Diurnal Measurements of H_2, CO, CO_2: Diagnosing Combustion Sources & Systematic BL Variations

Optical (SSA) Diagnostic of Absorbing Aerosols by a new PA instrument on the AMV

Thom Rahn, Claudio Mazzoleni, and Manvendra Dubey*

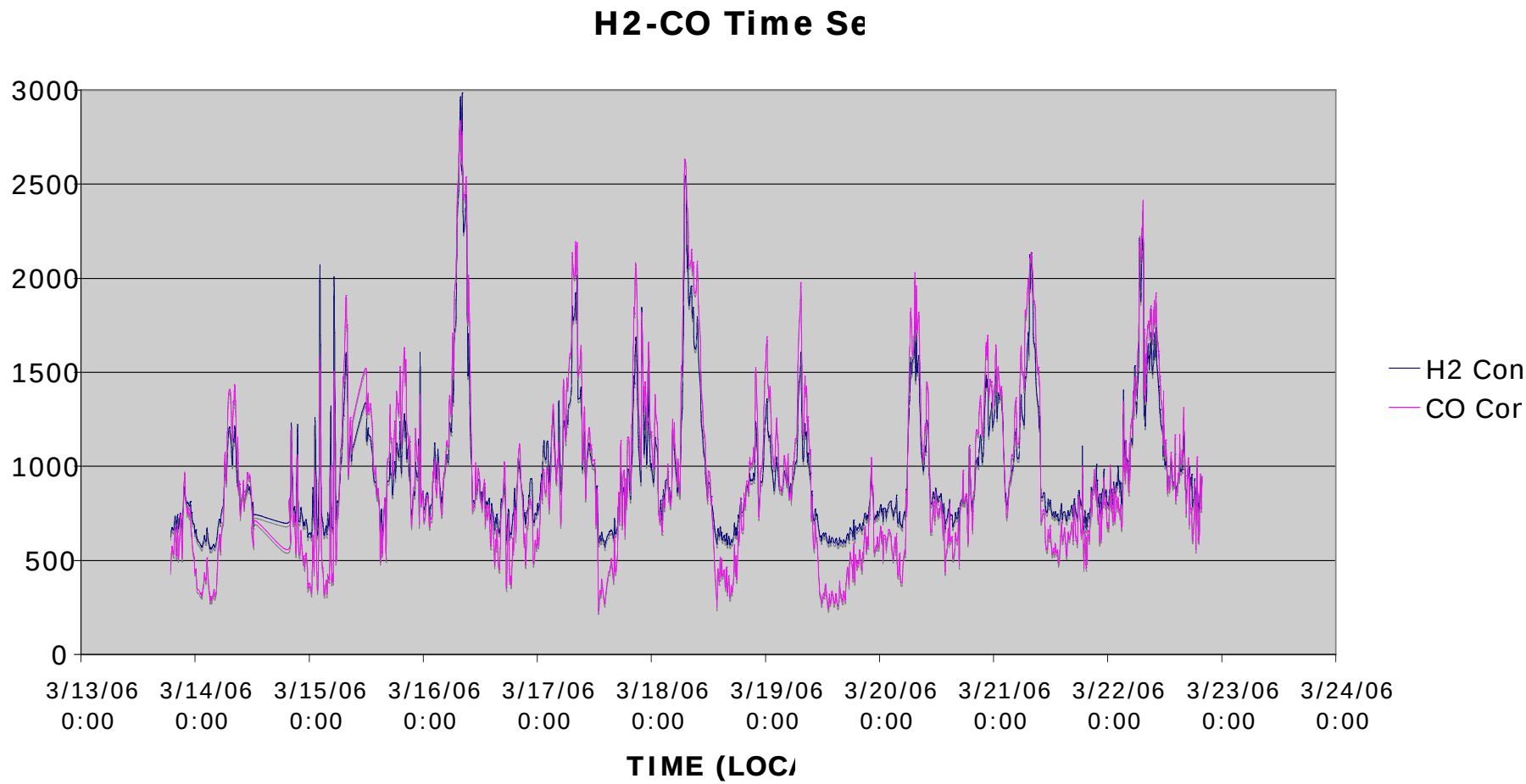
Los Alamos National Laboratory

Dubey@lanl.gov

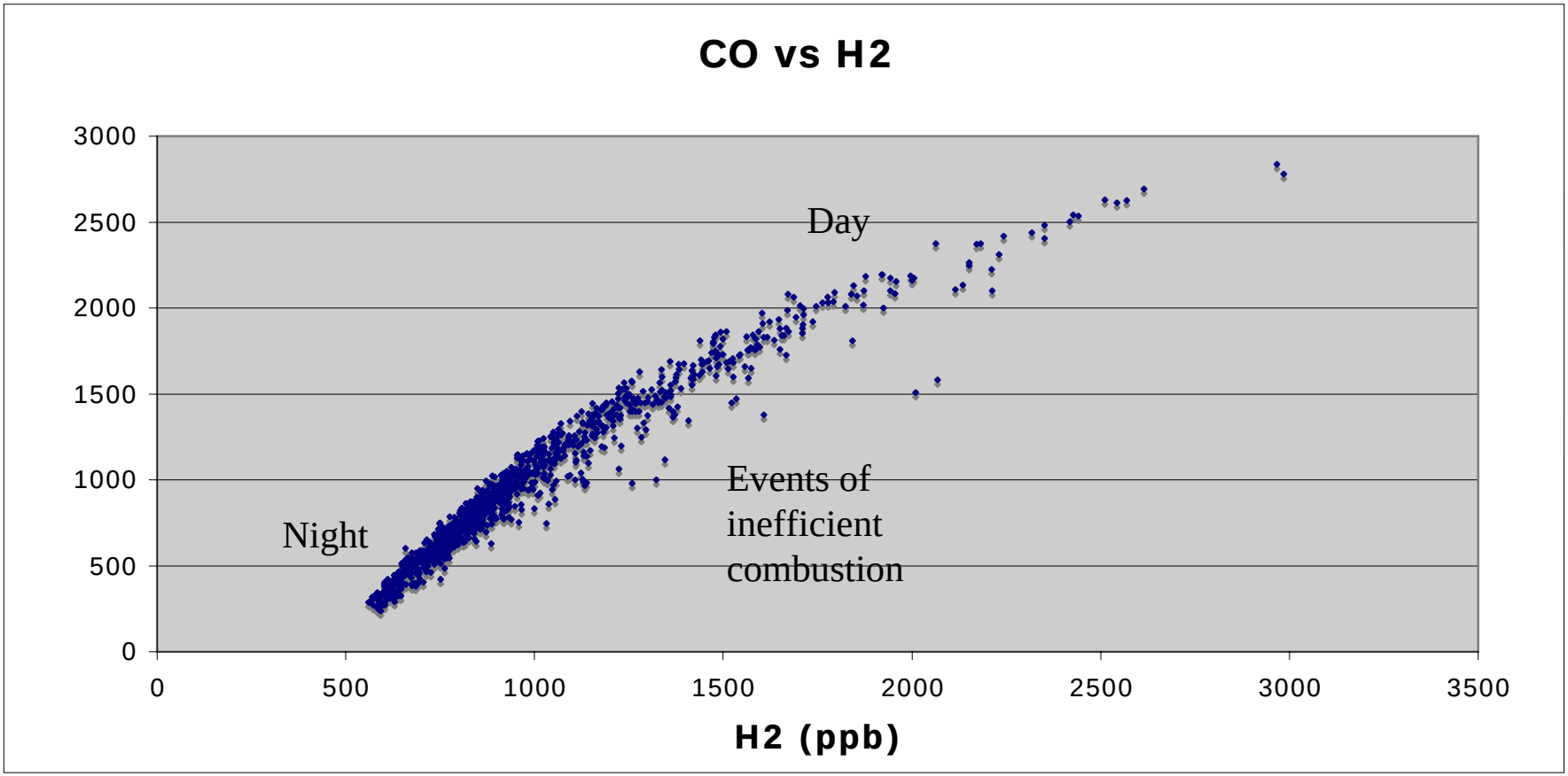
Preliminary data and analysis subject to alteration and re-interpretation

