High Spectral/Temporal Resolution Cloud Detection

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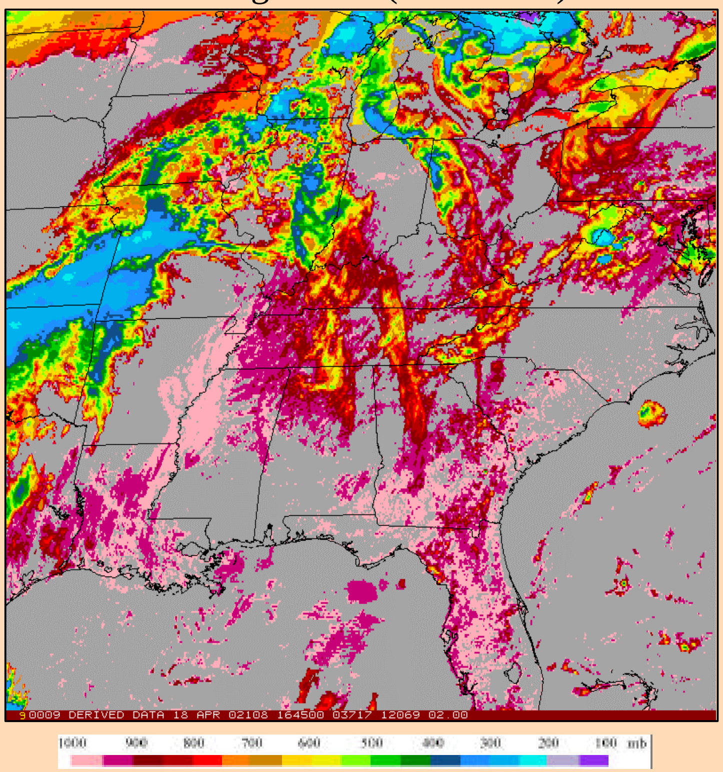
Identify cloud and surface characteristics in high spectral resolution data which best delineate clouds, aerosols, and surface properties from one another

Develop a cloud detection algorithm that exploits high spectral resolution measurements such as GIFTS/IOMI

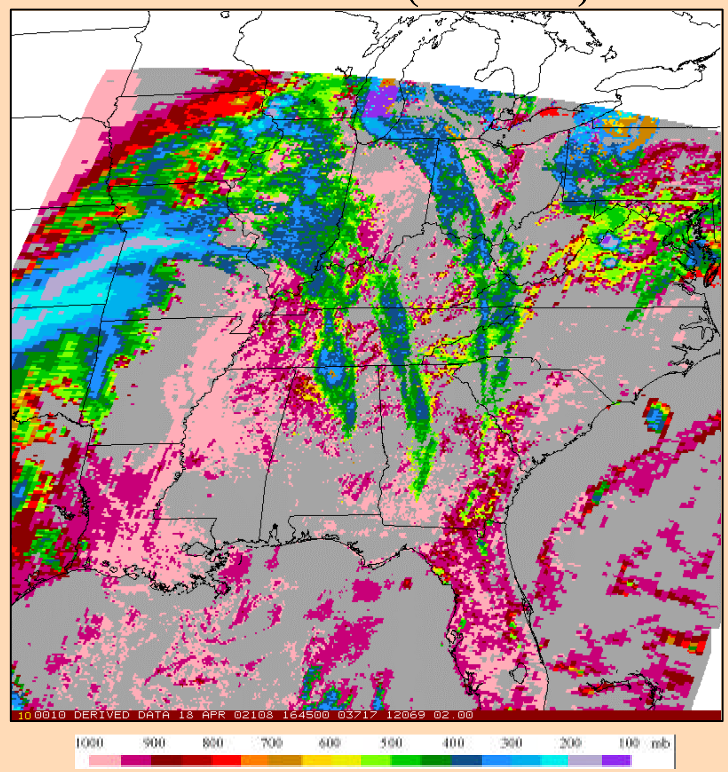
Past Year Accomplishments

UAH student (Kevin Laws) complete M.S. refining cloud detection algorithm with GOES – *BTH technique* – *<u>demonstrates value of spatial and temporal thresholds in difference images</u>*

GOES Imager CTP (1645 UTC)



MODIS CTP (1635 UTC)



