Surface Characterization

3rd Annual Workshop on
Hyperspectral Meteorological Science of UW MURI
And Beyond

University of Hawai'i

Paul G. Lucey

Co-Investigator

Hawaii Contributions To Wisconsin MURI Project

MURI Research Components	University of Hawaii Contributions		
	IR Spectral Phenomenology	Hyperspectral Data Collection	Hyperspectral Data Compression Methodologies
Mathematical Quantification of Hyperspectral Information		**Provide test data sets**	Leverage other-funded UH research to reduce data volume
Radiative Transfer Modeling	Contribute experience with measurement and modeling of surfaces		
Mathematical Retrieval Algorithm Development		Contribute ground-truthed data sets	
Product Research	Integrate modeling/data collection/information extraction		

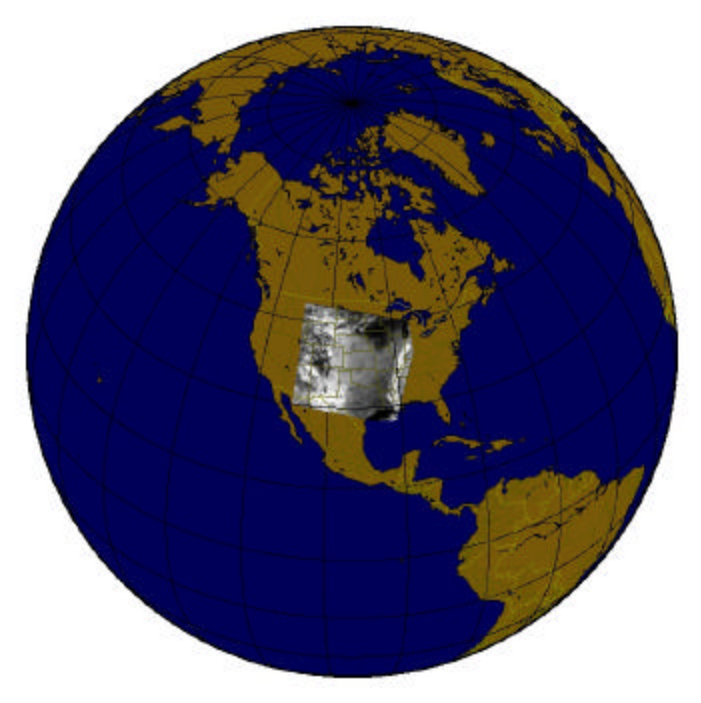
Surface Emissivity Simulation

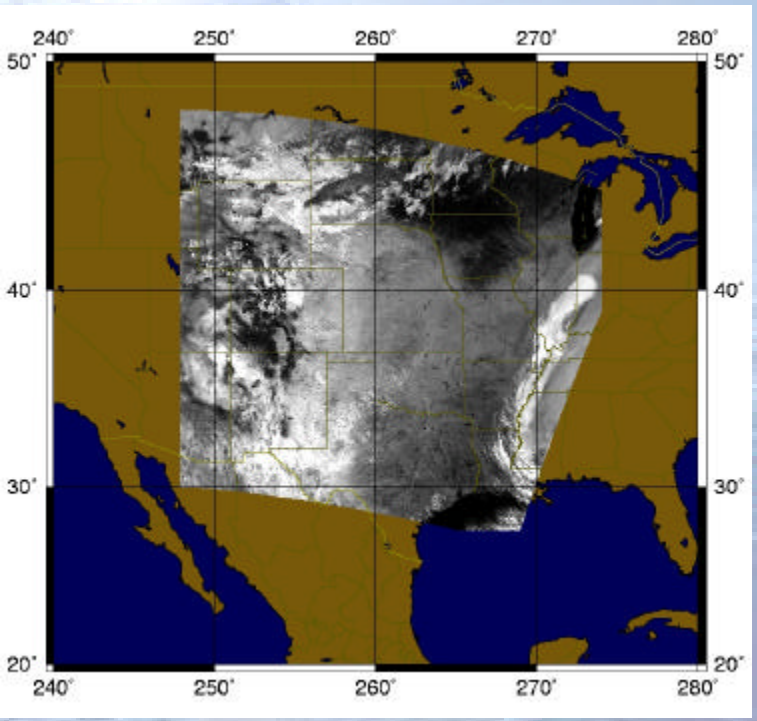
- Use multispectral infrared satellite data as base map
- Fit infrared multispectral data with hyperspectral library data
- Produce continuous sampled spectrum at each pixel

