NASA Perspective and New Projects on “Earth Observations for Health (EO4HEALTH)”

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Discovering and demonstrating innovative and practical uses of Earth observations in organizations’ policy, business, and management decisions.

Applications
Prove-out, develop, and transition applications ideas for sustained uses of Earth obs. in decision making.

Capacity Building
Build skills and capabilities in US and developing countries to access Earth observations to benefit society.

Mission Planning
Identify applications early in mission lifecycle and integrate end-user needs in mission design and development.

http://AppliedSciences.NASA.gov
Applications Areas

NASA Earth Science

Emphasis in Applications Areas

Support opportunities in additional areas

Health & Air Quality

Water Resources

Ecological Forecasting

Energy

Disasters

Agriculture / Food Security

Wildland Fires (through 2017)

Urban Development

Transportation / Infrastructure

Wildfires will be covered in Eco.Fore & Disasters after FY17; climate & weather play into all areas
Why Health & Air Quality?

Potential Health Effects of Climate Variability and Change

CLIMATE CHANGE (Natural and Human-Caused)

Regional Weather Changes
- Heat Waves
- Extreme Weather
- Temperature
- Precipitation

Air Pollution Levels
Contamination Pathways
Transmission Dynamics

Moderating Influences

Health Effects
- Heat-related Illnesses and Deaths
- Extreme Weather Events - related Health Effects
- Air Pollution-related Health Effects
- Water- and Food-borne Diseases
- Vector- and Rodent-borne Diseases

Research

Adaptation Measures

Source: GEO, 2003
Global Emerging Diseases*

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

• 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.
Over 90% of malaria in the Western Hemisphere is located in the Amazon.

In Peru, 75% of malaria cases occur in the Department of Loreto, in the Northern Amazonian Region.

Key factors related to continued malaria endemicity:
- expansion of vector habitats from land use change (deforestation for logging and road development)
- social and ecological processes that increase human exposure to the mosquito vector *Anopheles darlingi*

This project developed a spatially explicit model of malaria transmission risk on the basis of predicted *Anopheles* mosquito density and mapped human settlement and activity patterns. A risk monitoring system was developed to inform decisions on resource distribution and vector management by project collaborators (Peru State Health Ministry, US NAMRU-6).

Earth observation inputs to the Land Data Assimilation Systems (LDAS) — particularly TRMM precipitation data — performed remarkably well in the study region for characterizing malaria transmission risk. A key finding was that climate and hydrological variability influence total mosquito abundance, while land cover influences the relative density of vector species.

The project received a continuation in Nov. 2014 to transfer the malaria risk model to operations at partner organizations. Additionally, the project is expanding the system to bordering regions of Ecuador, Columbia, and Brazil and to also investigate cutaneous leishmaniasis in Peru. The project leverages data from GPM, SMAP, S-NPP/VIIRS, and Landsat 8.

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/GPM 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.”

http://iridl.ldeo.columbia.edu/maproom/
Connecting NASA Data and Tools with Health and Air Quality Stakeholders

Tracey Holloway - Team Lead (University of Wisconsin-Madison)
Bryan Duncan (NASA Goddard Space Flight Center)
Arlene Fiore (Columbia University)
Frank Freedman (San Jose State University)
Daven Henze (University of Colorado, Boulder)
Jeremy Hess (University of Washington, Seattle)
Yang Liu (Emory University)
Jessica Neu (NASA Jet Propulsion Laboratory)
Susan O’Neill (USDA Forest Service)
Ted Russell (Georgia Tech)
Daniel Tong (George Mason University)
Jason West (University of North Carolina, Chapel Hill)
Mark Zondlo (Princeton University)

https://haqast.org
Breakthrough: NASA Satellites Used to Show Impact of Cookstoves on Health and Air Quality

• For the first time ever, data from NASA satellites and instruments (Terra and Aqua MODIS, Terra MISR, SeaStar SEAWiFS, CALIPSO CALIOP) were used to model ambient air pollution and associated health impacts of particulates from cookstoves apportioned to emissions by species and country.

• Air pollution from cookstoves currently contributes 370,000 – 500,000 annual deaths worldwide.

• NASA’s data can now help environmental and public health organizations focus their efforts.