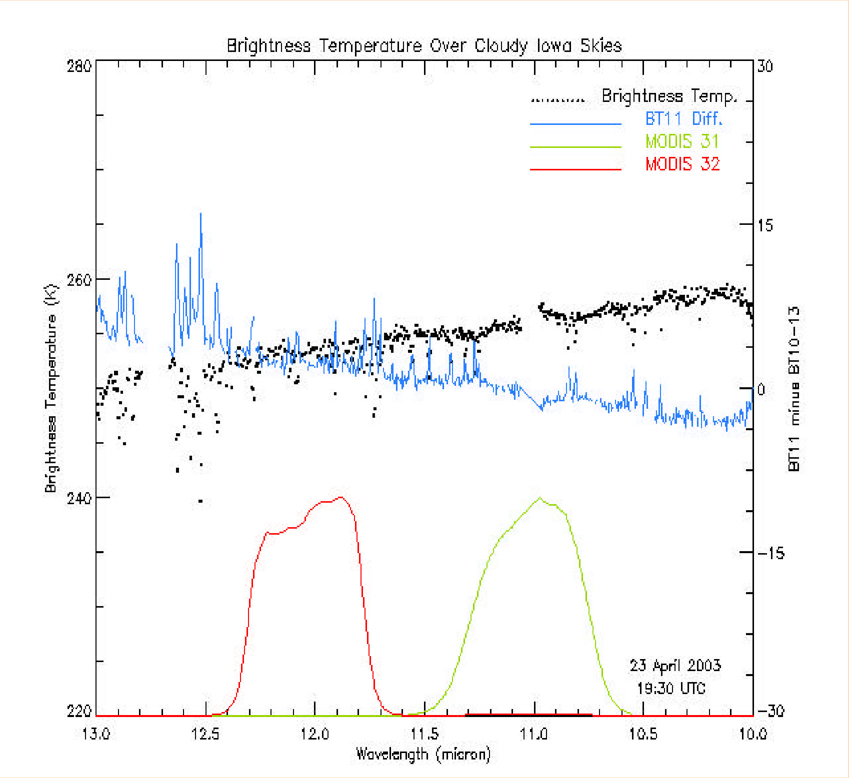
Past Year Accomplishments (continued)

New UAH graduate student (Nicole Slodysko) began thesis work with analysis of AIRS data

