AVIRIS Contribution at the WTC

- On the 14th of September Roger Clark of the USGS called to say there was a concern with asbestos contamination at the WTC disaster site
- Through the support of NASA HQ and others AVIRIS flew the disaster site on the 16th, 18th, 22nd, and 23rd
- AVIRIS contributed in three areas
  - Hot spot location and temperature determination
  - Asbestos mapping
  - Debris composition and distribution mapping

WTC Hot Spot Temperature Estimates From AVIRIS Spectra

- On the 16th of September 2001 AVIRIS acquired data over the WTC disaster site.
- Preliminary analysis on the 17th showed the location of 8 hot spot zones where surface temperatures where very high indicating active fires
- In record time, Joe Boardman determined the latitude and longitude of the 8 hot spot areas.

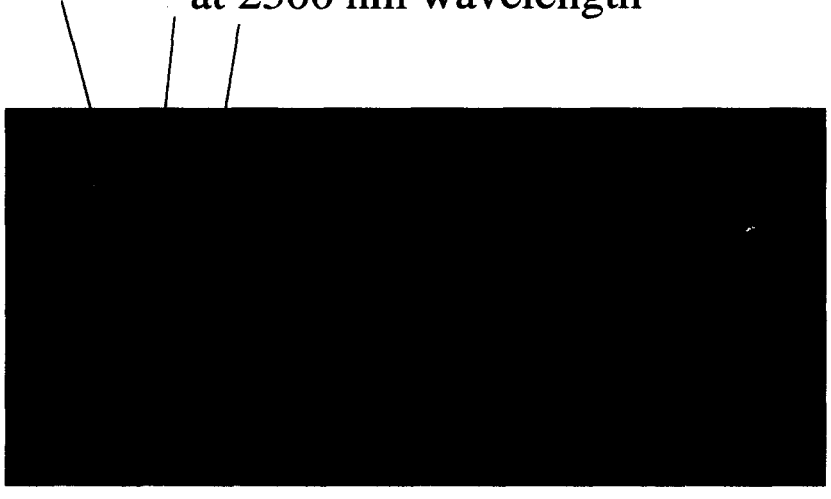
WTC Hot Spot Temperature Estimates From AVIRIS Spectra

- The temperature and location of the hottest target in each of the zones was determined.
- At the request of the Office of Science and Technology Policy a second AVIRIS data set was acquired on the 18th of September 2001.
- Analyses from these data were provided on the 19th and show a decrease in the number and temperature of the remaining hot spots.

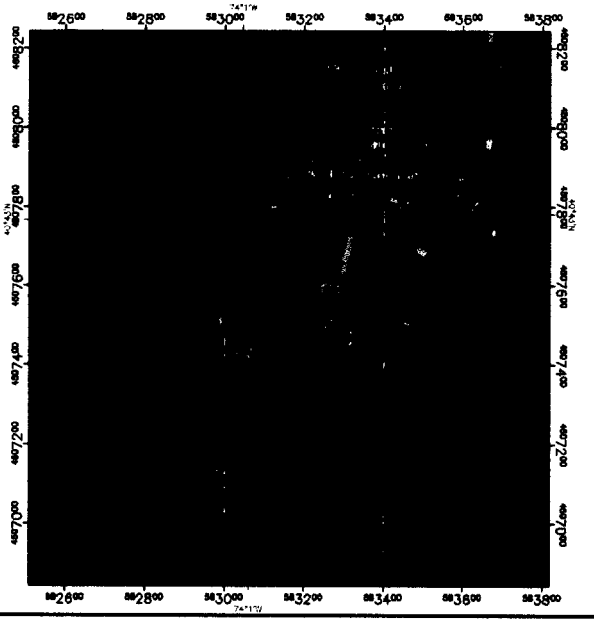
AVIRIS Data Set of WTC Disaster Site 010916

Hot Areas at the WTC Disaster Site

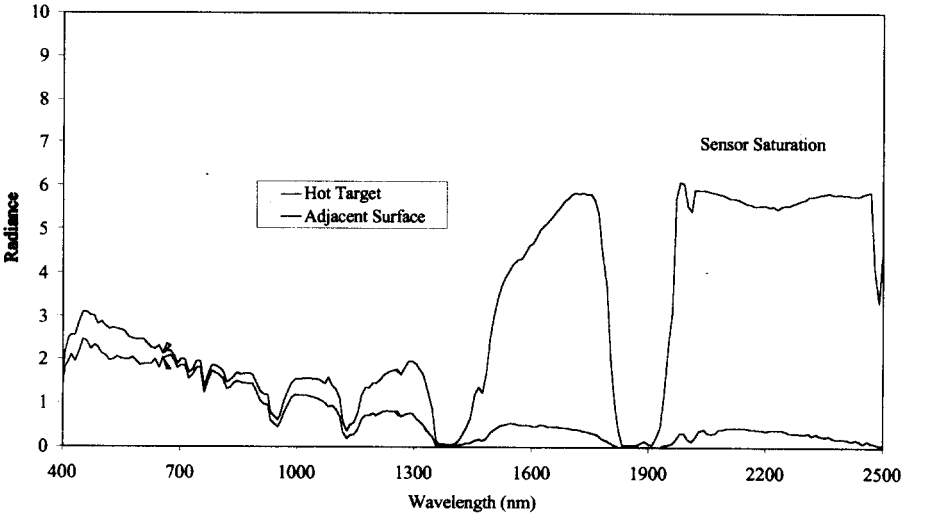
Hot Areas at the WTC Disaster Site at 2300 nm wavelength



