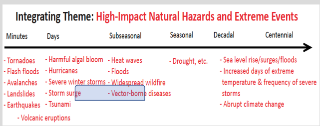
SBG Applications: Public Health and Urban Environments

Jeffrey Luvall[1], Ryan Avery[2], Jorge Gonzalez[3]
Christine Lee[4], Natasha Stavros[4], and Nancy Glenn[5]
[1] NASA, MSFC, [2]LSU, [3]CCNY, [4]Jet Propulsion Laboratory, California Institute of Technology, [5]Boise State Univ.

Societal or Science Question/Goal	Earth Science/Applications Objective
QUESTION H-2. How do anthropogenic changes in climate, land use, water use, and water storage interact and modify the water and energy cycles locally, regionally, and globally, and what are the short- and long-term consequences?	**H-2a.** Quantify how changes in land use, water use, and water storage affect evapotranspiration rates, and how these in turn affect local and regional precipitation systems, groundwater recharge, temperature extremes, and carbon cycling.
QUESTION H-3. How do changes in the water cycle impact local and regional freshwater availability, alter the biotic life of streams, and affect ecosystems and the services these provide?	**H-3b**. Monitor and understand the coupled natural and anthropogenic processes that change water quality, fluxes, and storages in and between all reservoirs (atmosphere, rivers, lakes, groundwater, and glaciers) and the response to extreme events.
QUESTION H-4. How does the water cycle interact with other Earth system processes to change the predictability and impacts of hazardous events and hazard chains (e.g., floods, wildfires, landslides, coastal loss, subsidence, droughts, human health, and ecosystem health), and how do we improve preparedness and mitigation of water related extreme events?	**H-4d.** Understand linkages between anthropogenic modification of the land, including fire suppression, land use, and urbanization on frequency of, and response to, hazards. (This is tightly linked to H-2a, H-2b, H-4a, H-4b, and H-4c.)
QUESTION W-1. What planetary boundary layer (PBL) processes are integral to the air-surface (land, ocean, and sea ice) exchanges of energy, momentum, and mass, and how do these impact weather forecasts and air quality simulations?	**W-1a.** Determine the effects of key boundary layer processes on weather, hydrological, and air quality forecasts at minutes to sub seasonal time scales
QUESTION W-3. How do spatial variations in surface characteristics (influencing ocean and atmospheric dynamics, thermal inertia, and water) modify transfer between domains (air, ocean, land, and cryosphere) and thereby influence weather and air quality.	**W-3a.** Determine how spatial variability in surface characteristics modifies regional cycles of energy, water, and momentum (stress) to an accuracy of 10 W/m2 in the enthalpy flux, and 0.1 N/m2 in stress, and observe total precipitation to an average accuracy of 15% over oceans and/or 25% over land and ice surfaces averaged over a 100 × 100 km region and 2- to 3-day time period.
QUESTION E-1. What are the structure, function, and biodiversity of Earth's ecosystems, and how and why are they changing in time and space ?	**E-1a.** Quantify the distribution of the functional traits, functional types, and composition of terrestrial and shallow aquatic vegetation and marine biomass, spatially and over time. **E-1b.** Quantify the global three-dimensional (3D) structure of terrestrial vegetation and 3D distribution of marine biomass within the euphotic zone, spatially and over time. **E-1c**. Quantify the physiological dynamics of terrestrial and aquatic primary producers. E-1d. Quantify moisture status of soils. **E-1e.** Support targeted species detection and analysis (e.g., foundation species, invasive species, indicator species, etc.).
QUESTION E-3. What are the fluxes (of carbon, water, nutrients, and energy) within ecosystems, and how and why are they changing?	**E-3a.** Quantify the flows of energy, carbon, water, nutrients, and so on, sustaining the life cycle of terrestrial and marine ecosystems and partitioning into functional types.