• The scientific team was supported by NASA HAQAST. Team member Daven Henze (University of Colorado-Boulder) is one of 13 HAQAST PIs.
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MISSION

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FOCUS AREAS

- Airnow International: Expanding Networks and Integrating Methods for Air Quality and Health Data (Community Activity)
- Copernicus Atmospheric Monitoring Service (CAMS) (Community Activity)
- Harmful Algal Bloom (HAB) Early Warning System (Community Activity)
- Global Observation System for Persistent Organic Pollutants (GOS4POPS) (Initiative)
- Global Observation System for Mercury (GOS4M) (Flagship)
- Earth Observations for Health (vector-borne and water-related diseases) (Community Activity)

http://www.geohealthcop.org/
Purpose of Solicitation

The purpose of this solicitation was to select projects to advance specific elements of the GEO Work Programme 2017-2019.

Work through this call for proposals includes projects, studies, workshops, trainings, and other activities.

NASA was especially interested in involving non-Federal domestic organizations in contributing to and achieving progress on the GEO Work Programme.

Amendment to ROSES-16 Issued: November 29, 2016
NOIs Due: January 13, 2017
Proposals Due (110 total received): March 10, 2017
extended from Feb. 28, 2017
Review Panels: May, June, August 2017
ESD Steering Committee: Sept. 29, 2017
Expected start date: December 1, 2017
3.3 Earth Observations for Health

This Community Activity focuses on development and uses of Earth observations that improve the strategic and tactical capacities to anticipate, respond to, and reduce environment-related health risks, such as infectious diseases and vector-borne diseases. The element addresses combinations of Earth observations with social, demographic, and health information to enhance analysis, preparedness, and resilience. NASA requests proposals that connect Earth observations with vector-borne and infectious disease issues, challenges, and decision-making through active partnerships with public health managers and organizations, such as NGOs, that support them. Proposals should address topics related to vector-borne disease (e.g., malaria, zika, dengue fever, chik-v) and water-related disease (e.g., cholera). Proposed efforts may address: Applications projects; Feasibility studies, including testing and validation of proofs-of-concept of possible applications; Development of data-fusion products with strong applications and applied research potential; Demonstrations that complete the transition, adoption, and sustained use of Earth observations; training; Activities to demonstrate and enable uses of Earth observations to support the Agenda 2030 Sustainable Development Goals; and, Studies on value of Earth observations for decision making, preparedness, response, or resilience. NASA particularly encourages proposals focused on AfriGEOSS and AmeriGEOSS member countries as well as on mosquito-borne disease in Central America, South America, and the Caribbean.
The United Nation’s Sustainable Development Goals target to eliminate global malaria epidemics by 2030. Considerable progress has been made towards this goal across the world. However, the recent emergence of artemisinin-resistant populations of malaria carrying parasites in the Greater Mekong posed not only to slow down the progress but potentially undermine the entire elimination campaign by rendering the most efficient malaria treatment available to date ineffective. Myanmar, one of the 5 countries with documented cases of emergence of artemisinin resistance, carries a disproportional malaria burden in the region with ~4% of the region’s population and 20% of the region’s malaria. The project aims to support these efforts by developing a robust satellite data driven early warning system to forecast malaria hotspots dynamically in space-time. Myanmar Malaria Early Warning System (MMEWS) will be designed to move the satellite-based malaria forecasting beyond the narrow scope of monitoring and forecasting vector habitat suitability and potential for surge in vector prevalence. The project brings together a team of experts in optical and microwave remote sensing, spatial analysis, and malariology to develop a system that will support medical intervention activities.

Implementation of a geospatial surveillance and response system resource for vector borne disease in the Americas will be tested using NASA satellite data, geographic information systems and ecological niche modeling to characterize the environmental suitability and potential for spread of selected endemic and epizootic vector borne diseases. The initial focus will be on developing prototype geospatial models on visceral leishmaniasis, an expanding endemic disease in Latin America, and geospatial models for dengue and other Aedes aegypti borne arboviruses (zika, chikungunya) -- emerging arboviruses that have potential for epizootic spread from Latin America and the Caribbean and establishment in North America. This project intersects AmeriGEOSS.
Benjamin Zaitchik (Johns Hopkins University); “Environmental determinants of Enteric Infectious Disease” - Childhood undernutrition is linked to more than 50% of child deaths worldwide. A key aspect of malnutrition is the role of environmental enteric dysfunction, in which exposure to enteropathogens alters intestinal integrity and metabolic state. In response the Interactions of Malnutrition & Enteric Infections: Consequences for Child Health and Development project (MAL-ED) established an unprecedented coordinated cohort study at sites in eight countries across three continents. But EID transmission is environmentally mediated, and many EID exhibit some form of seasonality or other environmental sensitivity. MAL-ED is limited because it does not have an Earth Observation component, sites are point locations. This project will develop a develop a database of relevant climate, hydrology, ecology, and human activity at each study site. This database will be used to develop statistical models of high impact EID, with the goal of informing understanding, monitoring, and prediction. The project will use the global coverage available from EO to perform objective regionalization of global tropical land areas on the bases of seasonality and environmental associations of specific EID. This project intersects AmeriGEOSS and AfriGEOSS and leverages MAL-ED funding from the Bill and Melinda Gates Foundation.

