Future SBG Observables: Supporting Applications for Societal Benefits

NASA Applied Sciences Program Mission Statement

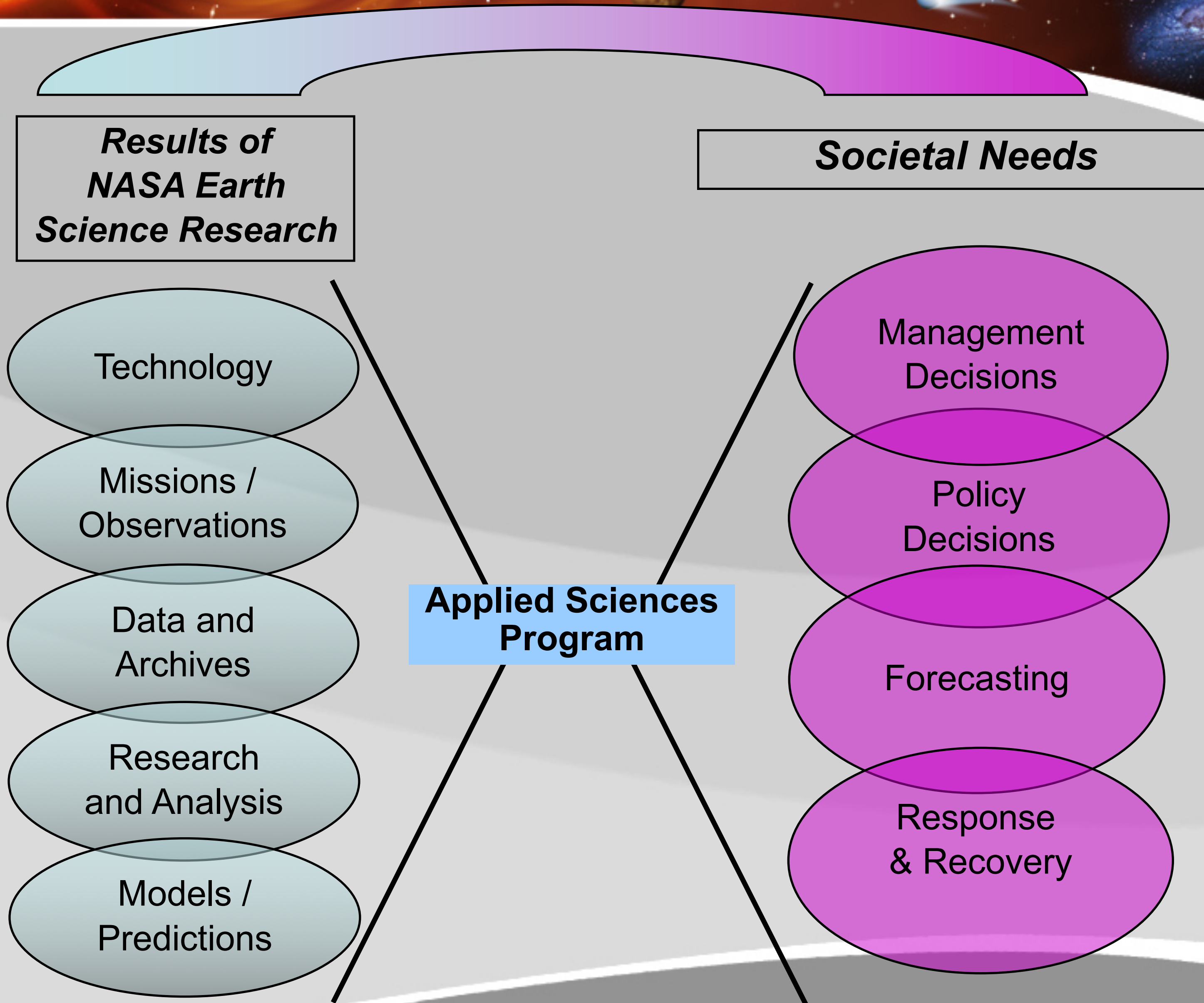
Advance the realization of societal and economic benefits from NASA Earth science by identifying societal needs, conducting applied research and development, and collaborating with application developers and users.

Apply Earth observations to improve and develop decision-making activities and enable transition and adoption by public- and/or private-sector organization(s) for sustained use in decision making and services to end users in the areas of public health and air quality.

Jeffrey C. Luvall, Christine Lee, and Simon Hook
Marshall Space Flight Center and JPL

θΔ ics

NASA Applied Sciences Architecture



Societal Benefits

RESOURCES FOR THE FUTURE

Research People Events Blog About

RFF CONSORTIUM

The Consortium for the Valuation of Applications Benefits Linked with Earth Science (VALUABLES)

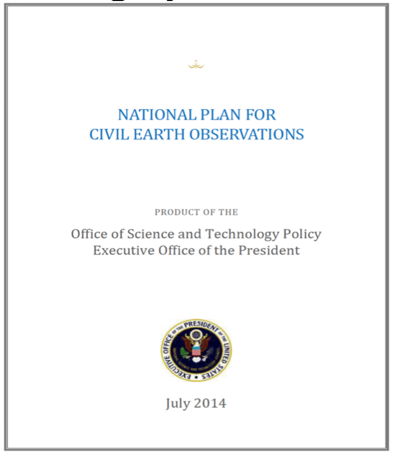
RFF has created a new consortium, in cooperation with NASA, to help experts better understand the socioeconomic benefits of Earth observations.

NATIONAL STRATEGY FOR CIVIL EARTH OBSERVATIONS 2013/2014

Tier 1

Based on results of the EOA, the following measurement groups support a majority of the societal themes. These measurement groups represent the highest priority measurements in the category of sustained observations for public services. They are listed below in priority order.

1) ***Weather and seasonal climate monitoring and prediction***
2) ***Dynamic land-surface monitoring and characterization***
3) ***Elevation and geo-location***
4) ***Water level and flow***


NATIONAL PLAN FOR
CIVIL EARTH OBSERVATIONS

PRODUCT OF THE

Office of Science and Technology Policy
Executive Office of the President

July 2014

Tier 2

The following measurement groups are identified based on the remaining high-impact observing systems identified in the EOA. These measurement classes are of next-highest priority and importance in the category of sustained observations for public services.

1) ***Ecosystem and biodiversity resource surveys for terrestrial, freshwater, and marine ecosystems***
2) ***Environmental-quality monitoring, specifically disease-vector surveillance, water quality, and AQ***
3) ***Geo-hazard monitoring for earthquakes, volcanoes, landslides, regional and local subsidence***
4) ***Space-weather***

Applications Policy

NASA HEADQUARTERS
SCIENCE MISSION DIRECTORATE (SMD)

EARTH SCIENCE DIVISION

DIRECTIVE ON PROJECT APPLICATIONS PROGRAM

Approved by:

Michael Freilich
Director, Earth Science Division
Science Mission Directorate, NASA Headquarters

29 June 2016
Date

4.1 Pre-Phase A

Purpose: To enhance overall science objectives and societal benefits from the project's data, and establish characterization of the Communities of Practice and Potential. Initiate a team for the integration and inclusion of applications in the project concept review, and for articulation at the Key Decision Point for Phase A (KDP-A).

Focus: To determine and clarify the applications dimension of the overall project concept and initiation to amass the applications communities (Community of Potential and Community of Practice).

Implementation Activities: Perform assessments to determine what results techniques and products are useful to the applications community, as a result of associated research. A strong characterization of the Communities of Practice and Potential will enhance overall science objectives and societal benefits from the project's data. Produce a Community Assessment and Report.

Guidance: There are a number of people and organizations that may supply information or capabilities such as the Project Manager, the Project Scientists, the Science Team lead, the Project Science Data Systems Representative, the NASA Distributed Active Archive Centers (DAAC), and the Project Applications Coordinator (PAC). Additionally, it is expected that the Program Executive (PE), the Program Scientist (PS) and the Program Applications (PA) lead will be engaged in supporting the project's applications activities.