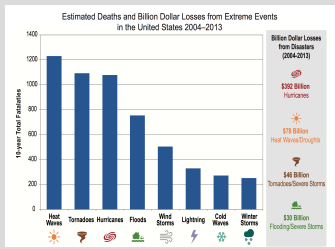


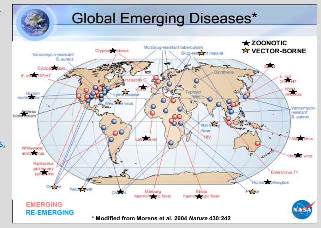
SBG Questions H-2a,3b,4d, W-1a,3a, E-1a,1b,1c,1e,3a call for measurements or the generation of higher level data products in combination with other data sources:

Measure environmental state functions important to vector & disease life cycles (within vector)
Precipitation, Soil moisture, temperature, vapor pressure deficits, wet/dry edges, solar radiation….

***But also the interfaces as process functions*:**
Land use/cover mapping; Ecological functions/structure, canopy cover, species, phenology, aquatic plant coverage…..

And provides a Spatial Context
Spatial coverage & topography – local, regional & global…
Lastly, but perhaps the greatest strength:
Provides a time series of measurements

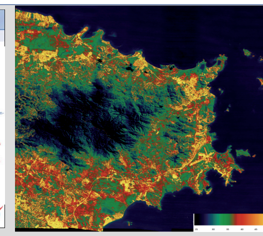




Vector borne diseases are emerging and re-emerging on a global scale. Vector-borne diseases were once a major public health concern only in tropical and subtropical areas, but today they are also an emerging threat for the continental and developed countries. Vector-borne diseases are among the most complex of all infectious diseases to prevent and control. Not only is it difficult to predict the habits of the vectors, but most vector-borne agents can infect animals as well. Currently existing satellites do not meet all of spectral, spatial, and temporal requirements to define and quantify these significant multi-factorial relationships affecting vector borne disease life cycles.

The leading cause of deaths in urban areas are heat waves which are enhanced by the increased urban air temperatures resulting from urbanization (urban heat island effect)

Urbanization Impacts:
Precipitation patterns
Air Temperatures (Urban Heat Island, UHI)
Regional Climate/weather
Hydrology
Air & water quality



Thermal image for the Luquillo Mountains and surrounding area of Puerto Rico showing the impact of urban development on surface temperatures.

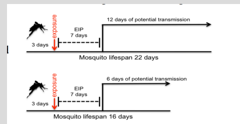


Figure 8 (from Christofferson & Mores 2016): Schematic demonstrating the impact of mosquito mortality on the cumulative transmission potential of an arbovirus.

The UHI may risk of transmission of vector borne diseases due to increases in air temperatures and the its impact on life cycles

