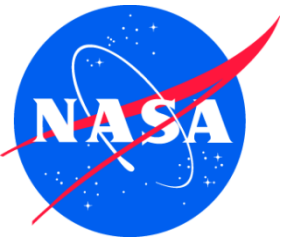
Examples of Level Products Possible from Existing Assets

Dale A. Quattrochi
NASA
Earth Science Office
Marshall Space Flight Center
Huntsville, AL

HyspIRI Science Products Symposium – NASA/GSFC – May 16-17, 2012

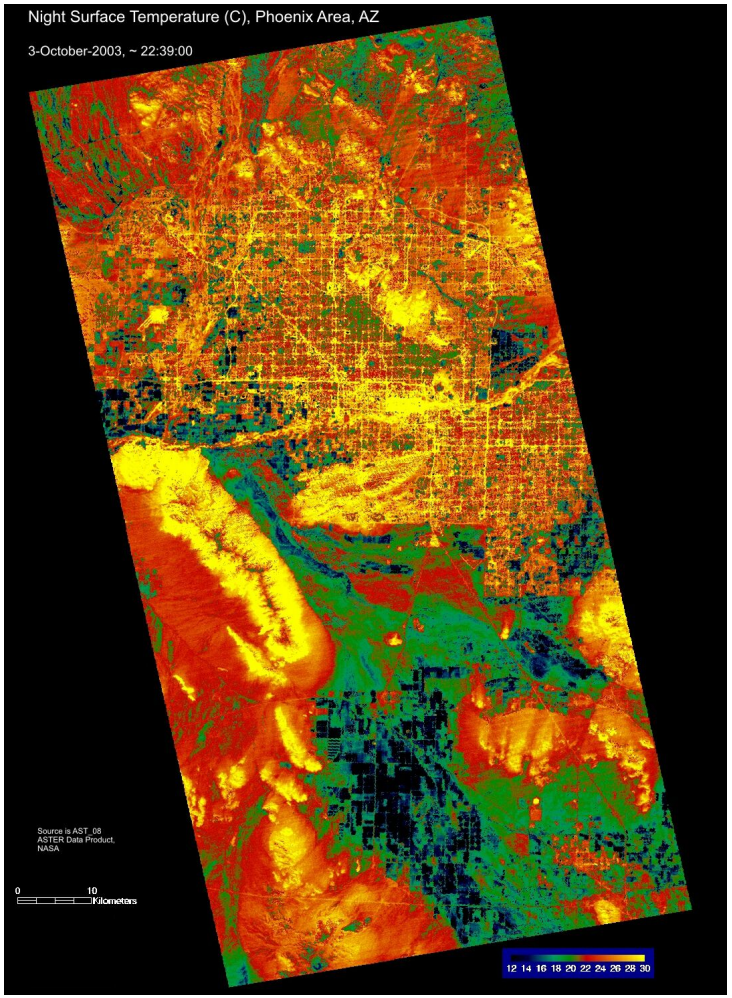


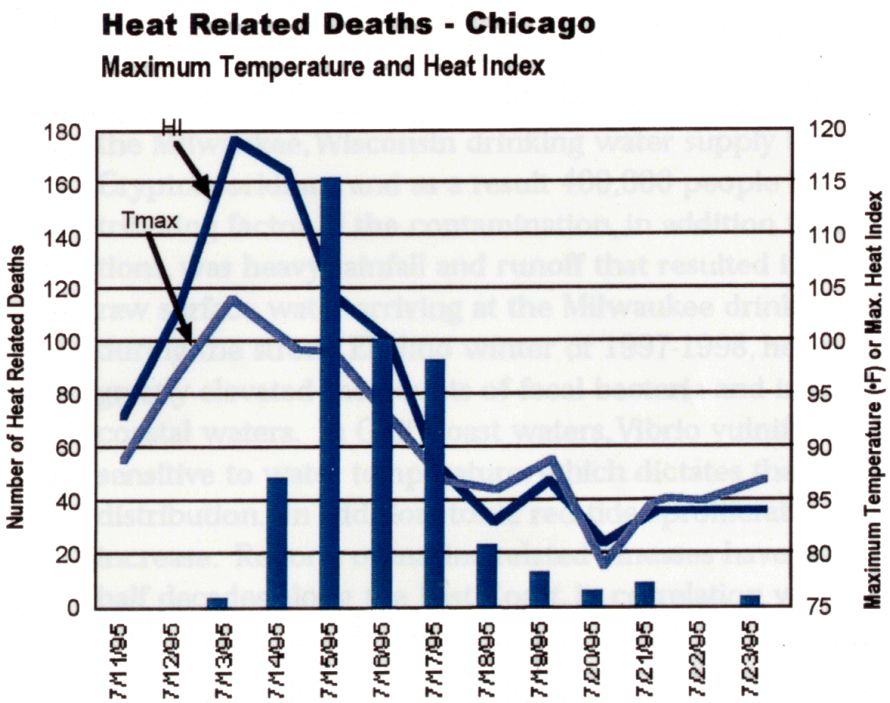
Back to the Fundamentals: HysplRl Science Questions

CQ6 Overarching Question: *How do patterns of human environmental and infectious diseases respond to leading environmental changes, particularly to urban growth and change and the associated impacts of urbanization?*

CQ6. HysplRI Science Questions

Human Health and Heat Island



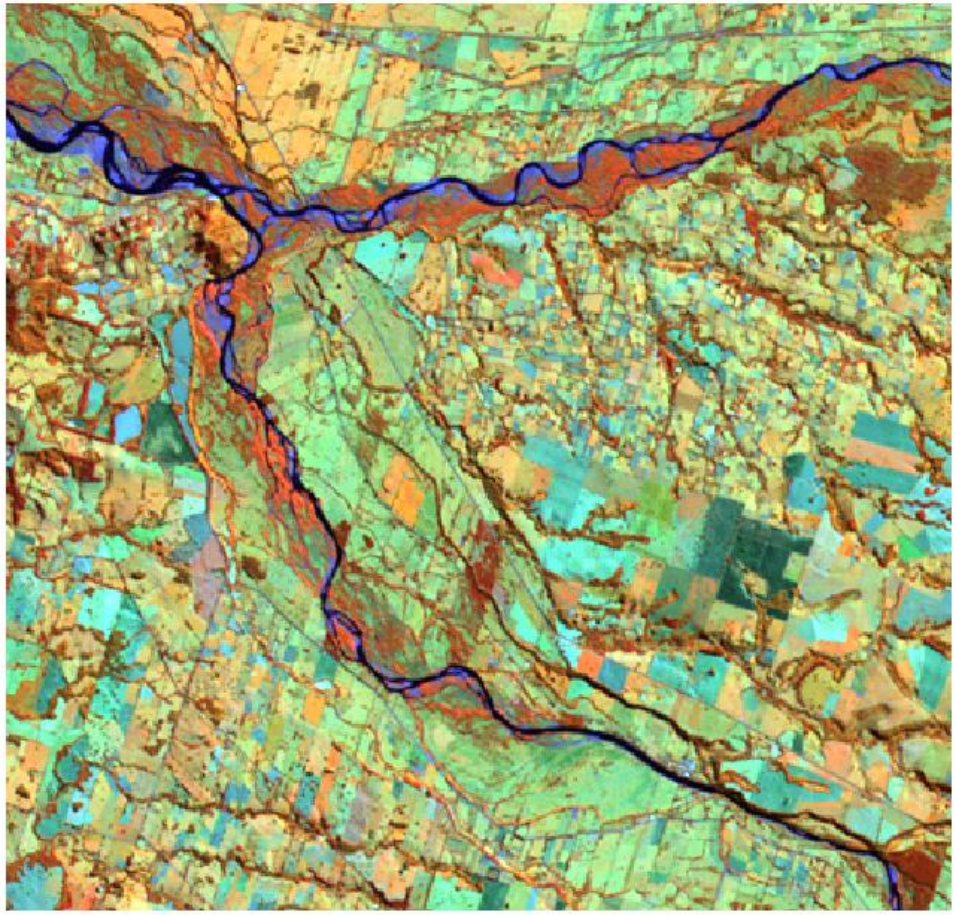


This graph tracks maximum temperature, heat index, and heat-related deaths in Chicago each day from July 11 to 23, 1995. The gray line shows maximum daily temperature, the blue line shows the heat index, and the bars indicate number of deaths for the day.