- analyzed AIRS spectrum of clouds
- categorized spectral signatures

  day, night, cloud type, view angles
- preliminary insight on detection

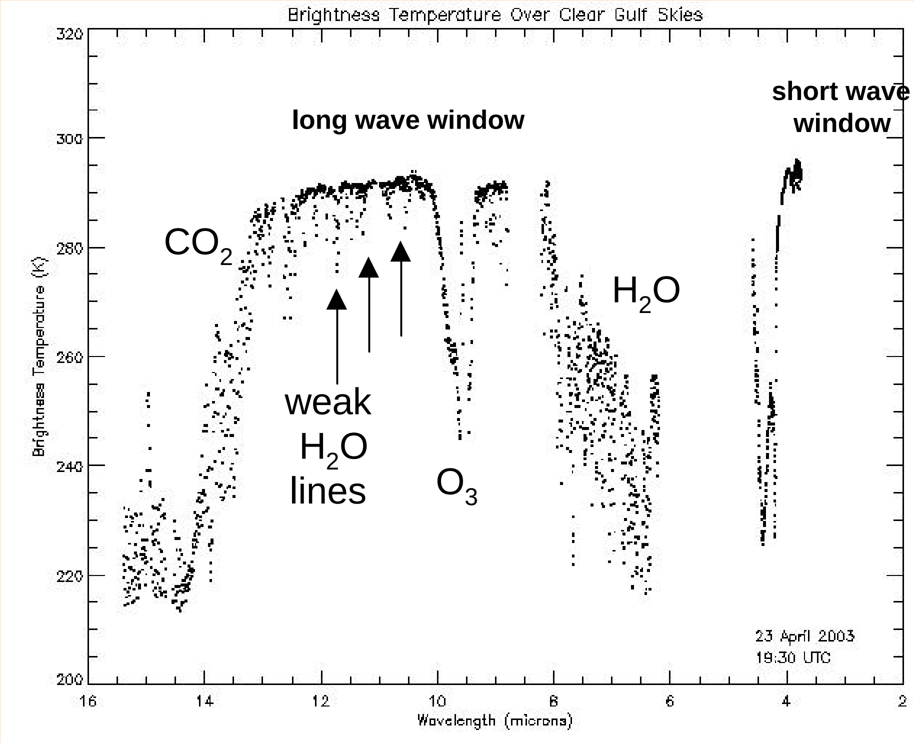
  strategy

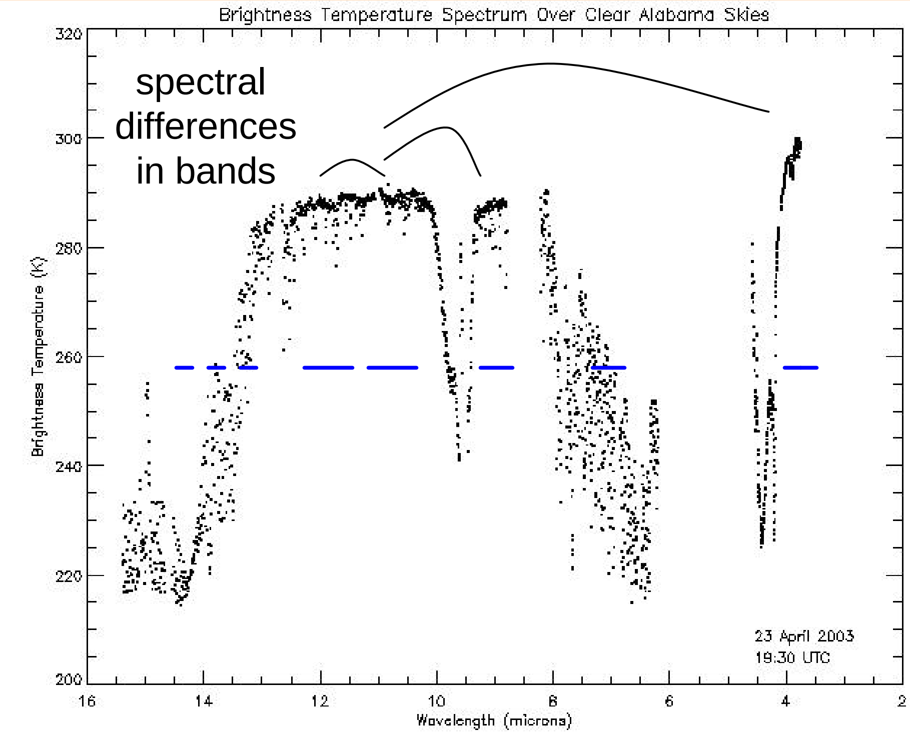


Earth-Atmosphere Emission Spectrum

Examine Earth-atmosphere emission spectrum (AIRS)

- Relatively transparent (window) regions detect emission/reflective properties from surface and clouds
- GOES and MODIS look at this emission in relatively broad bands – measure integrated effect of spectral emission





Spectral Signature of Clouds

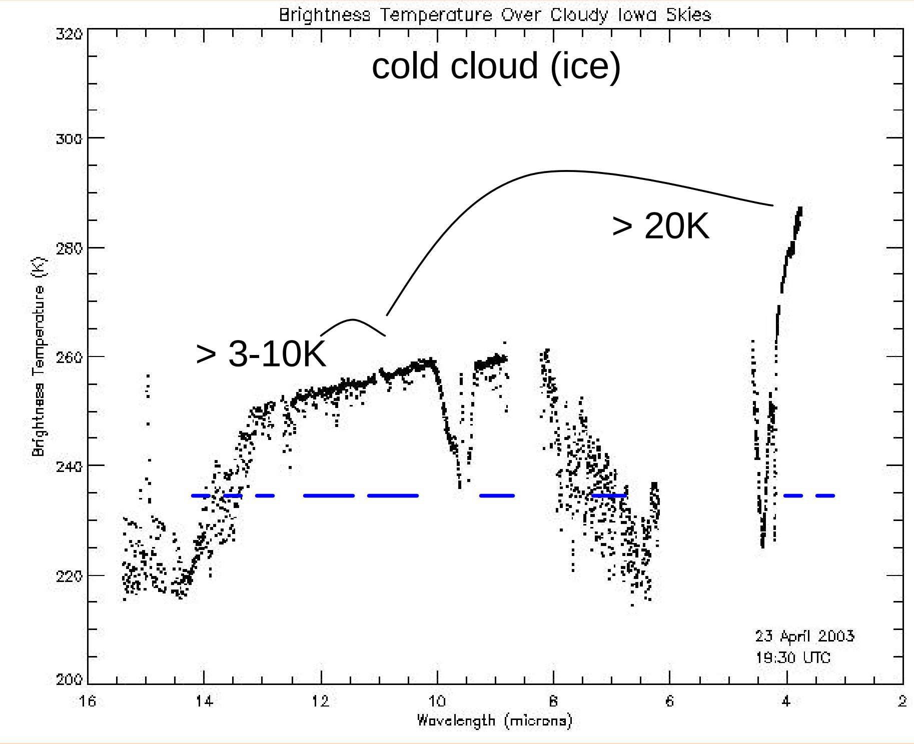
<u>GOES</u> BTH technique: 11µm, and 11–3.9 µm differences (day and night)