Hot Spots at the WTC Disaster Site 010916



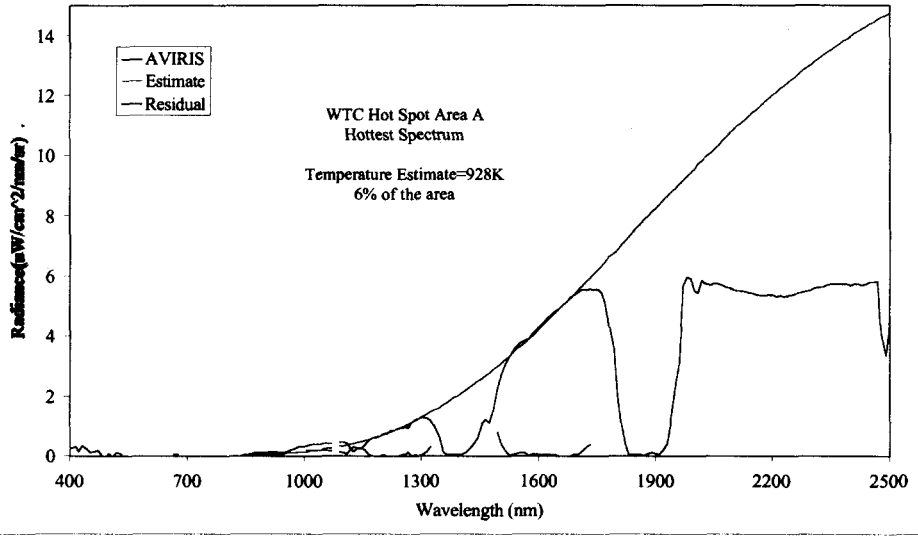
Spectra of Hot Areas at the WTC Disaster Site



WTC Hot Spot Temperature Estimates From AVIRIS Spectra

- Temperature is estimated from the shape of the Planck function after subtracting reflected light estimate and excluding zones of saturation and strong atmospheric absorption
- Both the temperature and fractional area of the hot spot are derived.
- The analysis has been performed on the hottest targets in the eight identified hot spot areas of the WTC AVIRIS data set acquired on 16 September 2001
- Future analysis is planned to better account for the transmittance of the atmosphere and the emissivity of the surface

AVIRIS Temperature Estimate WTC Hot Spot Zone A



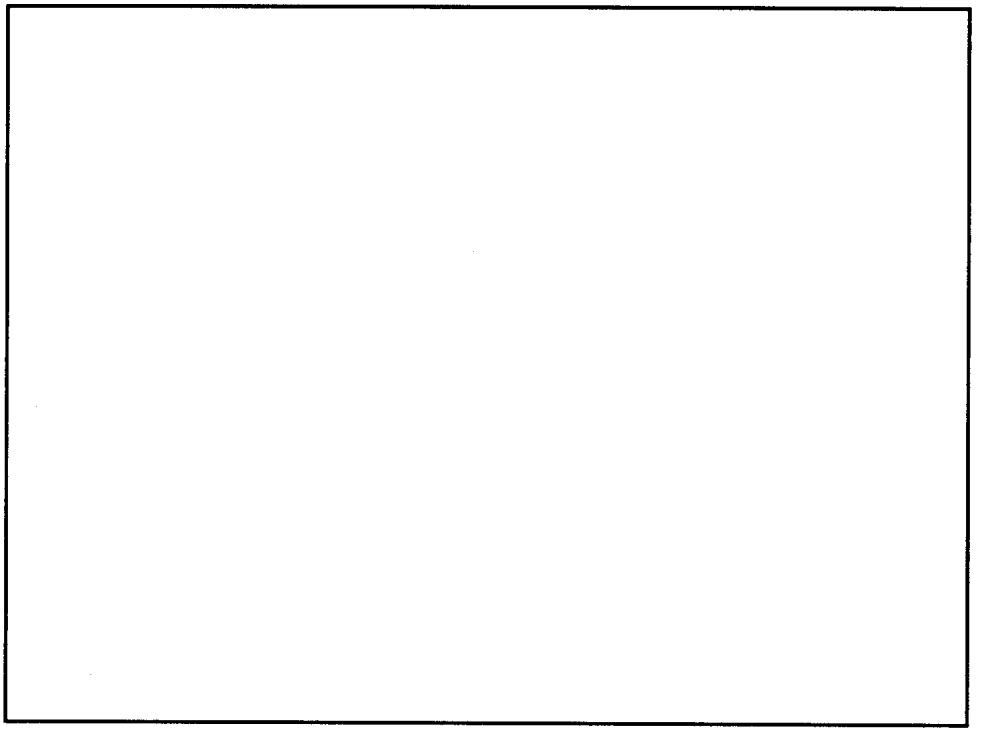
WTC Hot Spot Locations Temperature Estimates From AVIRIS Spectra 010916

Hot Spot		Lat/Lon	Temperature Estimation (K)
• a	40-42-47.18	74-00-41.43	928
• b	40-42-47.14	74-00-43.53	827
• c	40-42-42.89	74-00-48.88	921
• d	40-42-41.99	74-00-46.94	791
• e	40-42-40.58	74-00-50.15	710
• f	40-42-38.74	74-00-46.70	700
• g	40-42-39.94	74-00-45.37	1019
• h	40-42-38.60	74-00-43.51	817

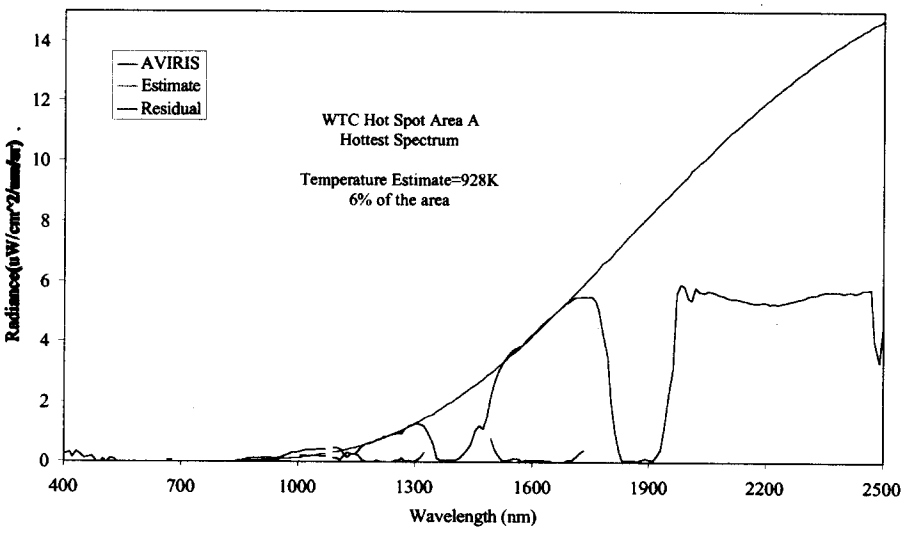
- Lat/lon values are in WGS-84 datum, deg-min-decimal seconds
- Location accuracy should be good to ~18 feet (6 meters)

