresh water flux

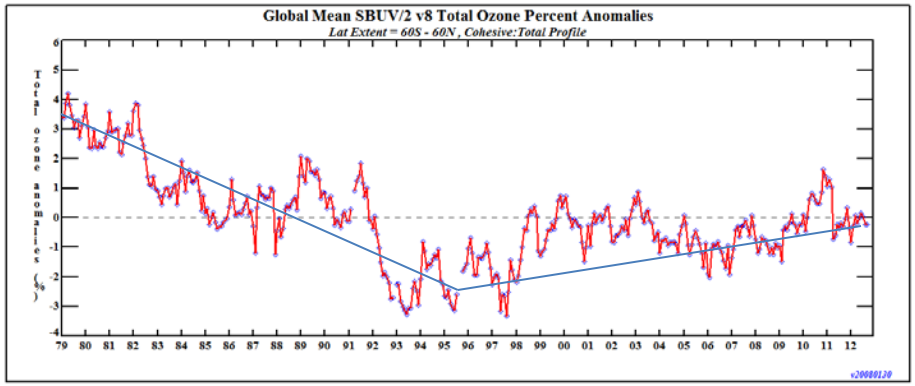


Stratospheric Ozone Monitoring



2014 Antarctic Ozone Hole

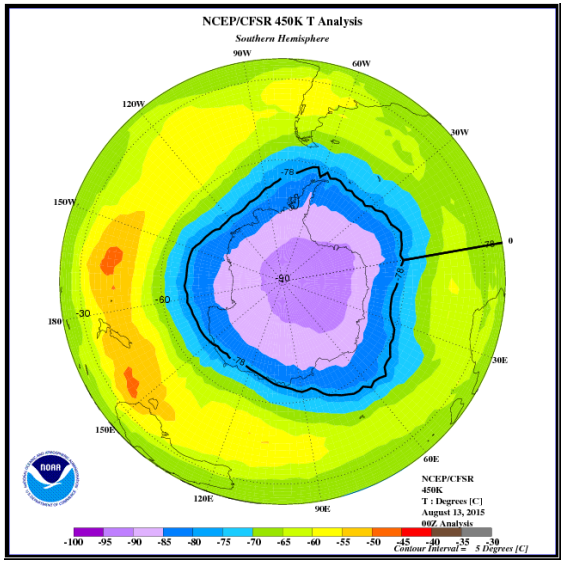
CPC monitors the ozone layer daily and historically. Ozone observations in the vertical and total column from the SBUV/2 instrument on NOAA satellites are analyzed daily to **monitor short term** depletion events such as the "ozone hole" over Antarctica.

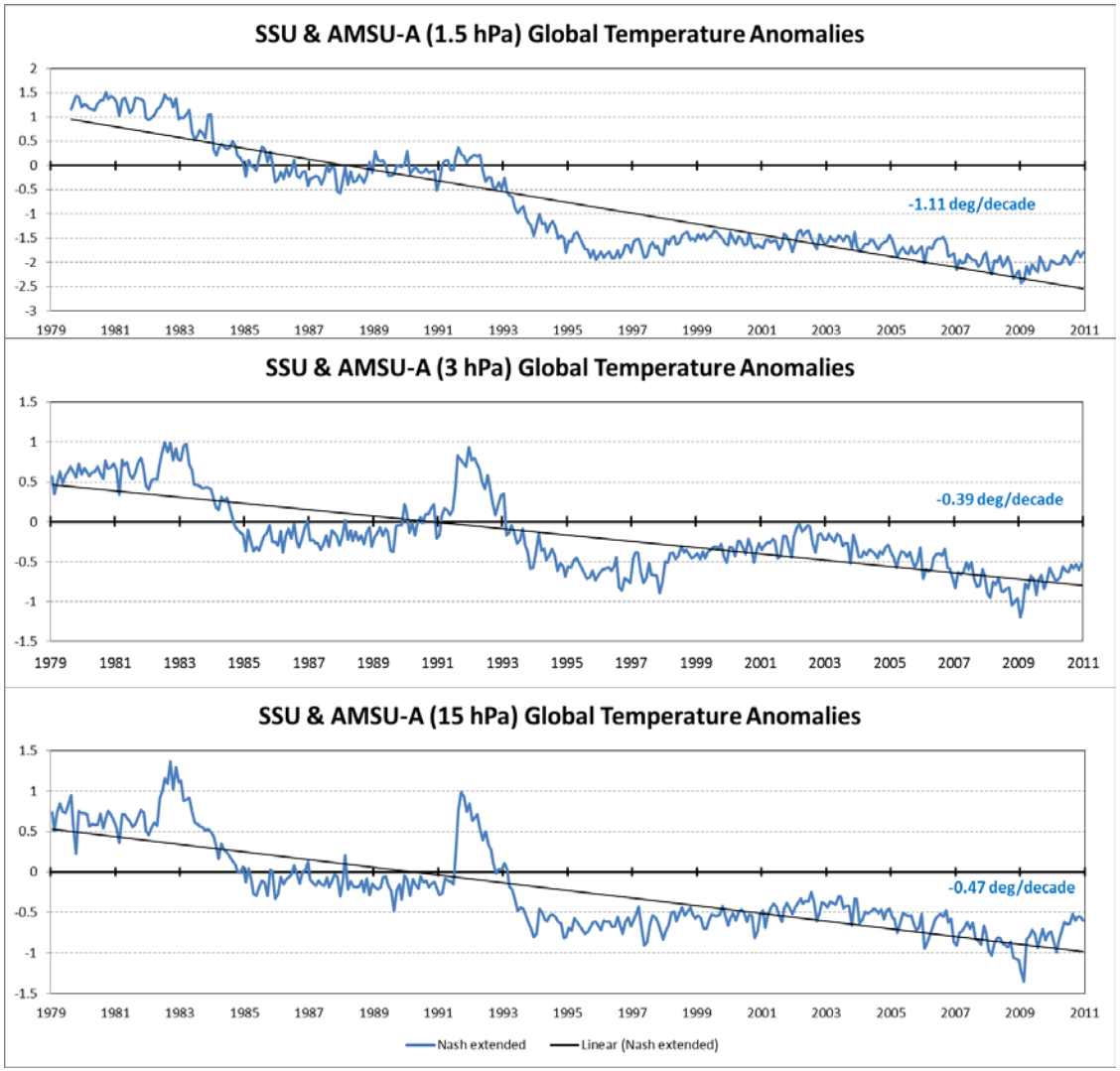


Long term monitoring using successive SBUV datasets allow CPC to monitor the global ozone depletion that occurred in the 1980s and early 1990's and the status of ozone recovery since the mid 1990's. Increased UV radiation at the surface results from ozone depletion. Environment, food supply, and human health communities are concerned about the impacts of increased UV radiation. The Montreal Protocol in 1987 lead the way towards eliminating ozone depleting substances and the recovery of the ozone layer.

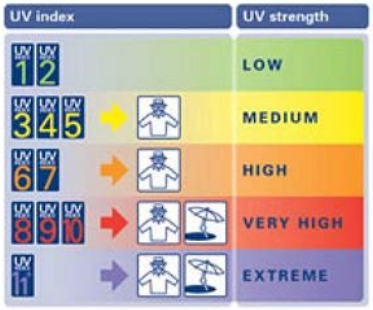
Stratospheric Temperature Monitoring

CPC monitors the **short term events** and **long term trends** of satellite derived temperatures in the stratosphere. There was strong cooling in the upper stratosphere in the 80's and 90's. Satellite temperature trends are validated using rocketsondes, Lidars, and microwave instruments.

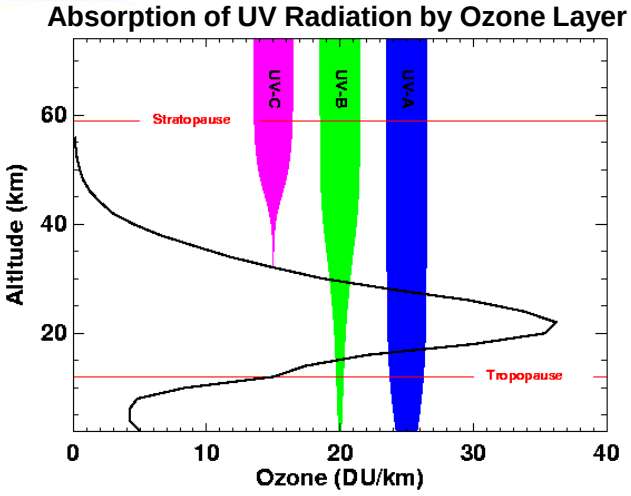


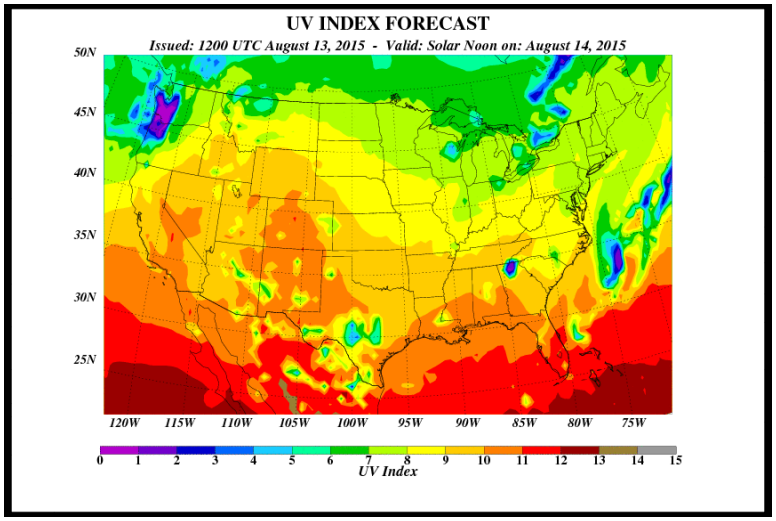


UV Index and Human Health

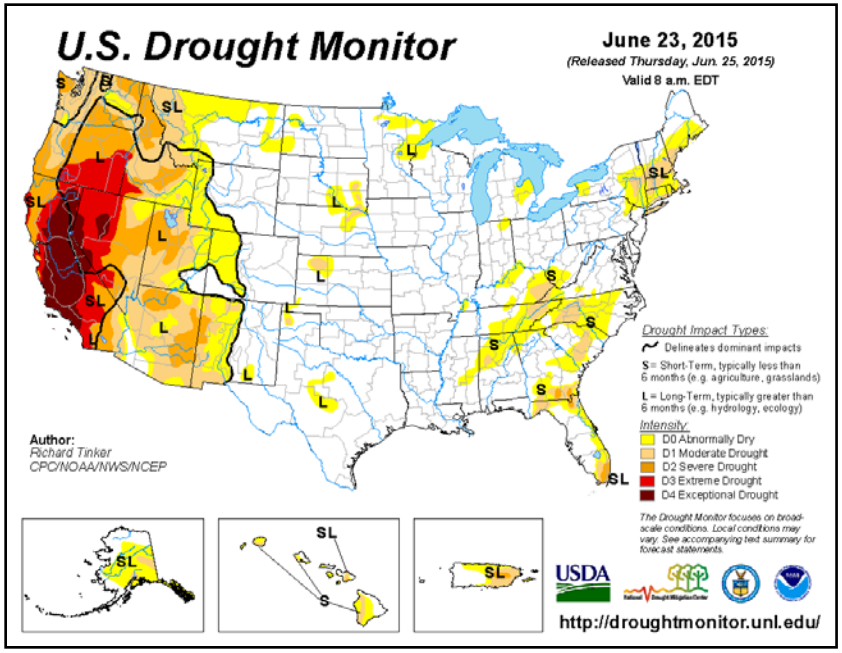


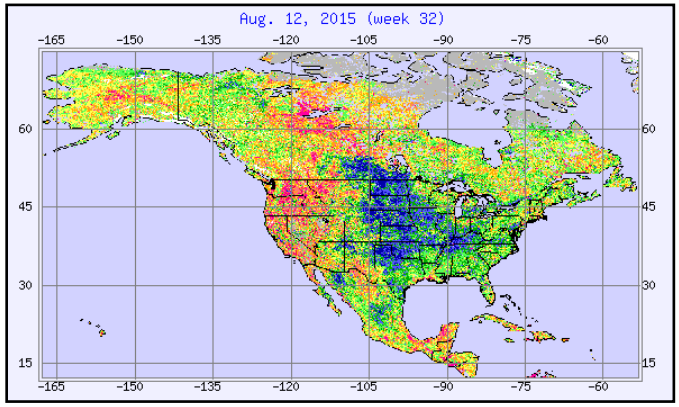
- A joint effort between the NWS and EPA to inform the public of the dangers of over exposure to the Sun's UV radiation.
- The NWS provides the UV Index forecast grids and data files.
- The EPA distributes the forecasts, UV radiation information, and precautionary steps to prevent over exposure.
- NWS UV Index forecasts are derived from forecasts of:
  - Total column ozone
  - Surface albedo (snow cover)
  - Clouds
  - Aerosols
- Satellite information feeds into each of these forecasts.



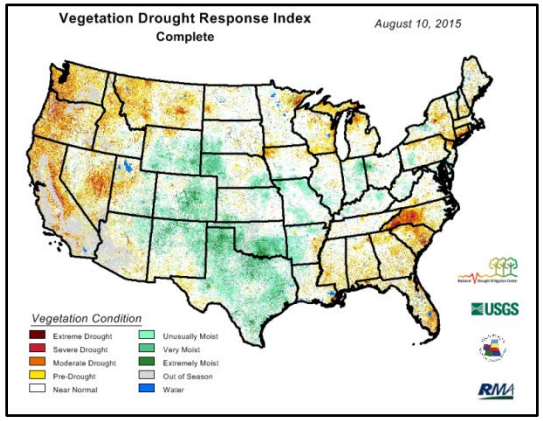


Drought Monitoring





VHI



VegDRI

CPC monitors drought conditions across the U.S. and North America.

The U.S. Drought Monitor is created weekly, using satellite and ground based data quantitative data, as well as qualitative reports from field agents.

Core partners in this activity are NCEI, NDMC, DRI, USDA, along with many others.

Future Plans

- Improving the quantitative documentation and model verification for the earth radiation budget and its tempo-spatial variations taking advantage of the JPSS measurements
  - Radiation budget at TOA
  - Validate / monitor GFS / CFS radiation budget
  - Construction of new OLR data to replace the operational AVHRR OLR using hyperspectral OLR data from JPSS and other missions
- Reprocessing the pole-to-pole CMORPH for the entire JPSS era
- Inclusion of all OMPS ozone products (nadir, mapper, limb) into CPC monitoring and NCEP assimilation
- Drought monitoring with NPP/VHI
- *Explore possibility of monitoring oceanic geobiochemical state with associated JPSS retrievals*

Summary

- JPSS satellite data is indispensable for climate applications at CPC and other climate centers.
- *Climate applications of satellite data requires real-time updated long-term (30+years) data sets of temporal homogeneity.*
  - *Long-term consistency needs to be addressed in developing new satellite technology and products*
  - *Reprocessing is required when a technique / product is updated and needs to be archived at CLASS*
- JPSS should put more efforts on the development of products suitable for climate applications.
- CPC – NESDIS collaborations are important to fully capitalize JPSS achievements for climate applications.

From Satellite Remote Sensing to Coral Reef Management:

NOAA Coral Reef Watch's End-to-end Operational Decision Support System

Gang Liu
Mark Eakin, Jacquie De La Cour
Erick Geiger, Kyle Tirak, Al Strong
William Skirving, Scott Heron, Tim Burgess

NOAA Coral Reef Watch – NESDIS/STAR

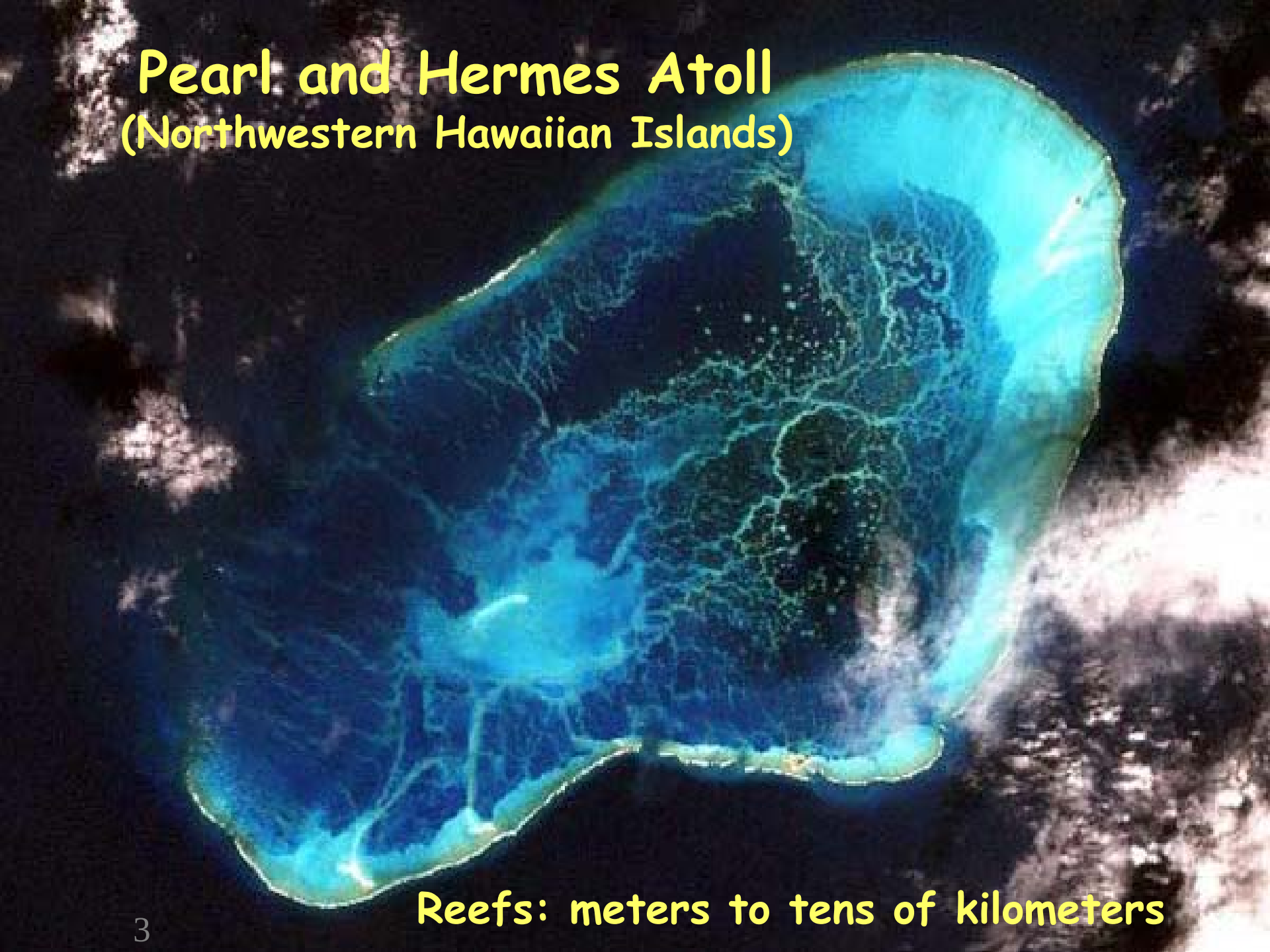
NOAA CORAL REEF CONSERVATION PROGRAM

2015 STAR JPSS Annual Science Team Meeting
24-28 August 2015 · NCWCP · College Park, Maryland

Global Science & Technology, Inc.

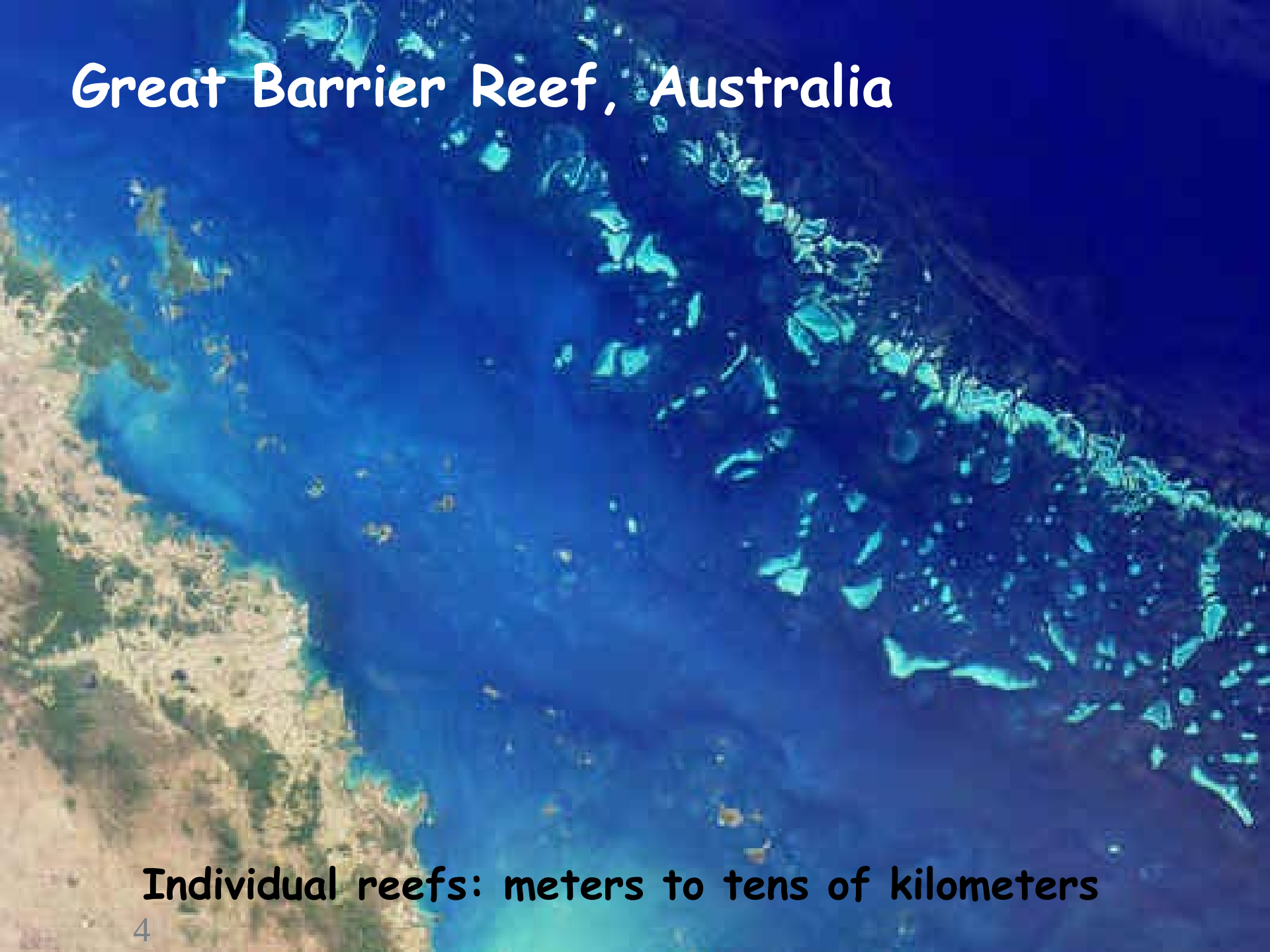
Coral Reef

Pearl and Hermes Atoll
(Northwestern Hawaiian Islands)



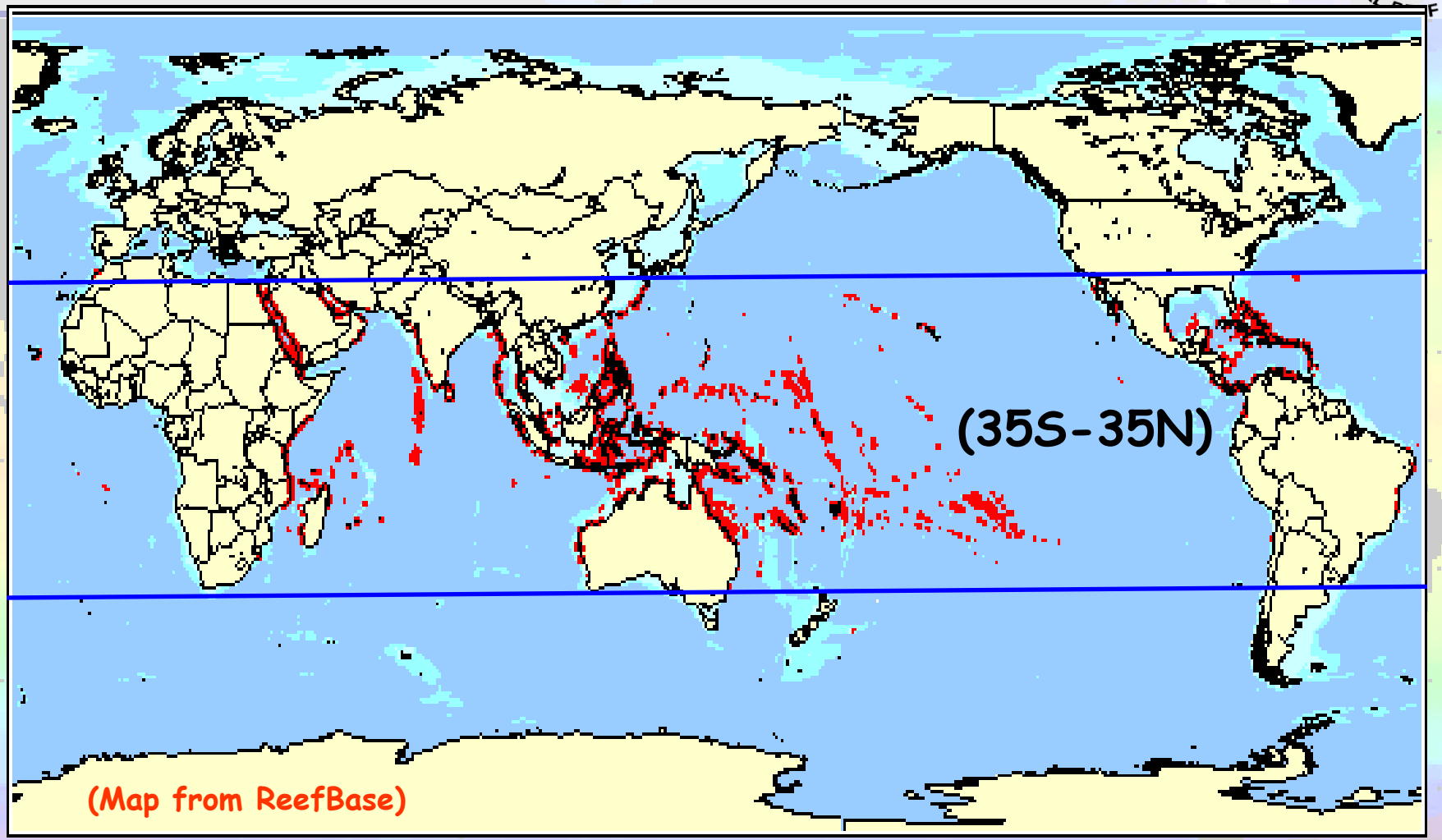
Reefs: meters to tens of kilometers

Great Barrier Reef, Australia



Individual reefs: meters to tens of kilometers

Distribution of World's Coral Reefs

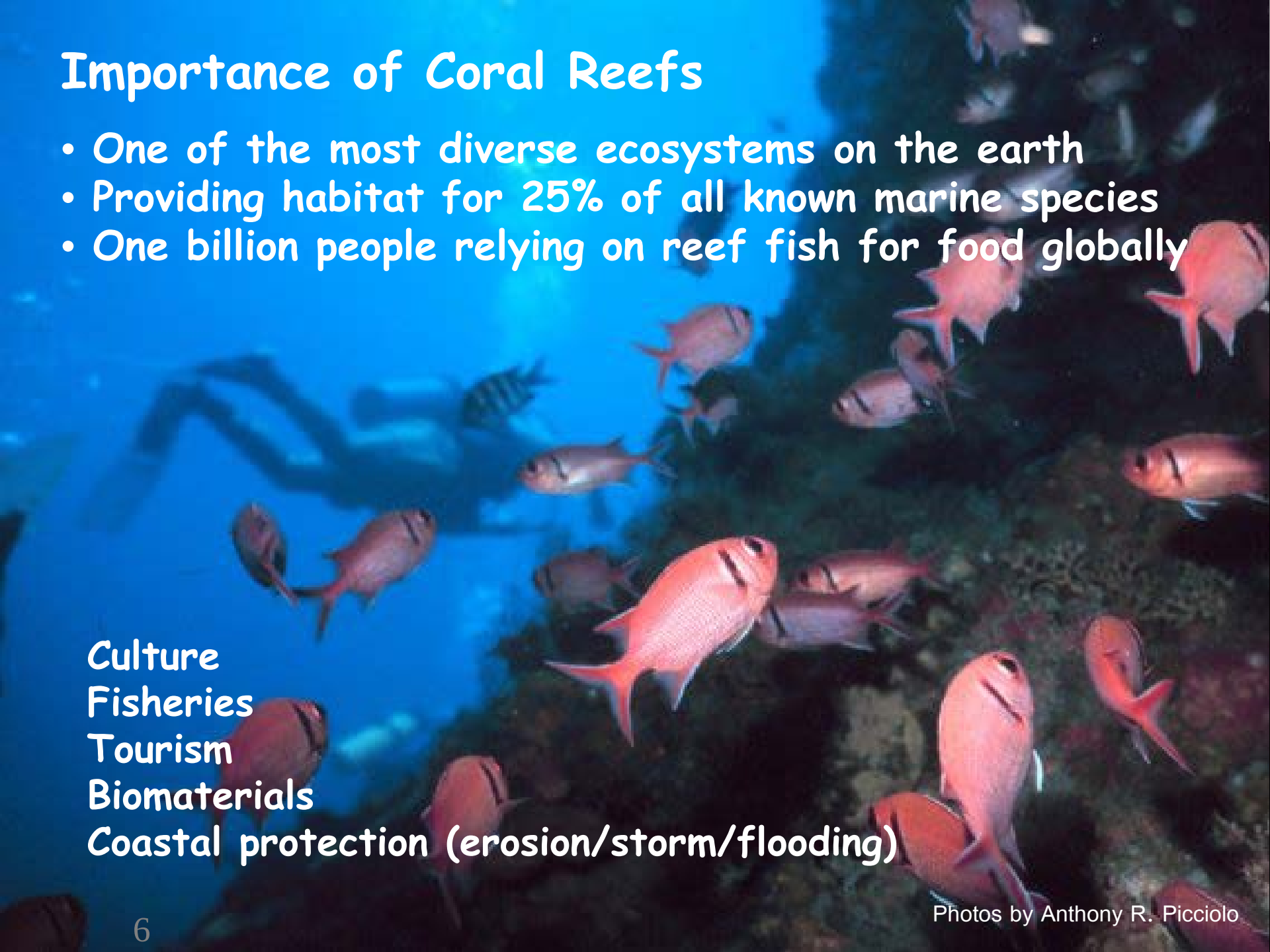


- Most in remote areas
- Covering only 1/10 of 1% of ocean floor

http://coralreefwatch.noaa.gov

Importance of Coral Reefs

- One of the most diverse ecosystems on the earth
- Providing habitat for 25% of all known marine species
- One billion people relying on reef fish for food globally



Culture
Fisheries
Tourism
Biomaterials
Coastal protection (erosion/storm/flooding)

Photos by Anthony R. Picciolo

Coral Bleaching


Bleached colony

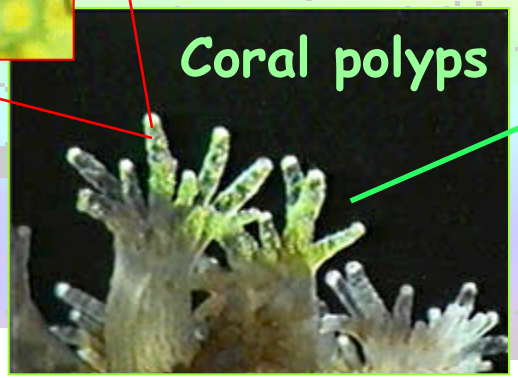
A major threat
to the world's coral reefs

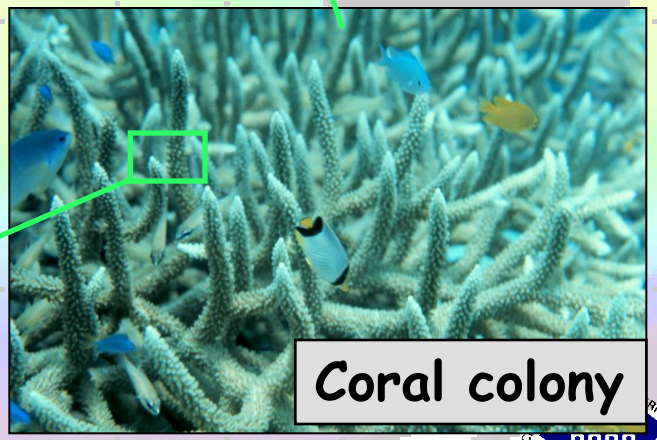
- Anomalously high water temperature induced mass bleaching
- Increasing in frequency & intensity over the past few decades

Coral and Symbiotic Algae

Symbiotic relationship
between algae and corals

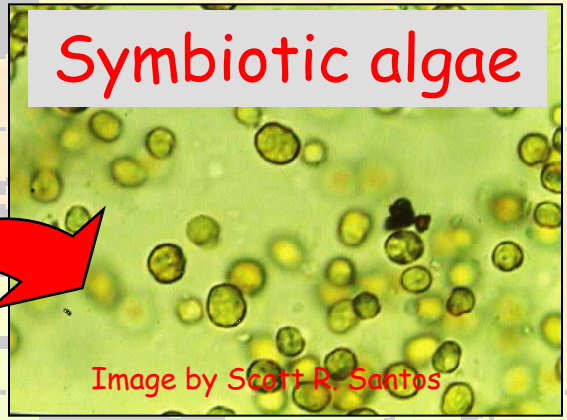
Symbiotic algae
(Zooxanthallae)



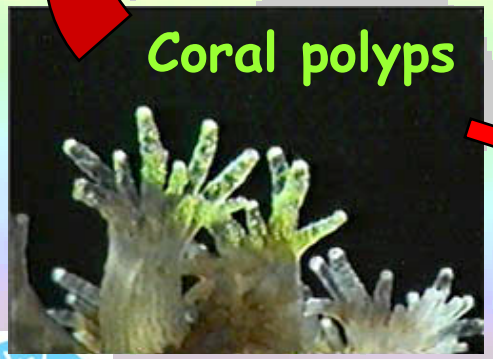


Coral Bleaching

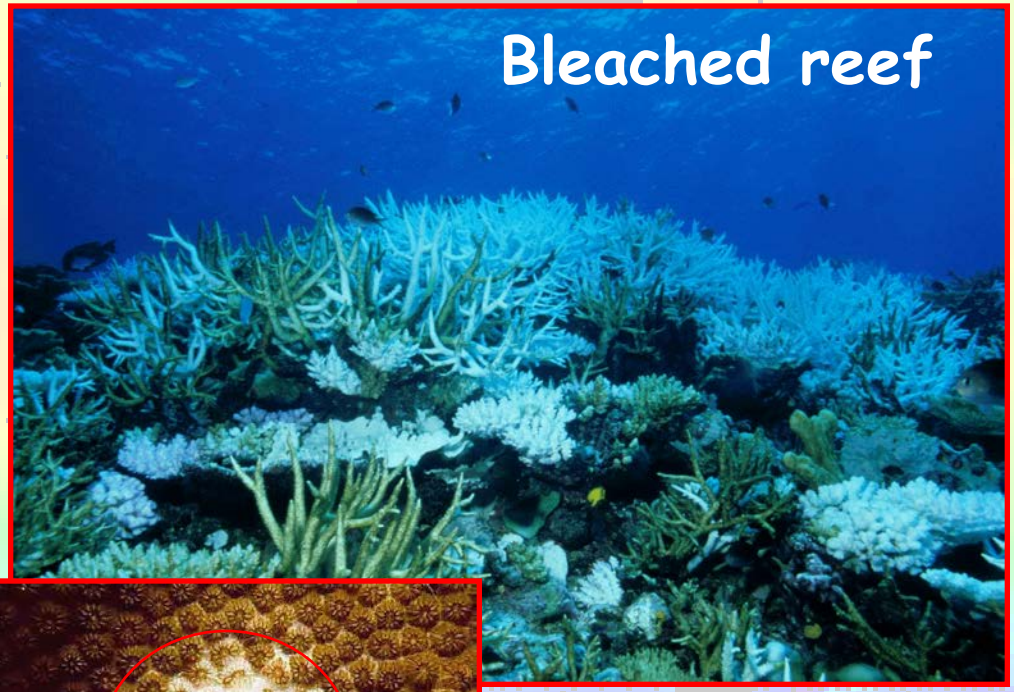
- Corals expel symbiotic algae under environmental stresses.
- White coral skeleton reveals through translucent coral tissue.
- Bleached colony becomes pale, even stark white.

