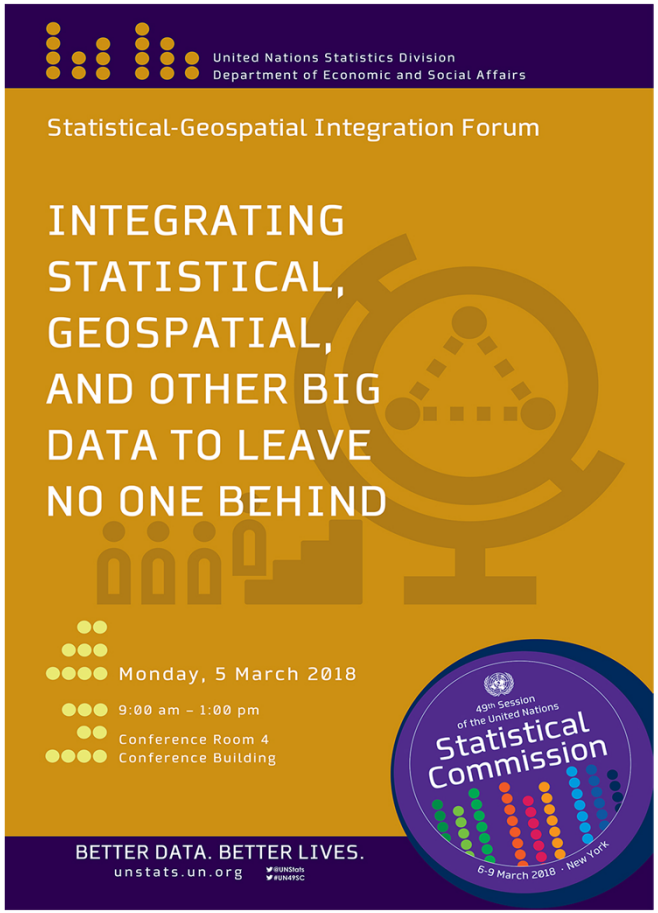


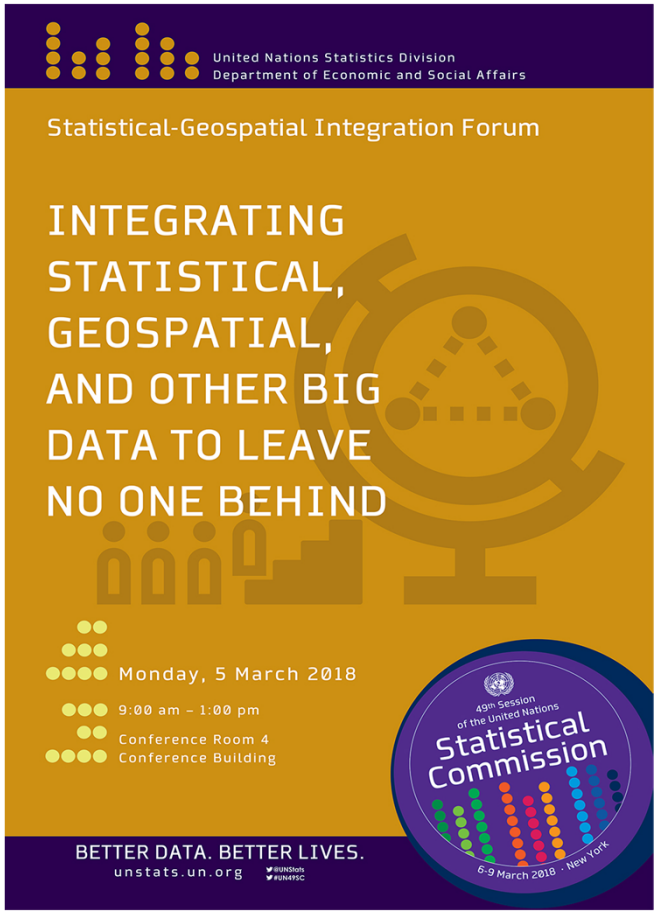
STATISTICAL-GEOSPATIAL INTEGRATION FORUM
United Nations • 5 March 2018

Panel I:
Addressing Inequalities and Safeguarding Public Health

Earth Observations: Applications for Health

Lawrence Friedl
Argie Kavvada
Applied Sciences Program
NASA Earth Science



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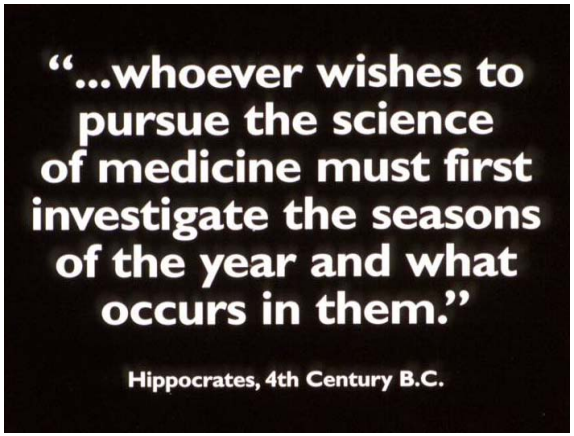
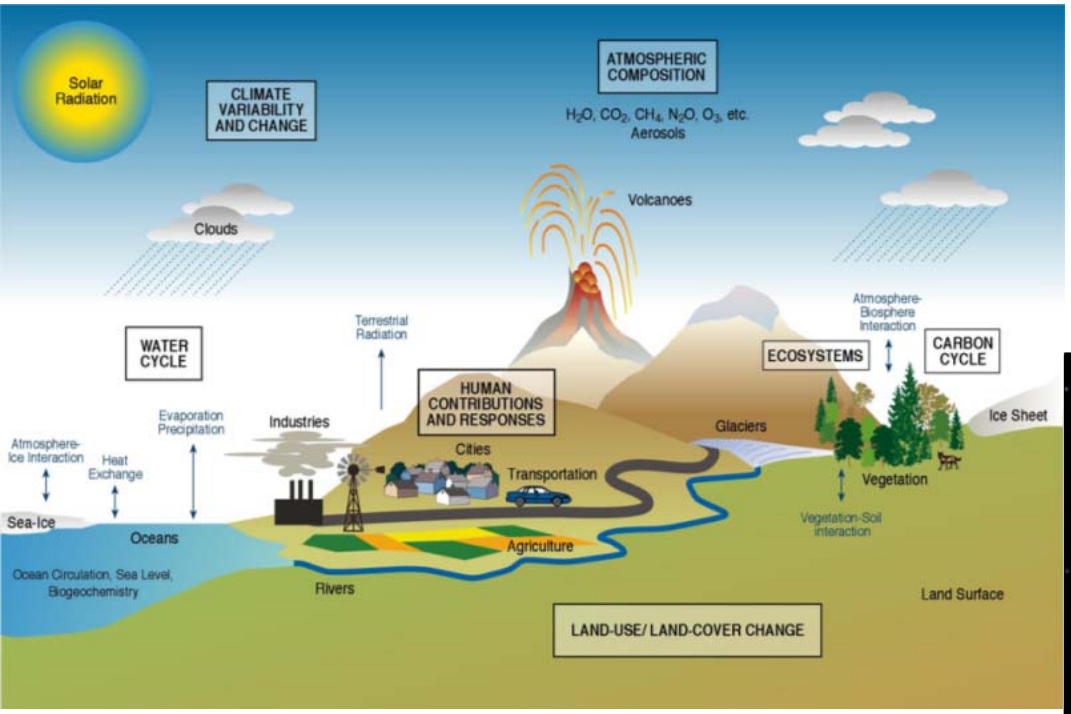
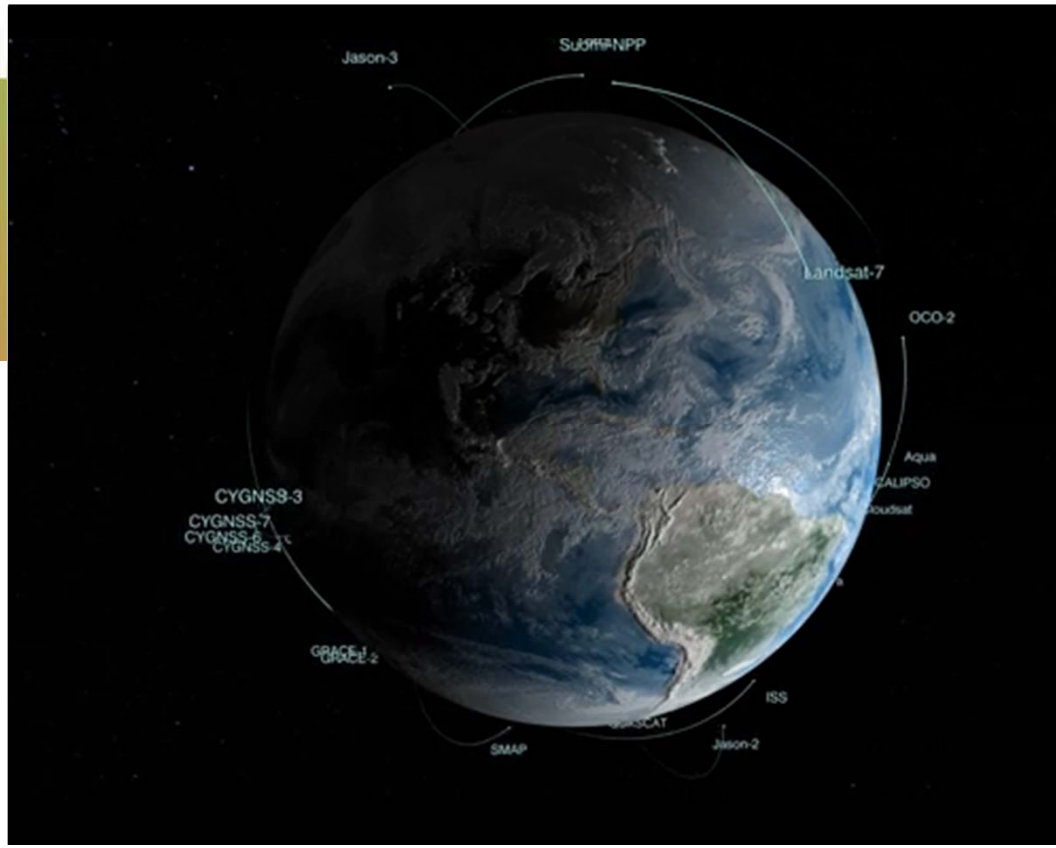