Space Policy 29 (2013) 76–82

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journal homepage: www.elsevier.com/locate/spacepol

ELSEVIER

Policy for robust space-based earth science, technology and applications

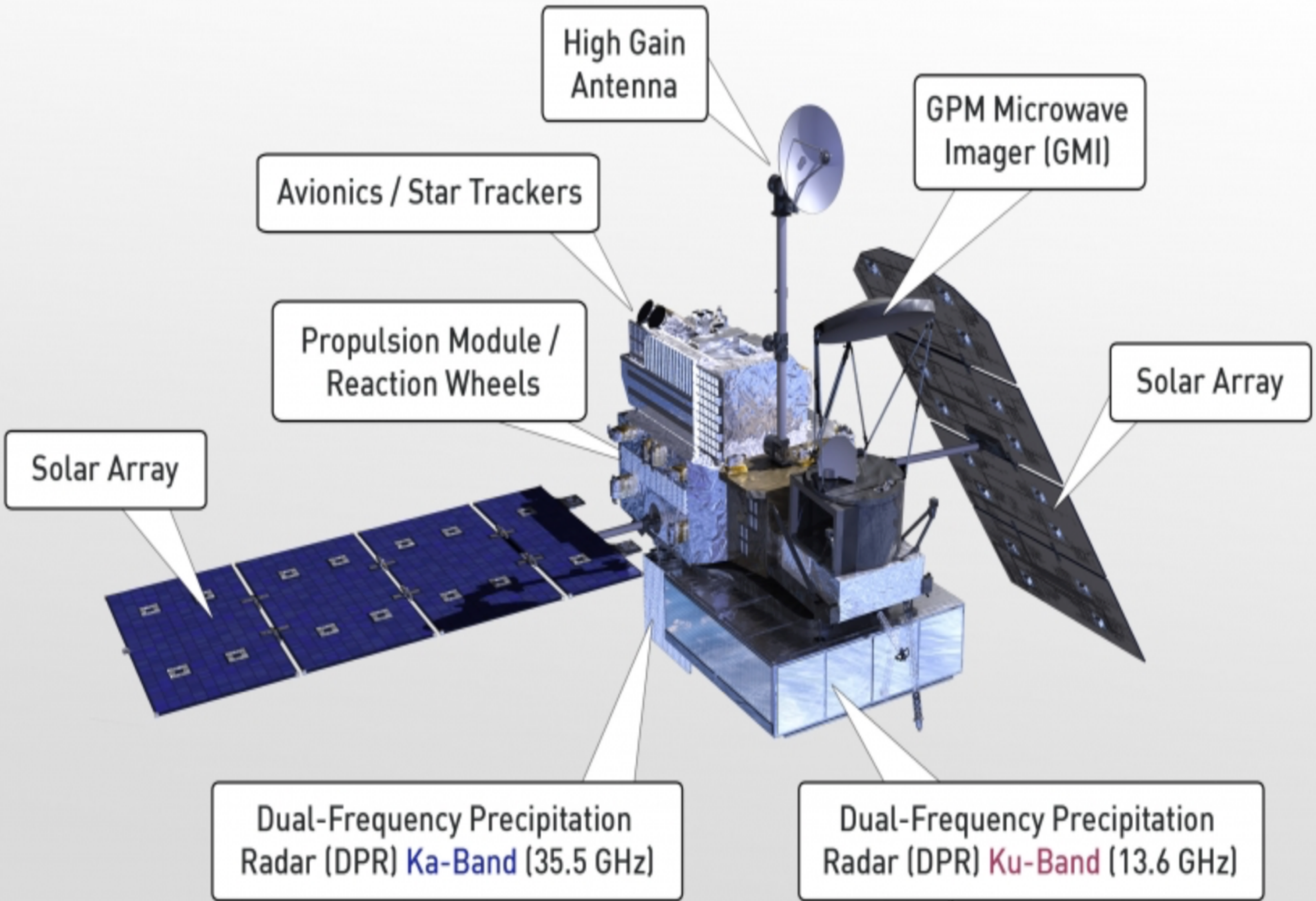
Molly E. Brown [a,*], Vanessa M. Escobar [b], Josef Aschbacher [c], Maria Pilar Milagro-Pérez [d], Bradley Doorn [e], Molly K. Macauley [f], Lawrence Friedl [g]