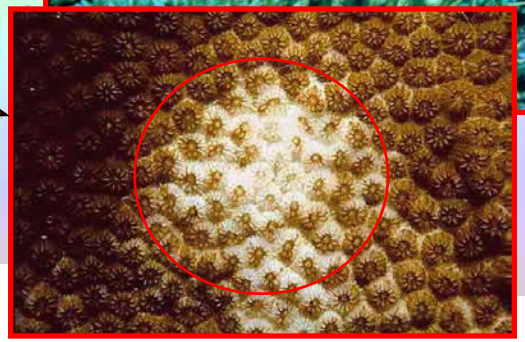


Expelling



Bleaching





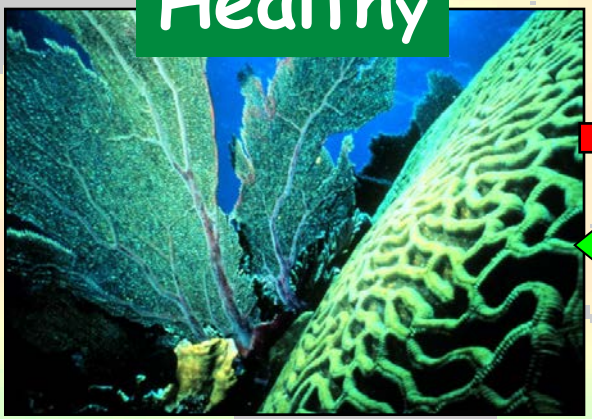
Bleached colony

Coral Bleaching & Coral Reefs in Crisis

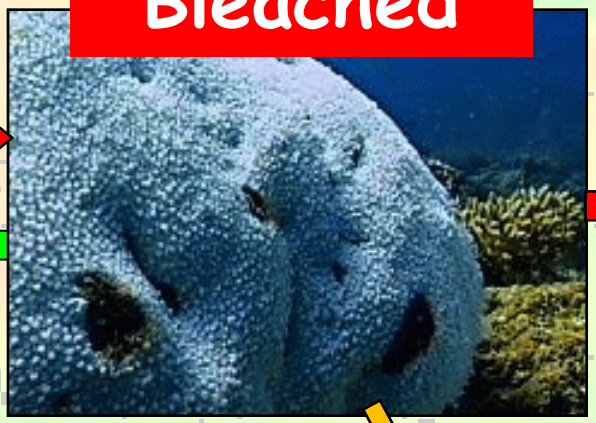
Dramatic long-term ecological and social consequences

??? (long time, favorable environmental conditions)

Healthy



Bleached



Dead

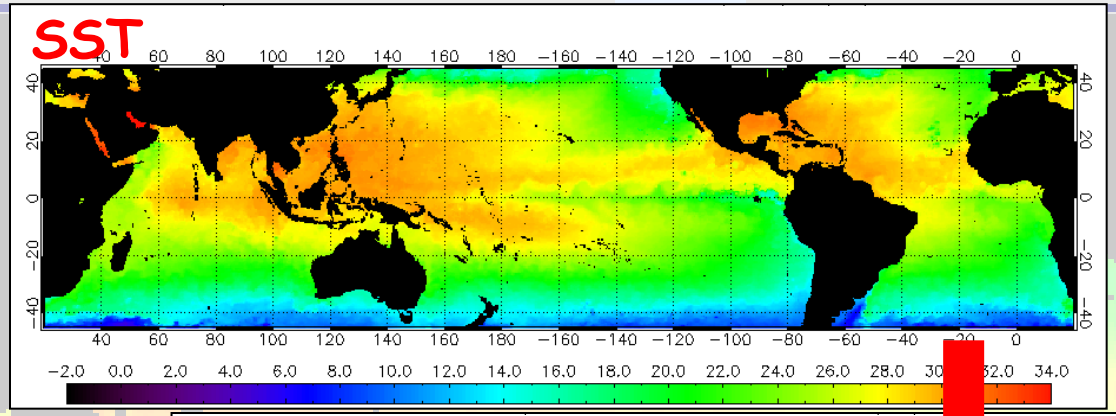
Bleaching increases the susceptibility of corals to disease

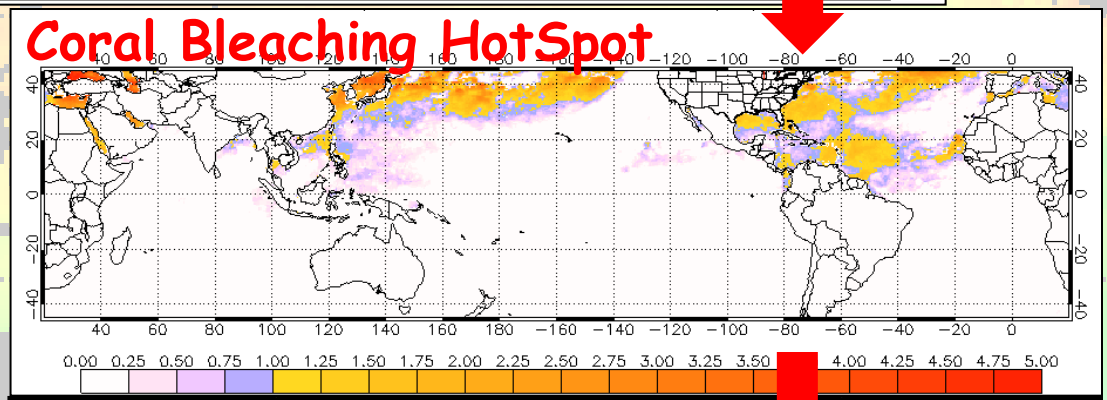
Disease

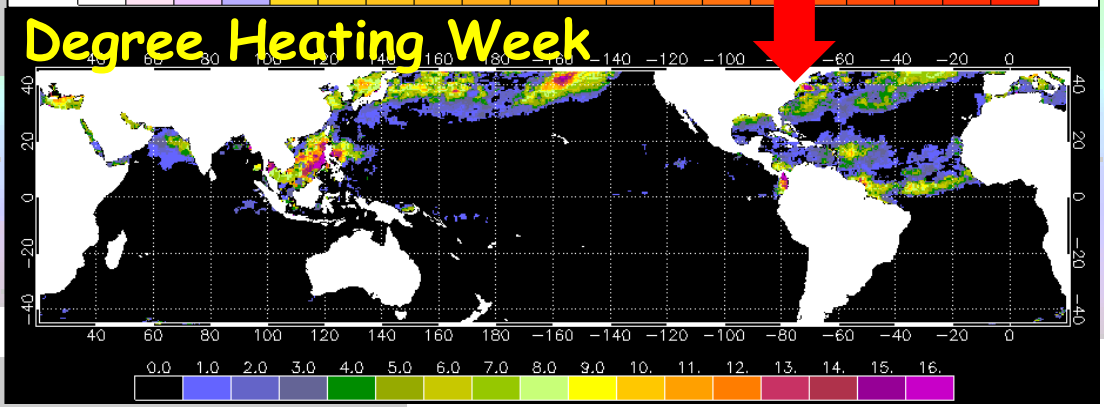
(Photo Credit: J.Lamb)

NOAA Coral Reef Watch

Decision Support System for Coral Reef Management







Since 1997

50-km

Twice-weekly

1997

2000

Workshops, Outreach, and Trainings

2000-present: Bring managers, scientists, and stakeholders together

American Samoa, 2007

Pigeon Key, Florida, 2008

Maui, Hawaii, 2008

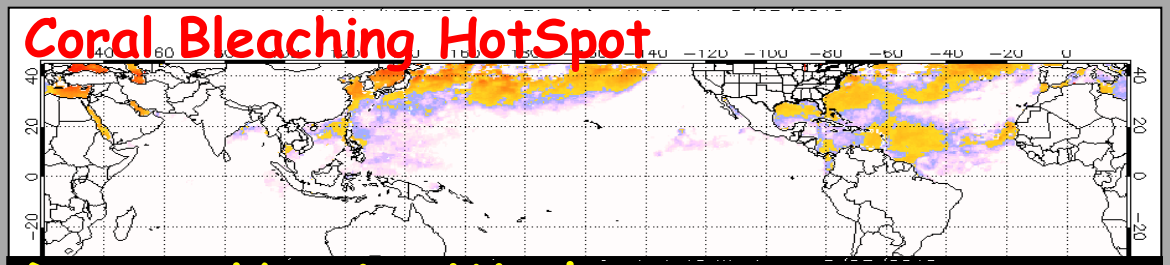
Thailand and Indonesia, 2013

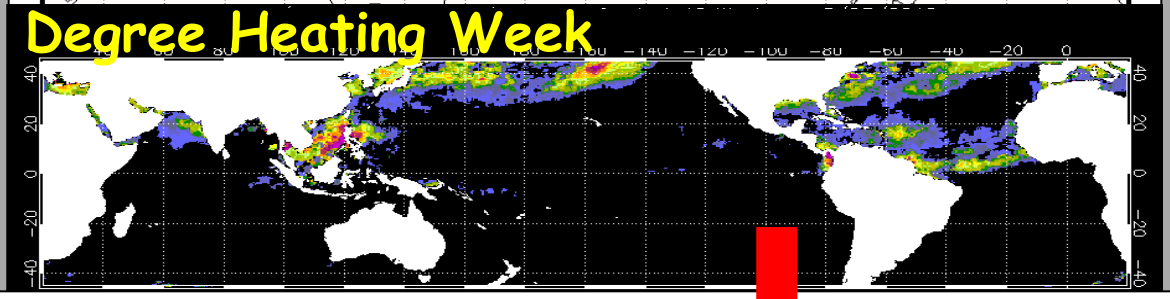
American Samoa, 2014

St. Lucia, 2015

NOAA Coral Reef Watch

Decision Support System for Coral Reef Management





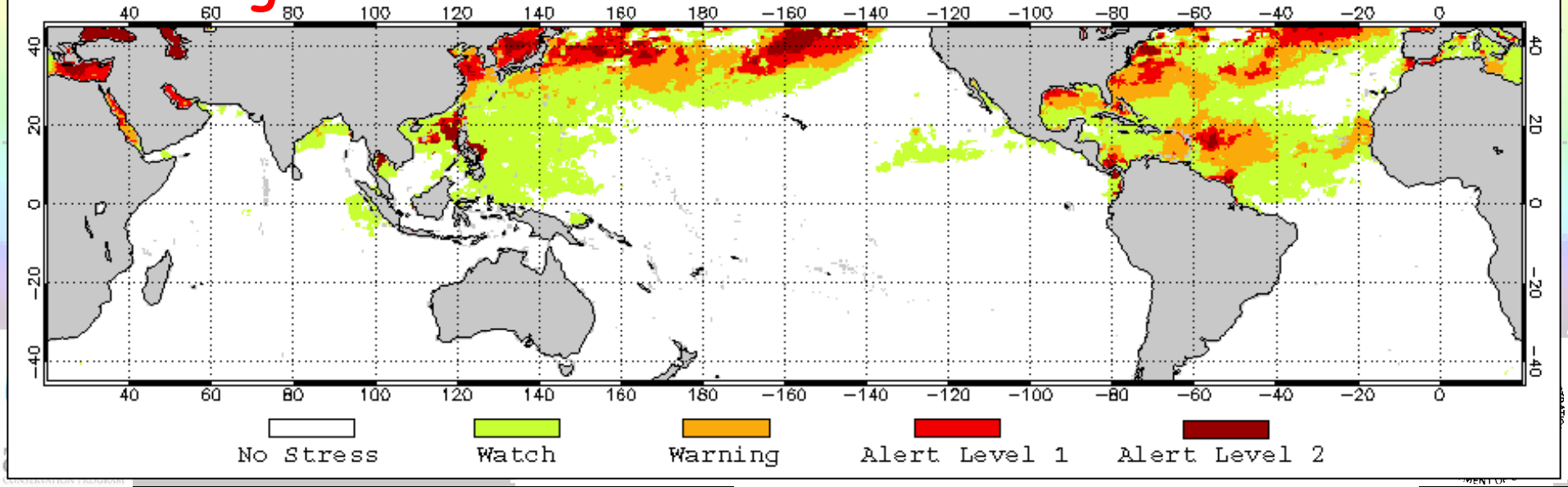
Since 1997

50-km

Twice-weekly

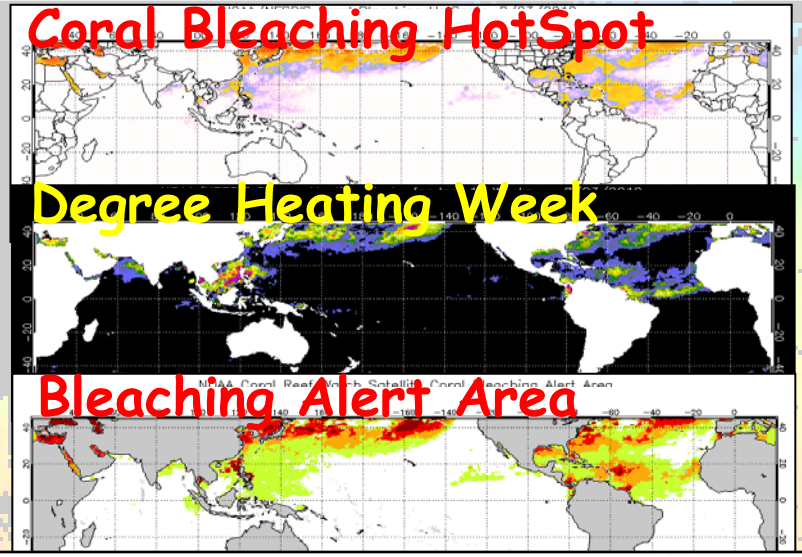
2009

Bleaching Alert Area



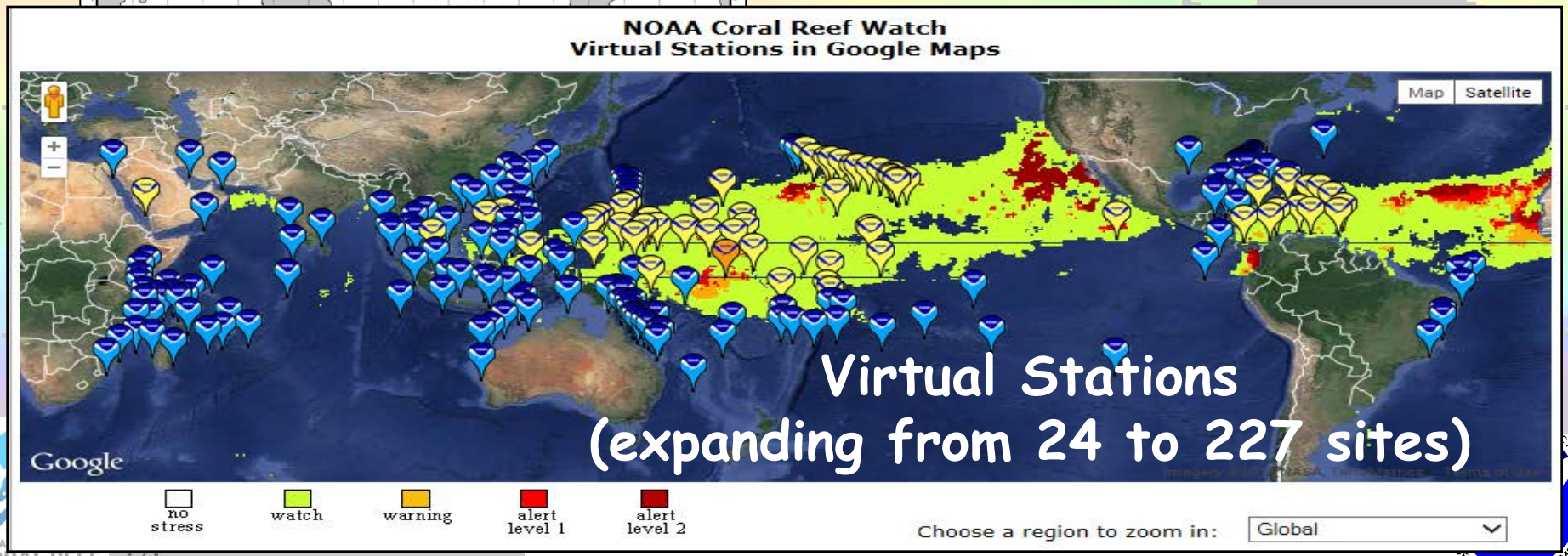
NOAA Coral Reef Watch

Decision Support System for Coral Reef Management



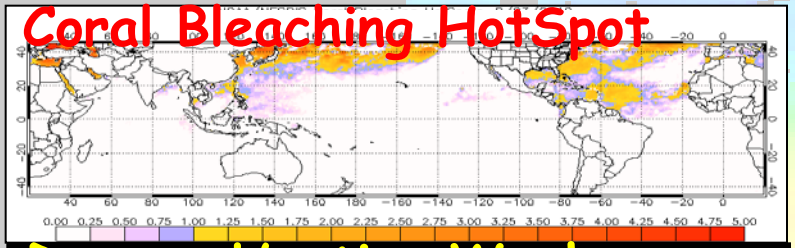
50-km
Twice-weekly

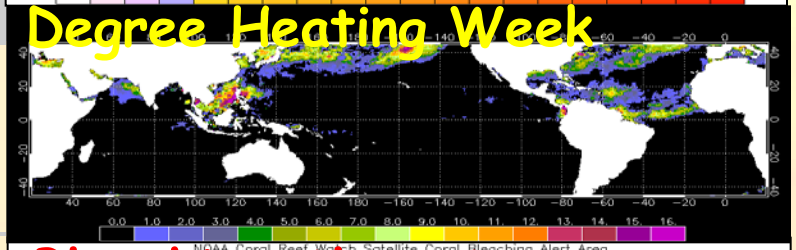
2000-2011

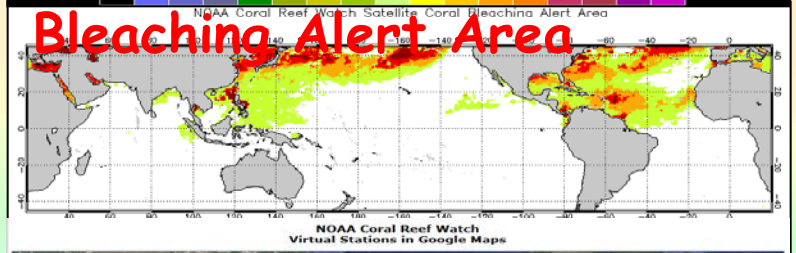


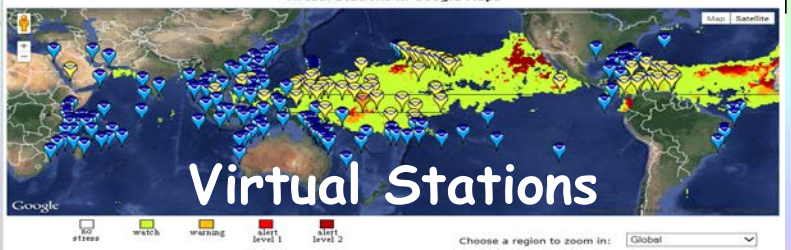
NOAA Coral Reef Watch

Decision Support System for Coral Reef Management









50-km, twice-weekly

2005

==========

[NOAA Coral Reef Watch Coral Bleaching Alert 20120621]

==========

Atlantic Ocean

** Caribbean

-- Bocas del Toro, Panama	(+) Bleaching Watch
-- Cayos Miskitos, Nicaragua	(+) Bleaching Watch
-- San Bernardo, Colombia	(+) Bleaching Watch
-- Santa Marta, Colombia	(+) Bleaching Watch

** Florida

-- Gulf Sloughsway, Florida	(-) No Stress
-- SW FL Shelf Inshore, Florida	(-) No Stress

Pacific Ocean

** Eastern Pacific

-- Clipperton Island, France	(-) No Stress

** Micronesia

== Federated States of Micronesia

-- Chuuk, FSM	(+) Bleaching Watch
-- Pisaras, FSM	(+) Bleaching Watch

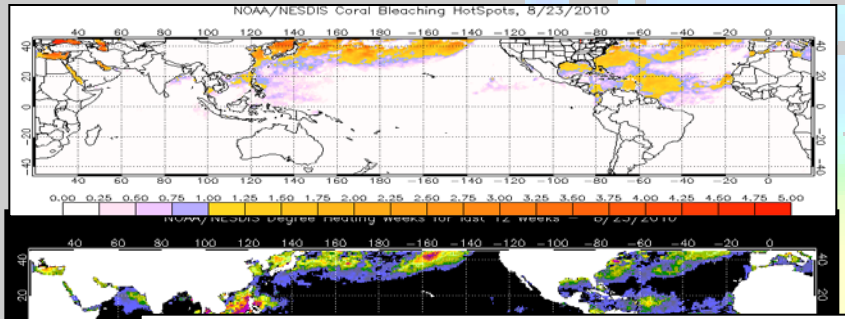
** Polynesia

-- Funafuti, Tuvalu	(+) Bleaching Watch

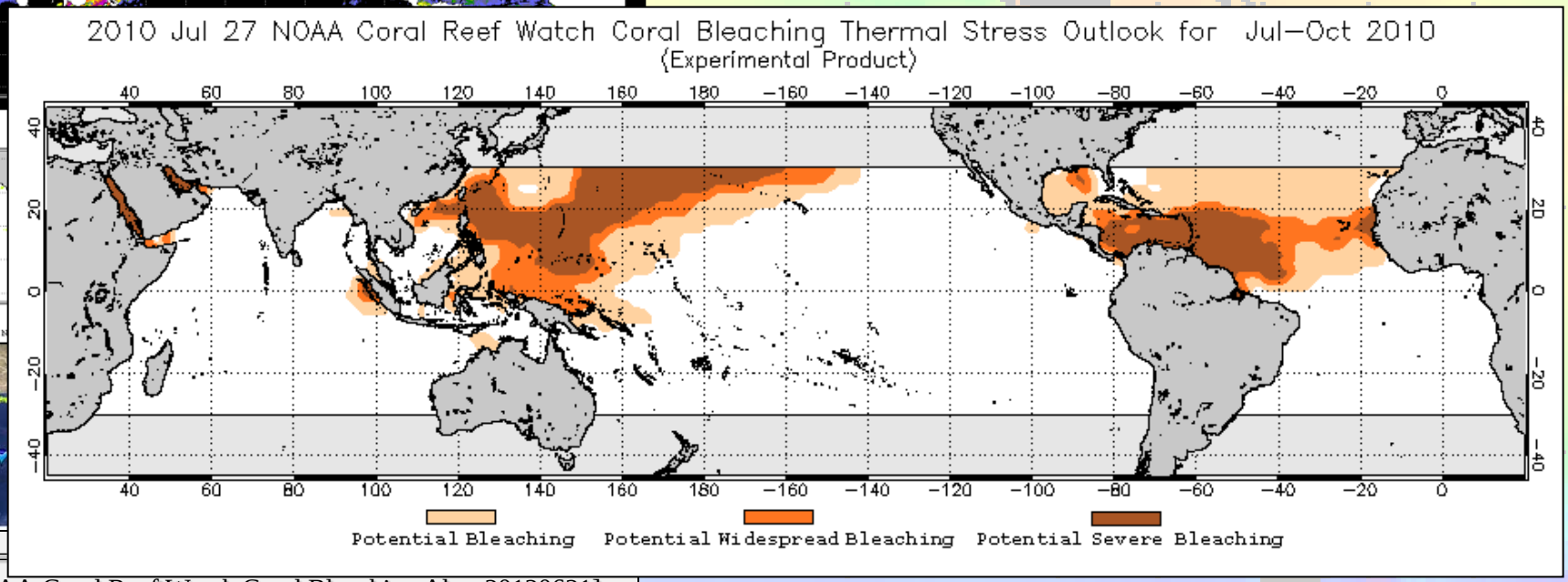
Automated email alert for Virtual Stations

NOAA Coral Reef Watch

Decision Support System for Coral Reef Management



2008



[NOAA Coral Reef Watch Coral Bleaching Alert 20120621]

==========

Atlantic Ocean

** Caribbean

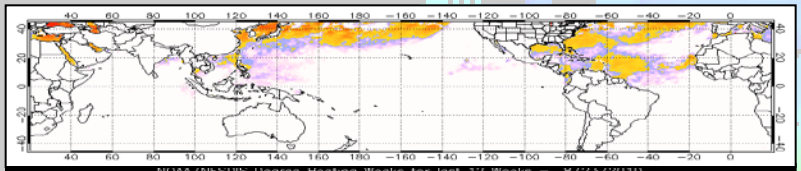
-- Bocas del Toro, Panama (+) Bleaching Watch

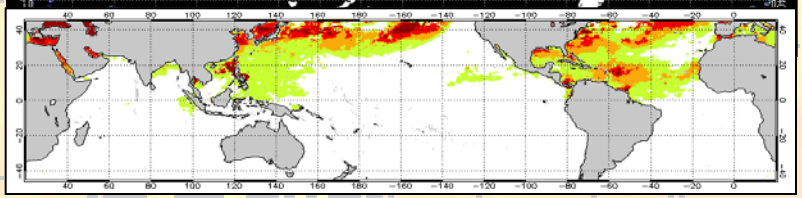
-- Cayos Miskitos, Nicaragua (+) Bleaching Watch

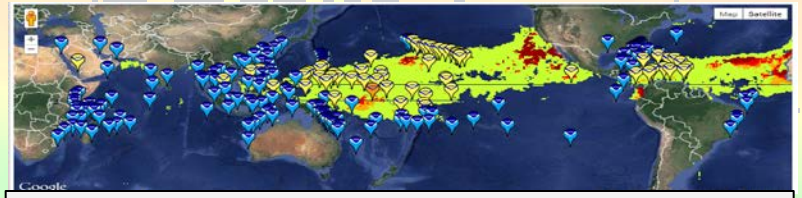
Seasonal Bleaching Outlook

NOAA Coral Reef Watch

Decision Support System for Coral Reef Management







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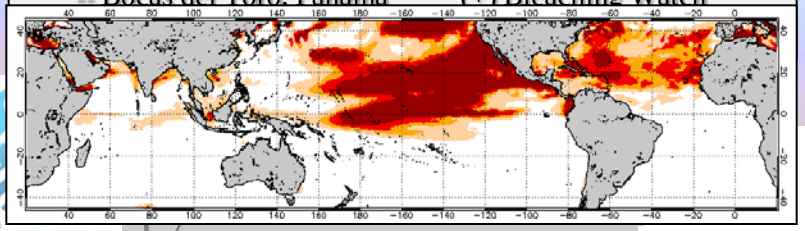
[NOAA Coral Reef Watch Coral Bleaching Alert 20120621]

==========

Atlantic Ocean

** Caribbean

-- Bocas del Toro, Panama (+) Bleaching Watch



Bleaching Thermal Stress Analysis/Seasonal Guidance

Pacific Climate Update
Coral Bleaching Thermal Stress Analysis and
Seasonal Guidance through August 2015

(Released May 3, 2015)

NOAA Coral Reef Watch's near-real-time satellite monitoring has shown significant and persistent elevation of sea surface temperature (SST) throughout the equatorial Pacific Ocean. High SST anomalies are now well-developed in the eastern equatorial Pacific Ocean and along the coast of South America, consistent with a conventional El Niño (Figure 1). Meanwhile, a significantly high anomaly in the central equatorial Pacific Ocean that started early last year has persisted, consistent with an atypical El Niño Modoki or central Pacific El Niño event (Figure 1). SST anomalies in the western equatorial Pacific Ocean also remain higher than normal.

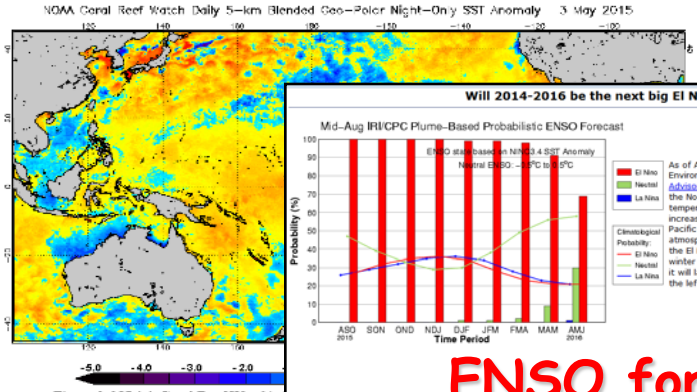
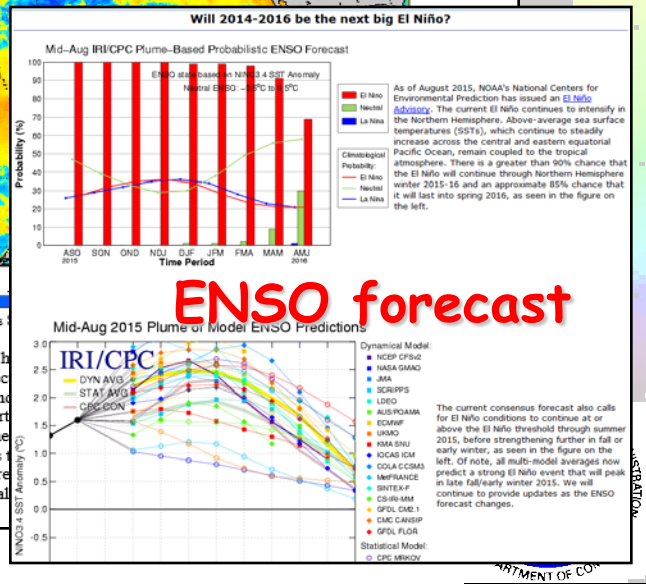


Figure 1. NOAA Coral Reef Watch's

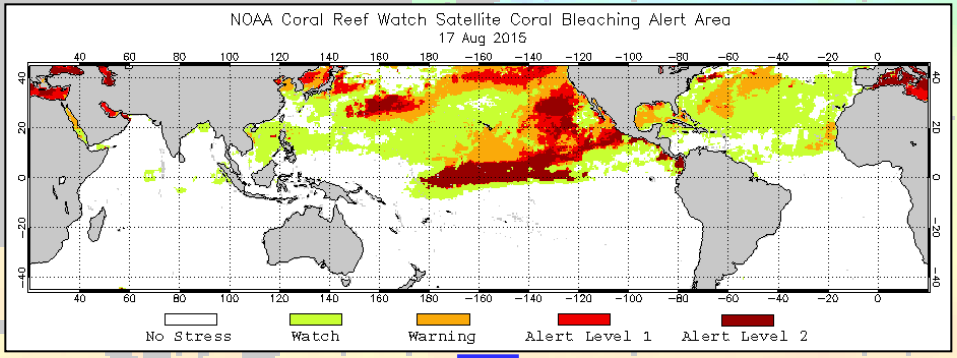
As a result, Coral Bleaching HotSpots h
equatorial Pacific Ocean (Figure 2), acc
(Figure 3). Bleaching Alert Levels 1 and
soon bleach on reefs in Kiribati (Gilbert
west, and the Galapagos Islands and the
western South Pacific has decreased as t
thermal stress still can be seen in Figure
come from regions such as Fiji and Wal



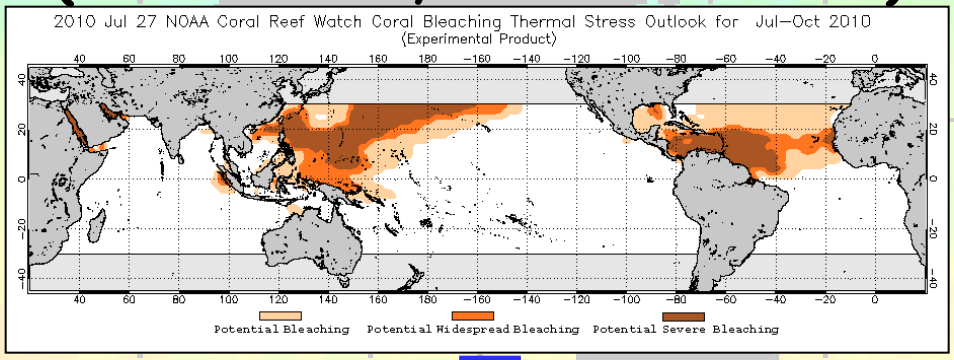
ENSO forecast

Next-Generation Products

50 km Twice-weekly Satellite Products



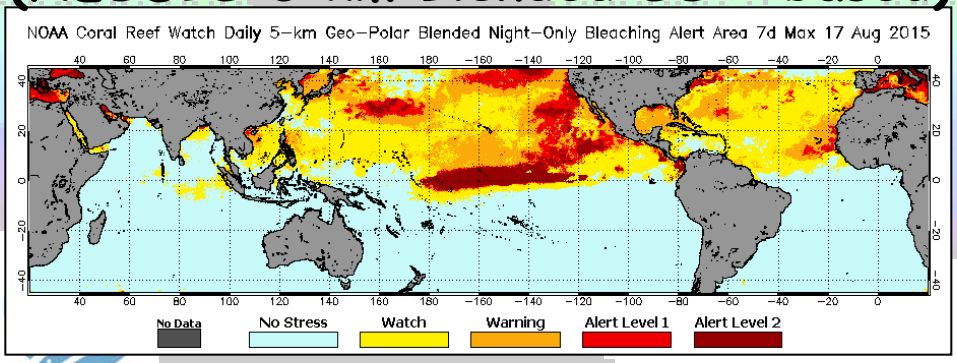
2 degree 4-Month Outlook (deterministic, OAR/LIM-based)