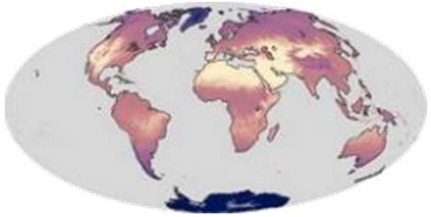
NASA Earth Science



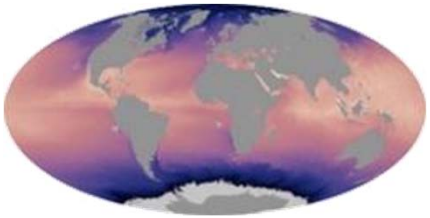
NASA Earth Science supports basic and applied research on the Earth system and its processes.

NASA seeks to help everyone characterize, understand, and improve predictions of the Earth system to advance knowledge and benefit society.

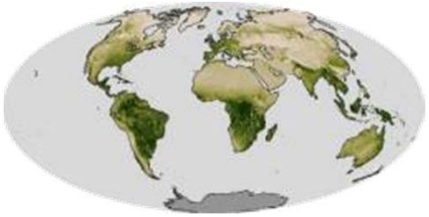
Some Types of Earth Observations at Global to Local Scales . . .



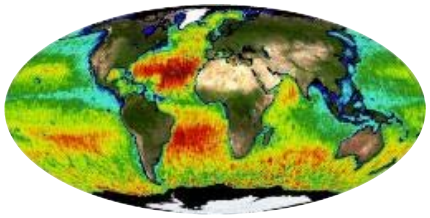
Land Temperature



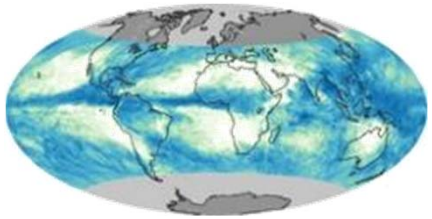
Sea Surface Temperature



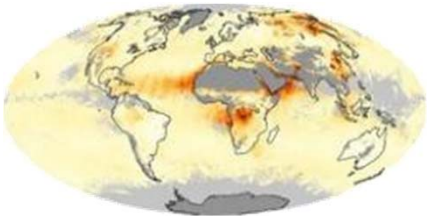
Vegetation



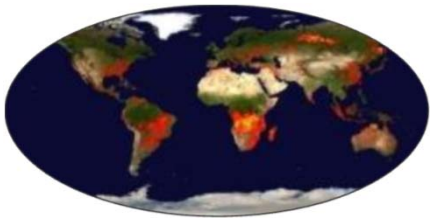
Sea Surface Salinity



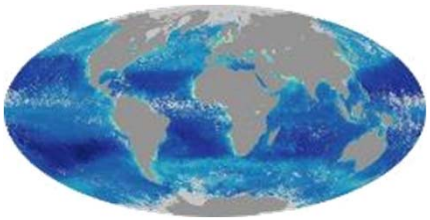
Total Rainfall



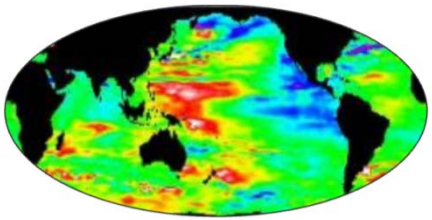
Aerosols



Fires & Thermal Anomalies



Chlorophyll

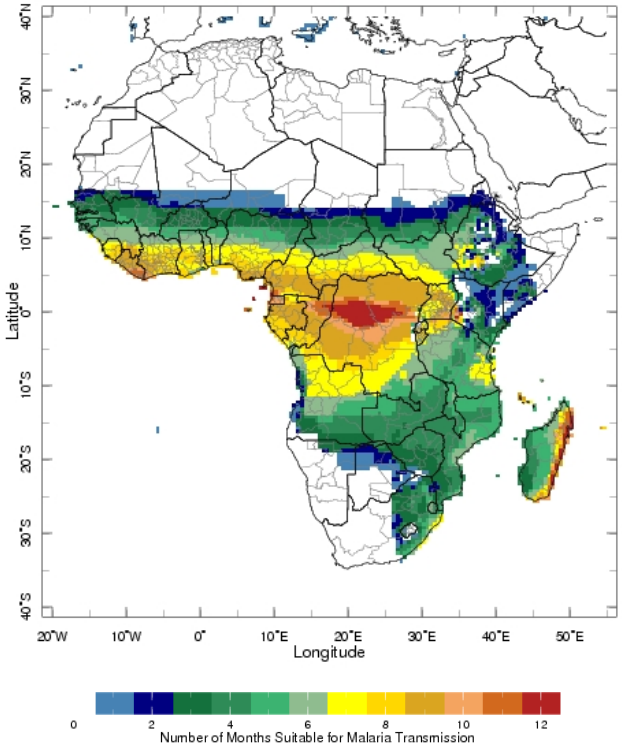


Sea Surface Height

Malaria

IRI Map Rooms

Climate Suitability ≡ Coincidence of 18-32°C + 80mm + RH>60%



Note: Masked to exclude malaria-absent or endemic areas.