Work supported by LANL-LDRD Program

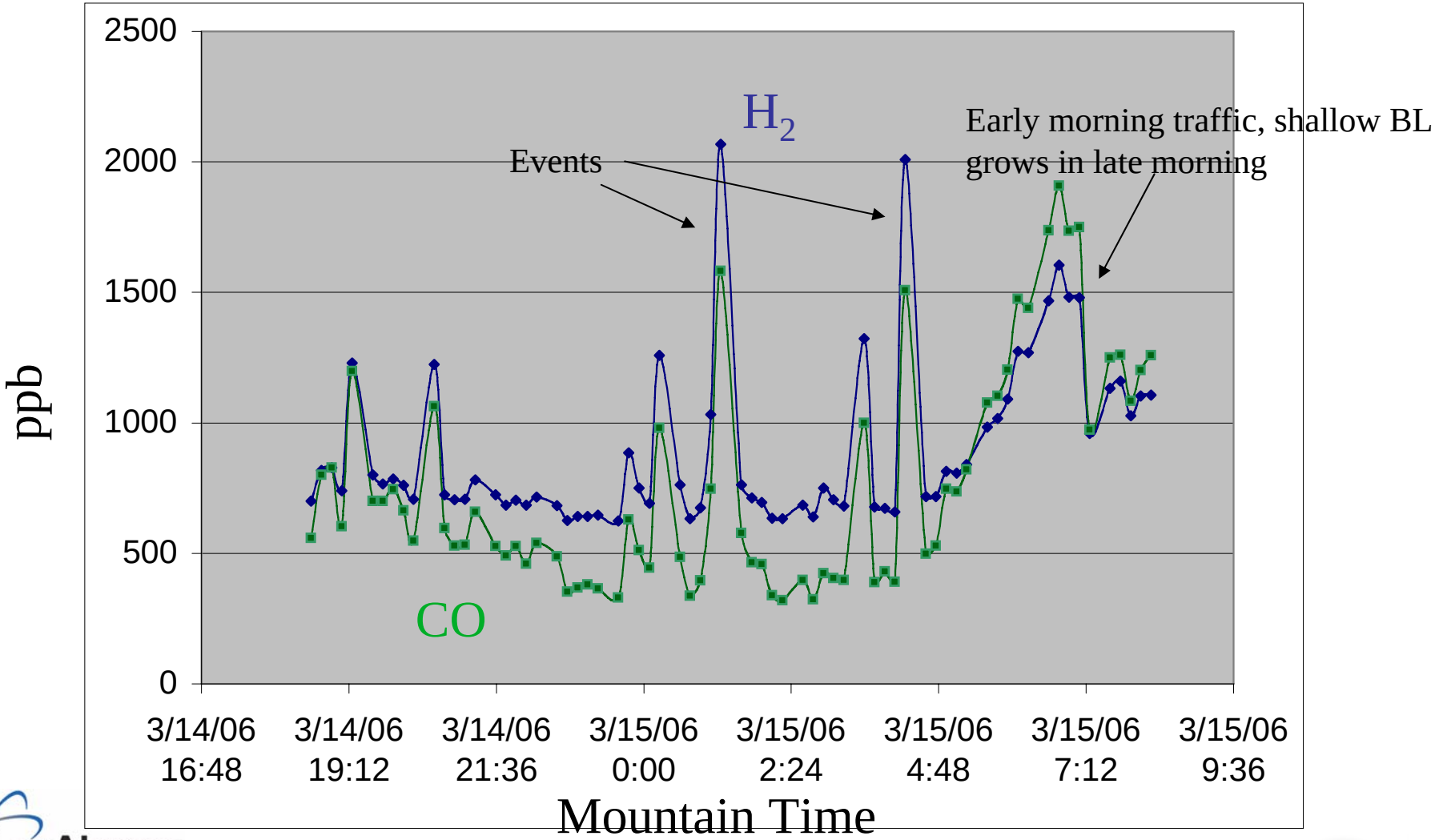
H_2 and CO Time Series



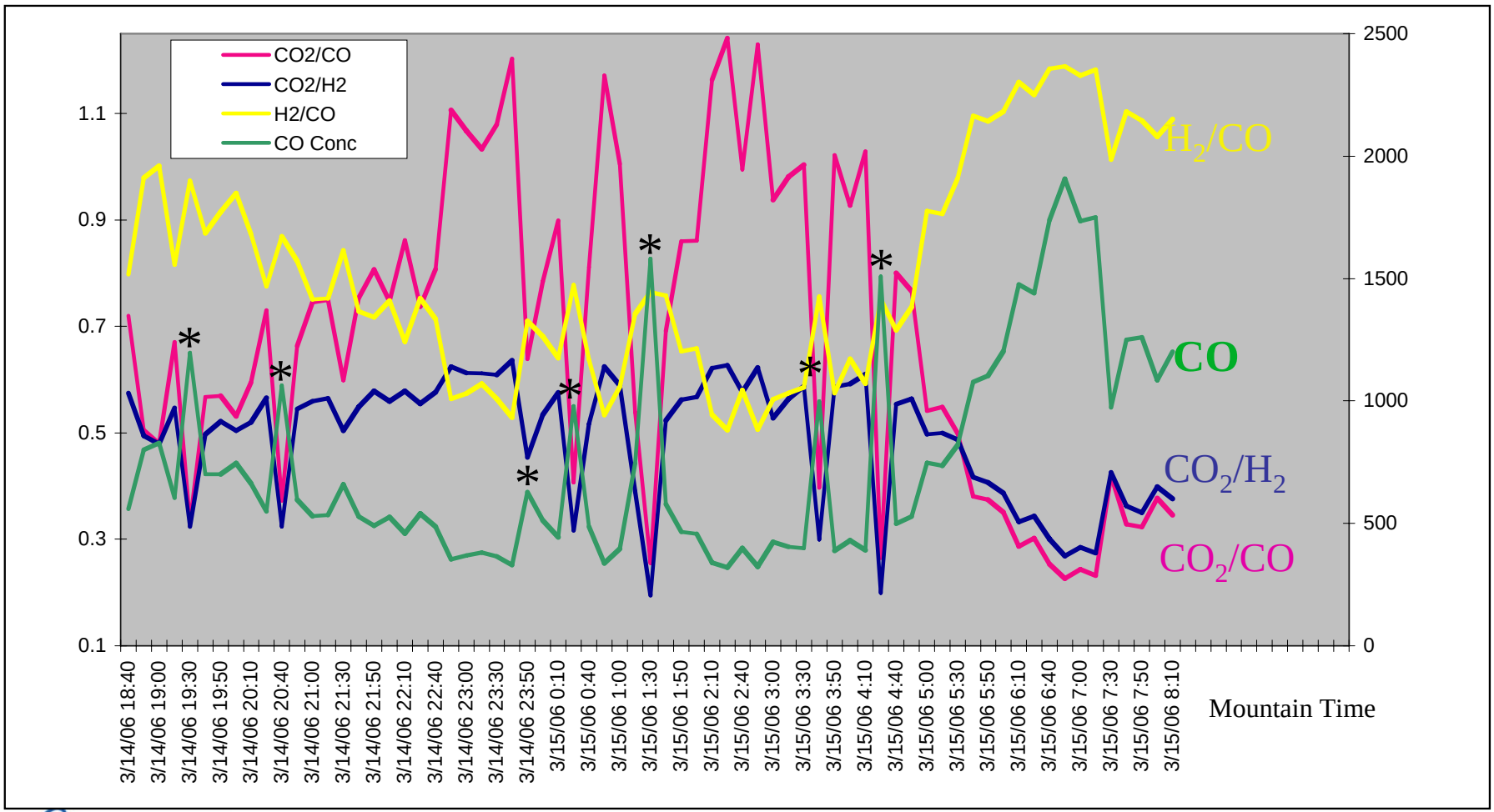
H_2 vs CO


CO vs H2
3000
2500
2000
1500
