Remote Sensing of Spatial Distributions of Greenhouse Gases in the Los Angles Basin

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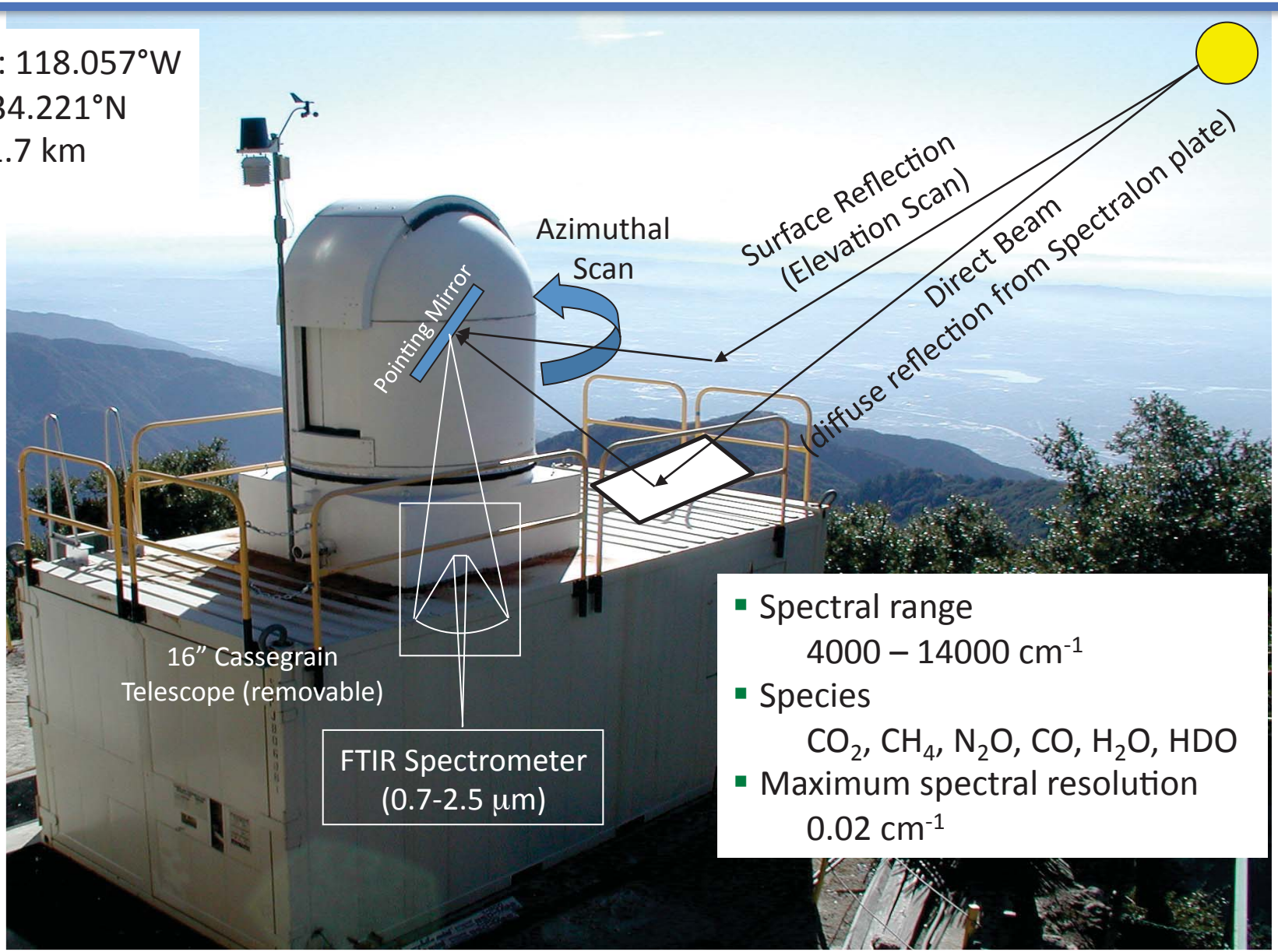
Introduction

- The Los Angeles air basin is a significant anthropogenic source of greenhouse gases and pollutants including CO_2, CH_4, N_2O, and CO, contributing significantly to regional and global climate change.
- Recent legislation in California, the California Global Warming Solutions Act (AB32), established a statewide cap for greenhouse gas emissions for 2020 based on 1990 emissions.
- Verifying the effectiveness of regional greenhouse gas emissions controls requires high-precision, regional-scale measurement methods combined with models that capture the principal anthropogenic and biogenic sources and sinks.
- We present a novel approach for monitoring the spatial distributions of greenhouse gases in the Los Angeles basin using high resolution remote sensing spectroscopy.
- We participated in the CalNex 2010 campaign to provide greenhouse gas distributions for comparison between top-down and bottom-up emission estimates.