Consistency Test

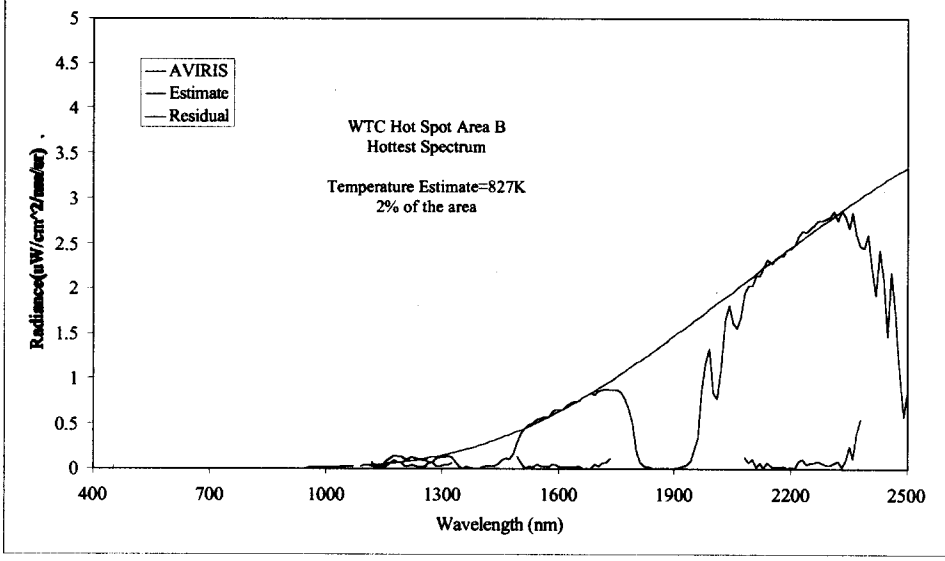
- Are the fractional area and temperature independent?
- Solve for a temperature and fractional area
- Dilute the spectrum with a non fire spectrum
- Solve for temperature and fractional area again.
  - Is the temperature the same?
  - Is the diluted area correct?



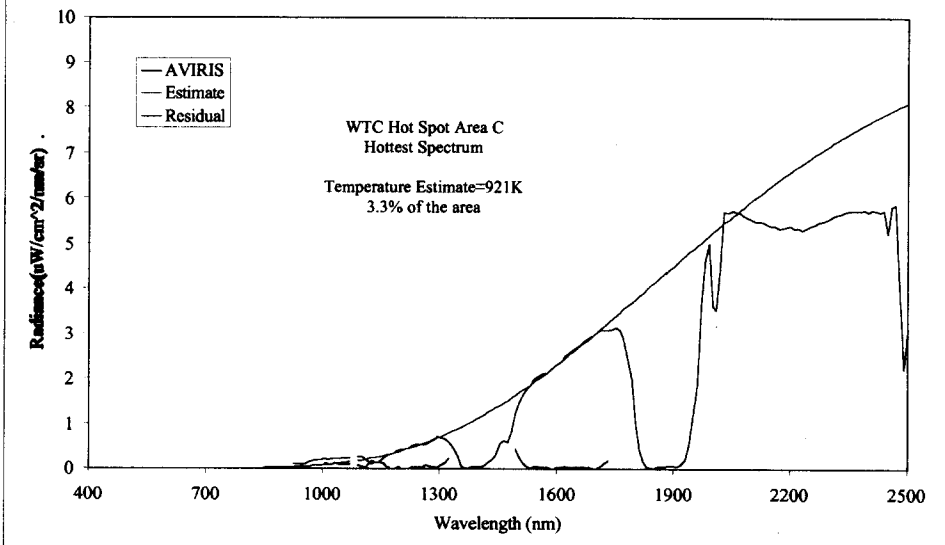
AVIRIS Temperature Estimate
WTC Hot Spot Zone A



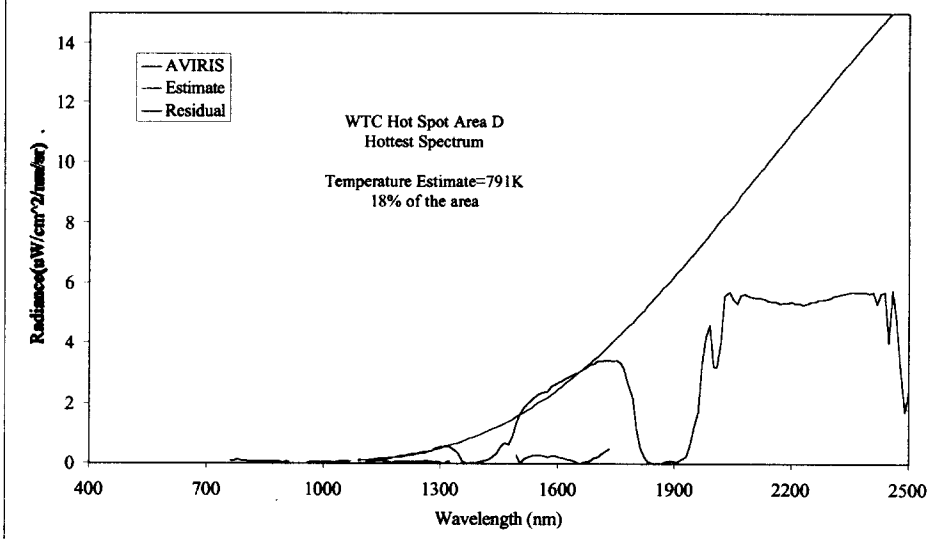
AVIRIS Temperature Estimate
WTC Hot Spot Zone B



