NASA Earth Science Research Results Enhancing Health and Air Quality Science for Soceity

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NASA
United States

Suomi NPP Launched on Oct. 28, 2011!

Launch of Landsat-8 (LDCM) on February 11, 2013

2010 NASA Science Plan

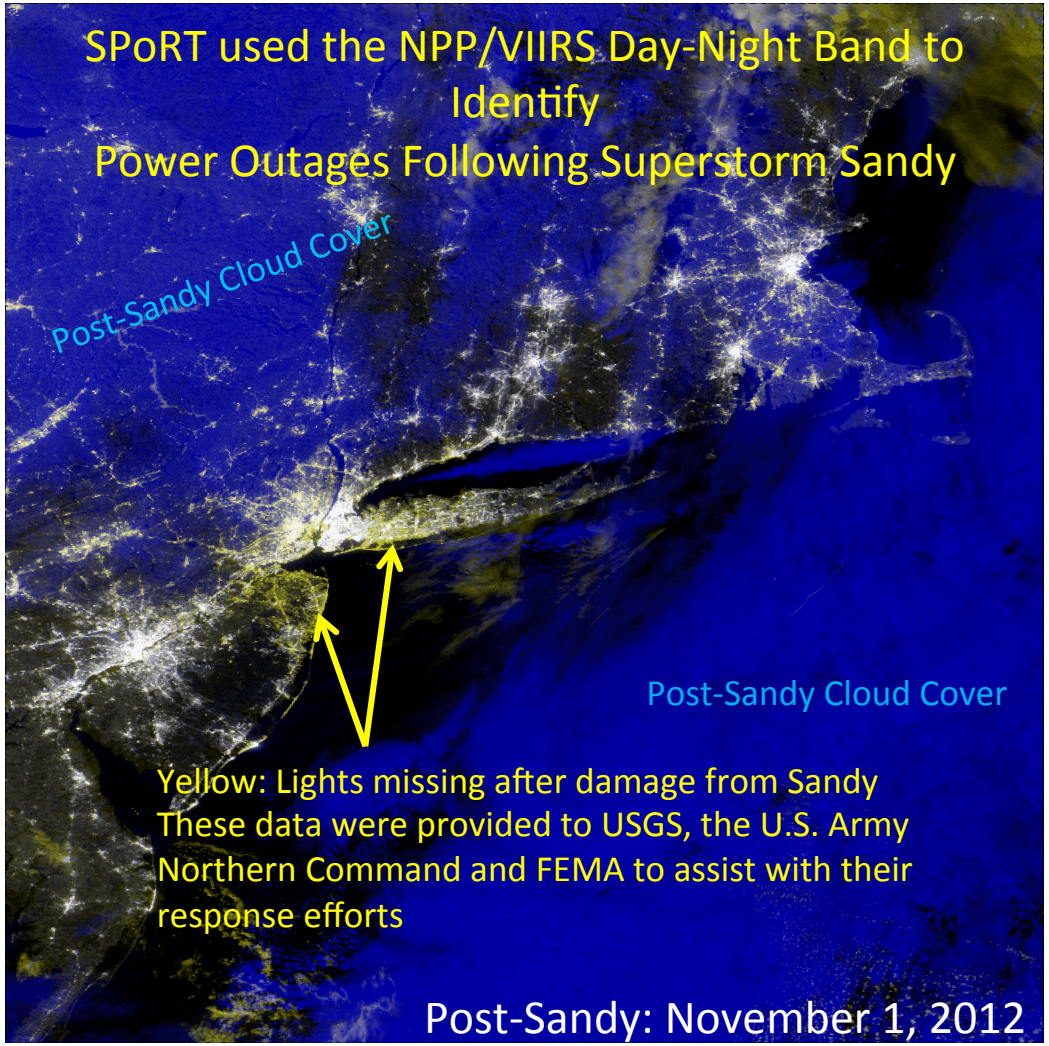
The 2010 Science Plan identifies the direction NASA has received from the Administration and Congress, advice received from the nation's science community, principles and strategies guiding the conduct of our activities, and challenges we face. The plan that results enables NASA, as Administrator Bolden says, to "do the best science, not just more science."

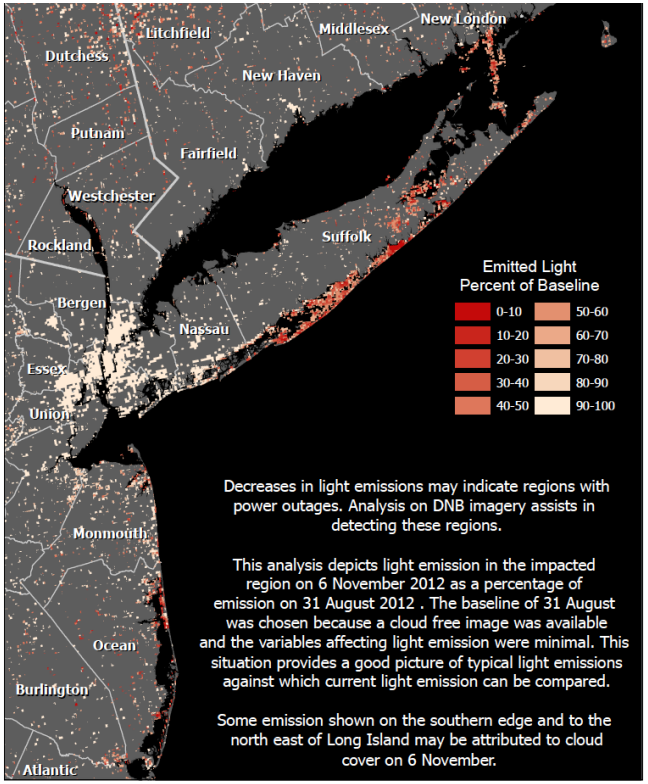
The NASA Earth Science strategic goal is stated as, ***"Advance Earth System Science to meet the challenges of climate and environmental change."***

http://science.nasa.gov/media/medialibrary/2010/08/30/2010SciencePlan_TAGGED.pdf


Earth Science Missions in Operation
Aquarius
OSTM/Jason 2 (NOAA)
Jason
2001-2013
QuikSCAT*
TRMM
EO-1
Landsat-7 (USGS)
Aqua
ACRIMSAT
Terra
SORCE
GRACE (2)
Aura
CALIPSO
CloudSat
NPP
Landsat-8

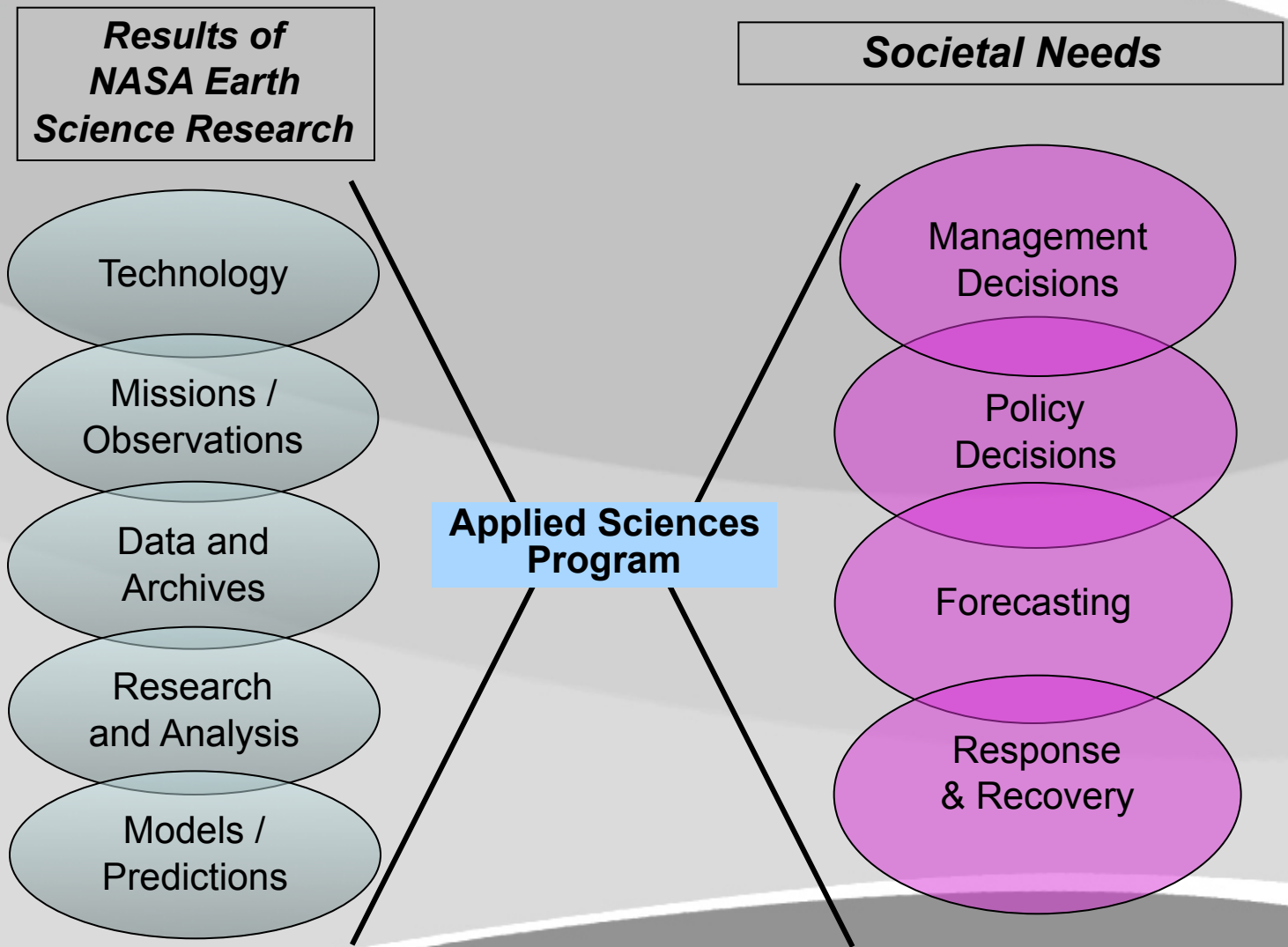
NASA's SPoRT Center Supports Disaster Response Following "Superstorm Sandy" (Landfall 10/29/12 in S. NJ)