CQ6. HysplRI Science Questions

Heat Stress & Drought

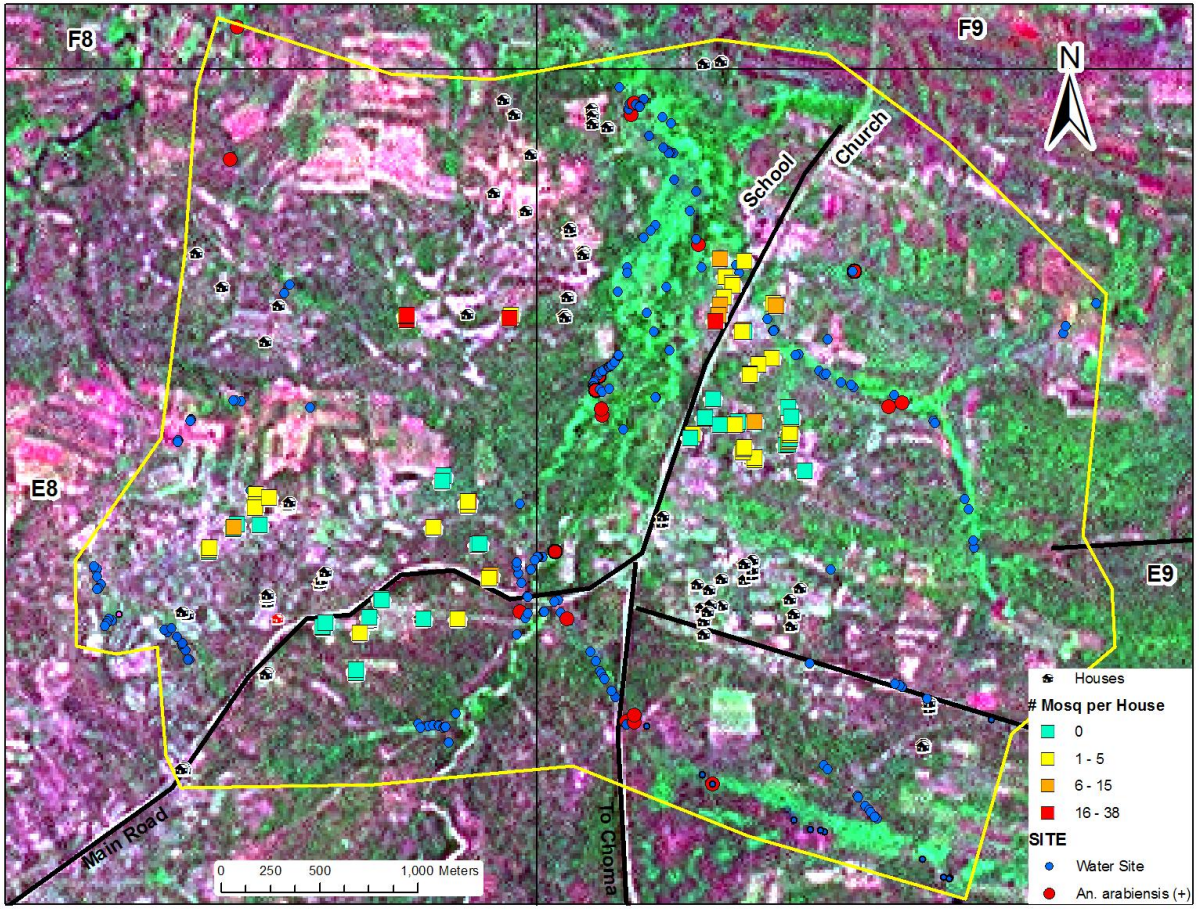
Chile 31 March 2001 Color Composite bands 3,5,4 (2.5% Saturation)

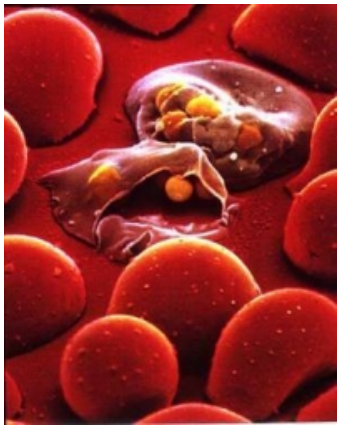


CQ6. HysplRI Science Questions

Vector-borne Diseases (Malaria)

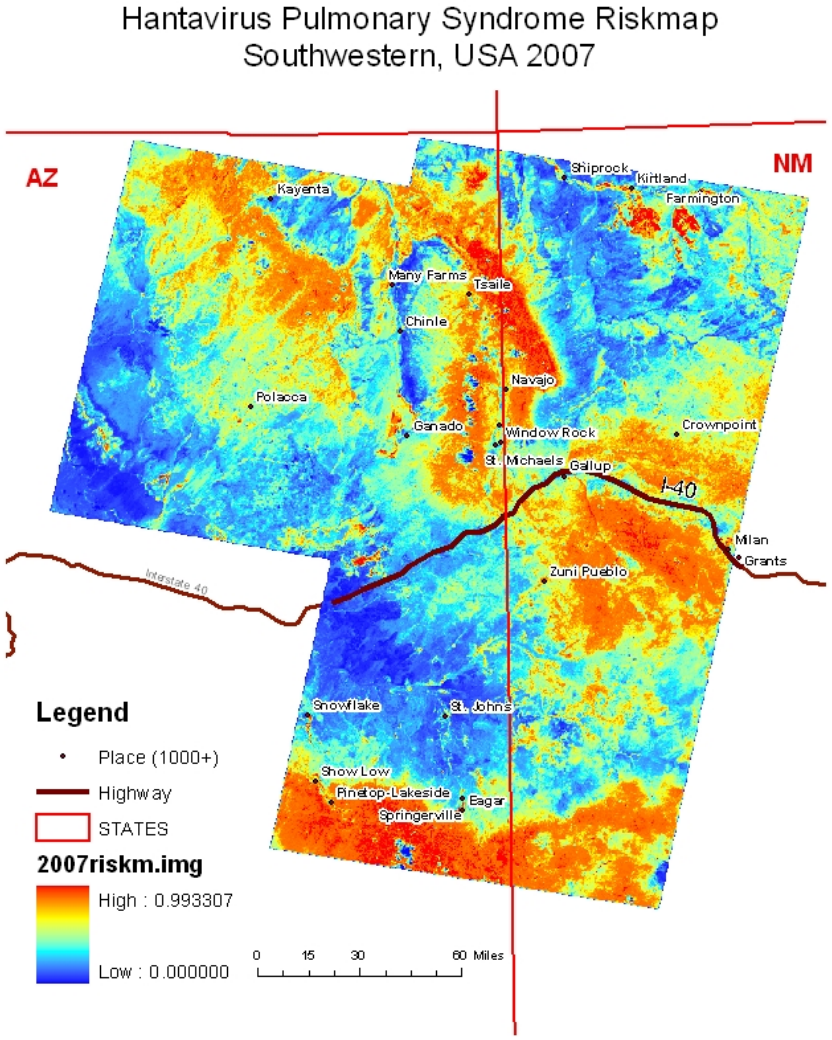
Heterogeneous Transmission with Landscape

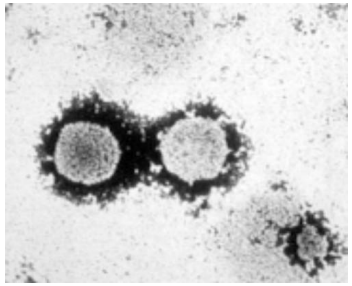




CQ6. HysplRI Science Questions

Zoonotic Diseases





Back to the Fundamentals: HysplRI Science Questions

TQ4 Overarching Question: *How does urbanization affect the local, regional, and global environment? Can we characterize this effect to help mitigate its impact and welfare?*

TQ4 HysplRI Science Questions

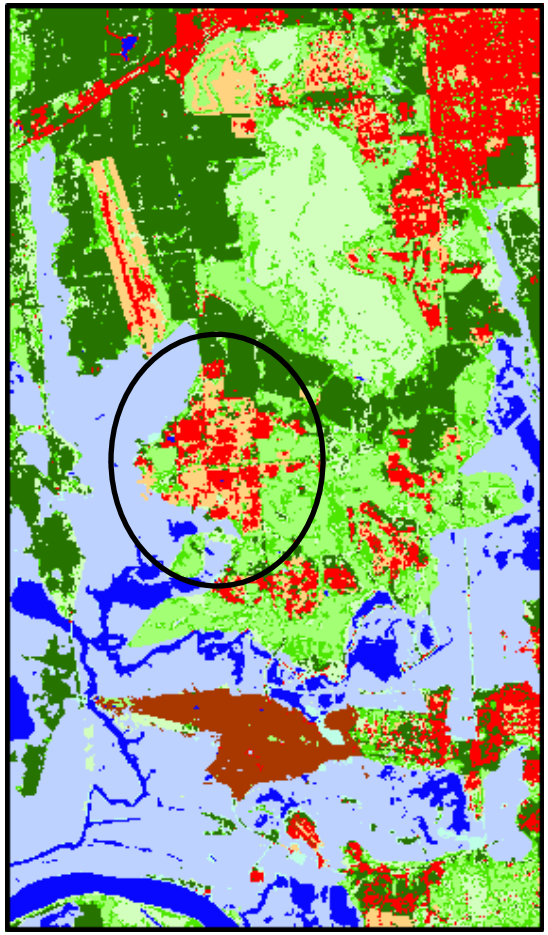
Science Issue: How do changes in land cover and land use affect surface energy balance and the sustainability and productivity of natural and human ecosystems?