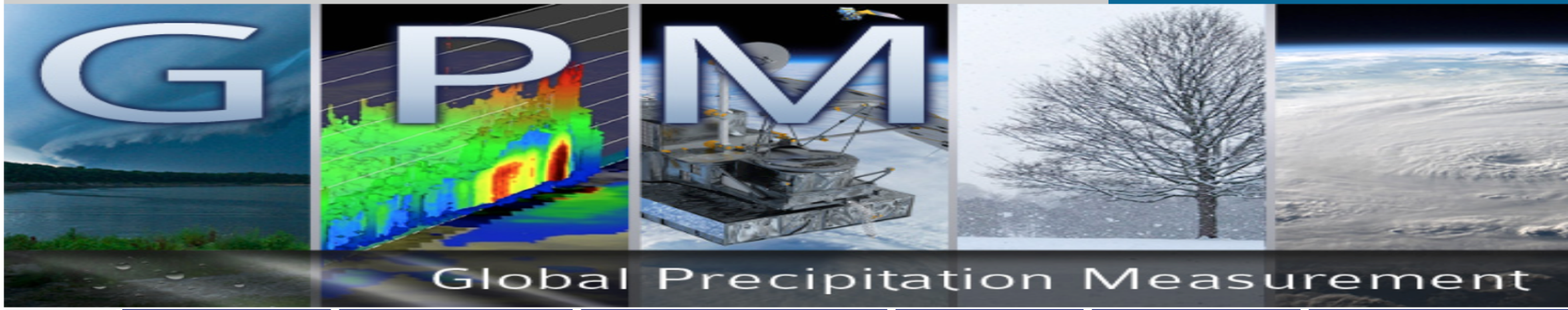
Applications Guidelines by Phase

APPENDIX A: PROJECT PRODUCTS BY DEVELOPMENT PHASE

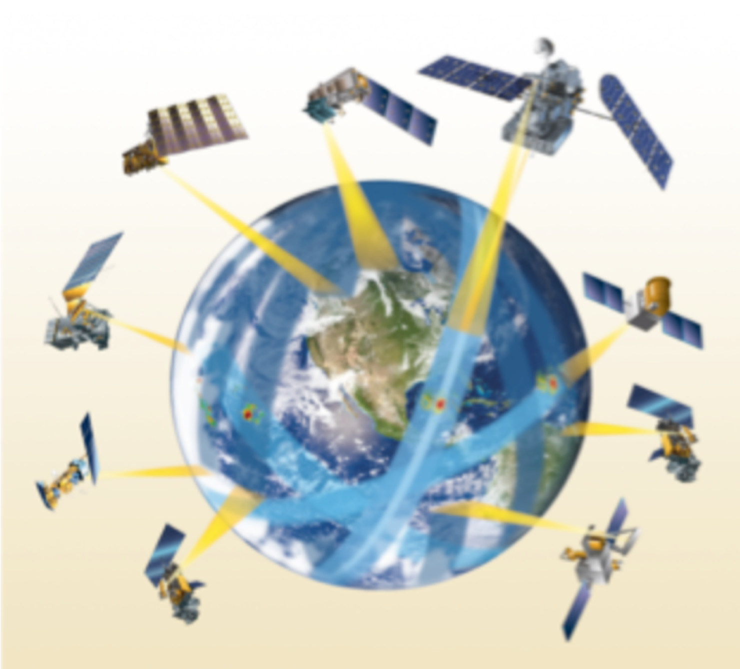
NASA Earth Science Division Guidelines for a Project Applications Program					
	Pre-Phase A	**Phase A**	**Phase B**	**Phases C & D**	**Phase E**
Project Life Cycle Phases	Concept Studies	Concept and Technology Development	Preliminary Design and Technology Completion	Final Design, Fabrication, System Assembly, Test and Launch	Operations and Sustainment
Purpose	Scope the applications portion of the mission concept	Articulate the applications plan for the mission	Implement the plan and build the applications user base	Engage Communities, articulate key applications benefits, support applications readiness and receive feedback	Realize and communicate the applications and societal benefits
Activities	Conduct Mission Studies	Generate a Project Applications Plan	Launch an EA Program	Conduct periodic EA meetings, Hold EA workshops and benchmark meeting	Conduct periodic EA meetings
	Characterize the applications value of the mission	Articulate audiences and implementation activities	Conduct workshops to inform communities about the mission	Receive feedback from EAs	Communicate societal benefits of the mission
	Identify and characterize applications communities	Develop the Applications Traceability Matrix (ATM) to inform the Science Traceability Matrix (STM)	Build awareness and receive input and feedback	Build awareness and encourage applications ideas and readiness	Conduct socioeconomic analysis of select EAs and conduct impact workshops
	Support MCR and design trade-offs	Conduct workshops to inform and build user community	Inform remaining design elements	Identify and maintain key applications for mission communications and outreach	Inform the Community of Practice of the status of the mission, data products, reprocessing, Science Team meetings and other items
	Consult with other projects to scope approaches to applications	Gather input and examine alternative to develop Project Applications Plan	Make open call(s) for EAs	Make open call(s) for EAs	Enable use of beta data by EAs and receive feedback
	Develop information to inform the FAD and PLRA	Compile contact information to support communications with users	Articulate DAAC support for applications users	Conduct events and data workshops to engage communities and build familiarity with access	Conduct events and data workshops to engage communities and build familiarity with access
	Inform concept discussions	Initiate use cases to examine uses in design	Identify simulated data products for testing in decision systems	Conduct case studies with EAs	Revisit Community Assessment Report and reassess user communities and opportunities
			Continue use cases to examine uses in-depth	Support efforts to test and practice with simulated data	Assess and report on the Project Applications Program (PAP) and Plan
				Prepare baseline information to support Senior Review	
Deliverables	Project Studies	Project Applications Plan	Updated applications plan and Applications Traceability Matrix	Updated applications plan and Applications Traceability Matrix	Updated Community Assessment Report
	Community Assessment and Report	Applications Traceability Matrix	Applications Posters	EA telecons and case studies	EA telecons and case studies
		Applications Workshop and report	Applications Workshop(s) and report(s)	Applications Workshop(s) and report(s)	Applications Workshop(s), short courses and report(s)
		Community Contact List	DAAC Engagement summary	Data workshops and short courses	Socioeconomic analyses and reports
		Use Cases/Case Studies	Use Cases/Case Studies	Baseline report for Senior Review	Information for Senior Review Submissions
Events	MAR: Conduct a Mission Applications Review prior to MCR	SRR: Systems Requirements Review	PDR: Preliminary Design Review	CDR: Critical Design Review	Commissioning
	MCR: Articulate applications as part of the overall mission concept			SIR: Systems Integration Review	Data Availability
				ORR: Operations Readiness Review	
				MRR: Mission Readiness Review	
	KDP-A	KDP-B	KDP-C	KDP-D/KDP-E	KDP-F

Global Precipitation Measurement Mission Core Observatory





GPM Ground Validation Data Archive



Welcome to the **Global Precipitation Measurement (GPM)** mission Ground Validation (GV) web portal. The goal of this site is to provide a one-stop-shopping portal for accessing the various radar, disdrometer, gauge and other instrument data sets supporting GPM GV activities. Use the tabs above to access the various datasets, including:

- **Radar**
- **Gauge**
- **Disdrometer**
- **MRMS/NMQ**
- **Field Campaigns**
- **Validation Network**
- **Wallops Precipitation Research Facility**
- **Precipitation Measurement Missions (PMM) Data Access Portal**

ISS

- ✓ ECOSTRESS
- ✓ DESIS
- ✓ GEDI
- (EMIT)

Hyperion

11/21/2000 to 2/22/2017

Airborne data

Big Data and Deep Learning + Intelligent Payload Module (IPM)= ???

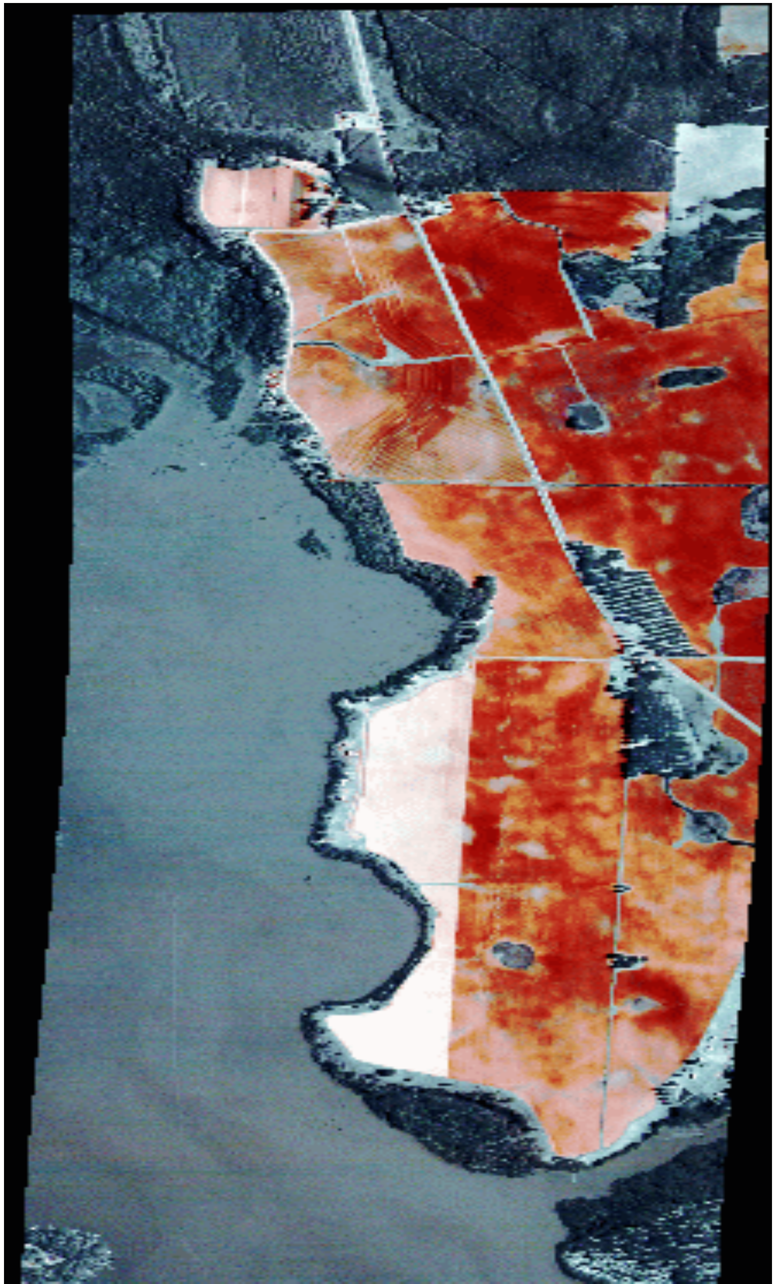
10m Salt Lake City Sept 1998

11,14,13

ATLAS Emissivity

2.5 m Georgia Farm

May 2000



ICUC10 & 14th AMS/SUE

"Sustainable & Resilient Urban Environments"

August 6-10, 2018

<u>Host and Co-Organized By:</u>

International Association of Urban Climate

The City University of New York

NOAA CREST Institute

American Meteorological Society/BUE

ICUC 10
New York City
August 6-10, 2018

RESILIENT URBAN ENVIRONMENTS Grand Challenges

Urban Climate Modeling & Observation Grand Challenges

- Storm surges modeling and prediction
- Tropical and extra-tropical storms in cities
- Modeling and observations of urban flooding
- Modeling and observations of extreme heat events in cities
- Boundary layer and canopy layer urban heat islands
- Modeling and observation of surface energy and water balances
- Flows and dispersion in the urban canopy layer
- Modeling and observation of clouds-aerosol interactions in UBL flows
- Air quality/aerosols/radiative transfers in the urban boundary layer.

