ECOSTRESS - Pathway for Use of HyspIRI Thermal Data

- Urban Climatology
- Aquatic Ecosystems
- Public Health
- DEVELOP Projects
- Water Resources
**HyspIRI Objectives and Approach**

### Key Science and Science Applications

**Climate:** Ecosystem biochemistry, condition & feedback; spectral albedo; carbon/dust on snow/ice; biomass burning; evapotranspiration

**Ecosystems:** *Global* biodiversity, plant functional types, physiological condition, and biochemistry including agricultural lands

**Fires:** Fuel status; fire frequency, severity, emissions, and patterns of recovery *globally*

**Coral reef and coastal habitats:** *Global* composition and status

**Volcanoes:** Eruptions, emissions, regional and *global* impact

**Geology and resources:** *Global* distributions of surface mineral resources and improved understanding of geology and related hazards

**Applications:** Disasters, EcoForecasting, Water, Health/AQ

### Mission Urgency

The HyspIRI science and applications objectives are critical today and uniquely addressed by the combined imaging spectroscopy, thermal infrared measurements, and IPM direct broadcast.

### Measurement

**Imaging Spectrometer (VSWIR)**
- 380 to 2500nm in ≤10nm bands
- 30 m spatial sampling*
- 19 days revisit*
- Global land and shallow water

**Thermal Infrared (TIR):**
- 8 bands between 4-12 µm
- 60 m spatial sampling
- 5 days revisit; day/night
- Global land and shallow water

**IPM-Low Latency data subsets**

### Mission Concept Status

**Level 1 Measurement Requirements:** Vetted by community and stable

**Payload:** VSWIR Imaging Spectrometer, TIR Multi-spectral Radiometer, and **Intelligent Payload Module (IPM)**

**Full Mission original option:** Mature

**Separate Small Mission option:** Pegasus-based solutions identified and studied

*SLI Support: HyspIRI VSWIR evolving to 30m at 185km swath

**ECOSTRESS TIR:** Selected EVI for ISS

**VSWIR Dyson Option:** Technology/Science ISS Demonstration

**Summary:** The HyspIRI mission measurement requirements and baseline instruments approach are mature and stable with good heritage, low risk and modest cost. Now exploring a range of instrument and data options to save cost, per guidance letter.
HyspIRI TQ4. Urbanization/Human Health

- How does urbanization affect the local, regional and global environment? Can we characterize this effect to help mitigate its impact on human health and welfare?
- How do changes in land cover and land use affect surface energy balance and the sustainability and productivity of natural and human ecosystems?
- What are the dynamics, magnitude, and spatial form of the urban heat island effect (UHI), how does it change from city to city, what are its temporal, diurnal, and nocturnal characteristics, and what are the regional impacts of the UHI on biophysical, climatic, and environmental processes?

- Human Health - heat mortality, vector borne diseases
- Heat and Air Quality
- Urban Heat Island (UHI)
- Land Cover/Land Use change
- Regional climate impacts
Quantification and mitigation of long-term impacts of urbanization and climate change in the tropical coastal city of San Juan, Puerto Rico

Daniel E. Comarazamy1, Jorge E. González2 and Jeffrey C. Luvall3
1The NOAA-CREST Center, The City College of New York, New York, NY, USA
2The NOAA-CREST Center and Department of Mechanical Engineering, The City College of New York, New York, NY, USA; 3Global Hydrology and Climate Center, NASA Marshall Space Flight Center, Huntsville, AL, USA

Climate Impacts of Land-Cover and Land-Use Changes in Tropical Islands under Conditions of Global Climate Change

DANIEL E. COMARAZAMY
NOAA/CREST Center, City College of New York, New York, New York

JORGE E. GONZÁLEZ
NOAA/Cooperative Remote Sensing Science and Technology Center (CREST), and Department of Mechanical Engineering, City College of New York, New York, New York

JEFFREY C. LUVALL AND DOUGLAS L. RICKMAN
Global Hydrology and Climate Center, NASA Marshall Space Flight Center, Huntsville, Alabama

ROBERT D. BORNSTEIN
Department of Meteorology and Climate, San Jose State University, San Jose, California

(Manuscript received 7 February 2012, in final form 6 September 2012)

Combined impacts of land cover changes and large-scale forcing on Southern California summer daily maximum temperatures

Pedro Sequera, Jorge E. González, Kyle McDonald, Robert Bornstein, Daniel Comarazamy