Potential Higher Level Products

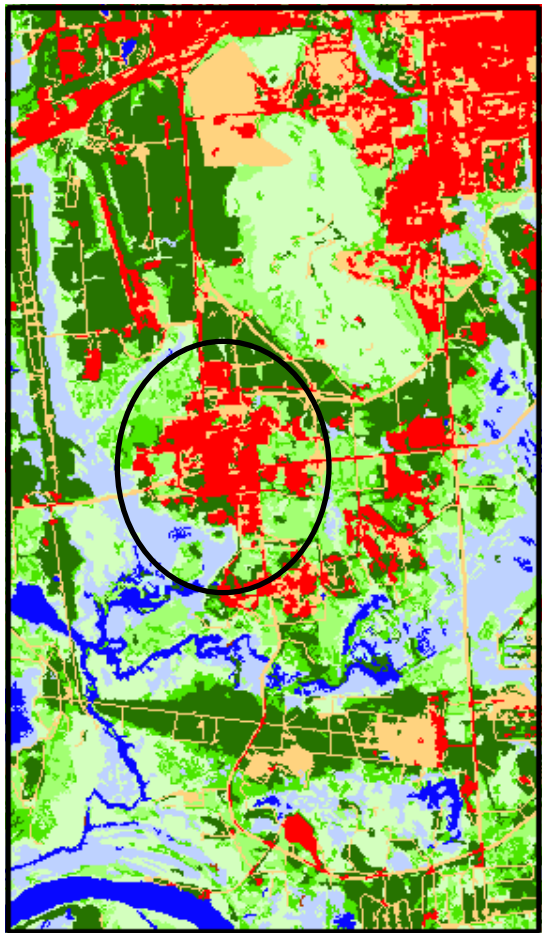
- **Multispectral thermal IR land cover maps at a high spatial resolution (60m) on a weekly basis for long-term validation of surface energy responses and changes in emissivity**
- **Integration of HysplRI TIR data with spatial modeling to assess changes in land cover/land use through time and subsequent changes in thermal energy responses**

Land Use Change around MSFC

Dramatic increase in urban-residential land use category from 1992-2001

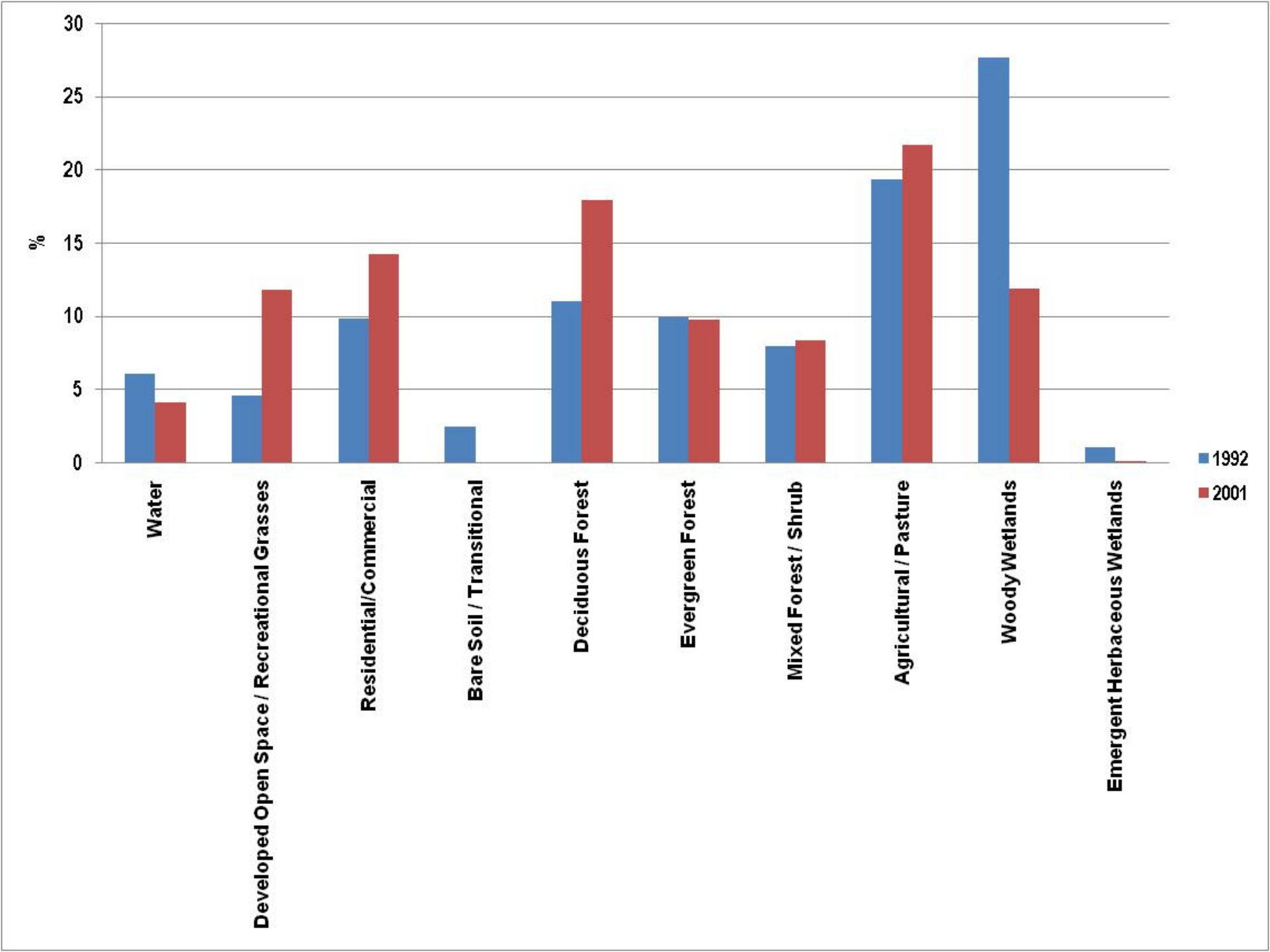


1992

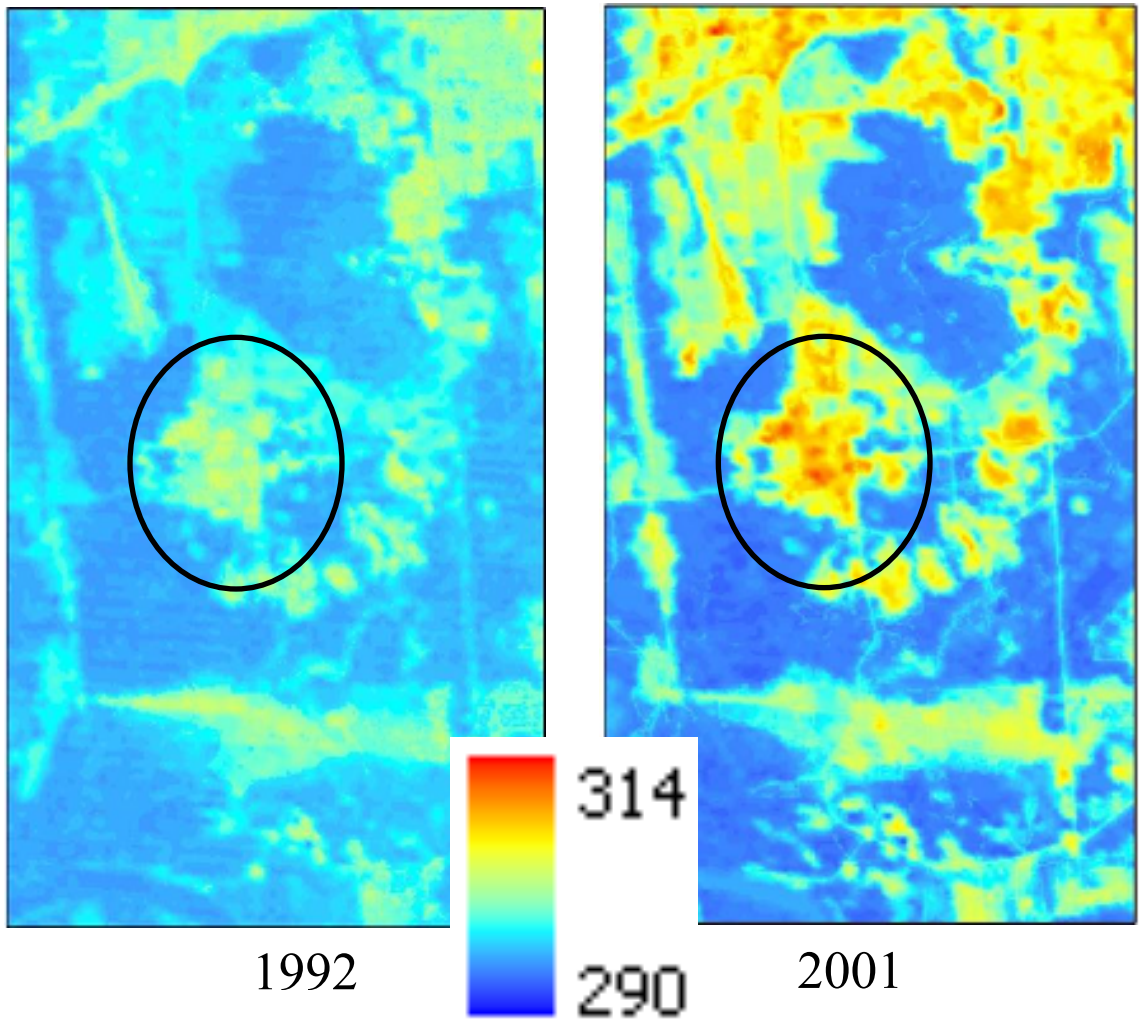


2001

- Water
- Developed Open Space/Recreational Grasses
- Residential/Commercial
- Bare Soil / Transitional
- Deciduous Forest
- Evergreen Forest
- Mixed Forest / Shrub
- Agricultural / Pasture
- Woody Wetlands
- Emergent Herbaceous Wetlands

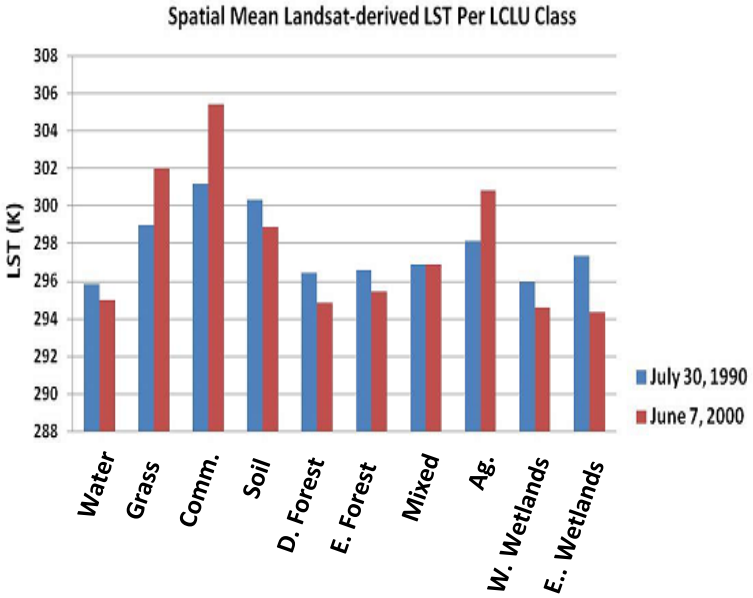

30
25
20
15
10
5
0
%
Water
Developed Open Space / Recreational Grasses
Residential/Commercial
Bare Soil / Transitional
Deciduous Forest
Evergreen Forest
Mixed Forest / Shrub
Agricultural / Pasture
Woody Wetlands
Emergent Herbaceous Wetlands
1992
2001