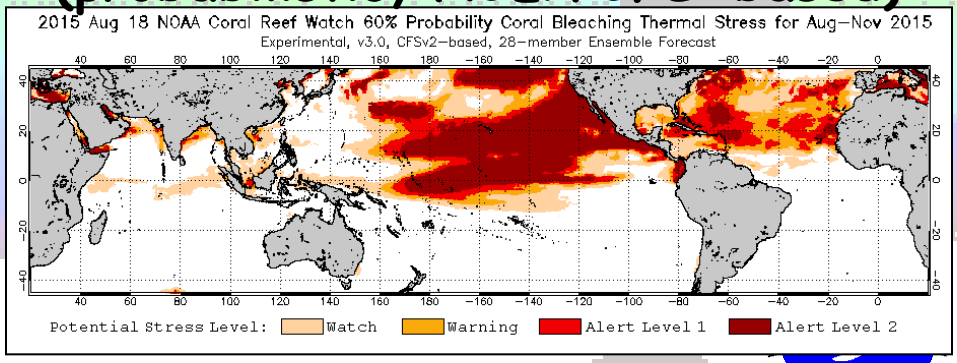
2012 2015

2012 2015

5 km Daily Satellite Products (NESDIS 5 km Blended SST-based)



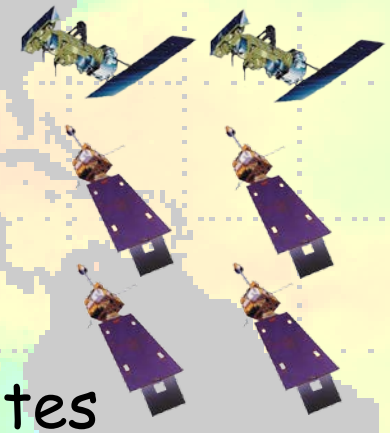
0.5 degree 4-Month Outlook (probabilistic, NCEP/CFS-based)



Next-Generation Satellite Products

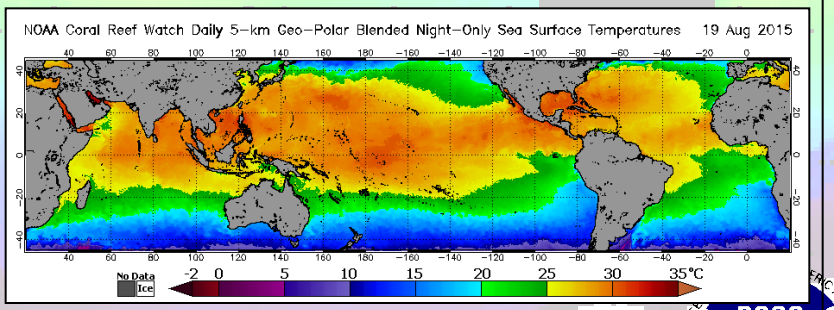
NESDIS Geo-Polar Blended Night-Only SST Analysis

Heritage		Next Generation
50 km	➔	5 km
twice-weekly	➔	daily
one polar-orbiter only	➔	blended data from polar-orbiting & geostationary satellites



Polar-orbiting satellites: **Suomi-NPP (VIIRS: highest spatial res.)**
MetOp-B

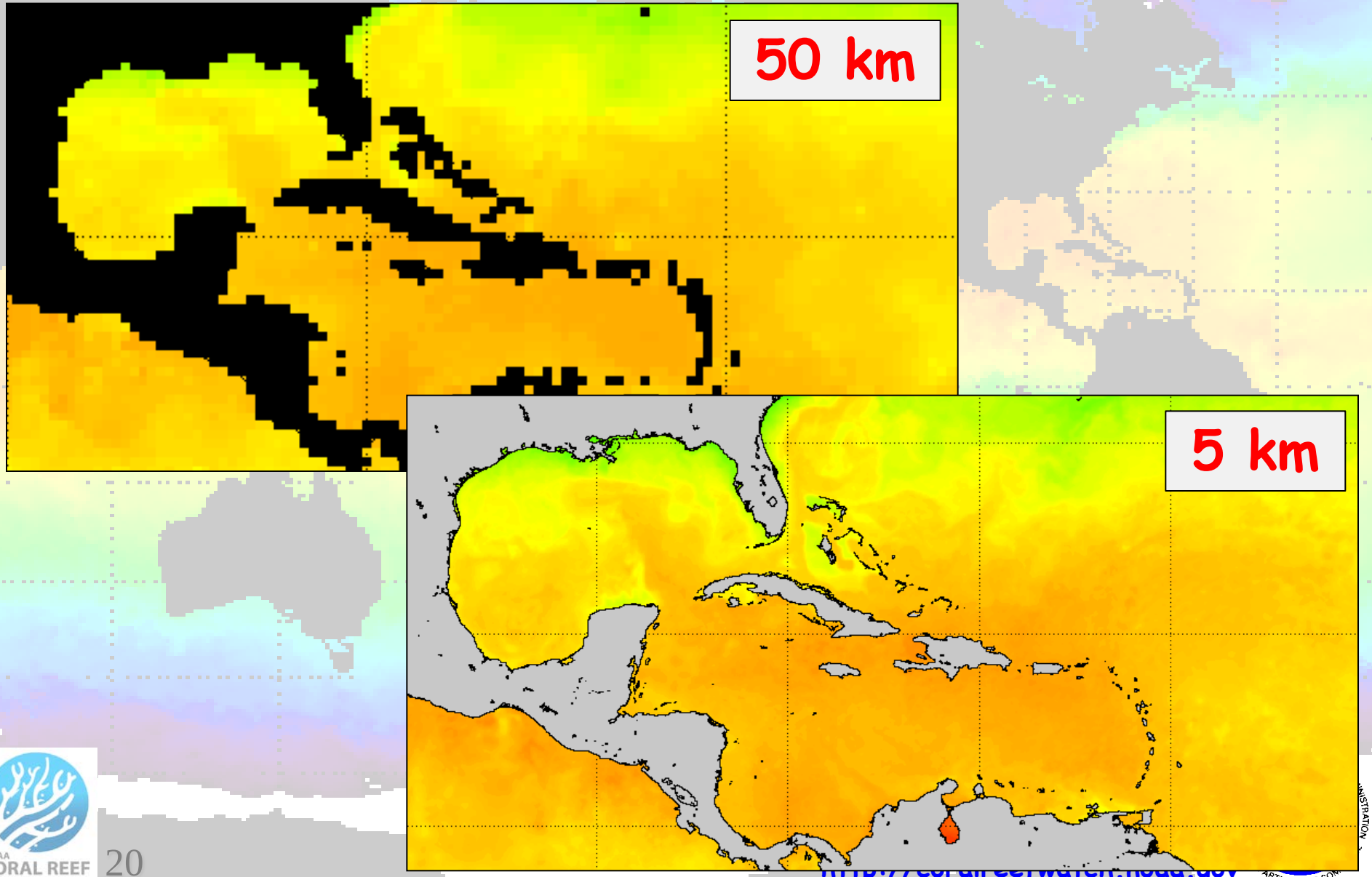
Geostationary satellites: **GOES-E**
GOES-W
MTSAT-2
MSG-3



http://coralreefwatch.noaa.gov

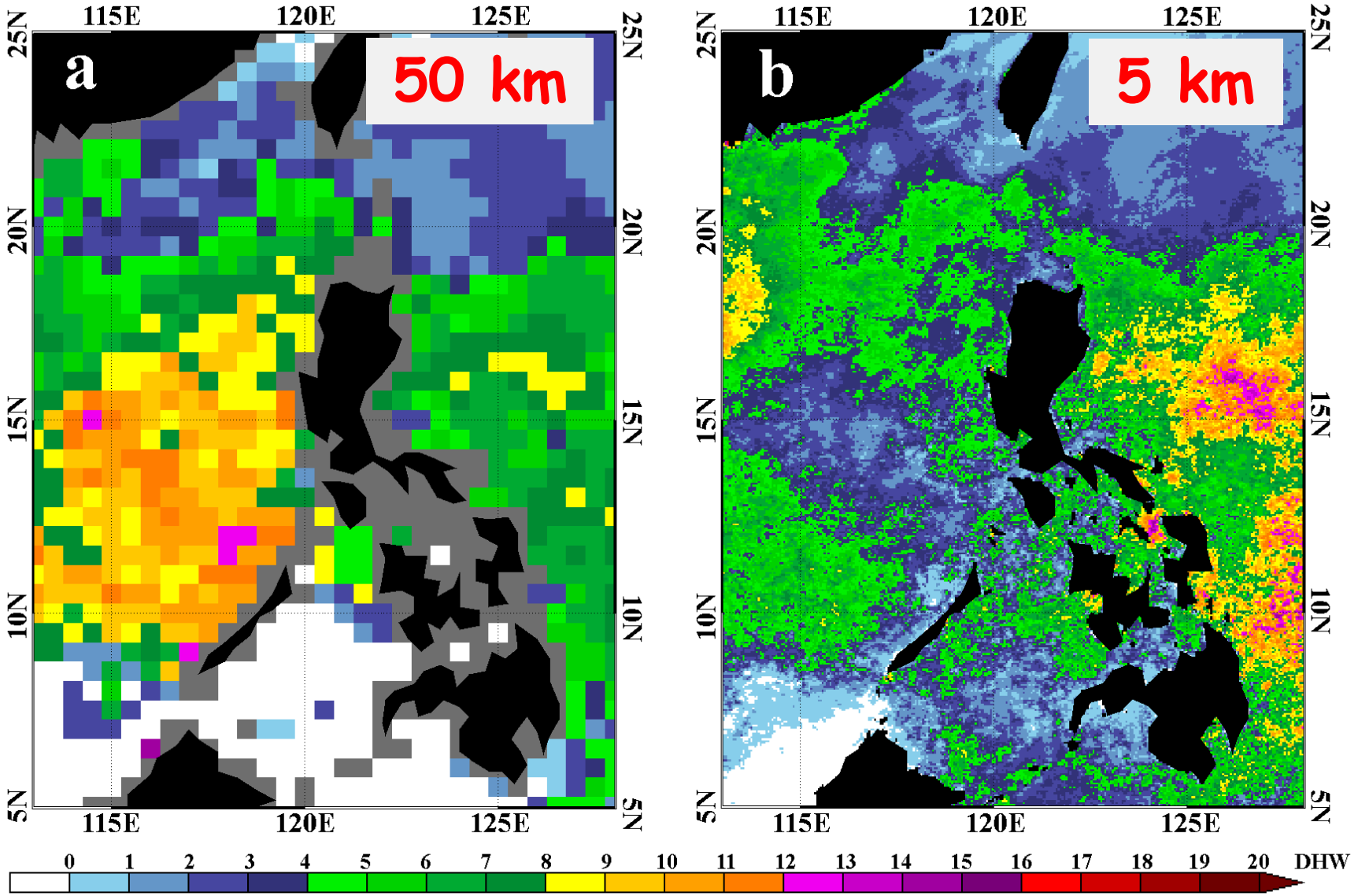
NOAA Coral Reef Watch

Sea Surface Temperature (Input)



NOAA Coral Reef Watch

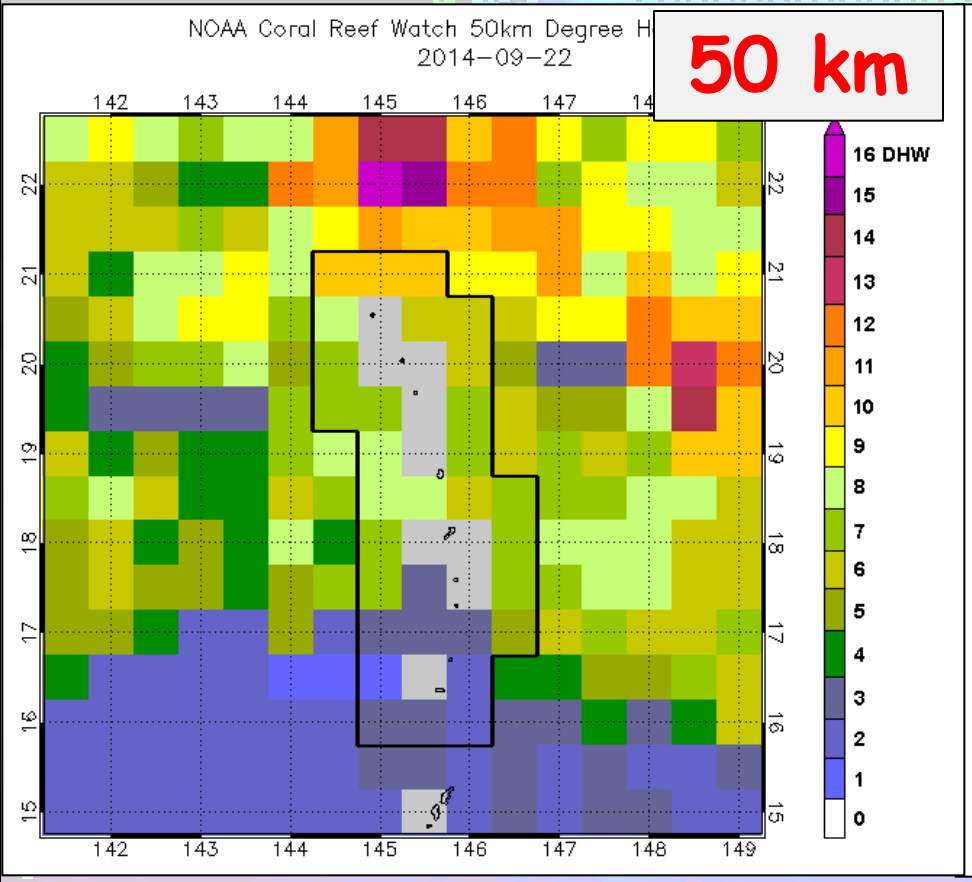
Degree Heating Weeks

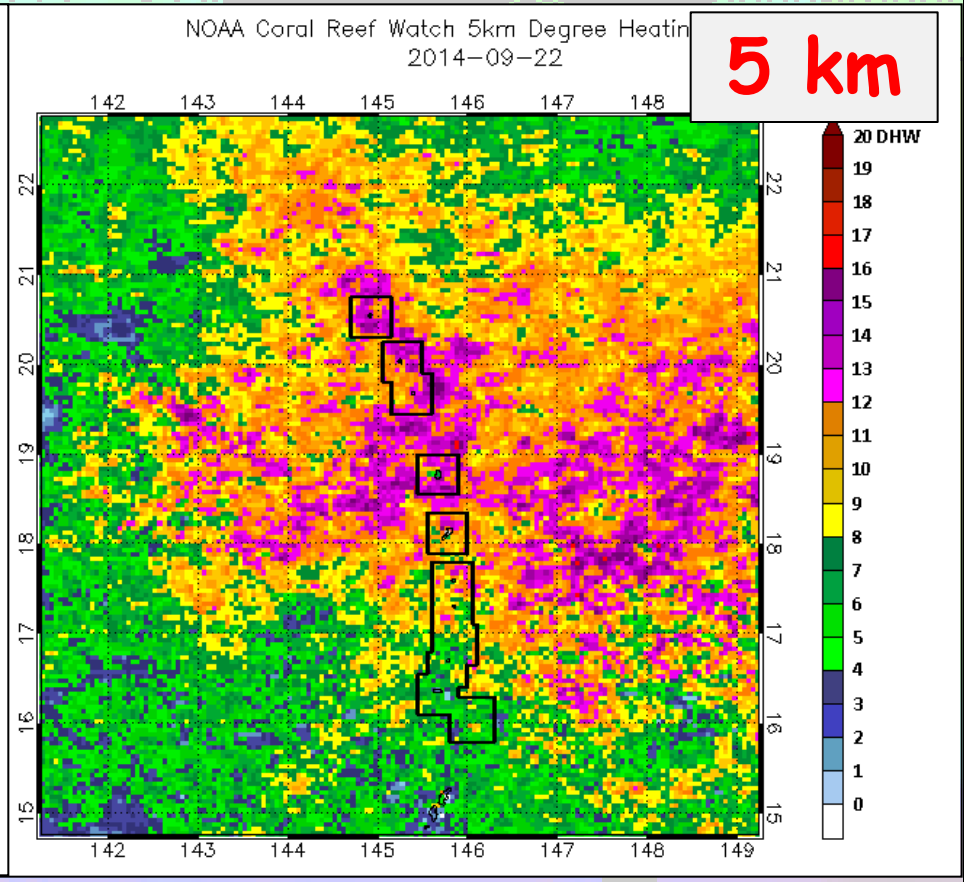


NOAA Coral Reef Watch

Degree Heating Weeks

2014 bleaching event in CNMI

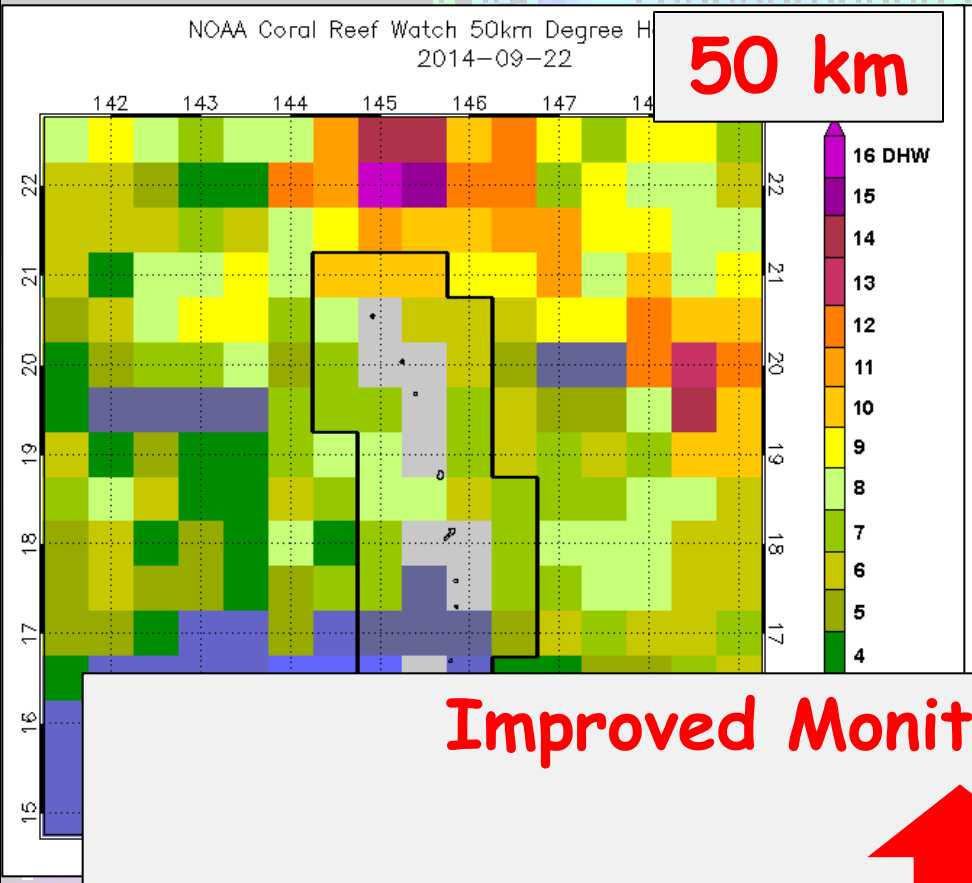


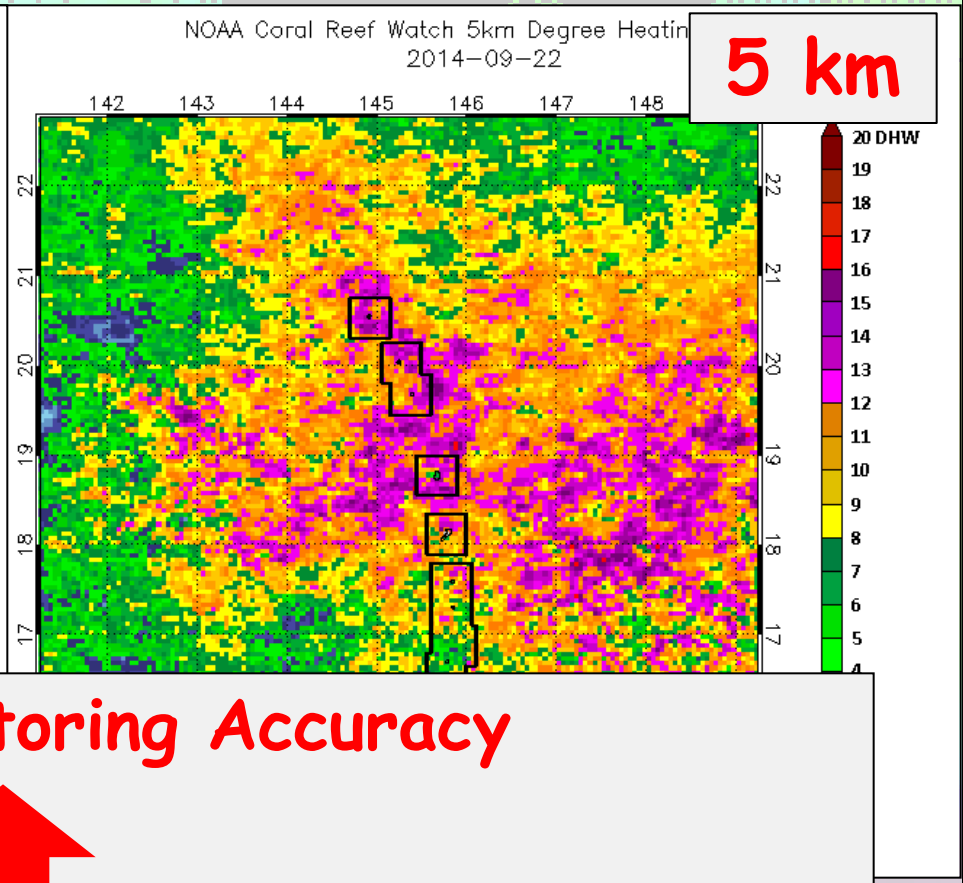


(CNMI: Commonwealth of the Northern Mariana Islands)

Degree Heating Weeks

2014 bleaching event in CNMI

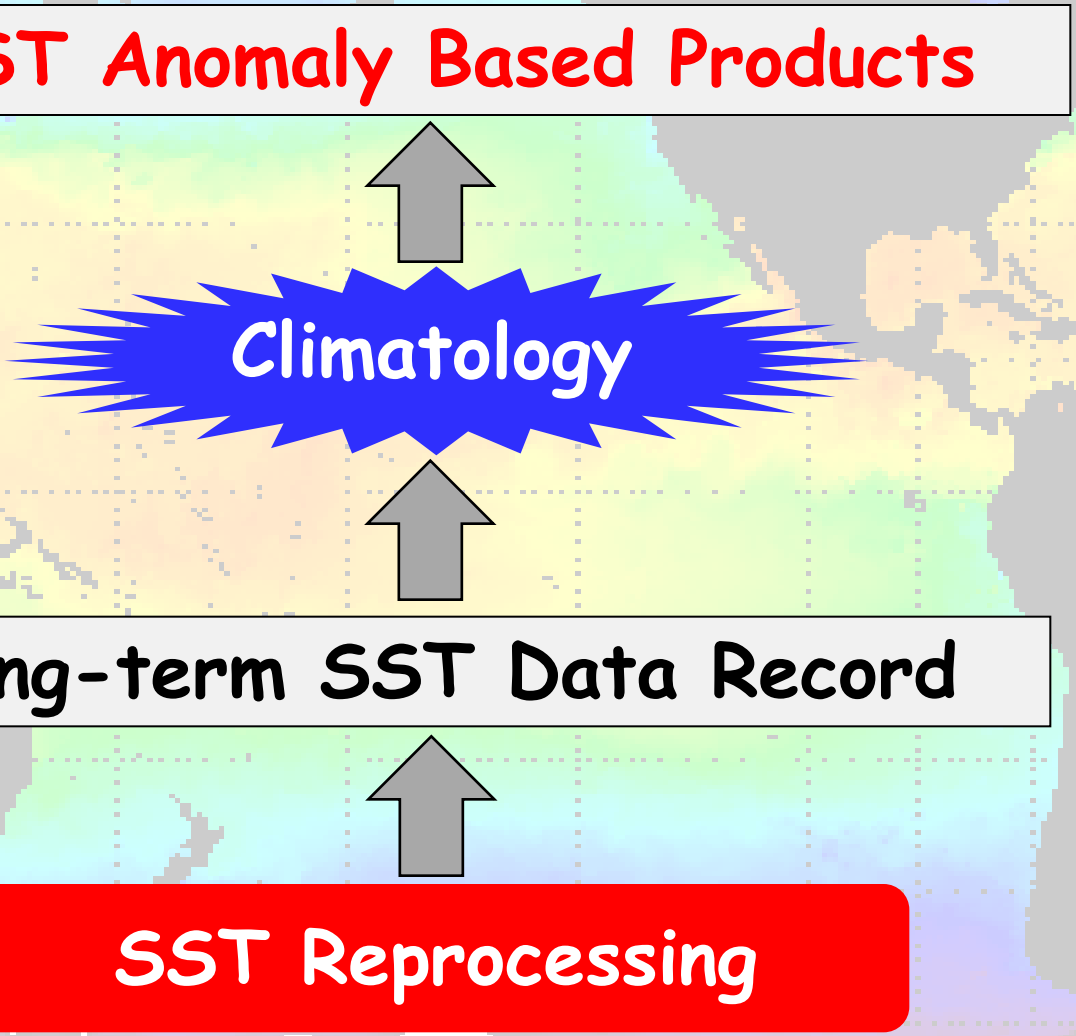




Improved Monitoring Accuracy

Improved SST quality / Improved Climatology

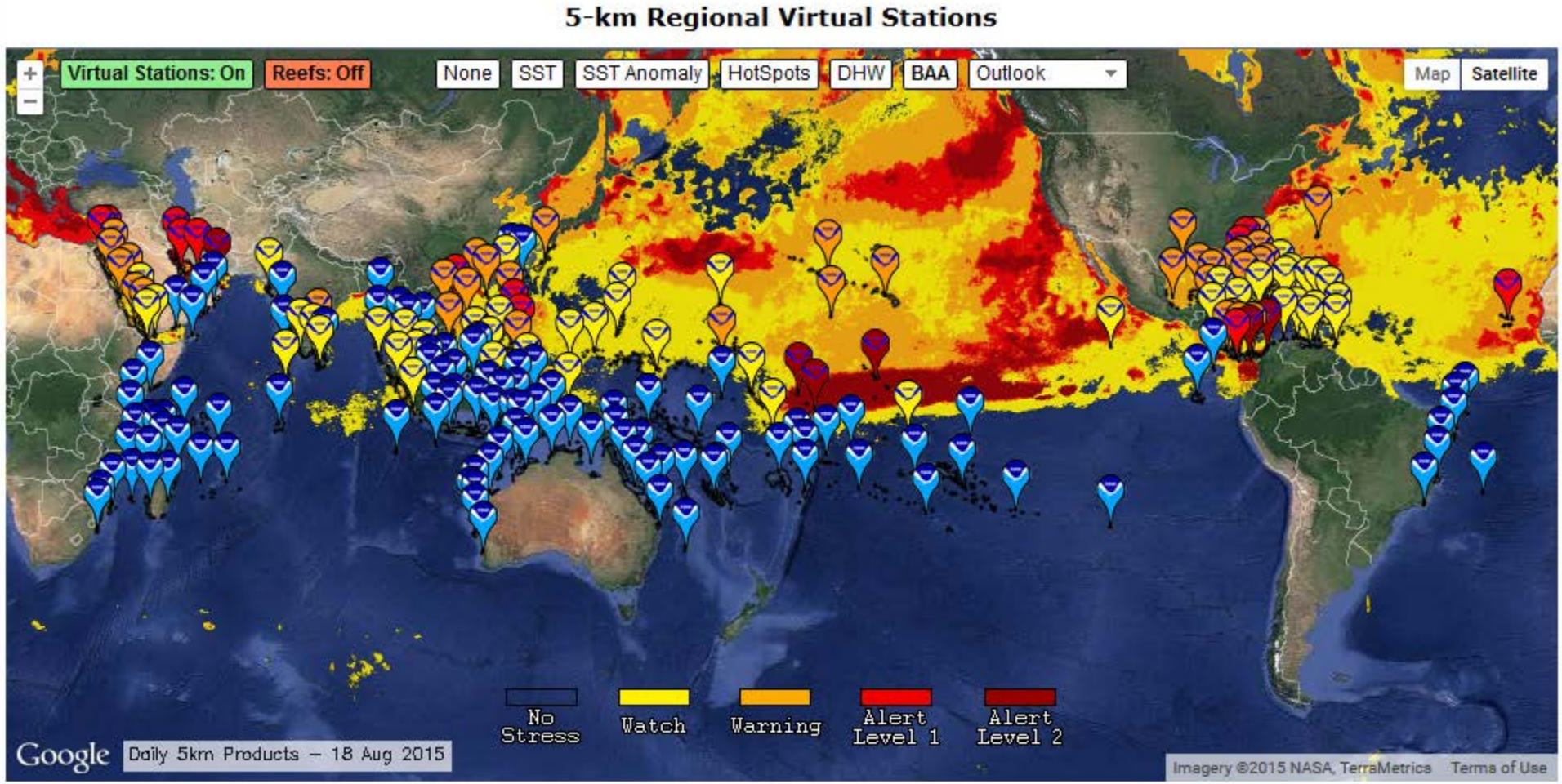
SST Reprocessing and Climatology



(STAR SST teams)

NOAA Coral Reef Watch

Satellite Bleaching Regional Virtual Stations (5-km)



View this map full screen.

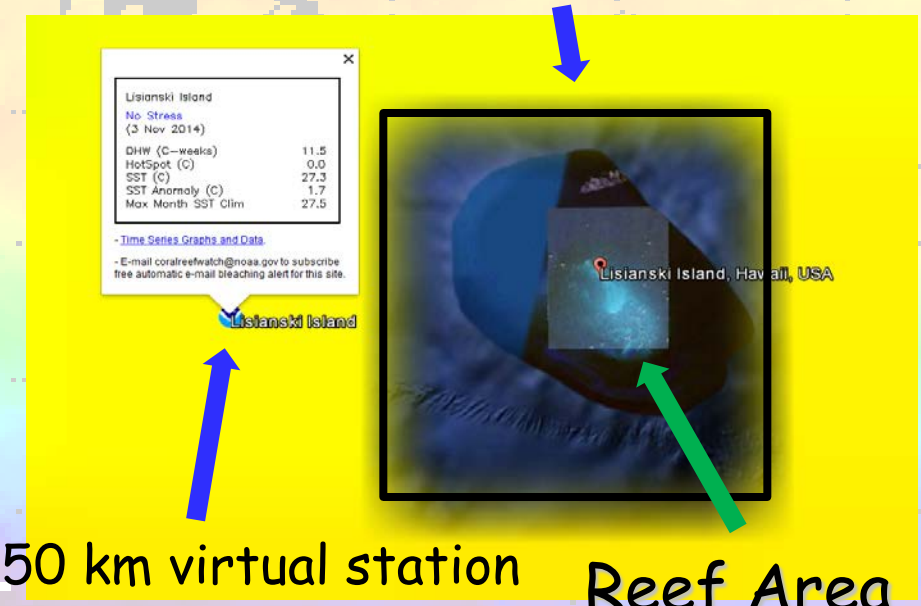
Select a region to zoom in: Global

http://coralreefwatch.noaa.gov

Satellite Bleaching Virtual Stations

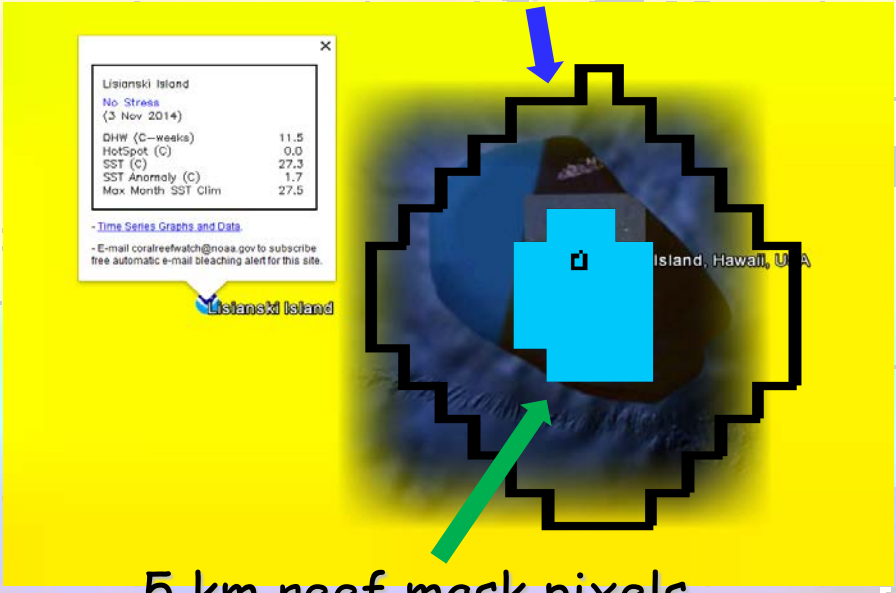
50 km virtual station
(a single 50-km pixel near reef)

Approx. 50 km pixel size

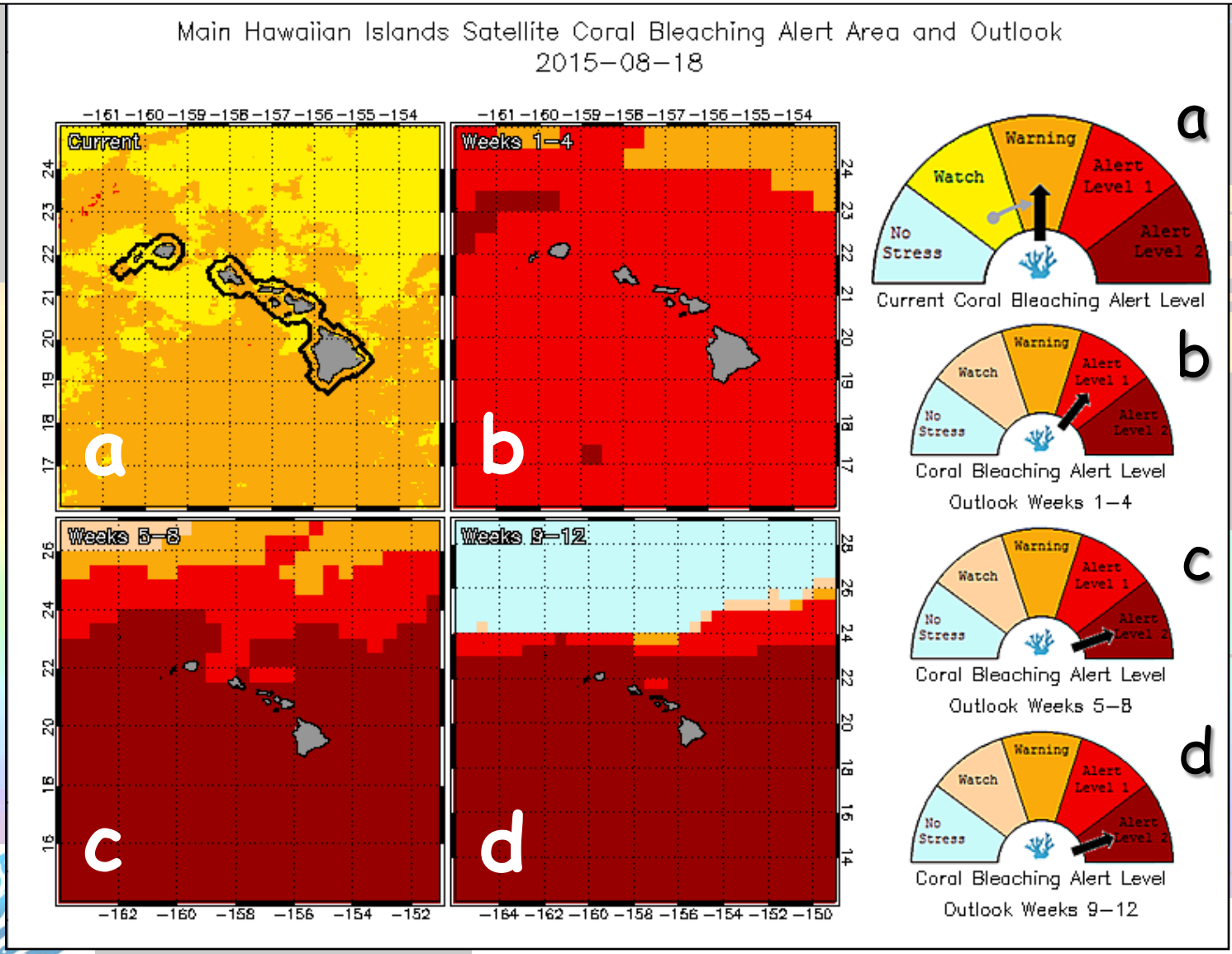


5 km regional virtual station
(a multi-pixel region of at reef)