Knowledge Transfer & Applications Grand Challenges

- Climate change mitigation & adaptation in urban environments
- Bioclimatology and public health
- Urban design and planning with climate
- Design for resiliency
- Energy supply and demand in cities – the role of urban climates
- Eco-system services and urban environments
- Socio-economics aspects of urban climate.

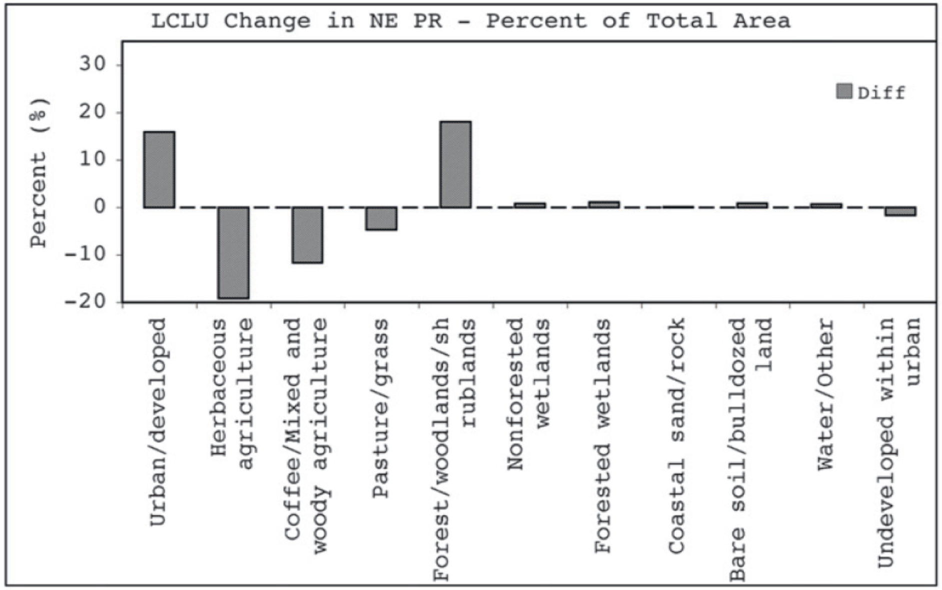
Cyber-Informatics Grand Challenge

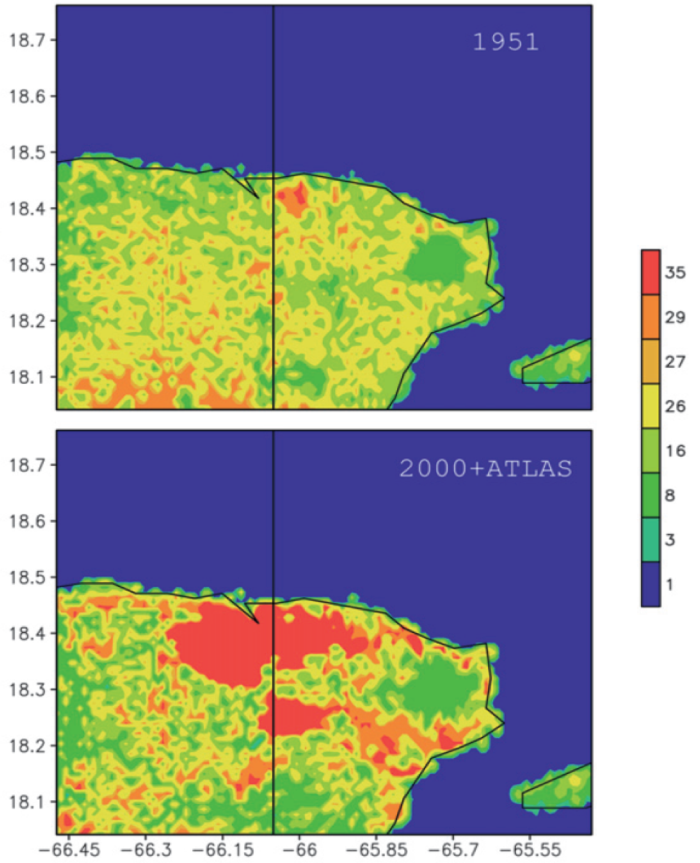
- Climate information services for cities
- Big data for urban climate studies
- Advance computational processes for high resolution weather and climate modeling
- Sensing challenges for complex urban environments
- Citizen driven sensing and informatics.

WORKING GROUP GOALS

To leverage ICUC10 to conduct a comprehensive survey study and for exploring solution pathways to the grand challenges in representing resilient urban environments in terms of:

- physical processes
- modeling and observational strategies
- socio-economic impacts
- alternatives for resiliency, and public outreach.





Northeastern Puerto Rico

Description	class	1951	2000	Diff
Background/water	0			
Urban/developed	30	1.92	17.81	15.89
Herbaceous agriculture	8	19.19	0.09	-19.10
Coffee/Mixed and woody agriculture	12	12.38	0.76	-11.62
Pasture/grass	27	33.73	28.99	-4.74
Forest/woodlands/shrublands	3	9.37	27.43	18.06
Nonforested wetlands	16	0.00	0.76	0.76
Forested wetlands	19	0.00	1.08	1.08
Coastal sand/rock	26	0.00	0.14	0.14
Bare soil/bulldozed land	29	0.00	0.91	0.91
Water/Other	1	0.23	0.93	0.70
Undeveloped within urban	7	1.71	0.00	-1.71