Land Use Change Drives Thermal Change



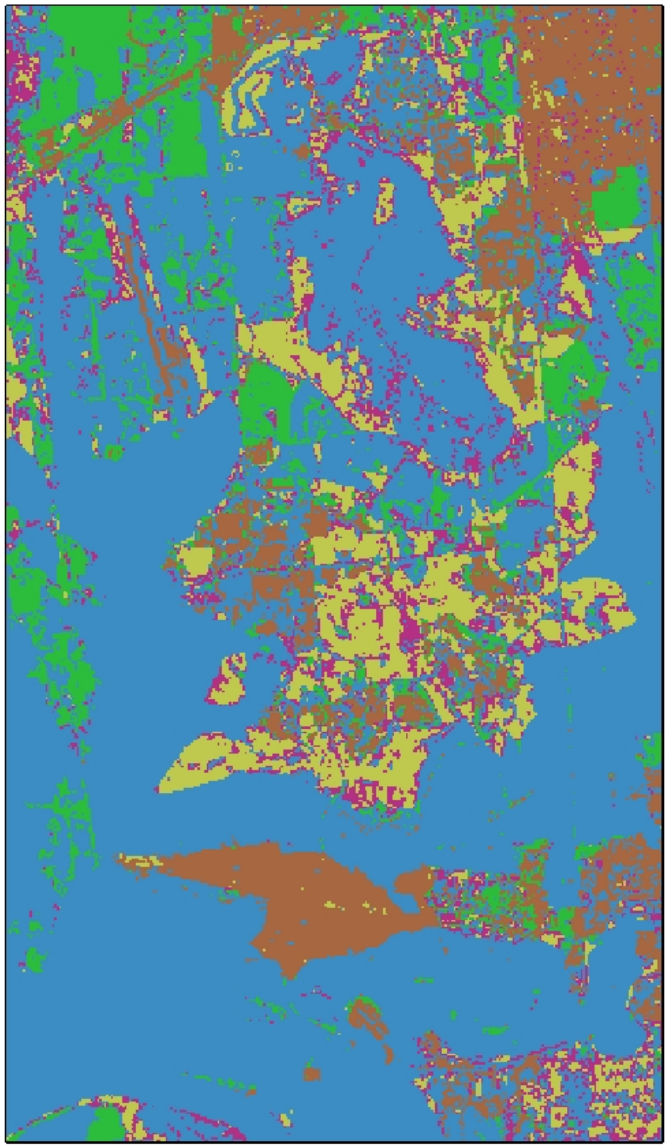
1992 2001

Conversion of forest, shrub, and agricultural land to MSFC infrastructure substantially changes surface thermal signatures



Need to determine impact on local temperatures

Emissivity 1992

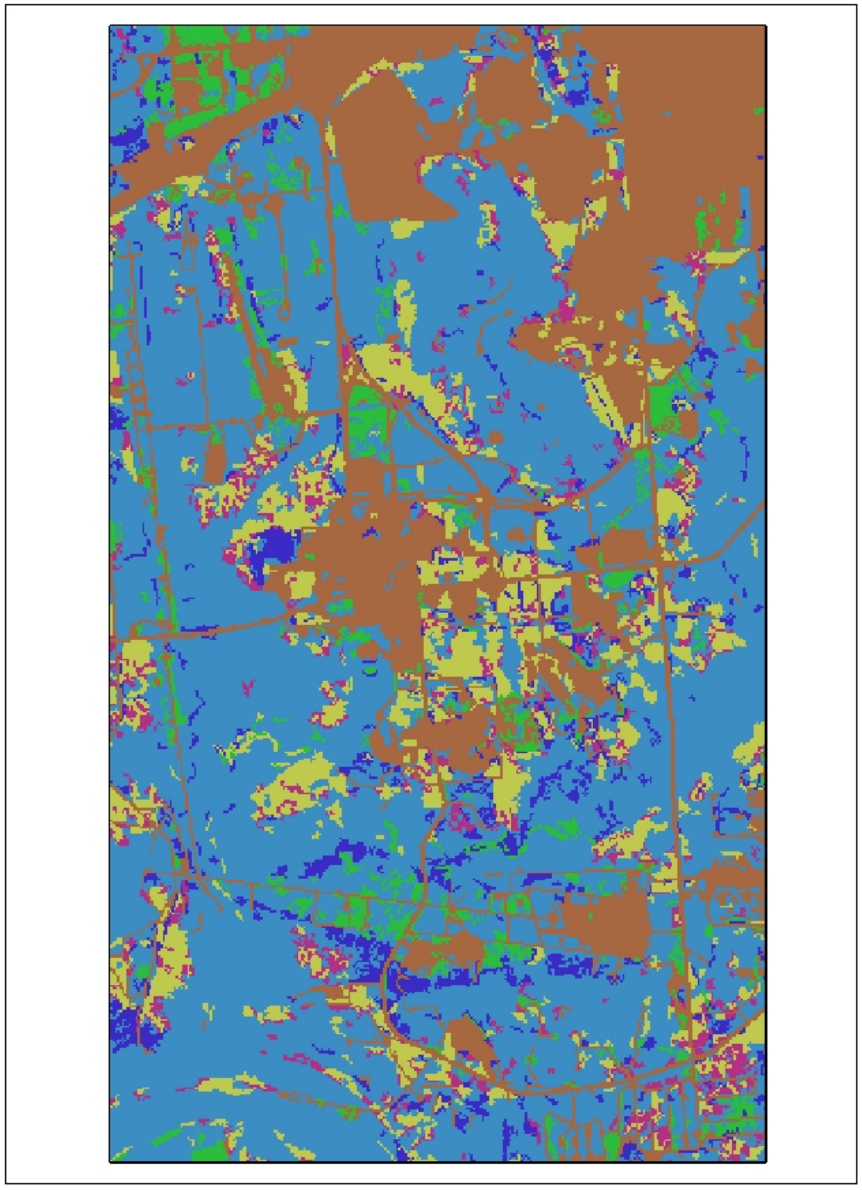


Emissivity

- 0.969 (Used for Bare Soil; and Developed Pixels)
- 0.974 (Used for Shrub Pixels)
- 0.980 (Used for Crops Pixels)
- 0.989 (Used for Deciduous Forests (assuming they're mostly Broadleaf); Wetlands, and Water Pixels)
- 0.9895 (Used for Mixed Forests Pixels)
- 0.990 (Used for Evergreen Pixels (assuming they're mostly Needle))

Based on a look-up table in Snyder et al. 1998 and given that our analysis is for a period when the vegetation is green.

