HyspIRI Thermal IR (TQ4) Science Questions

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Uses of Space-based Observations to Address Human Health Concerns

In addressing human health and security concerns, space-based observations are most useful when used along with many other sources of data. Public-health and risk management decision making has benefited from space-based technologies, <u>and can benefit further with improvements in these technologies</u>, through applications that include:

- *Prediction of occurrence of disease or disease outbreaks.* Space-based observations provide spatial and temporal data on environmental changes that affect the conditions related to disease occurrence and can be combined within predictive frameworks to forecast health emergencies.

- *Rapid detection and tracking of events.* Given sufficient temporal or spatial detail, space-based observations can provide data to support rapid detection of environmental changes or pollution events that affect human health.

- *Construction of risk maps.* The spatial extent of space-based observations provides a means to identify spatial variability in risk, potentially improving the scale of environmental observations so that they match the scale of activities in human communities.

- *Targeting interventions.* Activities to reduce the vulnerability of human communities to health risks, including environmental, behavioral, educational, and medical interventions, can be guided, improved, and made more efficient by use of available and proposed space-based observational systems.

- *Enhancing knowledge of human health-environment interactions.* Basic research on the causes of disease is ongoing, and remote sensing of environmental parameters that affect health is crucial for investigations that improve understanding of the spatial and temporal dynamics of health risk.

(*Decadal Survey*, pp. 155-156)

TQ4 HyspIRI Science Questions

Critical Questions on Human Health and Security as given in the Decadal Survey: (p. 155)

- How can remote sensing data be enhanced to assist detection and prediction of the places where disease risk is elevated or times when disease outbreaks are likely?

- Might such data enhance the rapid detection of events that threaten health or security?

- How can risk maps derived from space-based observations be used to enhance public health efforts directed at education and prevention?

- What new exchanges can expand interactions between remote sensing system designers and public health analysts that will help identify spatial and temporal risk patterns?

- What new understanding derived from remote sensing data can be used to target interventions aimed at reducing vulnerability of human communities to health risks?

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?*

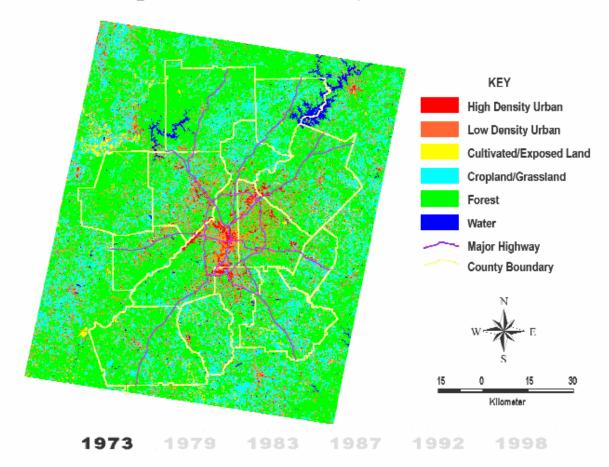# TQ4 HyspIRI Science Questions
Human Health and Urbanization Sub-questions

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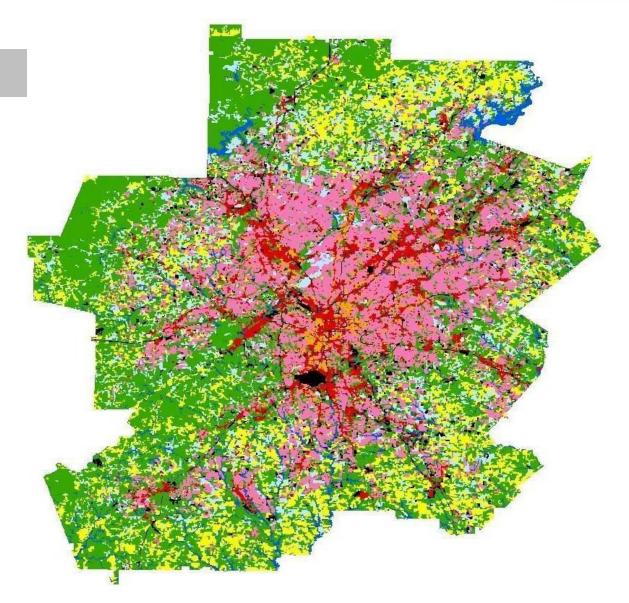

Changes in Land Use/Cover, Atlanta: 1973-1998

KEY
- High Density Urban
- Low Density Urban
- Cultivated/Exposed Land
- Cropland/Grassland
- Forest
- Water
- Major Highway
- County Boundary

1973   1979   1983   1987   1992   1998

Land Use in 1999

Legend:
- Low Density Residential
- Med. Density Residential
- High Density Residential
- Commercial/Services
- Institutional
- TCU
- Industrial/Commercial
- Water
- Crops/Pasture
- Row Crops
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Woody Wetlands
- Quarries/Mines/Gravel Pits
- Transitional

