



# **NASA Satellite Observations for Climate Research and Applications for Public Health**

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# 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](http://science.nasa.gov/media/medialibrary/2010/08/30/2010SciencePlan_TAGGED.pdf)



# Earth System Science



Sun- Earth  
Connection

Climate Variability  
and Change

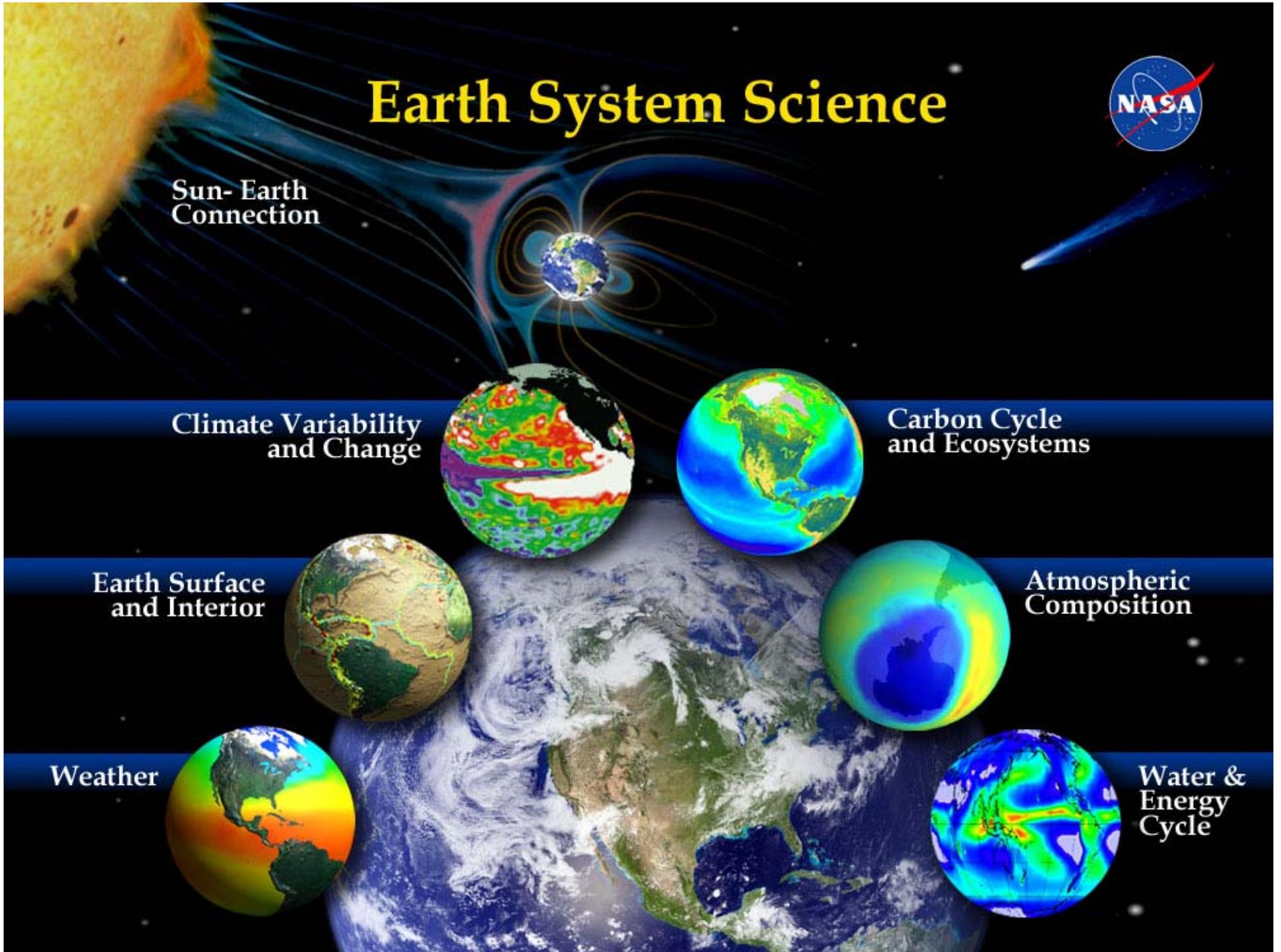
Carbon Cycle  
and Ecosystems

Earth Surface  
and Interior

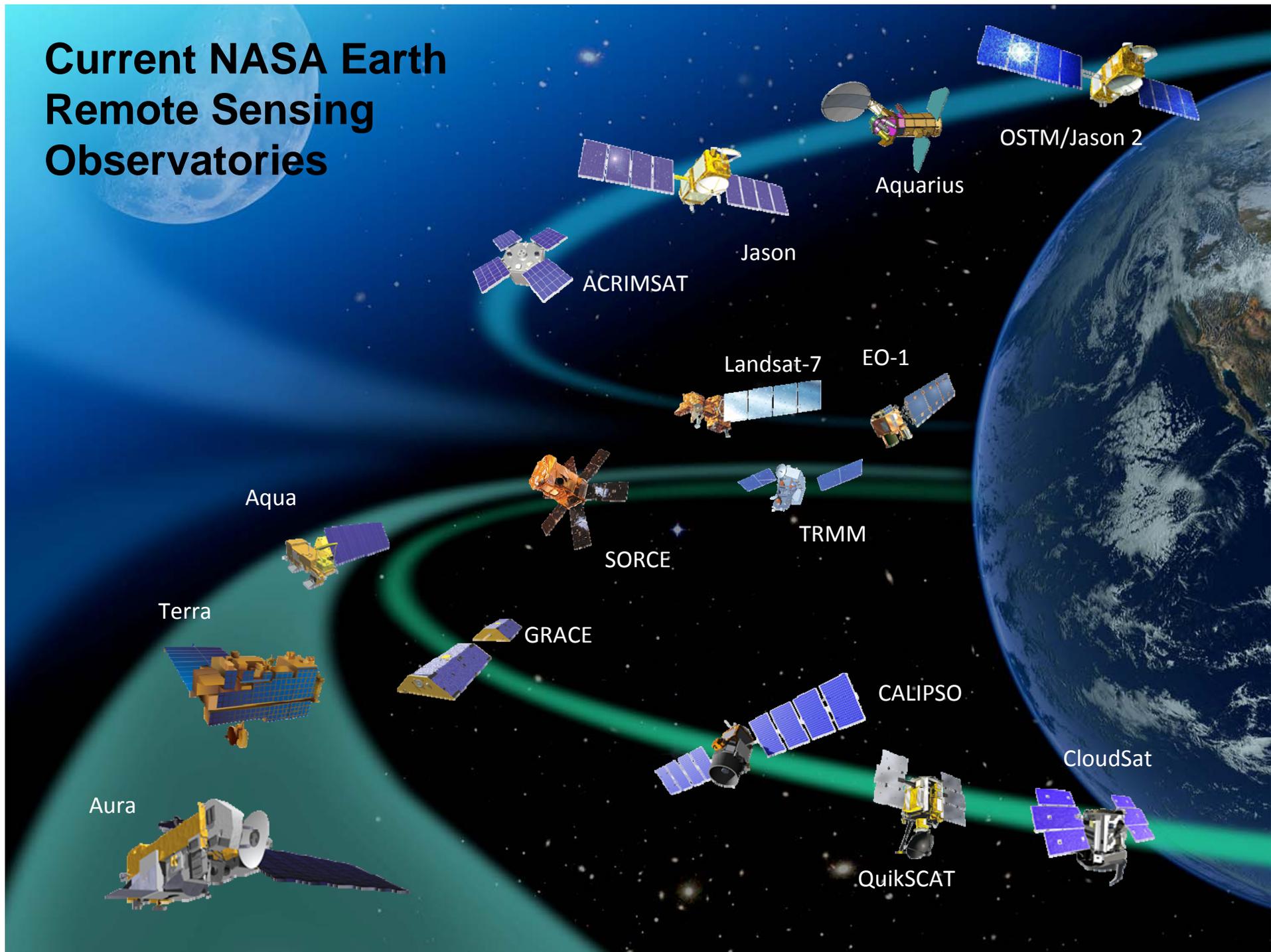
Atmospheric  
Composition

Weather

Water &  
Energy  
Cycle

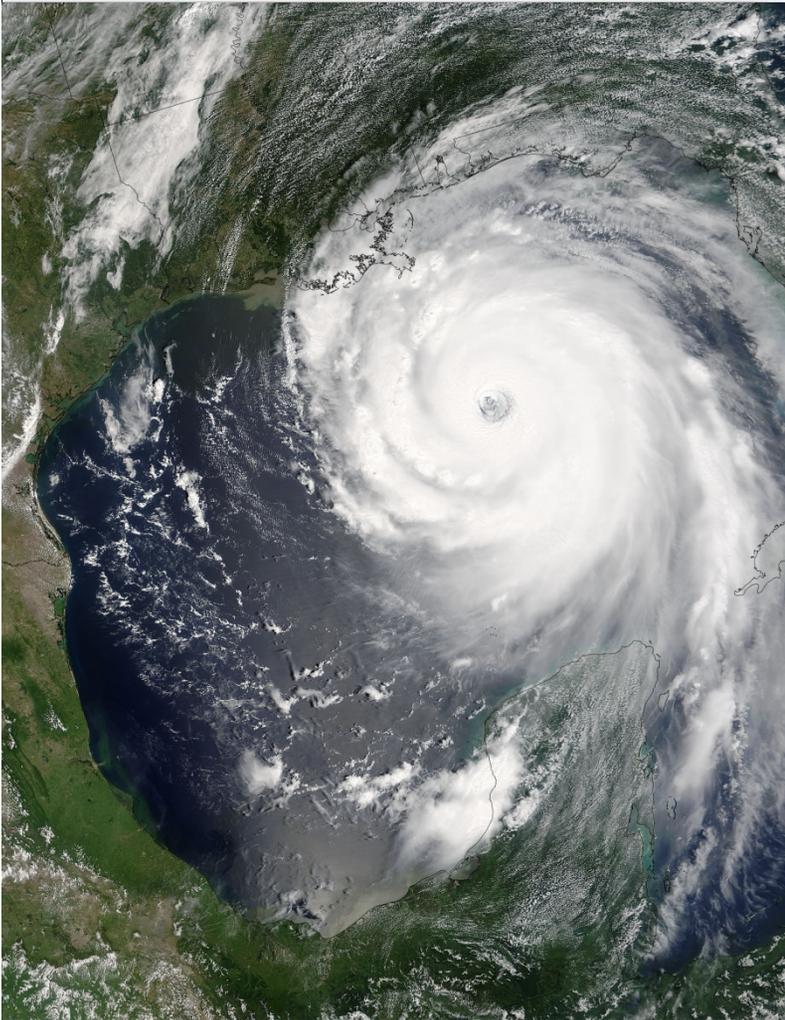


# Current NASA Earth Remote Sensing Observatories



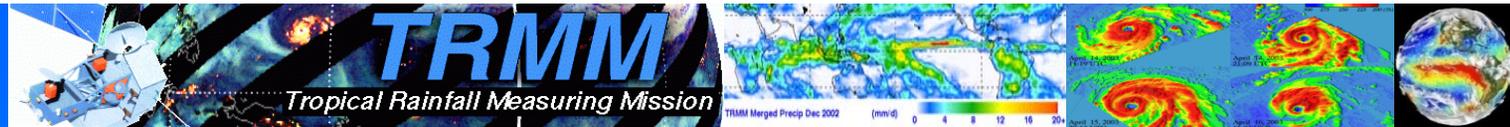
# Hurricane Katrina from NASA MODIS on August 28, 2005 @ 1700 UTC

(902 hPa was recorded at 1800 UTC)