<<< Suitability

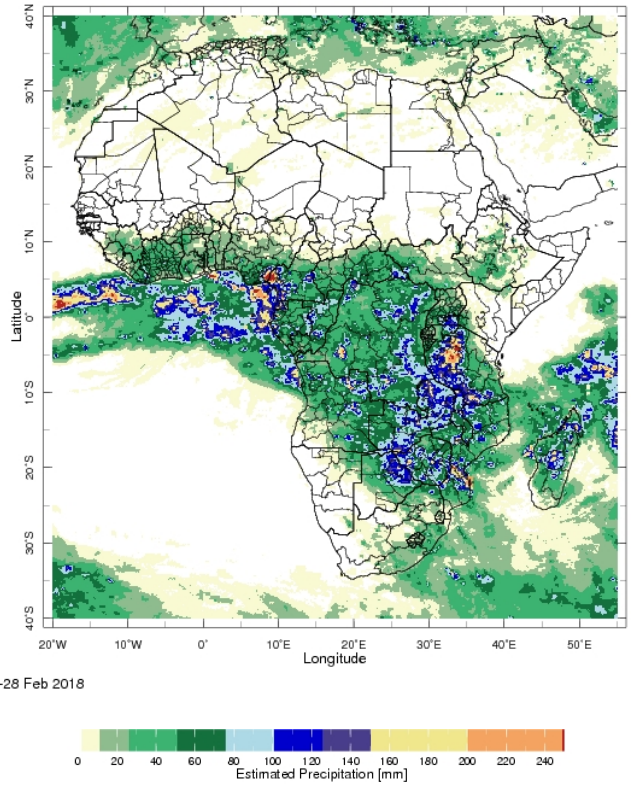
Number of months suitable for malaria transmission, based on monthly climatological averages: Conditions suitable for both the development of the parasite and the life cycle of the mosquito vector.

Malaria Early Warning >>>

Precipitation is factor related to sufficient surface water and moisture for mosquito breeding sites: Precipitation on short time scales aids in determining location and timing of potential outbreaks.

Dekadal (10-day) Precipitation

21-28 February 2018



Climate & Health Map Room available at: ***http://iridl.ldeo.columbia.edu/maproom/***

Earth Observations
and
Health

Malaria

Cholera

Zika

Ebola

West Nile

Dengue

Air Quality

Rift Valley Fever

Plague

Meningitis

Norovirus

Cyanobacteria

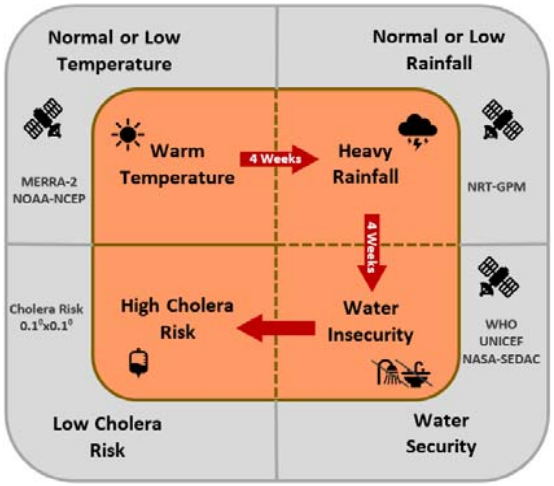
Onchcerciasis

Others

Cholera

NASA
Earth Science

Application of Earth observations for connecting large-scale hydro-climatological processes with cholera occurrence in epidemic regions.



Warm temperature= above climatological average temperature
Heavy rainfall= above climatological average precipitation
Water insecurity=lack of access to water and sanitation access
High cholera risk=probability of cholera greater than 50%

Simplified representation of the epidemic cholera algorithm that used GPM, MERRA-2, NOAA-NCEP and SEDAC data.

Types of Earth Observations used (depending on location)

Landsat: Land Use

MODIS/VIIRS: Surface Temperature, Ocean Color

TRMM/GPM: Precipitation

MERRA: Air Temperature

GRACE: Water Storage

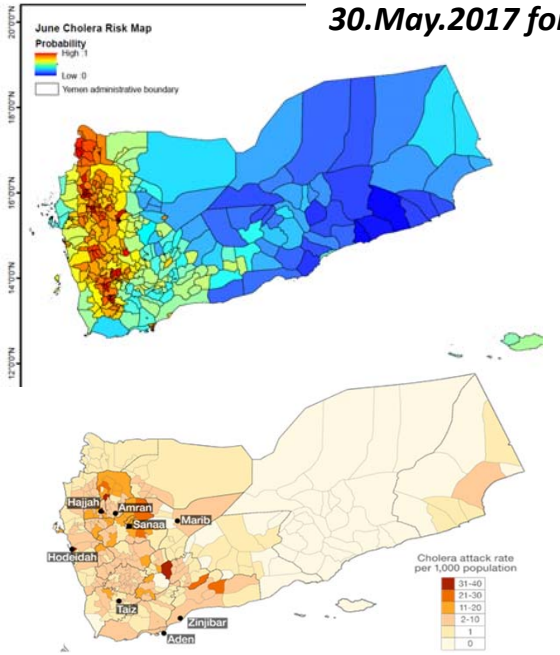
GPM: Precipitation

JASON: Sea Surface Height

AVHRR: Sea surface temperature

SRTM: Elevation

Risk estimated on 30.May.2017 for June 2017



Reported cholera cases for June 2017 (Source: WHO)

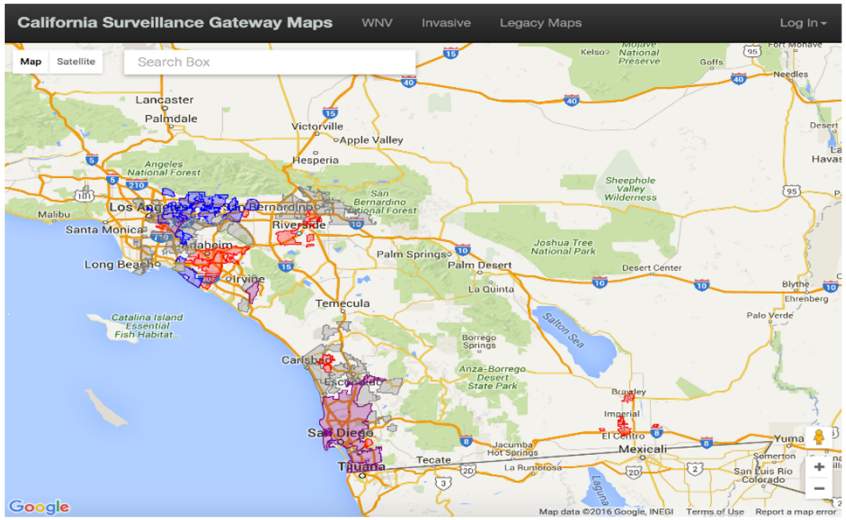
West Virginia University. UNIVERSITY OF MARYLAND

Zika

CalSurv California Vectorborne Disease Surveillance Gateway

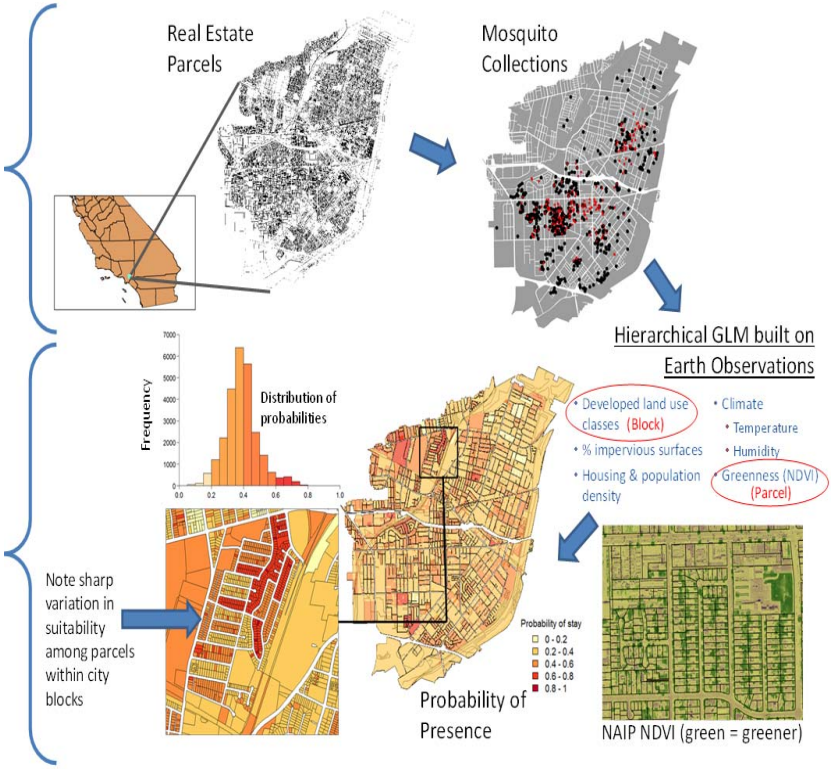
California Vectorborne Disease Surveillance Gateway
Modified its tool for West Nile virus to address Zika

Decision-support tools to control the invasive *Aedes aegypti* and *Aedes albopictus* mosquitoes, and map the risk of transmitting the dengue, chikungunya, and Zika viruses.