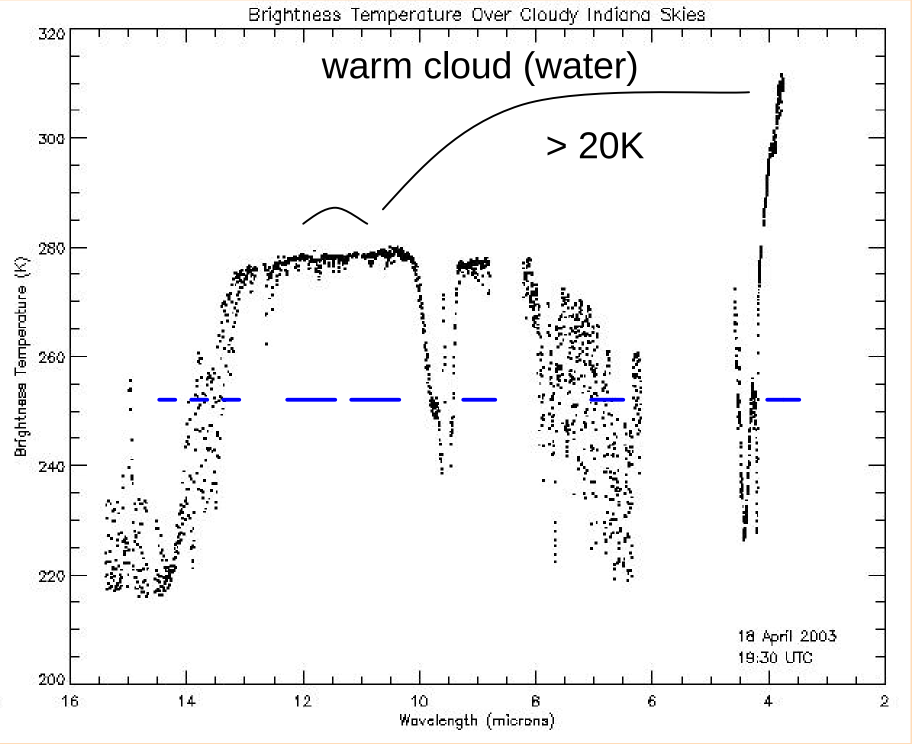
- spatial and temporal thresholds determined

EOS approach with <u>MODIS</u> uses many spectral difference tests

11–3.9 µm, 11-12 µm , 8.6-11 µm, 3.7-12 µm, 11-6.7 µm

These approaches can be successful but do not fully utilize high spectral information!





High Spectral Resolution Methodology

Examine high resolution spectral differences in AIRS data for cloud signatures

Stratify AIRS scenes into categories

- Day and night
- Cloudy and clear
- Types of clouds (cirrus of vary optical depth, various levels of opaque clouds)

Calculate average of 10 AIRS channels centered on 11.08 μm ($\overline{T_{bb}(11)}$) (between H_2O absorption lines)

Calculate and examine difference spectrum

Use results in spectral cloud detection scheme

$\overline{T_{bb}\ (11)} – T_{bb}(3\text{-}4)\mu m$ Difference Spectrum for Clouds