1000
500
0
0
500
1000
1500
2000
2500
3000
3500
H2 (ppb)
Day
Night
Events of
inefficient
combustion

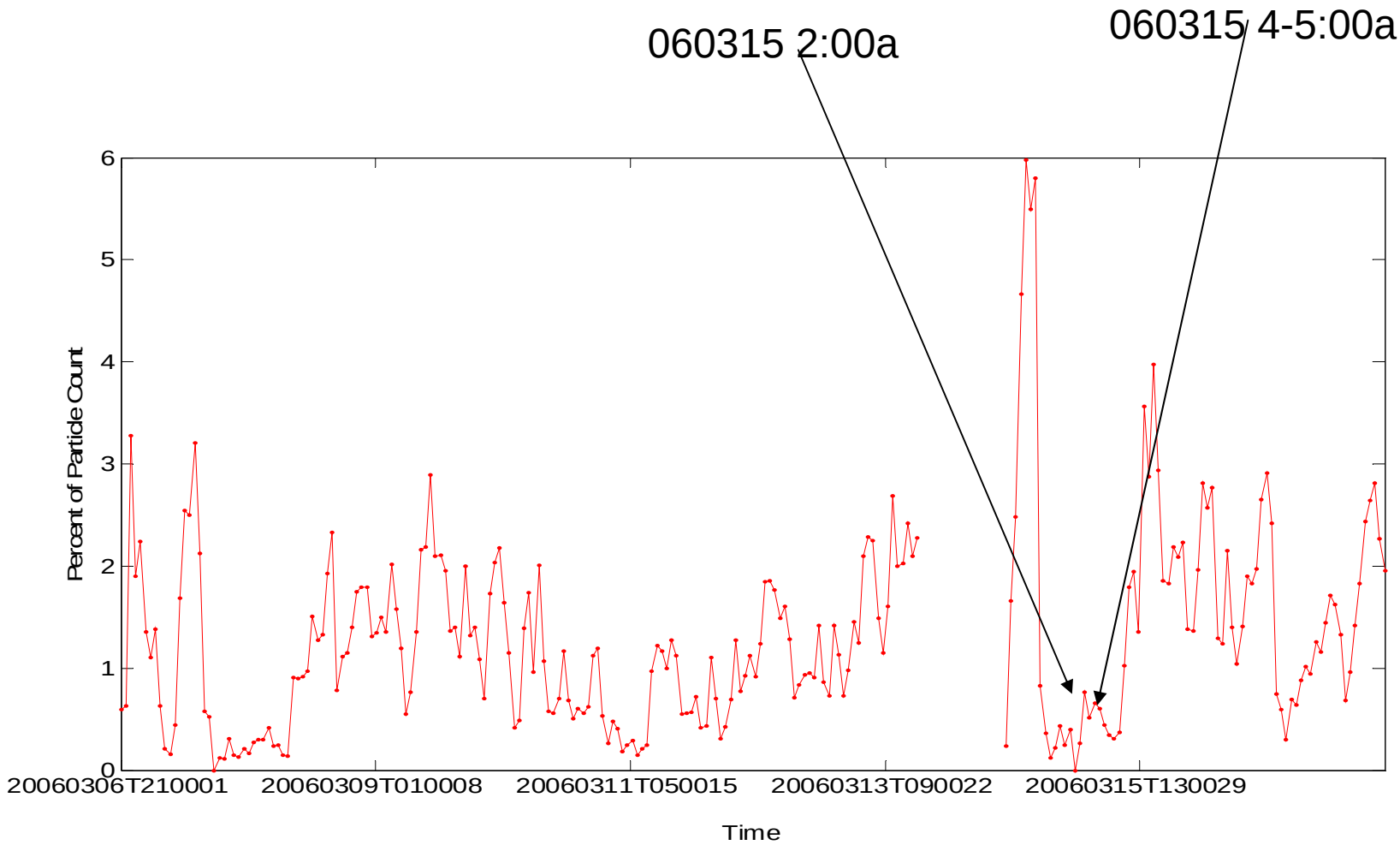
3/14 Night and 3/15 Morning Temporal Features