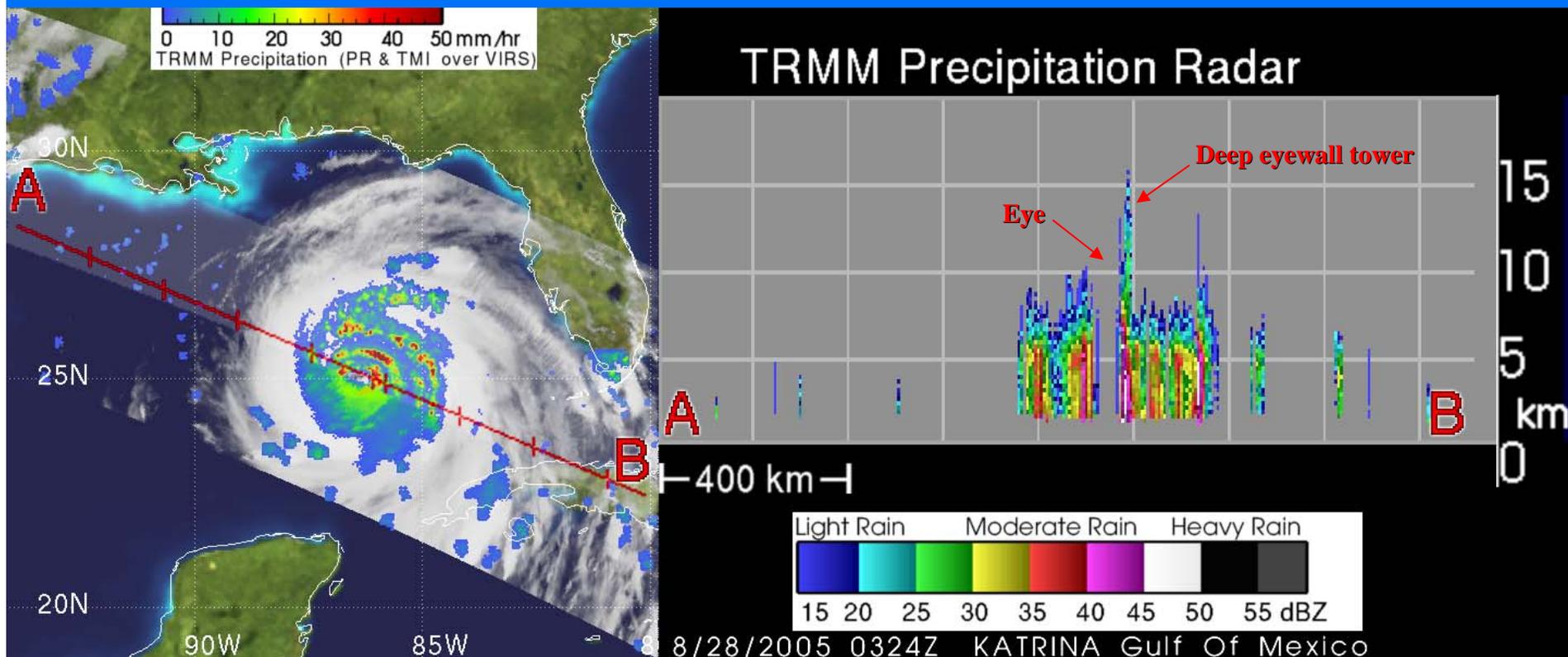


1km Resolution

Close-up of Eye at 250m Resolution



## TRMM 3D Precipitation Radar View of Hurricane Katrina



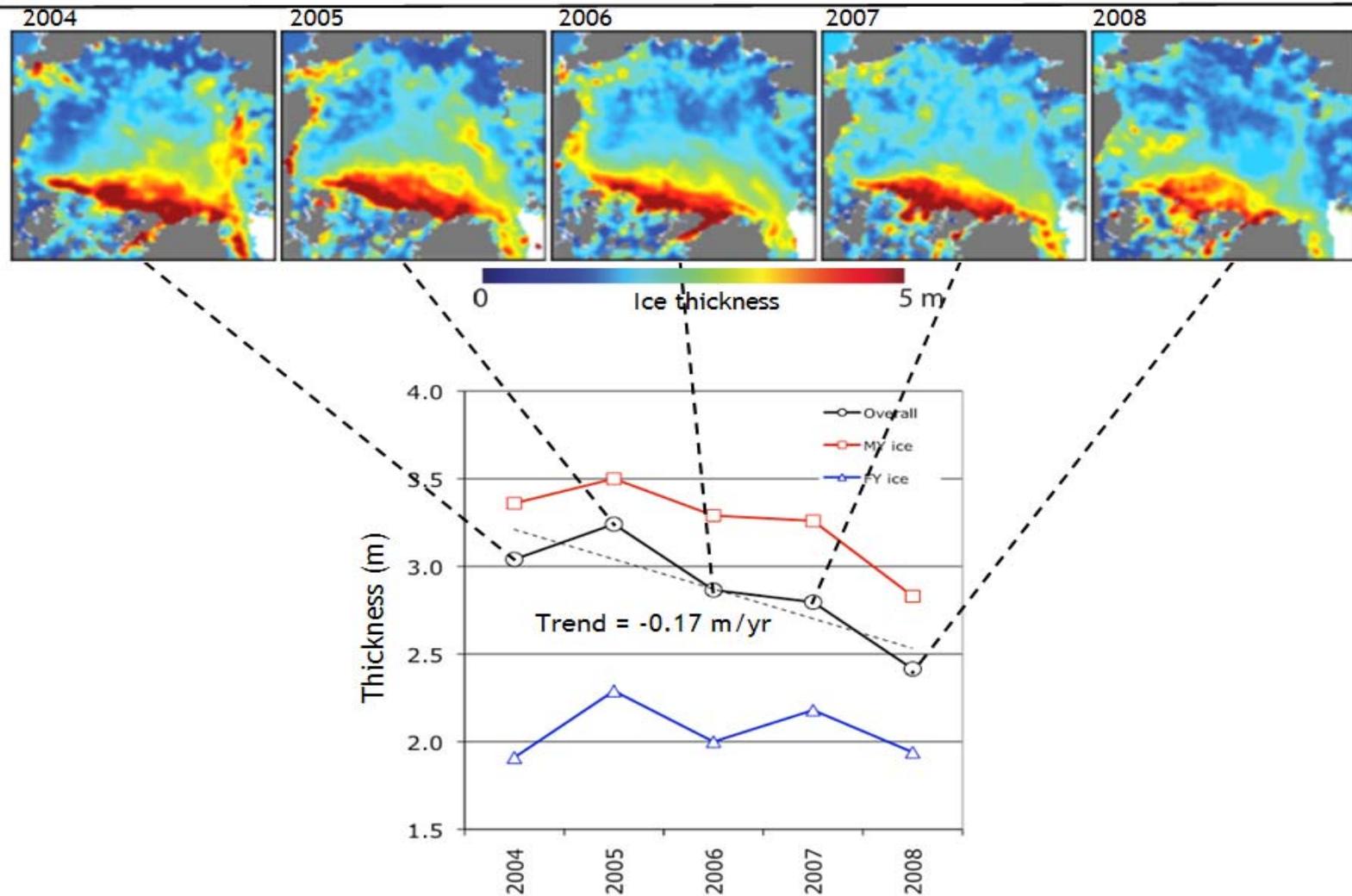
- ◆ Vertical rain structure as revealed by the TRMM Precipitation Radar in near-real time
- ◆ TRMM provides rain structure information over open oceans, the breeding and intensification grounds of most tropical cyclones