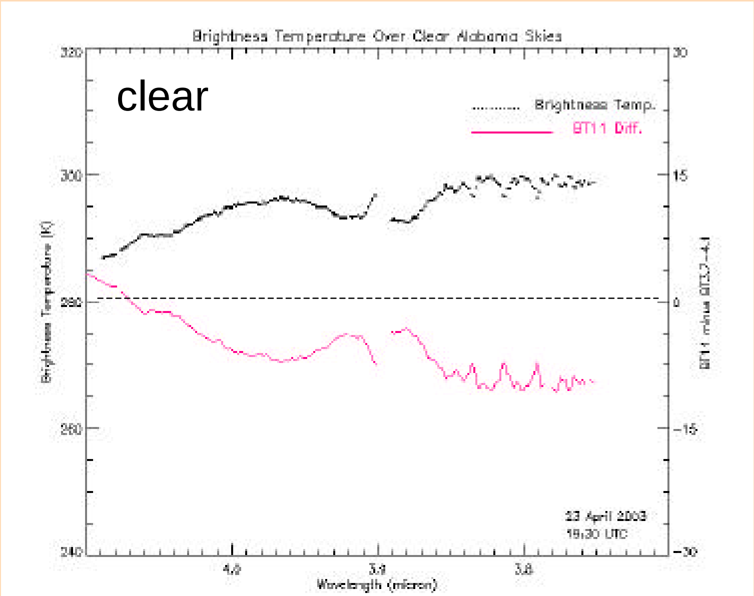
<u>Cloud (day):</u>

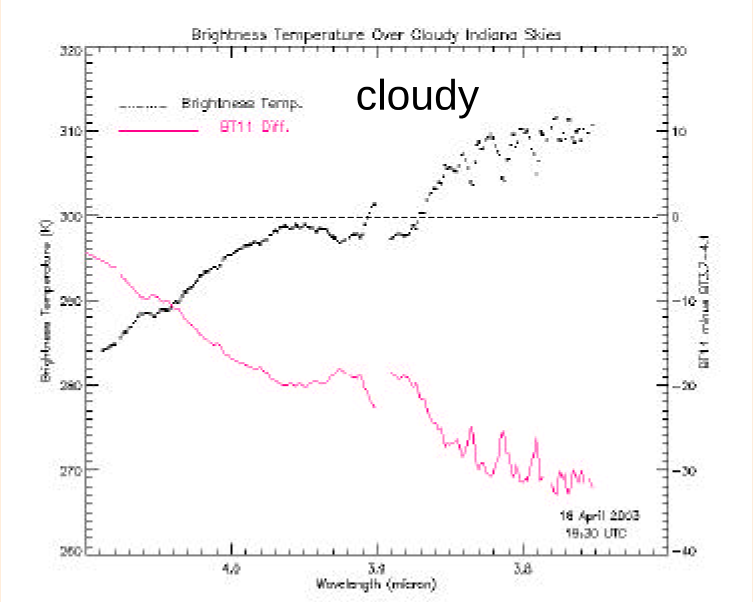
- difference is (large) negative

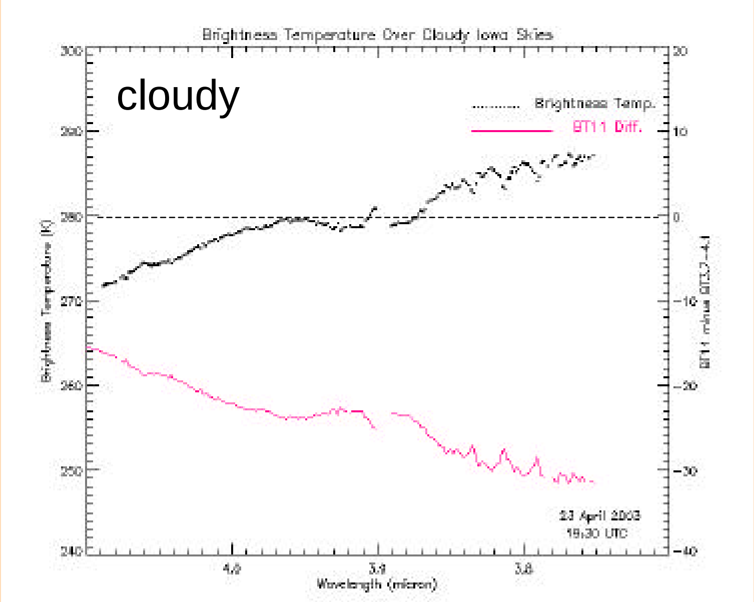
  magnitude depends reflected solar
- hump at 3.9μm is missing
- 3.9-4.1μm slope is more negative
- 3.7-3.9μm slope significant