20-km buffer around reef pixels



Main Hawaiian Islands Regional Virtual Station 5-km Bleaching Thermal Stress Gauges

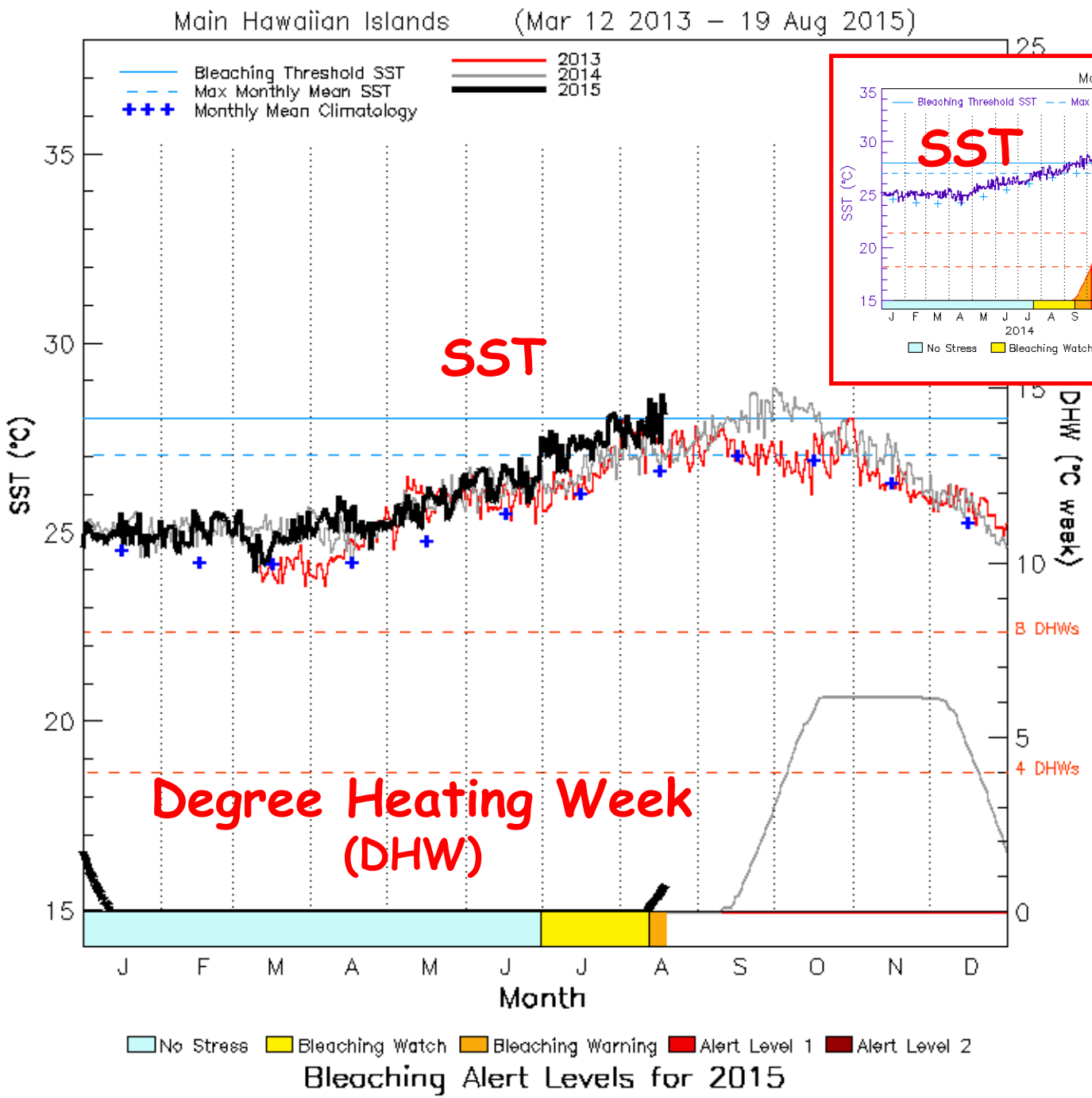


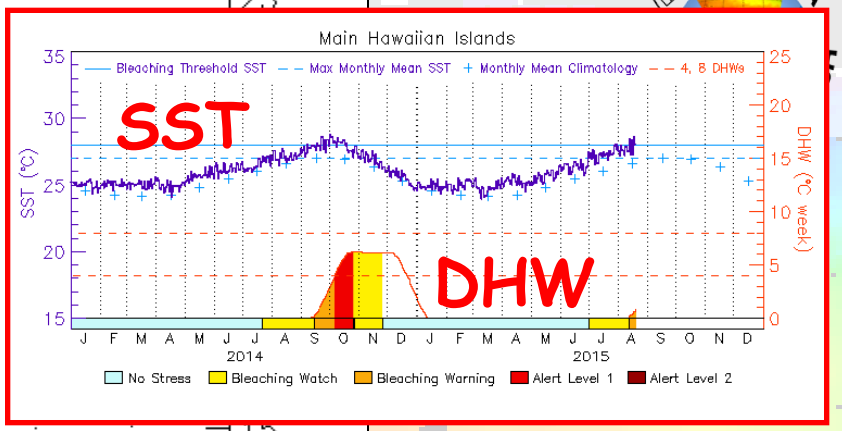
Current Satellite Bleaching Alert

Outlook (1-4 weeks)

Outlook (5-8 weeks)

Outlook (9-12 weeks)





SST and DHW time series for the Main Hawaiian Islands Regional Virtual Station

fwatch.noaa.gov

NOAA Coral Reef Watch

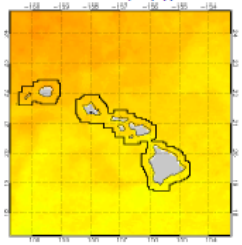
CRW's Products in Users' Newsletters/Bulletins

UPDATE: CORAL BLEACHING DATA

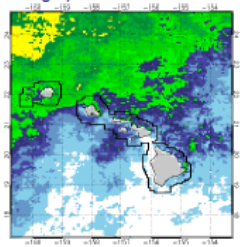
10/13/2014

NOAA CORAL REEF WATCH DATA (http://coralreefwatch.noaa.gov)

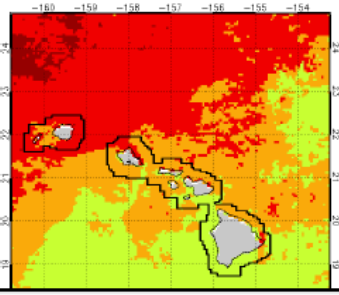
The NOAA Coral Reef Watch Sea Surface Temperature (SST) Anomaly map (top left) shows the difference between today's temperature and the long-term average. The Degree Heating Week map (top right) shows accumulated thermal stress, which can lead to coral bleaching. Significant coral bleaching usually occurs when DHW values reach 4 °C-weeks. At 8 °C-weeks, widespread bleaching is likely and significant mortality can be expected.

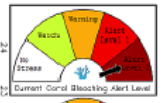


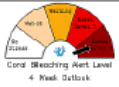
Sea Surface Temperature Anomaly—10/13/2014

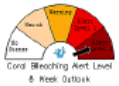


Degree Heating Week- 10/13/2014









NOAA Potential Bleaching Intensity Levels

No Stress	No bleaching
Bleaching Watch	Possible bleaching
Bleaching Warning	Possible bleaching
Alert Level 1	Bleaching Likely
Alert Level 2	Coral Mortality Likely

This experimental map product provides a summary of current satellite data as well as forecaste bleaching reflect the and forecas coral bleach

Mote Marine Laboratory / Florida Keys National Marine Sanctuary

Coral Bleaching Early Warning Network

Current Conditions Report #20150701

Updated July 1, 2015

Summary: Based on climate predictions, current conditions, and field observations, the threat for mass coral bleaching within the FKNMS is currently **MODERATE**.

NOAA Coral Reef Watch Current and 60% Probability Coral Bleaching Alert Outlook June 29, 2015 (experimental)

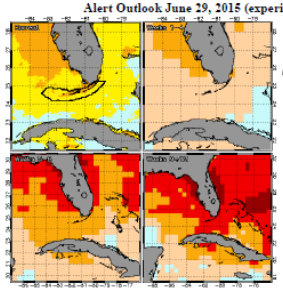


Figure 1. . NOAA's 5 km Experimental Current and 60% Probability Coral Bleaching Alert Outlook Areas through September 2015. Updated June 29, 2015.
http://coralreefwatch.noaa.gov/vs/gauges/florida_keys.php

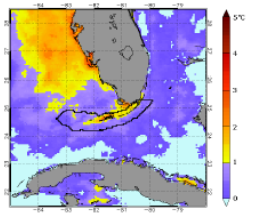
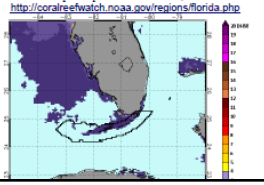


Figure 2. NOAA's Experimental 5km Coral Bleaching HotSpot Map for Florida June 29, 2015.
http://coralreefwatch.noaa.gov/regions/florida.php



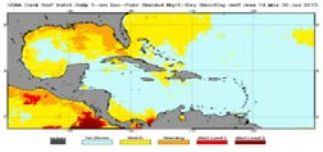
Weather and Sea Temperatures

According to the newly released NOAA Coral Reef Watch (CRW)

CARIBBEAN CORAL REEF WATCH

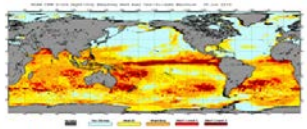
Notable Observations

- El Niño moderate in strength and intensifying.
- Southwestern Caribbean region already unusually warm with early bleaching watches and warnings.
- Bleaching Warning issued for Florida.



Current Conditions

- Reports on extensive bleaching have come from the British Indian Ocean Territory the Maldives, and western Indonesia in the Indian Ocean and from Kiribati in the Central Pacific.
- These observations are consistent with near-record high sea surface temperatures and with a moderate El Niño.



CARIBBEANCORAL REEF WATCH

Florida Department of Environmental Protection
Coral Reef Conservation Program

SEAFAN BleachWatch Program

Current Conditions Report #20130604

June 4, 2013

Summary: Based on climate predictions and field observations, the threat for mass coral bleaching in southeast Florida is LOW.

Environmental Monitoring

Climate predictions for this current conditions report are based on NOAA's Coral Reef Watch (CRW) satellite imagery products, which summarize sea surface temperature data and provide an indication as to when conditions are favorable for coral bleaching. Current CRW experimental 5 kilometer (km) Daily Coral Bleaching Alert Area indicates that the southeast Florida region is presently experiencing no thermal stress (Figure 1):

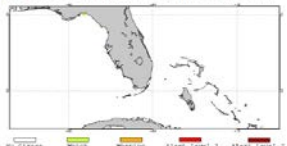


Figure 1. NOAA Coral Reef Watch Experimental 5 km Daily Geo-Polar Day-Night Blended Bleaching Alert Area; June 2, 2013.
http://coralreefwatch.noaa.gov/satellite/bleaching5km_index.html

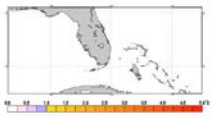


Figure 2. NOAA CRW Experimental 5km Daily Geo-Polar Day-Night Blended Hotspot Map for June 2, 2013.
http://coralreefwatch.noaa.gov/satellite/bleaching5km_index.html

Figure 3. NOAA CRW Experimental 5km Daily Geo-Polar Day-Night Blended Degree Heating Weeks; June 2, 2013.
http://coralreefwatch.noaa.gov/satellite/bleaching5km_index.html

WESTERN INDIAN OCEAN – Regional coral bleaching alert

DATE OF THIS ALERT: 22 April 2014

Contact: bleaching@cordioea.net; David Obura & Majambo Jarumani

22 April 2014 – Coral bleaching forecast – Western Indian Ocean

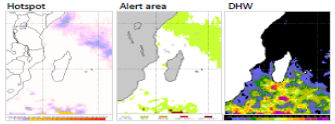
Area	Region	Alert	Bleaching observations
S Moz/S Africa	Cool, south (D1)	End	
SWIO/E Madag	Cool, south (D2)	End	Moderate bleaching, Reunion
SW Madagascar	Hot, south (A1)	End	Moderate bleaching, SW Mad
South Equat Curr	Moderate, central (C)	End	
East Moz Cha/Comoros	Hot, central (A2)	End	
NW Moz Cha /C Tanz	Warm, central (B)	End	Minor bleaching, Chumbe
NW Seychelles	Hot, north (A3)	End	
Kenya-Somalia	Variable, north (E)	End	Minor bleaching, C Kenya

Current conditions

The southeast monsoon winds are already in place, with warm SST moving northwards towards Somalia and out of the WIO region.

NOAA Products – 17 April 2014

Hotspot | Alert area | DHW



While thermal stress over most part of the WIO region has subsided, the CRW's satellite monitoring products show thermal stress has moved further north along the Somalia coast. Continuous monitoring of near real time satellite observations during the coming weeks will give a clear picture if this is the end of bleaching season in the region.

Virtual stations summary

NOAA's Coral Reef Watch program is issuing a bleaching warning to:

- Mahe, Seychelles

Tropical Cyclones

None currently.

Doldrums

The chart show mean wind speeds of less than 3m/s in Seychelles for four days ending 31 March.

Bleaching observations

20 April/Bazaruto Isbambane, Mozambique, no signs of bleaching – David Obura

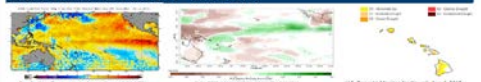
Climate Impacts and Outlook

Hawaii and U.S. Pacific Islands Region

3rd Quarter 2015

Significant Events and Impacts for 2nd Quarter 2015

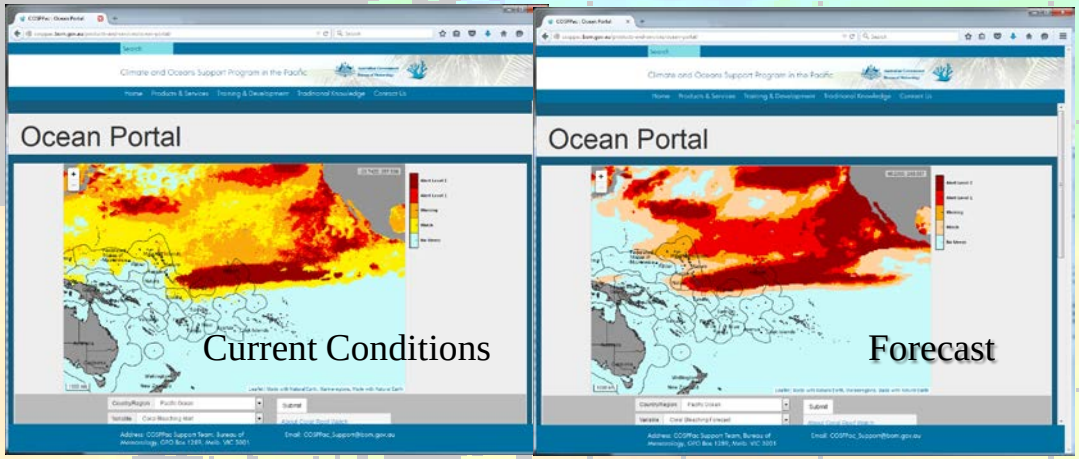
Regional Climate Overview for 2nd Quarter 2015



CRW's Products in Users' Online GIS

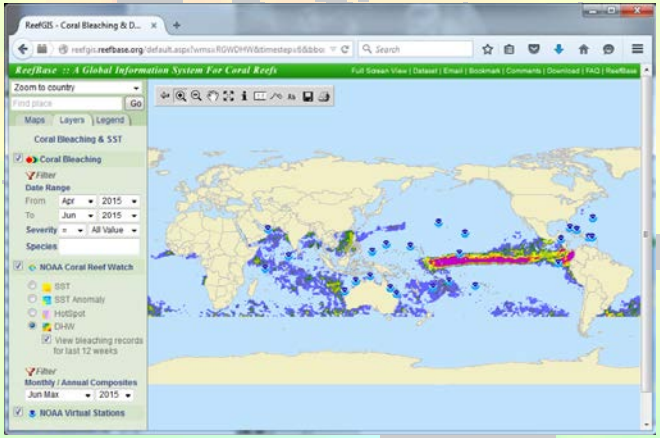
Climate and Oceans Support Program in the Pacific (COSPPac)

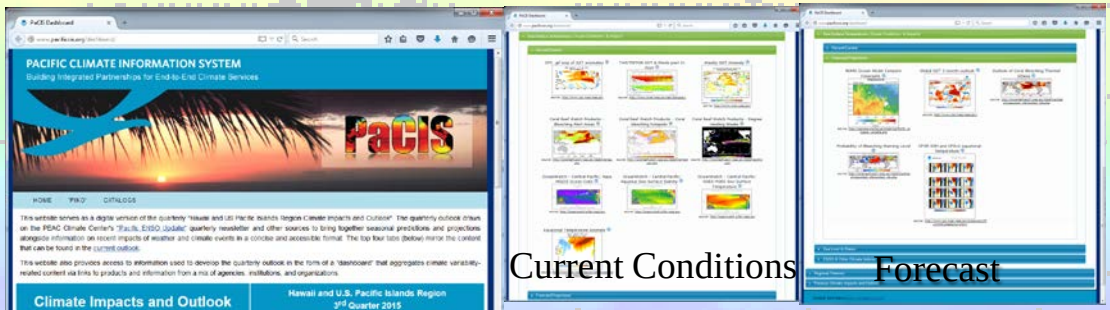
http://cosppac.bom.gov.au/products-and-services/ocean-portal/



ReefBase ReefGIS

http://www.reefbase.org



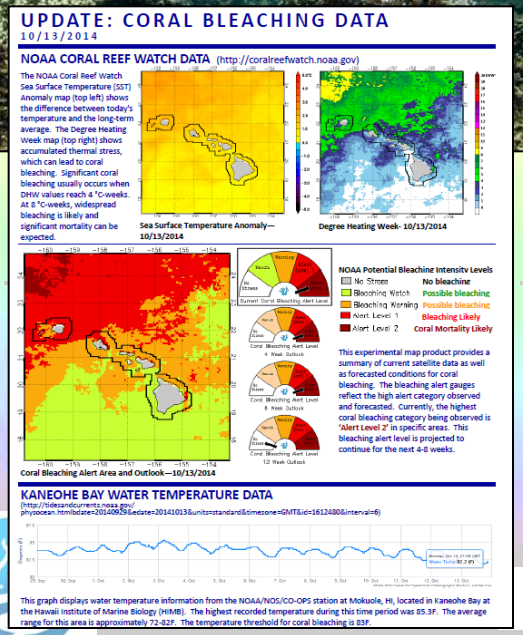


Pacific Climate Information System (PcCIS)

http://www.pacificcis.org/dashboard

NOAA Coral Reef Watch

Information for Local Bleaching Responses



UPDATE: CORAL BLEACHING DATA
10/13/2014

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Sea Surface Temperature Anomaly— 10/13/2014

Degree Heating Week- 10/13/2014

Coral Bleaching Alert Area and Outlook—10/13/2014

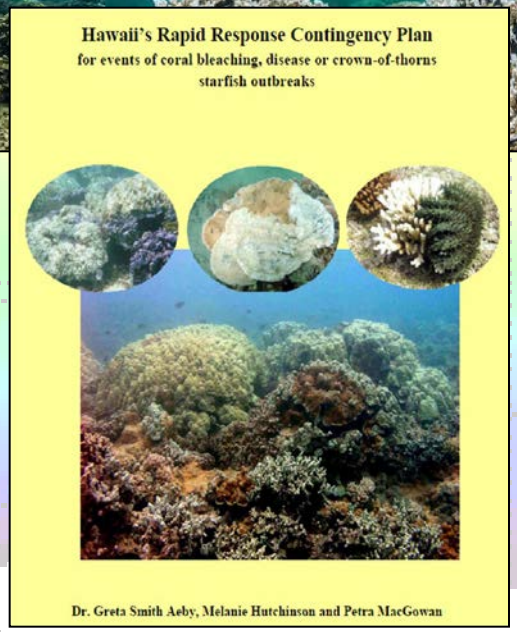
NOAA Potential Bleaching Intensity Levels

No Stress	No bleaching
Bleaching Watch	Possible bleaching
Bleaching Warning	Possible bleaching
Alert Level 1	Bleaching Likely
Alert Level 2	Coral Mortality Likely

This experimental map product provides a summary of current satellite data as well as forecasted conditions for coral bleaching. The bleaching alert gauges reflect the high alert category observed and forecasted. Currently, the highest coral bleaching category being observed is 'Alert Level 2' in specific areas. This bleaching alert level is projected to continue for the next 4-8 weeks.

KANEOHE BAY WATER TEMPERATURE DATA

This graph displays water temperature information from the NOAA/NOS/CO-OPS station at Mokuole, HI, located in Kaneohe Bay at the Hawaii Institute of Marine Biology (HIMB). The highest recorded temperature during this time period was 85.3F. The average range for this area is approximately 72-82F. The temperature threshold for coral bleaching is 83F.



Hawaii's Rapid Response Contingency Plan

for events of coral bleaching, disease or crown-of-thorns starfish outbreaks

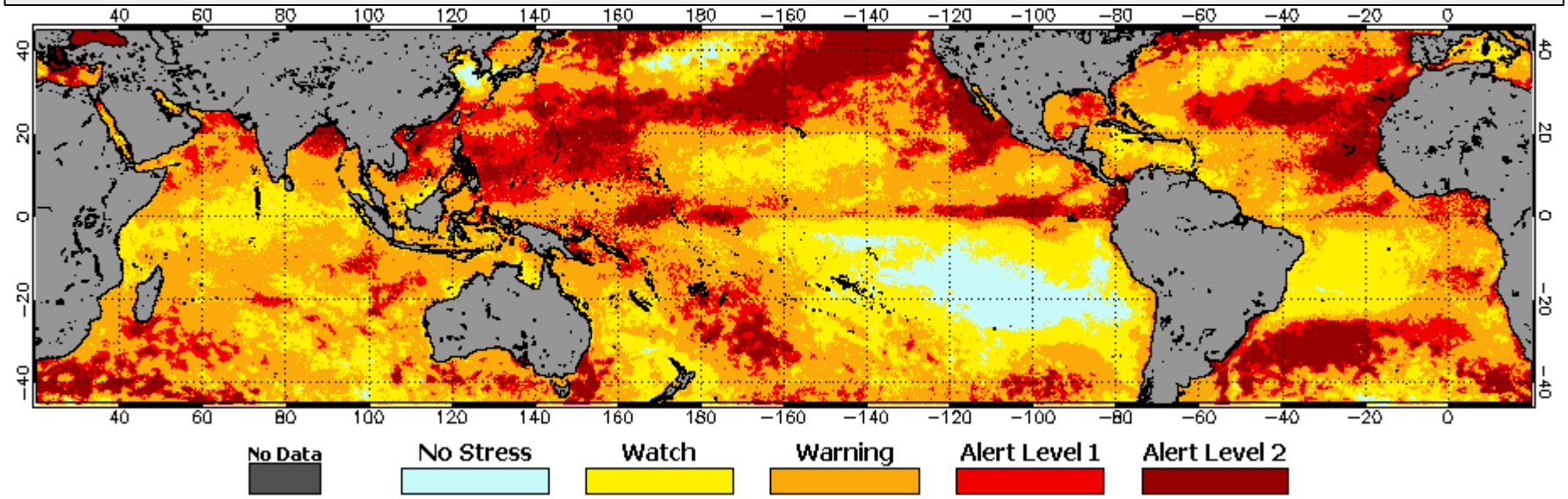
Dr. Greta Smith Aeby, Melanie Hutchinson and Petra MacGowan

Hawaii Division of Aquatic Resources (DAR)

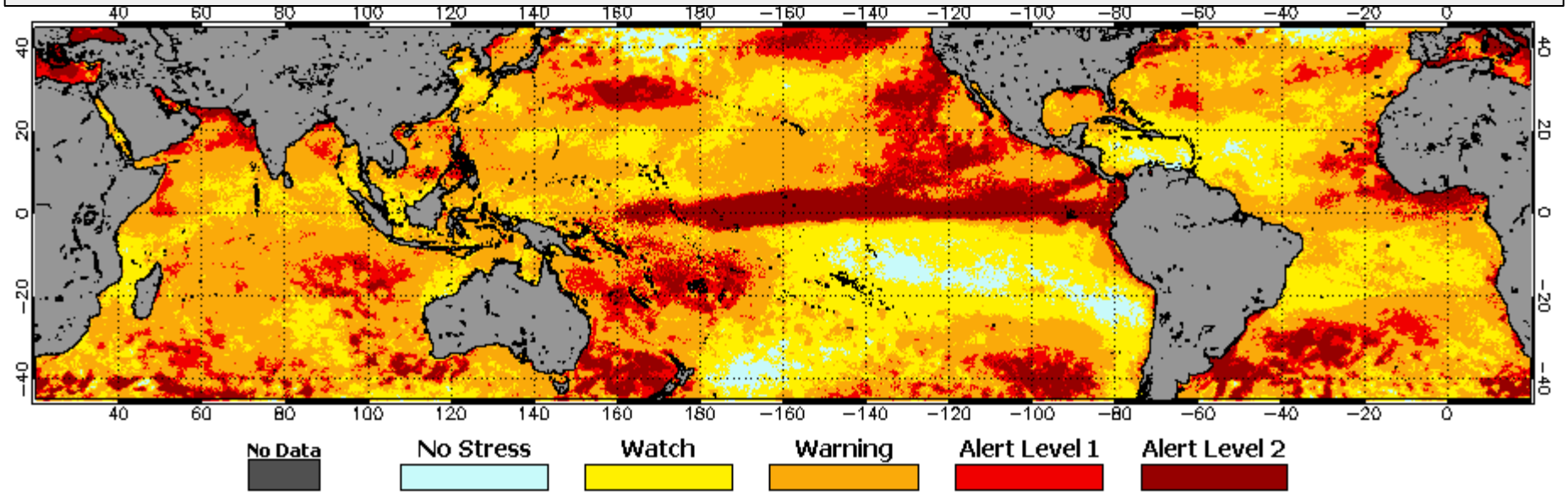
Hawaii Division of Aquatic Resources

http://coralreefwatch.noaa.gov

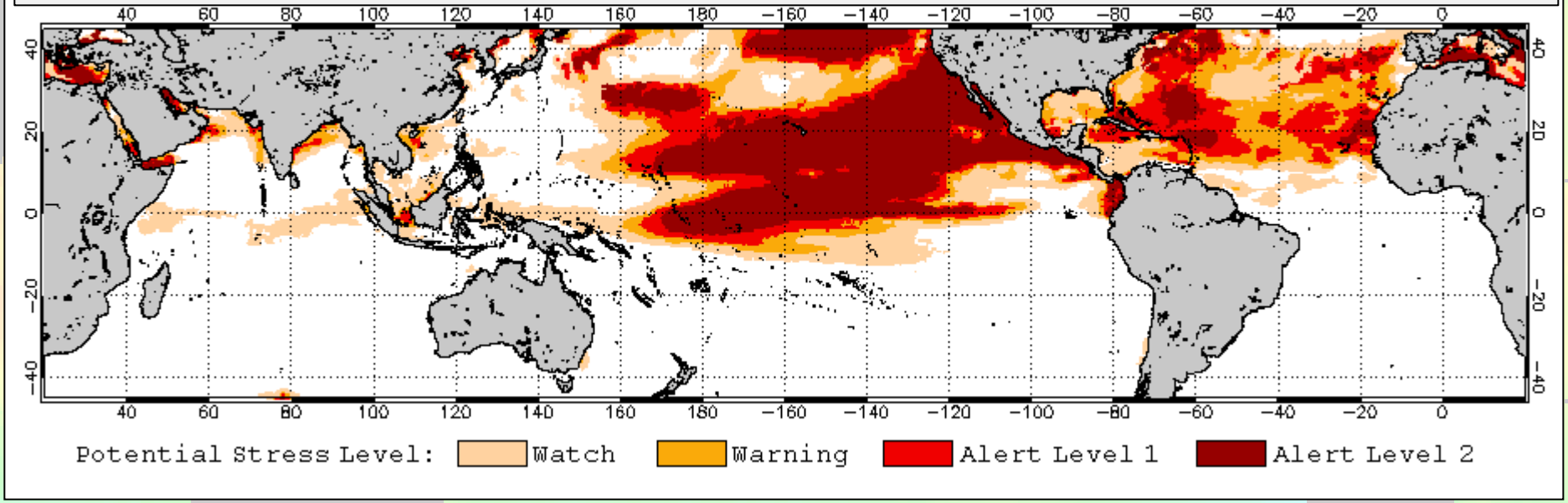
Bleaching Alert Area (Maximum) 2014



Bleaching Alert Area (year-to-date max) 2015



Four-month Outlook for Aug-Nov 2015



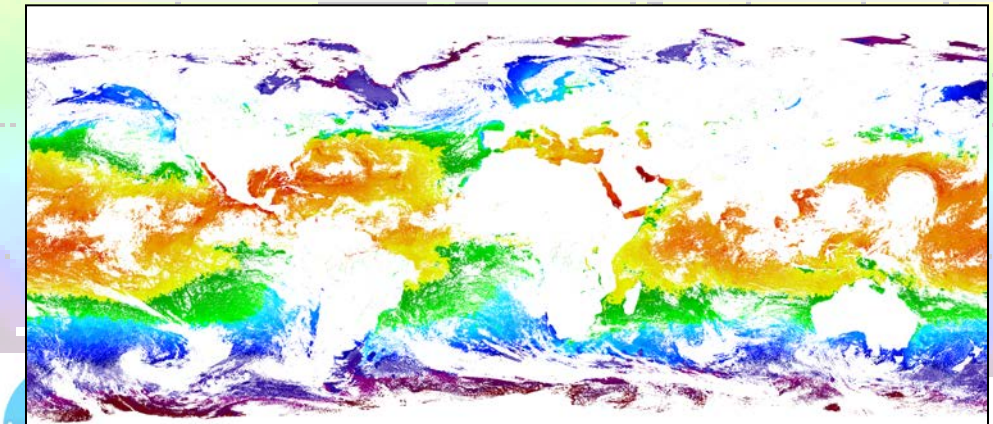
http://coralreefwatch.noaa.gov

2015: American Samoa before and after: Flower Pot Island in Dec. 2014 & Feb. 2015

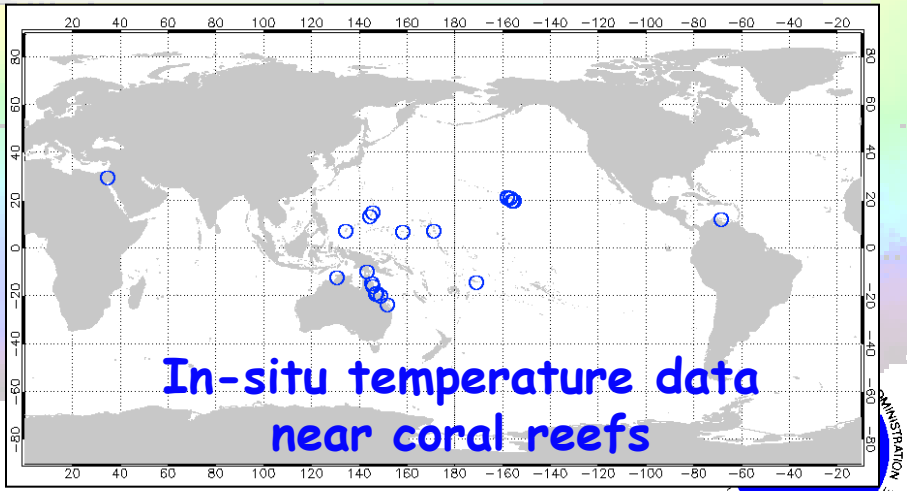
CATLIN SEAVIEW SURVEY

VIIRS SST for Higher Resolution CRW Products

- **JPSS funded collaboration with STAR's Polar SST team:**
  - -- Develop 0.02-deg gridded VIIRS SST for CRW applications.
  - -- Set up *in situ* dataset in near-shore, coral-specific regions for calibrating and improving VIIRS SST (as well as other SSTs).
- **Proposals in collaboration with STAR's Blended SST team:**
  - -- Develop 1-2 km geo-polar blended SST analysis using VIIRS SST as main global data source.