Projected Land Use in 2030
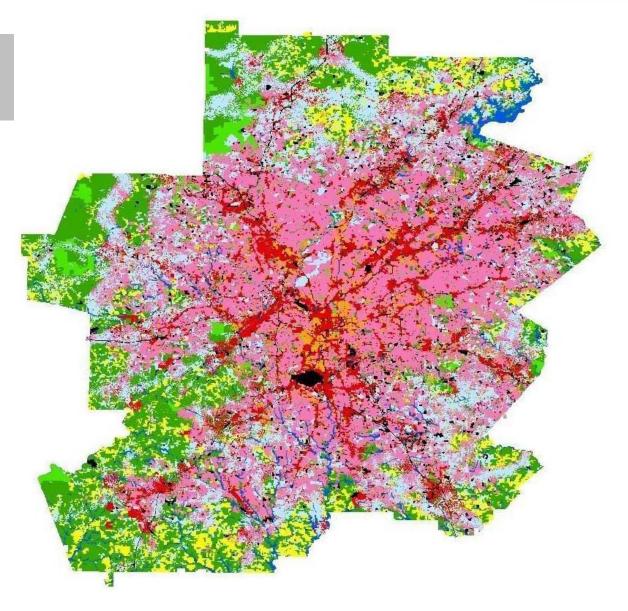
Legend:
- Low Density Residential
- Med. Density Residential
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TQ4 HysplRI Science Questions
Human Health and Urbanization Sub-questions

Scottsdale, AZ
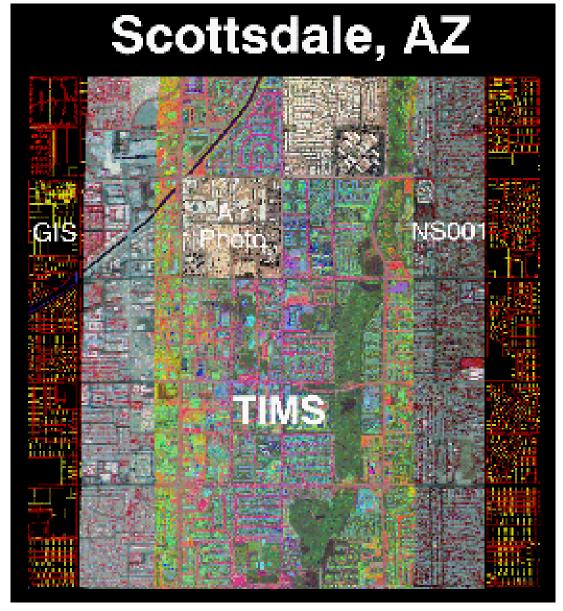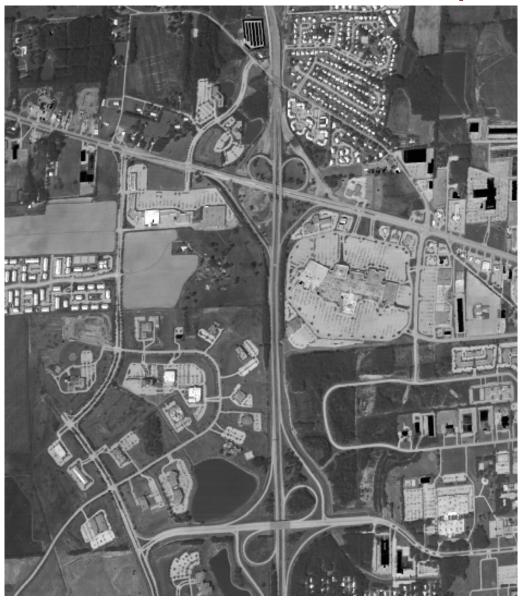
TQ4 HysplRI Science Questions
Human Health and Urbanization Sub-questions