<u>Cloud (night)</u>

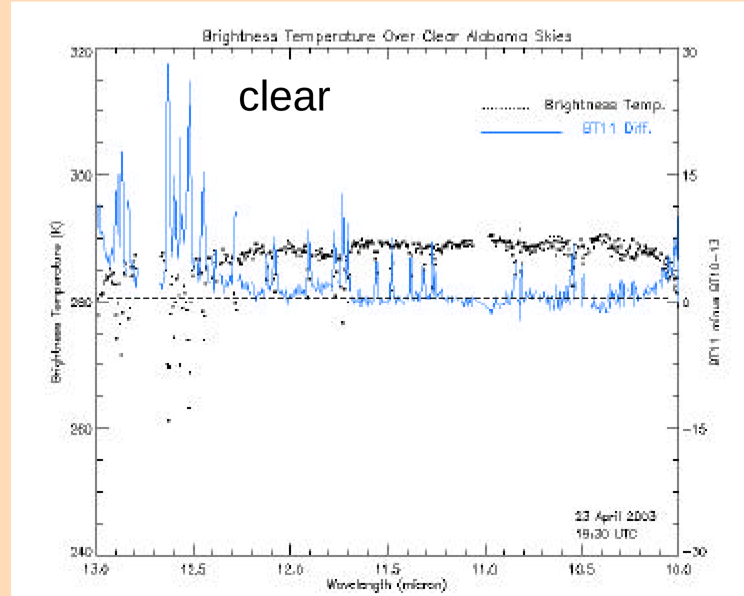
- difference is (small) positive (absence of reflected solar)
- 3.9-4.1μm slope is flat







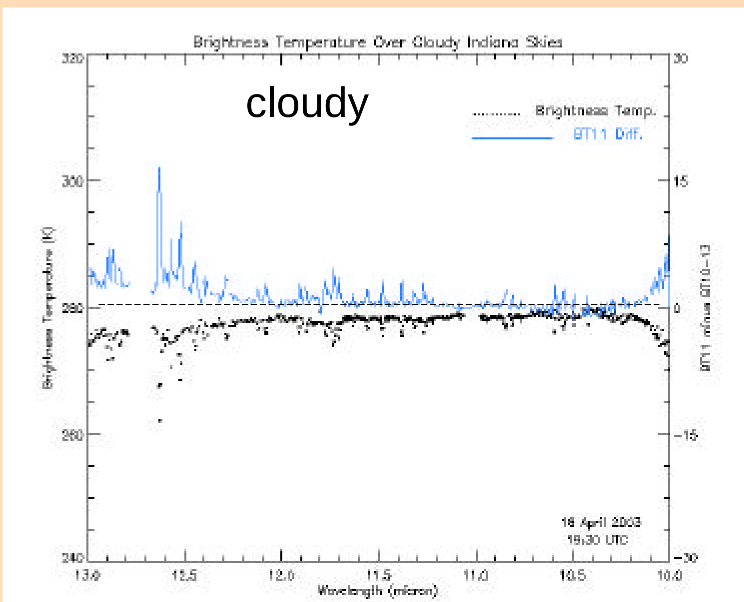
$\overline{T_{bb}\ (11)} - T_{bb}(10\text{-}13)\mu m$ Difference Spectrum for Clouds

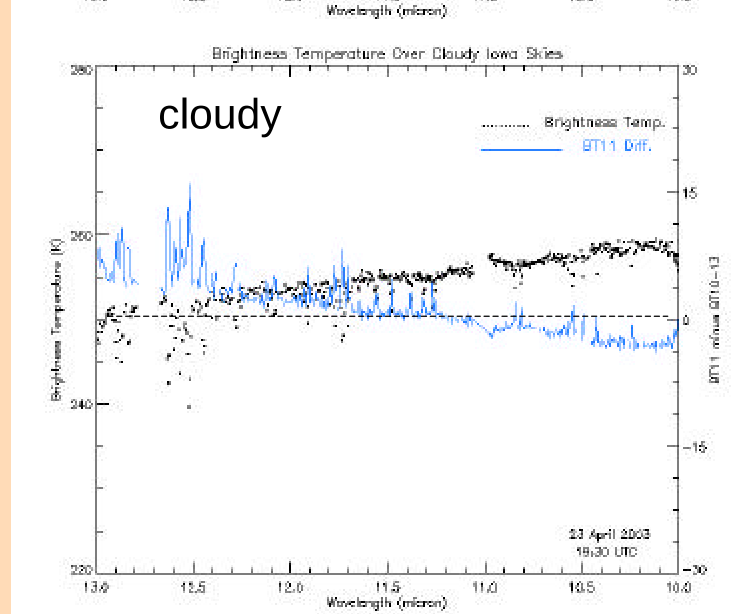


<u>Cloud (day & night):</u>

- negative slope more pronounced for cirrus clouds
- magnitude of absorption lines are small