SPoRT provided NPP/VIIRS data to the Joint Task Force Civil Support (JTF-CS) and the Department of Defense Northern Command (NORTHCOM). With SPoRT's support, analysts adapted the VIIRS data into their own product to help gauge power restoration in support of recovery efforts.

NASA Applied Sciences Architecture



Applied Sciences Program

Four Major Program Elements

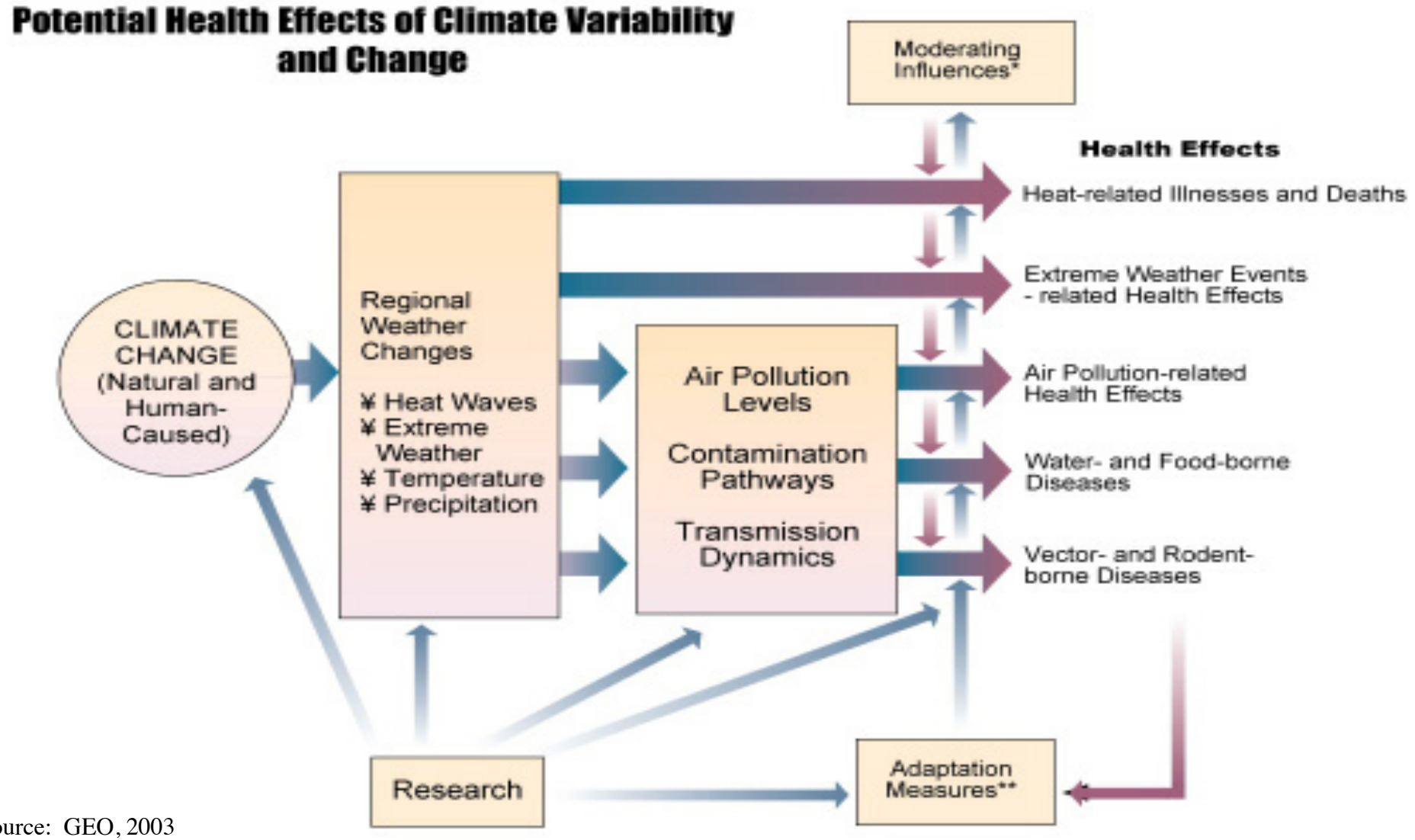
Health and Air Quality

Ecological Forecasting

Water Resources

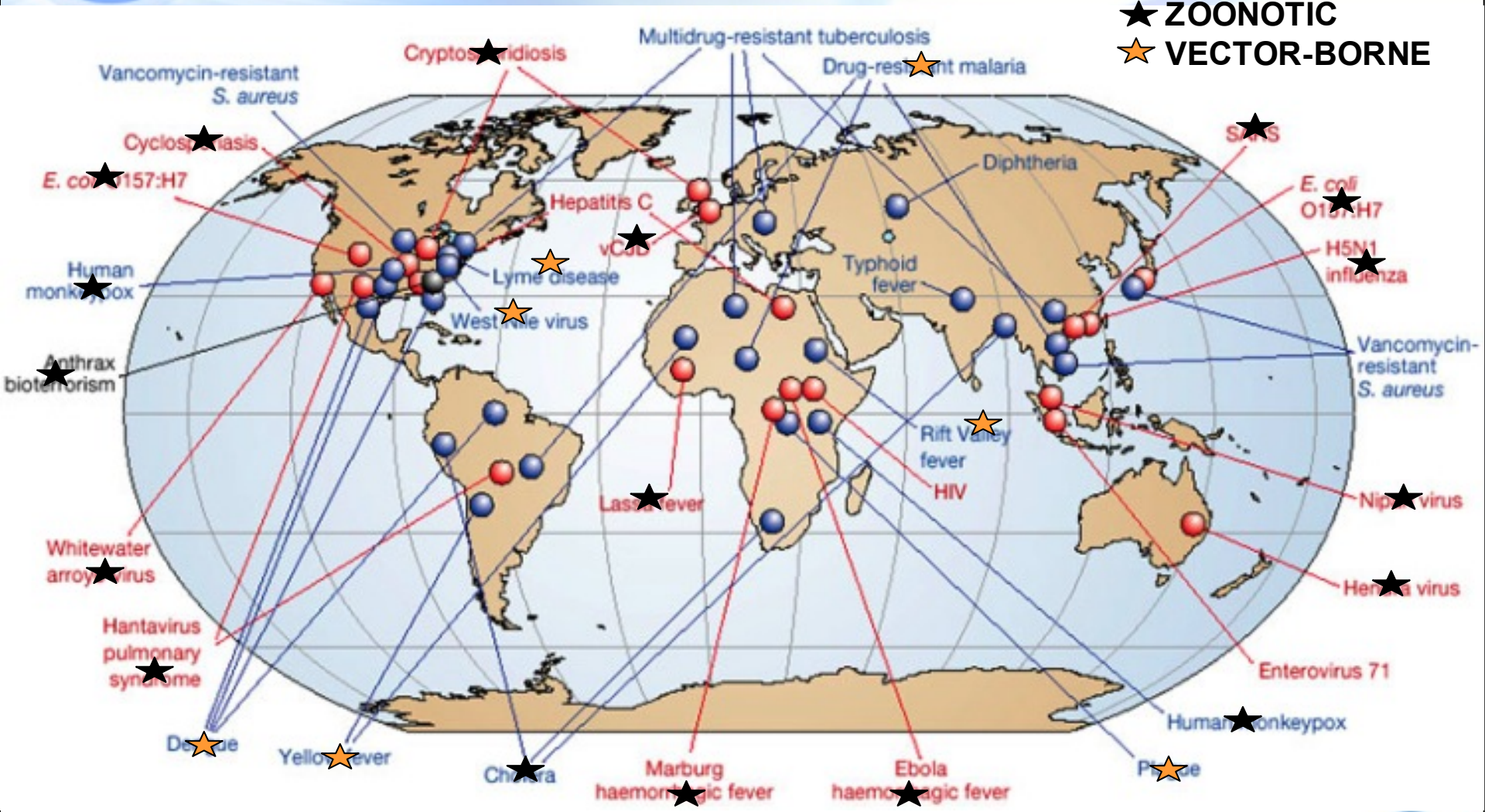
Disaster Management

Why Health and AQ?



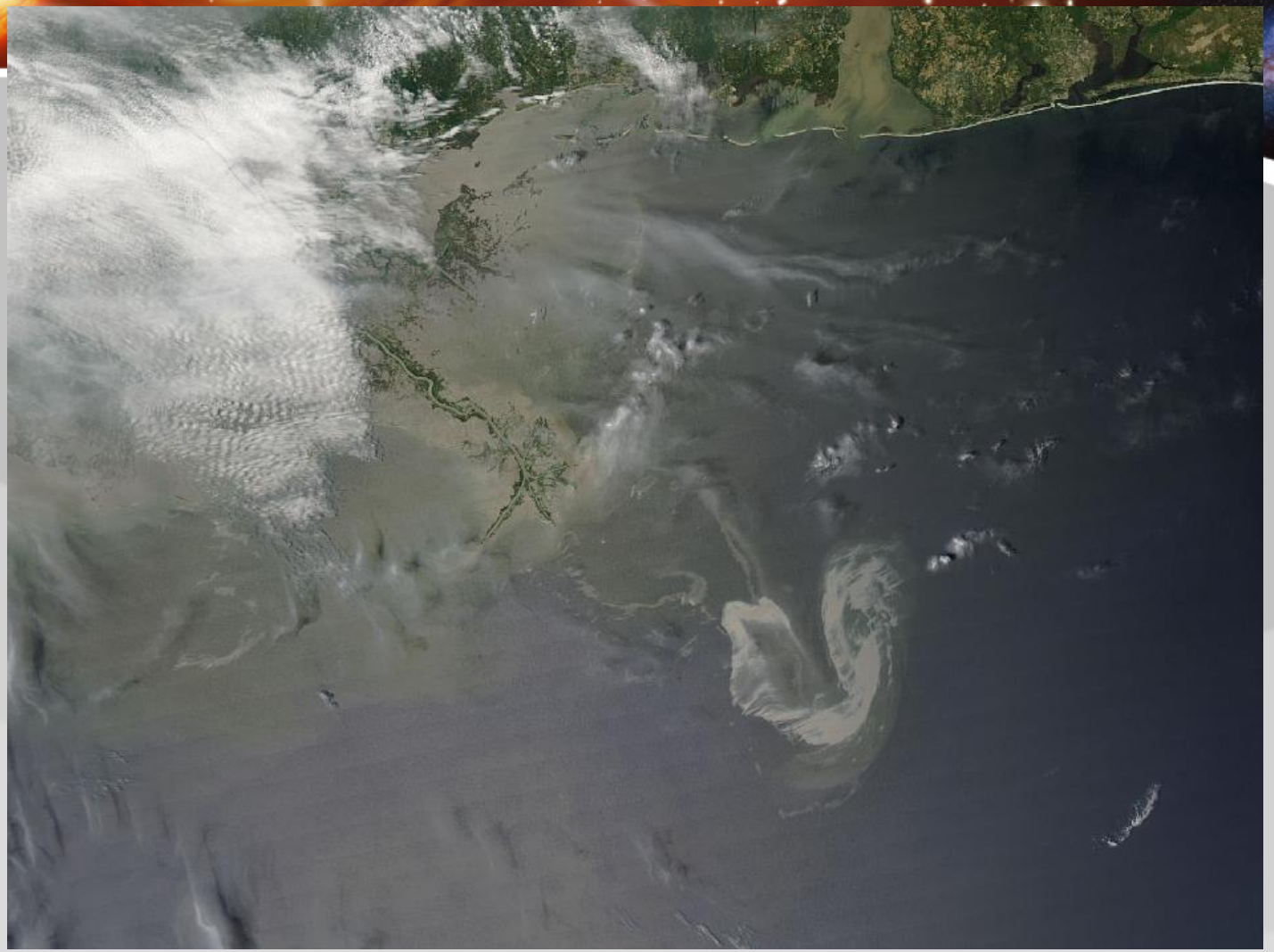
Source: GEO, 2003

Global Emerging Diseases*



* Modified from Morens et al. 2004 *Nature* 430:242

New Environmental Threats



This visible image of the Gulf oil slick was taken on May 9, 2010, at 19:05 UTC (3:05 p.m. EDT) from MODIS aboard NASA's Aqua satellite. Crude oil brings volatile organic compounds into the air which can react with nitrogen oxides to produce ozone.