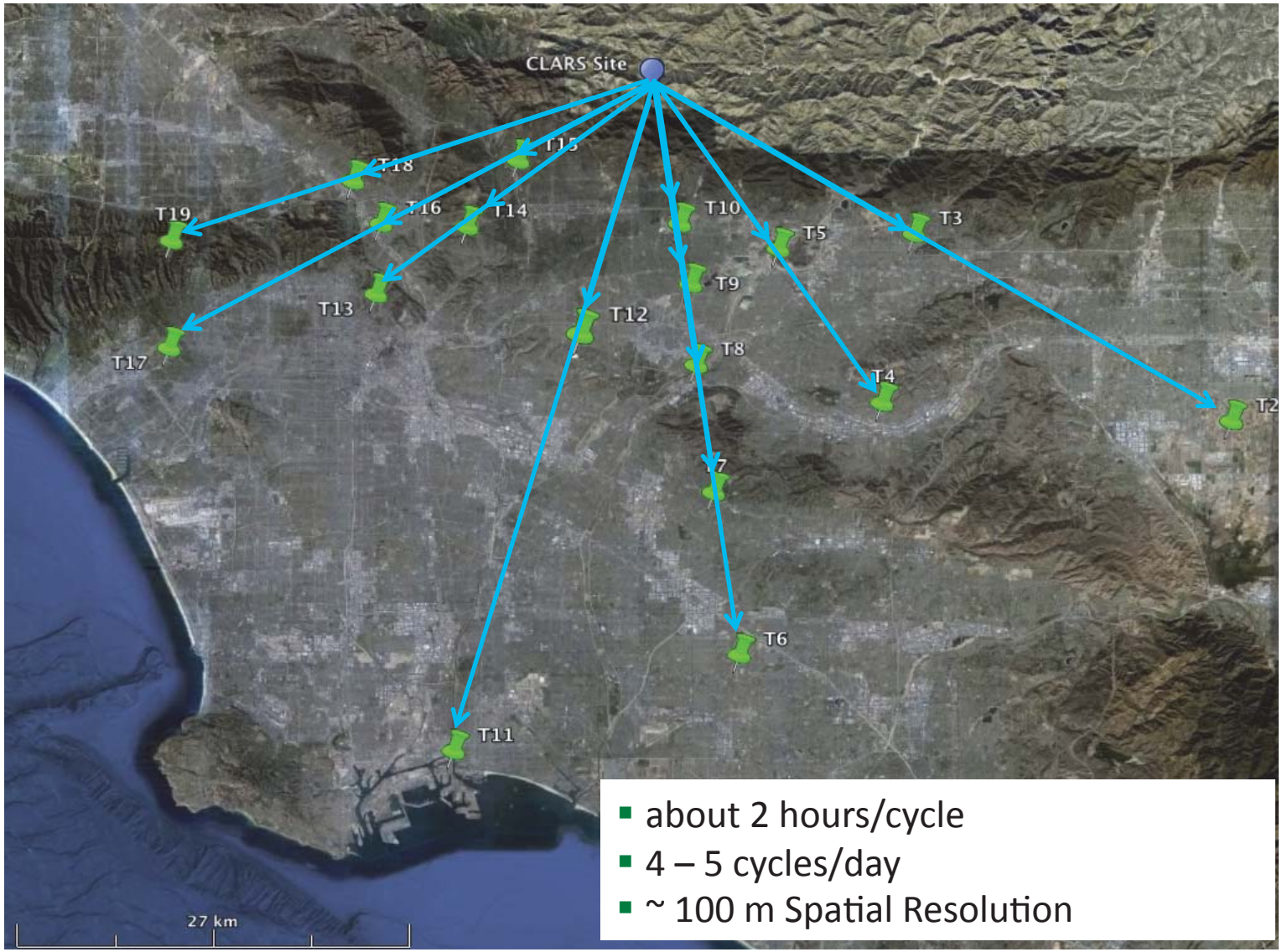
California Laboratory for Atmospheric Remote Sensing (CLARS) at Mt. Wilson

