

An aerial remote sensing image of a city and surrounding landscape. The image is overlaid with a grid, likely representing a spatial sampling or analysis scheme. The colors are somewhat muted, with a mix of greens, browns, and greys, suggesting different land cover types like vegetation, urban areas, and water. The text is overlaid on the image in a yellow, bold font.

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 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

Mars Global Surveyor TES



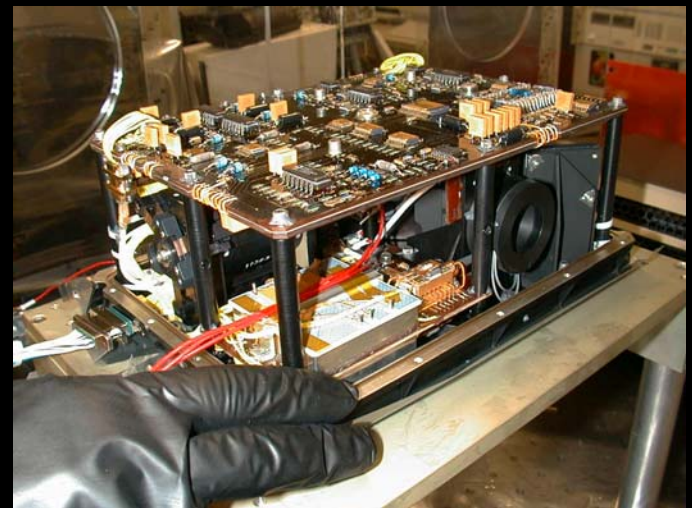
Mars Odyssey THEMIS



Spirit Rover Mini-TES



Opportunity Rover Mini-TES



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

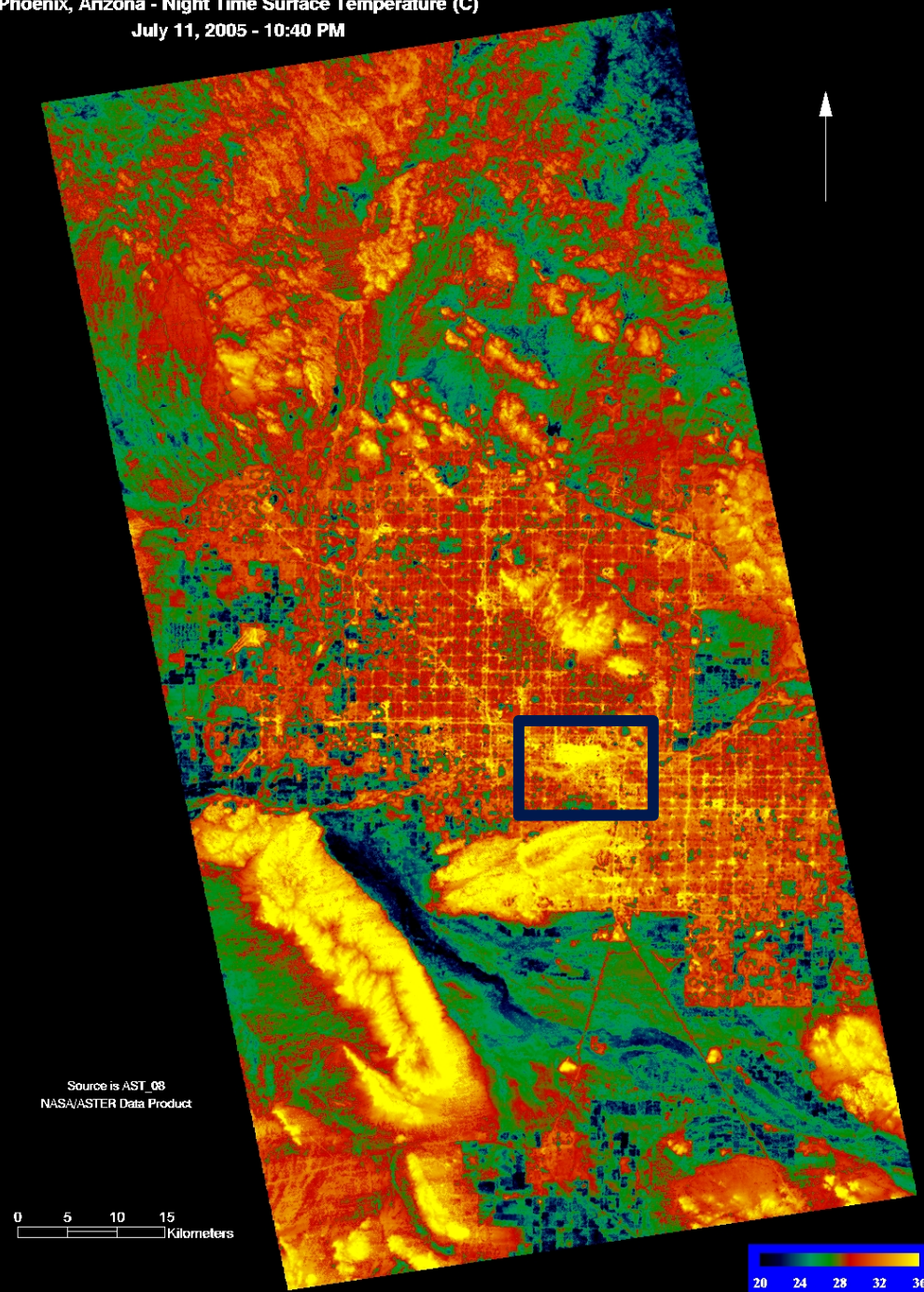


Daytime Temperature

Scottsdale, AZ

Phoenix, Arizona - Night Time Surface Temperature (C)
July 11, 2005 - 10:40 PM

Phoenix Nighttime Surface Temperature

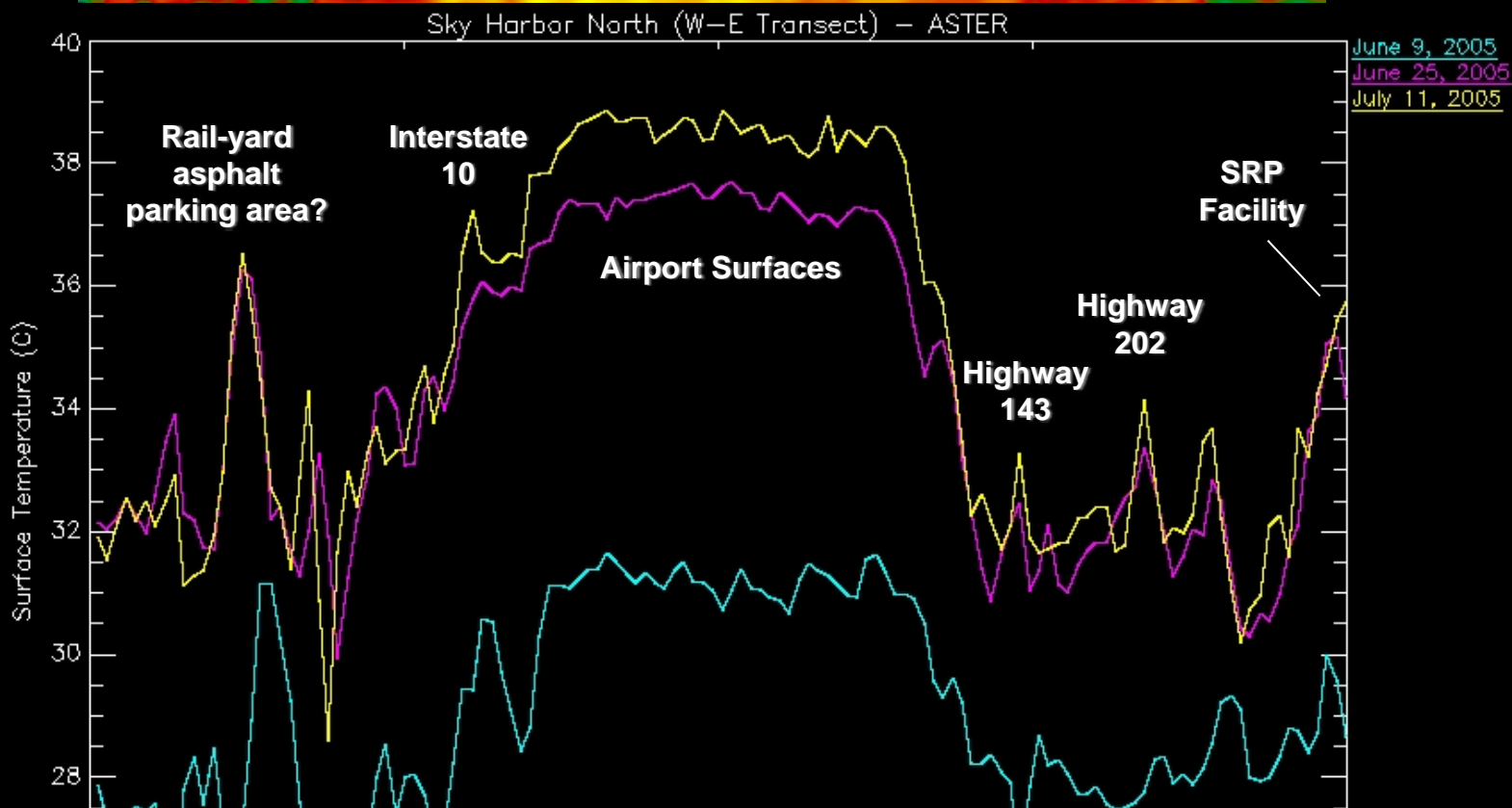
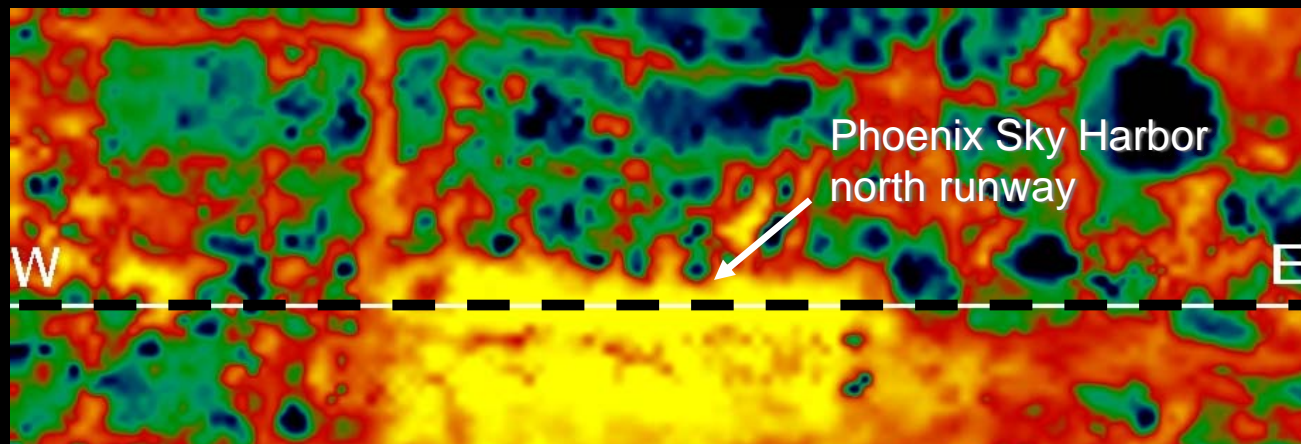