- ◆ Energy-releasing deep convective clouds (to 16 km) in the eyewall of Katrina on August 28 occurred while the storm was intensifying to Cat 5; TRMM data have established this association in many storms



TRMM E/PO Team  
Halverson, Pierce, Lang



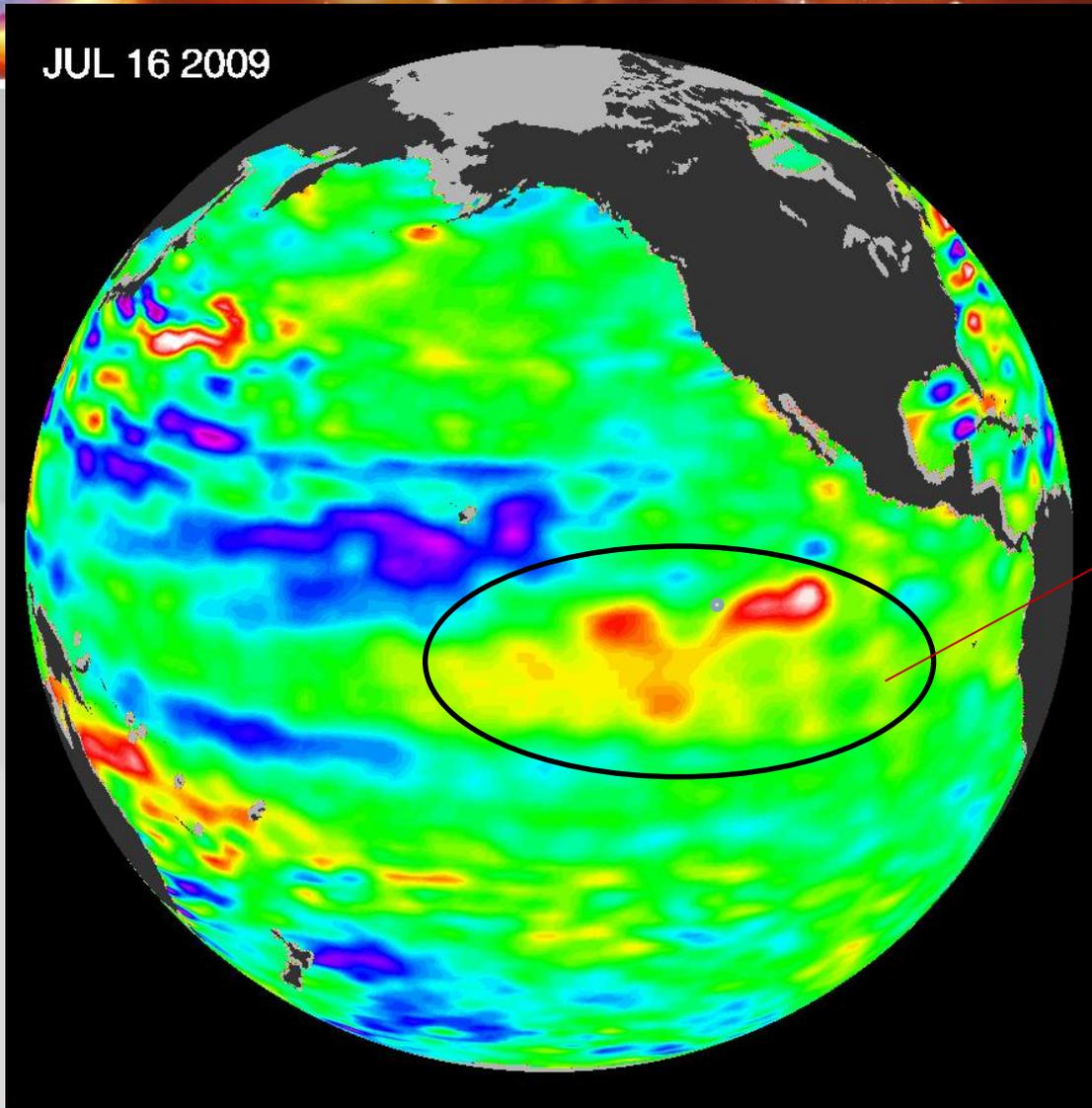
## Trend in winter sea ice thickness



ICESat measurements of the distribution of winter sea ice thickness over the Arctic Ocean in 2004-08, along with the corresponding trends in overall, multi-year and first-year winter ice thickness.