Long: 118.057°W
Lat: 34.221°N
Alt: 1.7 km



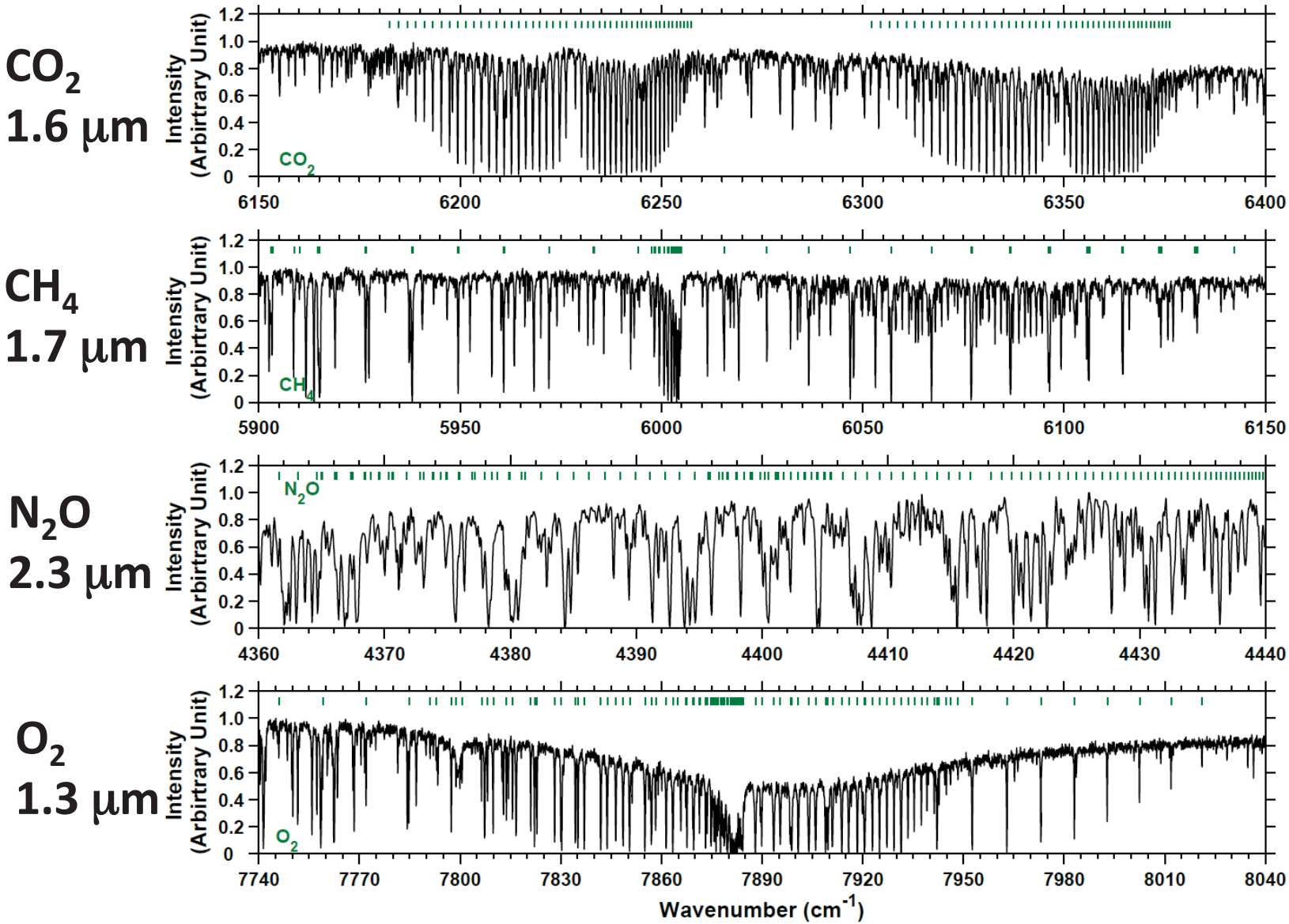
- Spectral range
  4000 – 14000 cm^{-1}
- Species
  CO_2, CH_4, N_2O, CO, H_2O, HDO
- Maximum spectral resolution
  0.02 cm^{-1}