ATLAS thermal IR daytime image Huntsville, AL

TQ4 HysplRI Science Questions
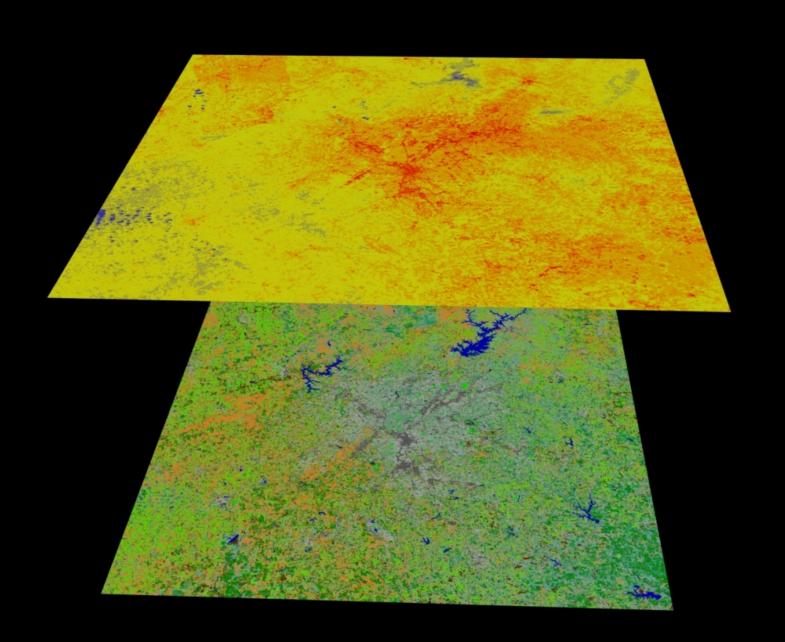## Human Health and Urbanization Sub-questions
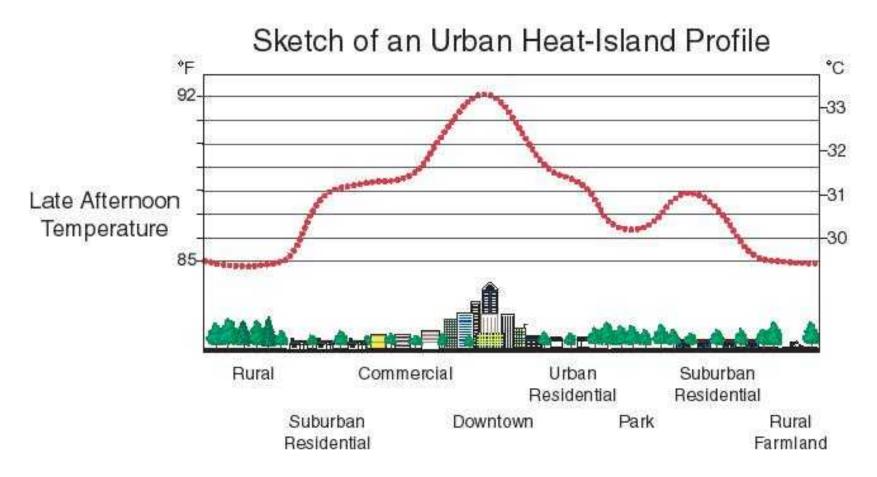
ATLAS thermal
IR nighttime
image
Huntsville, AL

- 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?
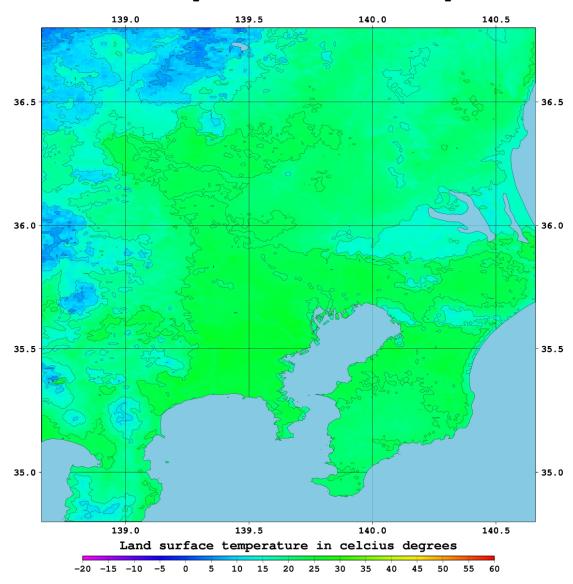

Sketch of an Urban Heat-Island Profile

TQ4 HysplRI Science Questions
Human Health and Urbanization Sub-questions

MODIS Daytime LST Dec 2004 in Tokyo

Land surface temperature in celcius degrees
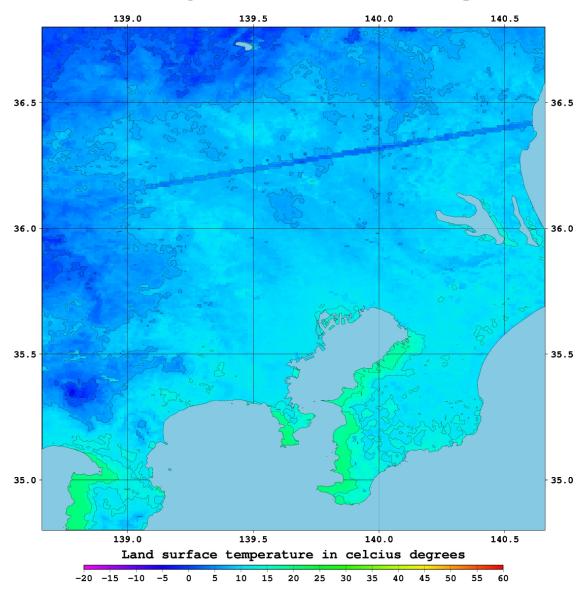
TQ4 HyspIRI Science Questions
Human Health and Urbanization Sub-questions