Kinetic Surface Heat

10:40PM

W-E *Transect*
Phoenix Sky-Harbor north

ASTER
Thermal Bands
90m²/pixel
~0.3 °C
sensitivity



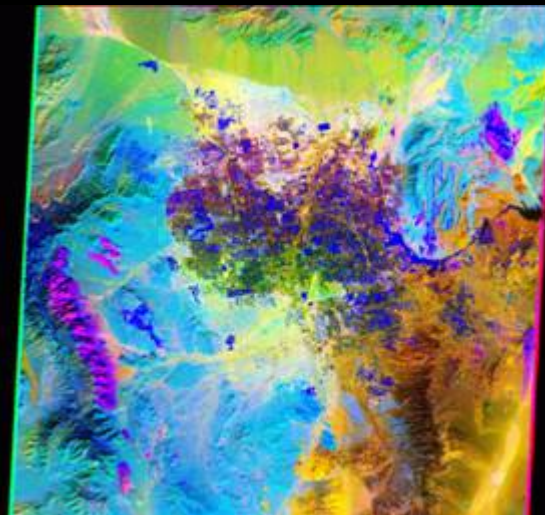
Even at low spatial resolution, heat island features can be correlated to materials on the ground

Multi-Wavelength Approach



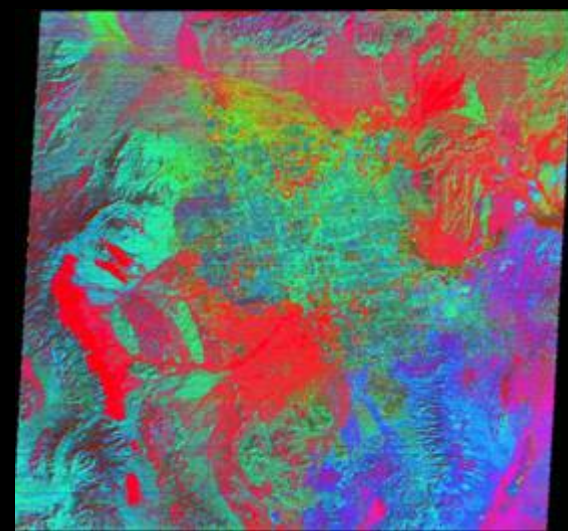
Visible to near-infrared
15 m/pixel

- 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 HypsIRI
 - 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
 - $\leq \$100$ M over ~2 years

Phoenix Regional View