Reflection Points Selected for CLARS-FTS

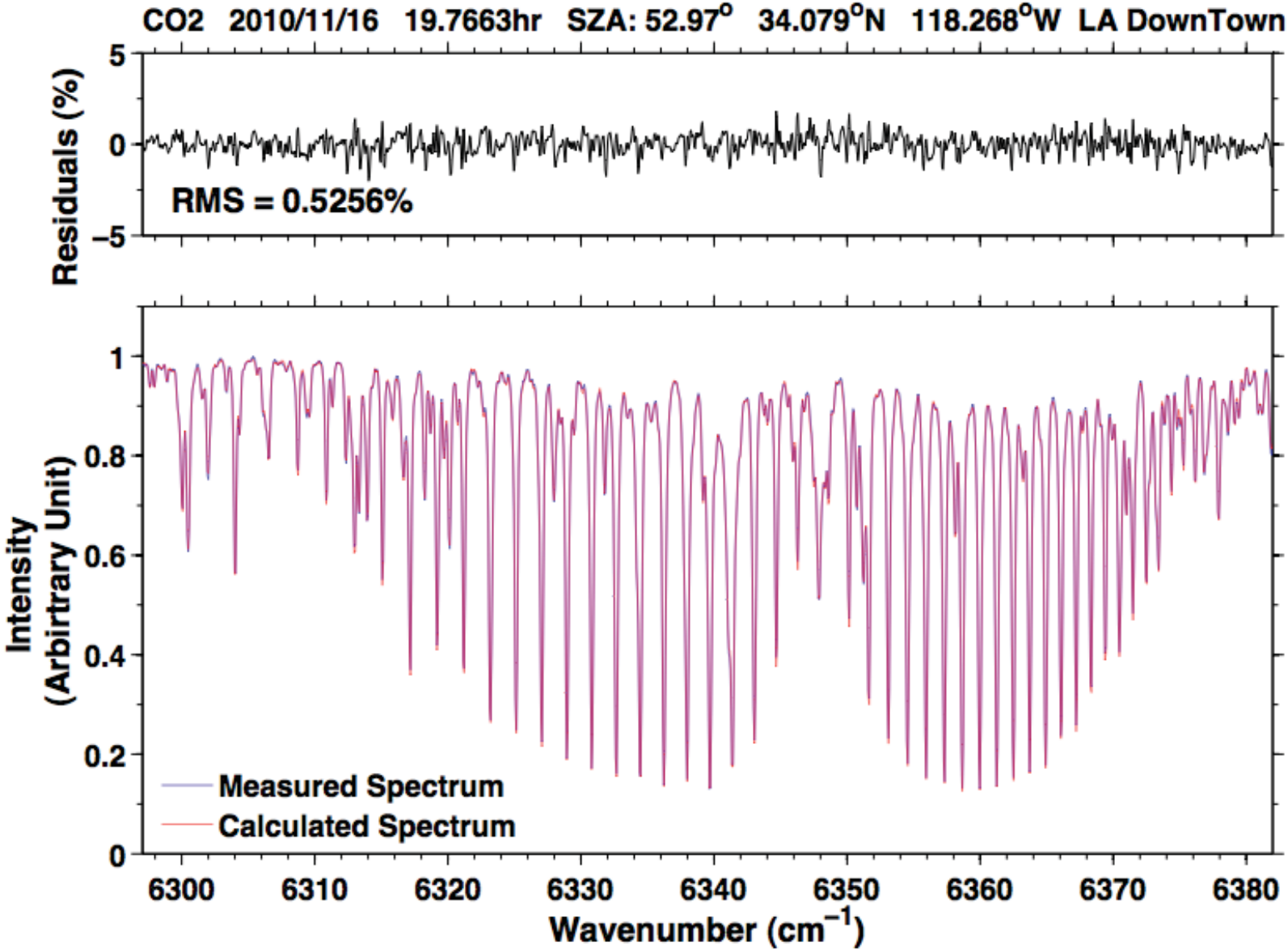


- about 2 hours/cycle
- 4 – 5 cycles/day
- ~ 100 m Spatial Resolution

Sample CLARS FTS GHG Spectra Reflectance from Land Surface



Spectral Fitting to Determine CO_2 Slant Column Density

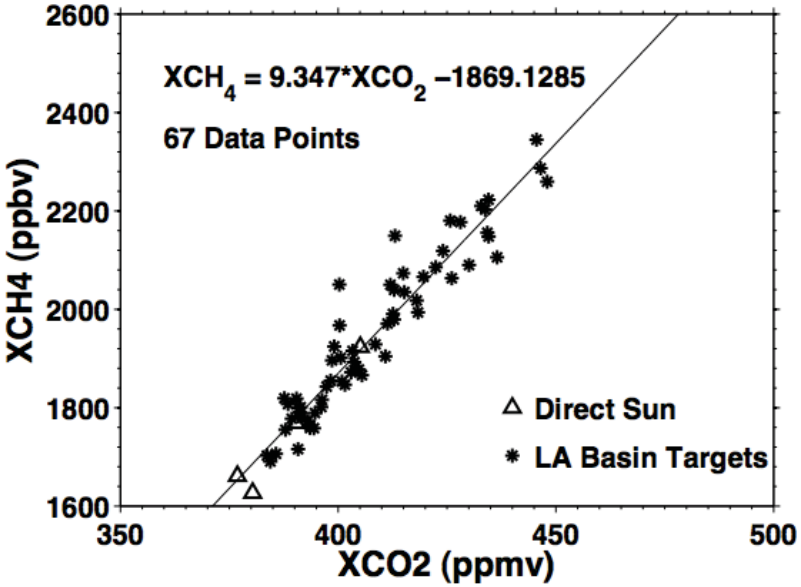


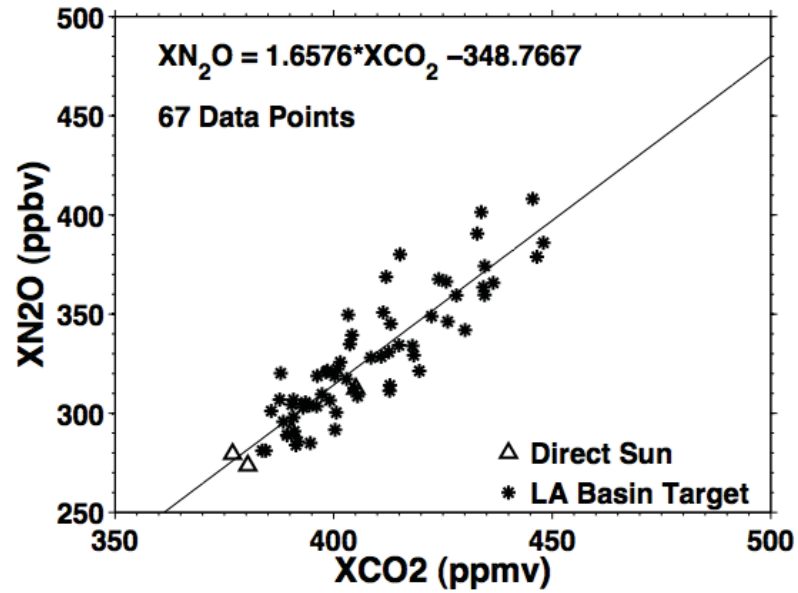
Measurement Precisions

Species	Slant Column-averaged Volume Mixing Ratio (Typical Range)	Retrieval Precision (Random Error)