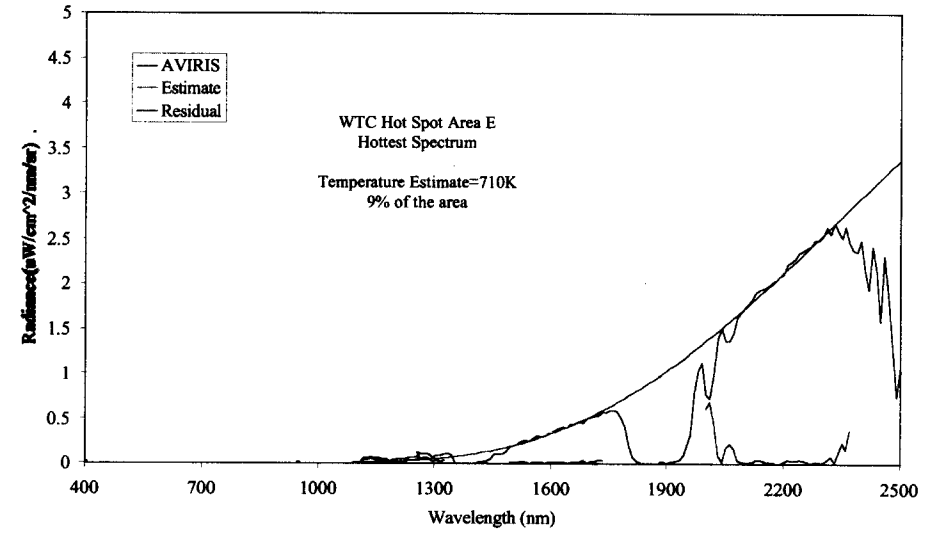
AVIRIS Temperature Estimate
WTC Hot Spot Zone C



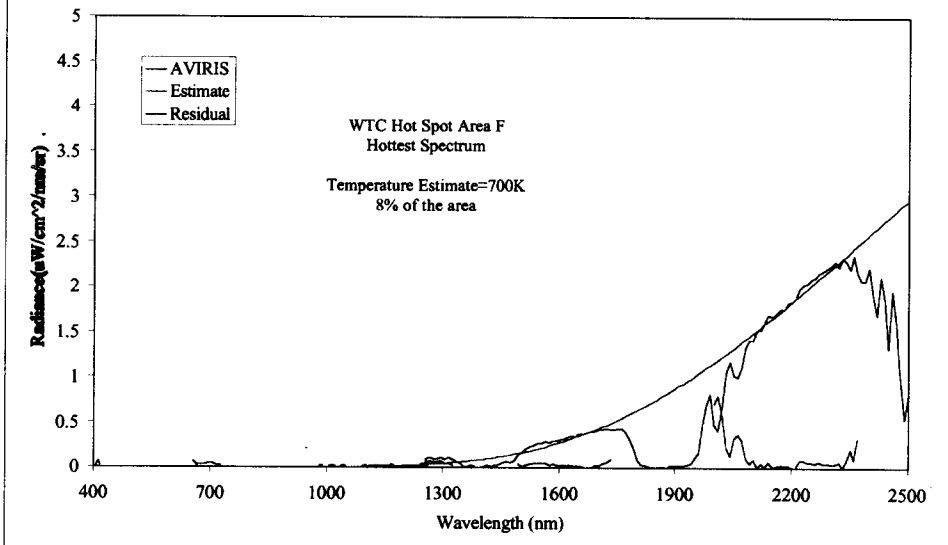
AVIRIS Temperature Estimate
WTC Hot Spot Zone D



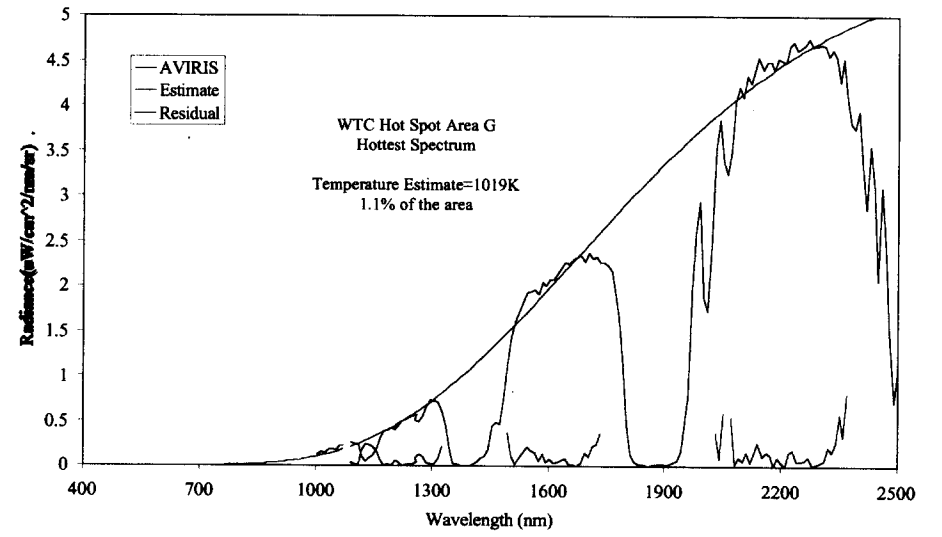
AVIRIS Temperature Estimate
WTC Hot Spot Zone E



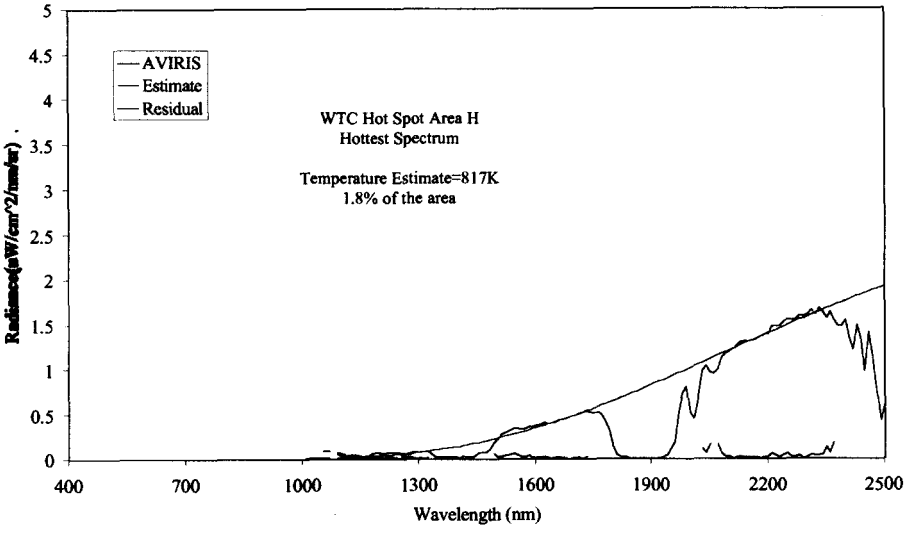
AVIRIS Temperature Estimate
WTC Hot Spot Zone F