Base Map

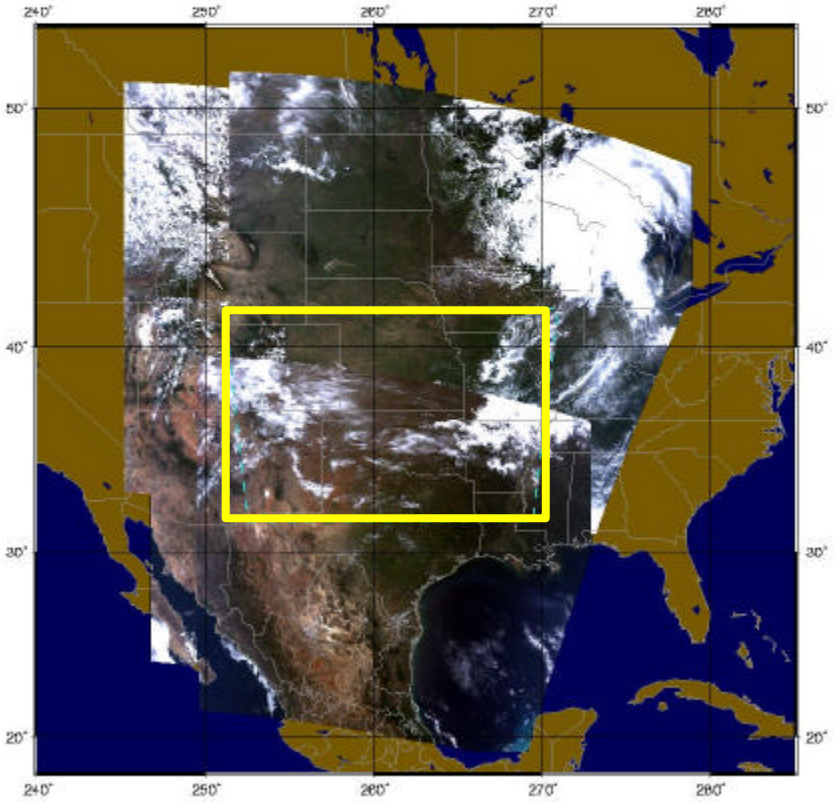
- Data from MODIS
- Convert to emissivity
- Detect and eliminate clouds
- Produce mosaic of simulation area