# Sea Surface Height from OSTM/Jason-2

JUL 16 2009

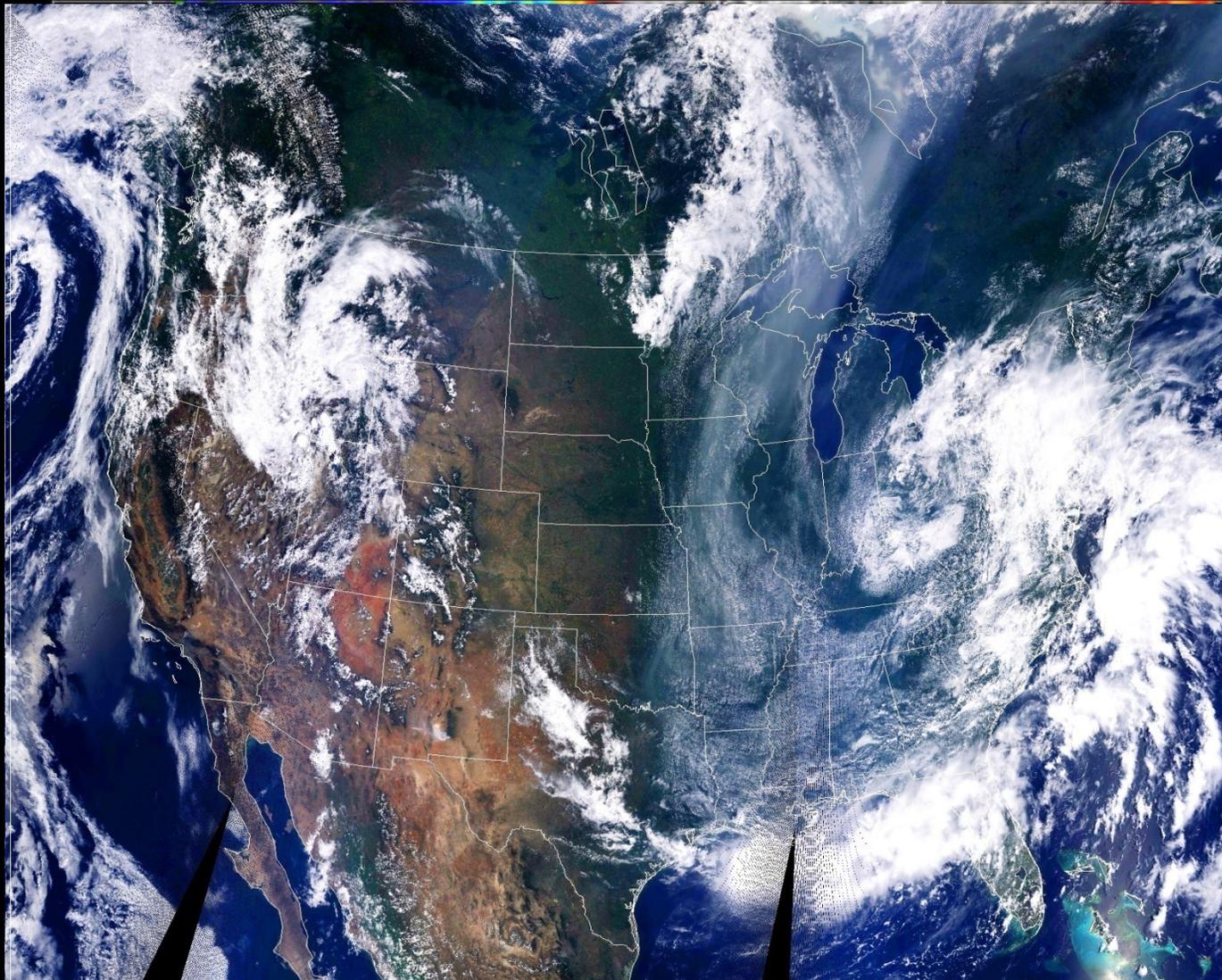


El Niño development – continued through the winter of 2009-10.

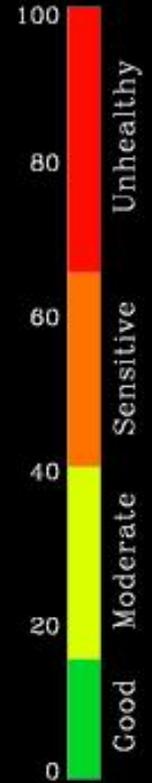


# Smoke from Alaskan/Yukon Fires 18 July 2004

2004 07 18 18Z



PM<sub>2.5</sub>  
( $\mu\text{g}/\text{m}^3$ ) AQI



0.0 0.2 0.4 0.6 0.8 1.0 0 10 20 30 40 50 60 70  
AOD COT



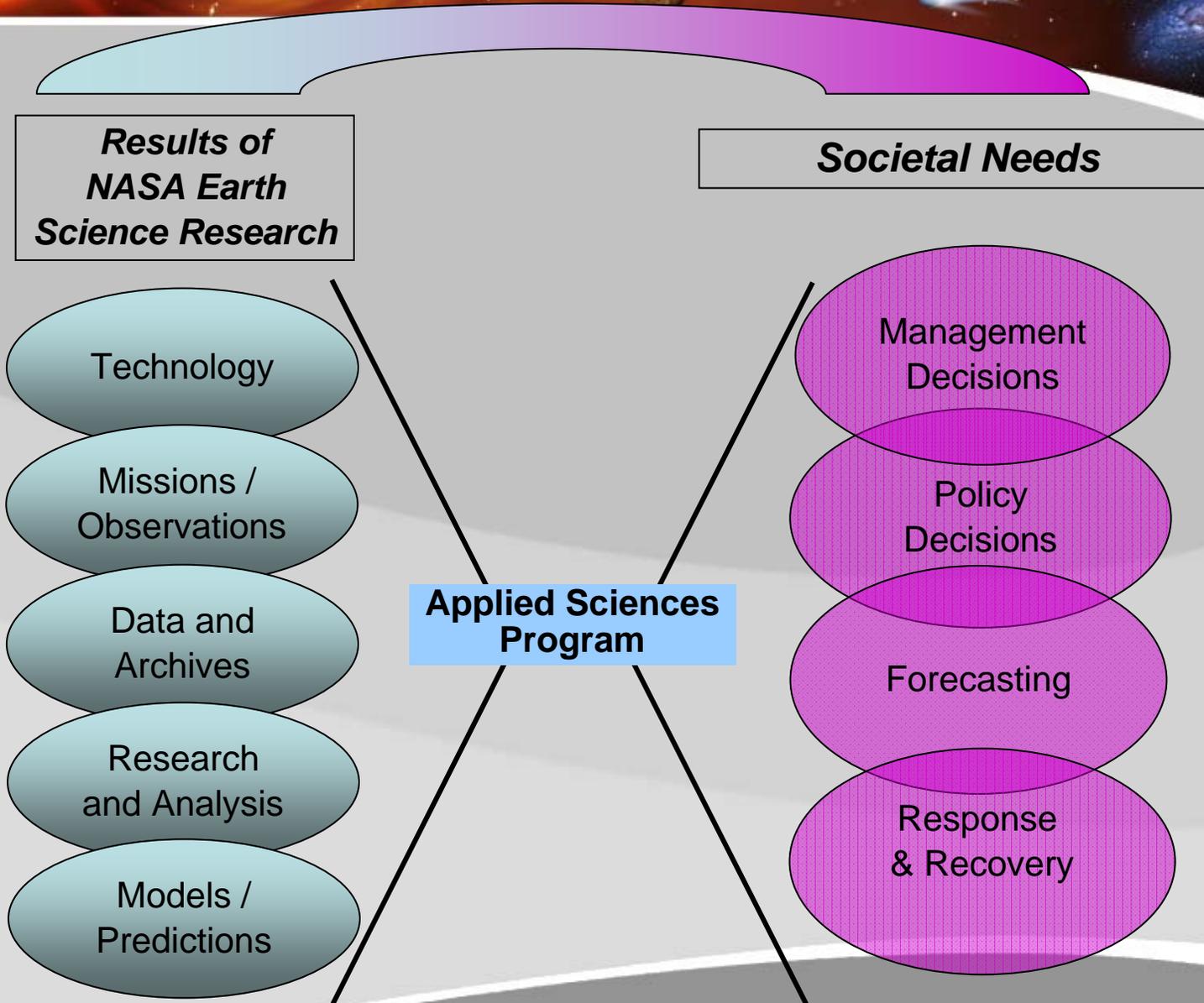


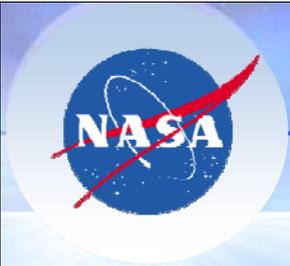
# **NASA Applied Sciences Program Mission Statement**

**Advance the realization of societal and economic benefits from NASA Earth science by identifying societal needs, conducting applied research and development, and collaborating with application developers and users.**