AVIRIS Temperature Estimate
WTC Hot Spot Zone G



AVIRIS Temperature Estimate
WTC Hot Spot Zone H



WTC Hot Spot Temperature Estimates From AVIRIS Spectra 18 September 2001

- The hot spot zones labeled A to H are the same as in the 16th data set.
- Several additional hot spots were identified on the 18th. This may simply be due to increasing sophistication of the analysis.
- The AVIRIS data on the 18th were acquired in the afternoon under cloud cover

Hot Spots at the WTC Disaster Site 010918

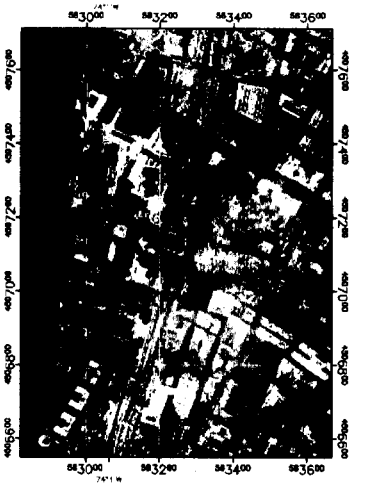
AVIRIS georectified image with hot spot zones labeled.

Hot Spot Color Scale

Red=high intensity

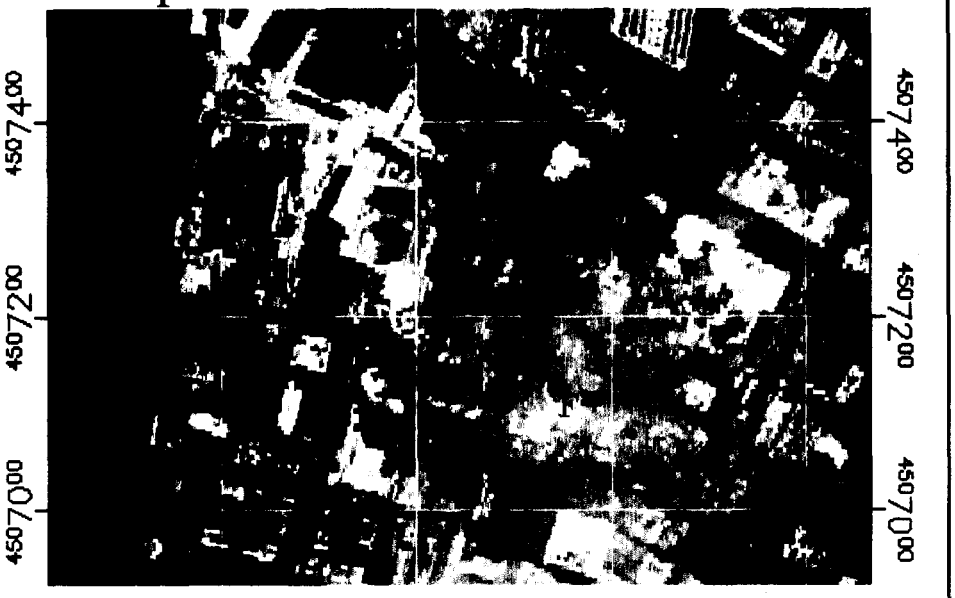
to

Blue=lower



AVIRIS 09-18-2001 Fire Hot Spot Map
Color Coded red-green-blue =
hottest-medium-lower temperature
UTM projection, NAD-83-WGS-84 datum
1.7 meter pixels, ~4.3 meter accuracy

Hot Spots at the WTC Disaster Site 010918



WTC Hot Spot Locations Temperature Estimates From AVIRIS Spectra 010918

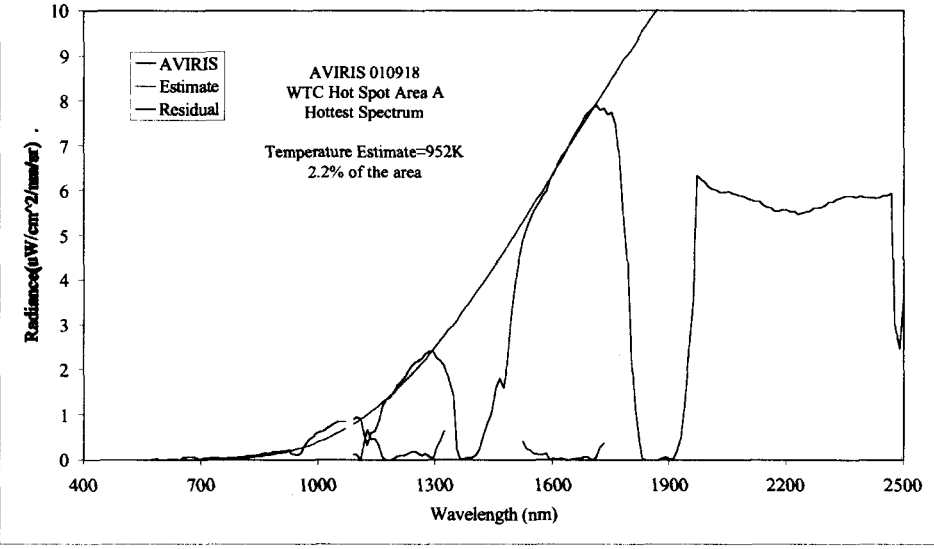
Hot Spot		Lat/Lon	Estimation (K)	Area%
A	40-42-46.96	74-00-41.21	952	2.2%
B	40-42-47.31	74-00-43.31	790	36
C	40-42-43.38	74-00-48.15	500	22
D	40-42-42.48	74-00-46.64	700	5
E	not seen on Tuesday			
F	40-42-38.62	74-00-46.41	725	7
G	40-42-39.77	74-00-45.45	932	2
H	40-42-39.04	74-00-43.65	471	4
I	40-42-37.50	74-00-44.54	762	35
J	40-42-36.97	74-00-47.01	no fit	
K	40-42-42.69	74-00-45.26	538	7
L	40-42-44.14	74-00-46.98	805	0.5

- Lat/lon values are in WGS-84 datum, deg-min-decimal seconds
- Location accuracy should be good to ~18 feet (6 meters)
- Temperatures and Areas are initial estimates for the hottest spectrum in each hot spot zone.