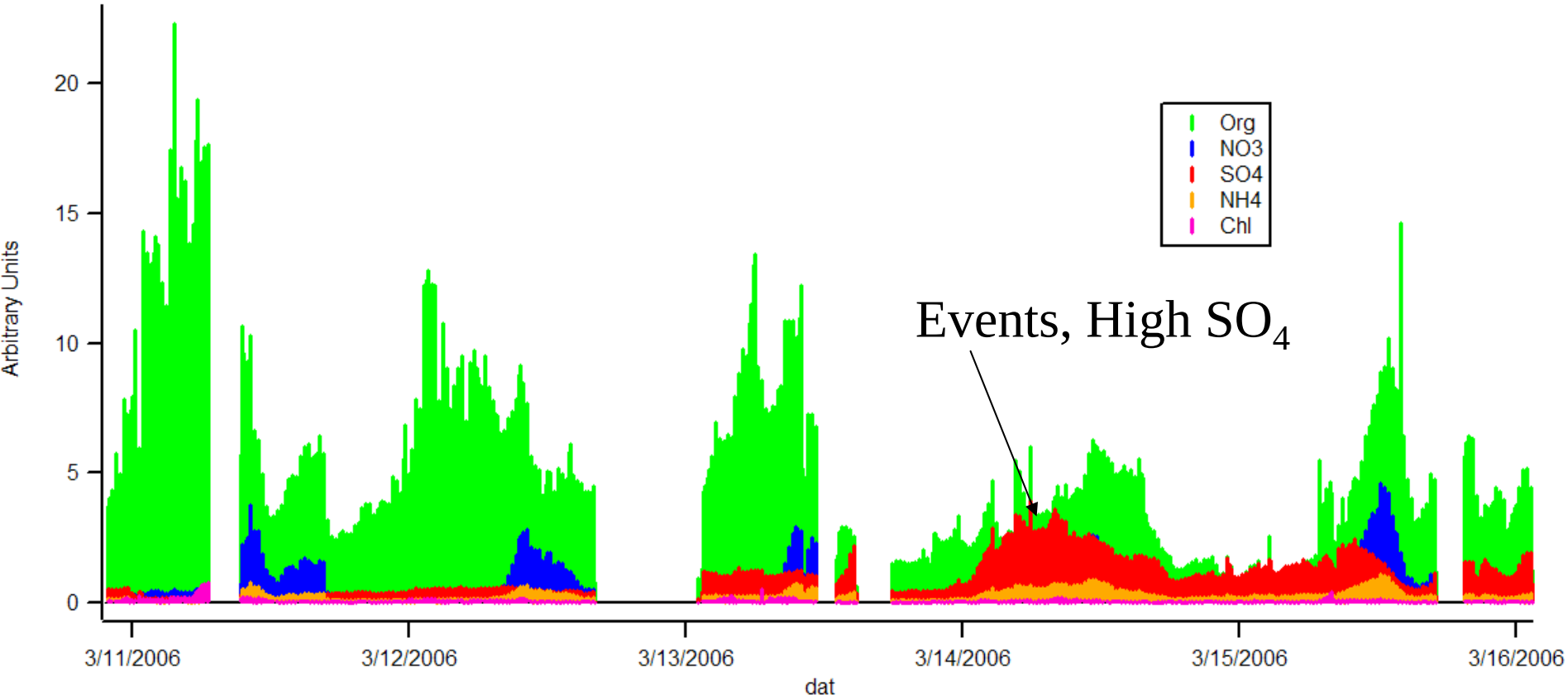
7 Events* have inefficient combustion



Vanadium in Events (Ryan, Kim Prather)



Aerosol Composition (AMS) at T0



AMS T0, Raw Mass Loadings
Allison C. Aiken, Jose L. Jimenez

Allison Aiken and Jose Jiminez (CU Boulder)

Mexico City: Complex Sources, Chemistry and Dynamics

- **Host of combustion sources and chemistry**
  - Automobiles and trucks
  - Tula power plant, refineries, industries, cement (NW)
  - Inefficient combustion produces high H_2/CO_2 and CO/CO_2
  - Catalytic converters in autos produce H_2 directly
  - Formaldehyde photolysis produces H_2 indirectly
  - Volcanoes (Popo and Izta)
- **Local Topography (Valley) and Meteorology**
  - Shallow nocturnal BL, expands later in day due to solar heating
  - Regional Met: Flexpart forward and back trajectories
- **Diurnal Traffic Variations**
  - Morning and evening rush hour
  - Weekends, particularly this long holiday one