# NASA Applied Sciences Architecture





# Applied Sciences Program

## *Eight Program Elements*



**Agricultural  
Efficiency**



**Air Quality**



**Climate**



**Disaster  
Management**



**Ecological  
Forecasting**



**Public Health**



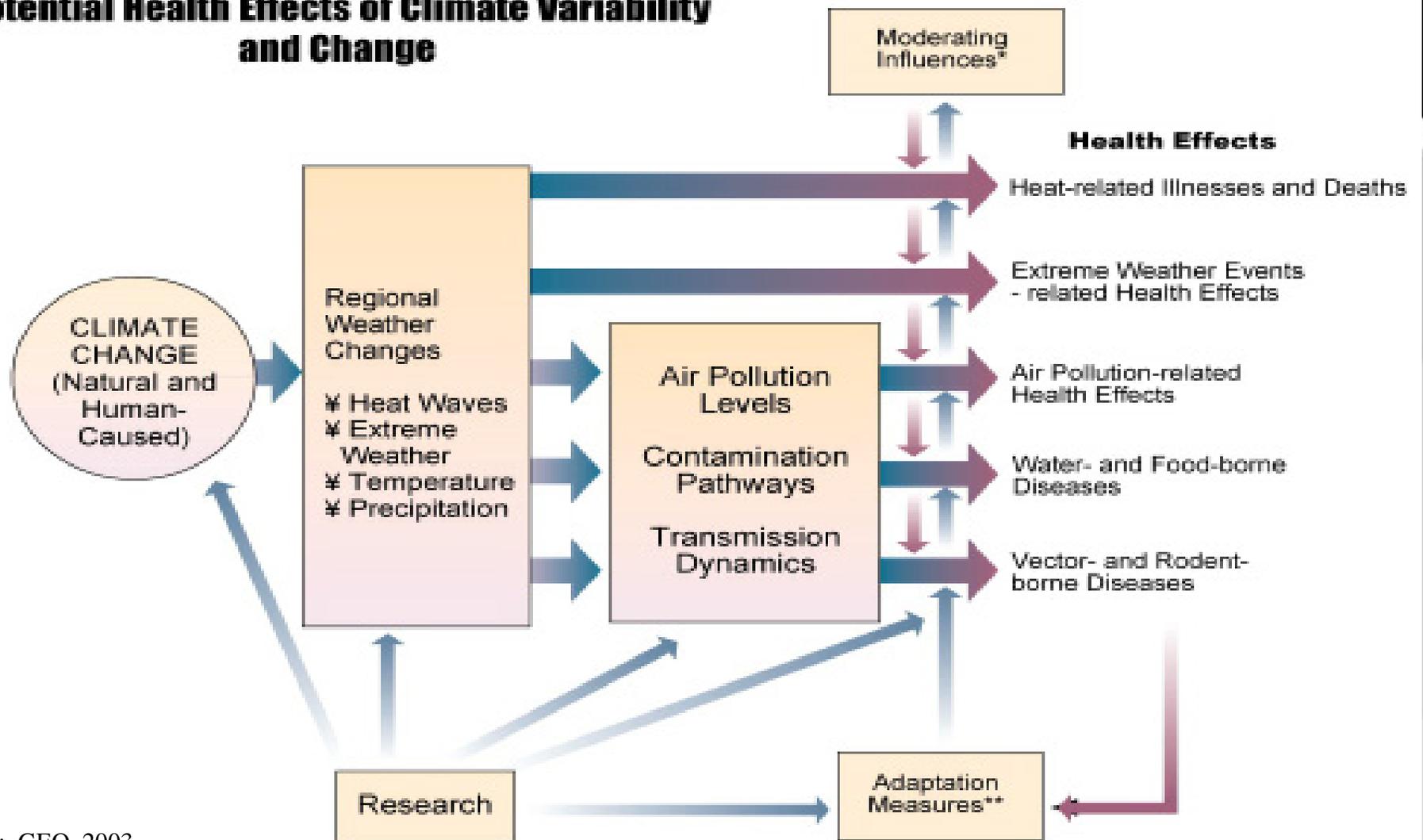
**Water  
Resources**



**Weather**

# Why public health?

## Potential Health Effects of Climate Variability and Change

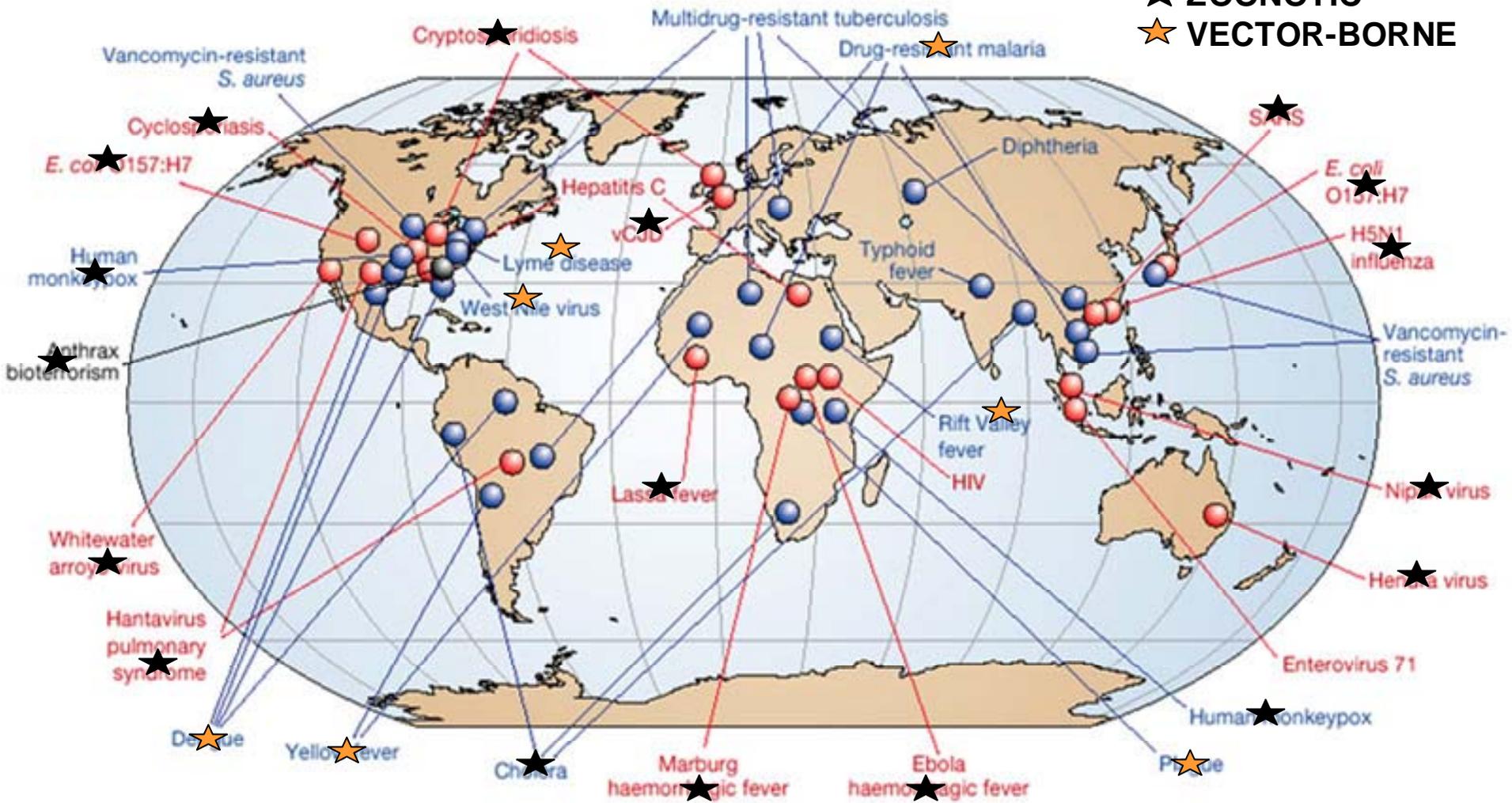


Source: GEO, 2003



# Global Emerging Diseases\*

★ ZONOTIC  
★ VECTOR-BORNE

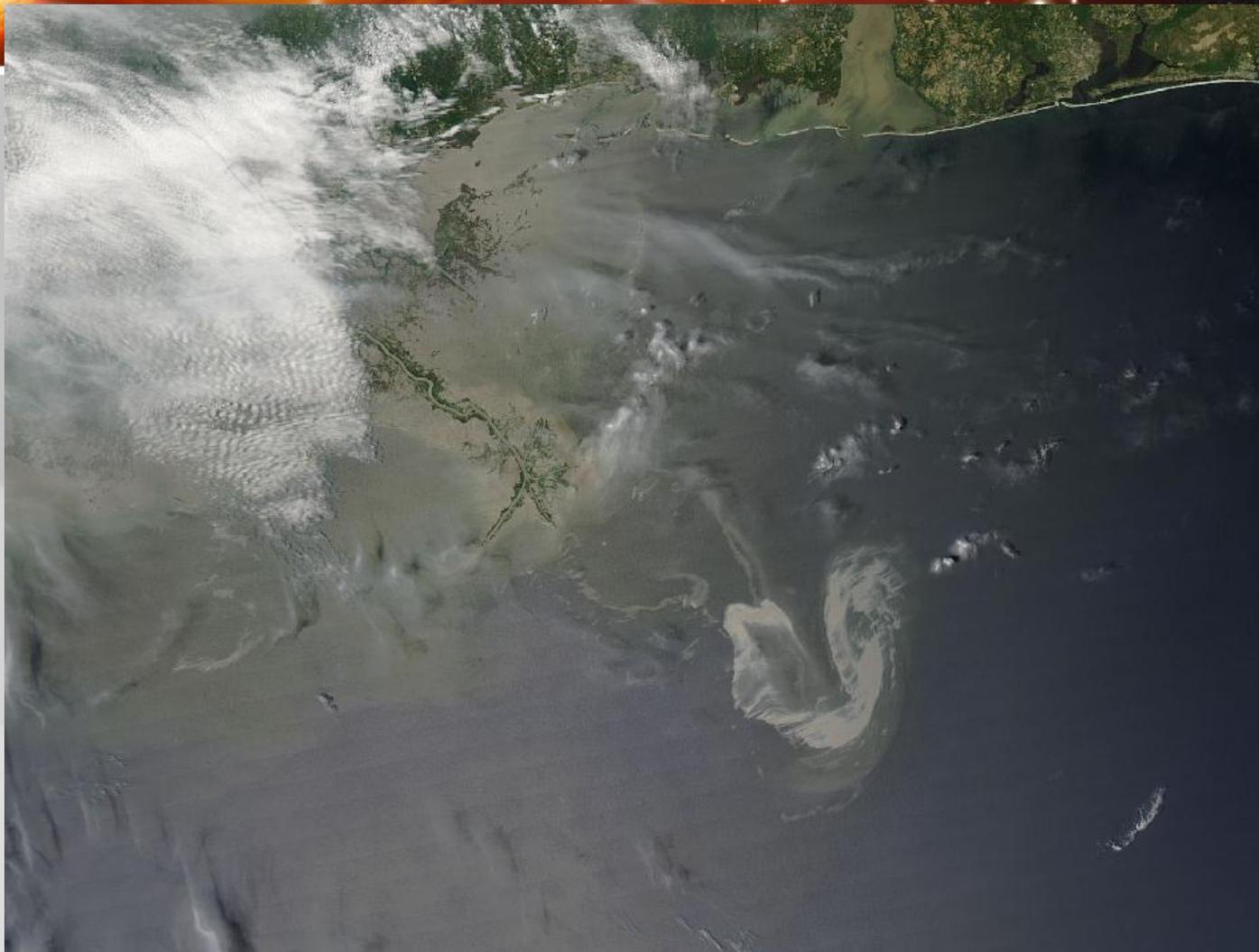


EMERGING  
RE-EMERGING

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

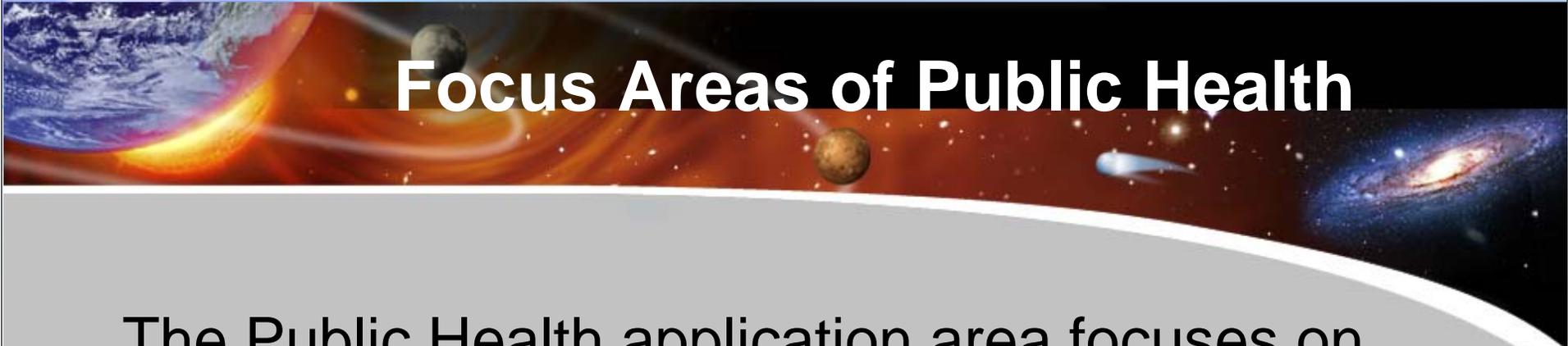


# New Environmental Threats



This visible image of the Gulf oil slick was taken on May 9 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 Public Health

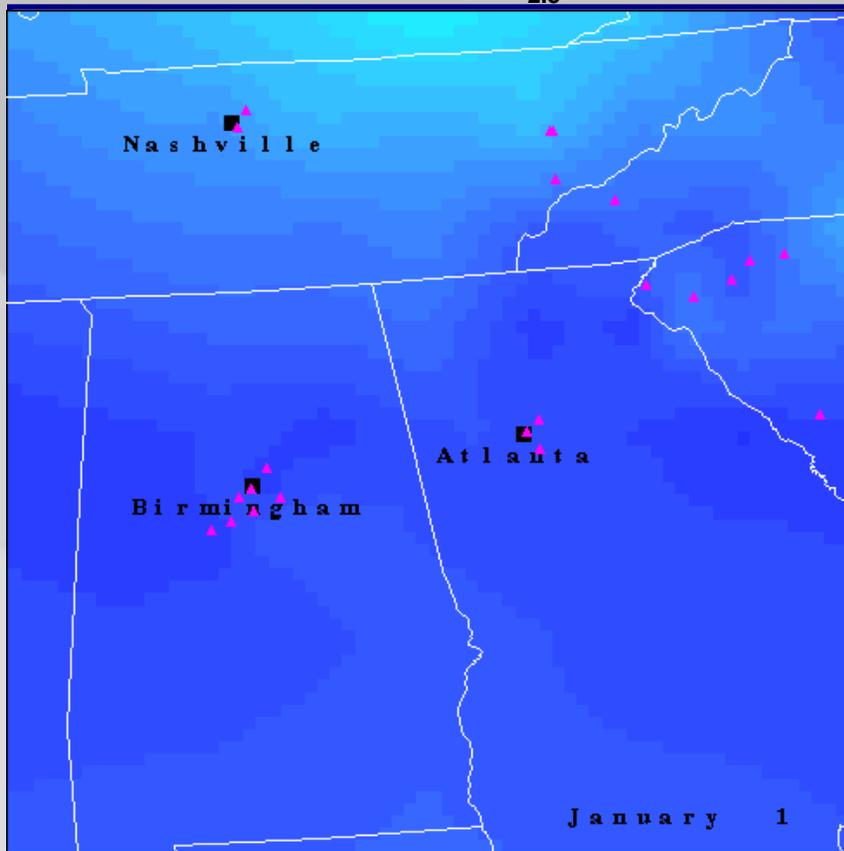
The Public Health application area focuses on Earth science applications to public health and safety, particularly regarding ***infectious disease, emergency preparedness and response, and environmental health*** issues. The application explores issues of toxic and pathogenic exposure, as well as natural and man-made hazards and their effects, for risk characterization/mitigation and improvements to health and safety.



# Collaboration with the CDC and EPA to Enhance the Environmental Public Health Tracking Network

v. Jan 2010