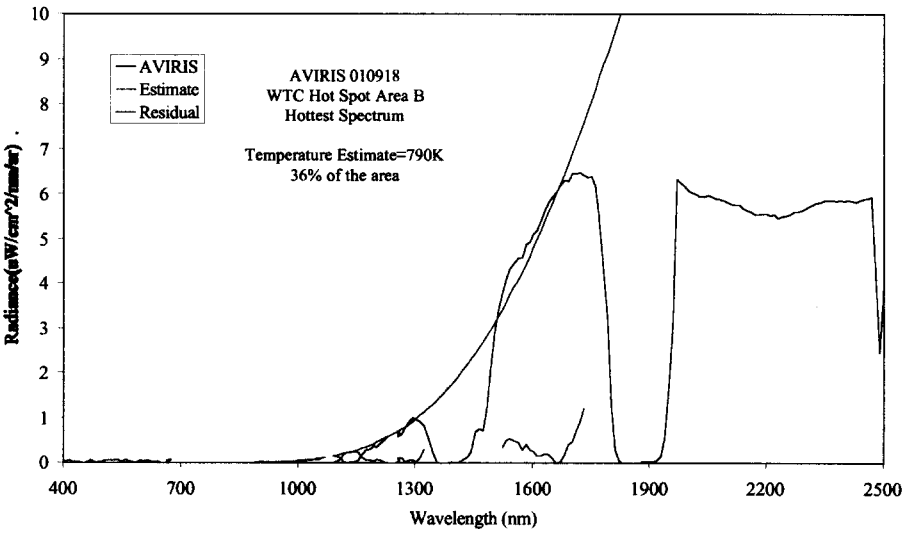
WTC Hot Spot Temperature Estimates From AVIRIS Spectra 010918

- Temperature is estimated from the shape of the planck function after subtracting reflected light estimate and excluding zones of saturation and strong atmospheric absorption
- Both the temperature and fractional area of the hot spot are derived.
- The analysis has been performed on the hottest targets in the identified hot spot areas of the WTC AVIRIS data set acquired on 18 September 2001
- Future analysis will better account for the transmittance of the atmosphere and the emissivity of the surface

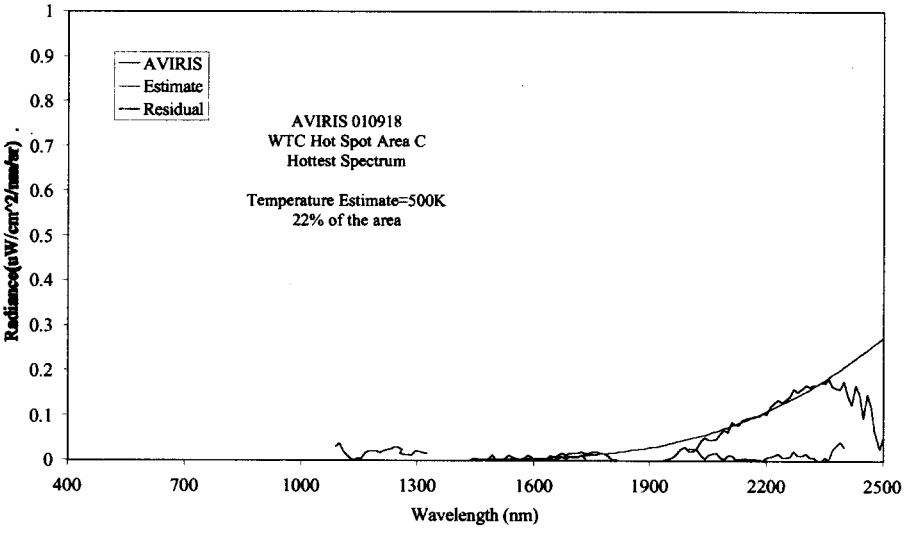
AVIRIS Temperature Estimate WTC Hot Spot Zone A



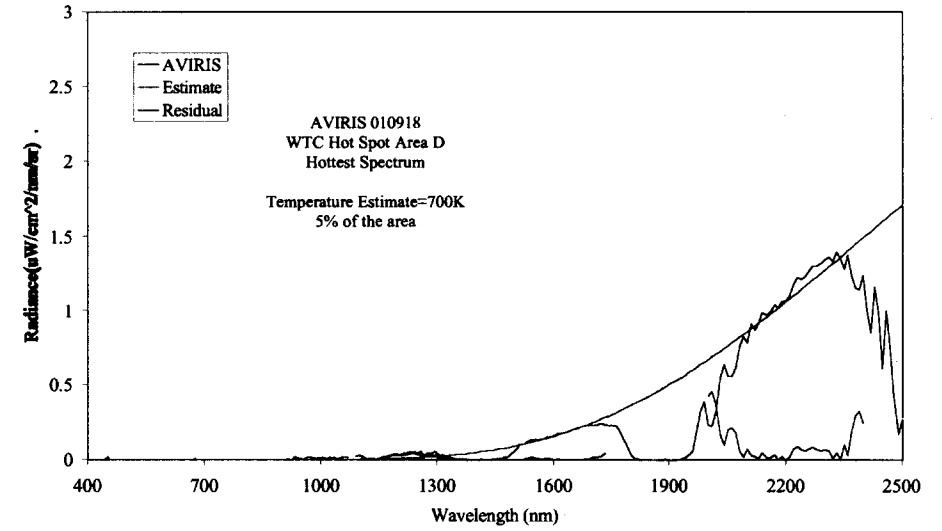
AVIRIS Temperature Estimate
WTC Hot Spot Zone B