MODIS Nighttime LST Dec 2004 in Tokyo

Land surface temperature in celcius degrees

TQ4 HysplRI Science Questions
Human Health and Urbanization Sub-questions

MODIS DayNightDifference LST Dec 2004 in Tokyo
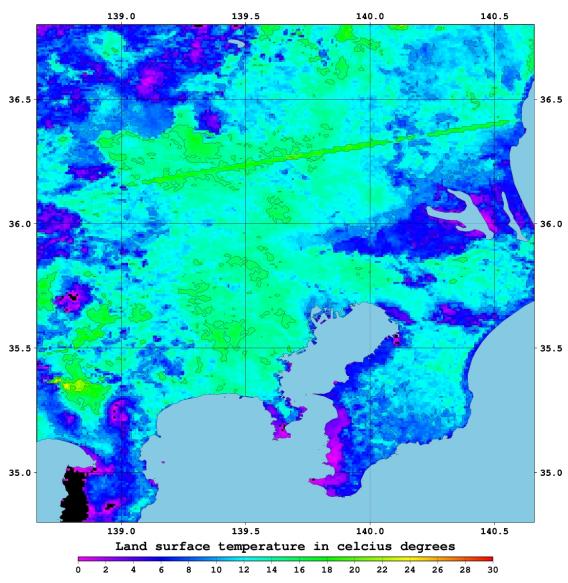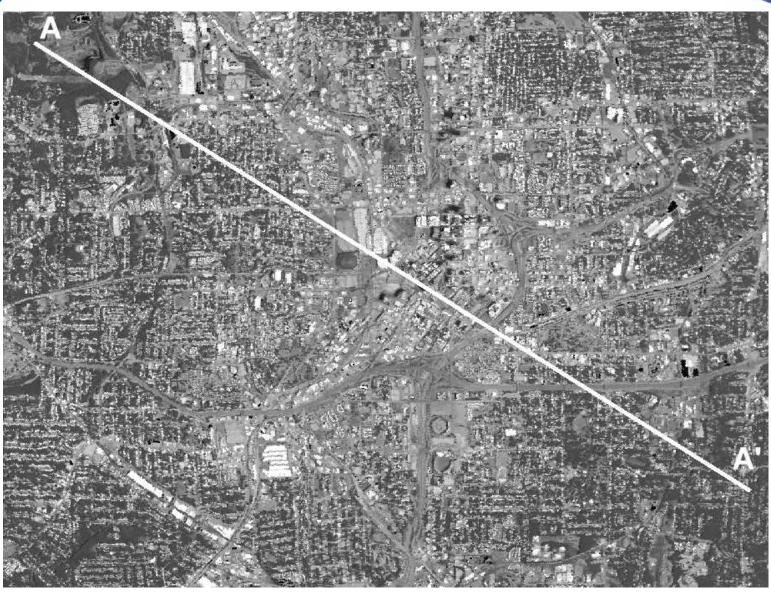
Land surface temperature in celcius degrees
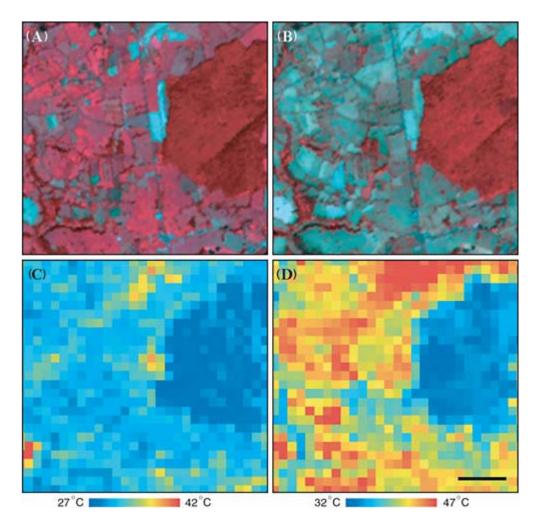
FIGURE 6.2.3 Small-scale vegetation and temperature differences associated with the heat wave of 2003; seen from ASTER. A and B, false color images for August 2000 and 2003, with vegetation in red and bare soil in pale blue. C and D, emission