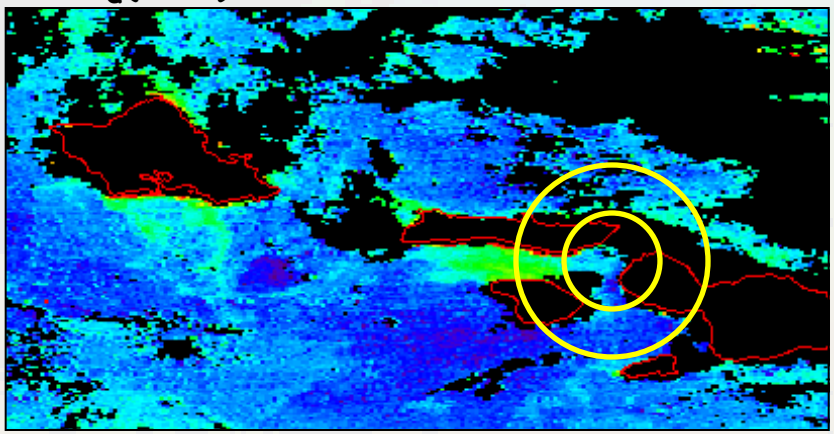
ACSPO L3 VIIRS 0.02-deg SST-skin



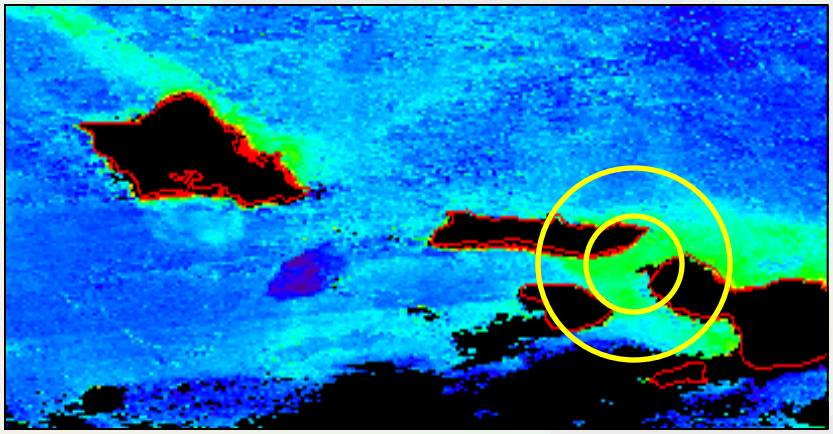
Ocean Color Product (Land Based Sources of Pollution)

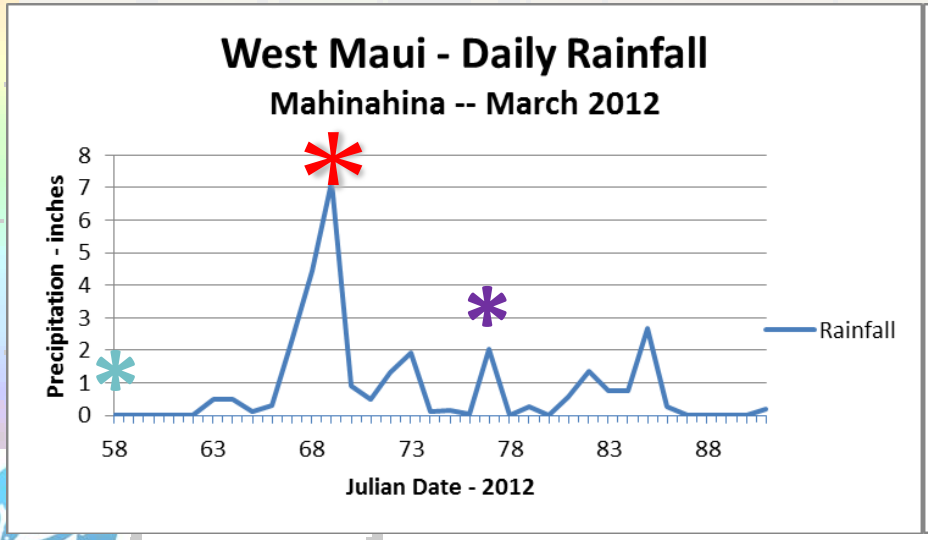
RECORD MAUI FLOODS – 8 MARCH 2012*

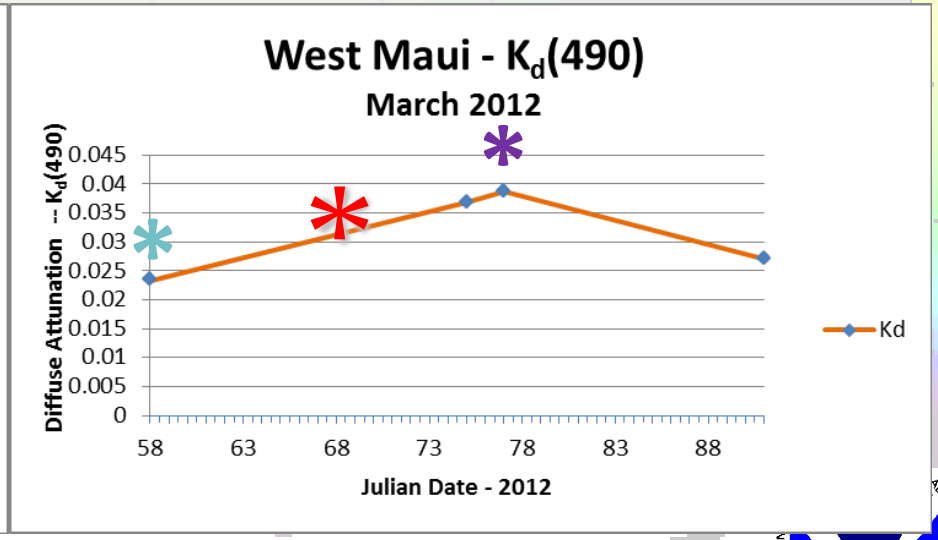
K_d(490): Before – 27 Feb *



K_d(490): After – 17 Mar *

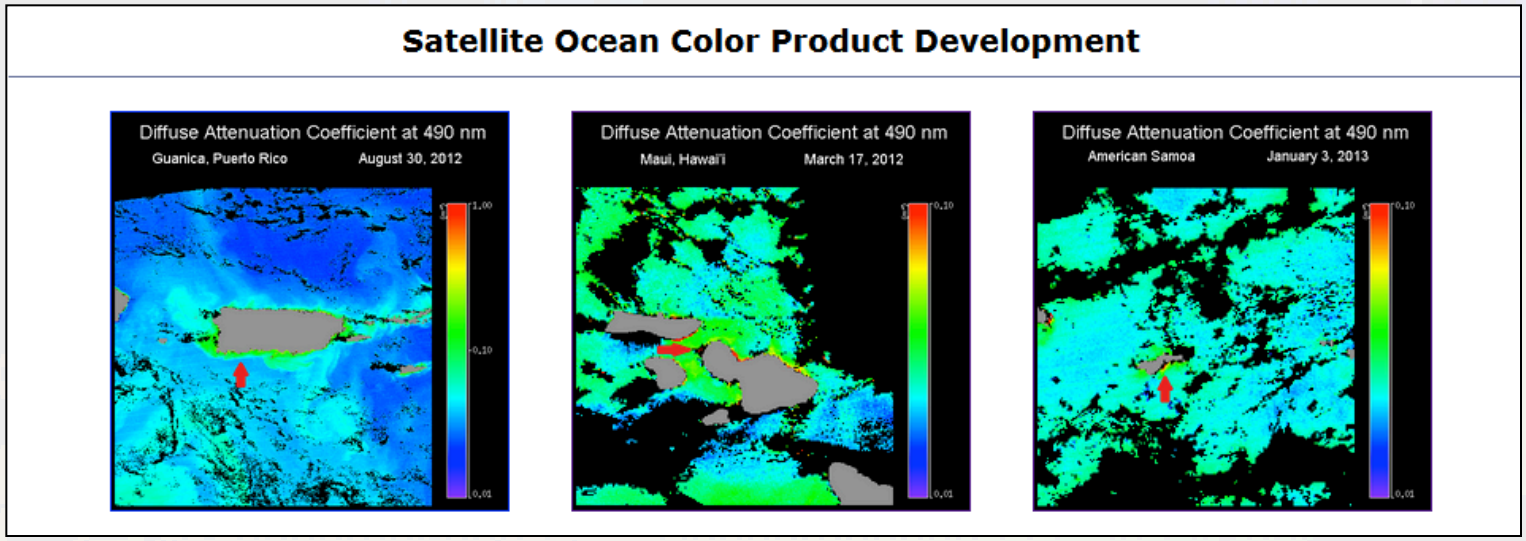






In collaboration with STAR's Ocean Color Team

Ocean Color Product (Land Based Sources of Pollution)



- Based on STAR's 2 km VIIRS ocean color data
- Developing climatology for anomaly detection
- Focusing on USCRTF's 3 "priority" watersheds:
  - Southern Puerto Rico (Guánica)
  - W. Maui (Ka'anapali)
  - American Samoa (Faga'alu)
- Collaboration with STAR's Ocean Color Team

Summary

- CRW operates the only near-real-time global Decision Support System (DSS) for coral reef management.

- CRW develops new products to address ever-growing coral reef management needs in a changing climate.

- CRW's end-to-end DSS engages reef managers and scientists throughout product development, validation, and improvement.

- Data from next generation satellites such as JPSS and GOES-R/Himawari-8 are critical for CRW's DSS to support U.S. and international coral reef conservation.

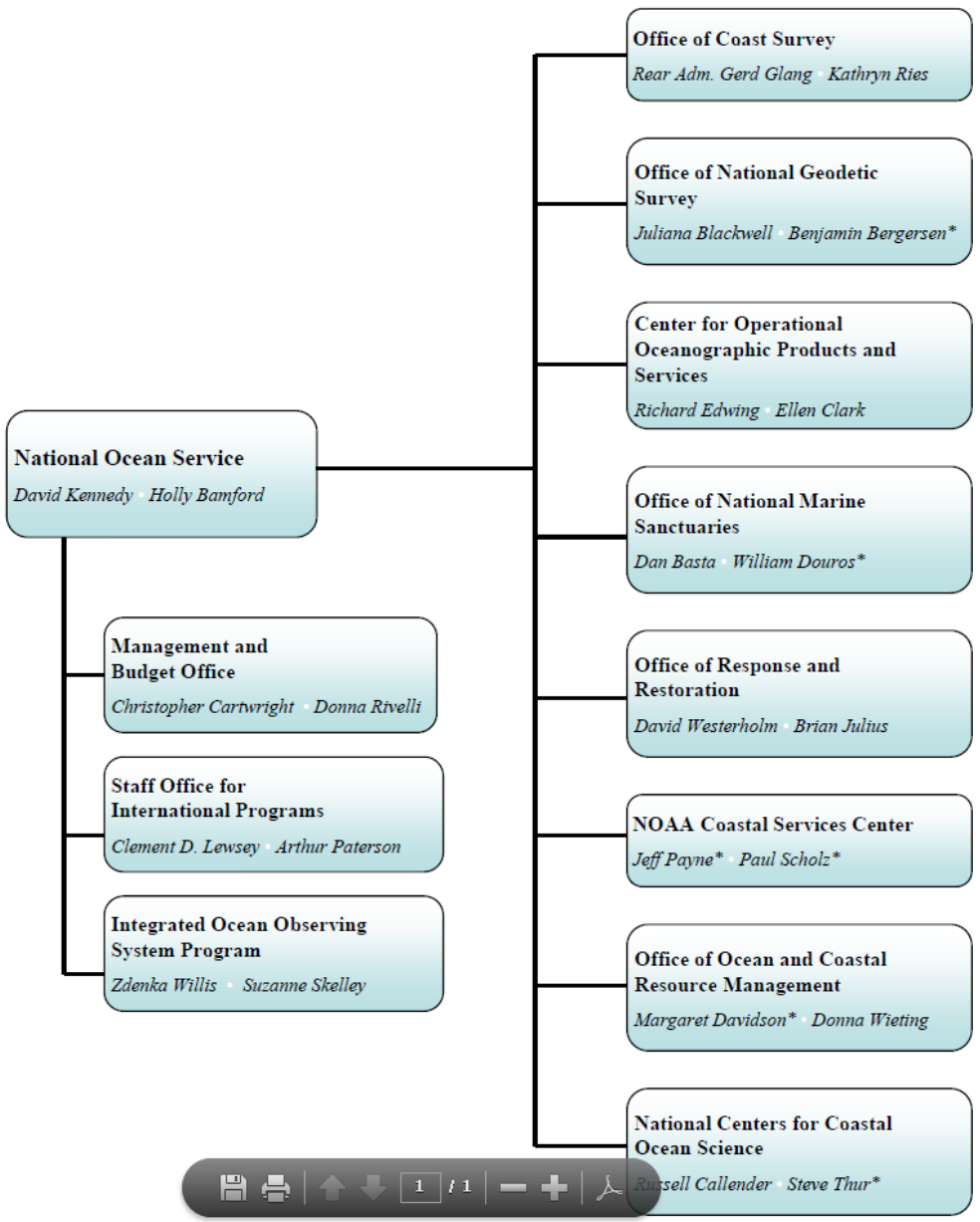
http://coralreefwatch.noaa.gov

Remote Sensing Applications in NOS

- All resolutions
- High resolution (WorldView etc.)
  - coral habitat, bathymetry
- Medium resolution (Landsat)
  - wetlands/coastal habitat, some bathymetry
- Moderate to low resolution (300-1 km)
  - Water quality, SST, algal blooms, etc.

Ocean applications discussed here.

NOS Organization and Working Relationships



- Modeling
- Bathymetry, shorelines
- Operational HAB forecasts
- Ocean habitat assessment
- Oil spill response
- Bottom and wetland habitat
- R & D

Ocean Satellite data types

SST (VIIRS)

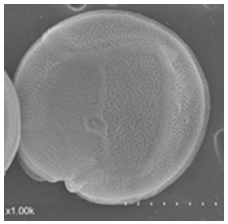
Visible imagery, with glint (VIIRS)

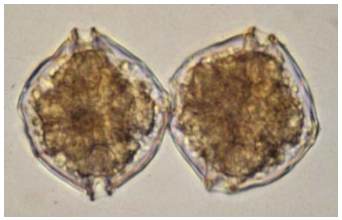
Ocean color for chlorophyll (VIIRS)

Higher spectral/spatial (OLCI/Sentinel-3)

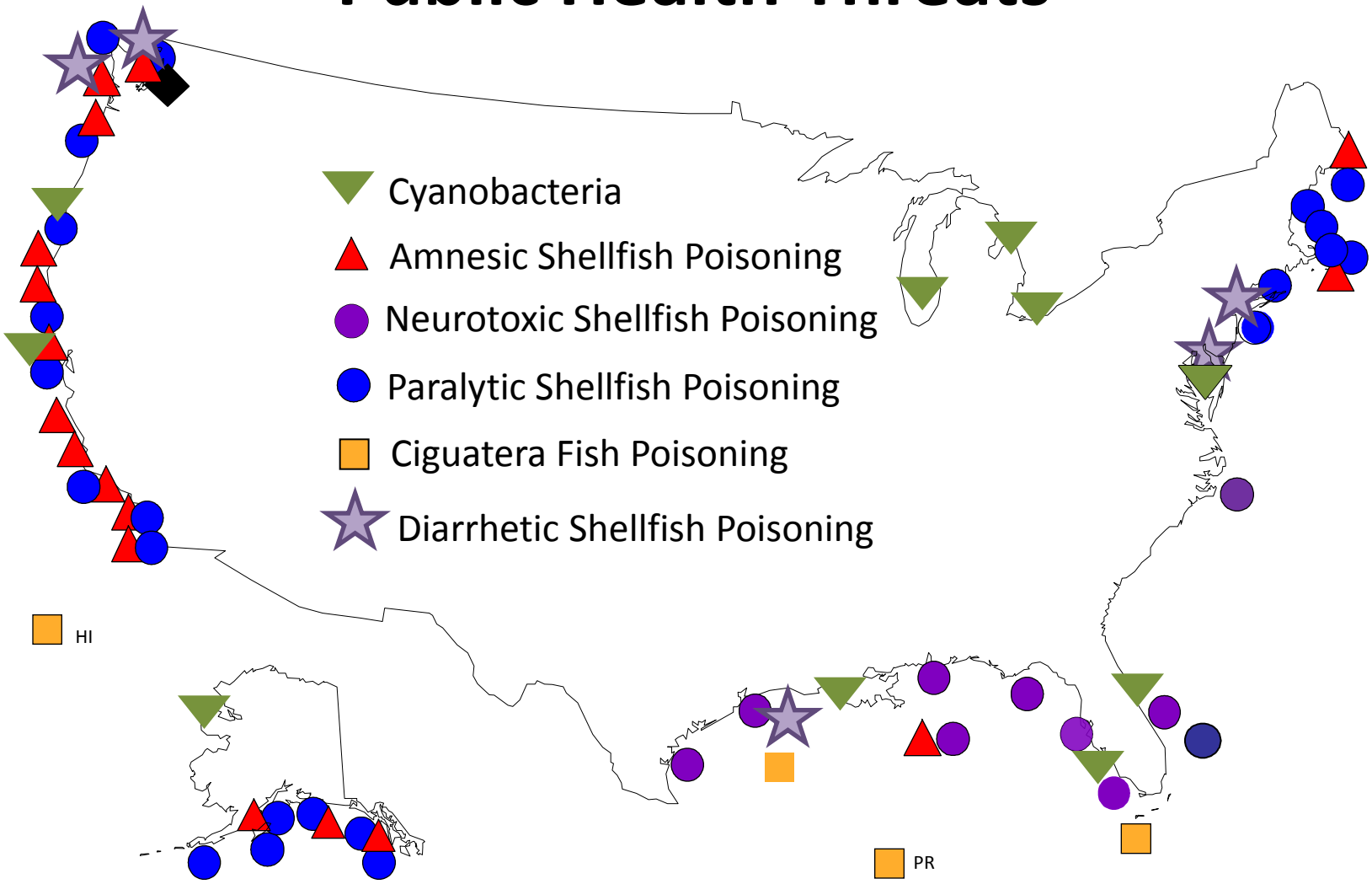
Applications:Harmful Algal Blooms (HABs)

- Harmful impacts human health, ecosystems, economies
- Algae—base of marine & aquatic food chains
  - Includes micro-, macroalgae, & Cyanobacteria (aka blue green algae)
  - Marine HABs: Mostly dinoflagellates
  - Freshwater HABs: Mostly cyanobacteria
- Bloom—"excessive" growth
  - May or may not discolor water, red, brown green, purple, white
  - 10^2 to 10^7 cells/liter may be "bloom" depending on species



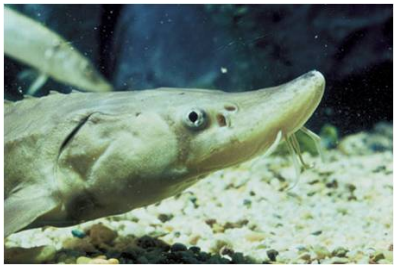


Coastal HABS
Public Health Threats



What is the Harm?

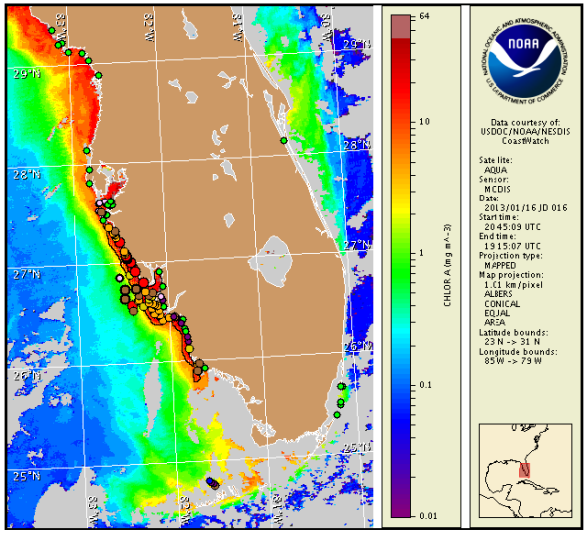
- Animal illness and death
  - Fish
  - Endangered and protected species: mammals, birds, turtles, fish
  - Livestock and pets



Examples

- HAB Operational Forecast, Gulf of Mexico. Ensemble of algorithms being used.

Gulf of Mexico Harmful Algal Bloom Bulletin
Region: Southwest Florida
Thursday, 17 January 2013
NOAA National Ocean Service
NOAA Satellite and Information Service
NOAA National Weather Service
Last bulletin: Monday, January 14, 2013



Satellite chlorophyll image with possible *K. brevis* HAB areas shown by red polygon(s). Cell concentration sampling data from January 7 to 15 shown as red (high), orange (medium), yellow (low b), brown (low a), blue(very low b), purple (very low a), pink (present), and green (not present). Cell count data are provided by Florida FWC Fish and Wildlife Research Institute. For a list of sample providers and a key to the cell concentration categories, please see the HAB-OFS bulletin guide:
http://tidesandcurrents.noaa.gov/hab/habfs_bulletin_guide.pdf

Detailed sample information can be obtained through the Florida FWC Fish and Wildlife Research Institute at:
http://myfwc.com/research/redtide/events/status/statewide/

To see previous bulletins and forecasts for other Harmful Algal Bloom Bulletin regions, visit at: http://tidesandcurrents.noaa.gov/hab/bulletins.html

Conditions Report

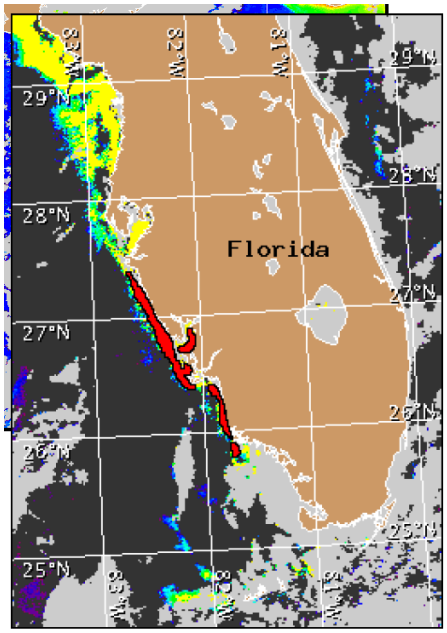
Very low to high concentrations of Karenia brevis (commonly known as Florida Red Tide) are present along- and offshore from southern Pinellas to Collier counties, as well as offshore the gulfside of the lower Florida Keys. In the bay regions of southern Manatee and northern Sarasota counties, patchy low respiratory impacts are possible today through Monday. Alongshore Sarasota and northern Charlotte counties, patchy high respiratory impacts are possible today, with patchy moderate respiratory impacts possible Friday through Monday. In the bay regions of Charlotte, Lee, and Collier counties, patchy high respiratory impacts are possible today through Monday. Alongshore southern Lee County, patchy low respiratory impacts are possible today, with patchy very low respiratory impacts possible Friday through Monday. Alongshore northern Collier County, patchy moderate respiratory impacts are possible today, with patchy very low respiratory impacts possible Friday through Monday. No respiratory impacts are expected elsewhere alongshore southwest Florida, including the Florida Keys, today through Tuesday, January 22. Over the past few days, reports of respiratory irritation were received from Manatee, Sarasota and Charlotte counties. Reports of dead fish were received from Manatee, Sarasota, Lee, and Collier counties.

Analysis

Due to the upcoming federal holiday, the next bulletin will be issued on Tuesday, January 22.

Southwest Florida: A harmful algal bloom of *Karenia brevis* is present along- and offshore southwest Florida from southern Pinellas to Collier counties, with *K. brevis* concentrations ranging from 'not present' to 'high'. Samples received this week indicate that *K. brevis* concentrations have increased along the coast of Sarasota County, with 'medium' to 'high' concentrations identified alongshore northern to southern Sarasota, and 'low a' concentrations identified at the Ringling Causeway and Lido Beach (SCHD, FWRI; 1/14). Samples also indicated increased *K. brevis* concentrations in Charlotte County, with 'high' concentrations identified at Englewood Beach and at the northern end of Gasparilla Sound (FWRI; 1/15). Samples collected throughout the Pine Island Sound region of Lee County identified 'low a' to 'medium' *K. brevis* concentrations, with background to 'very low a' concentrations identified alongshore central Lee County (FWRI; 1/14). 'Very low a' to 'low b' concentrations were identified alongshore northern Collier County, and one 'low a' sample was collected along South March Beach in southern Collier (FWRI; 1/14). One 'low a' sample was collected alongshore School Key in Manatee County, and samples continue to indicate not present to background concentrations in Pinellas County (FWRI; 1/13-1/15). Respiratory irritation continues to be reported at several beaches along Sarasota County; reports were also received from Manatee (Manatee Beach, Coquina Beach) and Charlotte (GI South Bridge) counties (MML; 1/13-1/17). Numerous fish kills have also been reported over the last several days in Manatee, Sarasota, Lee, and Collier counties (FWRI; 1/13-1/16).

In recent MODIS Aqua imagery (1/16, shown left), elevated to high chlorophyll (4-20 μg/L) is visible stretching along- and offshore the southwest Florida coastline from Pinellas to Collier counties, with patches of very high chlorophyll (>20 μg/L) visible alongshore Sarasota and southern Lee to Collier counties. Imagery is obscured by clouds along- and offshore Monroe County, limiting analysis in this region.



Verified and suspected HAB areas shown in red. Other areas of high chlorophyll concentration shown in yellow (see p. 1 analysis for interpretation).

Experimental Lake Erie Harmful Algal Bloom Bulletin

National Centers for Coastal Ocean Science and Great Lakes Environmental Research Laboratory

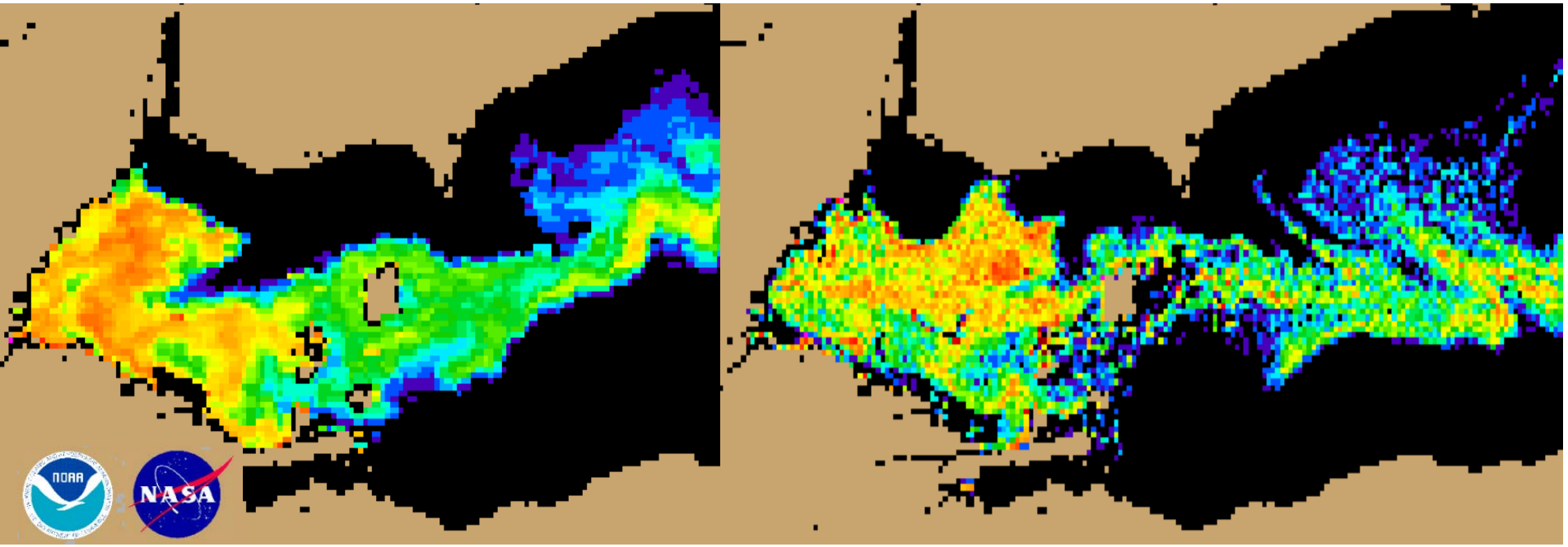
24 August, 2015, Bulletin 13

The *Microcystis* cyanobacteria bloom continues across a large part of the western basin along the Michigan and Ohio coasts and into

Over 1500 subscribers by Aug 2015

1 km MODIS Aug 22

Aug 26 forecast



Extensive use of MERIS for monitoring

(Lake Erie example). Algorithm moved to 1 km MODIS in 2012.

Experimental
Lake Erie Harmful Algal Bloom Bulletin
2011-008
08 September 2011
National Ocean Service
Great Lakes Environmental Research Laboratory
Last bulletin: 22 July 2011

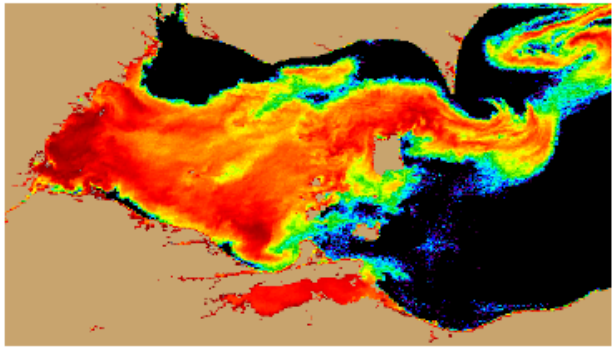
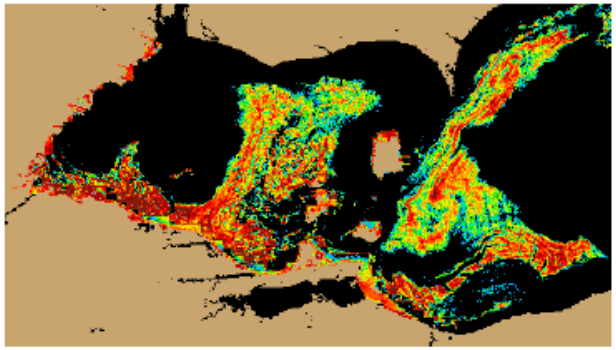
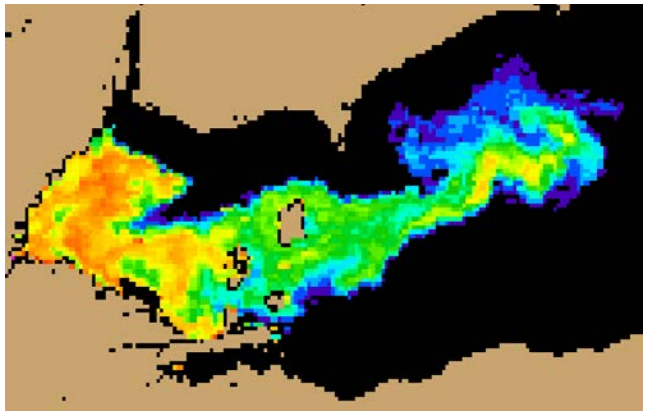


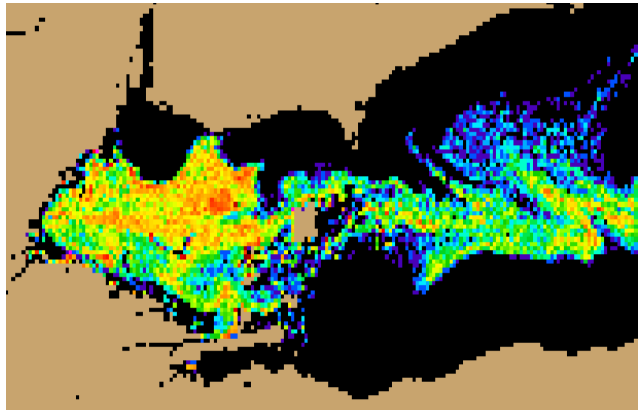
Figure 1. MERIS image from the European Space Agency. Imagery shows the spectral shape at 681 nm from September 03, where colored pixels indicate the likelihood of the last known position of the *Microcystis* spp. bloom (with red being the highest concentration). *Microcystis* spp. abundance data from shown as white squares (very high), circles (high), diamonds (medium), triangles (low) , + (very low) and X (not present).