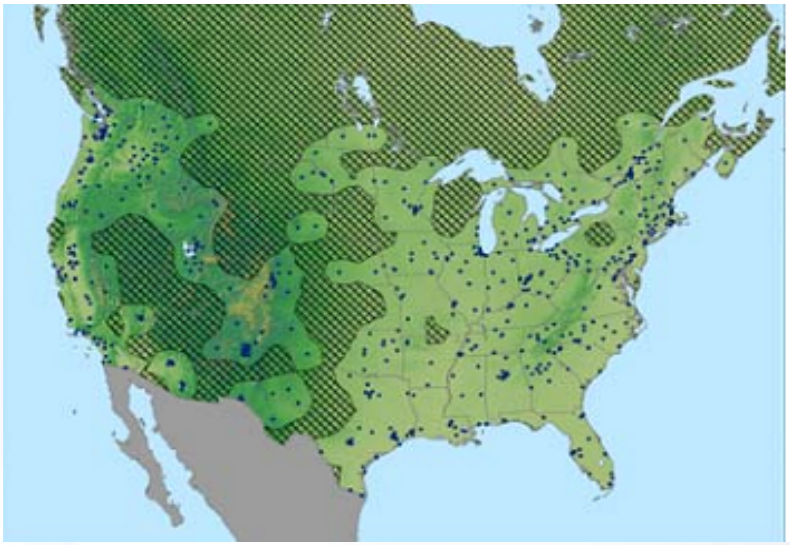
Focus Areas of Health and AQ

NASA's Health & Air Quality Applications Area supports the use of Earth observations in air quality management and public health, particularly regarding **infectious disease** and **environmental health** issues. The area addresses issues of toxic and pathogenic exposure and health-related hazards and their effects for risk characterization and mitigation. The area promotes uses of Earth observing data and models regarding implementation of **air quality standards, policy, and regulations** for economic and human welfare. The Health & Air Quality Applications Area also addresses **effects of climate change on public health and air quality** to support managers and policy makers in their planning and preparations.