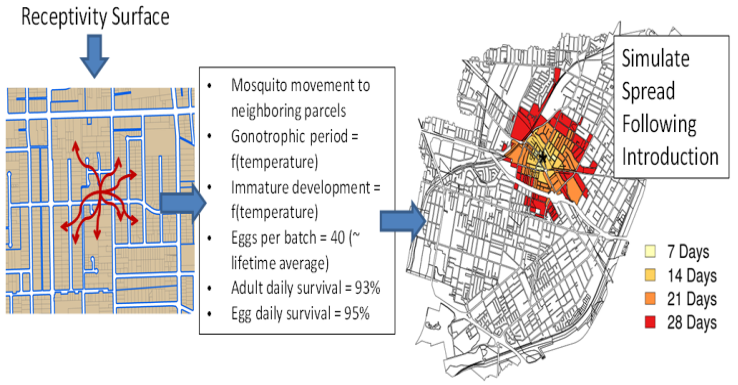


NASA

Suitability estimates



Spread simulation



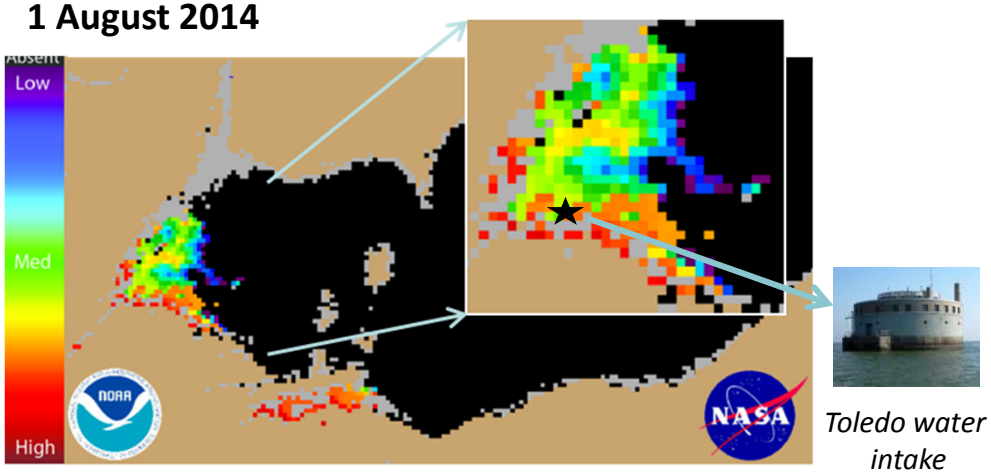
Cyanobacteria

NASA
Earth Science

August 2014: City of Toledo, Ohio, USA, issued a "do-not-drink" message for 400,000 people.

NASA satellite observations combined with wind forecasts and observations helped detect the intensification of the bloom and enable Toledo to prepare for a potential hazard.

1 August 2014



Toledo water intake

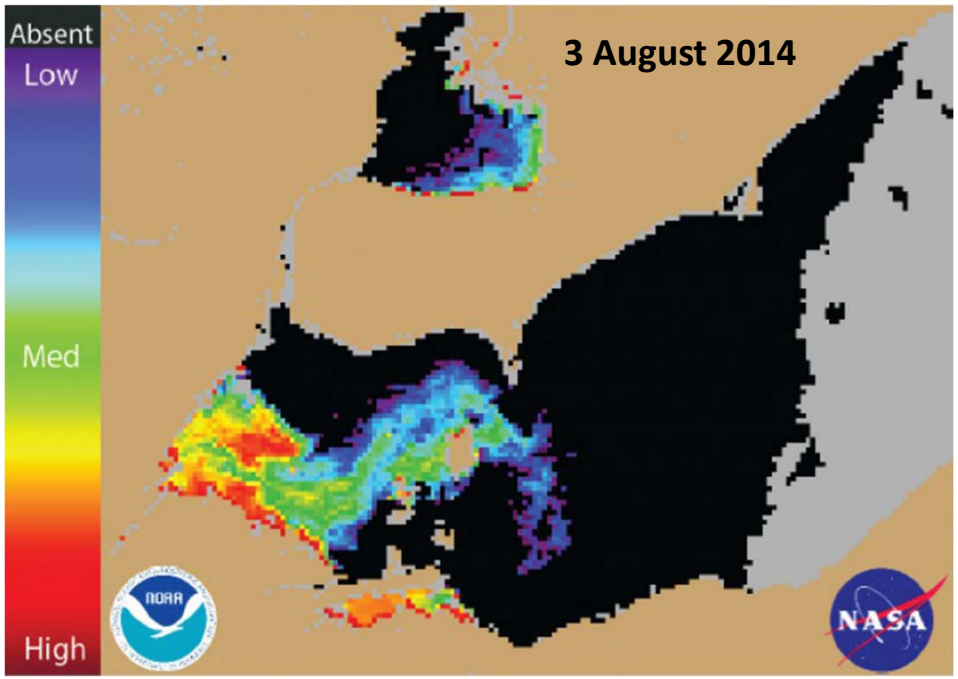
02 August 2014

Urgent water notice!

URGENT NOTICE TO RESIDENTS OF TOLEDO & LUCAS COUNTY
WHO RECEIVE WATER FROM THE CITY OF TOLEDO

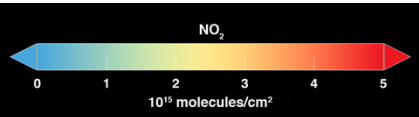
DO NOT DRINK THE WATER
DO NOT BOIL THE WATER

Concentration of Cyanobacteria



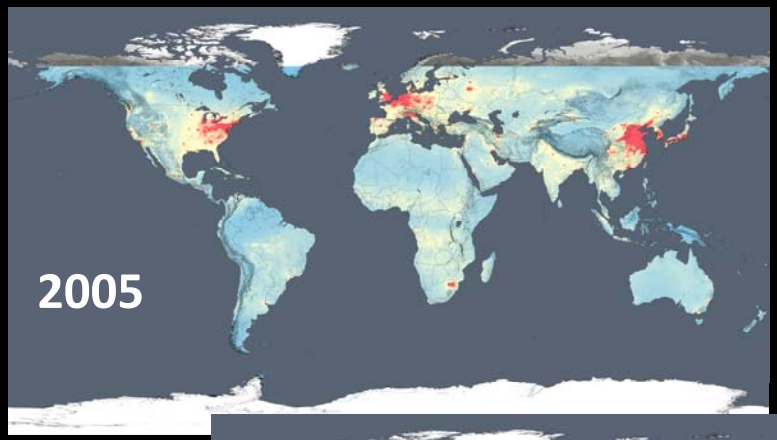
3 August 2014 at 1:10 pm: Cyanobacterial Index from NASA's Aqua-MODIS space-based instrument. Black represents no cyanobacteria detected. Grey indicates clouds or missing data. Estimated threshold for detection is 35,000 cells/mL.