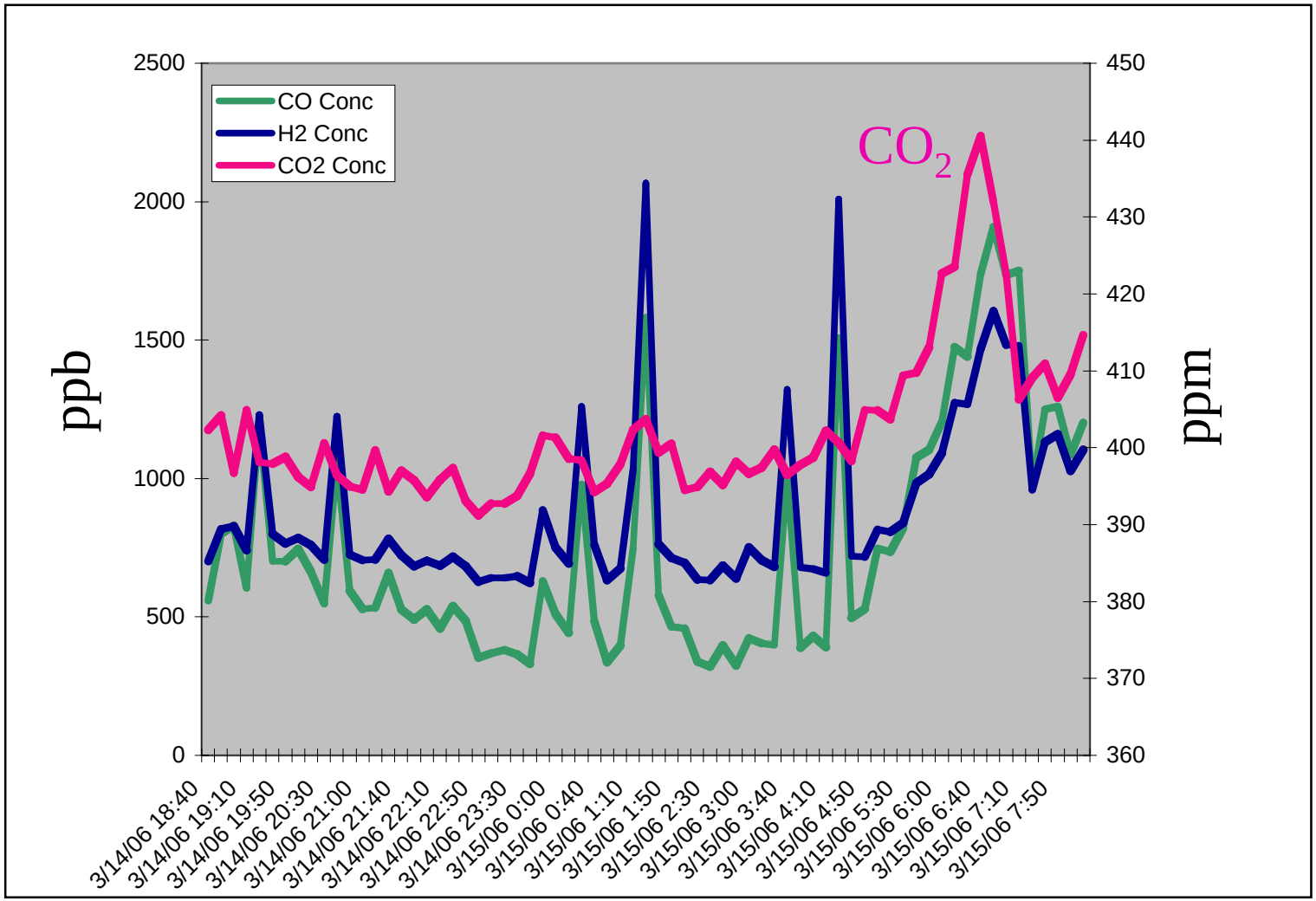
GC-Reduced Gas Analyzer: H_2, CO

- $CO + HgO (s) = CO_2 + Hg(v)$
- $H_2 + HgO (s) = CO_2 + Hg (v)$
- 2 Standards, 5 Samples
- 10 mt. resolution, automated
- High precision
- CO_2 by NDIR