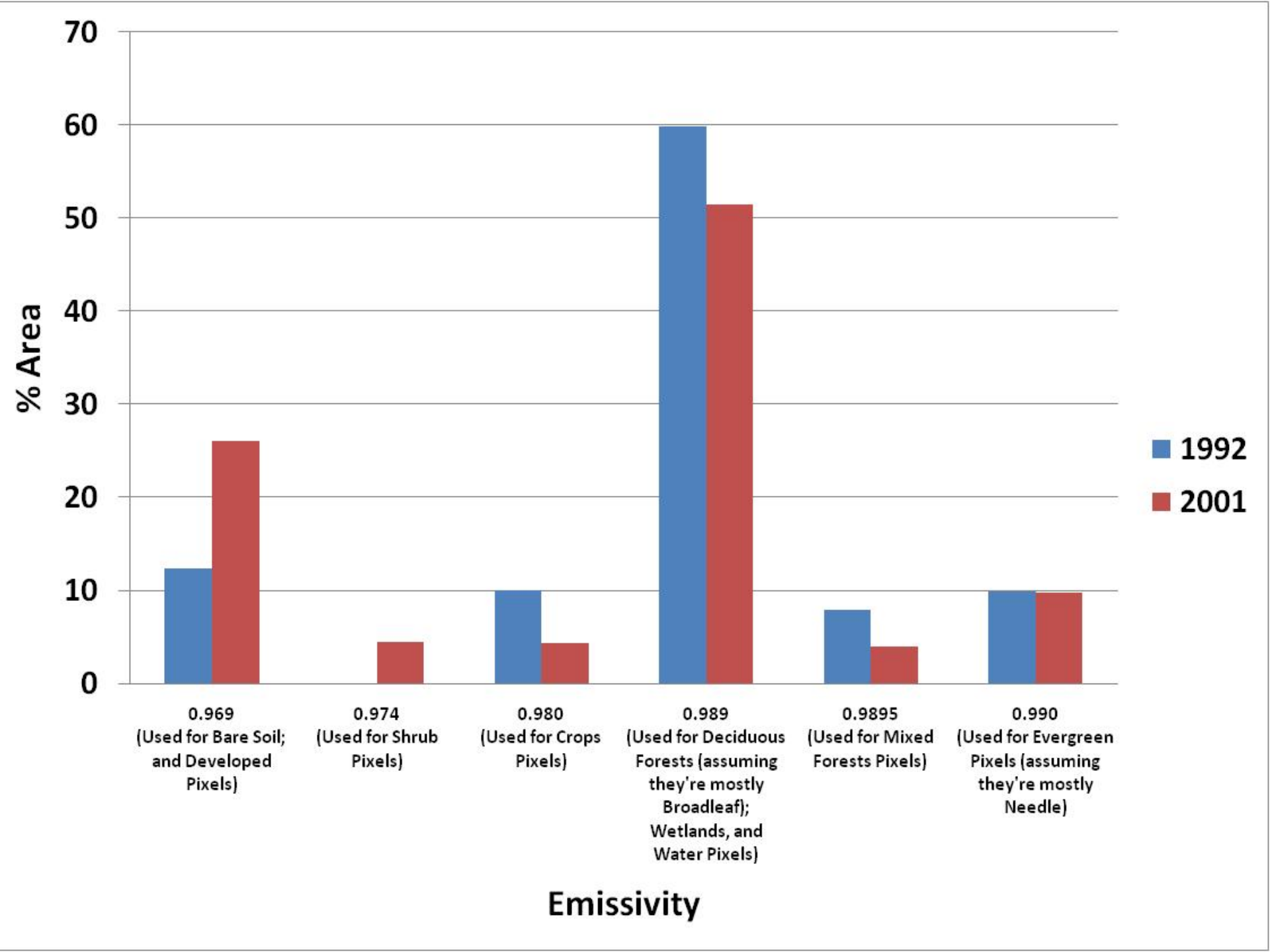
Emissivity 2001



Emissivity

- 0.969 (Used for Bare Soil; and Developed Pixels)
- 0.974 (Used for Shrub Pixels)
- 0.980 (Used for Crops Pixels)
- 0.989 (Used for Deciduous Forests (assuming they're mostly Broadleaf); Wetlands, and Water Pixels)
- 0.9895 (Used for Mixed Forests Pixels)
- 0.990 (Used for Evergreen Pixels (assuming they're mostly Needle))

Based on a look-up table in Snyder et al. 1998 and given that our analysis is for a period when the vegetation is green.

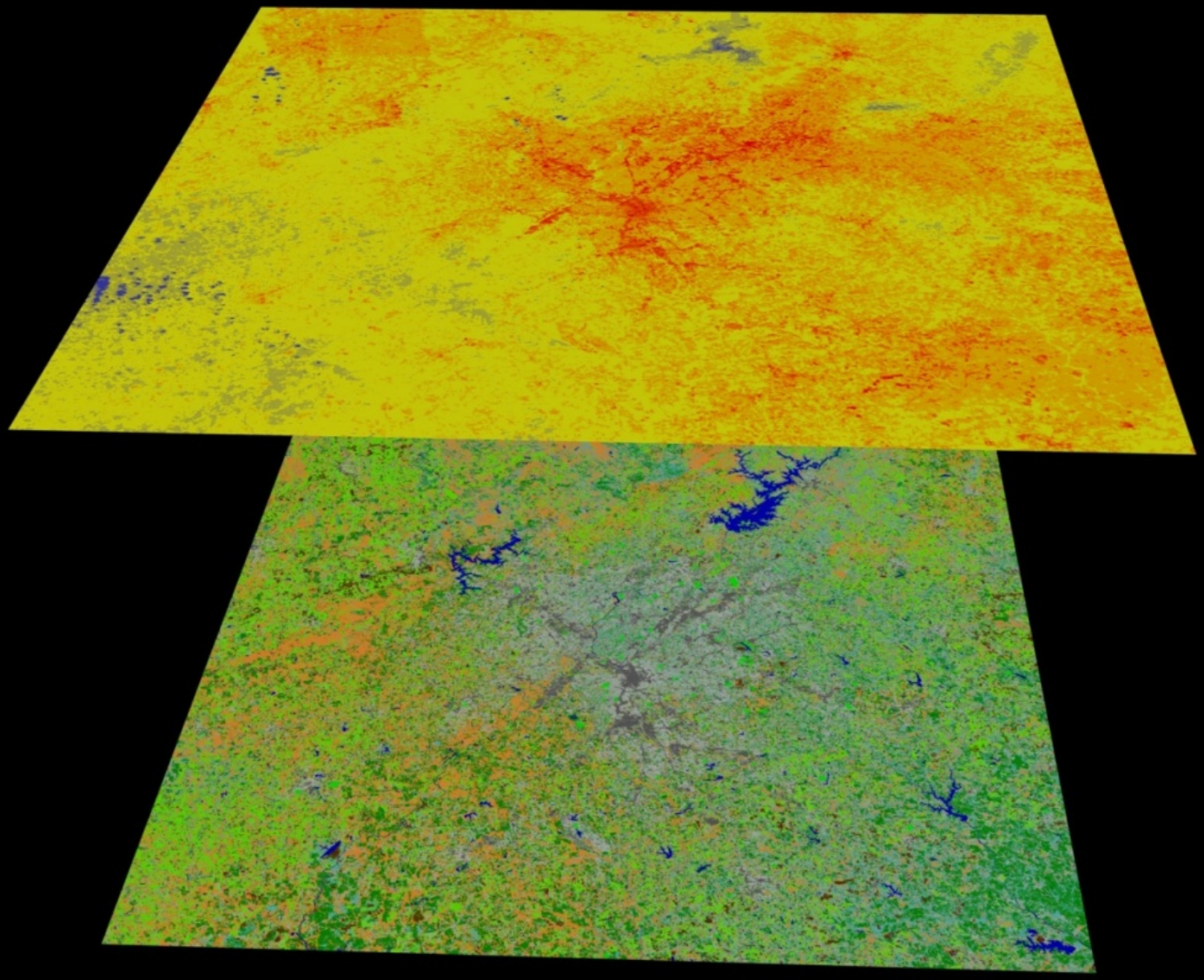

70
60
50
40
30
20
10
0
% Area
1992
2001
0.969 (Used for Bare Soil; and Developed Pixels)
0.974 (Used for Shrub Pixels)
0.980 (Used for Crops Pixels)
0.989 (Used for Deciduous Forests (assuming they're mostly Broadleaf); Wetlands, and Water Pixels)
0.9895 (Used for Mixed Forests Pixels)
0.990 (Used for Evergreen Pixels (assuming they're mostly Needle)
Emissivity

TQ4 HysplRI Science Questions

Science Issue: What are the dynamics, magnitude, and spatial form of the UHI? How can it best be characterized?

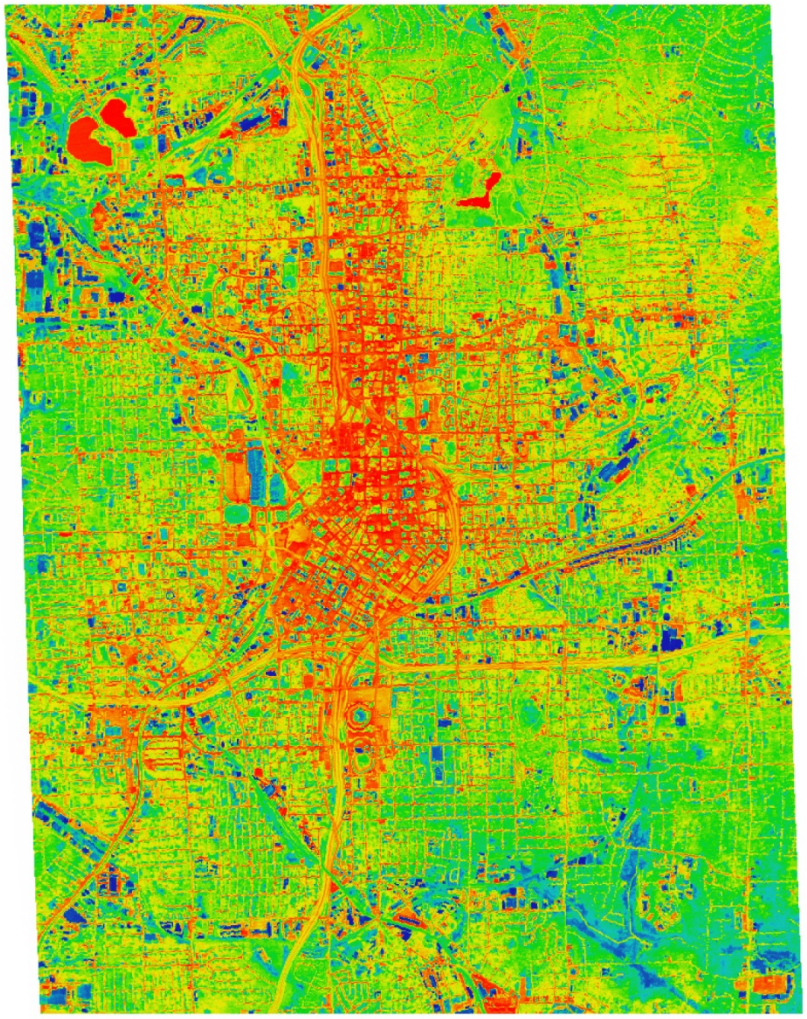
Potential Higher Level Products

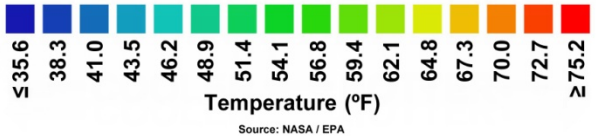
- **Maps of UHI development, extent and dynamics for various cities around the world using HysplRI high spatial resolution (60m) data**
- **Multitemporal (weekly, seasonal) maps of UHI dynamics**
- **Day/Night maps of UHI dynamics**




Temperature
°C ≤17 21.7 26.4 31.1 35.8 40.5 45.2 ≥50
°F ≤62.6 71.1 79.5 88.9 96.4 104.9 113.4 ≥122