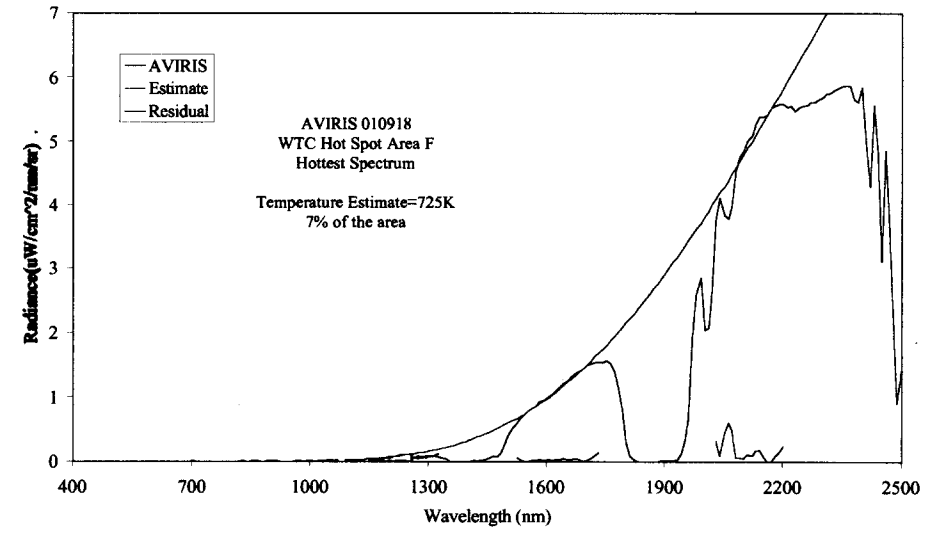
AVIRIS Temperature Estimate
WTC Hot Spot Zone C



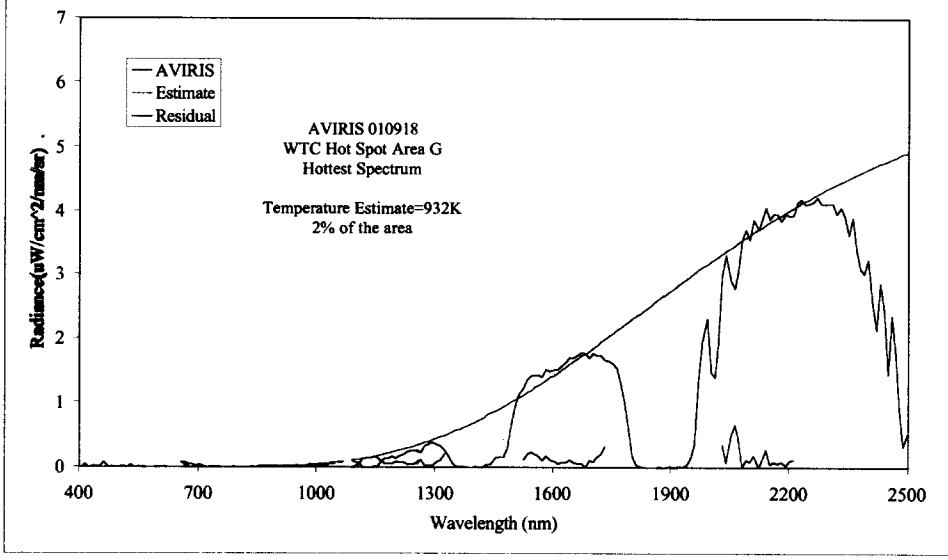
AVIRIS Temperature Estimate
WTC Hot Spot Zone D



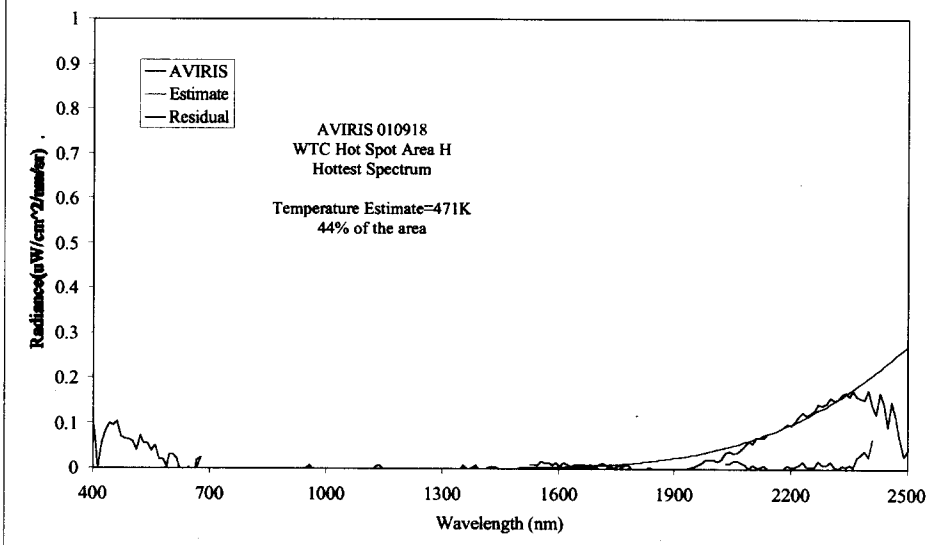
AVIRIS Temperature Estimate
WTC Hot Spot Zone F



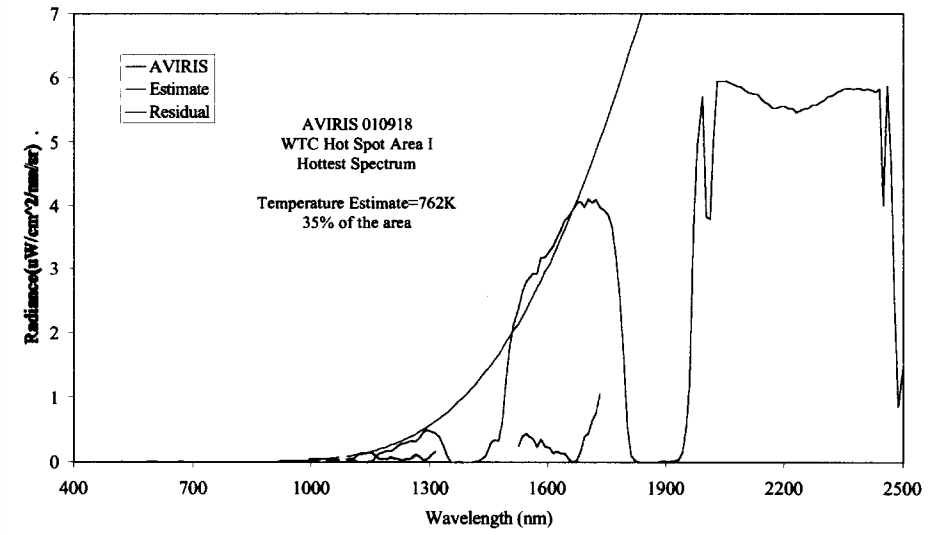
AVIRIS Temperature Estimate
WTC Hot Spot Zone G



