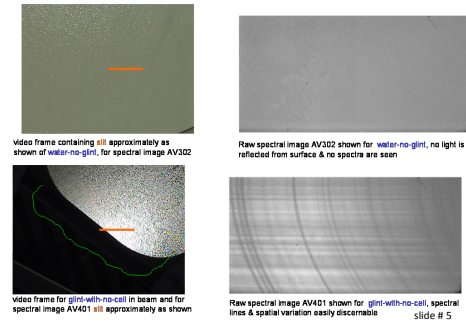


Summary: IIP TIMS completed Dec. 2008

- Developed mapping spectrometers @ 2.33 & 4.67 μm for vertical tropospheric CO retrieval
 - Demonstrated
 - multi-layer vertical CO retrieval from measurements of atmospheric radiance that simulate GEO-CAPE operations that
 - satisfies the Decadal Survey GEO-CAPE areal coverage rate & footprint requirement also demonstrated
 - H₂O retrieval with potential for unprecedented vertical resolution in the boundary layer (BL)
 - 1% precision for total column CH₄ retrieval
 - Developed an instrument concept using TRL 6 or better supporting components to implement the GEO-CAPE operation
 - Expanded the concept to include ozone bands @ 9.6, 3.3 & 3.6 μm and extrapolation of the performance data showed these provide tropospheric ozone capability
 - Expanded GEO-CAPE TIMS provides vertical information including
 - Vertical resolution including Boundary Layer (BL) CO, tropospheric ozone and BL H₂O and
 - Total CH₄ column 1% precision and does this
 - With Decadal Survey Report specified
- slide # 1

Example: sun glint off the bay

Sample spectral images & corresponding video frames



- Conclusions from the zeppelin deployment
- performance is consistent with that reported from the 2008 joint field campaign with Denver University
 - This supports the conclusion from the IIP08 study that the TIMS will satisfy all the GEO-CAPE requirements for CO measurements
 - Highly variability albedo is a non problem.
 - We have shown an example of removing the smile.

- Tasks still to be done
- Retrieval from data acquired over
 - a covered over land fill and
 - Moffett Field

Joint atmospheric spectral measurements conducted @ Denver U

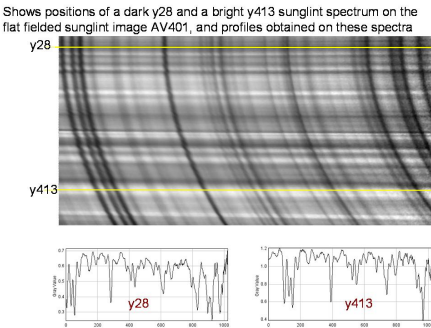
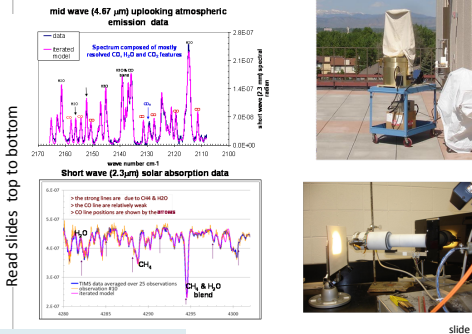
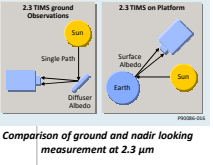


Table 1. Comparison of precision of retrieved column in the 2008 IIP joint campaign with University of Denver vs preliminary results from the 2010 Zeppelin deployment

| | % precision of retrieved column multipliers and the retrieved albedo | | | | |
|----------|--|------|------|------|--------|
| | albedo | CH4 | CO | H2O | albedo |
| IIP 2008 | 0.40 | 1.86 | 17.2 | 7.44 | 0.23 |
| Zeppelin | 0.60 | 1.16 | 17.0 | 4.54 | 0.60 |

The next step (to TRL 6) is to deploy on an air borne platform. On this poster we describe the deployment and show examples of preliminary results.



Key steps in processing the spectra of y28 and y413 shown in 4 panels below

- Upper left panel (ULP) y28 and y413
- URP Y13 is scaled by the ratio of the y413 albedo to 0.919 to that 0.525 of y28 so the two overlay showing the spectral signatures are independent of albedo
- LLP The scale for y413 is shifted & adjusted to co-register the spectra
- LRP y28 is compared to the retrieved model. NO this is comparison of the average of 5 consecutive y28 spectra against the retrieved model

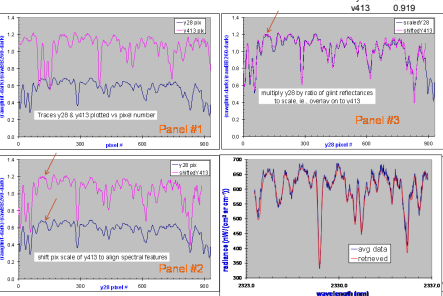
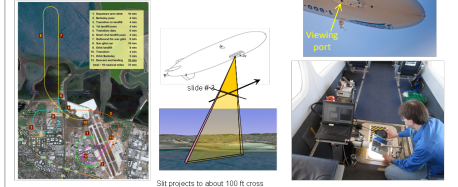


table 3. model & retrieved columns (molecules/cm²)

| | CH4 | CO | H2O |
|---------------------|----------|----------|----------|
| "ncep" columns = | 3.54E+19 | 2.37E+18 | 5.70E+22 |
| gats LC columns = | 3.48E+19 | 2.37E+18 | 7.32E+22 |
| retrieved columns = | 3.61E+19 | 1.89E+18 | 6.48E+22 |



Five y28&29 spectra from consecutive images AV401-405 shown plotted below

- These simulate a GEO-CAPE measurement on a 6 km x 6 km footprint in that the integration time is 1s and spectra of two pixels along the slit are co-added to form each of the 5 spectra
- The traces are plotted to a logarithmic scale and are labeled by albedo
- The average of the 5 vs the retrieved model is plotted in the LRP directly above

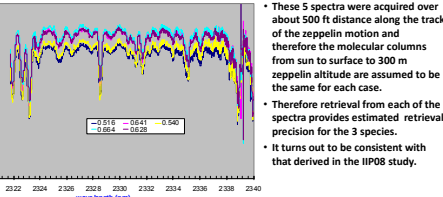


Table 2. column multipliers and albedo multiplier

| | CO | CH4 | H2O | albedo |
|-------------|-------|-------|-------|---------|
| 401 | 0.628 | 1.026 | 0.820 | 1.00663 |
| 402 | 0.662 | 1.041 | 0.890 | 1.00302 |
| 403 | 0.890 | 1.032 | 0.902 | 0.99154 |
| 404 | 0.875 | 1.052 | 0.926 | 0.99882 |
| 405 | 0.905 | 1.025 | 0.872 | 0.99535 |
| stdv | 0.135 | 0.012 | 0.040 | 0.00598 |
| % precision | 17.05 | 1.16 | 4.54 | 0.59849 |
| mean | 0.792 | 1.035 | 0.882 | 0.99907 |
| AvgSpectra | 0.795 | 1.036 | 0.885 | 0.99903 |

These 5 spectra were acquired over about 500 ft distance along the track of the zeppelin motion and therefore the molecular columns from sun to surface to 300 m zeppelin altitude are assumed to be the same for each case.

- Therefore retrieval from each of the spectra provides estimated retrieval precision for the 3 species.
- It turns out to be consistent with that derived in the IIP08 study.