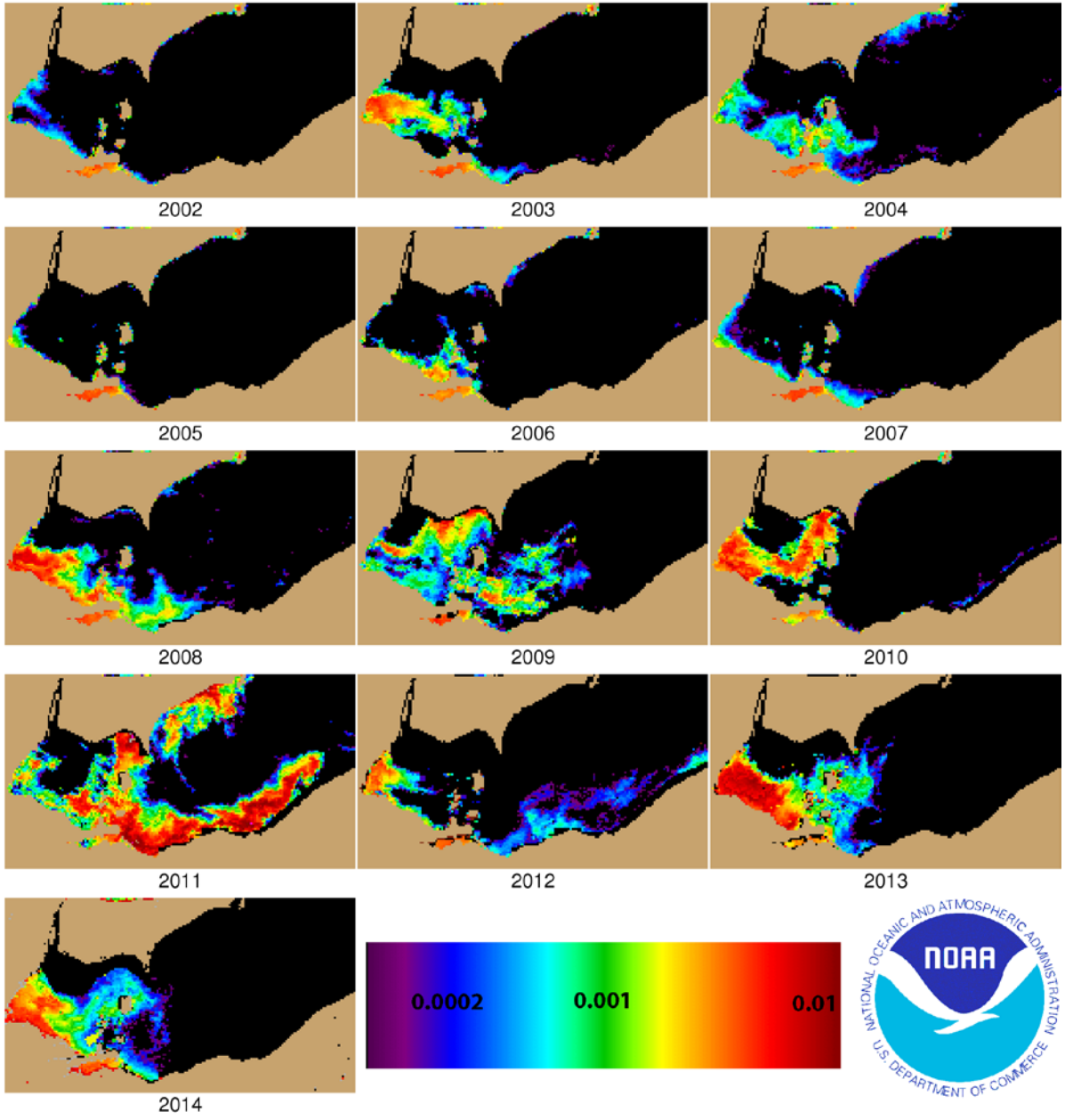
Experimental Lake Erie Harmful
National Centers for Coastal Ocean Science and Great Lak
24 August, 2015, Bulletin 13

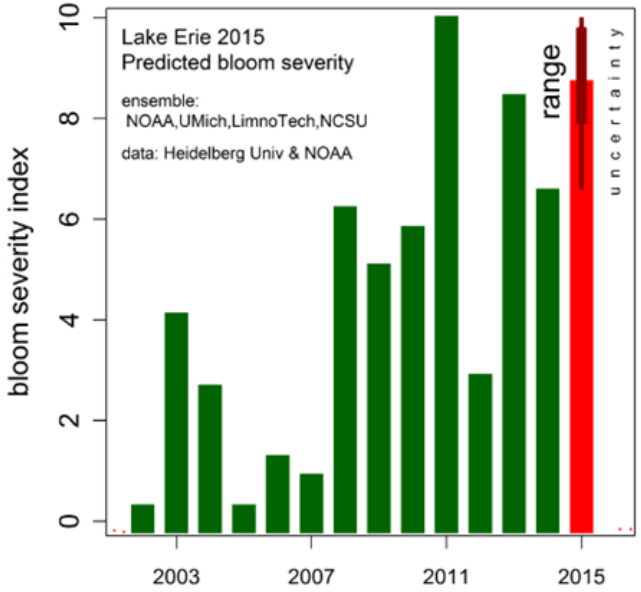
The *Microcystis* cyanobacteria bloom continues across a large part of the western basi





13 years of data provide data to model seasonal forecast





Data from
MERIS 2002-2011,
MODIS 2012-2014;
(MODIS forced to MERIS;
loss in sensitivity & resolution)

Examples

- Oil spill response

EXPERIMENTAL MARINE POLLUTION SURVEILLANCE REPORT

Analysis Provided by: The National Oceanic and Atmospheric Administration/National Environmental Satellite, Data and Information Service (NOAA/NESDIS)

REPORT DATE: MAY 24, 2010
REPORT TIME: 1150Z (0650 CDT)
ANALYST: BELGE

DATA SOURCE: ALOS PALSAR HH
MODE: SCANSAR
RESOLUTION: 100 METERS
IMAGE DATE/TIME: 5/23/2010 1622Z (1122 CDT)

Legend

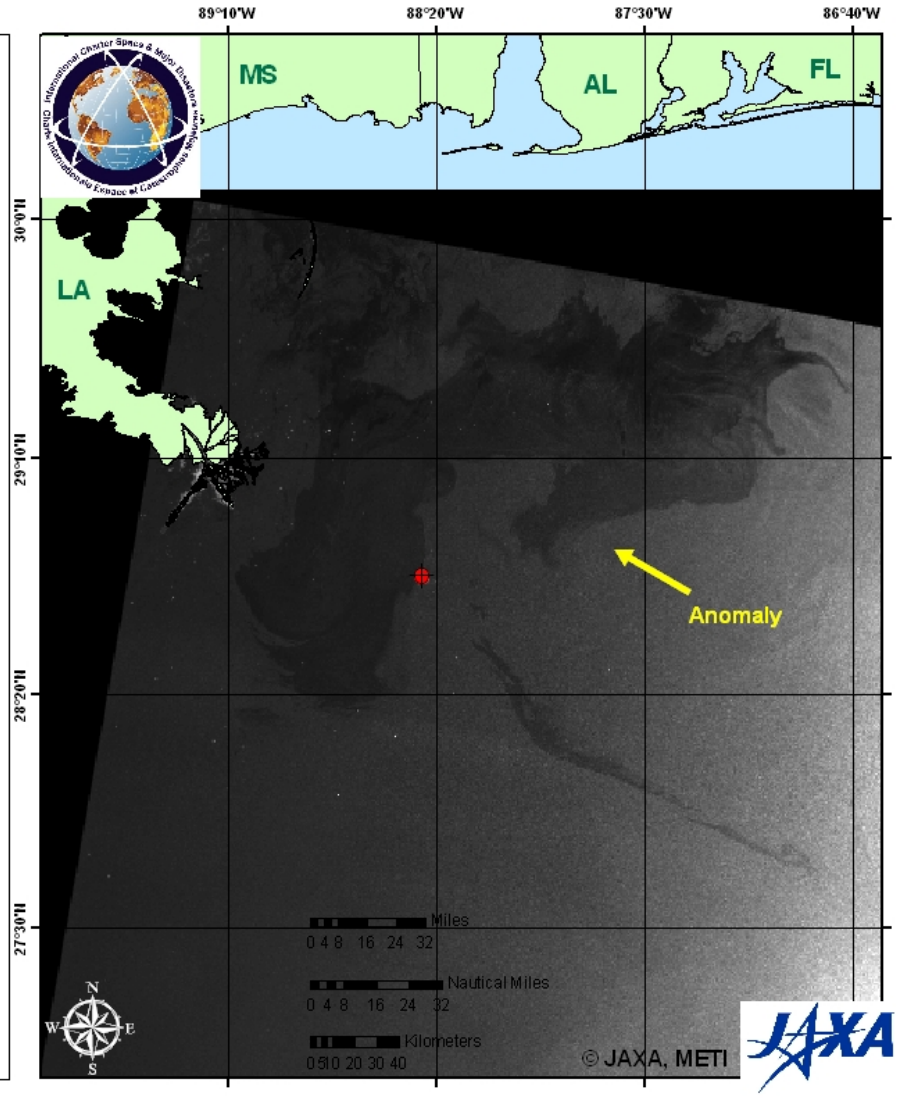
Anomaly

Location of Deepwater Horizon Platform: [28°44'12" N / 88°23'14" W]

REMARKS:

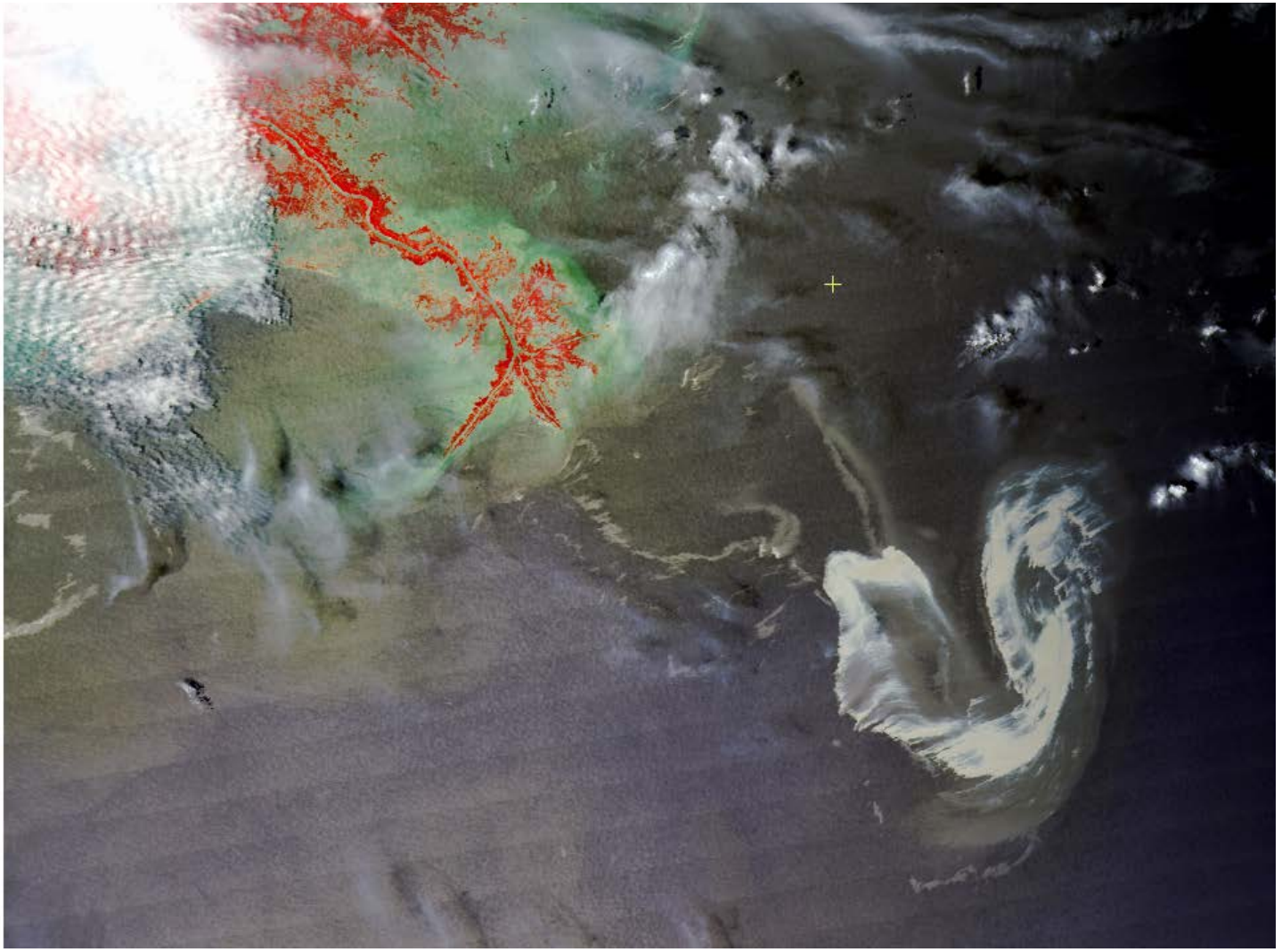
This ALOS pass from late morning/early afternoon shows most of the oil with little change change from previous day's images.The northern extent of the oil slick near and just east of the Chandeleur Islands appears to be oil, however the image resolution made it hard to discern an exact outline in this region.

This is an experimental product of the Satellite Analysis Branch and not operationally maintained. We will do our best to make it available in a timely manner.



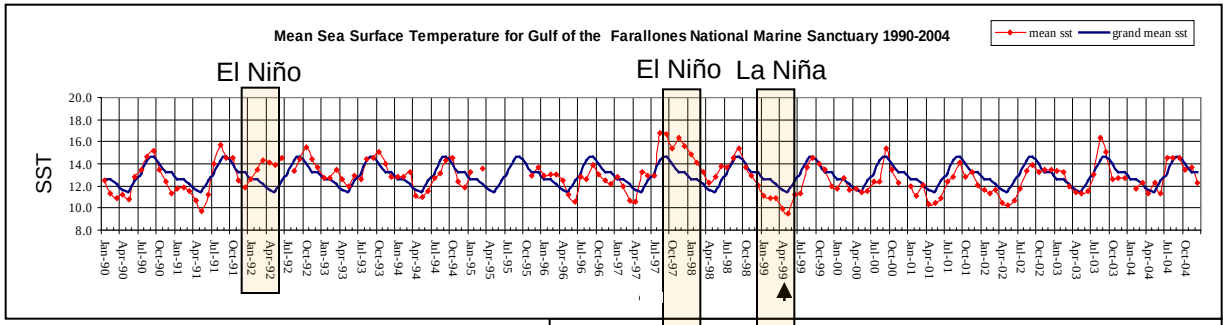
Examples

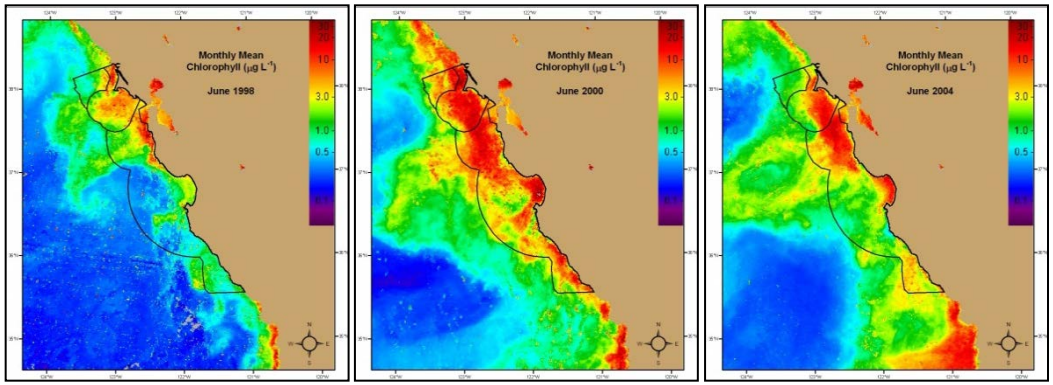
- Oil spill response, MODIS image

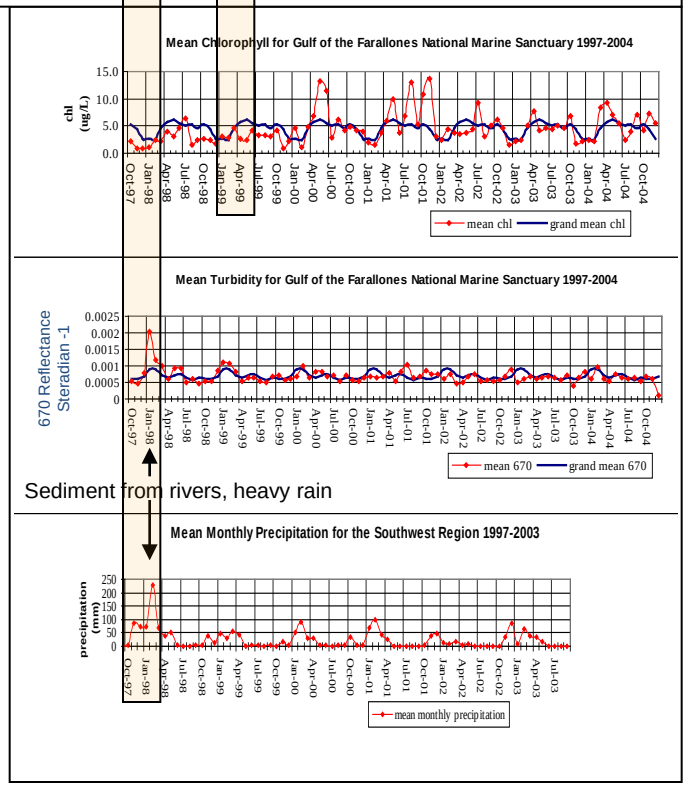


National Marine Sanctuaries, habitat characterization
(Gulf of the Farallones, Cordell Bank, Monterey Bay)

Time Series Imagery and Analysis







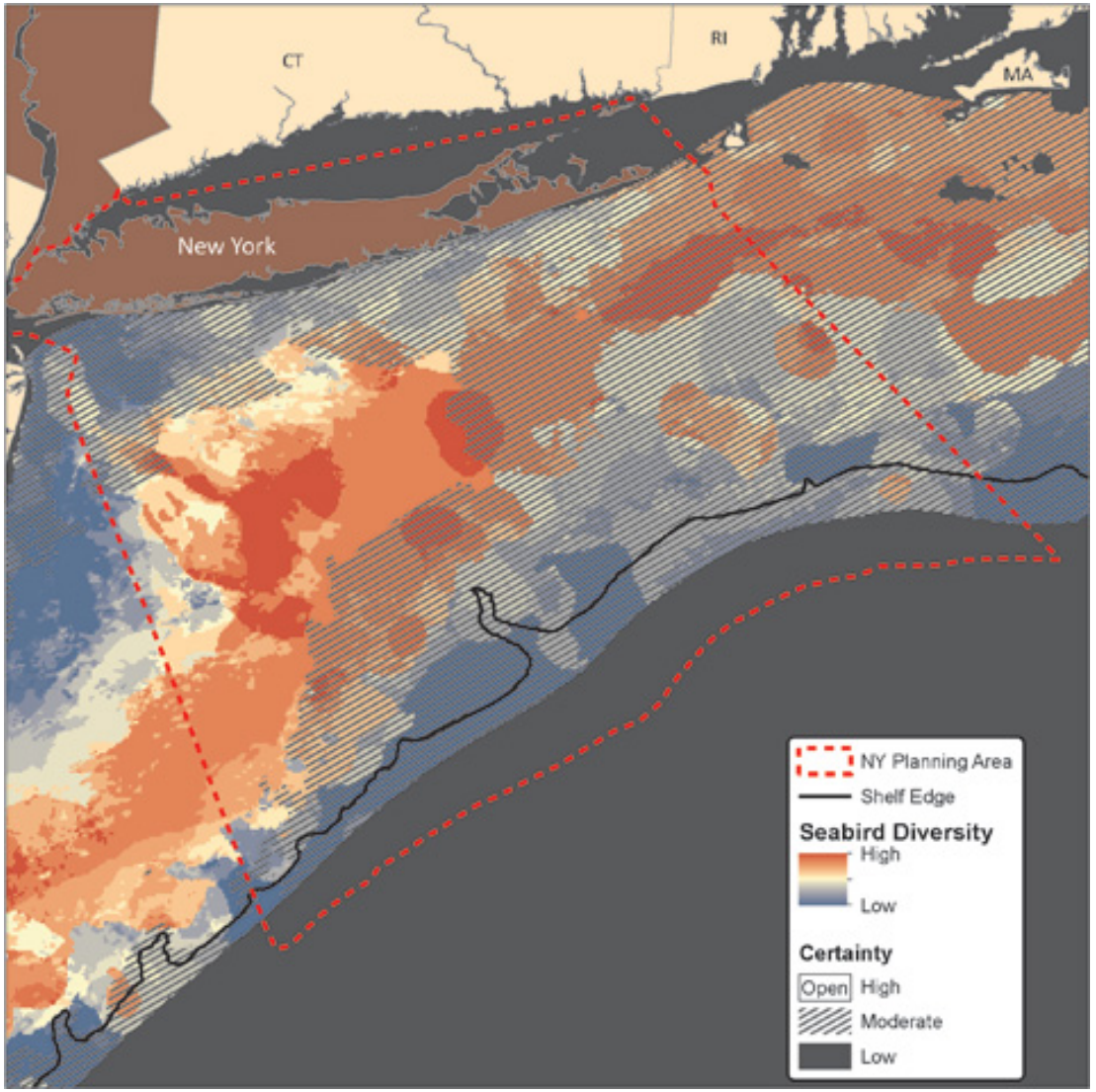
- Time-series imagery show the dynamic nature of the spatial oceanographic patterns. Ex. Chlorophyll concentrations are driven by upwelling which is influenced by ENSO.

- Time series analysis can derive seasonal and inter-annual patterns. Ex. Minimum SST and maximum CHL concentrations occur in April/May. Turbidity is more variable with a tendency towards minimums in December. Coastal areas directly influenced by river plumes may show a maximum during the winter rainy season.

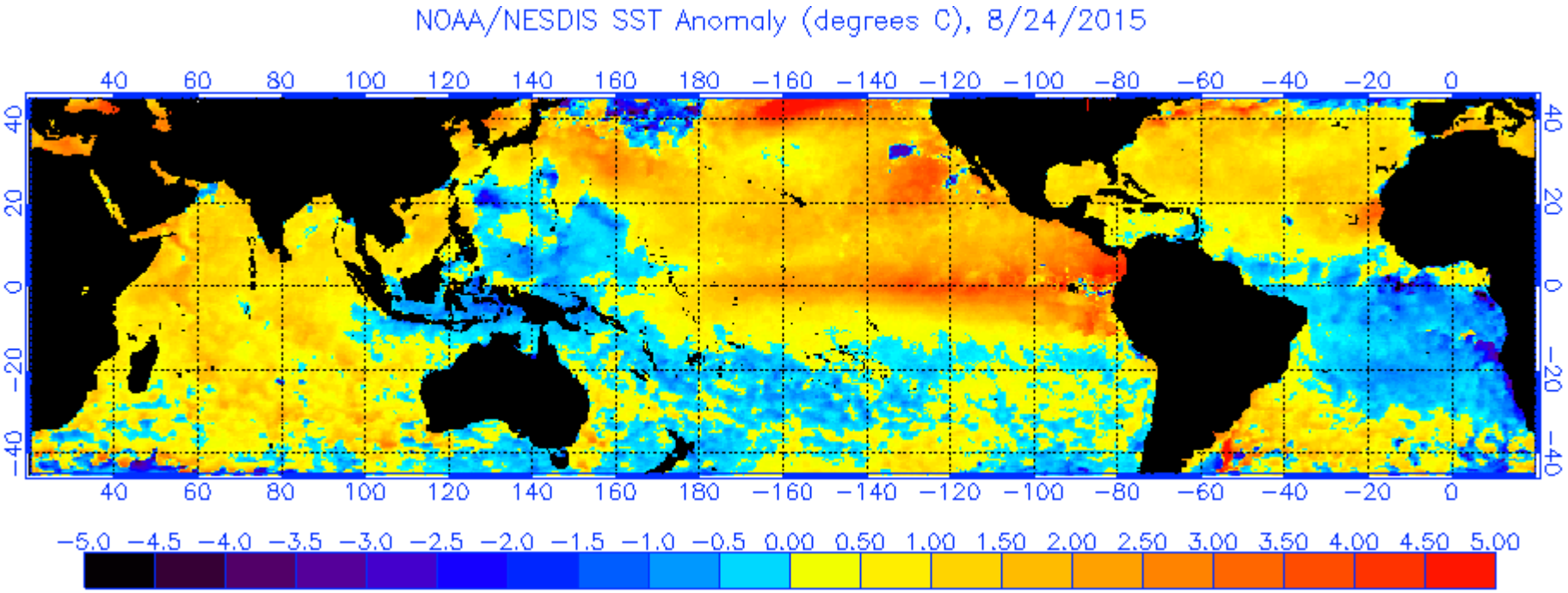
Habitats in the ocean (seabird) NOAA Biogeography program

These types of maps can be used by coastal managers to protect critical seabird habitats and identify the most suitable sites for future wind farms.

Data includes SST, climatic in situ, bird reports, etc.



Coral Reef Conservation Program



Summary

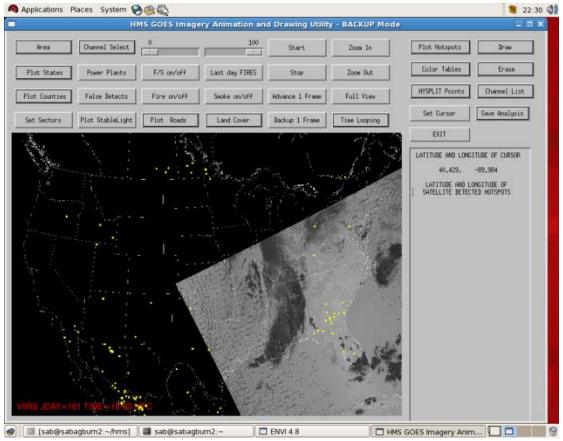
- NOS uses polar-orbiting data for
  - Operational harmful algal bloom forecasts
  - Response to other algal blooms
  - Oil spill response
  - Indirectly for boundary models for coastal hydrodynamic models
  - Sanctuaries and habitat assessment
- JPSS will replace MODIS/Aqua as primary monitoring tool for ocean color, with superior image quality.
  - Potential for usable data in bright targets, no sensor saturation
  - Less striping

An Overview of OSPO & Support for S-NPP Operations

Jason Taylor – User Services Coordinator
NESDIS/OSPO/ Satellite Products and Services Division

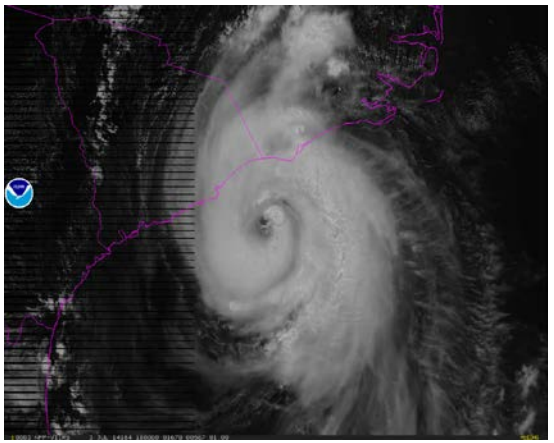
STAR JPSS Annual Science Team Meeting

Operational User Engagement: Session 4



Satellite Analysis Branch's
Hazard Mapping System

NCWCP
College Park, MD
August 25, 2015



Hurricane Arthur
S-NPP VIIRS July 3, 2014

Coordination for Presentation

NESDIS / OSPO / SPSD @ NCWCP

- Shuang Qiu, Suomi NPP PAL
- Tom Renkevens, SPSD Division Chief
- Natalia Donoho, User Services Coordinator

NESDIS / OSPO / SPSD / SAB @ NCWCP

- Mark Ruminski, Fire Team Lead & All Desks

NESDIS / OSPO / MOD @ NSOF

- Chris Sisko, JPSS Data Operations Manager
- Donna McNamara, Data Access Manager
- Brian Walling, S-NPP Engineering Team Lead

National Center for Weather & Climate Prediction (NCWCP)

NOAA Satellite Operations Facility (NSOF)

Presentation Overview

- Overview of the Office of Satellite and Product Operations (OSPO)
- Current status of S-NPP satellite support for operational products and users
- S-NPP VIIRS data for Satellite Analysis Branch (SAB) operational use
- Q&A

NESDIS Office of Satellite and Product Operations (OSPO)

- Operates the Nation's 16 environmental satellites:
  - 3 Geostationary (GOES) by NOAA
  - 4 Polar-Orbiting (POES) by NOAA
  - 6 Defense Meteorological Satellite program (DMSP) operated by NOAA
  - 1 OSTM Jason-2 (Ocean Surface Topography Mission) - Joint NOAA, NASA, CNES, EUMETSAT effort
  - 1 DSCOVR (Deep Space Climate Observatory) by NOAA
  - 1 Suomi National Polar-orbiting Partnership (NPP) by NOAA & NASA

NESDIS Office of Satellite and Product Operations (OSPO)

- OSPO has locations at four major facilities housing around 700 people.
- NOAA Satellite Operations Facility (NSOF) in Suitland, Maryland
  - Mission Operations Division (MOD)
  - U.S. National Ice Center (NIC)
- NOAA Center for Weather & Climate Prediction (NCWCP) in College Park, Maryland.
  - Satellite Products and Services Division (SPSD)
- Command and Data Acquisition Stations in Alaska and Virginia.

NSOF

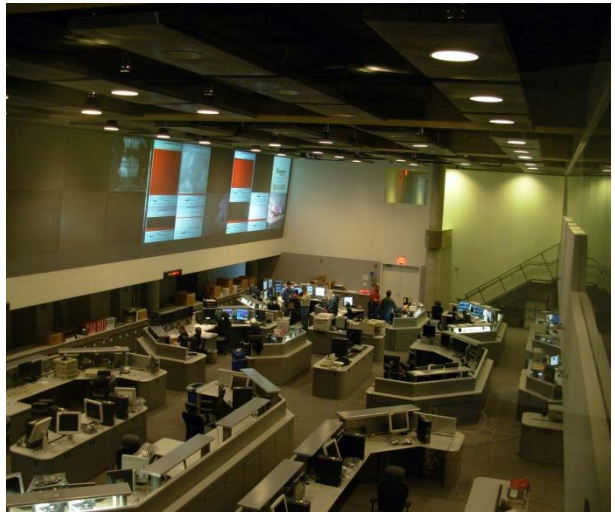
Fairbanks CDAS

NCWCP

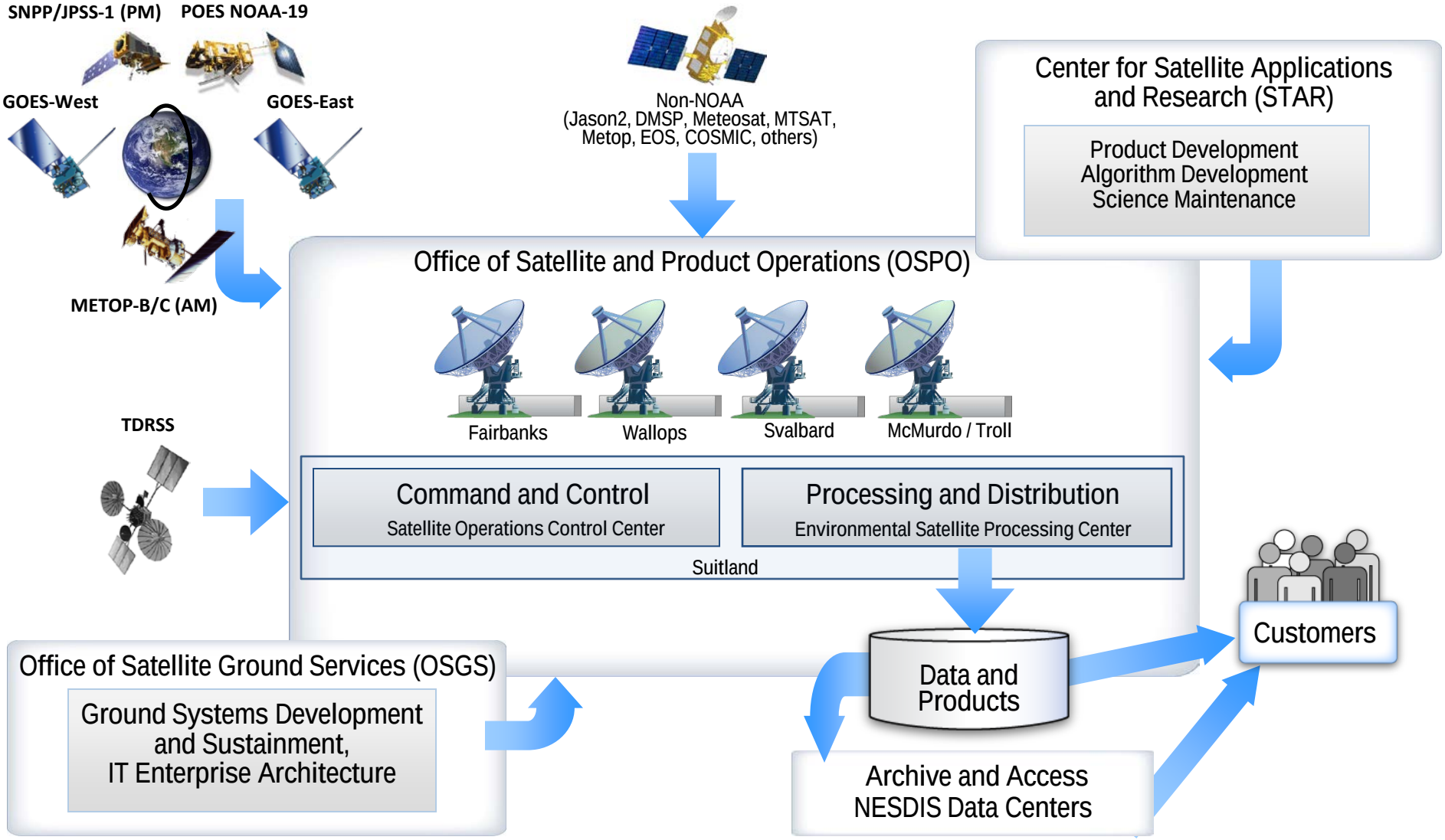
Wallops CDAS

OSPO's Key Roles

- Ground System Command & Control, Ingest, Generation, and Distribution
- Pre-Launch and Post-Launch Testing
- Operational Testing, Validation, and Verification
- User Readiness for Broadcast Services and Product Delivery
- Long-Term Continuity of Products and Services



Satellite Operations, Processing and Distribution



Satellite Direct Service Operations

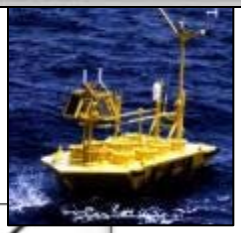
Emergency Managers Weather Information Network (EMWIN):

- NOAA satellites relay critical information to users across the country.
  http://www.weather.gov/emwin/index.htm

Low Resolution Image Transmission (LRIT):

- NOAA satellites are used to relay satellite and weather products to users in remote locations, that do not have landlines or internet connections.
  http://www.noaasis.noaa.gov/LRIT/

Data Collection:



- NOAA satellites are used to collect and relay scientific data from around the globe.
  http://www.noaasis.noaa.gov/DCS/ http://www.noaasis.noaa.gov/ARGOS/

Search and Rescue Satellite Aid Tracking (SARSAT):

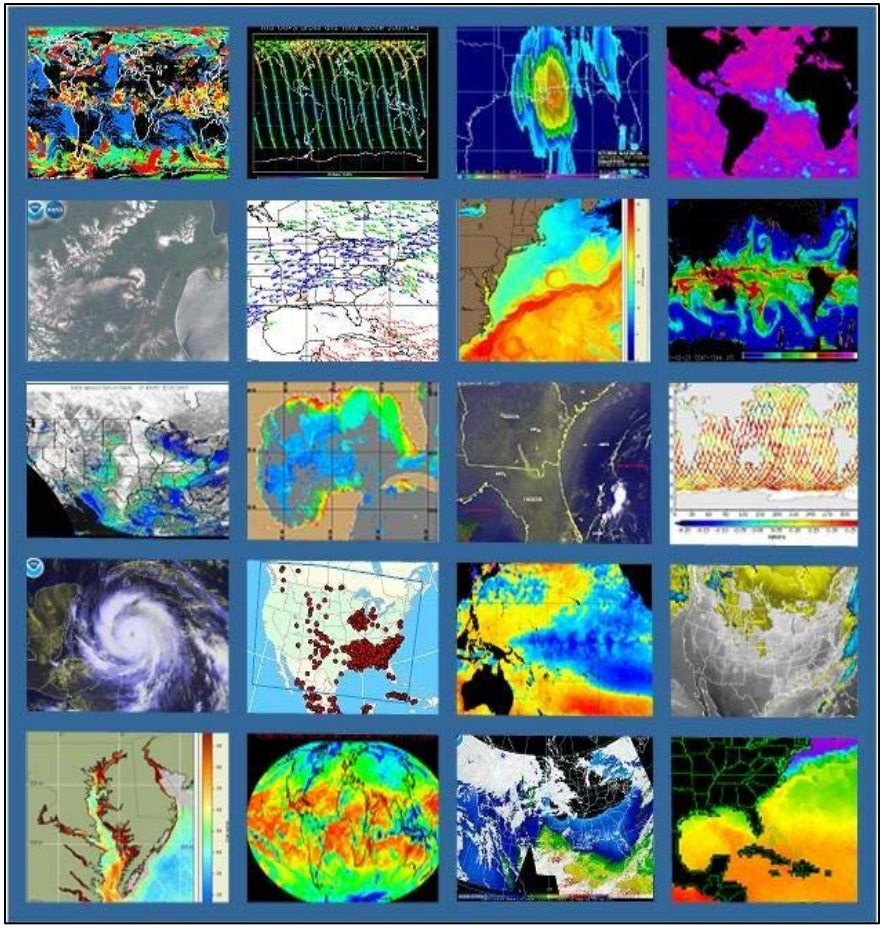
- NOAA satellites are used to relay distress alerts from aviators, mariners and land-based users (135 rescued through July 31, 2015).
  http://www.sarsat.noaa.gov/

Geonetcast Americas:

- Data from NOAA for diverse societal benefits - agriculture, energy, health, climate, weather, disaster mitigation, biodiversity, water resources, and ecosystems.
  http://www.geonetcastamericas.noaa.gov/index.html

OSPO's Satellite Products and Services Division

- Provides 24x7 interpretive analyses of satellite data
  - Atmospheric temp/moisture
  - Hurricane intensity & position
  - Significant Precipitation
  - Volcanic Ash
  - Fire and Smoke
  - Oil Spills
- Manages automated environmental products
- Collaborates with partners to support transition of research products into operations



Mission Systems Status

S-NPP Space System is GREEN

Spacecraft	S-NPP
Launch Date	Oct 28, 2011
Mission Lifetime	5 years
Mission Category	LTAN 1330 (PM)

- Operational (or capable of)
- Operational with limitations (or standby)
- Operational with degraded performance
- Not functional

Spacecraft Subsystem	Status
TLM, Command & Control	G
ADCS	G
EPS	G
Thermal Control	G
Communications	G
CDP	G
SCC	G
GPS	G
1553	G
1394	G

Payload Instruments	Status
ATMS	G
CERES	G
CrIS	G
OMPS – Nadir	G
OMPS – Limb	G
VIIRS	G

Note:
S-NPP declared prime afternoon satellite on May 1, 2014

http://www.ospo.noaa.gov/Operations/SNPP/status.html

Suomi-NPP Calendar of Events – Summary

Upcoming SNPP spacecraft maneuvers and other known events that may impact data distribution are:

- Drag Make-Up maneuver (DMU) for maintaining optimum geo-location:
  - None scheduled/planned
- VIIRS Lunar Roll (~9 per year) for VIIRS calibration activities:
  - 23 Oct 2015 (~18:56 UTC)
  - 22 Nov 2015 (~04:13 UTC)
  - 21 Dec 2015 (~11:45 UTC)
  - 19 Jan 2016 (~21:02 UTC)
  - 18 Feb 2016 (~08:05 UTC)
  - 18 Mar 2016 (~20:54 UTC)
- Inclination Maneuver (IAM) to ensure optimum LTAN maintenance:
  - 23 Sep 2015 (TBD) – IAM #5

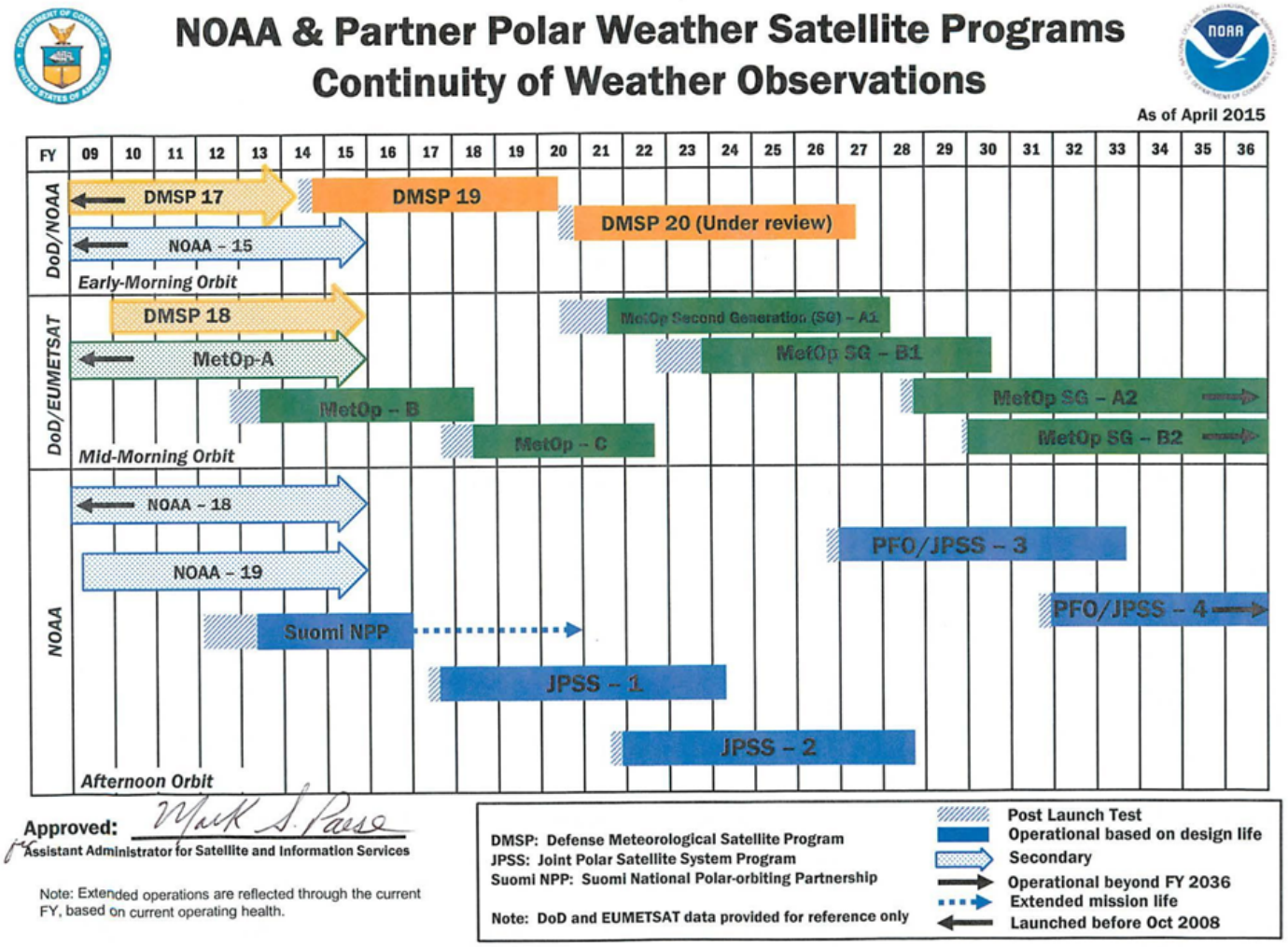
Note – IAM and DMU maneuvers are subject to change. More details for these events will be provided closer to the occurrence via official ESPC administrative notifications and JPSS mission notices.