XCO_2	380-500 ppmv	± (0.5-1) %
XCH_4	1800-2200 ppbv	± (0.5-1) %
XCO	20-200 ppbv	± (2-4) %
XN_2O	250-350 ppbv	± (2-4) %

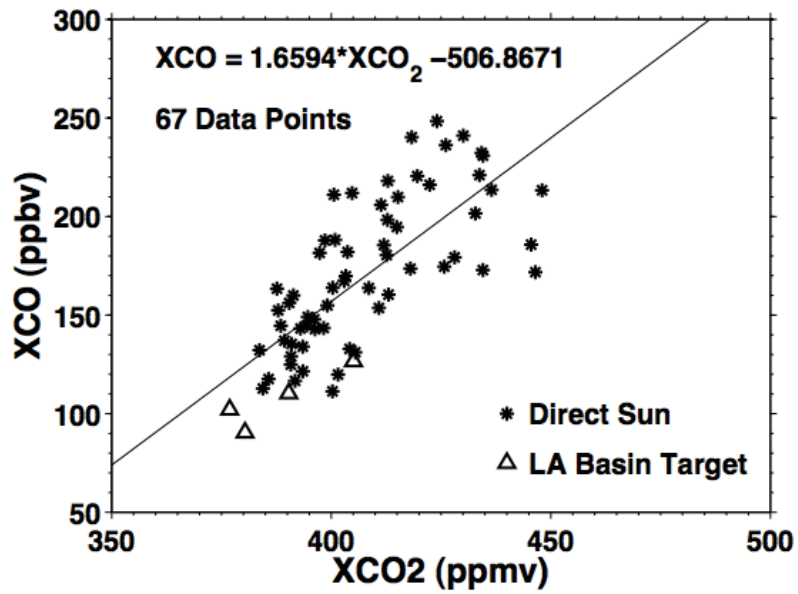
- XGAS = 0.2095x[Slant Column Density of GHG] /[Slant Column Density of O_2]
- Random error includes only the precision of the fitted spectra.
- Systematic error sources:
  - errors in spectroscopic parameters
  - higher-order uncertainties in optical path due to aerosols (O_2 measurement corrects first-order scattering effects)