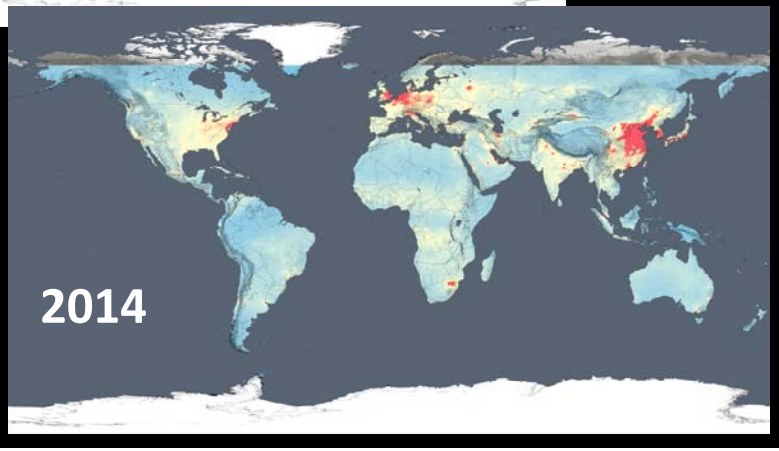
Nitrogen Dioxide NO_2

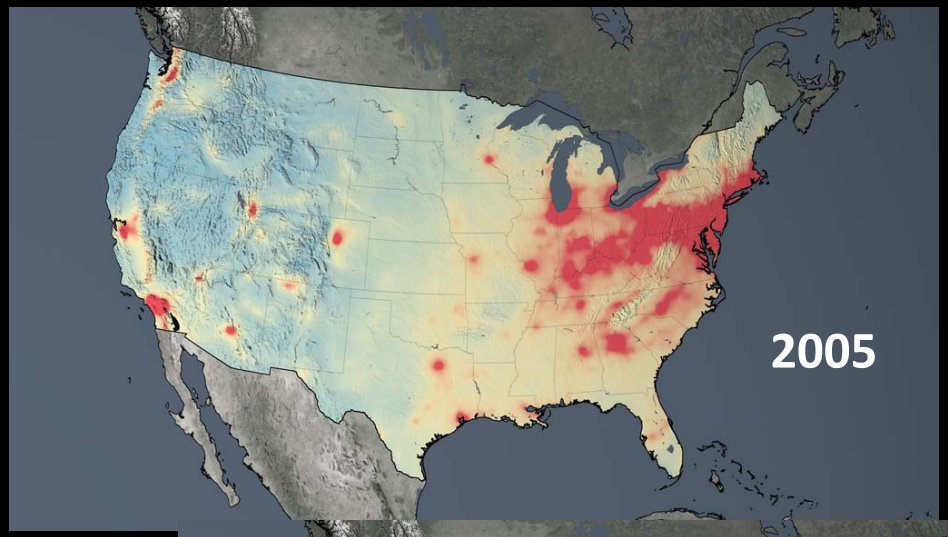


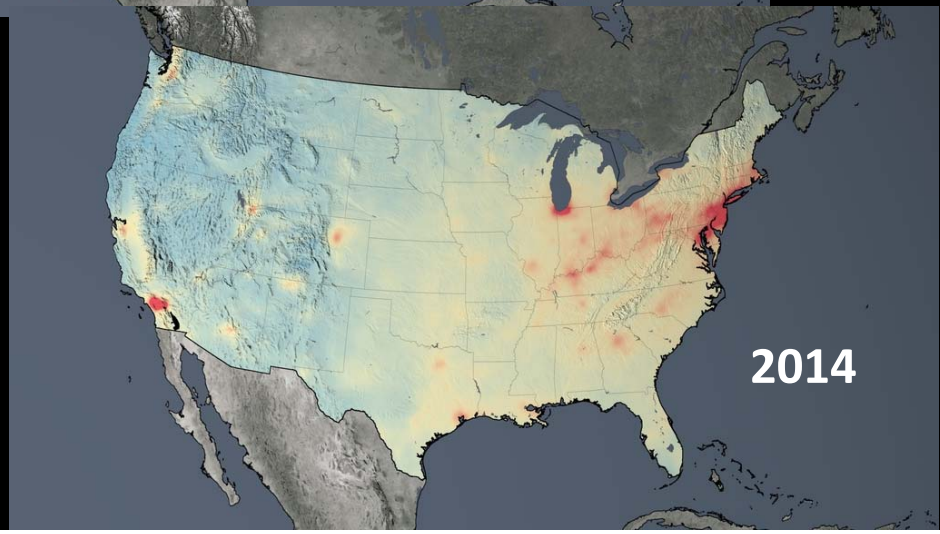
Images are free and publicly available at: http://svs.gsfc.nasa.gov/12094

Maps show the concentration of NO_2 in the troposphere as detected by the Ozone Monitoring Instrument aboard the Aura satellite, averaged over respective years.







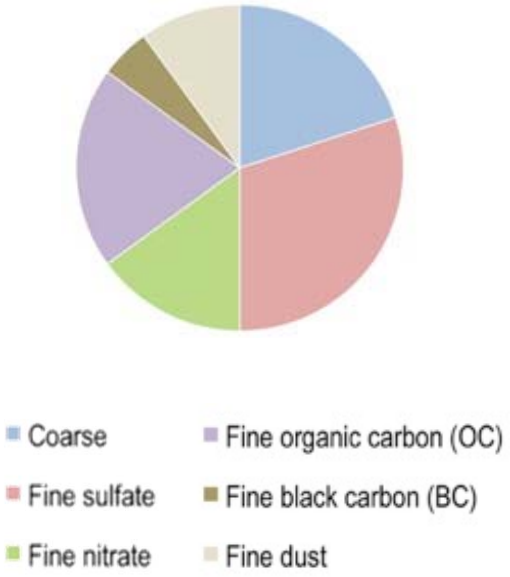


MAIA: Multi-Angle Imager for Aerosols

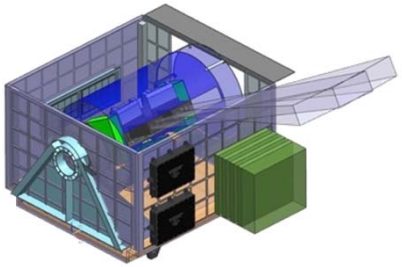
NASA
Earth Science

Assess the impacts of PM type on adverse birth outcomes, cardiovascular and respiratory diseases, and premature deaths.

Epidemiologists on the MAIA team will use the resulting data products to conduct health impact investigations.



MAIA
Multi Angle Imager for Aerosols



Radiometry: Sensitive to aerosol particle size and shape

Polarimetry: Sensitive to particle size and compositional proxies

Primary Target Areas
Observed routinely throughout the mission to map PM spatial variability at the neighborhood scale (~few km) and support epidemiological studies

Contact: David Diner, NASA-JPL
david.j.diner@jpl.nasa.gov

Earth Observations, Health, and SDGs

THE GLOBAL GOALS
For Sustainable Development

3.3 By 2030, end AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases

3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being

EO Applications for SDG 3

Good Health & Well-Being

3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination

3.b Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries

Health & Other SDGs *(Two examples)*

Improving water quality and access leads to improve health - without clean water and adequate sanitation it is difficult to achieve health gains. The latter are immediate in terms of decreased water-borne infections and improved nutrition. *Reinforcing*

Sustainable urban planning, and decent and affordable housing support mental health and access to health services, reduce non-communicable diseases and limit environmental impacts. *Reinforcing*

Credit: ICSU, Nilsson et al.