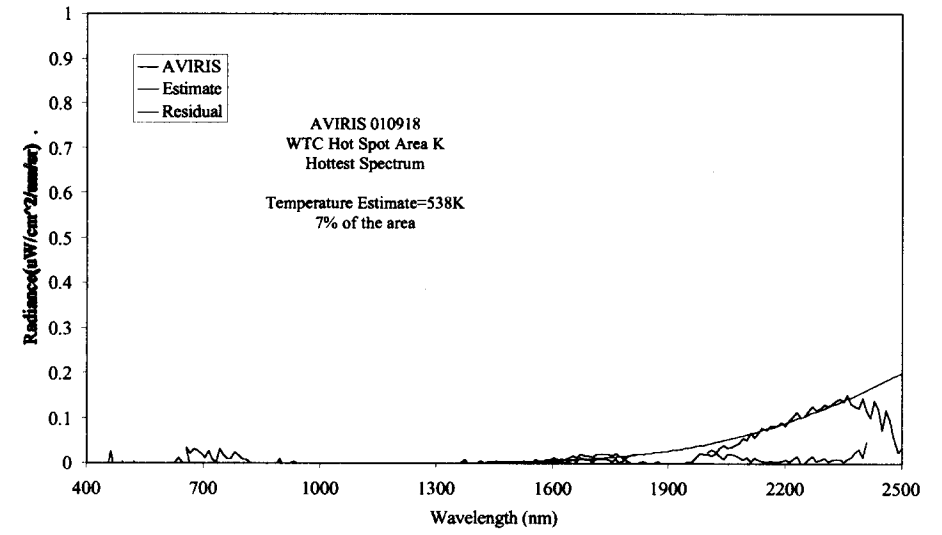
AVIRIS Temperature Estimate
WTC Hot Spot Zone H



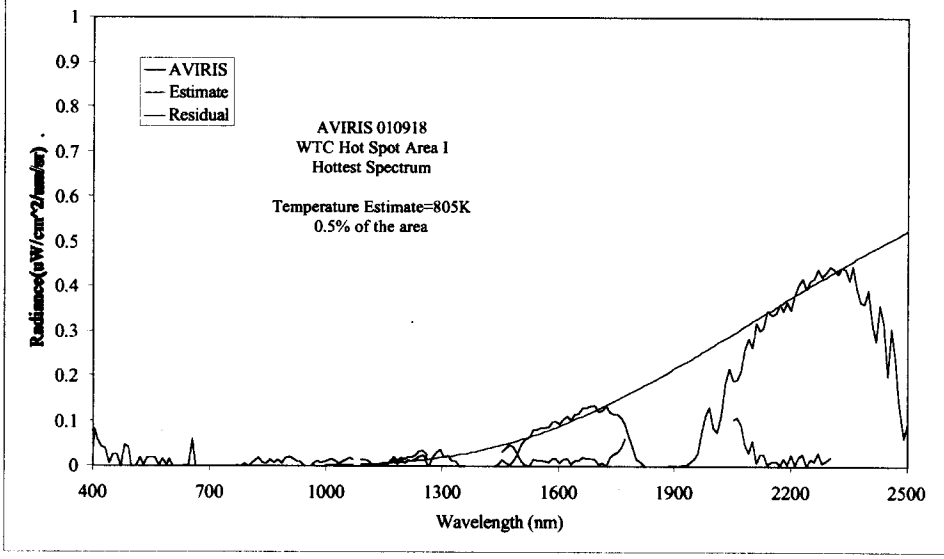
AVIRIS Temperature Estimate
WTC Hot Spot Zone I



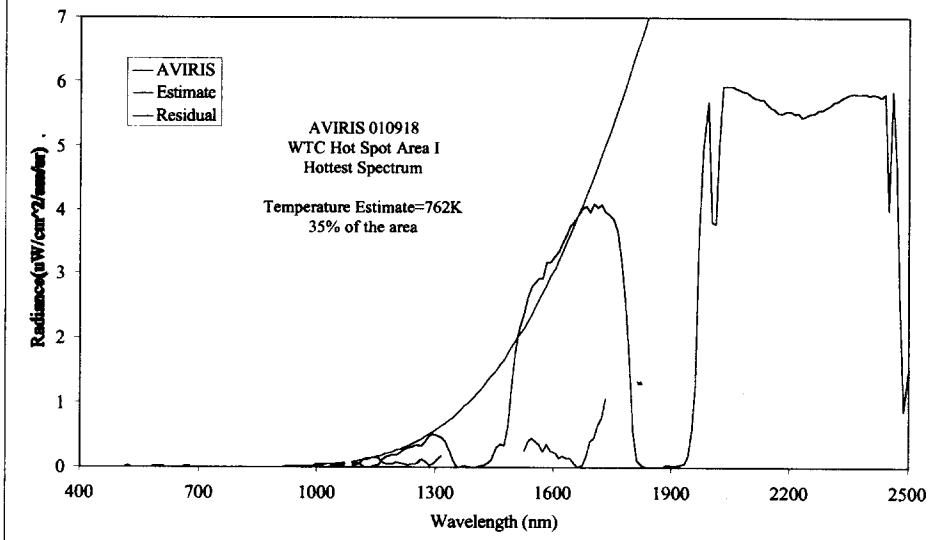
AVIRIS Temperature Estimate
WTC Hot Spot Zone K



AVIRIS Temperature Estimate
WTC Hot Spot Zone L



AVIRIS Temperature Estimate
WTC Hot Spot Zone I



Summary
WTC Hot Spot Temperature Estimates From AVIRIS Spectra

- On 16, 18, 22, and 23 of September 2001 AVIRIS acquired data over the WTC disaster site.
- Preliminary analysis on the 17th showed the location of 8 hot spot zones where surface temperatures where very high indicating fires.
- Detailed analysis was performed to determine the temperature and area of the hottest target in each hot spot zone.
- This information was provided to and used by the people on the ground

WTC Hot Spot Temperature Estimates From AVIRIS Spectra

- The hot spot zones labeled A to H are the same as in the 16th data set.
- Several additional hot spots were identified on the 18th. This may simply be due to increasing sophistication of the analysis.
- The AVIRIS data on the 18th were acquired in the afternoon under cloud cover
- AVIRIS data and spectra acquired in the AVIRIS spectral range provide an excellent basis for hot target temperature and fractional area determination.