XCO_2:XGAS Correlation on May 29th, 2010

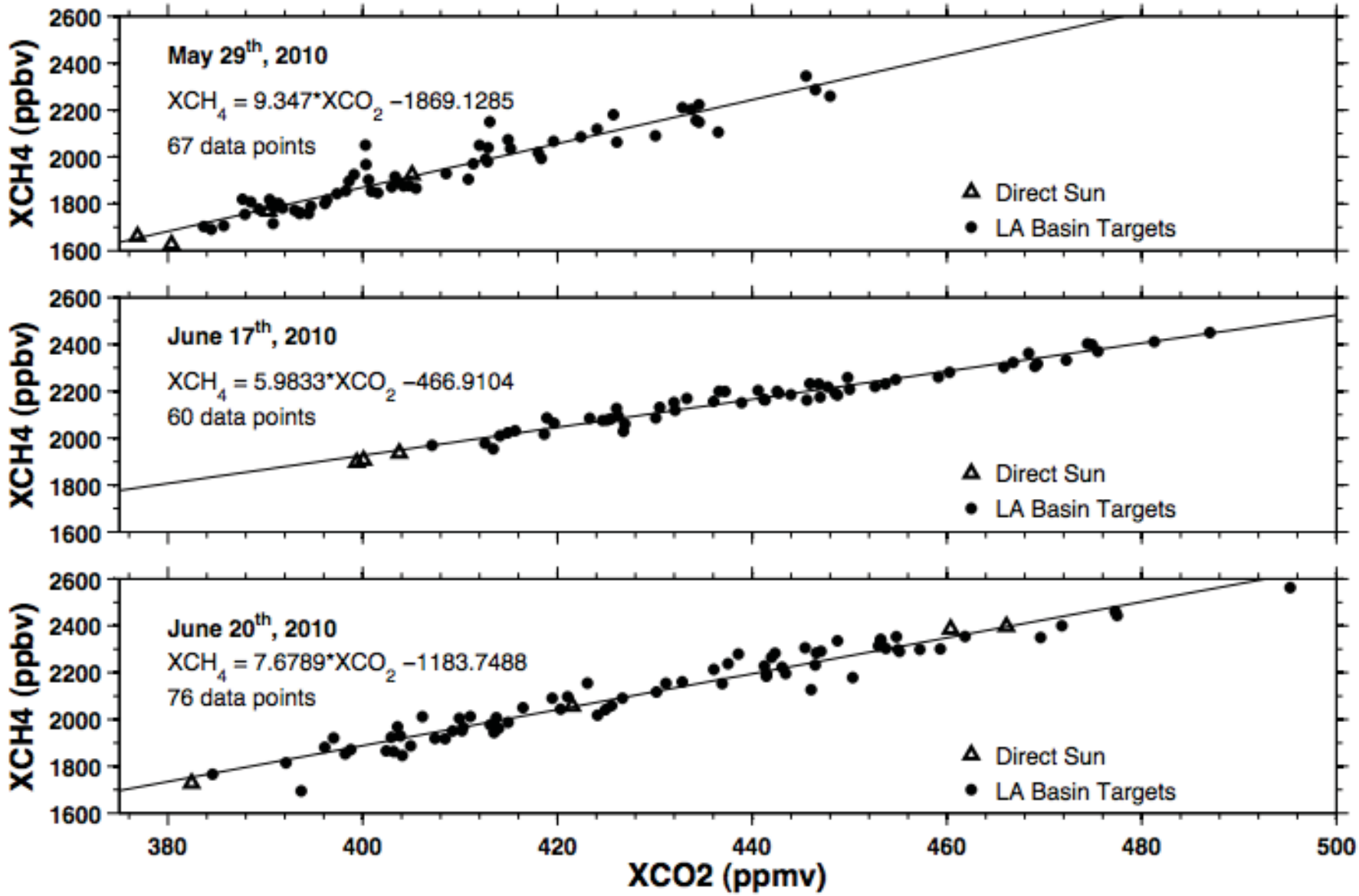




- XGAS = 0.2095x[GHG] /[O2]
- Ideal weather condition
- Near full day coverage
- XGAS for all targets on the pointing list are included