Applications Areas & SDGs

Health &
Air Quality

Water
Resources

Ecological
Forecasting

Energy

Disasters

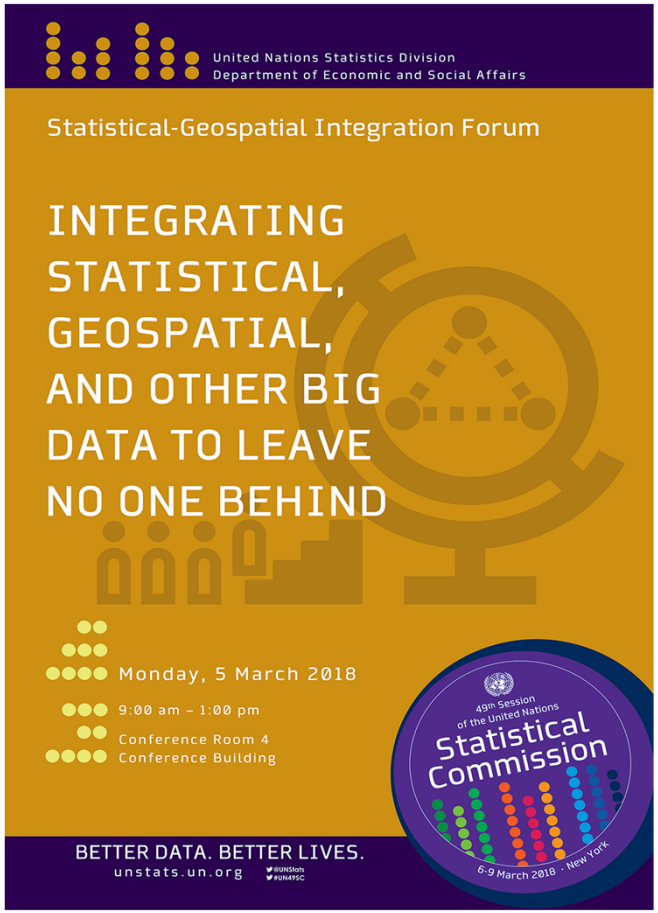
Agriculture /
Food Security

Transportation /
Infrastructure

Urban
Development

NASA

GEO GROUP ON EARTH OBSERVATIONS



STATISTICAL-GEOSPATIAL INTEGRATION FORUM
United Nations • 5 March 2018

Panel I:
Addressing Inequalities and Safeguarding Public Health

Earth Observations: Applications for Health

» Backup Materials «

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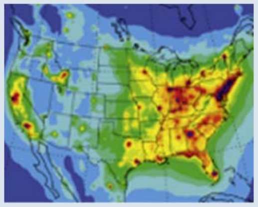
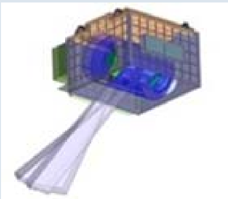
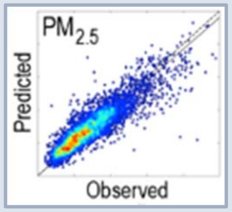


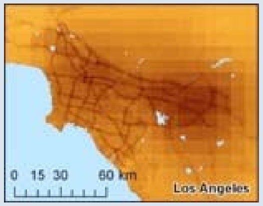
A chemical transport model (CTM) provides initial estimates of the abundances of different aerosol types.



The MAIA instrument uses multi-angle multi-spectral radiometry/polarime try to retrieve aerosol optical depths (AOD_x) of different particle types over major population centers



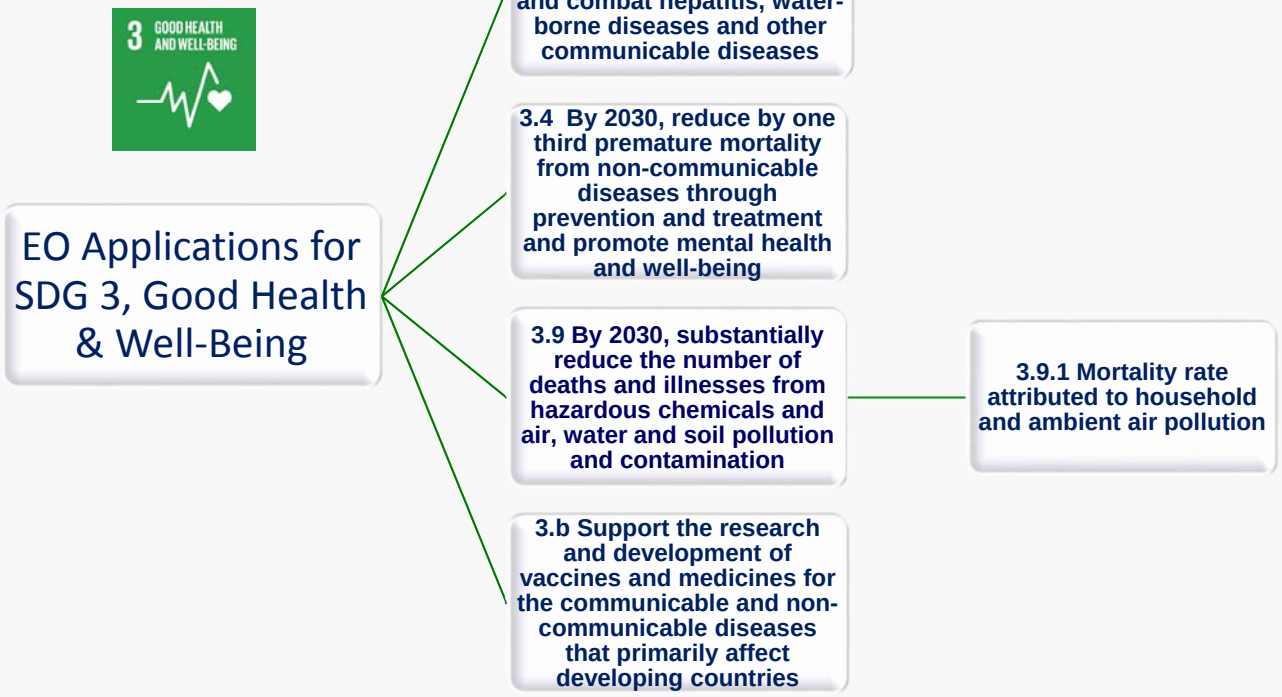
Geostatistical regression models (GRMs) derived from collocated surface and MAIA measurements relate AOD_x to near-surface concen-trations (PM_x).



Spatiotemporally gap-filled PM maps are generated by integrating PM surface monitor, MAIA instrument, and bias-corrected CTM data.

Geocoded birth, death, and hospital records and epidemiological methodologies are used to associate PM exposure with adverse health outcomes.

EO in SDG health monitoring and other SDGs



3 GOOD HEALTH AND WELL-BEING | 11 SUSTAINABLE CITIES AND COMMUNITIES

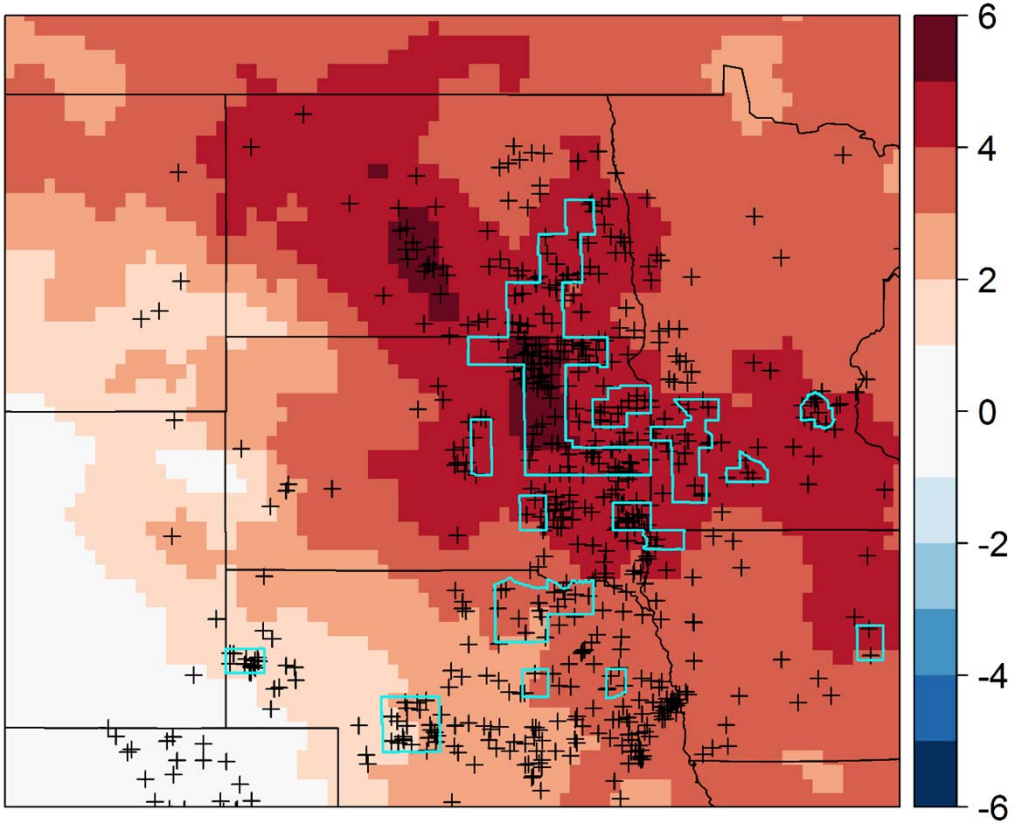
Sustainable urban planning, and decent and affordable housing support mental health and access to health services, reduce non-communicable diseases and limit environmental impacts.
Goal Interaction: Enabling, Reinforcing