Atlanta
Central Business District
Night Data – May 1997





Source: NASA / EPA

TQ4 HysplRI Science Questions

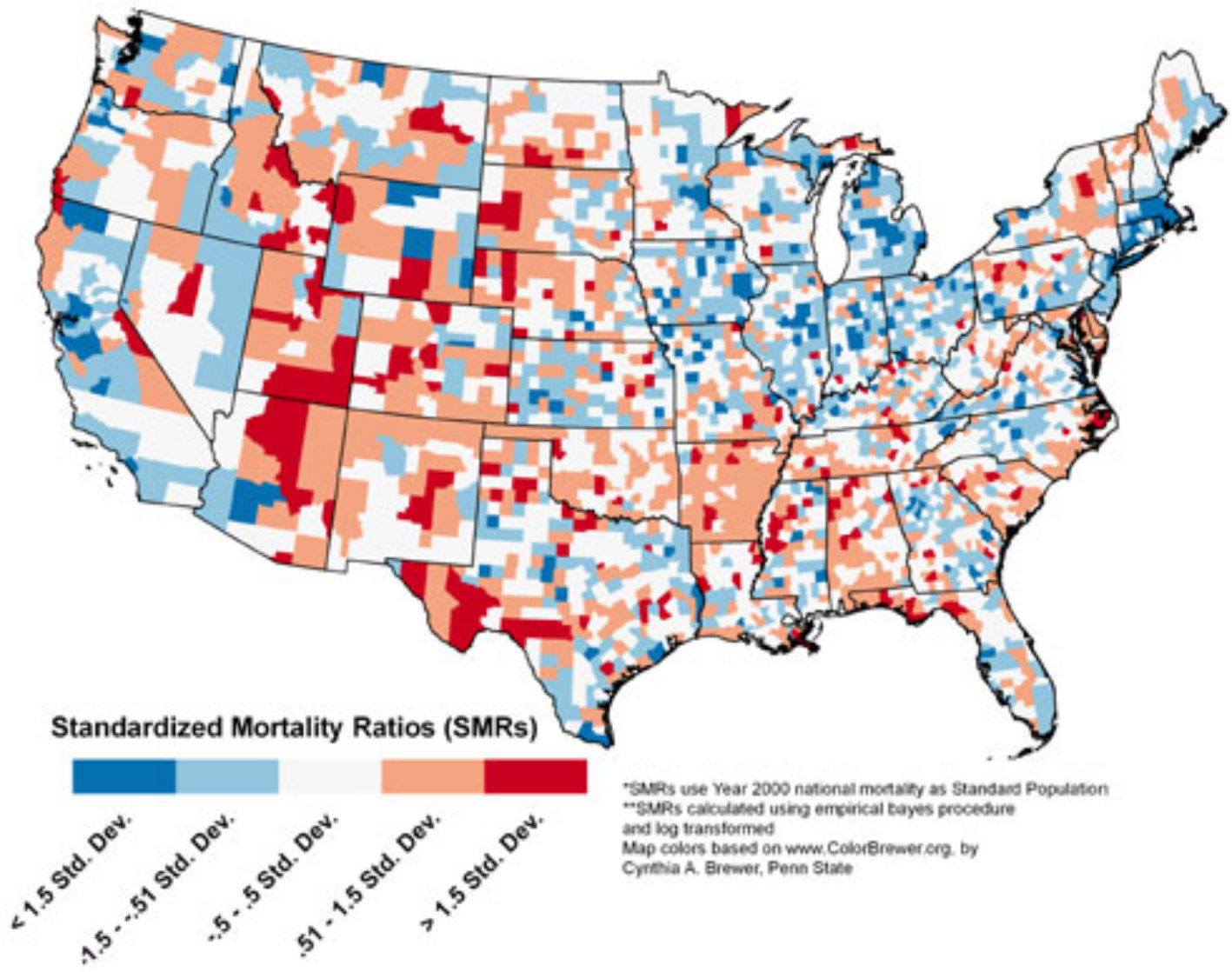
Science Issue: How can factors affecting heat stress on humans be better resolved and measured?

Potential Higher Level Products

- **Heat stress maps as derived from HysplRI thermal IR data for cities known to have morbidity/mortality cases during times of excess heat events**
- **HysplRI modeled data to develop risk assessment maps for people who are at high health risk from heat-related events**

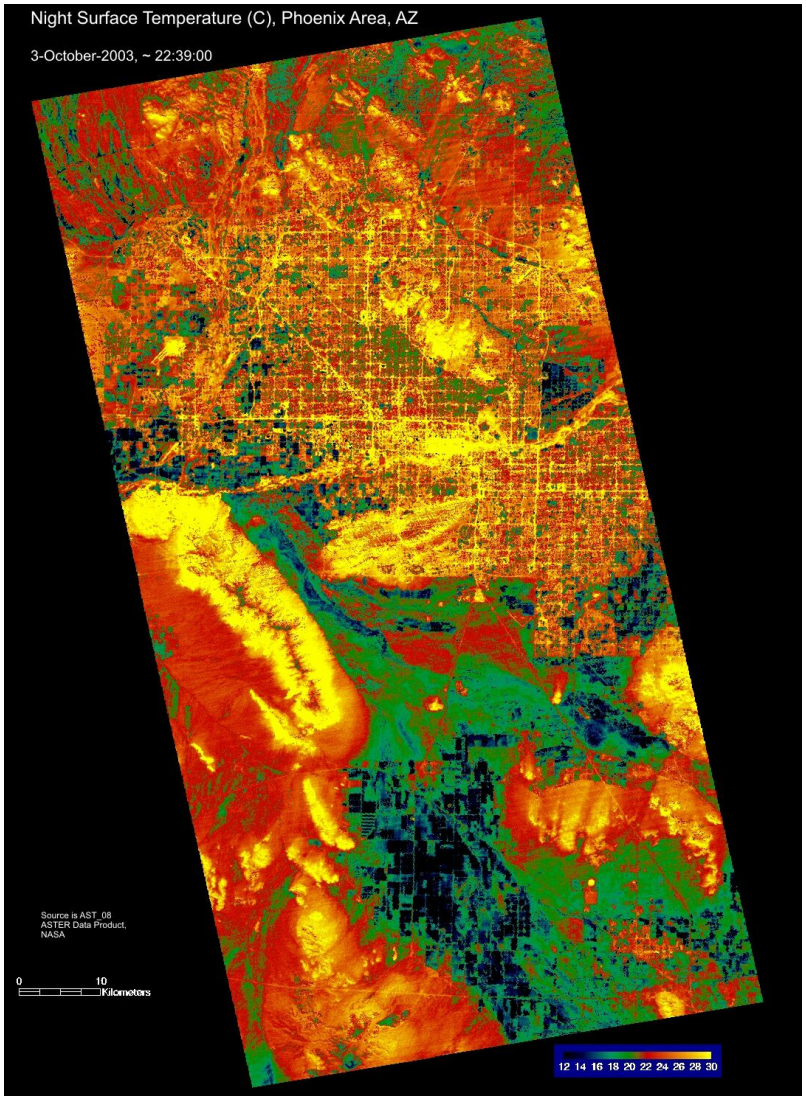
TQ4 HysplRI Science Questions

Science Issue: How can factors affecting heat stress on humans be better resolved and measured?



TQ4 HysplRI Science Questions

Science Issue: How can factors affecting heat stress on humans be better resolved and measured?



TQ4 HyspIRI Science Questions

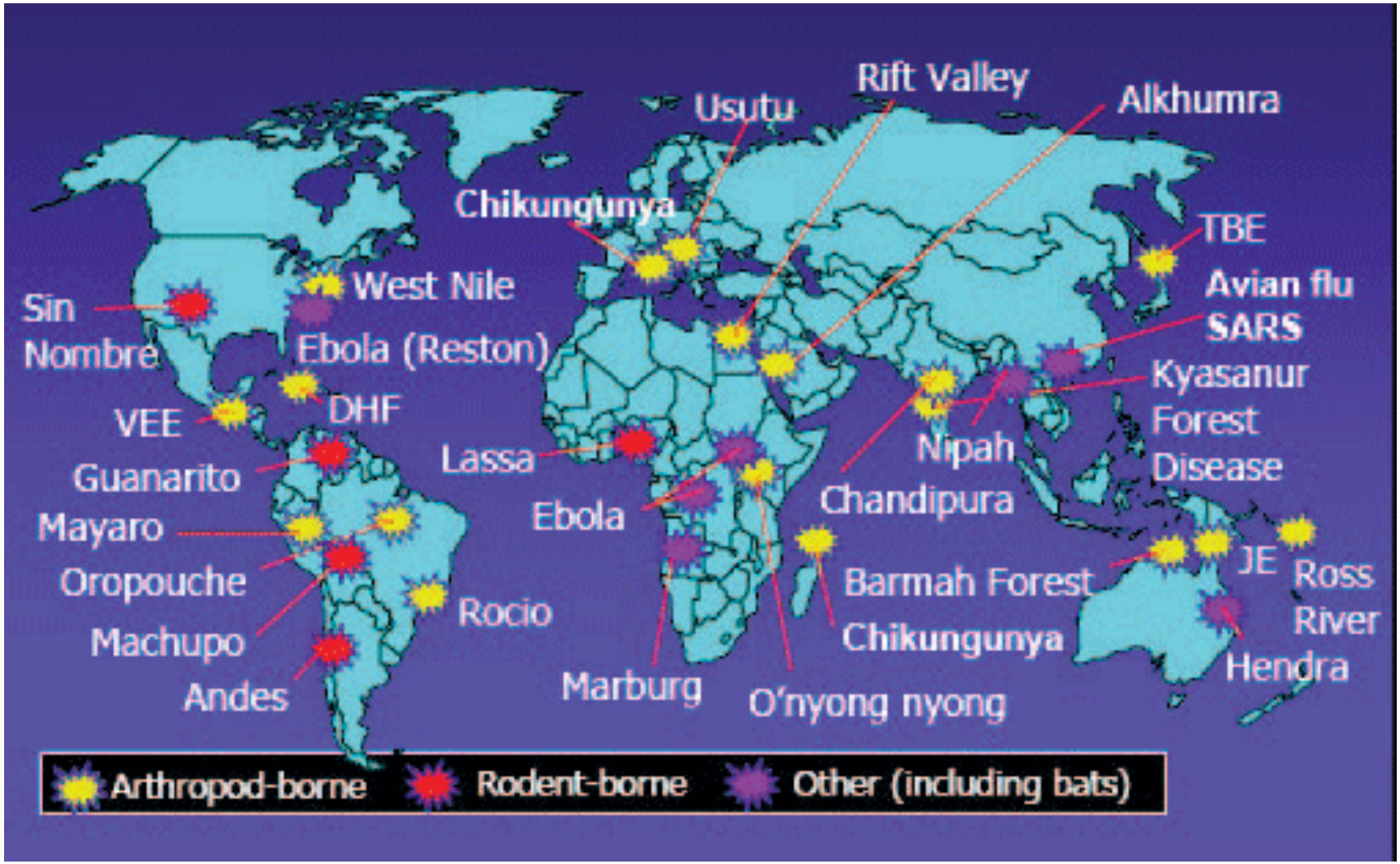
Science Issue: How can characteristics associated with environmentally-related health effects that affect vector-borne and animal-borne diseases be better measured and resolved?