CO/CO_2, H_2/CO_2, CO/H_2 diagnostic for combustion chemistry of sources

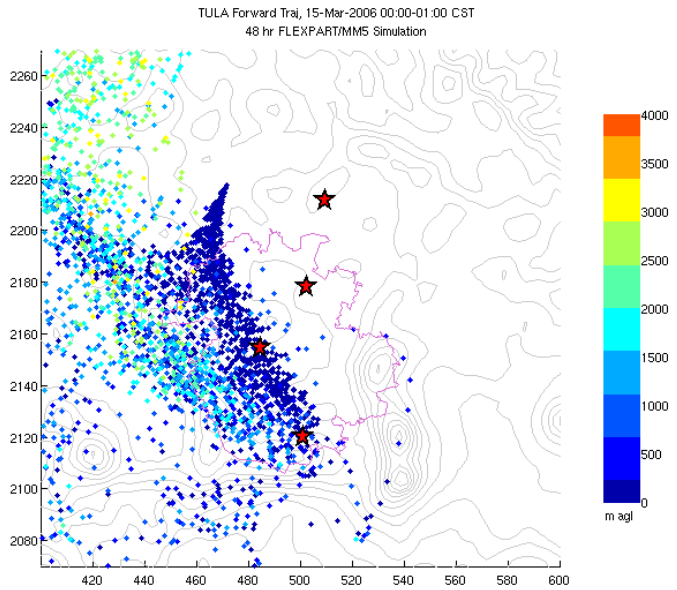
The Set-up

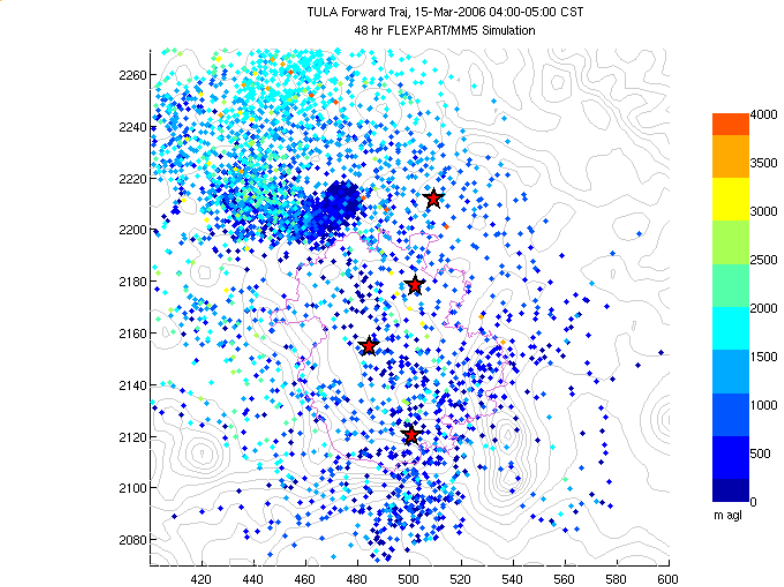
CO_2 tracks CO and H_2: Large scale vs. Smaller Events