temperature for the same two dates (see color bar). The scale bar in the lower right has a length of 500 m. The forest patch on the right stayed relatively cool while the affected agricultural fields heated significantly. (*Decadal Survey, p. 169*)
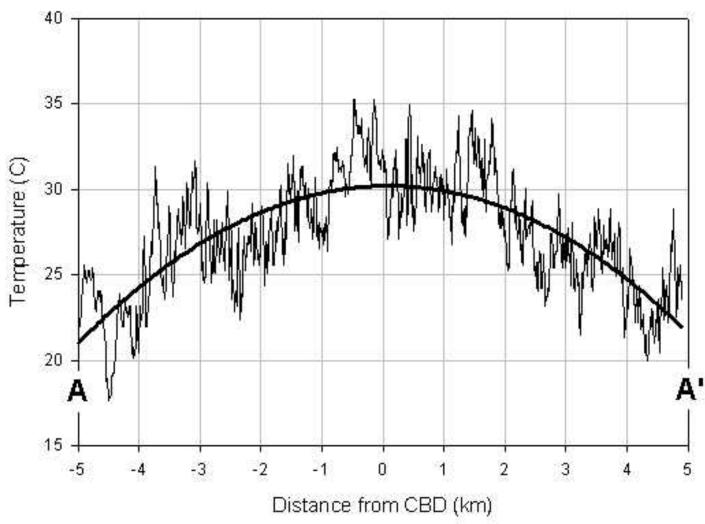
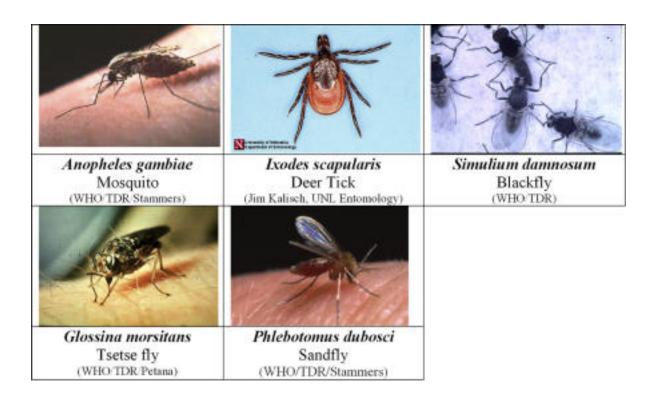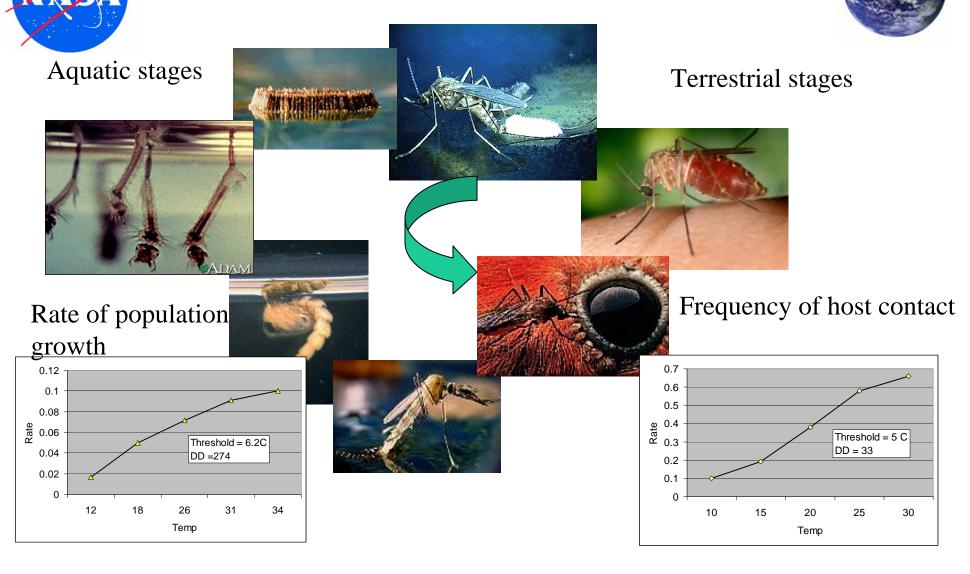- How can the characteristics associated with environmentally related health effects, such as factors influencing heat stress on humans and surface temperatures that affect vector-borne and animal-borne diseases, be better resolved and measured?