Potential Higher Level Products

- **Use HyspIRI TIR data to obtain observations and measurements of surface temperature and surface wetness as indicators of regions for possible disease transmission**
- **Use high spatial/temporal resolution, multispectral thermal HyspIRI data as inputs to disease models to produce risk maps for vector- and animal-borne disease persistence and expansion globally**

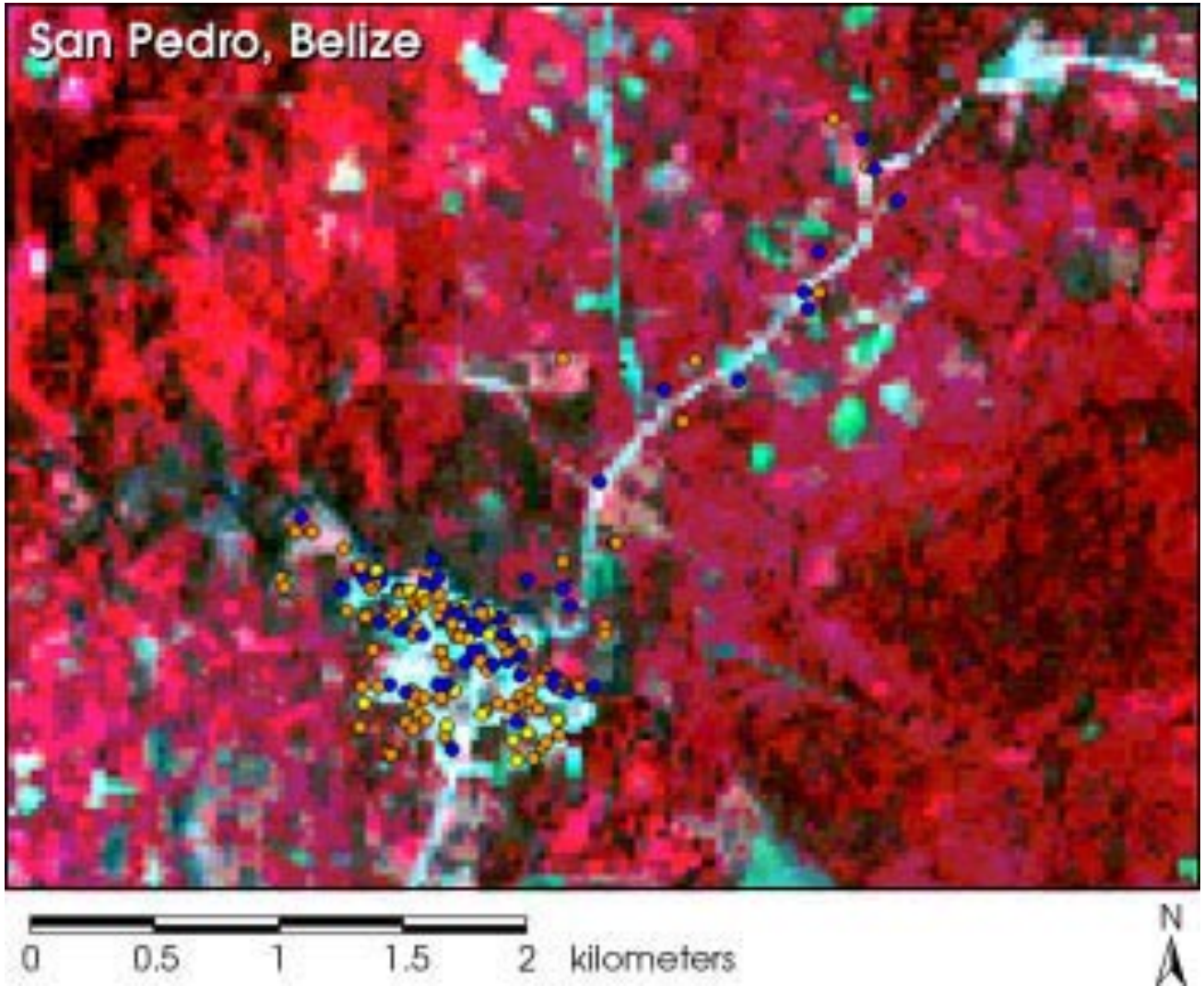
TQ4 HysplRI Science Questions

Science Issue: How can characteristics associated with environmentally-related health effects that affect vector-borne and animal-borne diseases be better measured and resolved?



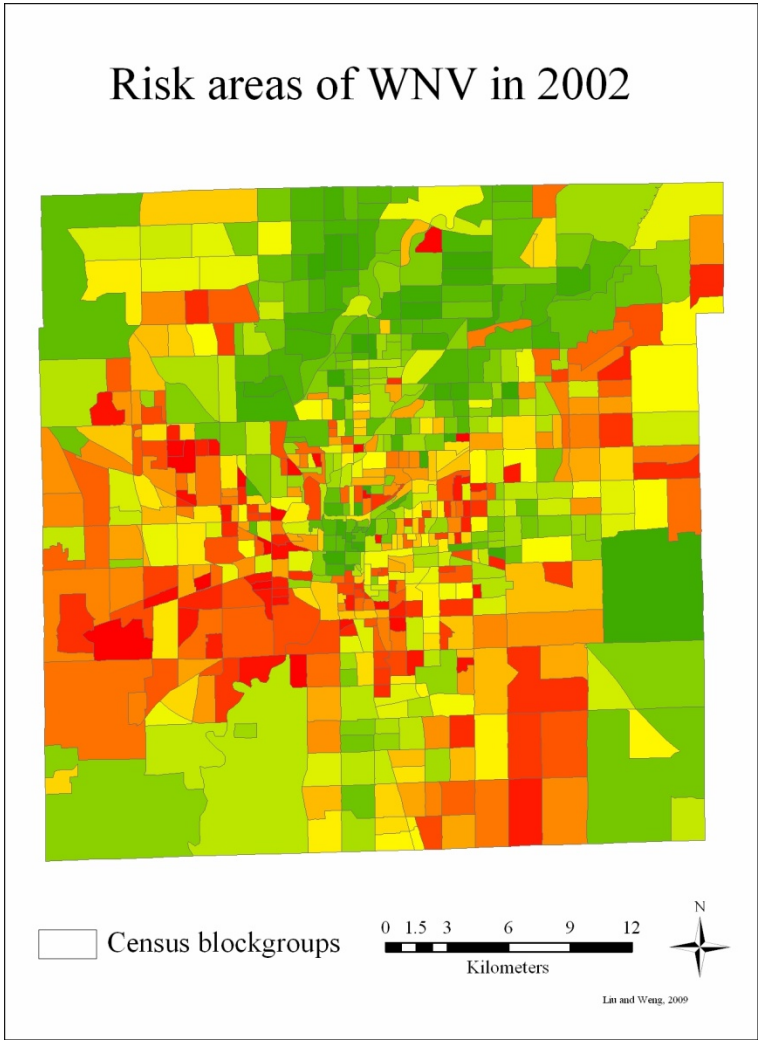
TQ4 HysplRI Science Questions

Science Issue: How can characteristics associated with environmentally-related health effects that affect vector-borne and animal-borne diseases be better measured and resolved? human ecosystems and urbanization?



TQ4 HysplRI Science Questions

Science Issue: How can characteristics associated with environmentally-related health effects that affect vector-borne and animal-borne diseases be better measured and resolved?

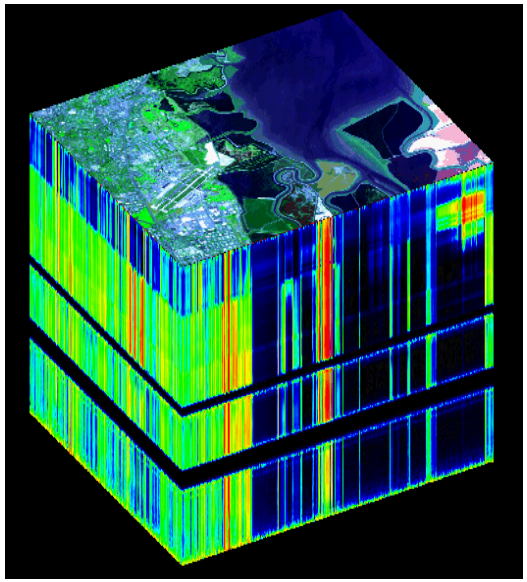


TQ4 HyspIRI Science Questions

Science Issue: How do horizontal and temporal scales of variation in heat flux and mixing relate to human health, human ecosystems and urbanization?

