New Opportunities in Urban Remote Sensing

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Role of Remote Sensing

• Advantages:
  • Uniform, global data
  • Repeatable at regular intervals over long periods of time
  • Broad range of non-visual, quantitative information

• Objective

• Limitations
  • Limitations in spatial, temporal resolution
  • Don’t measure human scale or human factor parameters

Remote sensing can provide foundation for other data
It is one component of a large toolbox
Example science questions and issues

- Understand urban growth impacts on key parameters, such as energy and water
- Quantify thermal energy fluxes across heterogeneous urban surface
- Understand and model the effect of urban land cover on land-atmosphere interactions
- Assess affects that cities have on local and regional meteorology, climate, air quality, and human and ecosystem health
- Hazard assessment
- Urban-rural-agricultural-natural boundary changes and effects through time
New Approaches

• Many remote sensing studies focus on a small number of cities and a small number of data sets
  • Data sets are (have been) expensive, large, complex
  • Therefore, only a limited set of variables can be isolated and studied
  • Important processes may be overlooked
  • For example: What are effects of diurnal, daily, seasonal, year-to-year variations?
New Approaches (con’t)

• Proposal to NASA for pilot study (Urban 4D) to collect a novel suite of aircraft remote sensing data
  • 5 US cities (Atlanta, Baltimore, Phoenix, Houston, San Francisco)
  • Broad spectrum of data from visible to thermal infrared
  • Every data collection done both day and night in single day

• Collect data:
  • Once a day for a week
  • Once a week for a month
  • Once a month for a season
  • Once a season for 3 years
Urban Heat Island

Daytime Temperature

Scottsdale, AZ
Phoenix
Nighttime
Surface
Temperature
Kinetic Surface Heat

10:40PM

W-E Transect
Phoenix Sky-Harbor north

ASTER Thermal Bands
90m²/pixel

~0.3 °C sensitivity

Even at low spatial resolution, heat island features can be correlated to materials on the ground
Visible to near-infrared
15 m/pixel

- Major land cover classes
- Vegetation health
- Soil properties
- Soil contamination

Shortwave infrared
30 m/pixel

- Urban surface materials
- Fugitive dust production
- Metal contamination
- Ecological communities

Thermal infrared
90 m/pixel

- Surface energy balances
- Heat island development
- Regional climate models
- Surface composition
CitySat Mission Conceptual Design

- Small, focused mission to provide frequent (≤3 day repeat cycle) observations of cities worldwide
  - Rapid response to new discoveries and needs
  - Opportunity to try new approaches and observations
- 2-3 modest instruments based on existing designs
  - Visible through infrared
- Operated from a university or similar research institution
- Extended team of science investigators
- Dedicated spacecraft
  - 52° inclination; 93 minute period
  - ~3-day repeat cycle
  - Fixed or varying solar illumination angle
  - Orbit would cover majority of urban centers
Where to go next?

- Articulate key science issues and measurement requirements for urban environmental assessment and monitoring
- Address the question of whether a small mission could address critical pieces of the global environmental monitoring program
  - Next planned near-IR/thermal-IR mission is HyspIRI
    - Tier 2 mission in the 2007 NRC Decadal Survey
  - NASA’s Venture-class program could be an opportunity for a dedicated urban satellite or instrument of opportunity
    - ≤$100 M over ~2 years