3 GOOD HEALTH AND WELL-BEING | 6 CLEAN WATER AND SANITATION

Improving water quality and access leads to improve health - without clean water and adequate sanitation it is difficult to achieve health gains. The latter are immediate in terms of decreased water-borne infections (e.g. acute diarrheal infections, viral hepatitis) and improved nutrition
Goal Interaction: Enabling, Reinforcing

Credit: ICSU, Nilsson et al.

Enhanced Forecasting of Mosquito-Borne Disease Outbreaks



Winter (Dec 2011-Feb 2012) temperature anomalies (C) overlaid with 2012 West Nile Virus (WNV) cases in the northern Great Plains. Blue lines highlight counties with significantly higher numbers of WNV cases in 2012 than in previous years.

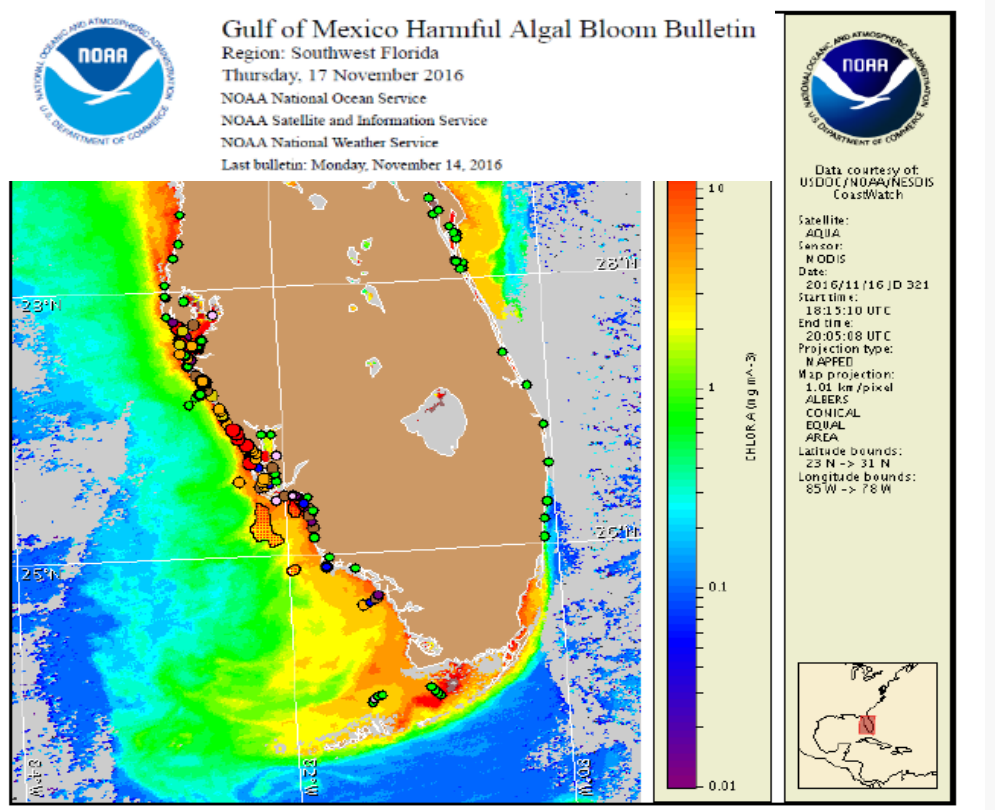
- Developed statistical models of mosquito population and West Nile Virus (WNV) incidence using data from the Advanced Microwave Scanning Radiometer - Earth Observing System (AMSR-E) sensor on NASA's Aqua satellite.
- Interannual variability in WNV incidence was positively associated with temperature anomalies in three regions of the United States.
- The strongest associations with temperature variables occurred in Dec-Mar, preceding the main transmission season (Jul- Sep).

"The NASA-funded project is giving us an immense amount of understanding of the West Nile virus disease and is adding a whole new dimension."

South Dakota State Epidemiologist, Lon Kightlinger

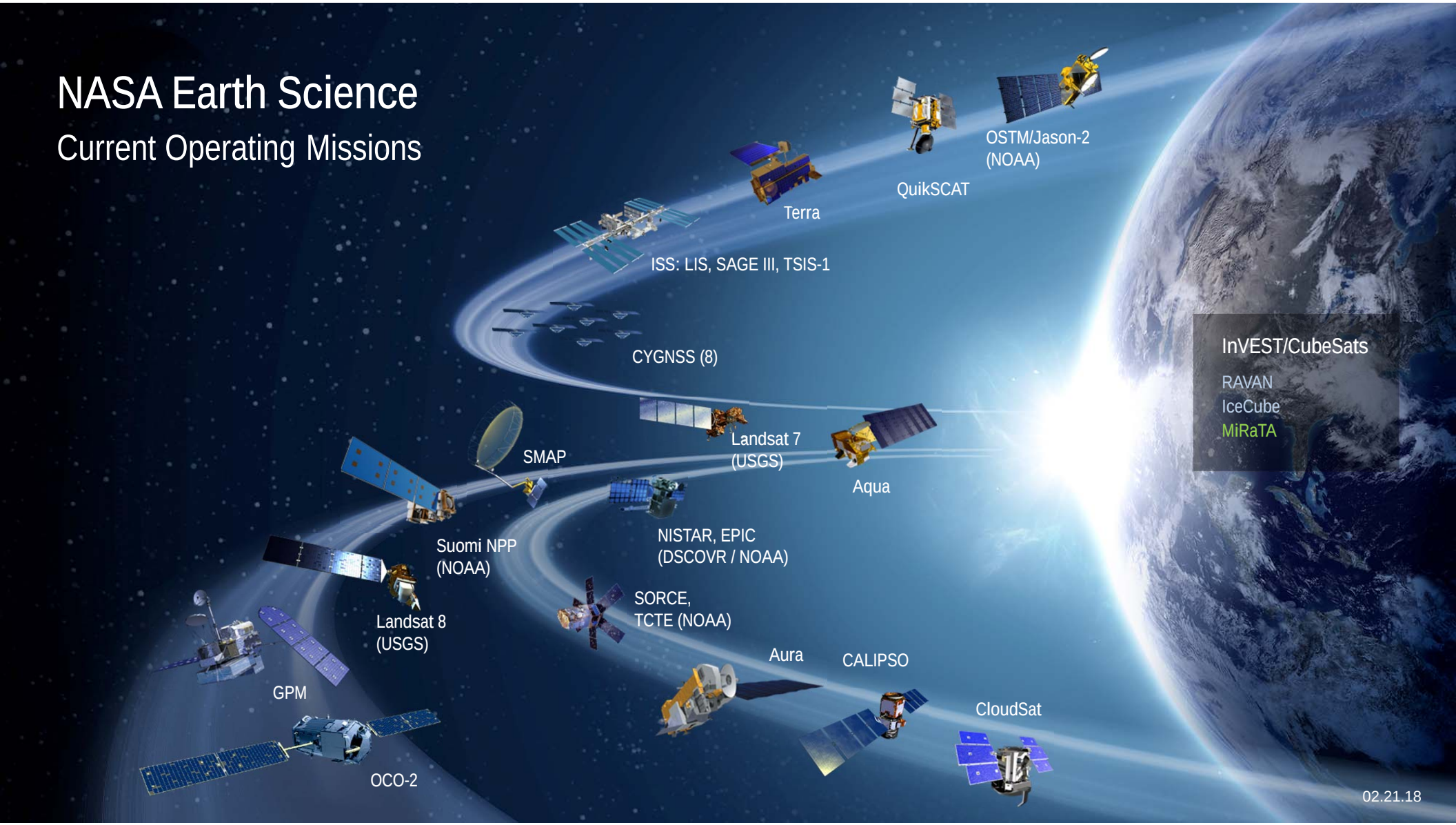
Prototype Model for Improved Forecasts of Respiratory Illness Hazard from GOM Red Tide

