Combined VSWIR-TIR Data Products

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Product List

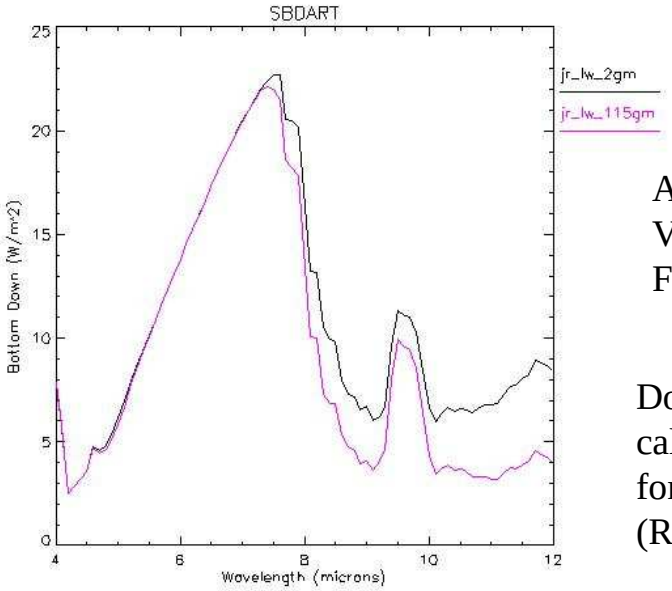
- **Improved Temperature Emissivity Separation**
- **Combined VNIR-SWIR Physiological/Thermal Stress Measures**
- **Combined Species/PFT and Thermal Stress Measures**
- **Combined Sub-pixel Fractions (GV, NPV, Soil, Shade) and Canopy/Soil Temperatures**
  - **Sub-pixel canopy temperature (experimental)**
  - **Sub-pixel soil temperature (experimental)**
- **Improved Sub-pixel Vegetation/Impervious/Soil fraction**
- **Urban Albedo/Temperature Product**

Improved Temperature Emissivity Separation

- **Product description:**
  - **Improved pixel-based estimate of Temperature and Emissivity**
- **Justification:**
  - **The largest error source in TES for ASTER is estimated atmospheric downwelling radiance and attenuation**
- **Unique Hyspiri Contribution**
  - **Hyspiri provides pixel scale column water vapor, significantly improving upon climatology, radiosonde or MODIS**
  - **Emissivity should be slowly varying, thus improved emissivity at 19 days should improve temperature estimates at 5 day intervals**
- **Climate Continuity Relevance**
  - **Temperature impacts numerous hydrological and biological processes including rates of ET, photosynthesis and respiration**
  - **HyspIRI provides a mechanistic understanding of temperature variability seasonally and across ecosystems**

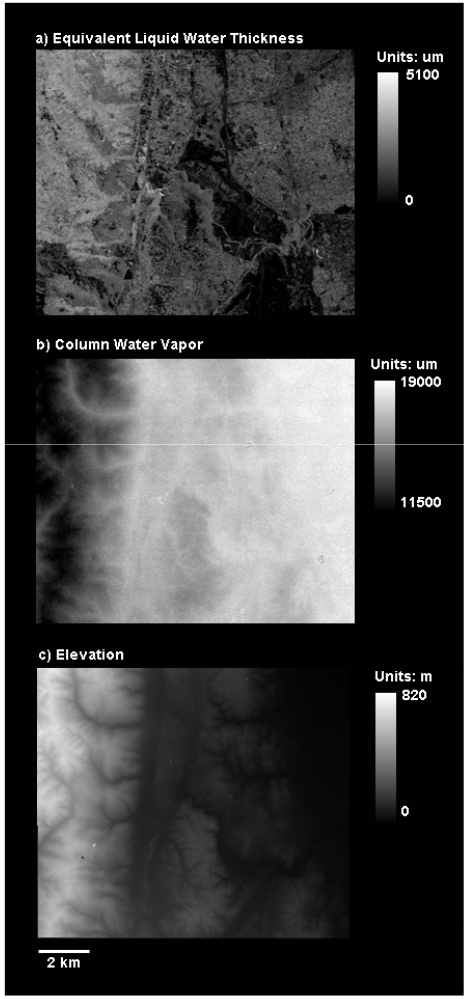
Improved Temperature Emissivity Separation

- **Column water vapor is estimated using forward inversion as it varies spatially and with elevation**
- **Column water vapor is used to calculated downwelling radiance as a first step for emissivity estimation**



AVIRIS EWT, Column Water Vapor, and a DEM
From Roberts et al., 1997

Downwelling longwave calculated using SBDART for 1.15 and 2 g/m^2 water vapor (Richiazzi et al.)