Spacecraft specific information obtained from the latest SNPP Planning and Scheduling Spacecraft Calendar and from other sources

Maneuvers Affecting Data Quality

	Drag Make-Up (DMU)	Inclination Adjust (INC)	VIIRS Lunar Calibration
Type	Propulsive	Propulsive	Non-Propulsive (Slew only)
Purpose	maintain Ground Track box with a Ground Track Error of 0 ± 20Km	Maintain Mean Local Time at Ascending Node (MLTAN) of 13:30 ± 00:10.	Monthly (Except during summer) VIIRS calibration.
Mnvr Location	In-track, orbit boost, in Eclipse	Cross-Track at Desc. Node, in Eclipse	Day side of orbit. Location provided by VIIRS Science Team.
Mnvr Freq.	3-5 times per year	Annual 2 month multi-maneuver campaign: 2014 onwards	8-9 times per year (Oct – May)
Out of MPM	13.5 min	Up to 33 min per maneuver	12 min
OMPS outage	Approx. 50 min (SVL contact dependent). Enter DECON mode 5 min before last Svalbard Contact prior to maneuver. Start Ops 4 mins after MPM.	Approx. 50 min (SVL contact dependent). Enter DECON mode 5 min before last Svalbard Contact prior to maneuver. Start Ops 4 mins after MPM.	N/A
CERES outage	Approx. 2 hours. Enter Contam Safe 20 min prior to mnvr. Ops Mode 101 mins after MPM	Approx. 2.5 hours. Enter Contam Safe 20 min prior to mnvr. Ops Mode 101 mins after MPM	Approx. 2 hours. Enter Contam Safe 20 min prior to mnvr. Ops Mode 101 mins after MPM
HRD outage (direct readout)	23.5 min. Turn off 5 mins. Before mnvr. Turn on 5 mins after maneuver	Approx 43 min. Turn off 5 mins. Before mnvr. Turn on 5 mins after maneuver	22 min. Turn off 5 mins. Before mnvr. Turn on 5 mins after maneuver

POES Flyout Schedule - April 2015



http://www.nesdis.noaa.gov/flyout_schedules.html http://www.jpss.noaa.gov

OSPO's Support of S-NPP Mission

➢ Objectives to ensure:

– S-NPP data continuity is maintained; that S-NPP provides research quality data products which can be used to analyze and determine actual geophysical trends in climate parameters;

– S-NPP flight and ground systems performance leads to validation and/or improvements in JPSS designs and procedures for future missions;
  - Block 2 Improvements will allow improved latency, cyber-security, and robustness
  - JPSS-1 Improvements
    - CrIS default set at "Full Spectrum for all channels
    - Replace Firewire with SpaceWire
    - VIIRS hardware Watchdog time

– S-NPP data are available to support the NOAA weather forecasting and ocean missions.

NDE Operational Products

Application Short Name	Application Name	Product Name	Format	Satellite
ACSPO SST	Advanced Clear Sky Processor for Oceans (NDE) - SST	SST, Clear Sky Mask	netCDF	SNPP
AOT	Aerosol Optical Thickness	VIIRS Aerosol Optical Thickness (NDE)	BUFR	SNPP
ATMS-SDR	ATMS SDR radiances	ATMS SDR radiances 22 channels (NDE)	BUFR	SNPP
CRIS-SDR-399	CrIS SDR radiances 399	CrIS IR sounder SDR radiances 399 channels for NWP data assimilation (NDE)	BUFR	SNPP
CRIS-SDR-1305	CrIS SDR radiances 1305	CrIS IR sounder SDR radiances 1305 channels for NWP data assimilation (NDE)	BUFR	SNPP
GVF	GVF	Green Vegetation Fraction – 7 day product	Grib2	SNPP
NUCAPS Level 2	NOAA Unique CrIS ATMS product System Level 2	CrIS/ATMS Atmospheric Temp Profile CrIS/ATMS Atmospheric Moisture Profile	netCDF	SNPP
NTCP	Tropical Cyclone Products	ATMS Microwave Tropical Cyclone Product	ATCF Ascii	SNPP
MIRS ATMS	Microwave Integrated Retrieval System (NDE) - ATMS	MIRS ATMS IMG products MIRS ATMS SND products	netCDF	SNPP
OMPS-NP	OMPS nadir profile	Ozone nadir profile (NDE)	BUFR	SNPP
OMPS-TC	OMPS total column	Ozone total column (NDE)	BUFR	SNPP
VIIRS-EDR	VIIRS EDR	VIIRS EDR (NDE)	netCDF	SNPP
VIIRS-SDR	VIIRS SDR	VIIRS SDR (NDE)	netCDF	SNPP
VIIRS Binary Snow Cover	VIIRS Binary Snow Cover	VIIRS Binary Snow Map	netCDF	SNPP
VPW	VIIRS Polar Winds	VIIRS Polar Winds	BUFR netCDF	SNPP

Upcoming Operational Products)

- Vegetation Health (Aug)
- GCOM → NDE 1.0 (Sep)

Internal and External Users

Internal Users	Product Type
VIIRSDIST	• NUPS – VIIRS
MiRS	• NUP – ATMS • xDR – ATMs (pass-thru)
SFS NIC-IMS	• xDR – VIIRS (pass-thru) • NUP – ATMS
NIC	• xDR – VIIRS (pass-thru) • NUP – ATMS
GCOM-GPDS	• xDR – GCOM RDR (pass-thru)
Coast Watch	• NUP – VIIRS
NUCAPS	• NUP – ATMS/CrIS
TOAST	• NUP – ATMS/ CrIS/OMPS
Okeanos	• xDR – VIIRS (pass-thru)
Blended SST	• NUP - VIIRS
DAPE	• NUP – ATMS/CrIS/VIIRS
Prod Mon	• NUP – ATMS/CrIS/VIIRS
DDS-Legacy	• Ancillary
Blended Hydro	• NUP – ATMS

External Users	Product Types
NWS-AWIPS	• NUP – VIIRS
~~NWSTG~~	• ~~NUP – ATMS /CrIS~~ (moved to NCO)
NCEP-NCO	• NUP – ATMS/CrIS/OMPS
NCEP-EMC	• NUP – VIIRS
EUMETSAT	• NUP – ATMS/CrIS/VIIRS
CMC	• NUP – ATMS/CrIS/OMPS/VIIRS
JMA	• NUP – ATMS/CrIS/OMPS
NASA-GPM	• xDR – ATMS (pass-thru)
NASA-JPL	• NUP - VIIRS
India-NCMWRF	• NUP – ATMS/CrIS
NEP-IDP	• NUP – VIIRS/ATMS-MiRS
STAR-CIRA	• xDR – VIIRS (pass-thru)
STAR	• NUP – ATMS/CrIS/VIIRS
NOAA-AOML	• NUP – VIIRS
CLASS	• NUP – VIIRS/ATMS/CrIS
***JTWC**	• ATMS (derived)
***NCEI**	• ACSPO – SST

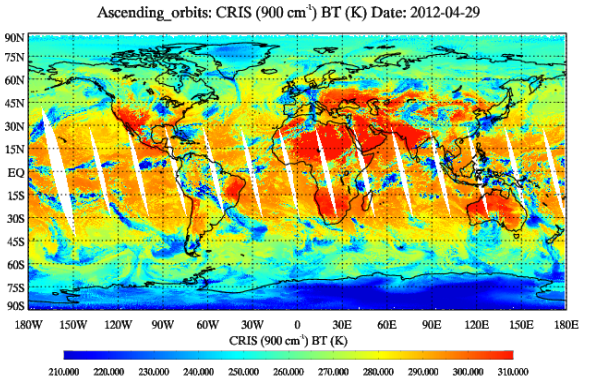
* New Users Note – NWSTG serviced moved to NWS/NCEP NCO

Operational User Examples

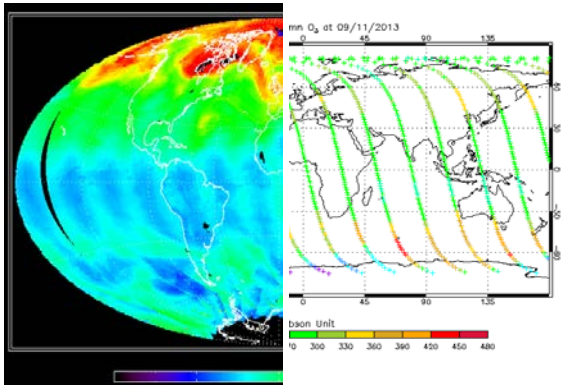
➢ Supporting NOAA's weather forecasting & oceans missions:

- May 1, 2012, VIIRS imagery used to support local warning and forecast operations throughout the NWS Alaska Region.
- May 22, 2012, the Advanced Technology Microwave Sounder (ATMS) radiances were operationally assimilated in the National Centers for Environmental Prediction's (NCEP)/ NWS Global Forecast System (GFS).
- September 25, 2012, ATMS data was assimilated operationally into the European Centre for Medium-Range Weather Forecasts (ECMWF) weather forecast models.
- April 2013, the United Kingdom Meteorology Office began assimilating operational data from the Cross-track Imaging Radiometer Suite (CrIS) and ATMS into its weather forecast models.
- August 20, 2013, NCEP began incorporating S-NPP CrIS satellite data operationally into the GFS.
- October 31, 2013, NCEP/CPC started to use OMPS Ozone operationally
- November, 2013, NRL started to use ATMS operationally in their global forecast model.

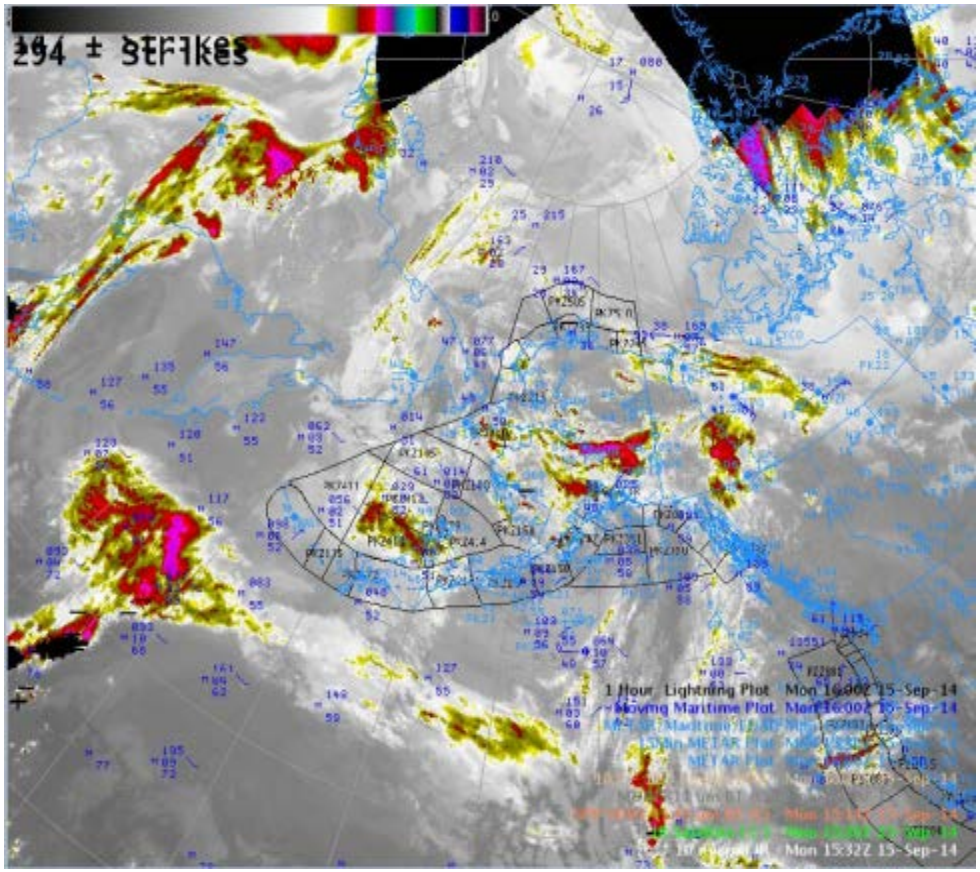
Cross-track Infrared Sounder



Ozone Mapping Profiler Suite



SNPP VIIRS Example
Fairbanks National Weather Service Office



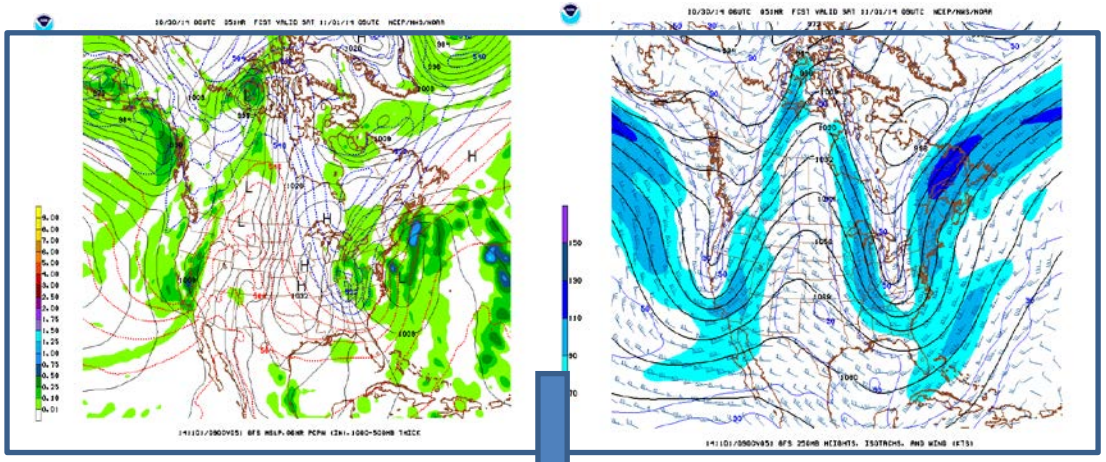
SNPP, GOES-West and MTSAT Composite imagery in AWIPS Forecast Display Systems from NWS-Fairbanks

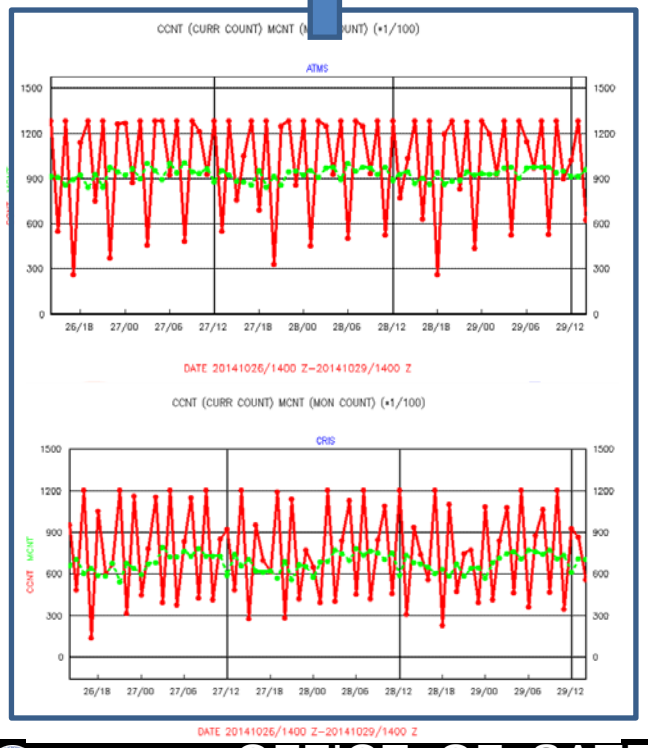
Example from NWS-Fairbanks depicting use of composite imagery (LEO & GEO) from several platforms that is used continuously to meet their critical mission needs.

Critical Applications:

- aviation safety
- Maritime safety
- public nowcasts/forecasts
- coastal/offshore forecasts
- fire weather
- ice flow monitoring
- emergency response support.

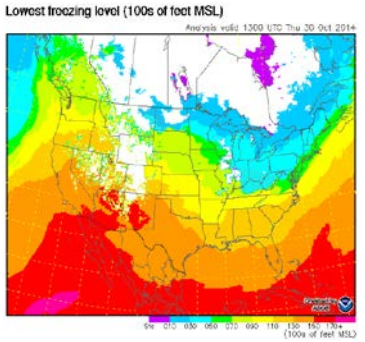
Numerical Weather Prediction – Data Assimilation (ATMS/CrIS BUFR)

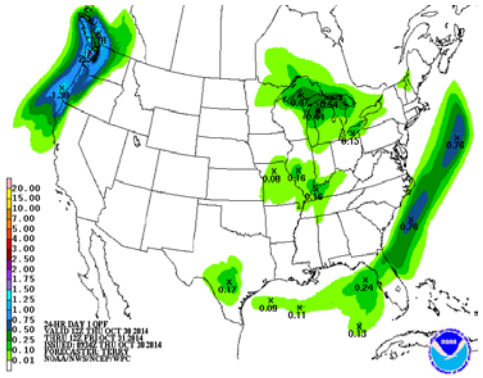


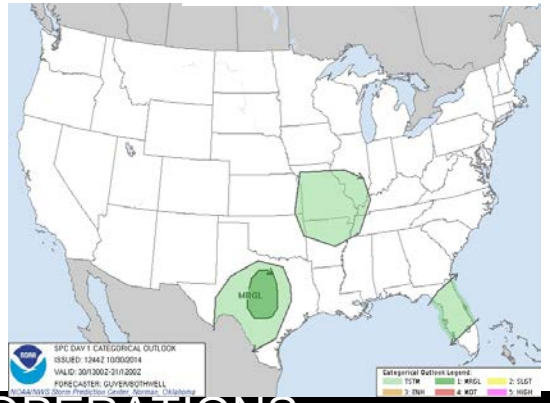


Unique Products and Services

- Public forecasts
- Outlooks
- Watches, Warnings and Advisories
- Private/Government Sectors
- Aviation
- Energy
- Environmental
- Maritime

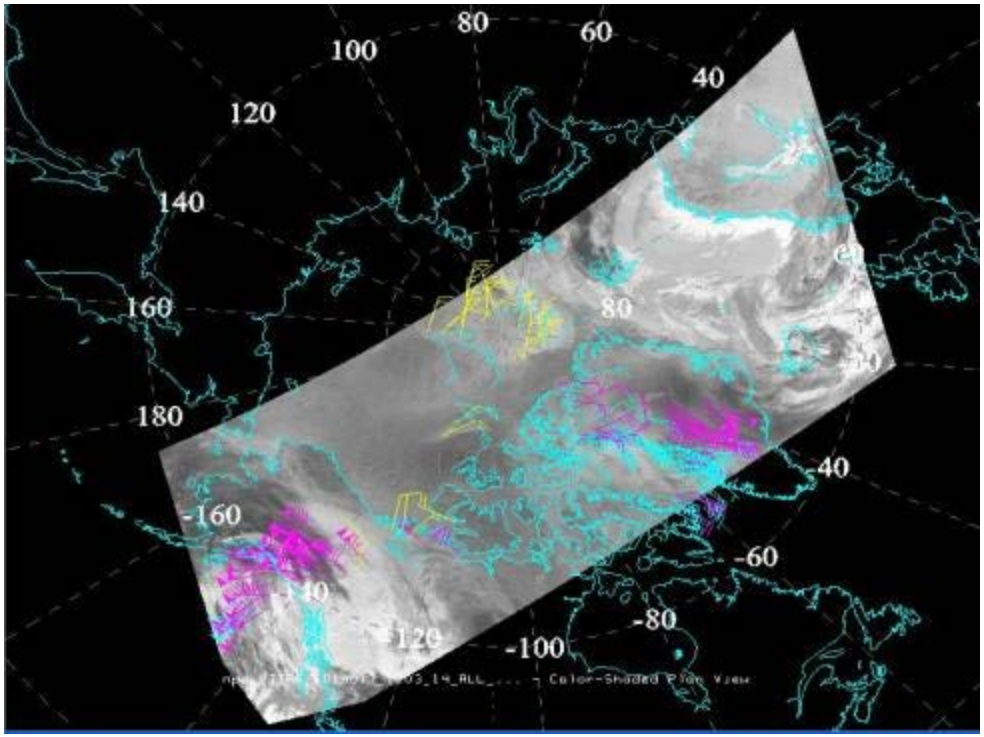




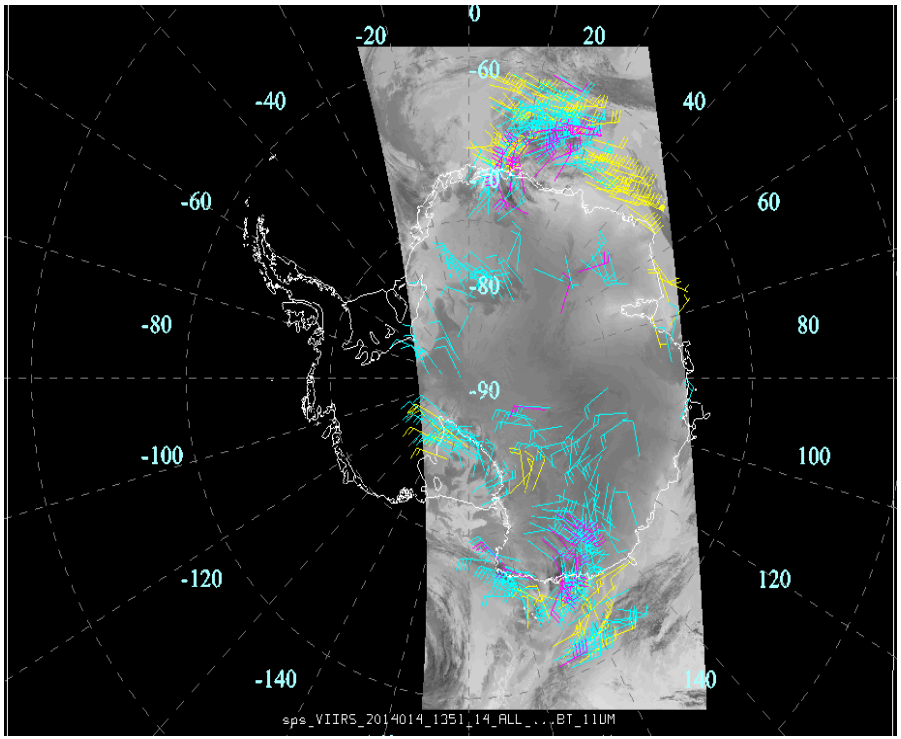


VIIRS Polar Winds (VPW) - Example

Arctic Region



Antarctic Region



VPW Real-time Users:

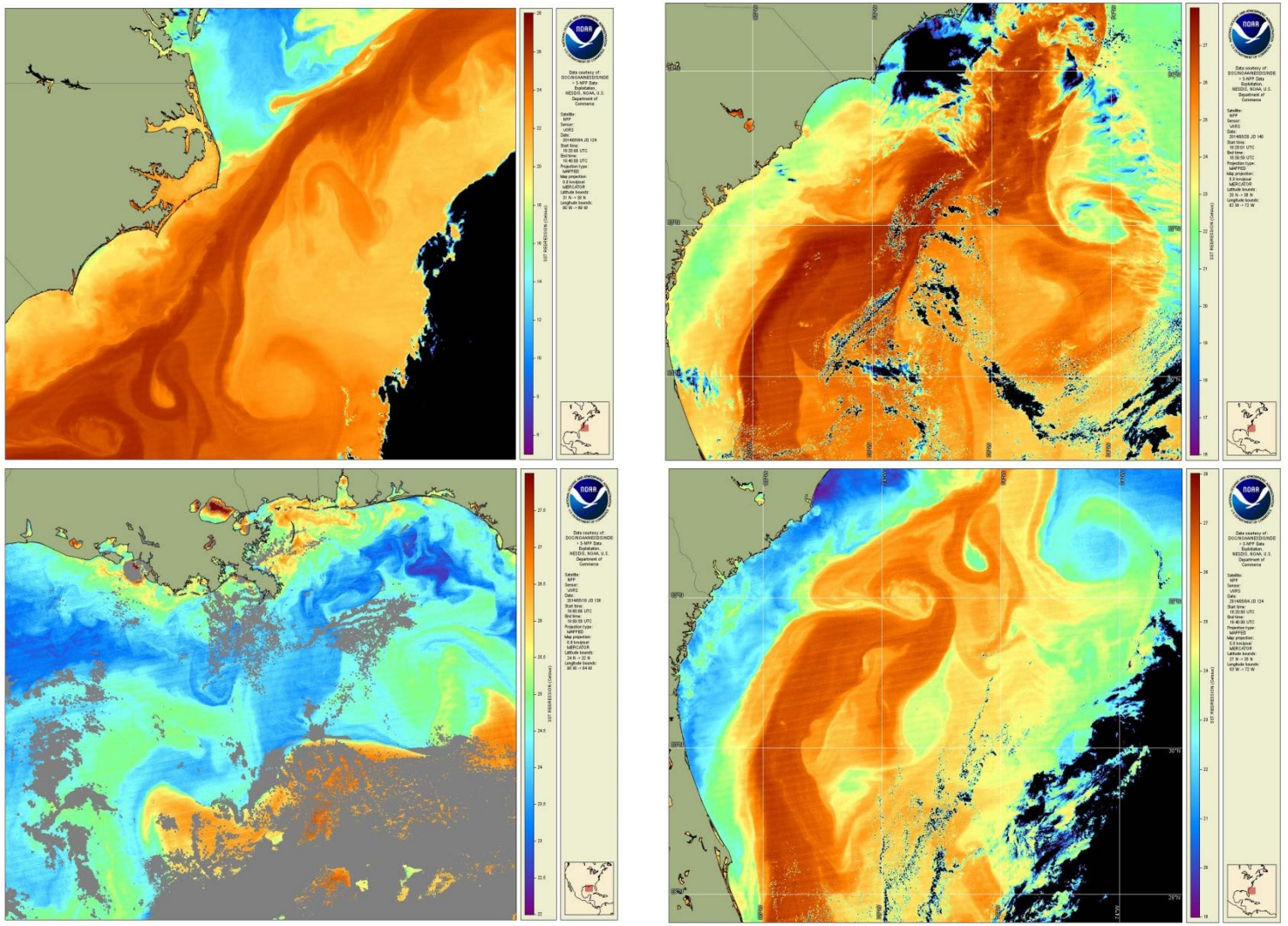
- NWS/NCEP, STAR, OSPO*(product monitoring),* EUMETSAT, CMC and JMA

Other Real-time Users (3rd party relay services via EUMETcast):

- UKMET Office and Norwegian Meteorological Institute

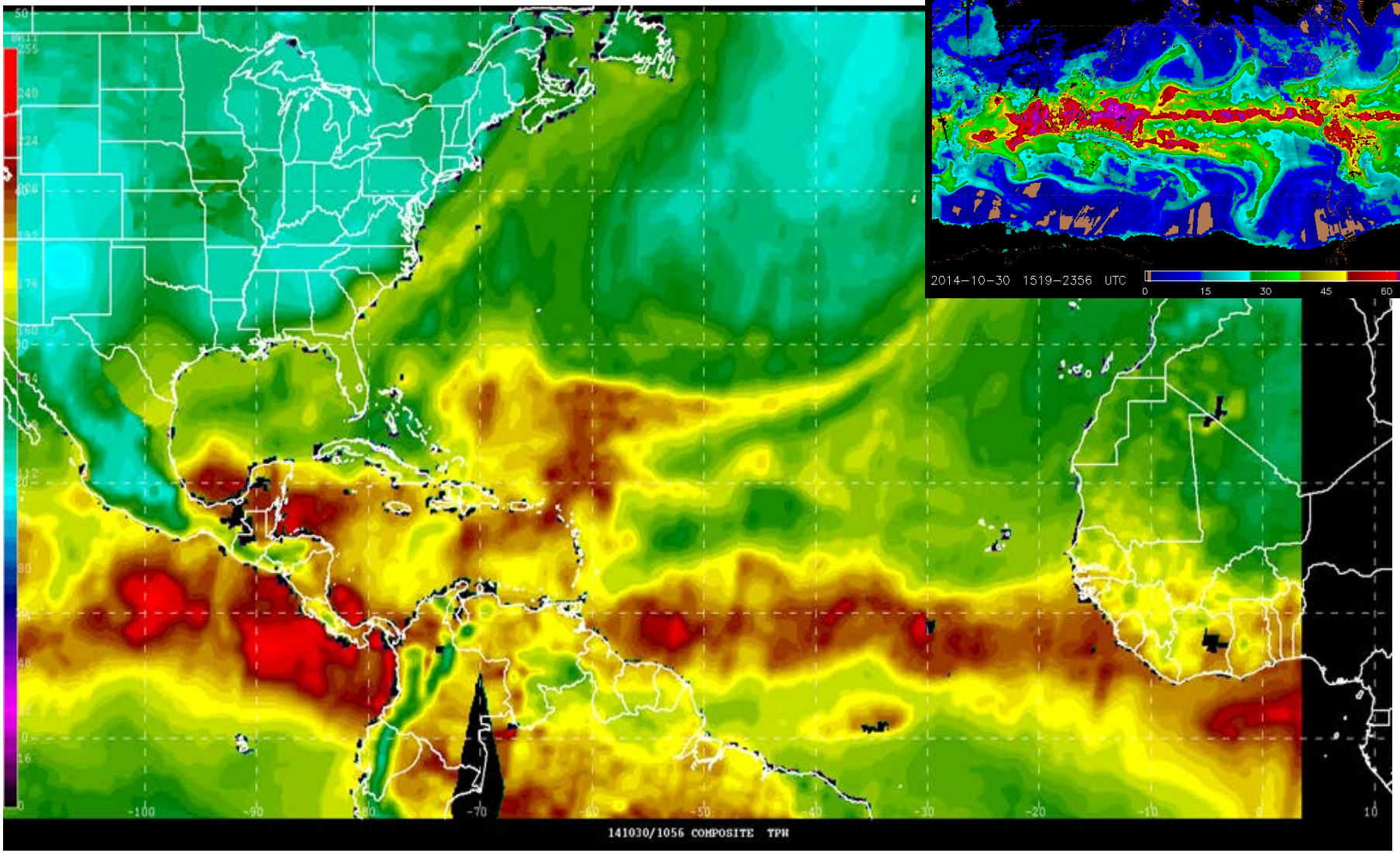
Source: NESDIS/OSPO/SPSD (Hongming Qi)