  (little moisture above cloud)
- spectral variability is reduced
- no day-night differences

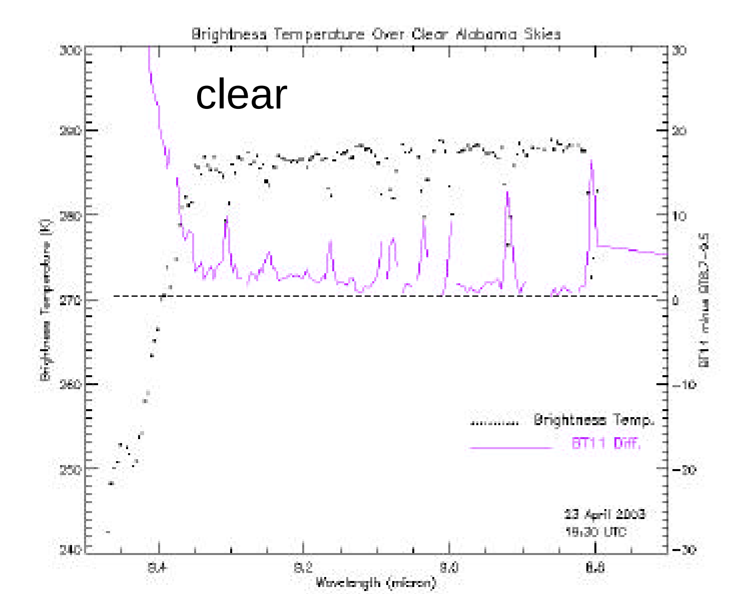


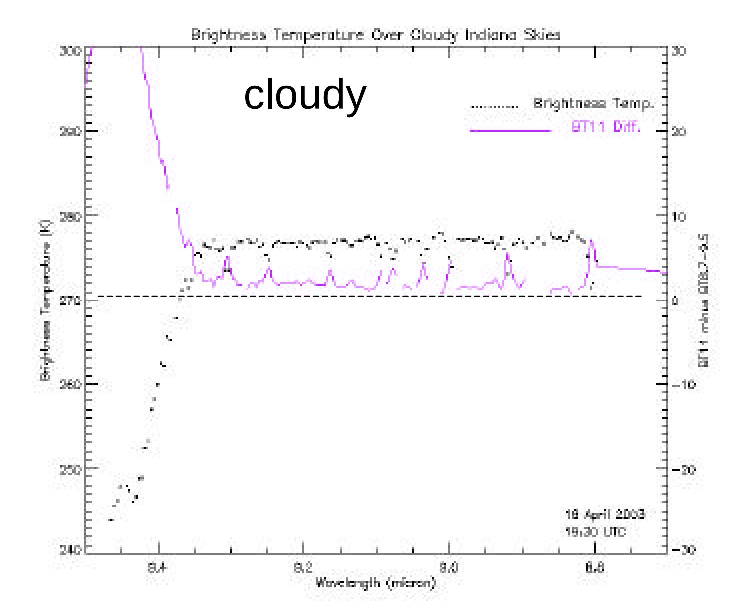


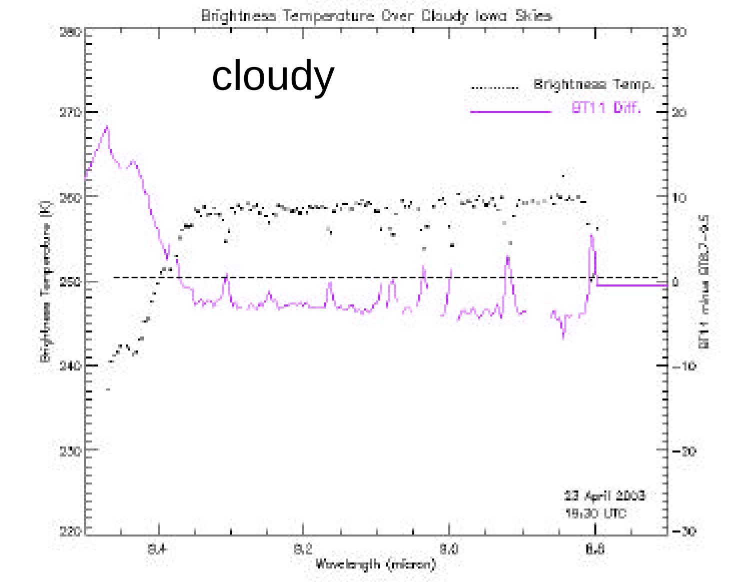
$\overline{T_{bb}\ (11)} - T_{bb}11(8\text{-}9)\mu m$ Difference Spectrum for Clouds

<u>Cloud (day & night):</u>

- negative differences for cirrus clouds
- magnitude of absorption lines are small
  (little moisture above cloud)
- spectral variability is reduced
- no day-night differences



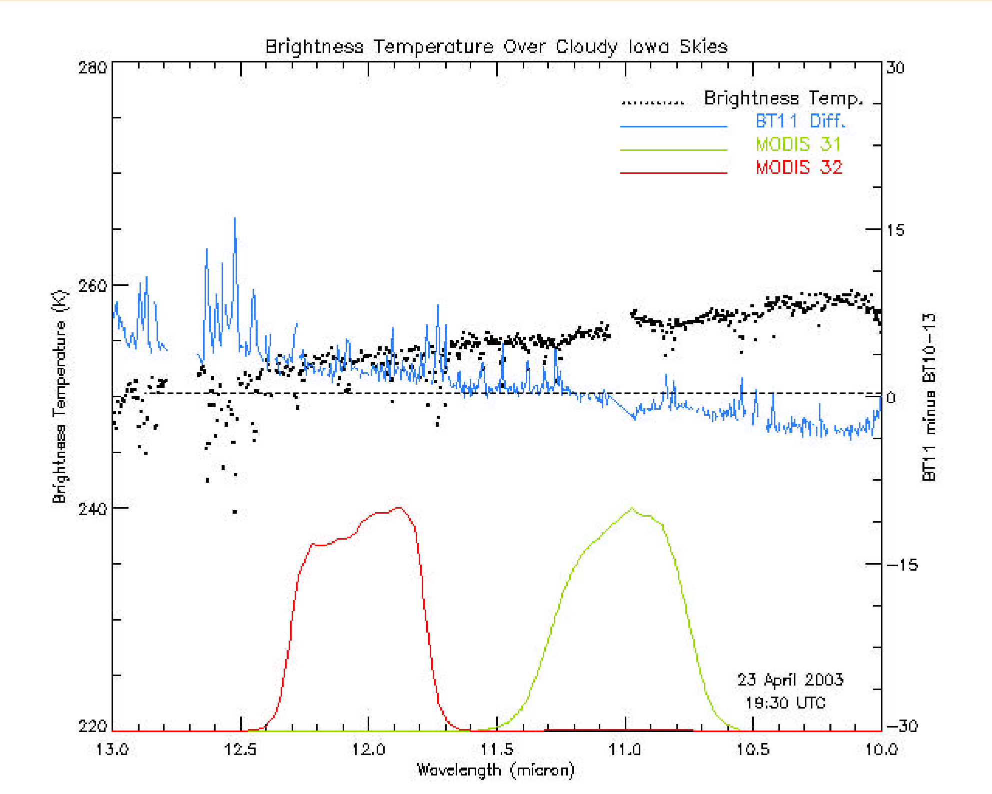




Preliminary Findings

High spectral resolution measurements in the short and long wave infrared regions provide significant information for the detection of clouds beyond rather broad channel measurements (like those of MODIS and GOES)

- Eliminate effects of absorption lines – changing amplitude of lines useful as well
- Spectral difference plots show slope and offset differences useful to detect presence and type of clouds



Future Work

Apply slope and offset methodology to develop a cloud detection and identification scheme for high spectral resolution data

- use multiple spectral difference plots to develop spatial/temporal slope and intercept images
- apply to high-resolution data for cloud retrieval
- explore AIRS channel-to-channel cloud signatures
- evaluate 5.0 μm window region in GIFTS cubes and a/c data