Improving US EPA AirNow $PM_{2.5}$ Monitoring

Objectives:

- Improve operational AQI maps in AirNow by fusing NASA satellite-estimated $PM_{2.5}$ with AirNow observations
- Provide satellite data products in AirNow-Tech for AQ forecasters and decision-makers; thus, improving the tools currently used for AQ forecasting

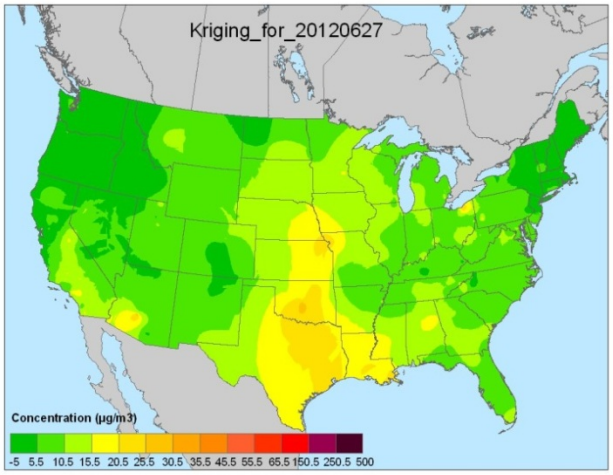


Without satellite data, no contouring or AQ information would be possible in the hatched areas

PI: Phil Dickerson, US EPA

Improving US EPA AirNow $PM_{2.5}$ Monitoring 6/27/12 Wildfires

AIRNow Interpolated Ground Observations



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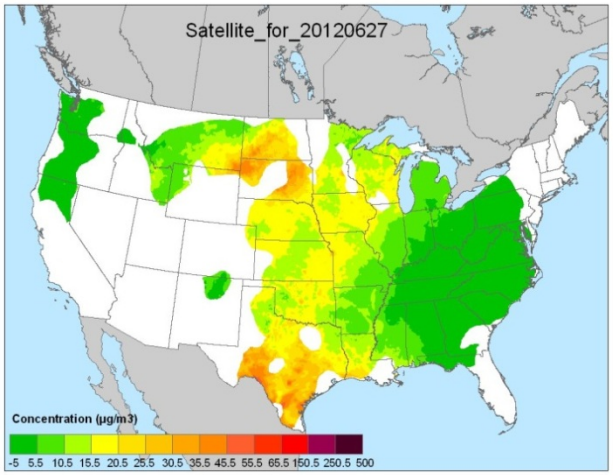
NASA Satellite-Derived $PM_{2.5}$ Estimates



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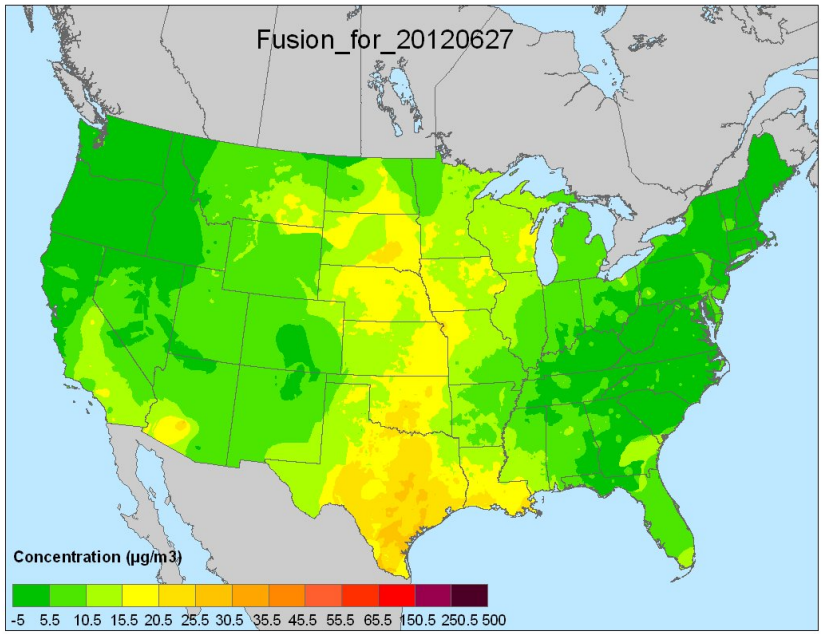
http://aspd.airnowtech.org

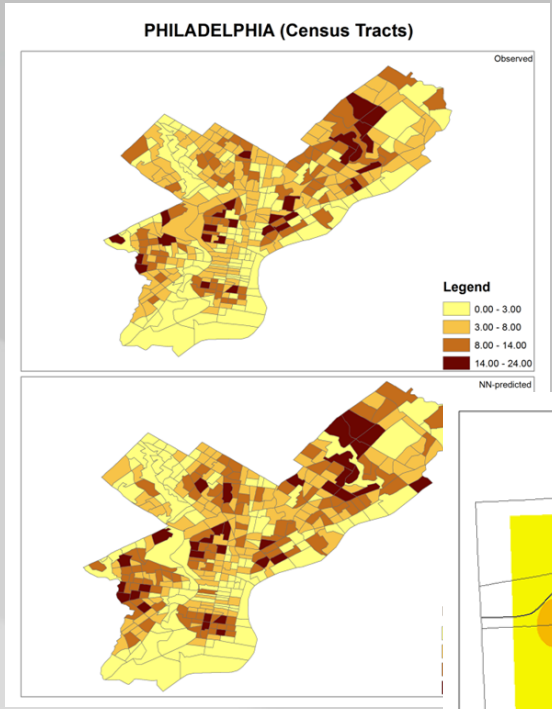
ASDP Fused Product

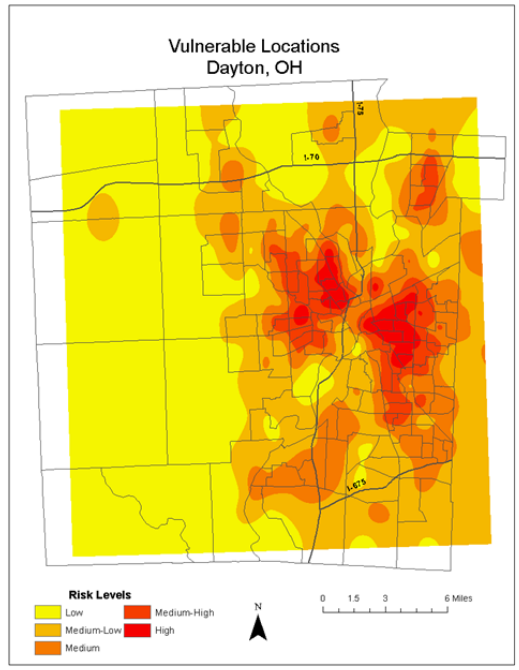


NASA data improve AIRNow maps in regions with few monitors (MT, WY, ND, SD NE, KS)

PI: Phil Dickerson, US EPA

Improving Heat Watch/Warning Systems for Decision Support





Objective: Develop a spatially specific warning system for the cities of Philadelphia, PA, Phoenix, AZ, and Dayton, OH as it pertains to extreme heat events. The development involves the incorporation of data from a variety of remote sensing platforms (MODIS, Landsat), the U.S. Census Bureau, and mortality statistics collected from the respective agencies. The assimilated data is integrated into an forecast that provides for the identification of the most vulnerable locations in each locale during episodes of extreme heat.

NASA

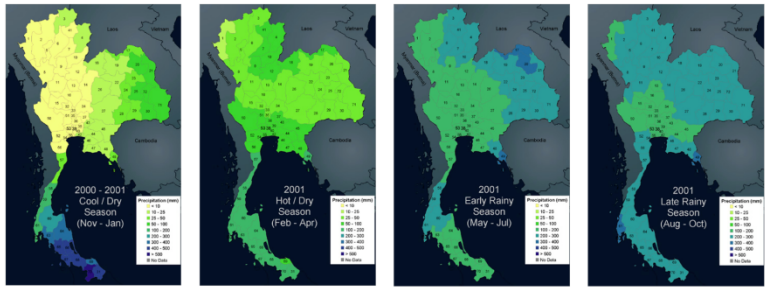
CDC
SAFER • HEALTHIER • PEOPLE™

PI: Dan Johnson, Indiana U.; Partner: George Luber, CDC

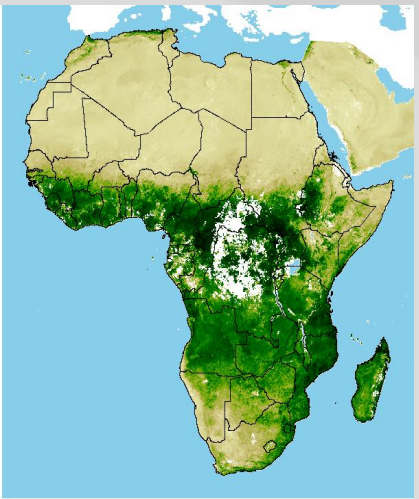
Man ploughs the sea like a leviathan, he soars through the air like an eagle; his voice circles the world in a moment, his eyes pierce the heavens; he moves mountains, he makes the desert to bloom; he has planted his flag at the north pole and the south; yet millions of men each year are destroyed because they fail to outwit a mosquito.