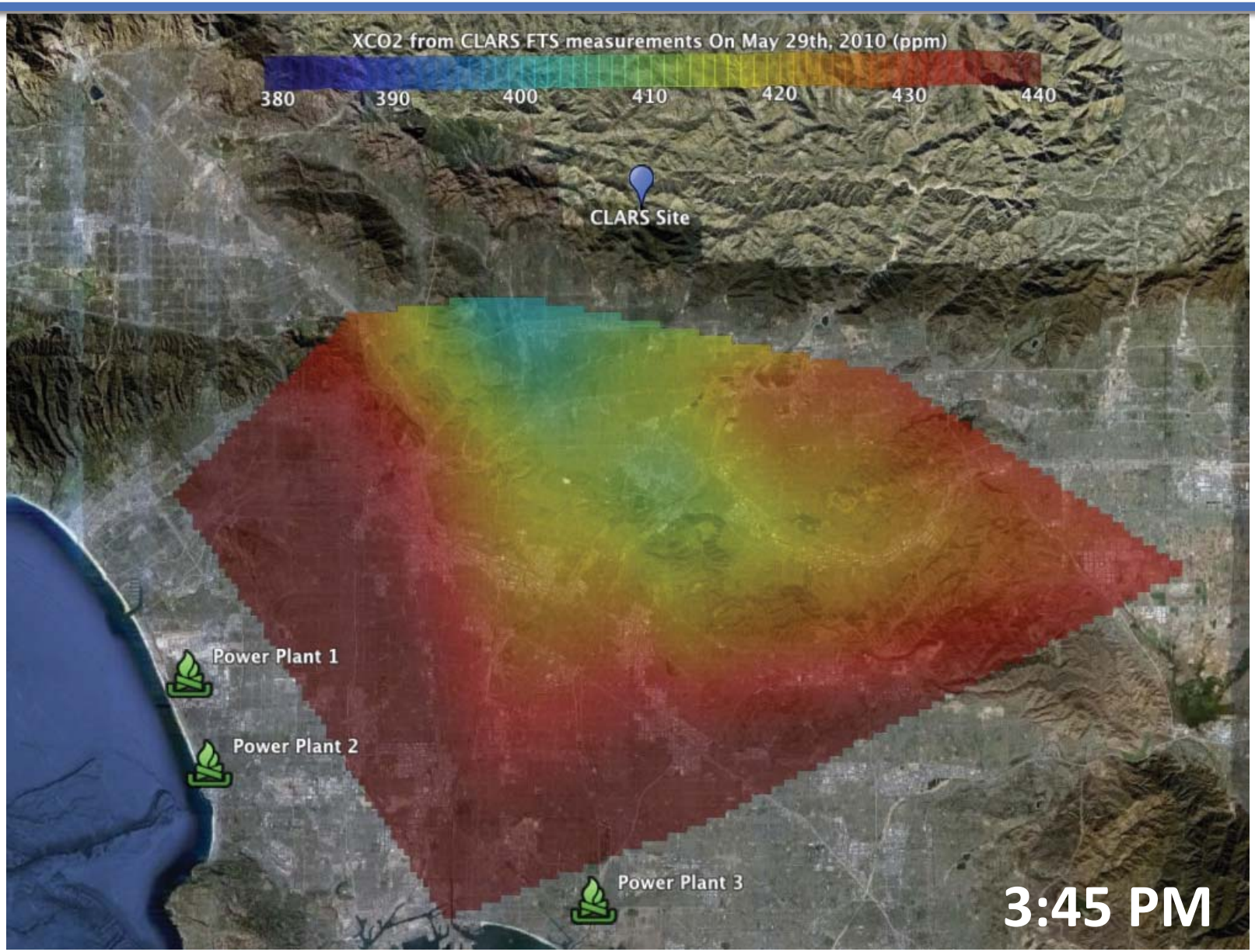


CH_4:CO_2 Correlation on May 29th, June 17th, June 20th, 2010



XCO_2 Distribution over LA Air Basin on May 29th, 2010

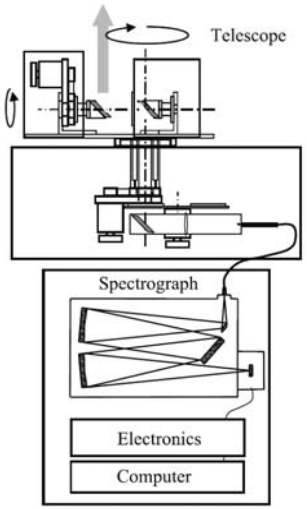
XCO_2 Distribution over LA Air Basin on May 29th, 2010



Summary and Future Work for CLARS FTS

- During CalNex campaign (May 14th to June 20th, 2010), CLARS FTS made measurements on 31 days (out of 38 days).
- Measurements are continuing after CalNex campaign for long term record.
- XCO_2, XCH_4, XCO, XN_2O are are computed using measured column densities. The XGAS show correlations that will be used to determine the emission rates of GHG.
- Validation/improvement of retrieval method using correlative data (ground-based and aircraft) are ongoing.
- The WRF-VPRM and WRF-CHEM models for Los Angeles are being developed by the group of Qinbin Li at UCLA. The model will directly assimilate GHG and CO slant columns to derive top-down emissions (poster A51D-0139 by C. Park et al.)