First published: 21 September 2015  Full publication history
DOI: 10.1002/2015JD023536  View/save citation
Cited by: 0 articles  Check for new citations

Funding Information
WUDAPT at the American Metereological Society (AMS) meeting

Join us at the AMS meeting, 22-26 January 2017

The World Urban Database and Access Portal Tools (WUDAPT) is an initiative to collect data on the form and function of cities around the world.
Sacramento
Skattergram of Albedo vs Temperature
Summer Field Studies to Improve Our Understanding of Extreme Heat Events in Dense Urban Environments

NYC Boundary-layer Observations:
The thermal conditions of the atmosphere above the City was continuously monitored using a microwave radiometer located at CCNY campus (operated by NOAA-CREST@CCNY). Fig below virtual potential temperature contours from ground to 5km beginning July 9 to July 23. During July 15th to 18th, when the 2-m air temperature were around 90°F during the midday and afternoon periods, high temperatures are visible in the lower portion of the boundary layer. This is also visible on July 22nd and 23rd as the heat wave sets in. During non-heatwave days, the temperature in the PBL is at least 10K cooler.

Jorge Gonzalez
gonzalez@me.ccny.cuny.edu
Urban Remote Sensing and Air Quality Models

Volatile Organic Compounds + Nitrogen Oxides + Sunlight → Ozone

- Air pollution remains a National issue.
- Temperature increases the ozone levels.
- Urban heat island has major effect on temperature and height of mixing layer.
- Measurement program is defining land use patterns and relationship to heat production.
- Remote sensing data are being used to improve air quality modeling.
Vicarious calibration and visible derivative spectroscopy to estimate the composition of the 2015 CyanoHAB in Sandusky Bay, Lake Erie

Dr. J.D. Ortiz (Kent State Univ), Stephen Schiller (SDSU), Jeffrey Luvall (NASA MSFC), John Lekki (NASA Glenn), and George Bullerjhan (BGSU)

CyanoHAB on Lake Erie
September 3, 2011

(AGU Blogosphere)

Ortiz et al., (HyspIRI 2015)
SST Composite from 00Z to 12Z - Great Lakes Regional

Select an image: [February 02, 2017 — 06:00 UTC]

Total number of images: 21. Total size: 1.1 MB.
Lake Erie Bathymetry
The epidemiological equations (processes) can be adapted and modified to *explicitly incorporate environmental factors and interfaces*.

Remote sensing can be used to measure or evaluate or estimate *both environment (state functions) and interface (process functions)*. The products of remote sensing must be expressed in a way they *can be integrated directly into the epidemiological equations*. The desired logical structures must be consistent with thermodynamic and with probabilistic frameworks.
Epidemiologic Triangle of Disease (Vector-borne Diseases)

A multi-factorial relationship between hosts, agents, vectors and environment

Morin 2014
Surface Energy Budget

\[ Q^* = H + LE + G \]

H = Sensible Heat Flux
LE = Latent Heat Flux
G = Storage (maybe + or - )
Maxent generated risk surfaces for Colombia generated from national scale datasets on Chagas disease

Malone 2005
Table 7. Descriptive statistics of dengue cases, environmental and socio-demographic characteristics compared across GND with incidence rate (IR) above and below the median IR