-- Paul F. Russell, 1931

Malaria



Precipitation is one of the main environmental determinants that promotes malaria transmission. The precipitation distribution in provincial resolution, based on NASA TRMM observations, is shown for the four Thailand season from 2000 to 2001.



This image shows vegetation density (NDVI) over Africa in May 2008. By closely monitoring vegetation in regions affected by increased rainfall, scientists can identify areas at increased risk for outbreaks of malaria.

Problem: Malaria kills up to 3 million people yearly worldwide, many of whom are children. The health and economic consequences of malaria make it a destabilizing phenomenon. Accurate characterization of malaria risk is important because of its impact on US military and humanitarian personnel and operations. Global climate change may expand malaria risk areas to new locales, particularly higher altitudes.

Solution: NASA and DOD (through GSAT) and USGS, USAID, and Columbia U. (through MEWS) are partners in utilizing environmental parameters such as precipitation, temperature, and vegetative cover to better characterize malaria transmission risks.

NASA Research Results: Model predictive capabilities and observations from NASA Earth-observing satellites such as Terra, Aqua, and TRMM.

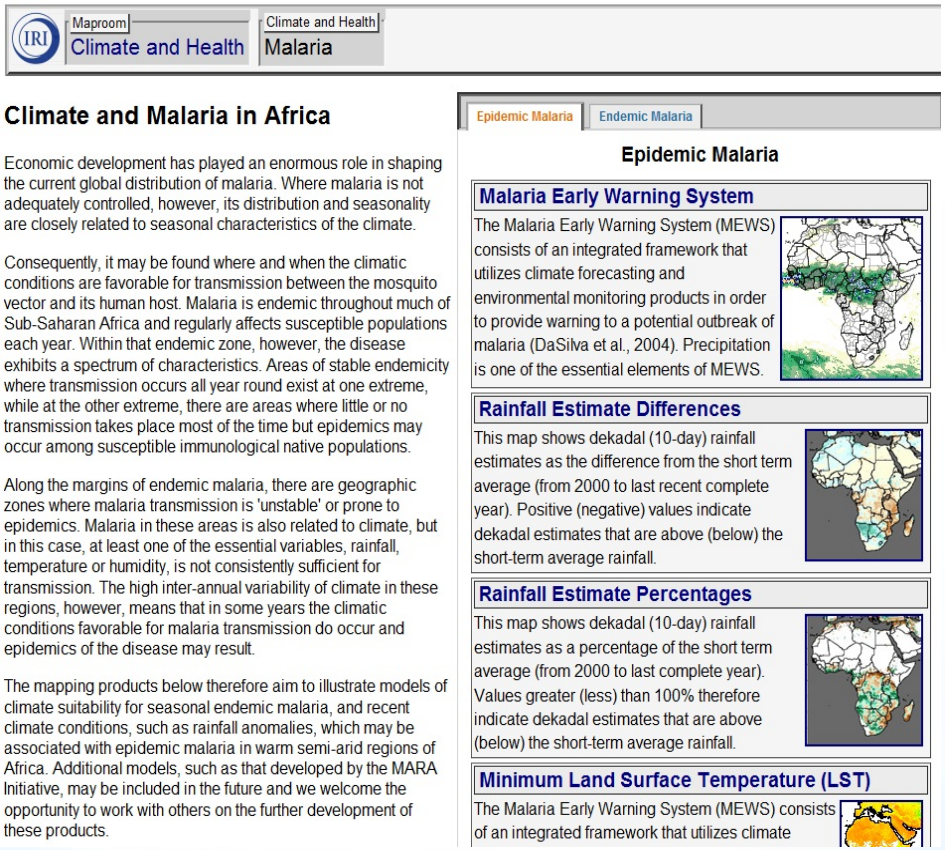
Status: Current and future malaria risks have been forecast in a quantitative, dynamic, and accurate manner in Thailand, Afghanistan, and Indonesia for use in GSAT. Rolling 10-day rainfall anomaly products and 8-day Vectorial Capacity products are produced for Africa and these data are disseminated on the web as both graphic and GIS products (available at the FEWS NET Africa Data Portal): http://earlywarning.usgs.gov/fews/africa/index.php).

Challenge: Obtaining reliable disease data from foreign countries. Such data are sensitive information. If handled improperly, the information may affect a country's tourism, foreign investment, and the ability to obtain foreign aid.

Investigators: R. Kiang, M. Brown, NASA Goddard

Improving Decision-Making Activities for Malaria And Meningitis

PI: Pietro Ceccato, IRI/Columbia University



NASA and Columbia U. have developed a repository of data specifically relevant for decision making in malaria and meningitis control . Online ‘Maprooms’ have been created to provide public health officials with dynamic maps and tools to create time-series of disease status and relevant environmental factors. These tools are available as layers in NASA SERVIR, Google Earth and WHO OpenHealth. MODIS, OMI, and TRMM observations, among others, were used in the creation of the Maprooms.

A spokesman for the Ministry of Health in Eritrea thanked the project for its results and stated that the Maprooms “are always useful for malaria.”

Improving Decision-Making Activities for Malaria And Meningitis

New Malaria Maproom

http://iridl.ldeo.columbia.edu/maproom/.Health/.Regional/.Africa/.Malaria/

contains:

- Rainfall Estimates and tools to analyze the data;
- MODIS vegetation products at 250m spatial resolution;
- Temperature map based on MODIS Land Surface Temperature during the night as an approximation of minimum air temperature;
- MODIS Land Surface Temperature during the day;
- New Reconstructed MODIS maximum air temperature with associated tool to compare product with maximum air temperature measured in stations;
- Vectorial Capacity Model;
- African Country-Average CMAP Weighted Anomaly Standardized Precipitation (WASP) with Selectable Baseline country; and
- Seasonal Climatic Suitability for Malaria Transmission

Improving Decision-Making Activities for Malaria And Meningitis

New Meningitis Maproom

http://iridl.ldeo.columbia.edu/maproom/.Health/.Regional/.Africa/.Meningitis/

contains:

•Regional Dust Model results from 1985-2006, including climate variables every 3 hours on: accumulated precipitation, accumulated incoming shortwave at ground, dust optical depth at 350m, dust optical depth at 550nm, accumulated dust emission, dust PM10 10m concentration, dust concentration, height, max 2m temperature, minimum 2m temperature, surface pressure, 2m specific humidity, specific humidity, incoming shortwave at ground, sea level pressure, 10m u wind, u wind component, friction velocity, 10m v wind, v wind component

• Precipitation Monitoring: TRMM Daily Precipitation Estimates

•Dekadal Aerosol Index and associated Interactive Map to extract spatial average per country, province, district boundaries and average boxes of 111x111km

•MISR Aerosol Monitoring: Dekadal Aerosol Optical Thickness (AOT)

• Specific Humidity Monitoring based on decadal near-surface specific humidity analyses from NCEP/NCAR Reanalysis

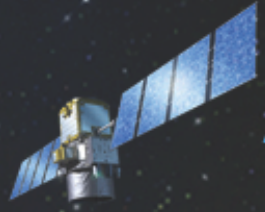
•Wind Monitoring based on decadal near-surface wind analyses from the NCEP/NCAR Reanalysis

•Temperature Monitoring based on decadal near-surface temperature analyses from the NCEP/NCAR Reanalysis

•Observed Distribution of Meningitis Epidemics during 1841-1999

•Predicted Probability of Meningitis Epidemic Experience based on an environmentally-driven model of predicted probability