MODIS Base Map

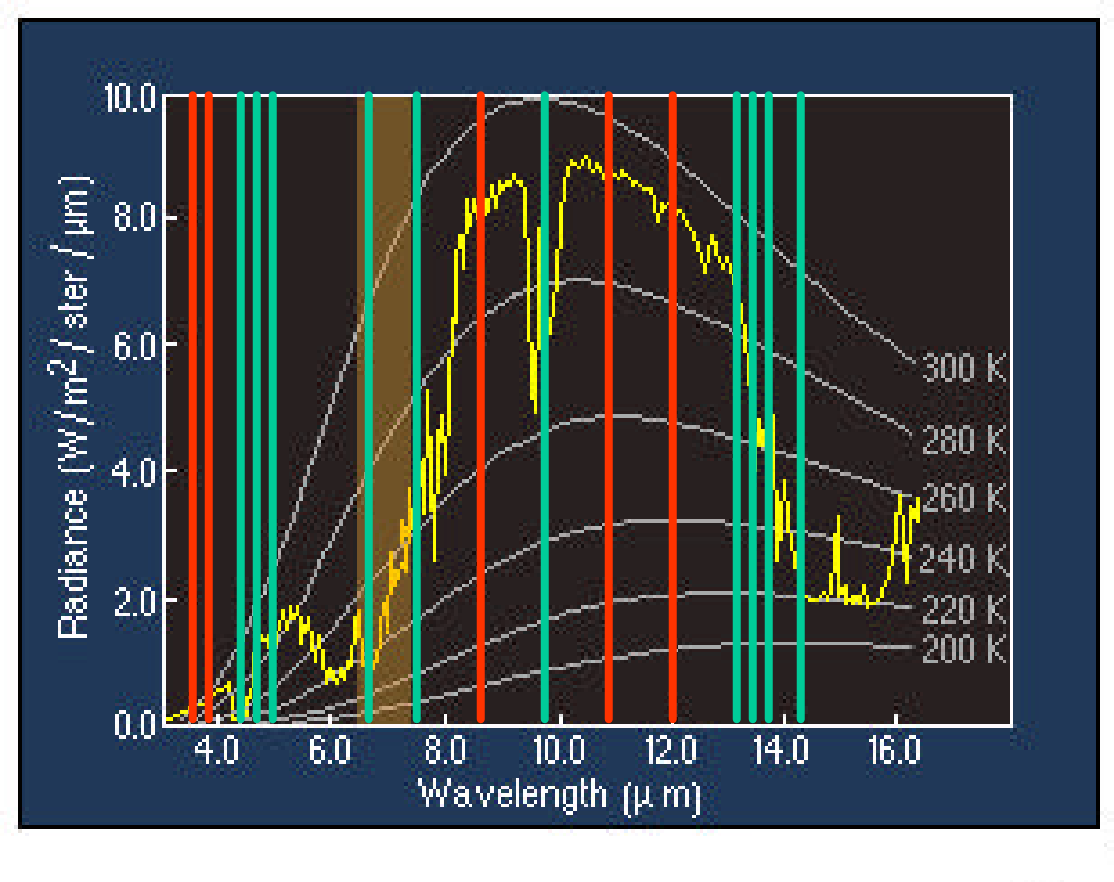




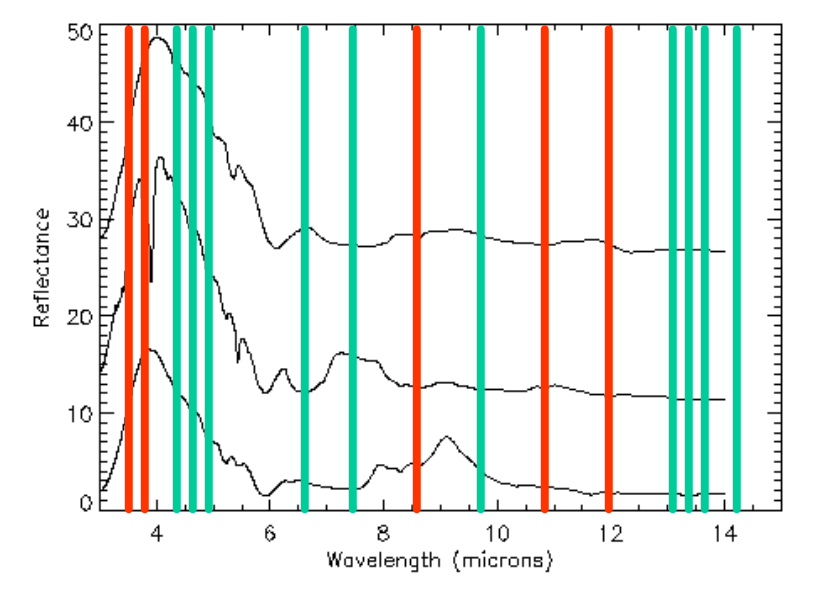
MODIS Base Map Mosaic



MODIS features several bands with weak atmospheric extinction appropriate for surface characterization



MODIS “surface” bands constrain surface compositional types



Estimate of MODIS surface emissivity

MODTRAN coupled with aerosonde measurements provides atmospheric transmission, up and downwelling radiance.

Assume no multiple scattering

$$L_{sat} = L_{atm\_upwelling} + [B(T)\varepsilon + L_{atm\_downwelling} * (1 - \varepsilon)] * t_{atm}$$