<table>
<thead>
<tr>
<th>Characteristics of dengue cases</th>
<th>Overall</th>
<th>High IR&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Low IR&lt;sup&gt;a&lt;/sup&gt;</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Cases (n)</td>
<td>5379</td>
<td>3096</td>
<td>2283</td>
<td></td>
</tr>
<tr>
<td>Number of Dengue cases by years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 2005</td>
<td>436</td>
<td>245 (7.9)</td>
<td>191 (8.4)</td>
<td>0.0342</td>
</tr>
<tr>
<td>Year 2006</td>
<td>300</td>
<td>156 (5.0)</td>
<td>135 (5.9)</td>
<td></td>
</tr>
<tr>
<td>Year 2007</td>
<td>261</td>
<td>167 (5.4)</td>
<td>102 (4.5)</td>
<td></td>
</tr>
<tr>
<td>Year 2008</td>
<td>314</td>
<td>195 (6.3)</td>
<td>116 (5.1)</td>
<td></td>
</tr>
<tr>
<td>Year 2009</td>
<td>812</td>
<td>479 (15.5)</td>
<td>322 (14.1)</td>
<td></td>
</tr>
<tr>
<td>Year 2010</td>
<td>1269</td>
<td>700 (22.6)</td>
<td>578 (25.3)</td>
<td></td>
</tr>
<tr>
<td>Year 2011</td>
<td>1987</td>
<td>1154 (37.3)</td>
<td>839 (36.8)</td>
<td></td>
</tr>
<tr>
<td>Age (mean, SD)</td>
<td>13.7</td>
<td>14.9 (14.3)</td>
<td>12.1 (12.8)</td>
<td></td>
</tr>
<tr>
<td>Age range (in years)</td>
<td>0.1-89</td>
<td>0.1-89</td>
<td>0.1-81</td>
<td>&lt;0.000</td>
</tr>
<tr>
<td>Age Categories (n, %)</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>0-5</td>
<td>1688 (31.4)</td>
<td>884 (28.6)</td>
<td>804 (35.2)</td>
<td></td>
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<tr>
<td>5.1 - 9</td>
<td>1222 (22.7)</td>
<td>687 (22.2)</td>
<td>535 (23.4)</td>
<td></td>
</tr>
<tr>
<td>9.1 to 19</td>
<td>1168 (21.7)</td>
<td>643 (20.8)</td>
<td>525 (23.0)</td>
<td></td>
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<tr>
<td>&gt;19</td>
<td>1302 (24.2)</td>
<td>882 (28.5)</td>
<td>419 (18.4)</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td>0.6017</td>
</tr>
<tr>
<td>Males</td>
<td>2897 (53.9)</td>
<td>1658 (46.5)</td>
<td>1239 (45.7)</td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>2482 (46.1)</td>
<td>1438 (53.6)</td>
<td>1044 (54.3)</td>
<td></td>
</tr>
</tbody>
</table>

Environmental Characteristics

| Buildings (mean, SD)            | 0.47 (0.07) | 0.48 | 0.45 | 0.1548 |
| Vegetation                      | 0.22 (0.09) | 0.21 (0.09) | 0.22 (0.08) | 0.7117 |
| Roads                           | 0.08 (0.04) | 0.12 (0.07) | 0.13 (0.05) | 0.7304 |
| Shadow                          | 0.13 (0.06) | 0.08 (0.04) | 0.07 (0.04) | 0.4616 |
| Green Space                     | 0.04 (0.04) | 0.04 (0.05) | 0.04 (0.03) | 0.9504 |

Household Characteristics

| Brick Walls                     | 0.4 (0.1) | 0.64 (0.12) | 0.54 (0.14) | 0.001  |
| Cement Walls                   | 0.6 (0.1) | 0.31 (0.13) | 0.40 (0.13) | 0.0169 |
| Other wall materials           | 0.1 (0.1) | 0.05 (0.07) | 0.06 (0.07) | 0.5195 |
| Tile Roofs                     | 0.4 (0.2) | 0.36 (0.13) | 0.36 (0.13) | 0.0244 |
| Asbestos Roof                  | 0.5 (0.1) | 0.52 (0.13) | 0.55 (0.09) | 0.3901 |
| Other wall materials           | 0.1 (0.1) | 0.04 (0.06) | 0.08 (0.08) | 0.0294 |

Population Characteristics

| Population density (per 1000 sq meters) | 20 (12.7) | 18 (13) | 24 (11) | 0.06  |
| Housing density                    | 4.2 (2.5) | 347 (258) | 494 (223) | 0.0277 |
NASA DEVELOP National Program 2017 Summer Project
Mobile County Health Department and Marshall Space Flight Center
Coastal Alabama Oceans

*Using NASA Earth Observations to Detect Water Quality in Coastal Alabama in Order to Enhance Marine Wildlife Management*
Confederated Tribes of the Umatilla Indian Reservation (CTUIR)

Thermal remote sensing data to better understand habitats for Pacific Salmon

Scott O’Daniel (CTUIR)
Geostatistics and Spatial Correlation of Metered Irrigation Data in the Apalachicola-Chattahoochee-Flint River Basin, southwestern Georgia

Lynn J. Torak, Hydrologist
Jaime A. Painter, Geographer
U.S. Geological Survey
Georgia Water Science Center
Norcross, Georgia
http://ga.water.usgs.gov/

NASA-MSFC, NSSTC
Presentation
March 19, 2014
Stat Region 1
Middle and Lower Chattahoochee-Flint River basin 2009

- 81 Telemetry sites
  - 46 GW
  - 35 SW
- 4,357 Annually reported sites
  - 3,609 GW
  - 748 SW