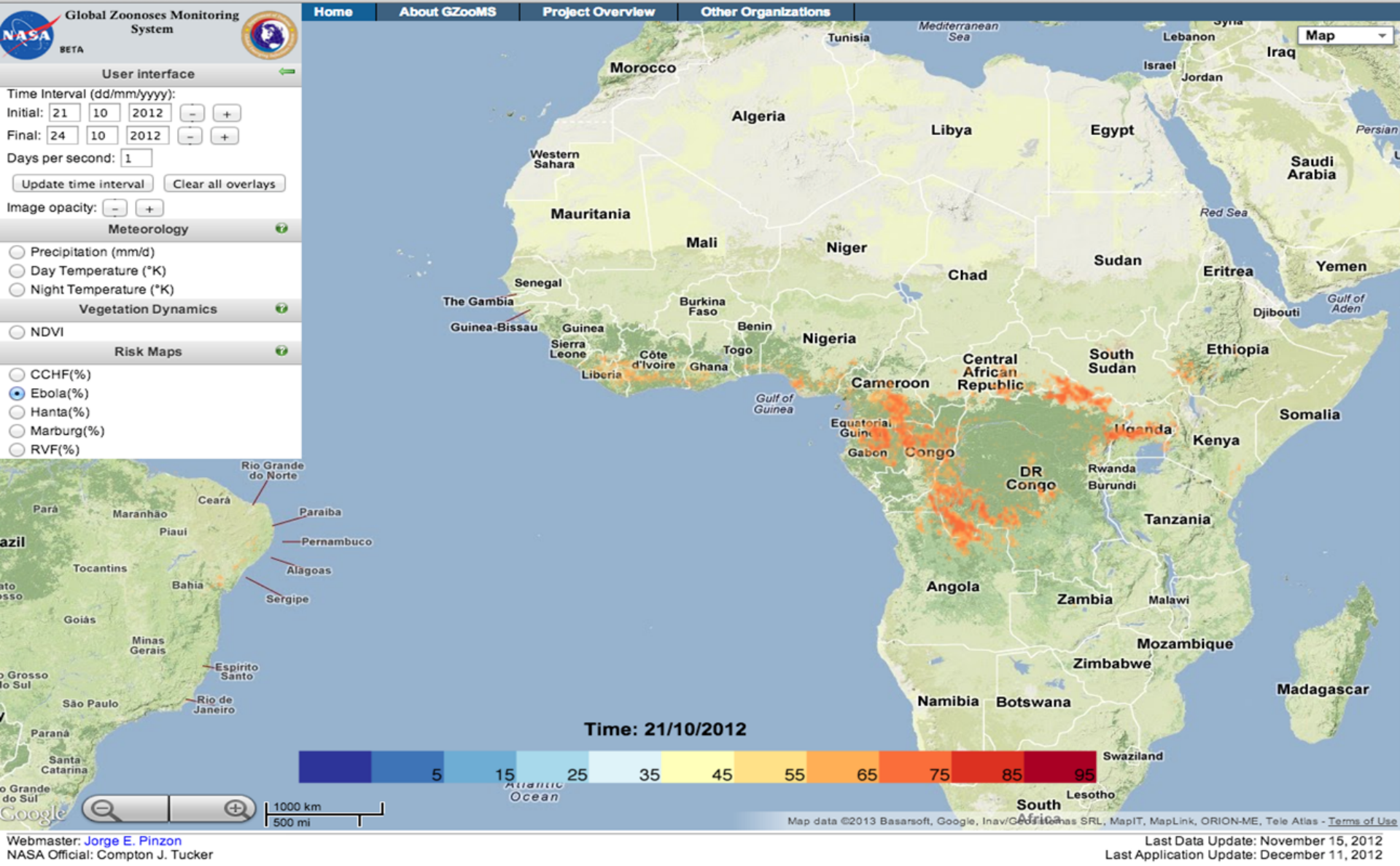
Predicting Zoonotic Hemorrhagic Fever Events in Africa using NASA Earth Science Data



Applied Sciences Program

Discovering Innovative & Practical Applications of NASA Earth Science

- This project has developed an operational predictive monitoring system, in cooperation with the DOD, based on NASA Earth science observations to detect environmental-related disease emergence signals and risk probabilities of hemorrhagic fever events (Rift Valley fever, Ebola, etc.) in Africa.
- The derived risk maps support multiple predictive surveillance programs. Results are shared with end users such as WHO and FAO. The system is designed to bring public health decision makers (and other users) advanced awareness of developing infectious disease threats, and give these end users an opportunity to plan and execute disease outbreak prevention, preparedness, and "control-and-response" actions.
- The environmental risk maps are the result of the NASA/GSFC/GIMMS disease-ecoclimatic monitoring system that integrates relevant NASA Earth Science missions and results with climate data, i.e. 16-day NDVI and 8-day temperature 1-km data from MODIS, land cover information from Landsat TM, elevation data from SRTM, monthly precipitation data from TRMM, and 15-day NDVI 8-km data processed by the GIMMS group from NOAA Advanced Very High Resolution Radiometer (AVHRR).
- The key challenge to overcome was the assimilation of all relevant bits of causality data that could explain interactions in disease patterns. Diseases are a function of the synergy of different factors, many arising from climate conditions and socio-economic transitions and infrastructure. With the integration of NASA satellite observations we can understand and predict spatio-temporal ecological factors associated to hemorrhagic fever events with enough confidence to infer risk of the disease.



Webmaster: Jorge E. Pinzon
NASA Official: Compton J. Tucker

Last Data Update: November 15, 2012
Last Application Update: December 11, 2012

Ebola confidence level of outbreak (CI) risk map during December 2012. Data is integrated into Google maps to improve availability and global accessibility. The risk maps are integrated with all the NASA primary data used to create the correspondent CI-risk maps (precipitation, temperature and vegetation index). All files can be played dynamically in a four month loop.

Investigator: J. Pinzon ,SSAI

Website: http://rs4gzm.org/gzm (Soon to be migrated to a system at NASA GSFC)

What is AQAST?

AQAST was created to serve the needs of US air quality management through the use of Earth Science satellite observations, suborbital data, and models. AQAST members have expertise in the wide array of Earth Science tools and data sets available from NASA and other agencies. They have the resources to carry out quick-turnaround projects (Tiger Teams) responding to urgent and evolving needs of air quality management, while also working on longer-term core projects.

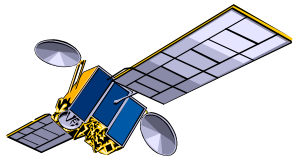
All AQAST projects are conducted in close partnership with air quality management partners.

http://aqast.org

Air Quality Applied Sciences Team (AQAST)

EARTH SCIENCE SERVING AIR QUALITY MANAGEMENT NEEDS

Earth science resources



satellites

suborbital platforms

models

AQAST

Air Quality Management Needs

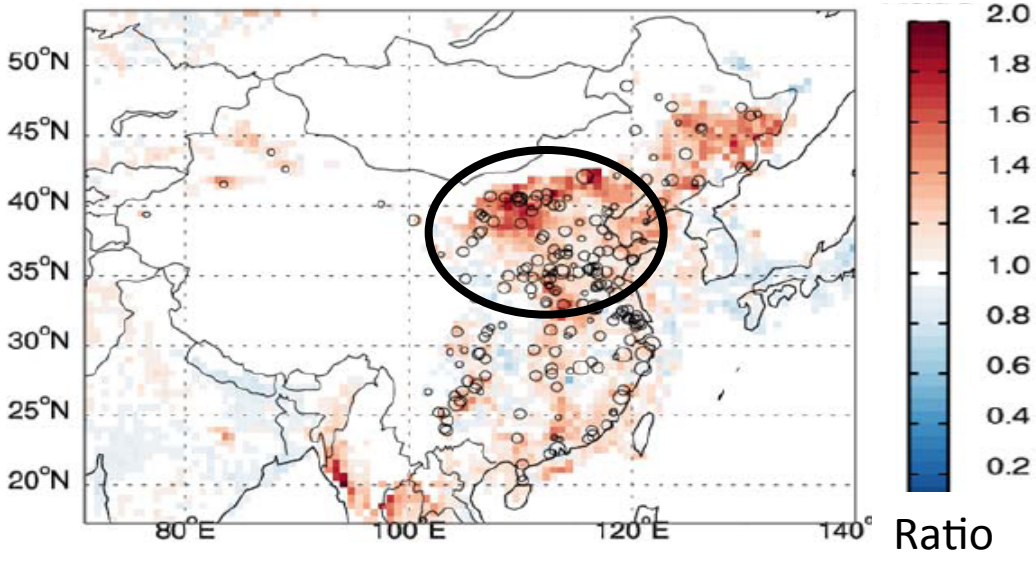
- Pollution monitoring
- Exposure assessment
- AQ forecasting
- Source attribution of events
- Quantifying emissions
- Assessment of natural and international influences
- Understanding of transport, chemistry, aerosol processes
- Understanding of climate-AQ interactions