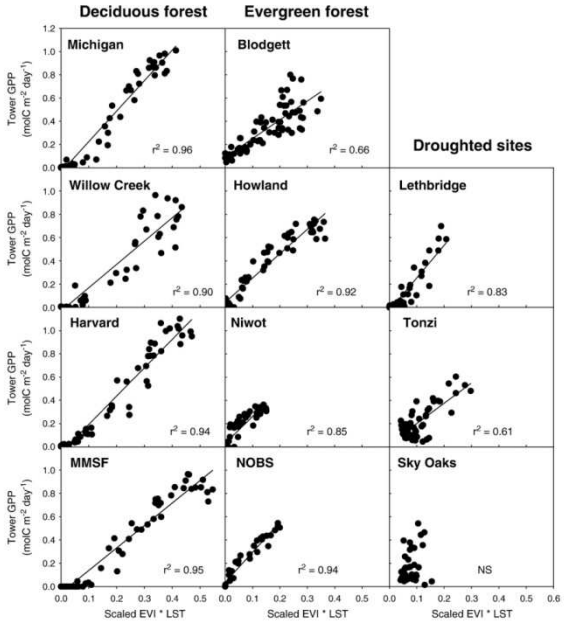
Production: Standard ASTER TES Algorithm modified to include 60 m Column water vapor and surface elevation. Other synergies are likely

Combined VNIR-SWIR Physiological/Thermal Stress Measures

- **Product description:**
  - **Fused VNIR-SWIR indices and canopy temperature**
- **Justification:**
  - **Plants respond to stress either biochemically, such as a change in plant chemistry or biophysically, such as through leaf drop or elevated canopy temperatures**
- **Unique Hyspiri Contribution**
  - **Hyspiri can generate a suite of standard hyperspectral stress indices such as PRI, MCARI, EWT, red-edge measures that cannot be generated with other sensors**
  - **Improved measures of canopy emissivity & temperature. Relationships established at a 19 day repeat can be interpolated using TIR at 5 day intervals**
  - **60 m spatial resolution can improve upon current 1 km products from MODIS**
- **Climate Continuity Relevance**
  - **Models for calculating GPP currently prescribe many physiologically significant variables such as LUE or WUE based on biome and thus fail to capture important interactions between vegetation, temperature and available moisture**
  - **Improved model performance should provide a better mechanistic understanding of how changes in temperature and moisture impact GPP**

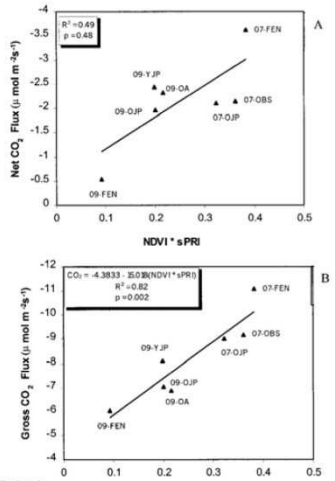
Combined VNIR-SWIR Physiological/Thermal Stress Measures

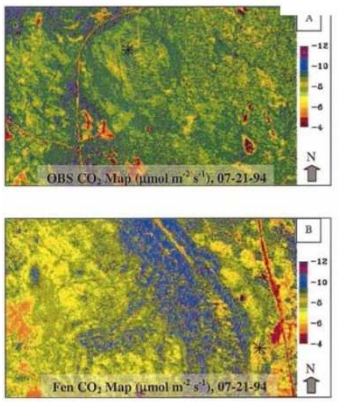
- **The ability to improve estimates of carbon uptake using PRI has been established using flux data and AVIRIS**
- **MODIS estimates of carbon uptake can be improved using LST and a vegetation index. What is the potential at 60 m with better indices?**



Plot of scaled EVI*LST compared to carbon uptake from flux towers.
Example derived from MODIS
From Sims et al., 2008

Plots of net and gross carbon dioxide flux measured at 7 Boreas flux tower sites compared to estimates of FPAR (NDVI) and quantum efficiency (PRI) from AVIRIS. From Rahman et al., 2001





Maps of carbon dioxide uptake estimated from scaled PRI and NDVI, calibrated to eddy flux data. From Rahman et al., 2001.