Anopheles gambiae
Mosquito
(WHO/TDR/Stammers)

Ixodes scapularis
Deer Tick
(Jim Kalisch, UNL Entomology)

Simulium damnosum
Blackfly
(WHO/TDR)

Glossina morsitans
Tsetse fly
(WHO/TDR/Petana)

Phlebotomus dubosci
Sandfly
(WHO/TDR/Stammers)

Effects of temperature on mosquito life cycle

Aquatic stages

Terrestrial stages

Rate of population growth

Frequency of host contact

Threshold = 6.2C
DD =274

Threshold = 5 C
DD = 33

Reisen et al. 1995. JME 32: 636
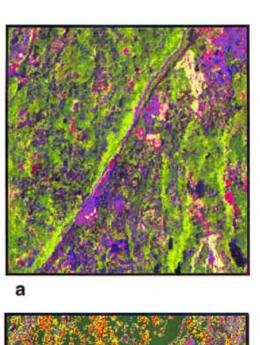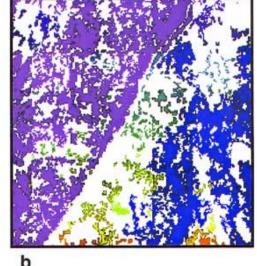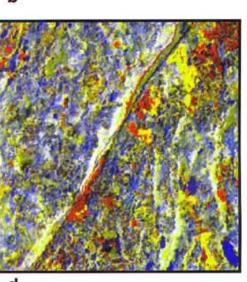
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TQ4 HysplRI Science Questions
Human Health and Urbanization Sub-questions

Lyme disease and remote sensing

Landsat Thematic Mapper (TM) satellite data for a 6x6-km area in Westchester County, New York
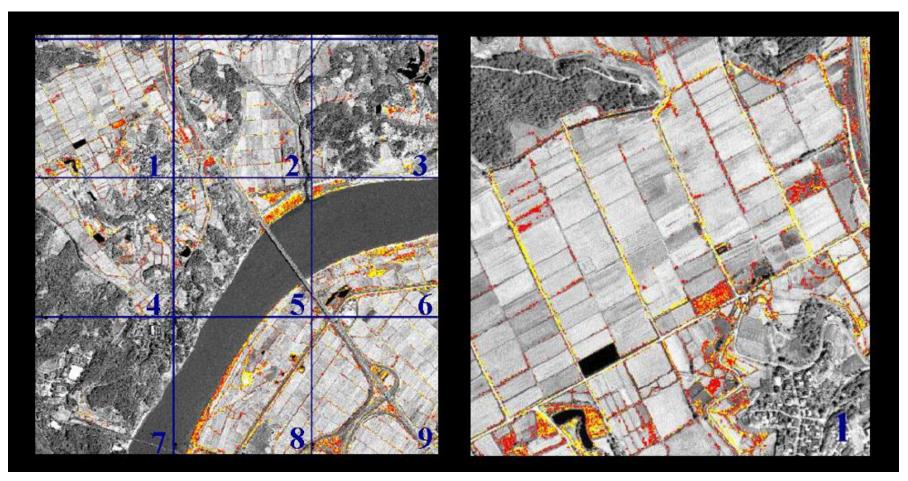
a) Raw Landsat TM image
b) contiguous forest patches
c) 12-class land cover map
d) Composite image of three spectral indices [brightness in red, greenness in green, and wetness in blue]

Detection of Ditches using Pan-sharpened Ikonos Data

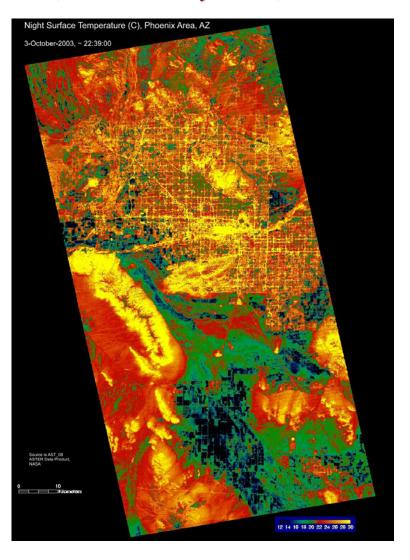(Larval Habitats of *Anopheles sinensis* in Korea)

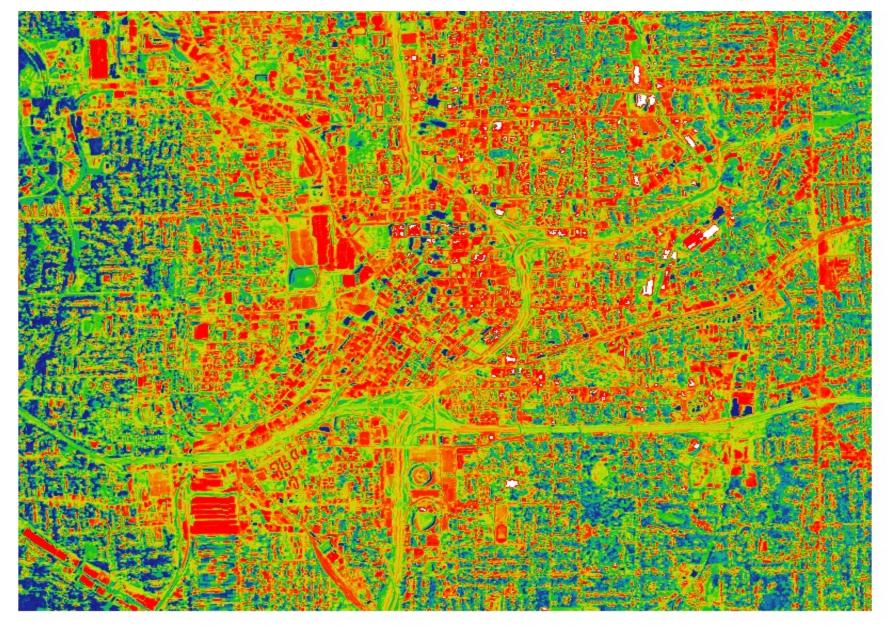**Detection of Ditches using Pan-sharpened Ikonos Data**