Potential Higher Level Products

- **Maps of heat flux dynamics for various natural (e.g., forest, desert, mountain) and human (e.g., agriculture) derived from high spatial/multitemporal resolution HyspIRI data over multiple time periods**
- **Maps of emissivity for various land covers around the globe using HyspIRI thermal IR data**
- **Maps of vertical dynamics of heat flux derived from HyspIRI thermal IR data (i.e., overlain on 3-D topographic perspective)**

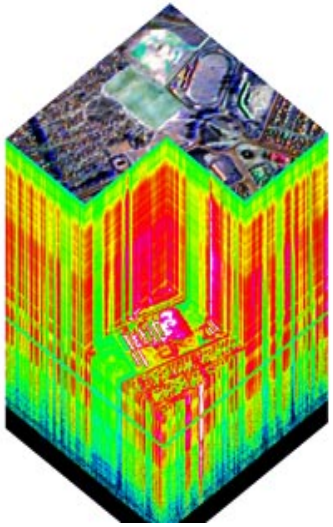


HyspIRI Hyperspectral VSWIR Level II Product
(NDVI, fPAR, surface reflectance characteristics)

+

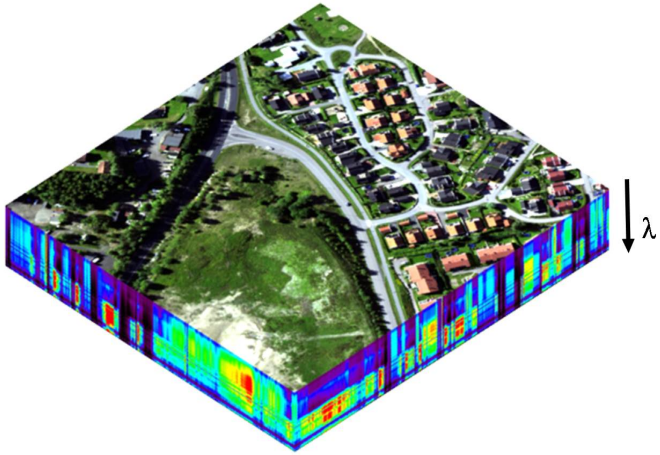
HyspIRI TIR multispectral Level II product (8 TIR Bands)
(surface temperature, radiance, [day/night], emissivity)

=

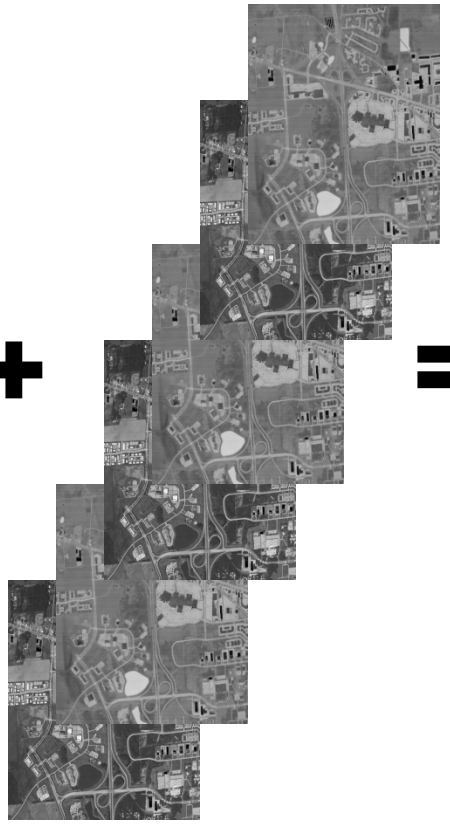


HyspIRI VSWIR/TIR composite data set
(quantitative integrative measurement of urban surface reflectances, temperatures, and emissivity across the urban ecosystem)

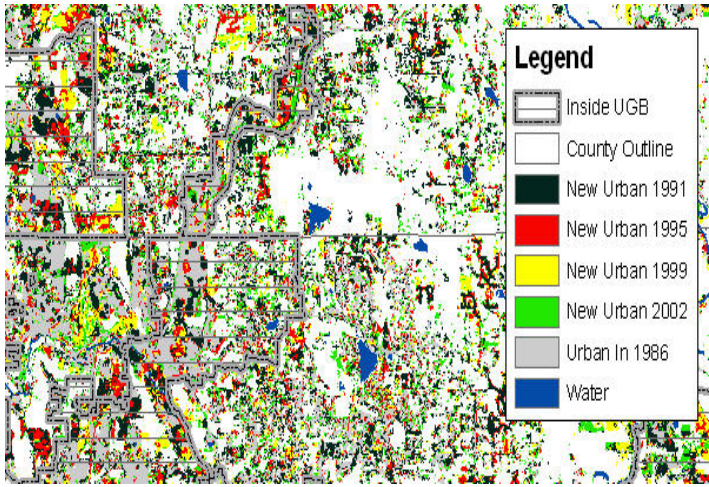
Through Time



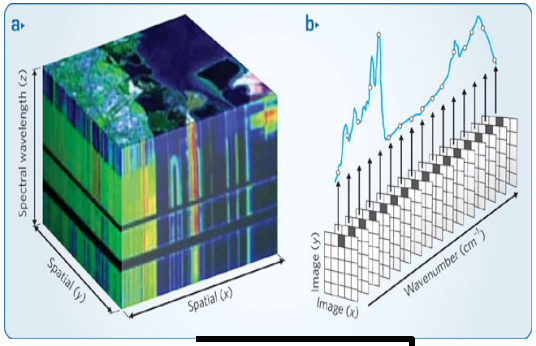
HyspIRI Hyperspectral VSWIR Level II Product
(NDVI, fPAR, surface reflectance characteristics)



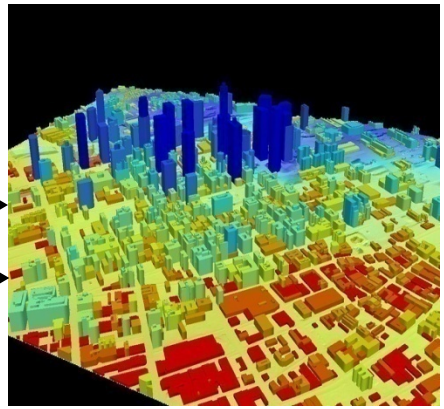
HyspIRI TIR multispectral Level II product (8 TIR Bands)
(surface temperature, radiance, [day/night], emissivity)



HyspIRI VSWIR/TIR composite land cover change data set
(quantitative integrative measurement of urban surface reflectances, temperatures, and emissivity across the urban ecosystem as they change through time)



HyspIRI Hyperspectral VSWIR Level II Product (NDVI, fPAR, surface reflectance characteristics)



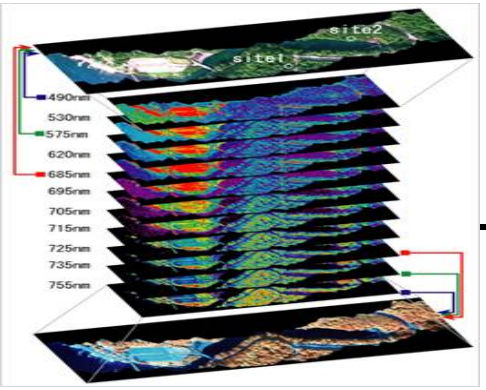
Lidar Data

=

HyspIRI TIR multispectral Level II product (8 TIR Bands) (surface temperature, radiance, [day/night], emissivity)

HyspIRI VSWIR/TIR and Lidarcomposite data set

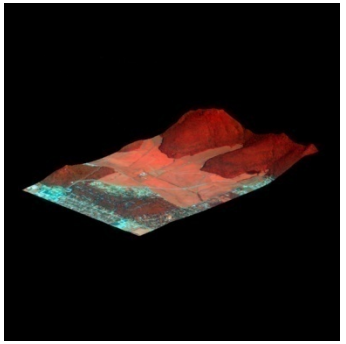
(X, y, z surface reflectance/ thermal interactions of urban ecosystem processes)

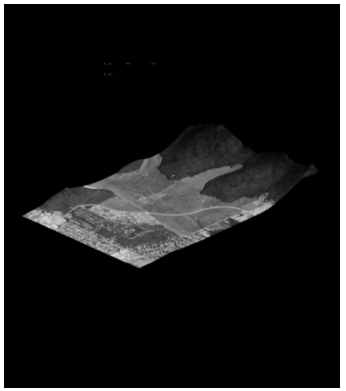


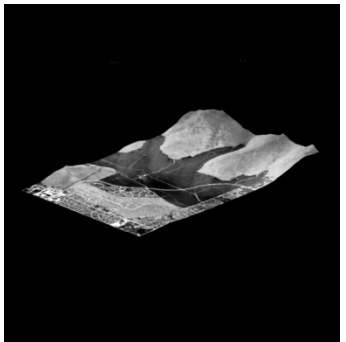
Hyperspectral VSWIR Level II Product (NDVI, fPAR, surface reflectance characteristics)

Digital Topographic Data (DEM)

=







HyspIRI VSWIR/TIR and DEM composite data set

(hyperspctral/day/night TIR digital elevation model data sets))

HyspIRI TIR multispectral Level II product (8 TIR Bands) (surface temperature, radiance, [day/night], emissivity)