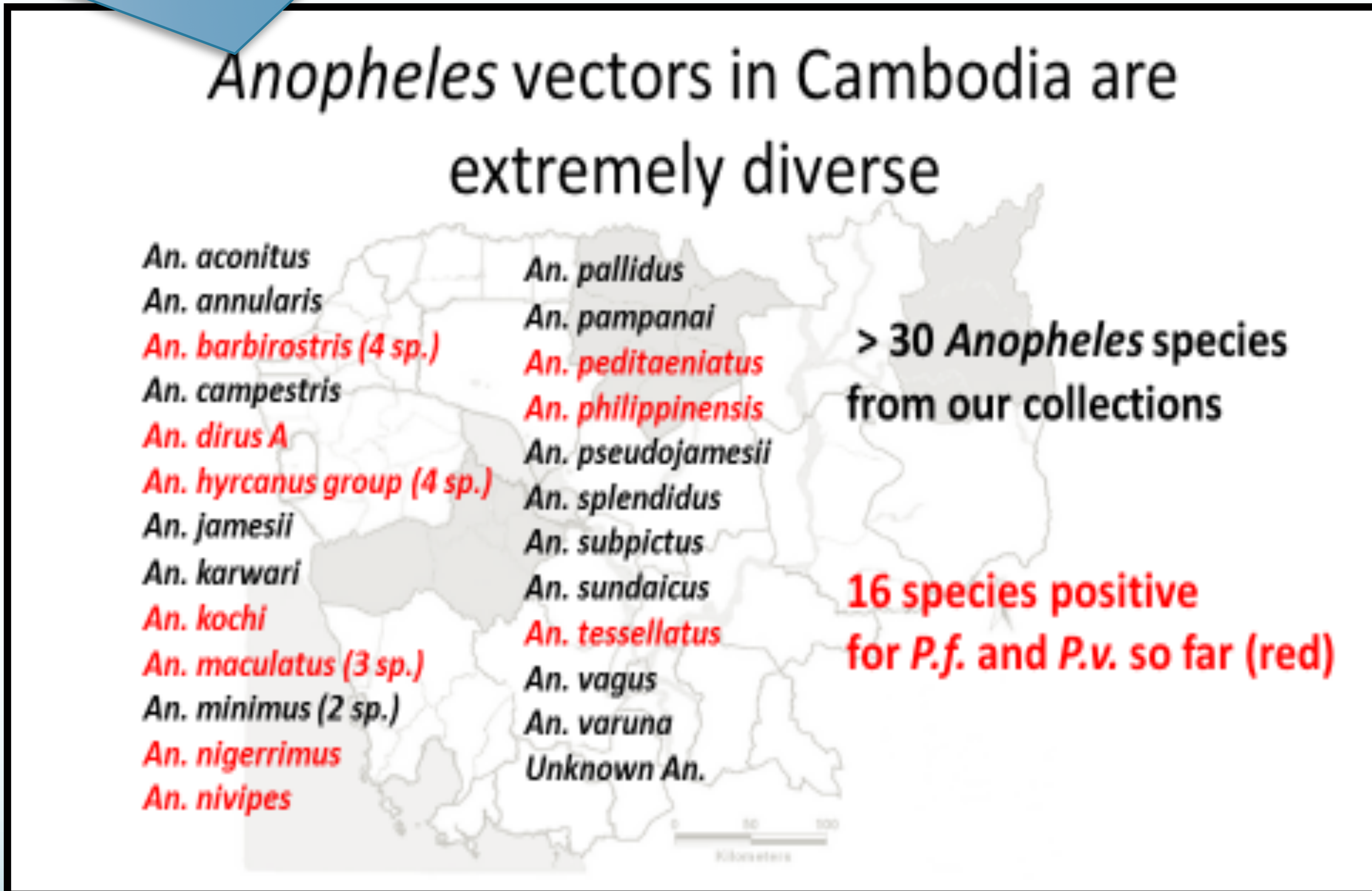
FIG. 3. (right) Map showing the LCLU specifications in northeastern Puerto Rico for (top) 1951 and (bottom) 2000; 2000 information is complemented with remote sensing data obtained from the ATLAS sensor. The thick solid vertical line represents the location of the north–south vertical cross section in Figs. 8 and 9. (left) (top) Histogram of historical LCLU changes in percent of total area covered from 1951 to 2000 and (bottom) description of the most relevant vegetation and land classes with percent change and conversion rates.

Comarazamy, Daniel E, Jorge E Gonz‡lez, Jeffrey C Luvall, Douglas L Rickman, and Robert D Bornstein. 2013. “Climate Impacts of Land-Cover and Land-Use Changes in Tropical Islands Under Conditions of Global Climate Change.”Journal of Climate 26 (5): 1535–50. doi:10.1175/JCLI-D-12-00087.

Environmental Surveillance and Monitoring System

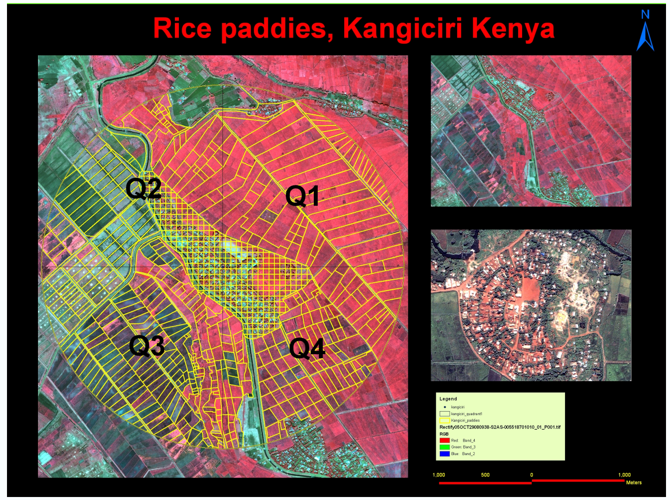
Robert J. Novak, PhD
University of South Florida
College of Public Health
Department of Global Health

Plasmodium falciparum is a protozoan parasite, one of the species of Plasmodium that cause malaria in humans.
(P. vivax was also present in Cambodia)



Key Input Elements of the Cyber System Platform.

Community Based = Evidence Based Data



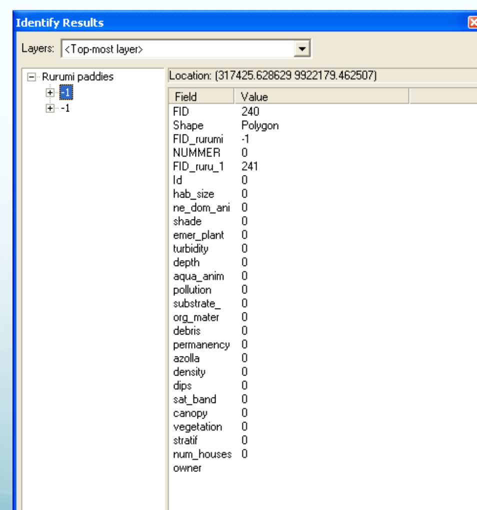
0.6m QuickBird
Image with digitized grid

Entomological Data Menu
- Adult Density
- Indoor Biting Collections
- EIR
- Larval Abundance
- Aquatic habitats
- Habitat productivity

Family Information Menu
- House location
- House type
- Children
- Animals
- Roof type
- Cell phone number