DS Question	Application Concept	Decision Approach	L2+ VSWIR (one row) and TIR (another row)	Spatial	Temporal	Latency	Other Design Considerations	End Users	Auxillary	Additional Comments, such as key references
H-2. How do anthropogenic changes in climate, land use, water use, and water storage, interact and modify the water and energy cycles locally, regionally and globally and what are the short- and long-term consequences?	Improving characterization of urban heat islands / heat stress / heat waves	Apply improved UHI and heat wave products to support response (cooling stations, heat alerts) and mitigation of impacts (different building materials, vegetation, etc.)	L4 - Albedo L3 - Vegetation - Impervious Surface Fraction L3 - Evapotranspiration L2 - Surface Reflectance L2 - Land Surface Temperature L2 - Land Surface Emissivity L3 - Heat Index L3 - Humidity	20-100m	Hourly	Daily; can get away with less latency and use geostationary for more frequent responses		NWS; NCAR; Weather Modelers; Public Health Agencies; Urban Planners		Algorithms would need to be developed to quantify surface humidity and combine it with LST (new L4). This may require use of multiple satellites.
H-2. How do anthropogenic changes in climate, land use, water use, and water storage, interact and modify the water and energy cycles locally, regionally and globally and what are the short- and long-term consequences?	Improving characterization of land surface products and of surface energy fluxes	Quantify thermal storage of built and natural surfaces to improve surface energy balance for city growth planning and climate models	L4 - Albedo L3 - Vegetation - Impervious Surface Fraction L3 - Evapotranspiration L3- Land surface classification, also need soil water content, soil moisture L2 - Surface Reflectance L2 - Land Surface Temperature L2 - Land Surface Emissivity L3 - Sensible heat flux LX - Latent flux	20-100m	Sub-Hourly to day-night pairs for a single durnal cycle; 4-5 day repeat as long as there are day-night pairs	Daily with day-night pairs; use with combination of geostationary (see above)	For the day-night pairs it critical to have the ability detect/screen cloud contaminated pixels	NWS; NCAR; Weather and Climate Modelers; city planners.	Lidar for urban volume. GOES 16 data for increased temporal resolution	Algorithms would need to be developed to quantify all surface energy terms. also use ECOSTRESS Use of the TRN- tjhermal response number for storage
H-4. How does the water cycle interact with other Earth System processes to change the predictability and impacts of hazardous events and hazard-chains (e.g. floods, wildfires, landslides, coastal loss, subsidence, droughts, human health, and ecosystem he	Improving characterization of surface water for predicting vector borne and infectious diseases (for specific outbreaks)	Mapping surface water and relative humidity directly relates to insect habitat for propagating vector borne diseases for public health (for specific outbreaks)	L4 - Albedo L3 - Vegetation - Impervious Surface Fraction L3 - Evapotranspiration L2 - Surface Reflectance L2 - Land Surface Temperature L2 - Land Surface Emissivity	20-100m; <30 m for fine scale water bodies/standing water bodies	2- 5 days	Monthly		CDC; Public health epidemiologists; Urban Planners;	Lidar for urban volume.	Artificial bodies of water (irrigation ditches) esp in urban environments; cholora need high temporal resolution (incidences) whereas others can have coarser temporal resolution (long-term monitoring)
H-4. How does the water cycle interact with other Earth System processes to change the predictability and impacts of hazardous events and hazard-chains (e.g. floods, wildfires, landslides, coastal loss, subsidence, droughts, human health, and ecosystem he	Improving characterization of surface water for predicting vector borne and infectious diseases (for long term monitoring)	Mapping surface water and relative humidity directly relates to insect habitat for propagating vector borne diseases for public health (for long-term monitoring)	L4 - Albedo L3 - Vegetation - Impervious Surface Fraction L3 - Evapotranspiration L2 - Surface Reflectance L2 - Land Surface Temperature L2 - Land Surface Emissivity	20-100m; <30 m for fine scale water bodies/standing water bodies	monthly to seasonally	Monthly		CDC; Public health epidemiologists; Urban Planners;	Lidar for urban volume.	Artificial bodies of water (irrigation ditches) esp in urban environments; cholora need high temporal resolution (incidences) whereas others can have coarser temporal resolution (long-term monitoring)
H-2. How do anthropogenic changes in climate, land use, water use, and water storage, interact and modify the water and energy cycles locally, regionally and globally and what are the short- and long-term consequences?	Improving characterization land cover for predicting vector borne and infectious diseases	Integrating urban expansion and land cover change into models to better understand transmission to new/different areas and inform policy of land use, clinic placement, etc.	L3 - Open Water L3 - Land Cover Class (urban, crop, crop type, etc) L3 - Substrate type (sand, clay, rock, etc) L3 - Water vapor L3- Canopy chlorophyll L3- NPV/PV L3-Vegetation water content L2 - Surface Reflectance L2 - Land Surface Temperature L2 - Land Surface Emissivity	30 m for landcover and vegetation 1 km for open water	Monthly - Seasonally	< 30 days		CDC; WHO; International policy makers; urban planners/developers; USDA APHIS; epidemiologists; biologists	health data	high resolution (30 m) need for municipalities
H-4. How does the water cycle interact with other Earth System processes to change the predictability and impacts of hazardous events and hazard-chains (e.g. floods, wildfires, landslides, coastal loss, subsidence, droughts, human health, and ecosystem he	Vector borne Disease Forecasting	Assimilate albedo, vegetation urban fractions and LST and into regional weather forcasting models to investigate the impact of urbanization on vector born disease enironmental response	L4-Albedo L3-Vegetation/Urban Fractions L2-Surface Reflectance	20-100m	2- 5 days			NWS; NCAR; Weather and Climate Modelers; Public health epidemiologists; Urban Planners.	Lidar for urban volume.	Moldels needed to be developed intregrating regional climate models/forcasts with disease vector epidemiological modeling

Comment Board

Info on who we are, charter, how to join

http://tinyurl.com/SBGApplicationsWG