UCLA Multi-Axis Differential Optical Absorption Spectrometer



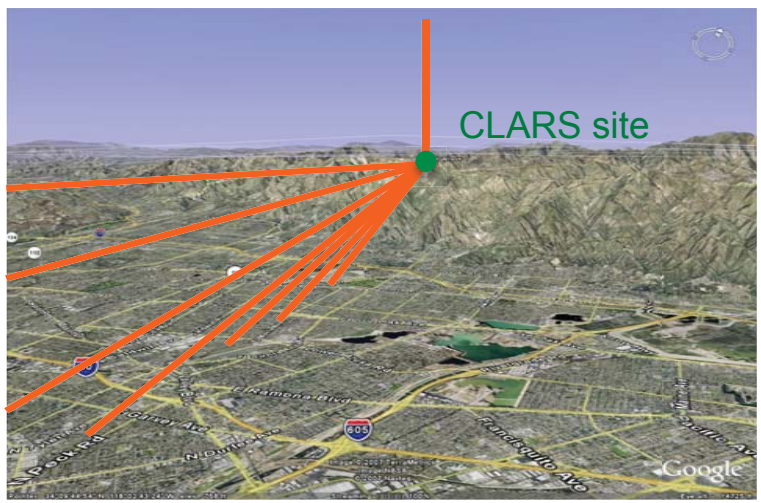
Pointing System

Grating Spectrograph

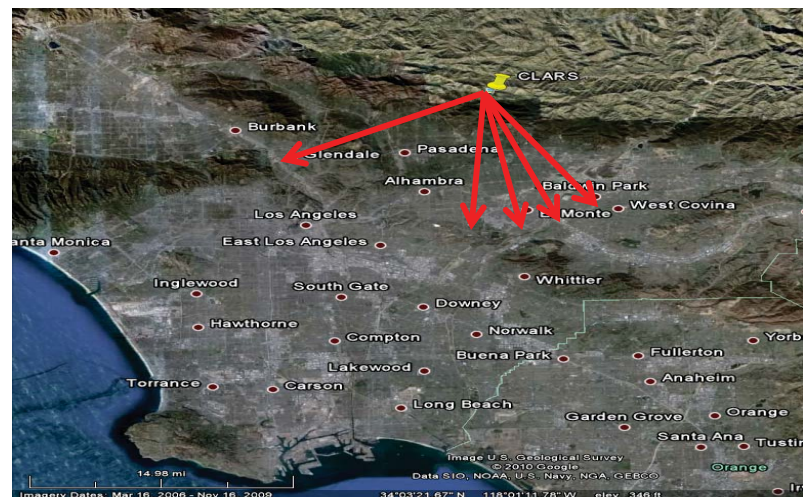
Poster ID: A21C-0105 by Ross Cheung
Location: Moscone South

Wavelength Interval (nm)	Trace Gases
316.4 – 448.2	NO_2, HCHO, Glyoxal, O_4
463.5 – 591.9	NO_2, O_4

- 9 elevation angles relative to the horizon
  -10°, -8°, -6°, -4°, -2°, 0°, 3°, 6°, 90°



- 5 azimuth angles shown on the map
  147.36°, 160.0°, 172.45°, 182.0°, 240.62°



Acknowledgements

- Drs. Geoffrey C. Toon and Jean-Francois Blavier at JPL
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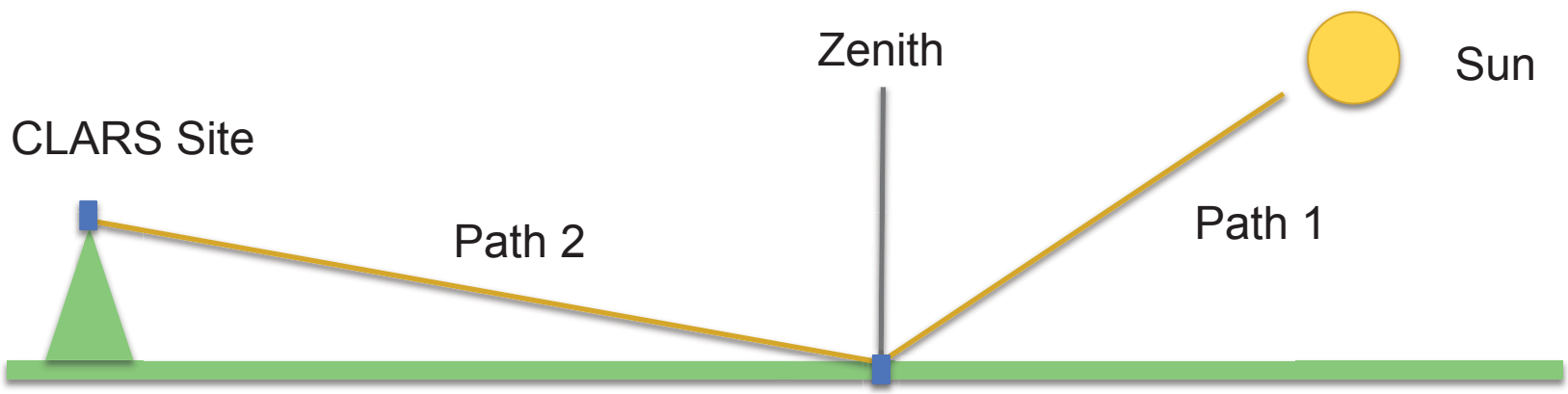
- California Air Resources Board
- NASA
- UCLA JIFRESSE

Los Angeles Air Basin December 31st, 2009

Impact of Viewing Geometry on XGAS Observation