AQAST

AQAST Membership: PIs and Co-Is

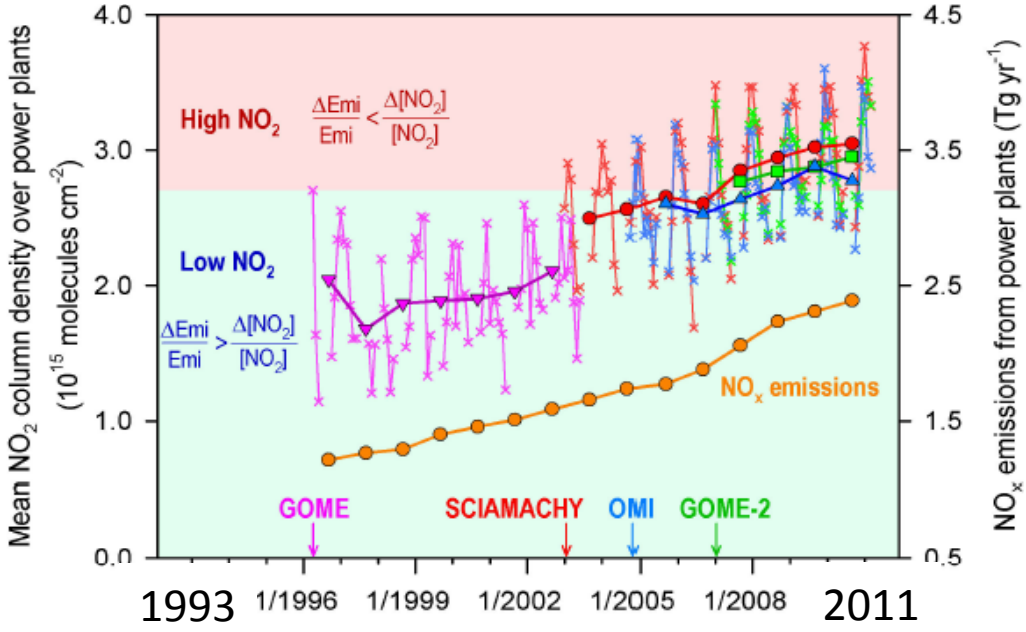
- **Daniel Jacob (leader),** Loretta Mickley (Harvard)
- **Greg Carmichael** (U. Iowa)
- **Dan Cohan** (Rice U.)
- **Russ Dickerson** (U. Maryland)
- **Bryan Duncan**, Yasuko Yoshida, Melanie Follette-Cook (NASA/GSFC); Jennifer Olson (NASA/LaRC)
- **David Edwards** (NCAR)
- **Arlene Fiore** (NOAA/GFDL); Meiyun Lin (Princeton)
- **Jack Fishman,** Ben de Foy (Saint Louis U.)
- **Daven Henze**, Jana Milford (U. Colorado)
- **Tracey Holloway,** Steve Ackerman (U. Wisconsin); Bart Sponseller (Wisconsin DRC)
- **Edward Hyer,** Jeff Reid, Doug Westphal, Kim Richardson (NRL)
- **Pius Lee,** Tianfeng Chai (NOAA/NESDIS)
- **Yang Liu**, Matthew Strickland (Emory U.), Bin Yu (UC Berkeley)
- **Richard McNider**, Arastoo Biazar (U. Alabama – Huntsville)
- **Brad Pierce** (NOAA/NESDIS)
- **Ted Russell,** Yongtao Hu, Talat Odman (Georgia Tech); Lorraine Remer (NASA/GSFC)
- **David Streets** (Argonne)
- **Jim Szykman** (EPA/ORD/NERL)
- **Anne Thompson**, William Ryan, Suellen Haupt (Penn State U.)

AQAST Highlight: Using satellite observations to monitor NO_x emission growth in China and India



OMI NO_2 tropospheric columns, Ratio of 2007 / 2005 values.

Circles are new power plants. Capacities of coal-fired power generation increased ~50%. [Wang, Streets, et al., 2012]

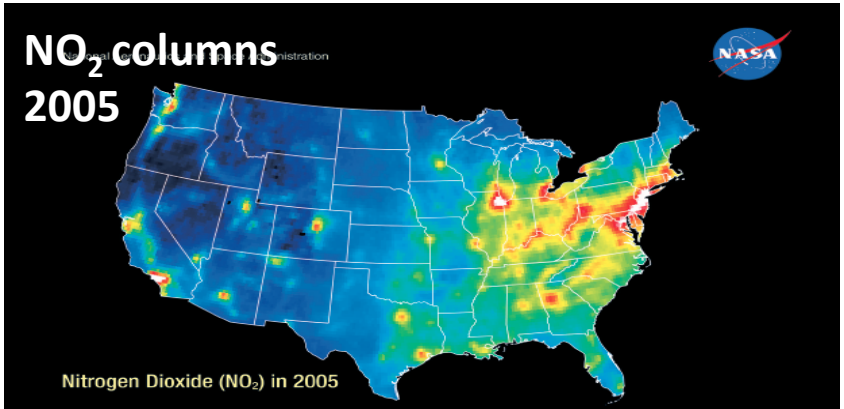


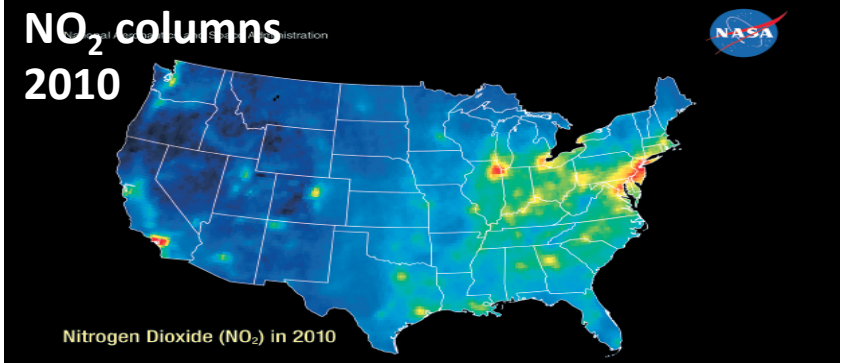
OMI NO_2 tropospheric columns over Indian power plants regions, 1996-2010

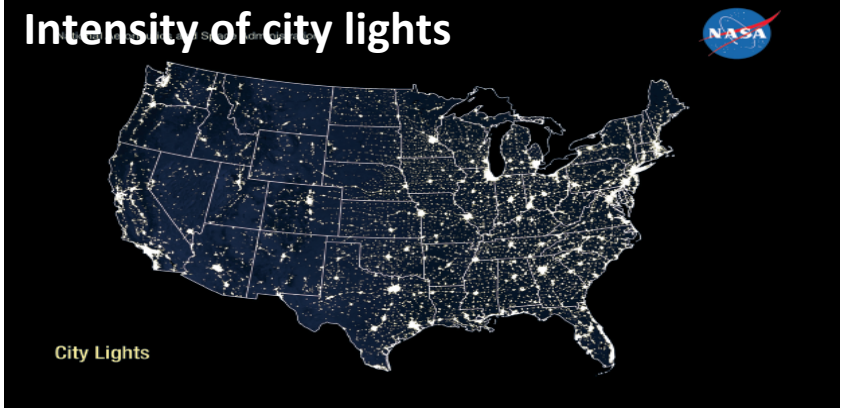
The observed 70% increase is consistent with a bottom-up emission inventory. [Lu and Streets, 2012]

AQAST PI: D.G. Streets

AQAST Highlight: Using satellite observations to monitor NO_x emission decrease over the USA







Observations from the Ozone Monitoring Instrument (OMI) onboard NASA Aura show a large decrease in nitrogen dioxide emissions across the USA as a result of federal and state regulations.

Nitrogen dioxide is unhealthy to breathe and reacts with other gases to produce ozone, an additional pollutant.