USGS

EXPLANATION
Subbasin
- Ichawaynochaway Creek
- Kinchafoonee–Muckalee Creeks
- Lower Chattahoochee River
- Lower Flint River
- Middle Chattahoochee River–Lake Harding
- Middle Chattahoochee River–Walter F. George Reservoir
- Middle Flint River–Lake Blackshear
- Spring Creek
- Upper Flint River

Chattahoochee and Flint River basins

Telemetry
- Annually read meter
- Permitted unmetered

Base modified from U.S. Geological Survey

GSWCC
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<tbody>
<tr>
<td>How do we schedule water use for irrigation?</td>
<td>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 parameterization.</td>
<td>Spatial variability of landscape elements necessitate fine spatial resolution measurements ~ 60m. Repeat measurements of approximately 5 days are required to constrain ET models.</td>
<td>Water Management Agriculture</td>
<td>University of California Davis</td>
<td>Hyperpectral Radiance measurements &amp; surface temperatures</td>
<td>Measure surface temperature within 1.5 km resolution and 5 day repeat cycle</td>
<td>6</td>
<td>Ecosystem structural &amp; functional measurements, hydrologic water chemistry measurements, basin-scale monitoring.</td>
</tr>
<tr>
<td>How does surface water temperature affect marine migration?</td>
<td>Characteristics patterns and trends in fine scale near river estuaries, and near coastal water temperatures.</td>
<td>All-ocean thermal measurements, 5–9 day thermal measurements (0.30) or at least 1 nighttime measurement within the 3–9 day window.</td>
<td>Ecological Forming</td>
<td>National Seashore Matthew Johnson, <a href="mailto:Matthew_w_johnson@nps.gov">Matthew_w_johnson@nps.gov</a> (2021) 219-4235</td>
<td>Hyperpectral Radiance measurements &amp; surface temperatures</td>
<td>Measure surface temperature within 0.5 km, 60 m resolution and 5 day repeat cycle</td>
<td>6</td>
<td>Key temperatures</td>
</tr>
<tr>
<td>What are the abiotic environmental factors important in determining the distribution of disease causing vectors and their life cycles?</td>
<td>Research/understanding global health program advocates for funding and policies that spur research to develop vital global health technologies.</td>
<td>Spatial variability of landscape elements necessitate fine spatial resolution measurements ~ 60m. Repeat measurements of approximately 5 days are required for environmental monitoring. 28 days for hyperspectral vegetation mapping/physiological status.</td>
<td>Public Health</td>
<td>Alejandro Frankel/Seahack, Global Health Program Manager, Global Health Research &amp; Development, 415-707-2177 (voice) 415-482-2707 (direct)</td>
<td>Hyperpectral Radiance measurements &amp; surface temperatures</td>
<td>Measure surface temperatures within 0.5 km, 60 m resolution and 5 day repeat cycle. Provide hyperpectral radiance measurements at 40 m resolution on a 5 day repeat cycle.</td>
<td>6</td>
<td>Assimilations: driven by observational data LSAT and satellite-derived environmental forcing data, parameter datasets, and assimilation observations, including Precipitation from TRMM, and SPM (Land Cover Type from HyperRI Global Runoff from AW3C-3 (where applicable), AAVD and Noah). Terrestrial Water Storage from GRACE and Gravity &amp; Surface Temperature, Vegetation Fraction (SST Index), and canopy physiology from HyperRI. Topography from SRTM. Epidemiological surveys of targeted diseases. Vector population sampling &amp; testing for disease vectors.</td>
</tr>
</tbody>
</table>
Full abstracts of these and other presentations are located at [www.agu.org/meetings/fm06/fm06-sessions/fm06_A33G.html, ...A34C.html, and ...A43A.html].


**Summary:** There is a rich and long history of thermal infrared (TIR) remote sensing data for multidisciplinary Earth science research. The continuity of TIR data collection, however, is now in jeopardy given there are no planned future Earth observing TIR remote sensing satellite systems with moderately high spatial resolutions to replace those currently in orbit.


- **Todd Steissberg** [University of California, Davis] *High-Spatial Resolution Thermal Infrared Satellite Images for Lake Studies* who discussed how TIR satellite images can be used to study transport processes in lakes.

- **Gregory Vaughan** [JPL] *Spaceborne Thermal Infrared Measurements of Volcanic Thermal Features* who described how TIR measurements of high-temperature volcanic features improve our understanding of volcanic processes and our ability to identify renewed volcanic activity, forecast eruptions, and assess hazards.

A number of other oral presentations were also given during the session.