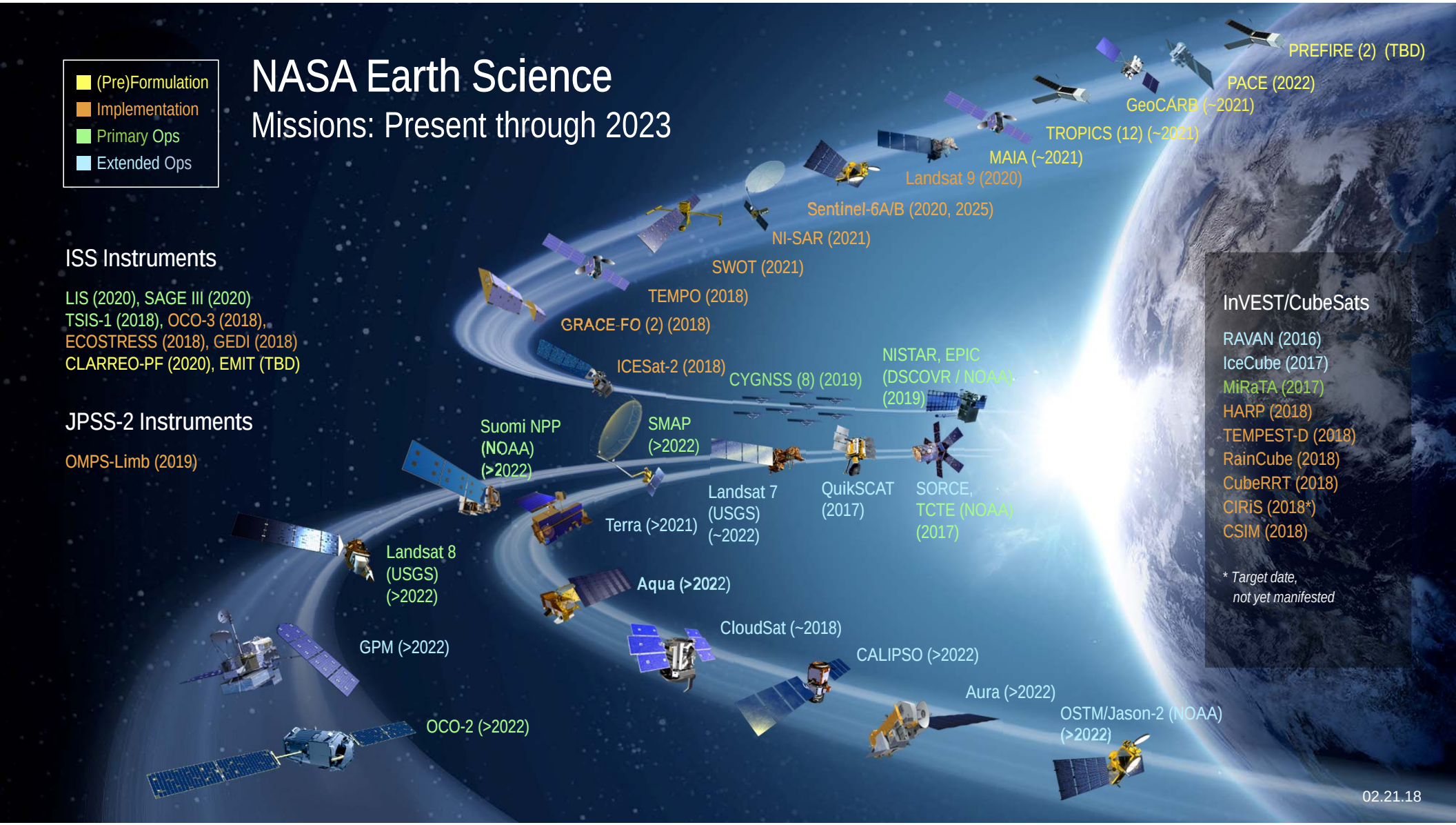
- Toxic algal blooms occur in the Gulf of Mexico from Texas to Florida mainly during the late summer/early fall.
- To forecast the public health risk from these blooms, the project utilized Earth observations integrated with beach samples from HABscope along the Florida Gulf Coast.
- Satellite based assessment for offshore exposure (MODIS/VIIRS ocean color)
- Forecasts disseminated :
  - NOAA HAB Operational Forecast System
  - Motes Marine Lab Beach Conditions Reporting System® (BCRS)
  - NWS Beach Hazards site



Satellite chlorophyll image with possible *K. brevis* HAB areas shown by red polygon(s), when applicable
Points represent cell concentration sampling data from November 7 to 15: red (high), orange (medium),

Combining satellite data (including MODIS/VIIRS), weather forecasts, and sampling from the HABscope device, respiratory distress forecasts are produced 1-2 times per day along the Florida Gulf Coast. Previous to this project, these forecasts were issued at most twice a week and were less accurate.


NASA Earth Science
Current Operating Missions
OSTM/Jason-2
(NOAA)
QuikSCAT
Terra
ISS: LIS, SAGE III, TSIS-1
CYGNSS (8)
InVEST/CubeSats
RAVAN
IceCube
MiRaTA
Landsat 7
(USGS)
SMAP
Aqua
NISTAR, EPIC
(DSCOVR / NOAA)
Suomi NPP
(NOAA)
SORCE,
TCTE (NOAA)
Landsat 8
(USGS)
Aura
CALIPSO
GPM
CloudSat
OCO-2
02.21.18


(Pre)Formulation
Implementation
Primary Ops
Extended Ops
NASA Earth Science
Missions: Present through 2023
ISS Instruments
LIS (2020), SAGE III (2020)
TSIS-1 (2018), OCO-3 (2018),
ECOSTRESS (2018), GEDI (2018)
CLARREO-PF (2020), EMIT (TBD)
JPSS-2 Instruments
OMPS-Limb (2019)
PREFIRE (2) (TBD)
PACE (2022)
GeoCARB (~2021)
TROPICS (12) (~2021)
MAIA (~2021)
Landsat 9 (2020)
Sentinel-6A/B (2020, 2025)
NI-SAR (2021)
SWOT (2021)
TEMPO (2018)
GRACE-FO (2) (2018)
ICESat-2 (2018)
CYGNSS (8) (2019)
NISTAR, EPIC
(DSCOVR / NOAA)
(2019)
Suomi NPP
(NOAA)
(>2022)
SMAP
(>2022)
Landsat 7
(USGS)
(~2022)
QuikSCAT
(2017)
SORCE,
TCTE (NOAA)
(2017)
Terra (>2021)
Landsat 8
(USGS)
(>2022)
Aqua (>2022)
CloudSat (~2018)
CALIPSO (>2022)
Aura (>2022)
OSTM/Jason-2 (NOAA)
(>2022)
GPM (>2022)
OCO-2 (>2022)
InVEST/CubeSats
RAVAN (2016)
IceCube (2017)
MiRaTA (2017)
HARP (2018)
TEMPEST-D (2018)
RainCube (2018)
CubeRRT (2018)
CIRiS (2018*)
CSIM (2018)
* Target date,
not yet manifested
02.21.18