## Particulate Matter (PM<sub>2.5</sub>) in 2003



NASA and the CDC are partners in linking environmental and health observations to enhance public health surveillance through the Environmental Public Health Tracking Network (EPHTN).

The integration of NASA earth science satellite observations, model predictive capabilities, and technology enhances the value of public health decision support.

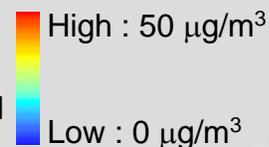
NASA and CDC verified and validated that augmenting the EPA Air Quality System (AQS) observations with NASA MODIS-derived PM 2.5 observations increases the temporal and spatial resolutions of fine particulate estimates and increases the accuracy in estimating concentrations of PM 2.5. These results are being built upon in a new project.

CDC Contact  
Dr. Judith Qualters  
National Environmental Public Health Tracking Program  
Centers for Disease Control & Prevention  
1600 Clifton Rd, NE, MS E19  
Atlanta GA 30333

NASA Program Contact  
John A Haynes, Program Manager  
Public Health Application,  
Applied Sciences Program  
NASA Headquarters  
Washington DC 20546-0001



Data from scattered EPA monitoring sites were used to make daily surfaces of particulate matter (PM) concentrations. High concentrations of PM are associated with adverse health reactions, eg. respiratory and cardiovascular problems.