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Human Health and Urbanization Sub-questions

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

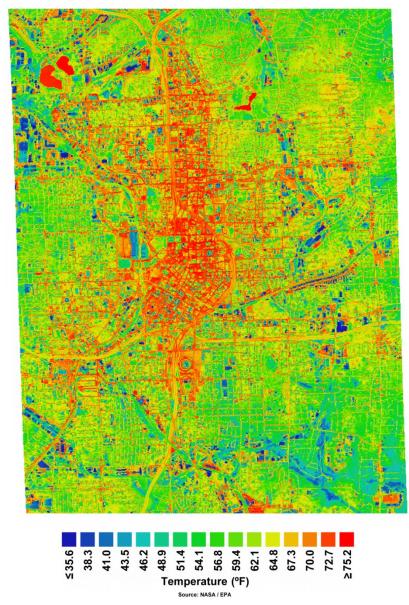| °C	≤17	21.7	26.4	31.1	35.8	40.5	45.2	≥50
Temperature								
°F	≤62.6	71.1	79.5	88.9	96.4	104.9	113.4	≥122

Atlanta
Central Business District
Night Data – May 1997

Temperature (°F)

| ≤35.6 | 38.3 | 41.0 | 43.5 | 46.2 | 48.9 | 51.4 | 54.1 | 56.8 | 59.4 | 62.1 | 64.8 | 67.3 | 70.0 | 72.7 | ≥75.2 |