At 11 microns assume $\varepsilon = 1$ to establish surface temperature

Solve for ε at all wavelengths

Cloud Detection and Removal

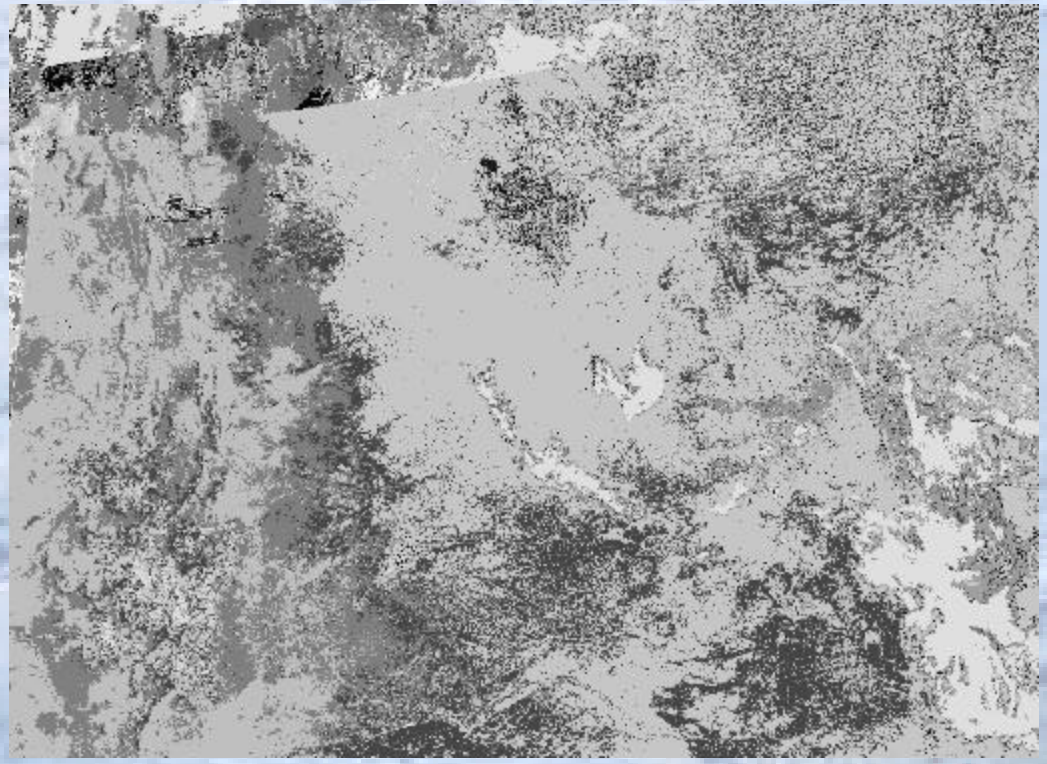
- High visible radiance
- Low infrared radiance
- Change detection

- Mask detections, average emissivities of non-cloudy areas
- Residual clouds set to blackbody radiances at mean surface temperature

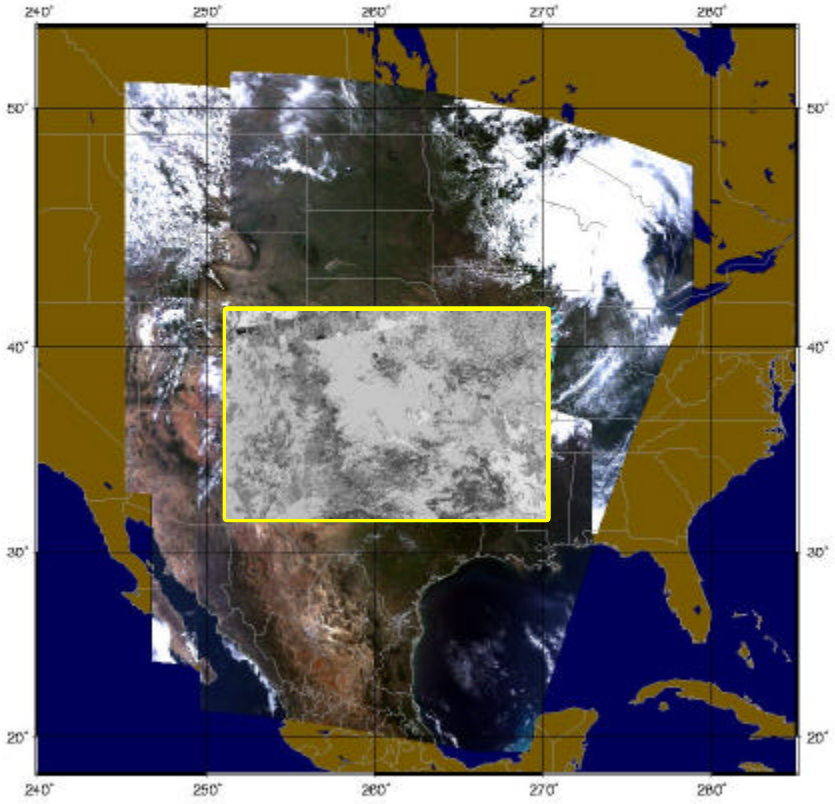
Emissivity assignment

- Extract soil emissivities at MODIS wavelengths (assumine Kirchoff's Law) from ASTER spectrum library (41 soils)
- Treat ASTER soils as lookup table
- Compare each MODIS spectrum to lookup table and return soil sample# for closest fit (by RMS differences)
- Insert full resolution ASTER spectrum at each location

Emissivity assignment



MODIS Emissivity Type Map



Spatial resolution:
1km

Wavelength range:

685-2250 cm^{-1}

Wavelength sampling:

2 cm^{-1}

Spectral channels:

801

Simulation Improvements for Following Year

- Dynamic emissivity
  - Vegetation senescence
  - Surface moisture
- “Ground truth” using data from ASTER