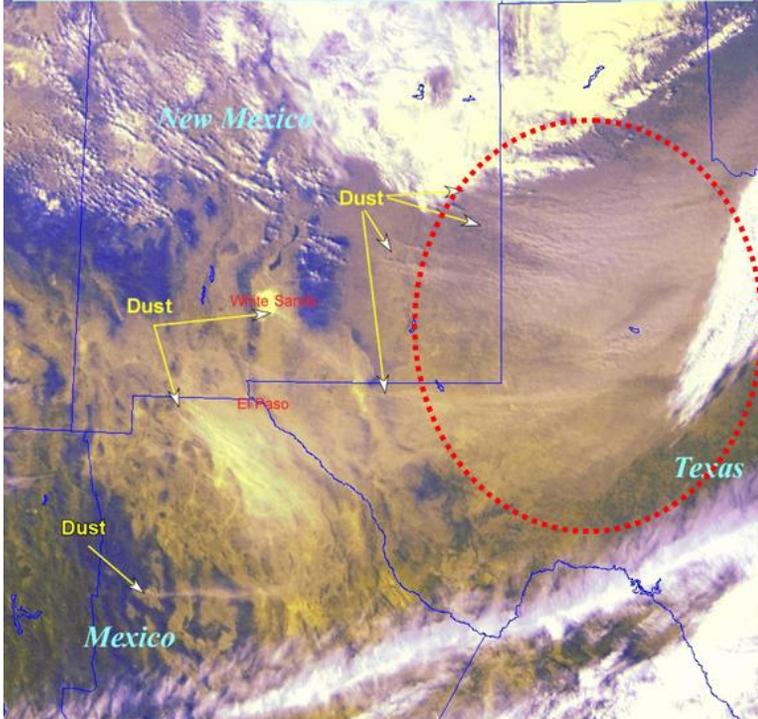
▲ EPA sites



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Dale Quattrochi (dale.quattrochi@nasa.gov)

# Dust Surveillance in the Southwest USA

GOES 12 - Vis/IR Composite 12/15/03 2:26 p.m. CST



<http://phairs.unm.edu>



<http://nmtracking.unm.edu>

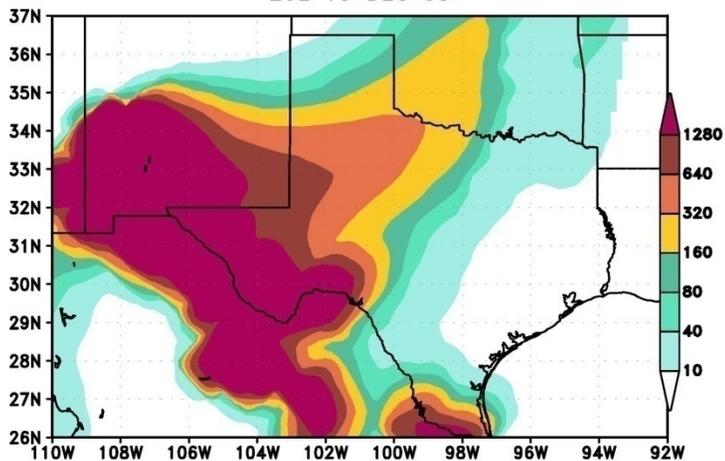
THE UNIVERSITY OF ARIZONA

Upper Left: Dust observed from the NOAA GOES 12 satellite at 20:26 UTC on December 15, 2003. The red dashed line encircles a large dust storm occurring in west Texas.

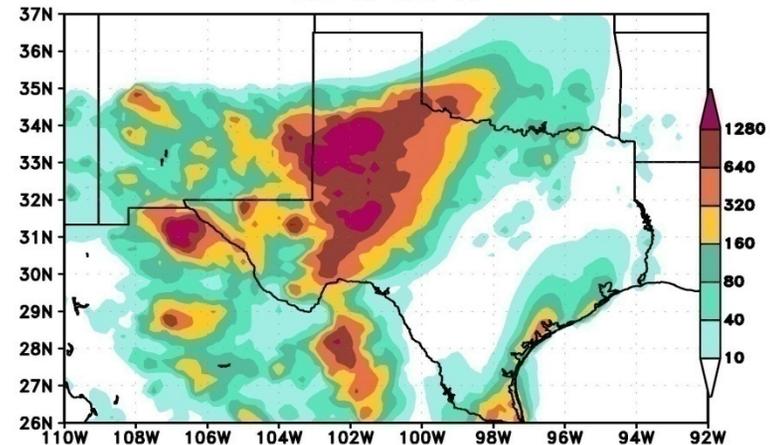
Lower Left: DREAM modeled dust concentration distribution for 20:00 UTC on December 15, 2003, before ingesting NASA MODIS land cover observations.

Lower Right: DREAM modeled dust concentration distribution for 20:00 UTC on December 15, 2003, after ingesting NASA MODIS land cover observations. Note that the DREAM model much more accurately represents the NOAA GOES 12 observed dust storm after ingesting NASA Earth science satellite observations.

Dust Concentration ( $\mu\text{g}/\text{m}^3$ )  
20z 15 DEC 03



Dust Concentration ( $\mu\text{g}/\text{m}^3$ )  
20z 15 DEC 03

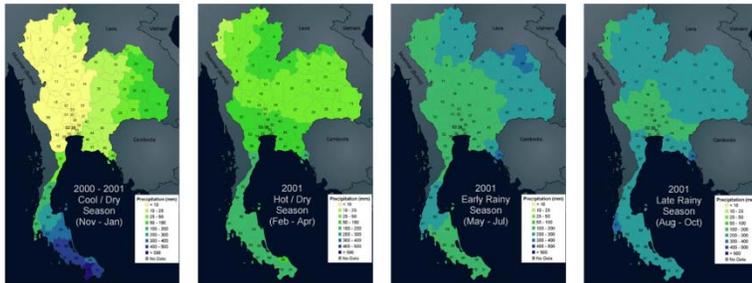


# Collaboration with DOD, USGS, USAID, and Columbia U. on Malaria

**USAID**  
FROM THE AMERICAN PEOPLE



**USGS**  
science for a changing world



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.

**Problem:** Malaria kills up to 3 million people yearly worldwide, many of whom are children. In addition, malaria costs African nations approximately \$12 billion in economic productivity. 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. 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>.

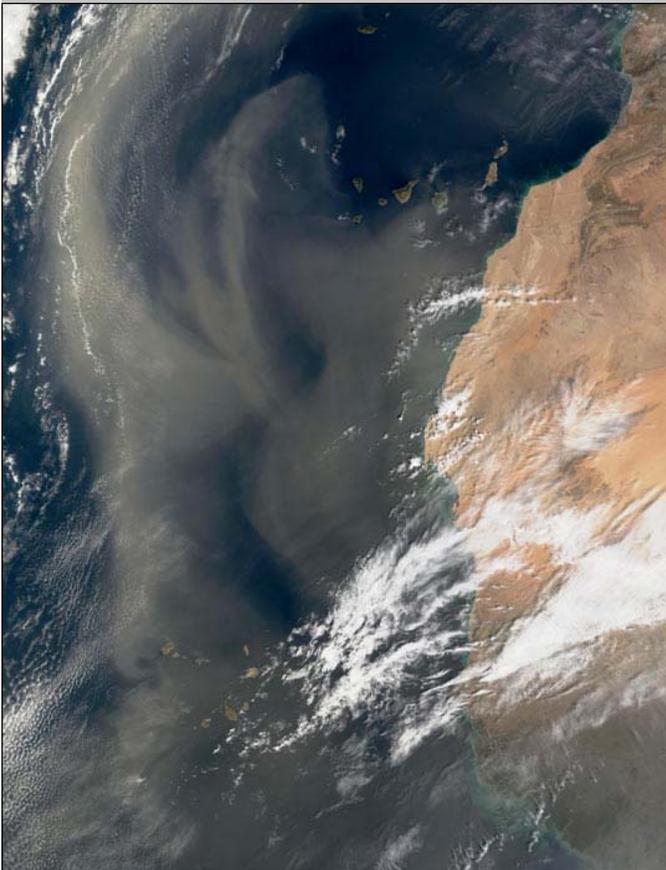
Investigators: R. Kiang, M. Brown, NASA Goddard



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.

# Collaboration with Columbia U. on Meningitis in the African Sahel

A large plume of African dust blows out over the Atlantic Ocean. This true color image of the dust event was acquired on February 11, 2002, by MODIS. Particles contained in dust clouds are suspected to be responsible for nasal irritations facilitating meningitis transmission in Africa.



The project is exploring environmental and demographic risk factors as predictors for meningitis outbreaks in the African Sahel, particularly in Niger.

The approach will take advantage of different sources of environmental information: in-situ data, model outputs and satellite observations (including those from the Multi-angle Imaging Spectroradiometer and TRMM). The latter are an important contribution in areas of sparse data coverage, poor real-time reporting, and limited access to reliable environmental information – such as the Sahel.

# New NASA Public Health Applications Projects Awarded in January 2011

- Nine new Public Health Applications projects were awarded by NASA in January 2011 representing an investment of over \$1.3M over two years.
- International Projects of note:
  - “Development of a Detection and Early Warning System for Malaria Risk in the Amazon”; PI: Benjamin Zatichik of Johns Hopkins University
  - “Improving Decision-Making Activities for Malaria and Meningitis Risk Mapping – Integration of NASA Products/Platforms (SERVIR) and UN WHO-Open Health”; PI: Pietro Ceccato of Columbia University
  - “Integrating Earth Observations and Satellite Telemetry of Wild Birds for Decision Support System of Avian Influenza”; PI: Xiangming Xiao of the Univ. of Oklahoma
  - “Modeling Global Influenza Risks Using NASA Data”; PI: Richard Kiang of NASA Goddard Space Flight Center
  - “Investigating the Potential Range Expansion of the Vector Mosquito *Aedes Aegypti* in Mexico”; PI: Bill Crosson of USRA



# NASA's Public Health Partners

.gov/ph



.gov/rs



.org



.edu



.int



# Future Observations for Health – Near Term

- **NPOESS Preparatory Mission (NPP) -- 2011**
  - NPP will serve as a bridge mission between the NASA Earth-observing research satellites Terra, Aura, and Aqua and the operational Joint Polar Satellite System (JPSS) constellation.
- **Landsat Data Continuity Mission (LDCM) -- 2012**
- **Global Precipitation Mission (GPM) – 2013**
  - 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.