Source: NASA / EPA

Human Health and Urbanization Sub-questions
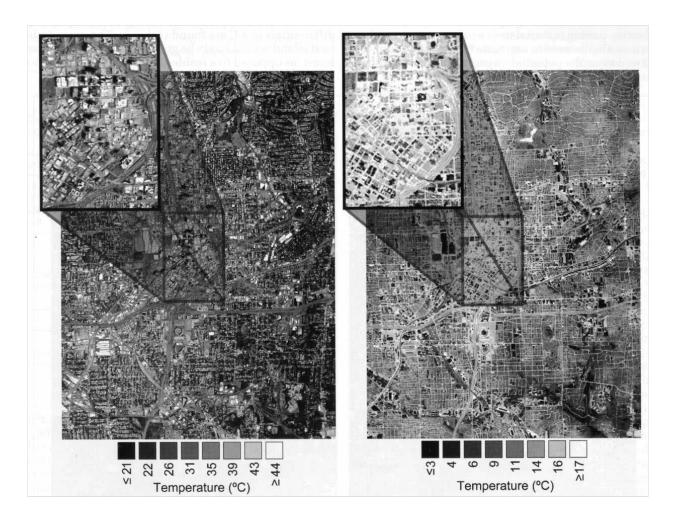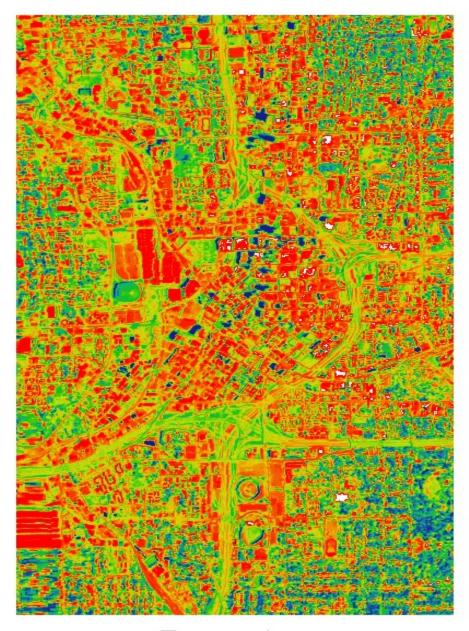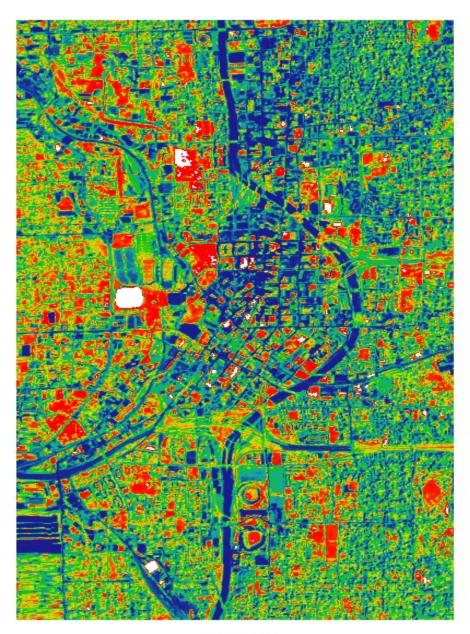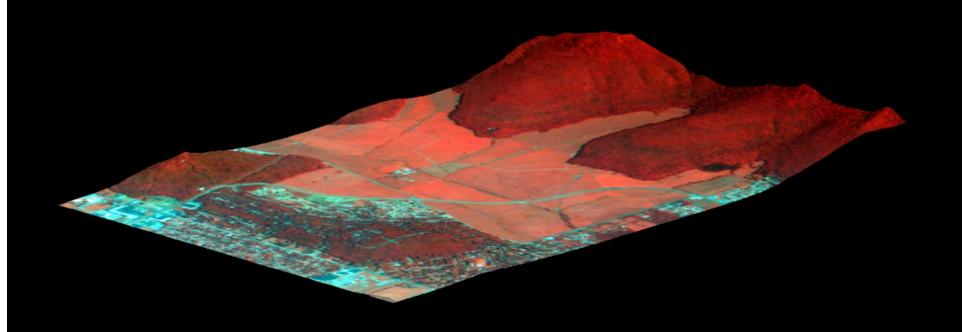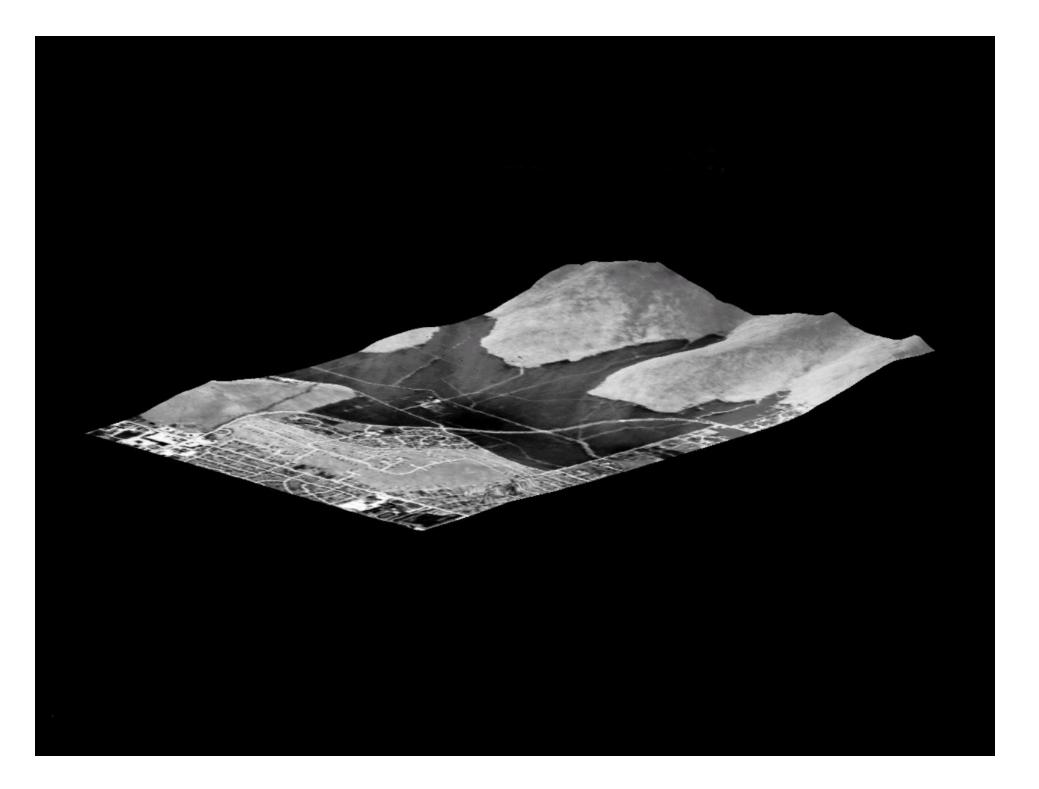
Temperature   Albedo

Atlanta, GA - May 1997

10m Composite (Bands 6,2,1)

TQ4 HysplRI Science Questions
Human Health and Urbanization Sub-questions

Summary from the Decadal Survey on "various needs for space-based observational data that will help to address human health problems in six areas of application"

PRIORITY OBSERVATIONS, MEASUREMENTS, AND TECHNOLOGY DEVELOPMENT

(Areas That HysplRI TIR Data Can Address)

- Ultraviolet radiation and cancer,
- ✓ Heat stress and drought,
- Acute toxic pollution releases,
- Air pollution and respiratory/cardiovascular disease,
- ✓ Algal blooms and water-borne infectious diseases, and
- ✓ Vector-borne and zoonotic disease

(*Decadal Survey*, p. 158)