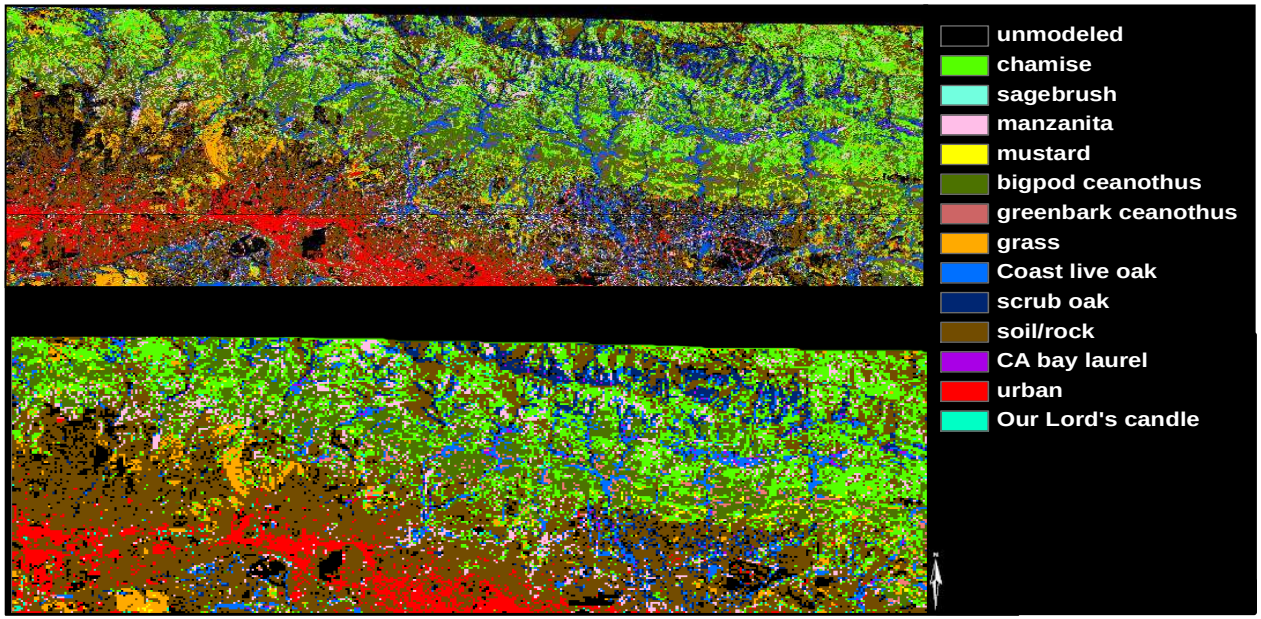
Production: Improved ASTER-TES algorithm and suites of standard hyperspectral indices from reflectance

Combined Species/PFT composition and Thermal Stress Measures

- **Product description:**
  - **Temperature estimates for HyspIRI-mapped plant species and PFTs**
- **Justification:**
  - **Physiological and compositional differences between plant species and PFTs are likely to impact surface temperatures**
- **Unique Hyspiri Contribution**
  - **Hyspiri can provide species-PFT level discrimination and surface temperature**
  - **Five day thermal repeat provides measures of how PFT/species change physiologically in response to environmental variation (PFT/Species are unlikely to change in distribution over such as short time scale).**
- **Climate Continuity Relevance**
  - **Temperature impacts numerous hydrological and biological processes including rates of ET, photosynthesis and respiration**
  - **HyspIRI provides a measure of how seasonal changes in the environment (moisture, air temperature) modify plant physiological functioning within distinct species-PFTS**

Combined Species/PFT composition and Thermal Stress Measures

- **Species/PFT responses to environmental variation, expressed in LST are likely to be lost at coarse spatial scales where they are mixed**



AVIRIS species map at 16 and 64 m spatial resolution. Accuracy actually increased as spatial resolution became coarser

Production: Standard ASTER TES Algorithm modified to include 60 m Column water vapor and surface elevation combined with PFT/Species product

Combined Sub-pixel Fractions (GV, NPV, Soil, Shade) and Canopy/Soil Temperatures

- **Product description (Experimental):**
  - **Sub-pixel green leaf, NPV, soil temperatures**
- **Justification:**
  - **ASTER TES provides an aggregate measure of temperature and emissivity and thus does not provide sub-pixel estimates of LST for each component.**
- **Unique Hyspiri Contribution**
  - **Hyspiri VNIR-SWIR can provide highly accurate sub-pixel measures of GV, NPV and Soil Fractions**
  - **Simultaneous TIR spectra provide aggregate measures of emissivity and temperature**
- **Climate Continuity Relevance**
  - **The ratio of ET to PET can be estimated from canopy temperatures, provides measures of how hydrology and surface energy balance varies locally and with environmental change**

Combined Sub-pixel Fractions (GV, NPV, Soil, Shade) and Canopy/Soil Temperatures

- **Example**
  - **Emission spectra over a range in temperatures for three materials show minor (GV-Alfisol) to significant (GV-NPV) spectral contrast**
  - **Mixing lines between a 315K NPV and 305 K GV**
- **Production: Experimental**
  - **VNIR-SWIR establishes composition and fractional cover**
  - **Emissivities assigned to endmembers from above**
  - **Temperatures estimated by intersection of mixing lines with pure temperature-radiance lines**
    - **Requires gradients in cover, assumes uniform temperatures within a cover type**
    - **Multiple wavelengths in TIR improve estimates of temperatures through greater emissivity contrasts**