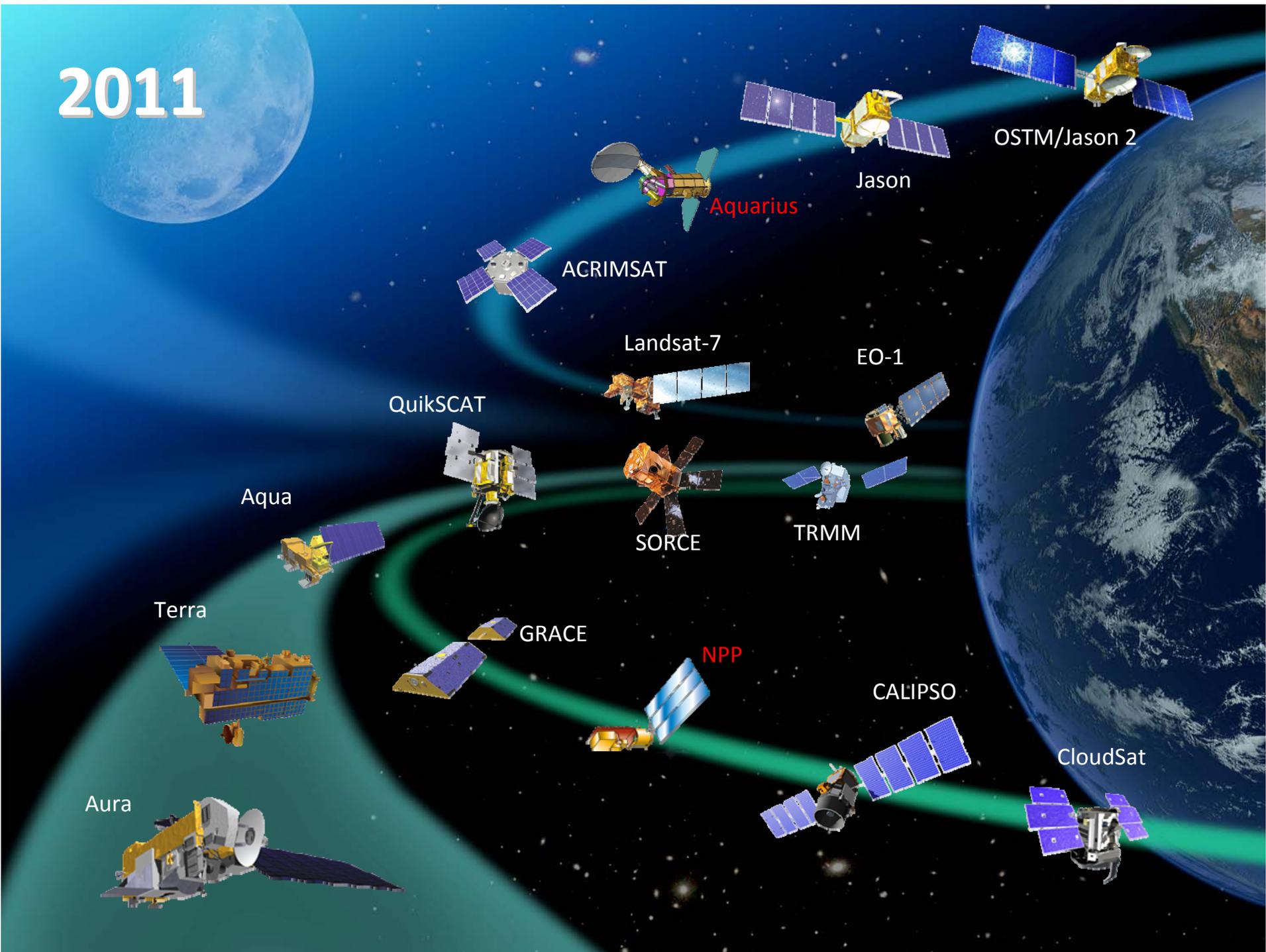


# Future Observations for Health – Decadal Survey

- **Hyperspectral Infrared Imager (HyspIRI) – ~2020**
  - HyspIRI will employ a hyperspectral imager and a thermal infrared scanner to monitor a variety of ecological and geological features at a wide range of wavelengths, including data on changes in vegetation type and deforestation for ecosystem management .
- **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.



2011



Aquarius

Jason

OSTM/Jason 2

ACRIMSAT

Landsat-7

EO-1

QuikSCAT

Aqua

SORCE

TRMM

Terra

GRACE

NPP

CALIPSO

Aura

CloudSat

2012



Aqua

Terra

Aura

LDCM

GRACE

NPP

CALIPSO

CloudSat

SORCE

TRMM

Landsat-7

QuikSCAT

EO-1

ACRIMSAT

Aquarius

Jason

OSTM/Jason 2

2013



OCO-2

Aquarius

OSTM/Jason 2

GPM

Landsat-7

ACRIMSAT

EO-1

QuikSCAT

Jason

Aqua

SORCE

TRMM

Terra

NPP

LDCM

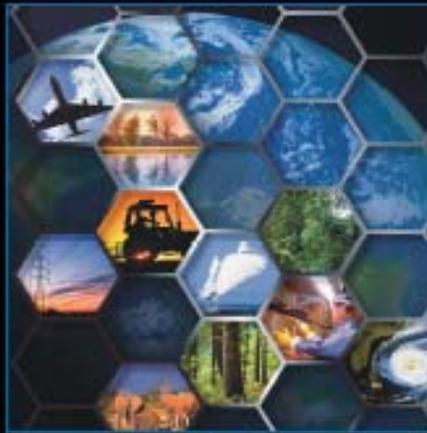
GRACE

CALIPSO

Aura

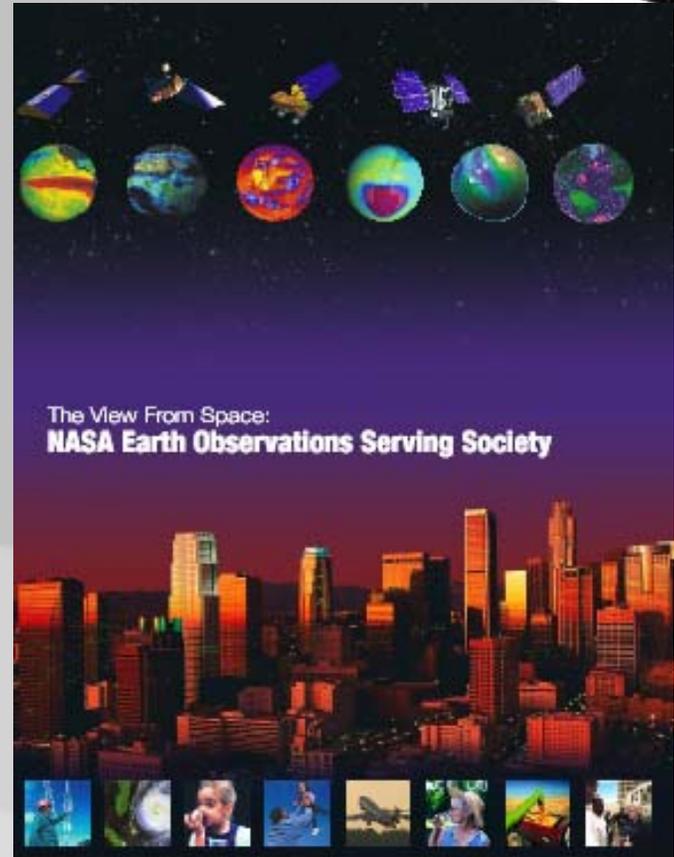
CloudSat

# Applied Sciences Program



National Aeronautics and  
Space Administration

Earth Science Enterprise  
Applications Plan



The View From Space:  
**NASA Earth Observations Serving Society**

<http://appliedsciences.nasa.gov>

[http://weather.msfc.nasa.gov/conference/phconference\\_home\\_sa.html](http://weather.msfc.nasa.gov/conference/phconference_home_sa.html)