Antarpreet Jutla (West Virginia University); “EO for Cholera Prediction” - Cholera continues to be a public health threat, particularly in regions that lack access to safe drinking water and sanitation (WASH) infrastructure. Africa is rapidly becoming the new homeland of cholera (66% of the total cholera outbreaks reported in the continent). Outbreaks of cholera can be divided into two components: the trigger in the environment and the transmission of the disease in human population. Growth of cholera bacteria in the environment is linked to hydroclimatic processes influencing the ecological niche of the vibrio. Consequently, consumption of water containing an infective dose of the bacteria forms the trigger component. The transmission component of cholera is the mechanism of spread of infection within the human population. V. cholerae exists naturally in the environment, therefore, it is not realistic or feasible to consider eradication of the pathogen from the aquatic environment. Therefore, the goal of this project is to employ earth observations to predict the risk of outbreak (trigger and transmission) of cholera in the environment and human populations in Africa, and thereafter develop a comprehensive capacity building plan to engage end-users to incorporate this information into decision making, so that appropriate intervention strategies can be devised and deployed. This project intersects AfriGEOSS.
Earth Venture Instrument-1:
Tropospheric Emissions: Monitoring of Pollution (TEMPO)

- **TEMPO is a pathfinder to using hosted commercial payloads from GEO**
  - Tropospheric pollution observations from Geostationary Orbit
    - Ozone, NO\textsubscript{2}, and CH\textsubscript{2}O.
  - Forms a global Air Quality constellation in GEO with EU Copernicus - Sentinel 4 and Korean GEMS.
  - EPA and NOAA are part of the science team.
  - Instrument delivery in 2018; Launch NLT 2021

**PI:** Kelly Chance, Smithsonian Astrophysical Observatory  
**PE:** Betsy Edwards; **PS:** Barry Lefer **PA:** John Haynes  
**Instrument Development:** Ball Aerospace  
**Project Management:** LaRC  
**RYS:** 93.2M  
**Orbit requirements:** Geostationary Orbit. Hosted on a commercial communication satellite
**Earth Venture Instrument-3**

**Multi-Angle Imager for Aerosols**

**Salient Features:**
- MAIA is PI-led NASA Earth Ventures Instrument (EVI-3 selection)
- Category 3 mission per NPR 7120.5E
- Risk Classification C per NPR 8705.4
- Cost capped at $100.1M
- Host platform: TBD, to be provided by ESSP Program
- Payload delivery: December 2019
- Orbit: 370-830 km, 50-130° inclination, sun-synch preferred
- Launch: Ready for 2020 launch on TBD launch vehicle
- Nominal Mission: 3 yr baseline; 2 yr threshold after 90-day IOC
- Principal Investigator: Dr. David Diner (JPL)
- Project Manager: Kevin Burke (JPL)
- ESSP Program Manager: Greg Stover, Msn Mgr: Diane Hope
- JPL Program Manager: Dr. Steven Bard, Deputy: Amit Sen
- Program Scientist: Dr. Hal Maring, NASA HQ
- Program Executive: Betsy Edwards, NASA HQ
- Program Applications: John Haynes, NASA HQ

**Mission Objectives:** Assess linkages between different airborne particulate matter (PM) types and adverse birth outcomes, cardiovascular and respiratory disease, and premature deaths.

**Instrument:** Multi-angle spectropolarimetric imaging instrument for operation in a sun-synchronous Earth orbit to measure the particle types, sizes, concentrations, and geolocation of atmospheric aerosols.
Questions:
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http://AppliedSciences.NASA.gov