Mosquito Control Menu
- indoor type
- outdoor
- timing

A single location multiple data menu system

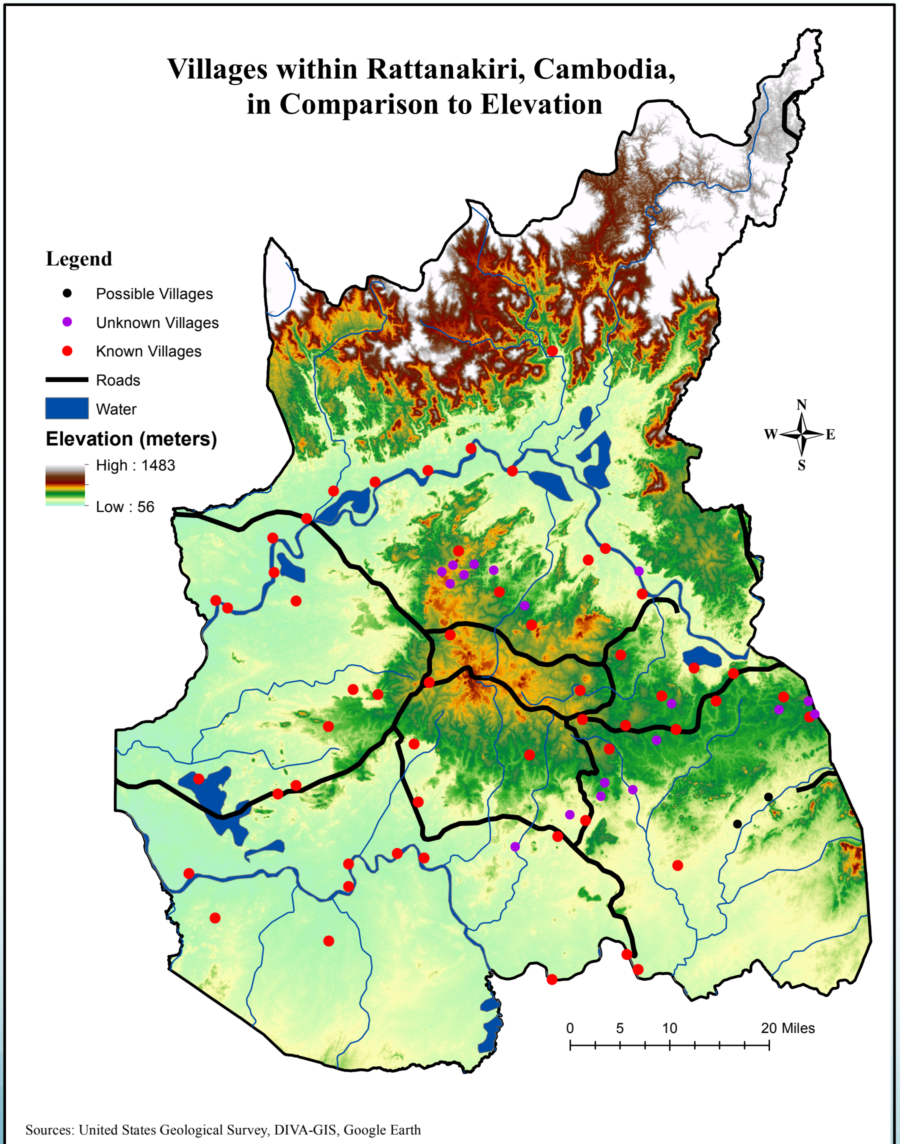


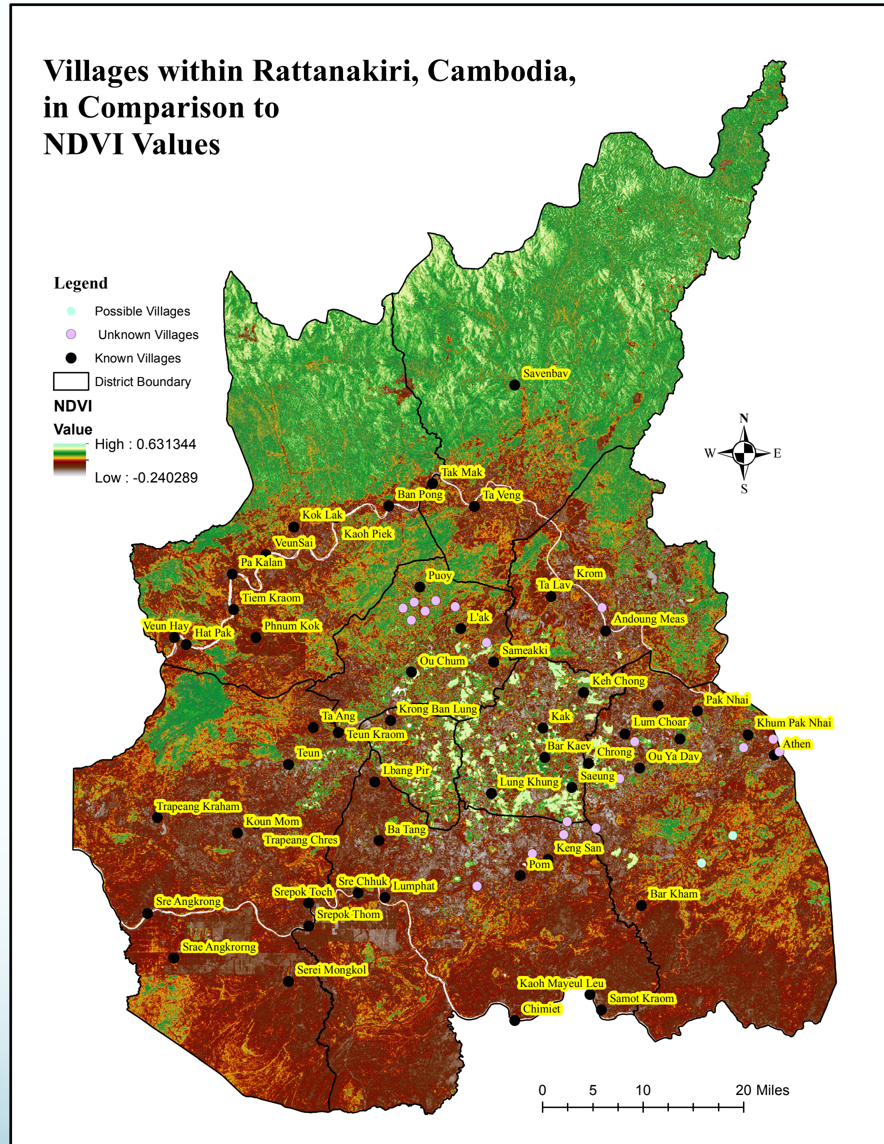
Parasitology Data Menu
- Thick smear
- plasmodium type
- therapy

Environmental Data Menu
- flood pattern
- shade
- containers
- water sources

Personal Protection Menu
- bed nets
- usage
- types
- location

RattanKiri Elevation and NDVI Maps



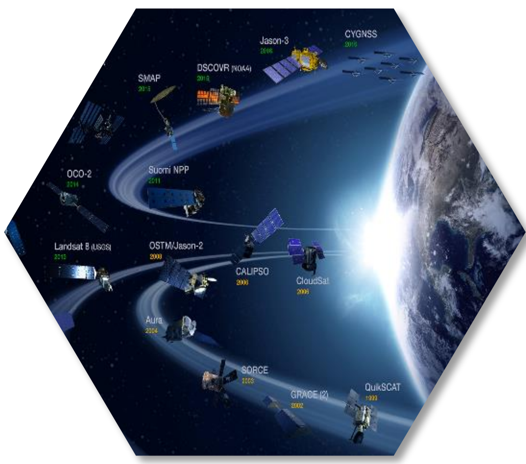


DELIVERABLES

1. To develop an “off the shelf” user friendly Product for “Environmental Surveillance and Monitoring using GIS, remote sensing technologies, providing for the basic elements applicable to multiple landscapes and geographic areas (global) to provide near real time information for decision makers at all levels of Government and malaria control operations.
2. The Product will provide the means for overlaying a measured and changeable grid for enhance logistics for surveillance and sampling from high resolution satellite data and the ability to create associated data files to specific areas of concern.
3. The product will also provide a user friendly means to identify and monitor aquatic and terrestrial mosquito habitats and create “unique habitat signature” for Anopheles species (habitat signatures to locate new and unknown habitats.
4. The Product will also provide “user friendly” means to create digital elevation, climate and vegetation models to locate and monitor areas of concern for malaria transmission.
5. The Product using remote sensing technology provides the means to detect plums of CO_2 and ammonia in 20 to 60 cm^2 units to locate areas of high attractive risk to human hosts.
6. The product will include open data architecture to accommodate multiple users and databases.
7. This new signature ability is combined with UAV (Drone) technology developed for mosquito surveillance and control to fine-tune habitat signatures regarding temporal habitat variations.

What is DEVELOP?

DEVELOP addresses environmental and public policy issues through interdisciplinary feasibility studies that apply the lens of NASA Earth observations to community concerns around the globe. Bridging the gap between NASA Earth Science and society, DEVELOP projects build capacity in both participants and partner organizations to better prepare them to address the challenges that face our society and future generations.