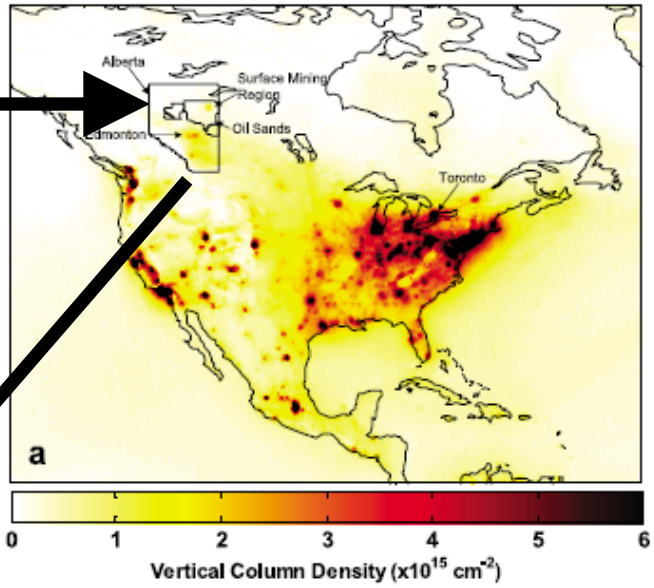
OMI NO_2 columns, x10^{15} molecules cm^{-2}

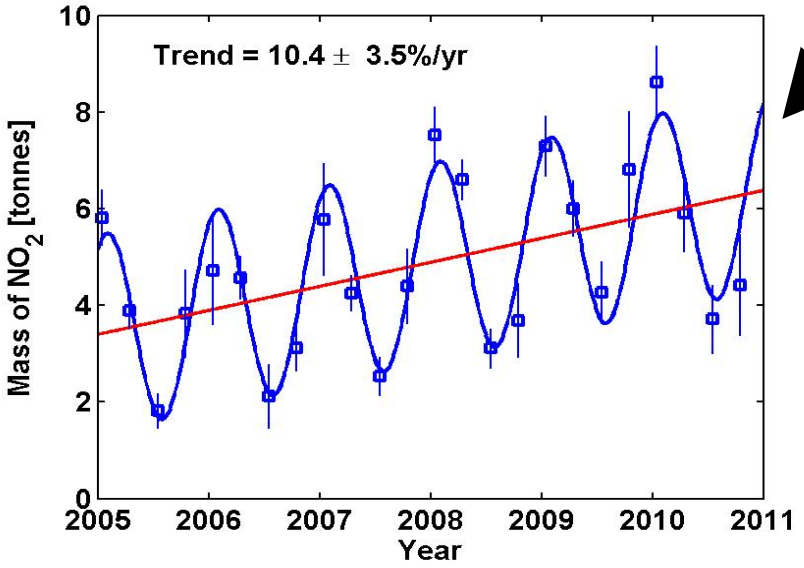
AQAST PI: B. Duncan

AQAST Highlight : Using satellite observations to monitor growth in emissions from Canadian oil sands

Oil sand recovery In Alberta

OMI NO_2 columns, 2004-2010





Oil sand extraction requires much energy to extract and upgrade the bitumen.

Observations show an increase in NO_2 columns of ~10% per year.

McLinden et al. [GRL 2012]

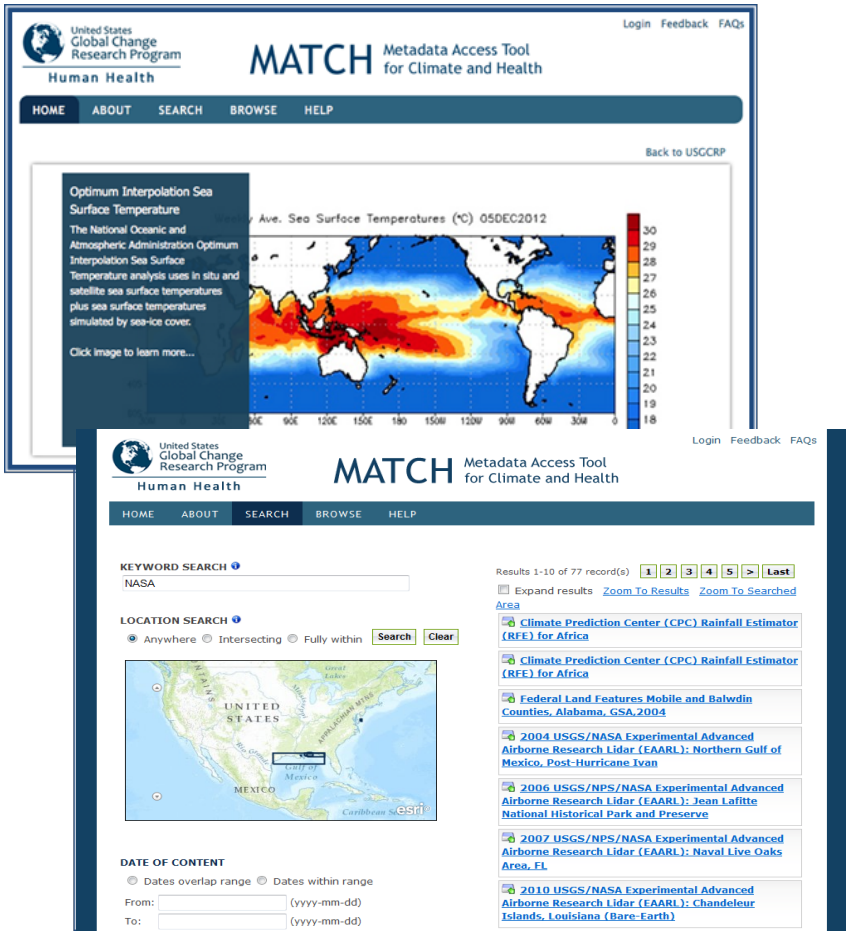
AQAST PI: R.R. Dickerson

Metadata Access Tool for Climate and Health (MATCH)

USGCRP, Climate Change and Human Health Working Group (CCHHG)

MATCH is a searchable clearinghouse that:

- Provides access to metadata for health surveillance, climate, ocean and environmental data sets through a single online geoportal;
- Characterizes and provides links to publicly available Federal data sets, early warning systems, and tools related to health impacts of global climate change;
- Is designed to facilitate and improve the quality of research and data stewardship;
- Includes points of contact and caveats about data;
- Was developed through a collaborative interagency effort of the USGCRP (including the NASA Health and Air Quality Applications Program).
- http://match.globalchange.gov



The MATCH portal launched on May 9, 2013, in conjunction with a new White House Open Data Policy and Executive Order on data management. MATCH was highlighted on the OSTP and CEQ blogs as a model for using Federal open data to address critical societal challenges. Future goals include adding metadata from additional federal agencies, supporting data overlay, and providing data integration capabilities.

Office of Science and Technology Policy

Council on Environmental Quality

Open Data for Climate and Health Insights

Posted by Tom Armstrong on May 9, 2013 at 1:28 PM EDT

Today, in conjunction with a series of landmark steps announced by the Obama Administration to unleash troves of useful data from the vaults of government, the interagency US Global Change Research Program (USGCRP) launched a new online tool that promises to accelerate research relating to climate change and human health—the Metadata Access Tool for Climate and Health, or "MATCH."

The Administration announcements made today include an Executive Order signed by the President declaring that information is a valuable national resource and strategic asset, and a new government-wide Open Data Policy

Recent and Future Observations for Health and AQ – Near Term

- **Landsat Data Continuity Mission (LDCM -- now Landsat-8)** -- 2/11/2013
  - Continues the longest running enterprise for acquisition of satellite imagery of Earth. Land use/land cover observations from this program date to 1972.

- **Global Precipitation Mission (GPM)** – 2014
  - Will provide accurate observations of the intensity and distribution of global precipitation. GPM builds on the heritage of the TRMM mission and is in partnership with JAXA.

Future Observations for Health and AQ – Near Term

- **Orbiting Carbon Observatory (OCO)-2** – 2014
  - NASA's first dedicated Earth remote sensing satellite to study atmospheric carbon dioxide from Space. OCO-2 will be collecting space-based global measurements of atmospheric CO_2 with the precision, resolution, and coverage needed to characterize sources and sinks on regional scales.

- **Soil Moisture Active Passive (SMAP)** – 2014
  - SMAP will use a combined radiometer and high-resolution radar to measure surface soil moisture and freeze-thaw state.

Future Orbital Flight Missions through 2020

Upcoming Conference/Workshops of Interest

- **GPM Applications Workshop**
  - **November 12-13, 2013**
  - **College Park, MD**
  - **http://pmm.nasa.gov/node/851**

- **SMAP Health Applications Workshop**
  - **January 7-8, 2014**
  - **Atlanta, GA (in cooperation with the CDC)**
  - **https://smap.jpl.nasa.gov/science/workshops/**

- **American Meteorological Society Annual Meeting**
  - **February 2-6, 2014**
  - **Atlanta, GA**
  - **5th Conference on Environment and Health**
  - http://annual.ametsoc.org/2014/index.cfm/programs-and-events/conferences-and-symposia/fifth-conference-on-environment-and-health/

For More Information…

New Health and AQ solicitation planned as Element A.44 of NASA ROSES 2013!!

Release date TBD

http:// nspires.nasaprs.com/external/

http://appliedsciences.nasa.gov

http://weather.msfc.nasa.gov/conference/phconference_np_home.html

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