Advanced Clear-Sky Processor for Oceans (ACSPO) Sea Surface Temperature



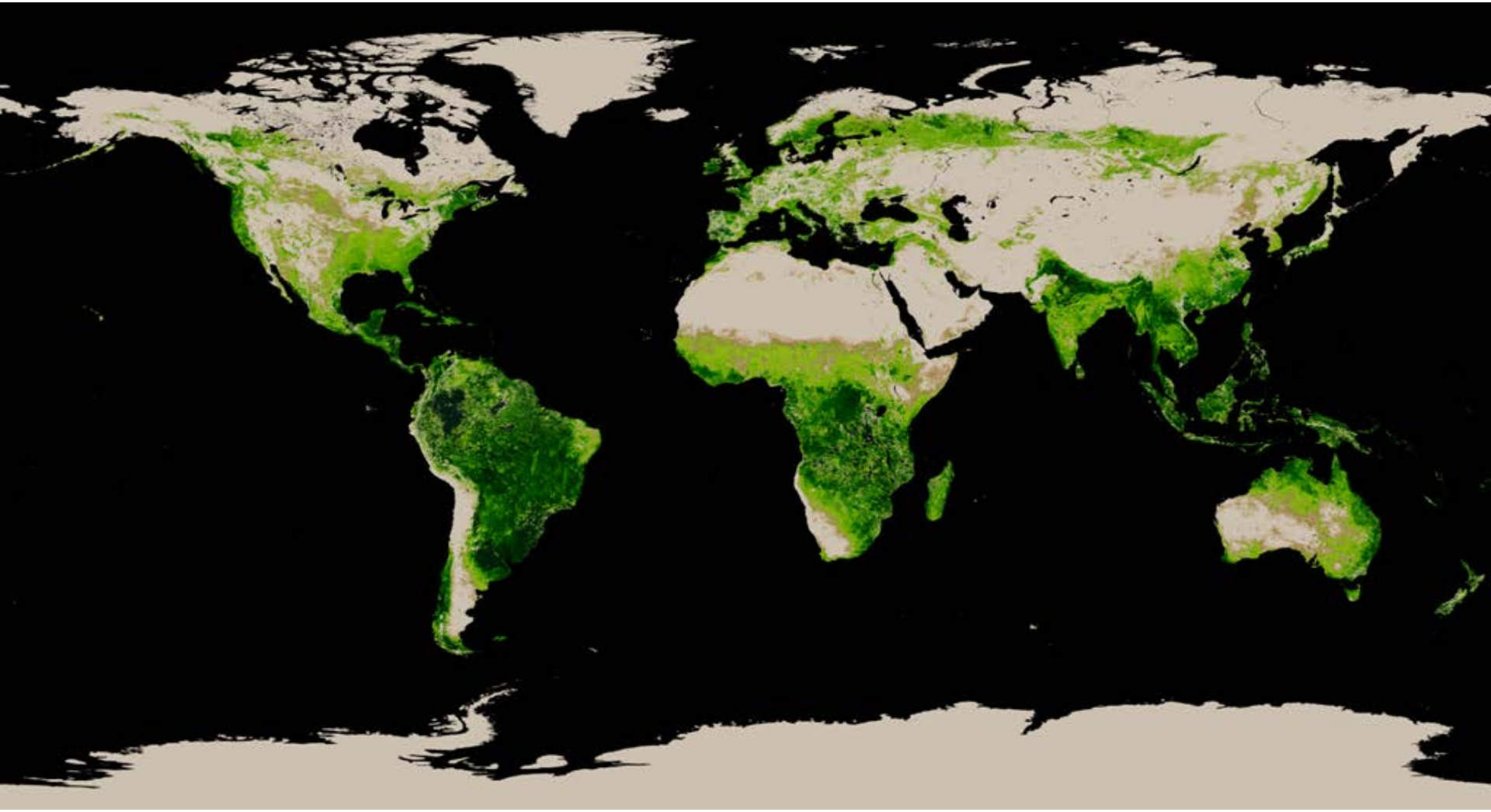
*Source: NESDIS/OSPO/SPSD (John Sapper)

Blended Products – Total Precipitable Water (TPW)



*Source: NWS National Hurricane Center (Dr. Brennan)

Green Vegetation Fraction (GVF) 7-day Product

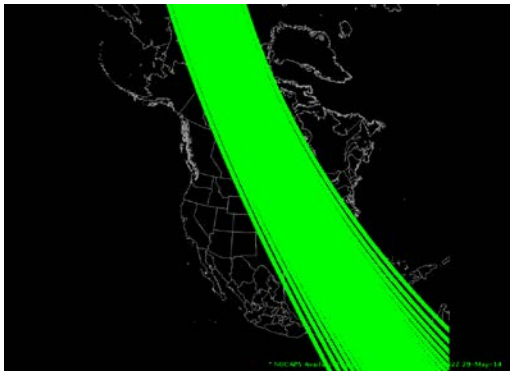


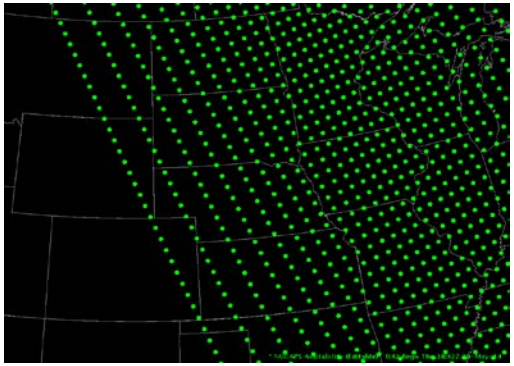
Computed once daily using the past seven days of information.

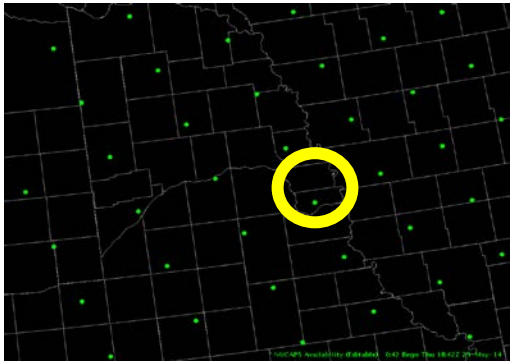
*Source: NESDIS/OSPO (Hanjun Ding)

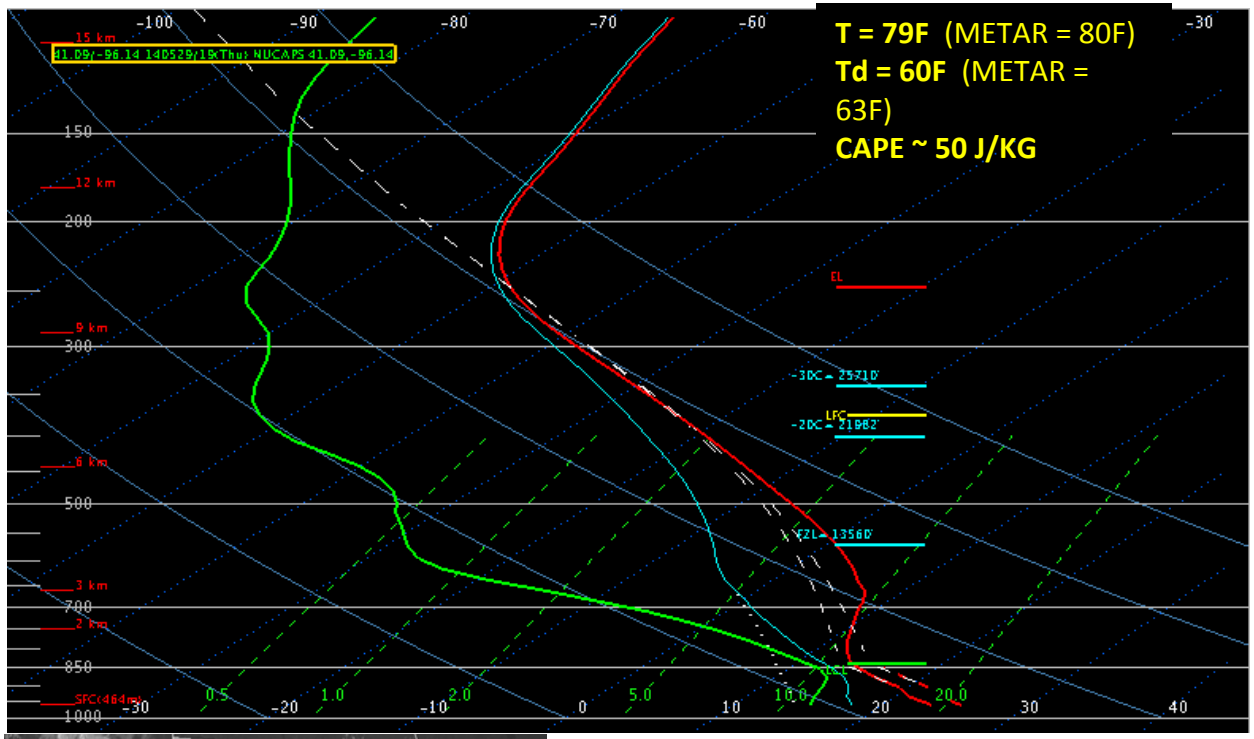
SNPP NUCAPS Soundings (T/q profiles) – NWS AWIPS2

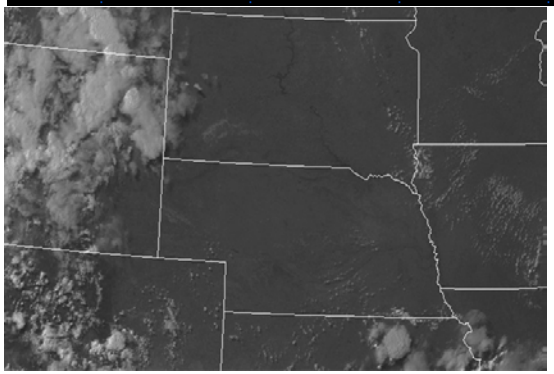
1842 UTC S-NPP Pass (May 29, 2014)











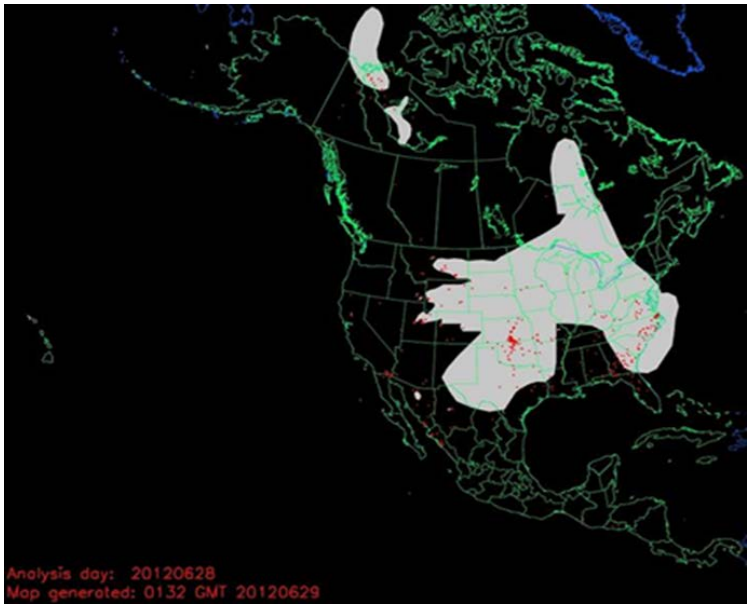
T/q retrievals

- Determine thermodynamics of atmosphere
- Cloud heights – base/tops
- Convective potential
- Help diagnose precipitation types

*Source: NWS Central Region

VIIRS for Satellite Analysis Branch (SAB) Operations (Current & Future Considerations)

- Fire and smoke analysis - Hazard Mapping System (HMS)
- Tropical cyclone analysis support
- Volcanic ash detection – Pavolonis technique VIIRS
- Aerosol detection - OMPS

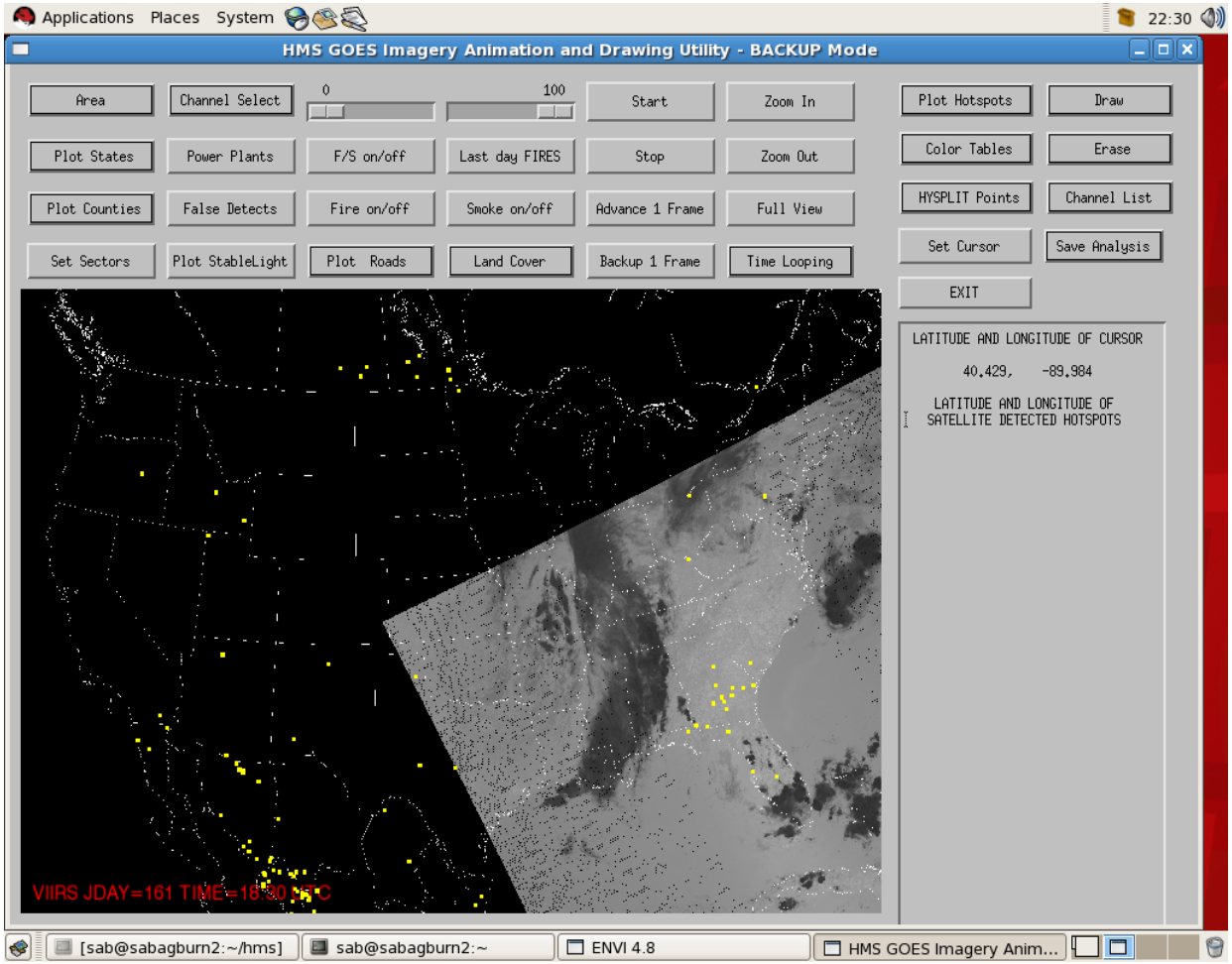


VIIRS for Satellite Analysis Branch (SAB) Operations (Future Considerations)

- Data Access
  - All 16 SAB McIDAS workstations have been setup to access and can connect to the VIIRSDIST server
  - HMS machines (gp55/54) have access to the VIIRSDIST server

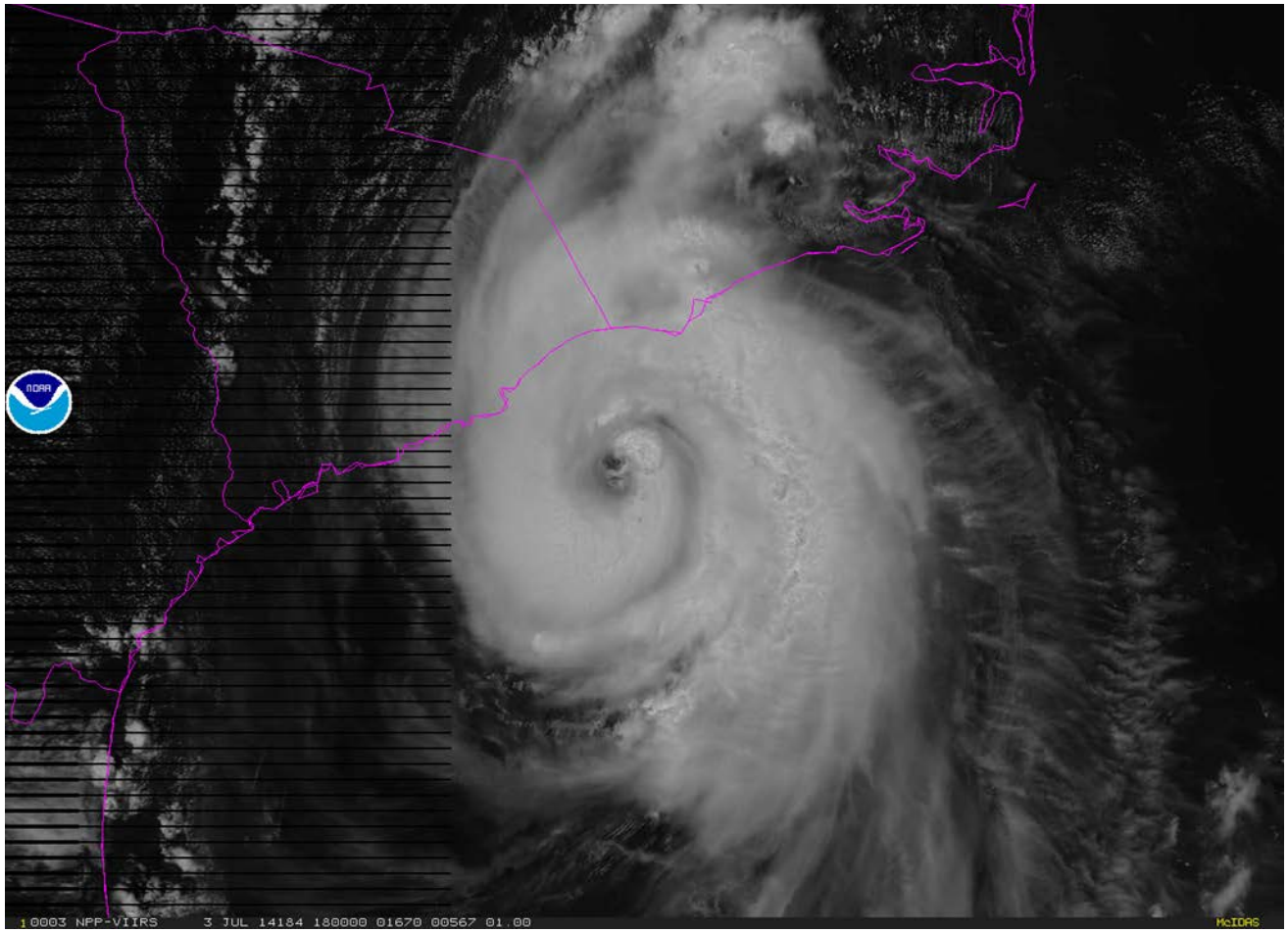
- Acceptance of Product
  - SAB has verified its capability to access the VIIRS data in McIDAS format.
  - SAB has access to M5 and M13 SDRs and Active Fire Points through HMS
  - Partial successful test of display HMS Analysis (VIIRS included) on GIS and KML page
  - User comparison of VIIRS Sensor Data Records (SDR) and Environmental Data Records (EDR) is needed
  - Development of enhancement tables for displaying VIIRS data is needed
  - There is still work left to be done to fully integrate into operations

SAB's Hazard Mapping System (HMS)



VIIRS Active Fire Points (yellow dots) overlaying on M13SDR image in HMS (Mark Ruminski)

Tropical Cyclone Analysis Support



Hurricane Arthur's banding-type eye is seen in this VIIRS image from July 3, 2014 at 1805 GMT. SAB can determine the temperature of a typhoon's eye from a VIIRS infrared image. (Michael.Turk)

Questions?

Additional Slides

ESPC Notifications, Status, and Contacts

24/7 Help Desk	ESPCOperations@noaa.gov
ESPC Messages	http://www.ssd.noaa.gov/PS/SATS/messages.html
WMO GTS Bulletins	Urgent: http://www.weather.gov/view/validProds.php?prod=ADM&node=KNES Routine: http://www.weather.gov/view/validProds.php?prod=ADA&node=KNES
User Services	SPSD.UserServices@noaa.gov
Data Access	NESDIS.Data.Access@noaa.gov
Webmaster	SSDWebmaster@noaa.gov
Facebook	www.facebook.com/NOAANESDIS
Twitter	www.twitter.com/noaasatellites
Satellite Ops Status	http://www.oso.noaa.gov/daily-news/index.asp
Press releases	http://www.nesdis.noaa.gov/news_archives/
Web	www.ospo.noaa.gov

Users	Associated Products
AWIPS_OPS	• VIIRS_I1_IMG_EDR_TIPB01_KNES • VIIRS_I4_IMG_EDR_TIPB04_KNES • VIIRS_I5_IMG_EDR_TIPB05_KNES
ESPC_VIIRSDIST	• VIIRS-AF-EDR • VIIRS_M13_SDR_10M • VIIRS_M15_SDR_10M • VIIRS_MOD_GEO_10M • VIIRS_MOD_GEO_TC_10M • VIIRS_SusMat_EDR_10M • VIIRS_I4_SDR_10M • VIIRS_IMG_GEO_10M • VIIRS_M5_SDR_10M • VIIRS_DNB_SDR_10M • VIIRS_DNB_GEO_10M • VIIRS_I4_IMG_EDR • VIIRS_IMG_GTM_EDR_GEO • VIIRS_I1_IMG_EDR
NASA_GPM	• ATMS-SDR • ATMS-SDR-GEO • ATMS-TDR
ESPC_MIRS	• MIRS_ATMS_IMG • MIRS_ATMS_SND • NPR-MIRS-IMG_33min_v9 • NPR-MIRS-SND_33min_v9 • ATMS-SDR • ATMS-SDR-GEO • ATMS-TDR

Users	Associated Products
ESPC_IMS	• MIRS_ATMS_IMG • MIRS_ATMS_IMG • MIRS_ATMS_IMG • MIRS_ATMS_IMG • MIRS_ATMS_IMG • VIIRS_I1_IMG_EDR_IMSAsia • VIIRS_I1_IMG_EDR_IMSNAm • VIIRS_I1_IMG_EDR_IMSPolarN • VIIRS_I2_IMG_EDR_IMSAsia • VIIRS_I2_IMG_EDR_IMSNAm • VIIRS_I2_IMG_EDR_IMSPolarN • VIIRS_I3_IMG_EDR_IMSAsia • VIIRS_I3_IMG_EDR_IMSNAm • VIIRS_I3_IMG_EDR_IMSPolarN • VIIRS_I5_IMG_EDR_IMSAsia • VIIRS_I5_IMG_EDR_IMSNAm • VIIRS_I5_IMG_EDR_IMSPolarN • VIIRS_IMG_GTM_EDR_GEO_IMSAsia • VIIRS_IMG_GTM_EDR_GEO_IMSNAm • VIIRS_IMG_GTM_EDR_GEO_IMSPolarN • VIIRS_NCC_EDR_IMSAsia • VIIRS_NCC_EDR_IMSNAm • VIIRS_NCC_EDR_IMSPolarN • VIIRS_NCC_EDR_GEO_IMSAsia • VIIRS_NCC_EDR_GEO_IMSNAm • VIIRS_NCC_EDR_GEO_IMSPolarN • VIIRS_SCD_BINARY_SNOW_FRAC_EDR_IMSAsia • VIIRS_SCD_BINARY_SNOW_FRAC_EDR_IMSNAm • VIIRS_SCD_BINARY_SNOW_FRAC_EDR_IMSPolarN • VIIRS_SIC_EDR_IMSAsia • VIIRS_SIC_EDR_IMSNAm • VIIRS_SIC_EDR_IMSPolarN • VIIRS_MOD_GEO_TC_IMSAsia • VIIRS_MOD_GEO_TC_IMSNAm • VIIRS_MOD_GEO_TC_IMSPolarN

Users	Associated Products
STAR_NCWCP	• NUCAPS_EDR_MONITORING • NUCAPS_FG_GRIDS_ASC • NUCAPS_FG_GRIDS_DSC • NUCAPS_FG_PCS1B_GRIDS_ASC • NUCAPS_FG_PCS1B_GRIDS_DSC • NUCAPS_GG_CCR_GRIDS_ASC • NUCAPS_GG_CCR_GRIDS_DSC • NUCAPS_GG_EDR_GRIDS_ASC • NUCAPS_GG_EDR_GRIDS_DSC • NUCAPS_GG_GFS_GRIDS_ASC • NUCAPS_GG_GFS_GRIDS_DSC • NUCAPS_GG_GRIDS_ASC • NUCAPS_GG_GRIDS_DSC • NUCAPS_GG_PCS3B_GRIDS_ASC • NUCAPS_GG_PCS3B_GRIDS_DSC • NUCAPS_PCS_MONITORING • NUCAPS_SDR_GLOBAL_MATCHUPS • NUCAPS_EDR • NUCAPS_CCR_AR • NUCAPS_GG_PCS1B_GRIDS_ASC • NUCAPS_GG_PCS1B_GRIDS_DSC • NUCAPS_EDR_GLOBAL_MATCHUPS • NUCAPS_1SCAN_BINARY • ACSPO_SST • VIIRS_WINDS_NH • VIIRS_WINDS_SH

Users	Associated Products
ESPC_GCOM	• AMSR2-SCIENCE-RDR
India_NC	• ATMS_BUFR • CrIS_C0399_BUFR
NCEP_NPDS	• VIIRS_I1_IMG_EDR_TIPG01_KNES • VIIRS_I2_IMG_EDR_TIPG02_KNES • VIIRS_I3_IMG_EDR_TIPG03_KNES • VIIRS_I4_IMG_EDR_TIPG04_KNES • VIIRS_I5_IMG_EDR_TIPG05_KNES • VIIRS_NCC_EDR_TIPG10_KNES • NPR-MIRS-IMG_33min_v9 • VIIRS_M9_EDR_TIPG19_KNES • VIIRS_M15_EDR_TIPG25_KNES • VIIRS_M16_EDR_TIPG26_KNES • NUCAPS_EDR_IUTN01_KNES • NUCAPS_EDR_IUTN02_KNES • NUCAPS_EDR_IUTN03_KNES • NUCAPS_EDR_IUTN04_KNES • NUCAPS_EDR_IUTN05_KNES • NUCAPS_EDR_IUTN06_KNES • NUCAPS_EDR_IUTN07_KNES • NUCAPS_EDR_IUTN08_KNES • NUCAPS_EDR_IUTN09_KNES

Not associated products with ESPC_Okeanos

Users	Associated Products
STAR_CIRA	• NPR-MIRS-IMG_33min_v9 • NPR-MIRS-SND_33min_v9 • MIRS_ATMS_SND • MIRS_ATMS_IMG • VIIRS-I1-SDR • VIIRS-I5-SDR • VIIRS-DNB-SDR • VIIRS-IMG-GEO-TC • VIIRS-DNB-GEO
NCEP_EMC	• VIIRS_WINDS_BUFR • ACSPO_SST_BUFR
ESPC_CW	• ACSPO_SST_aa • ACSPO_SST_ax • ACSPO_SST_ay • ACSPO_SST_az • ACSPO_SST_ce • ACSPO_SST_cw • ACSPO_SST_er • ACSPO_SST_gb • ACSPO_SST_gr • ACSPO_SST_hr • ACSPO_SST_mr • ACSPO_SST_sb • ACSPO_SST_sl • ACSPO_SST_sr • ACSPO_SST_wa • ACSPO_SST_wj • ACSPO_SST_wn • ACSPO_SST_ws

Users	Associated Products
ESPC_NUCAPS	• NUCAPS_EDR_MONITORING • NUCAPS_PCS_MONITORING • NUCAPS_ALL • NUCAPS_1SCAN_BINARY • NUCAPS_FG_GRIDS_ASC • NUCAPS_FG_GRIDS_DSC • NUCAPS_GG_GRIDS_ASC • NUCAPS_GG_GRIDS_DSC • NUCAPS_FG_PCS1B_GRIDS_ASC • NUCAPS_FG_PCS1B_GRIDS_DSC • NUCAPS_GG_PCS3B_GRIDS_ASC • NUCAPS_GG_PCS3B_GRIDS_DSC • NUCAPS_GG_GFS_GRIDS_ASC • NUCAPS_GG_GFS_GRIDS_DSC • NUCAPS_GG_EDR_GRIDS_ASC • NUCAPS_GG_EDR_GRIDS_DSC • NUCAPS_GG_CCR_GRIDS_ASC • NUCAPS_GG_CCR_GRIDS_DSC • NUCAPS_SDR_GLOBAL_MATCHUPS • NUCAPS_SDR_GLOBAL_MATCHUPS_txt • NUCAPS_EDR_GLOBAL_MATCHUPS • NUCAPS_EDR • NUCAPS_CCR_AR

Users	Associated Products
NWSTG_OPS	• NUCAPS_EDR_IUTN01_KNES • NUCAPS_EDR_IUTN02_KNES • NUCAPS_EDR_IUTN03_KNES • NUCAPS_EDR_IUTN04_KNES • NUCAPS_EDR_IUTN05_KNES • NUCAPS_EDR_IUTN06_KNES • NUCAPS_EDR_IUTN07_KNES • NUCAPS_EDR_IUTN08_KNES • NUCAPS_EDR_IUTN09_KNES
ESPC_TOAST	• NUCAPS_EDR • OMPS-NP-IP • OMPS-NP-GEO
ESPC_BSST	• ACSPO_VIIRS_v2-30_sst_sub1
ESPC_DAPE	• ATMS_BUFR • CrIS_C0399_BUFR • NPR-MIRS-IMG_33min_v9 • ATMS-SDR • ATMS-TDR • ATMS-SDR-GEO • VIIRS_WINDS_BUFR

Users	Associated Products
NOAA_AOML	• ACSPO_VIIRS_v2-30_sst_sub1
CLASS_OPS	• NUCAPS_CCR_AR • NUCAPS_EDR • MIRS_ATMS_IMG • MIRS_ATMS_SND • NDE.CLASS.RECON.FILE • VIIRS_WINDS_NH • VIIRS_WINDS_SH
EUMETSAT_OPS	• ATMS_BUFR • CrIS_C1305_BUFR • VIIRS_CTH_CCL_GEO_EDR • OMPS_NP_BUFR • VIIRS_AOT_BUFR • ACSPO_SST_GHRSST • VIIRS_WINDS_BUFR
NCO_OPS	• ATMS_BUFR • CrIS_C0399_BUFR • OMPS_NP_BUFR • OMPS_TC_BUFR

No products for
Navy_JWTC or DDS_OPS

Users	Associated Products
ESPC_PRODMON	• ACSPO_SST • NPR-MIRS-IMG_33min_v9 • NPR-MIRS-SND_33min_v9 • NUCAPS_PCS_MONITORING • NUCAPS_EDR_MONITORIN G • VIIRS_WINDS_NH • VIIRS_WINDS_SH
Canada_MC	• ATMS_BUFR • VIIRS_WINDS_BUFR • OMPS_NP_BUFR • OMPS_TC_BUFR • CrIS_C1305_BUFR
Japan_MA	• ATMS_BUFR • CrIS_C0399_BUFR • CrIS_C1305_BUFR • VIIRS_WINDS_BUFR • OMPS_NP_BUFR • OMPS_TC_BUFR
NASA_JPL	• ACSPO_SST_GHRSST

Users	Associated Products
ESPC_NIC	• MIRS_ATMS_IMG • VIIRS-I1-SDR • VIIRS-I2-SDR • VIIRS-I3-SDR • VIIRS-I4-SDR • VIIRS-I5-SDR • VIIRS-DNB-SDR • VIIRS-SIC-EDR • VIIRS-IMG-GEO-TC • VIIRS-DNB-GEO • VIIRS-MOD-GEO-TC • MIRS_ATMS_IMG • MIRS_ATMS_IMG • VIIRS-I1-SDR • VIIRS-I1-SDR • VIIRS-I2-SDR • VIIRS-I2-SDR • VIIRS-I3-SDR • VIIRS-I3-SDR • VIIRS-I4-SDR • VIIRS-I4-SDR • VIIRS-I5-SDR • VIIRS-I5-SDR • VIIRS-DNB-SDR • VIIRS-DNB-SDR • VIIRS-SIC-EDR • VIIRS-SIC-EDR • VIIRS-IMG-GEO-TC • VIIRS-IMG-GEO-TC • VIIRS-DNB-GEO • VIIRS-DNB-GEO • VIIRS-MOD-GEO-TC • VIIRS-MOD-GEO-TC

Users	Associated Products
ESPC_PRODMON	• ACSPO_SST • NPR-MIRS-IMG_33min_v9 • NPR-MIRS-SND_33min_v9 • NUCAPS_PCS_MONITORING • NUCAPS_EDR_MONITORIN G • VIIRS_WINDS_NH • VIIRS_WINDS_SH
Canada_MC	• ATMS_BUFR • VIIRS_WINDS_BUFR • OMPS_NP_BUFR • OMPS_TC_BUFR • CrIS_C1305_BUFR
Japan_MA	• ATMS_BUFR • CrIS_C0399_BUFR • CrIS_C1305_BUFR • VIIRS_WINDS_BUFR • OMPS_NP_BUFR • OMPS_TC_BUFR
NASA_JPL	• ACSPO_SST_GHRSST

Users	Associated Products
ESPC_NIC	• MIRS_ATMS_IMG • VIIRS-I1-SDR • VIIRS-I2-SDR • VIIRS-I3-SDR • VIIRS-I4-SDR • VIIRS-I5-SDR • VIIRS-DNB-SDR • VIIRS-SIC-EDR • VIIRS-IMG-GEO-TC • VIIRS-DNB-GEO • VIIRS-MOD-GEO-TC • MIRS_ATMS_IMG • MIRS_ATMS_IMG • VIIRS-I1-SDR • VIIRS-I1-SDR • VIIRS-I2-SDR • VIIRS-I2-SDR • VIIRS-I3-SDR • VIIRS-I3-SDR • VIIRS-I4-SDR • VIIRS-I4-SDR • VIIRS-I5-SDR • VIIRS-I5-SDR • VIIRS-DNB-SDR • VIIRS-DNB-SDR • VIIRS-SIC-EDR • VIIRS-SIC-EDR • VIIRS-IMG-GEO-TC • VIIRS-IMG-GEO-TC • VIIRS-DNB-GEO • VIIRS-DNB-GEO • VIIRS-MOD-GEO-TC • VIIRS-MOD-GEO-TC