NASA Earth Science

DEVELOP

Decision Makers

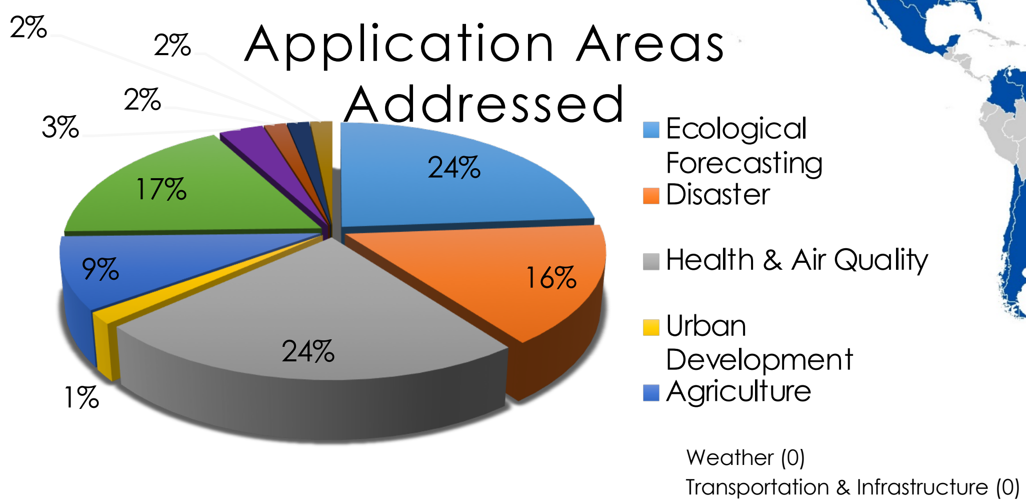
Alabama – Marshall Portfolio

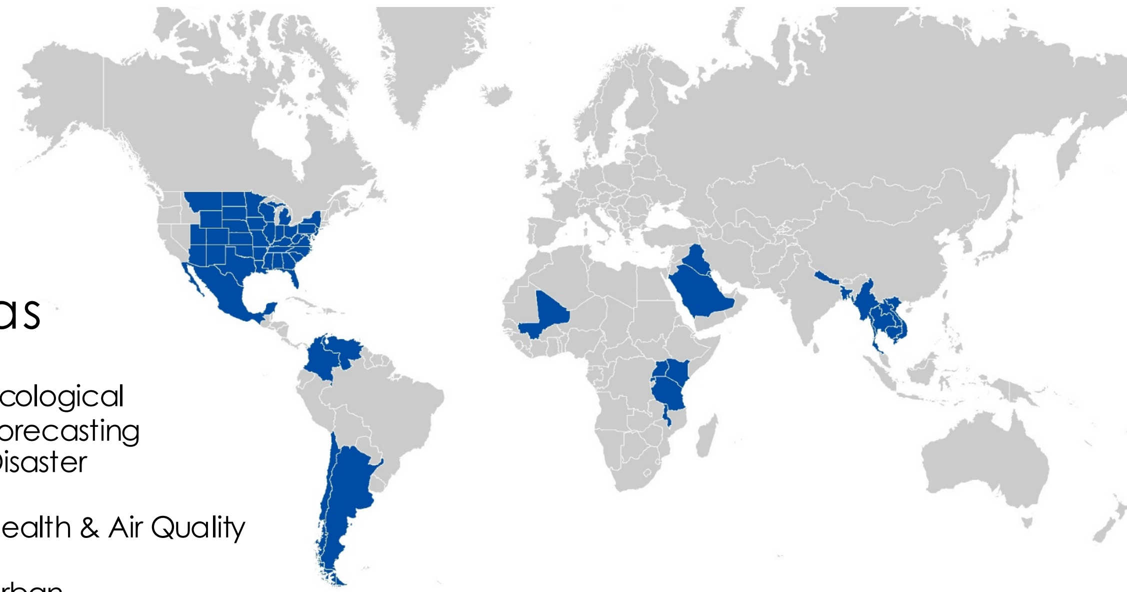
1st TERM (53)

2nd & 3rd TERM (10)

63 Projects

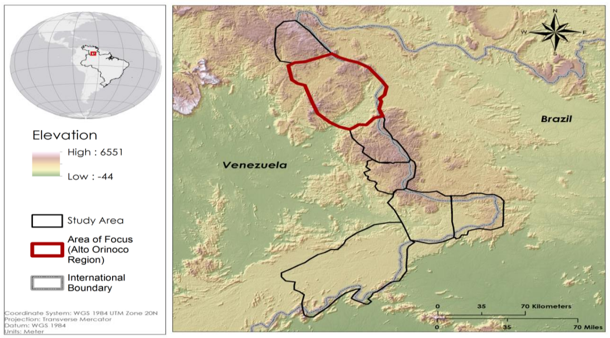
65% Domestic
35% International





Data from Fall 2004 to Spring 2018

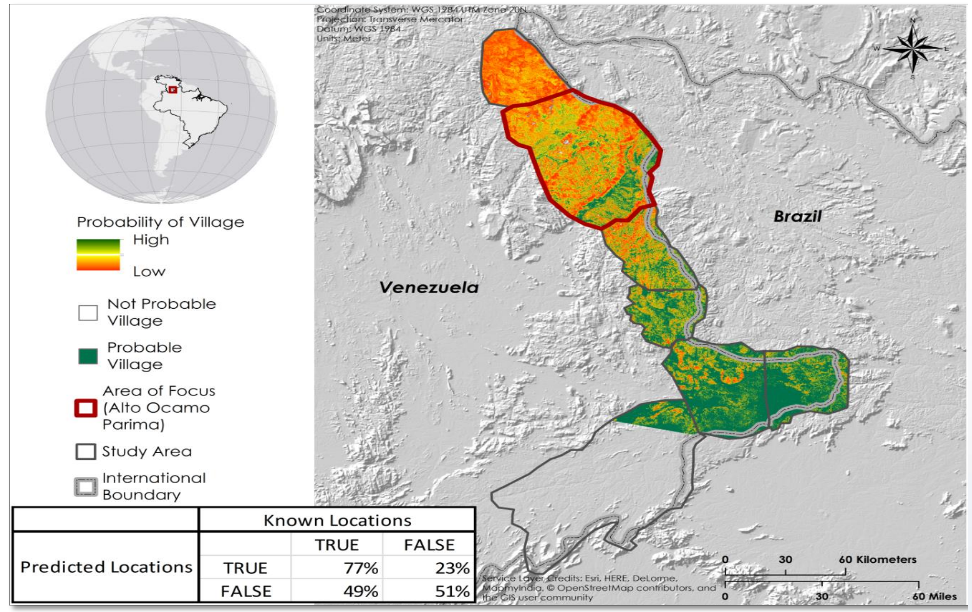
DEVELOP Projects May Have Significant Societal Impacts



Utilizing NASA Earth Observations to Locate Remote Yanomami Villages in the Alto Orinoco Municipality for Targeted Eradication of River Blindness Disease

NASA Goddard Space Flight Center/NASA Marshall Space Flight Center/Wise County

Summer 2015



		Known Locations	
		TRUE	FALSE
Predicted Locations	TRUE	77%	23%
	FALSE	49%	51%

Figure 7: Probable village locations estimated based on the environmental factors corresponding to the villages

These coordinates of village locations, as well as other environmental parameters, were used in a Suitability Model to estimate the probability of a village being located there (Figure 7). This process yielded results with a cross-validation accuracy of 76%, a cross-validation correlation of 0.6, and a significance of less than 0.01.

HyspIRI Application TM

Application Question	Application Concept	Application Measurement Goals	Applied Sciences Category	Potential Host Agency	Mission Data Product	Projected Mission Performance	ARL	Ancillary Measurements
How do we schedule water releases & determine availability for irrigation use?	The major pathway of water transport in the hydrologic cycle is evapotranspiration(ET). ET is difficult to measure directly for large areas and determination of ET relies on a combination of models and surface parameterizations. Accurate determination of surface temperatures is critical in model parameterizations.	Spatial variability of landscape elements necessaite fine spacial resolution measurements ~ 60m. Repeat measurements of approximately 5 days are required to constrain ET models.	Water Management Agriculture	Western Governors Association 1600 Broadway Suite 1700 Denver, CO 80202 303 623-9378 Sebal North America 1772 Picasso Avenue Suite E Davis, California Phone: (530) 757 9200	Surface temperature	Measure surface temperature within 0.5 K , 60 m resolution and 5 day repeat cycle.	9	SEBAL, other ET models, agricultural crop indentification/management info, stream flow, ppt, soils
productivity of the intercoastal waters & barrier islands, e.g. Monitoring Gulf Mexico - spawning cycles, migration, land-use, productivity.	Characterize the physical, chemical, and biological status of coastal and estuarine environments and ecosystems.	fine spacial resolution measurements ~ 60m. Repeat measurements of approximately 5 days are required for enviromental measurements. 19 days for hyperspectral vegetation mapping/physological status.	Ecological Forcasting	national Seashore Maththew Johnson, matthew_w_johnson@nps.gov (228) 230 4139.	Hyperspectral radiance measurements & surface temperatures	within 0.5 K , 60 m resolution and 5 day repeat cycle. Provide hyperspectral radiance measurements at 60 m resolution on a 19 day repeat cycle.	6	Ecosystem structural & functional measurments, hydrolab water chemistry measurements,
How does surface water temperature affect manatee migration	Characterize patterns and trends in fine spacial scale river, estuarine, and near coastal water temperatures.	30-60m spatial resolution, 3-5 day thermal measurements (0.5K). At least 1 nightime measurement within the 3-5 dya window.	Ecological Forcasting	Dauphin Island Sea Lab Ruth Carmichael rcarmichael@disl.org. (251) 861 7555	Surface temperature	Measure surface temperature within 0.5 K , 60 m resolution and 5 day repeat cycle	6	Bouy temperatures
What are the abiotic environmental factors are important in determining the distribution of disease-causing vectors and their life-cycles?	Research!America's global health program advocates for funding and policies that spur research to develop vitally important global health technologies.	Spatial variability of landscape elements necessaite fine spacial resolution measurements ~ 60m. Repeat measurements of approximately 5 days are required for enviromental measurements. 19 days for hyperspectral vegetation mapping/physological status	Public Health	Alexandra FrankAlexandra Frank Senior Program Manager, Global Health R&D Advocacy Research!America 703-739-2577 (main) 571-482-2707 (direct)	Hyperspectral radiance measurements & surface temperatures	Measure surface temperature within 0.5 K , 60 m resolution and 5 day repeat cycle. Provide hyperspectral radiance measurements at 60 m resolution on a 19 day repeat cycle.	6	Assimilations driven by observational data LDAS and satellite-derived meteorological forcing data, parameter datasets, and assimilation observations, including:Precipitation from TRMM, and GPM Land Cover Type from HyspIRI Soil Moisture from AMSR-E (where applicable), SMAP and HyspIRI. Terrestrial Water Storage from GRACE and GRACE II. Surface temperature, Vegetation Fraction/ Leaf Area Index, and canopy physiology from HyspIRI. Topography from SRTM. Epidemiological surveys of targed diseases. Vector population sampling & testing for disease organism.

Developing an Applied Science traceability matrix that is defensible and measurable in conjunction with the Science Traceability Matrix

Characterize the problem space or the baseline

- What are the characteristics of your application's current information product(s):
  - Variable
  - Temporal
  - Spatial
  - Units
  - Geographic domain
- How is the information currently used?

↓

Your hypothesis and objective.

- How would you evaluate the complementarity or the utility of your proposed work versus the baseline?
- How does your proposed work improve upon that baseline?

↓

Science and Applications Traceability Matrix

- Define your (Applied) Science Question and Objective
- Document your observables and their requirements and make the case that they can be used to address the hypotheses/objectives

Developing an SATM

Characterize the problem space or the baseline

- What are the characteristics of your application's current information product(s):
  - Variable
  - Temporal
  - Spatial
  - Units
  - Geographic dom
- How is th

Add sample text describe each category – start with baseline and hypothesis/objective

…the
…y of the utility of your
…d work versus the baseline?
How does your proposed work improve upon that baseline?

Your hypothesis and objective

Science and Applications Traceability Matrix

- Define your (Applied) Science Question and Objective
- Document your observables and their requirements and make the case that they can be used to address the hypotheses/objectives

Developing an SATM

Characterize the problem space or the baseline

- What are the characteristics of your application's current information product(s):
  - Variable
  - Temporal
  - Spatial
  - Units
  - Geographic domain
- How is the information currently used?

Example

Heat Index (0-1) based on daily weather forecasts over County region. Spatial resolution TBC.

Information is used to for county level emergency response to heat waves and planning of resources (cooling stations, hospital surveillance for heat stress-related conditions)

Your hypothesis and objective.

- How would you evaluate the complementarity or the utility of your proposed work versus the baseline?
- How does your proposed work improve upon that baseline?

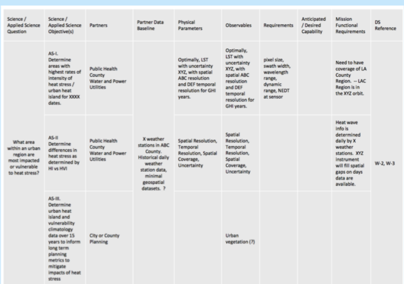
Determine utility of HVI (proposed RS-based product) versus the standard Heat Index for assessing heat wave impacts in X County.

HVI is better correlated with heat-related stress conditions reported at hospitals.

Science and Applications Traceability Matrix

- Define your (Applied) Science Question and Objective
- Document your observables and their requirements and make the case that they can be used to address the hypotheses/objectives

See table on next page.



Science / Applied Science Question	Science / Applied Science Objective(s)	Partners	Partner Data Baseline	Physical Parameters	Observables	Requirements	Anticipated / Desired Capability	Mission Functional Requirements	DS Reference
What area within an urban region are most impacted or vulnerable to heat stress?	AS-I. Determine areas with highest rates of intensity of heat stress / urban heat island for XXXX dates.	Public Health County Water and Power Utilities	X weather stations in ABC County. Historical daily weather station data, minimal geospatial datasets. ?	Optimally, LST with uncertainty XYZ, with spatial ABC resolution and DEF temporal resolution for GHI years.	Optimally, LST with uncertainty XYZ, with spatial ABC resolution and DEF temporal resolution for GHI years.	pixel size, swath width, wavelength range, dynamic range, NEDT at sensor		Need to have coverage of LA County Region. -- LAC Region is in the XYZ orbit.	W-2, W-3
	AS-II Determine differences in heat stress as determined by HI vs HVI	Public Health County Water and Power Utilities		Spatial Resolution, Temporal Resolution, Spatial Coverage, Uncertainty	Spatial Resolution, Temporal Resolution, Spatial Coverage, Uncertainty			Heat wave info is determined daily by X weather stations. XYZ instrument will fill spatial gaps on days data are available.	
	AS-III. Determine urban heat island and vulnerability climatology data over 15 years to inform long term planning metrics to mitigate impacts of heat stress	City or County Planning			Urban vegetation (?)				

DS Designated Observables (DOs) ***Surface Biology and Geology (SBG)***

Science – Applications Traceability Matrix Example

Science / Applied Science Question	Science / Applied Science Objective(s)	Partners	Partner Data Baseline	Physical Parameters	Observables	Requirements	Anticipated / Desired Capability	Mission Functional Requirements	DS Reference
What area within an urban region are most impacted or vulnerable to heat stress?	AS-I. Determine areas with highest rates of intensity of heat stress / urban heat island for XXXX dates.	Public Health County Water and Power Utilities	X weather stations in ABC County. Historical daily weather station data, minimal geospatial datasets. ?	Optimally, LST with uncertainty XYZ, with spatial ABC resolution and DEF temporal resolution for GHI years.	Optimally, LST with uncertainty XYZ, with spatial ABC resolution and DEF temporal resolution for GHI years.	pixel size, swath width, wavelength range, dynamic range, NEDT at sensor		Need to have coverage of LA County Region. -- LAC Region is in the XYZ orbit.	W-2, W-3
	AS-II Determine differences in heat stress as determined by HI vs HVI	Public Health County Water and Power Utilities		Spatial Resolution, Temporal Resolution, Spatial Coverage, Uncertainty	Spatial Resolution, Temporal Resolution, Spatial Coverage, Uncertainty			Heat wave info is determined daily by X weather stations. XYZ instrument will fill spatial gaps on days data are available.	
	AS-III. Determine urban heat island and vulnerability climatology data over 15 years to inform long term planning metrics to mitigate impacts of heat stress	City or County Planning			Urban vegetation (?)				