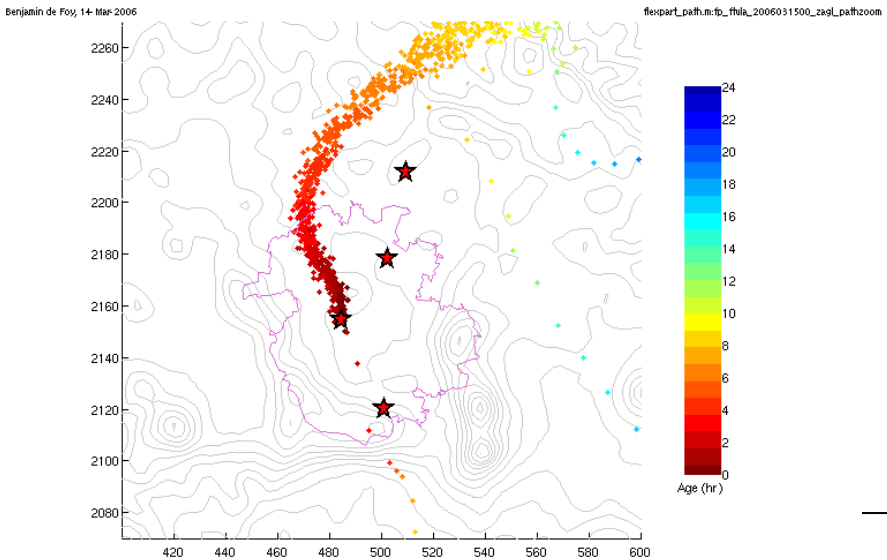


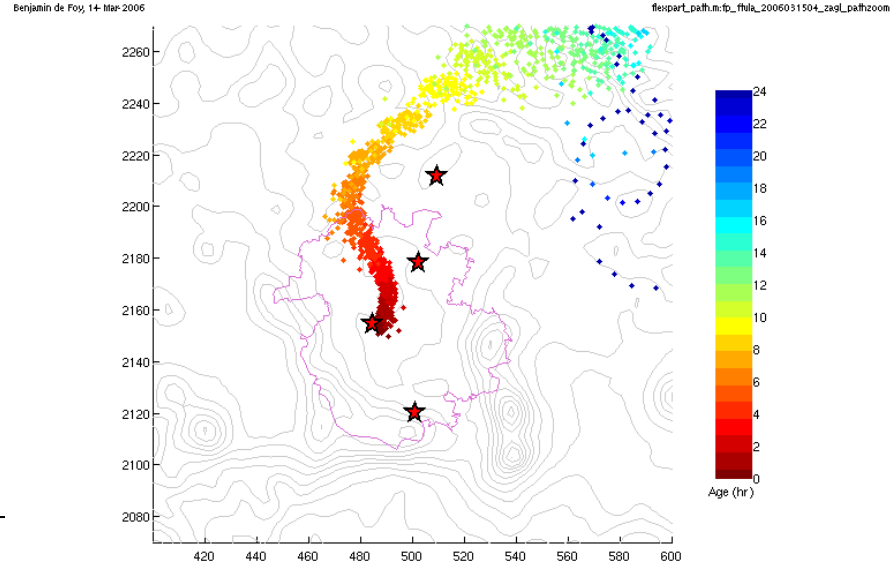
Mountain Time

Tula Forward and T0 Back Trajectories (Ben)

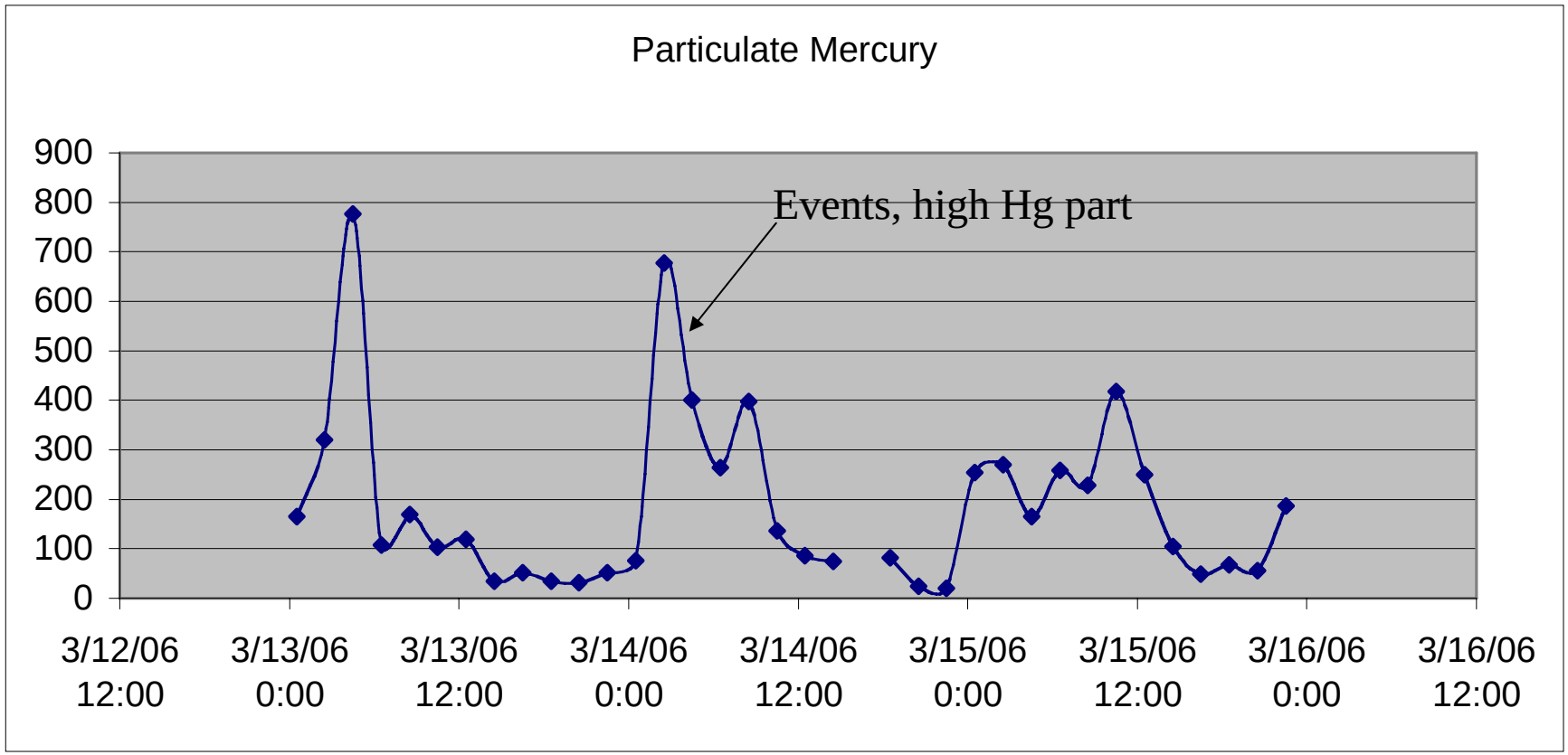






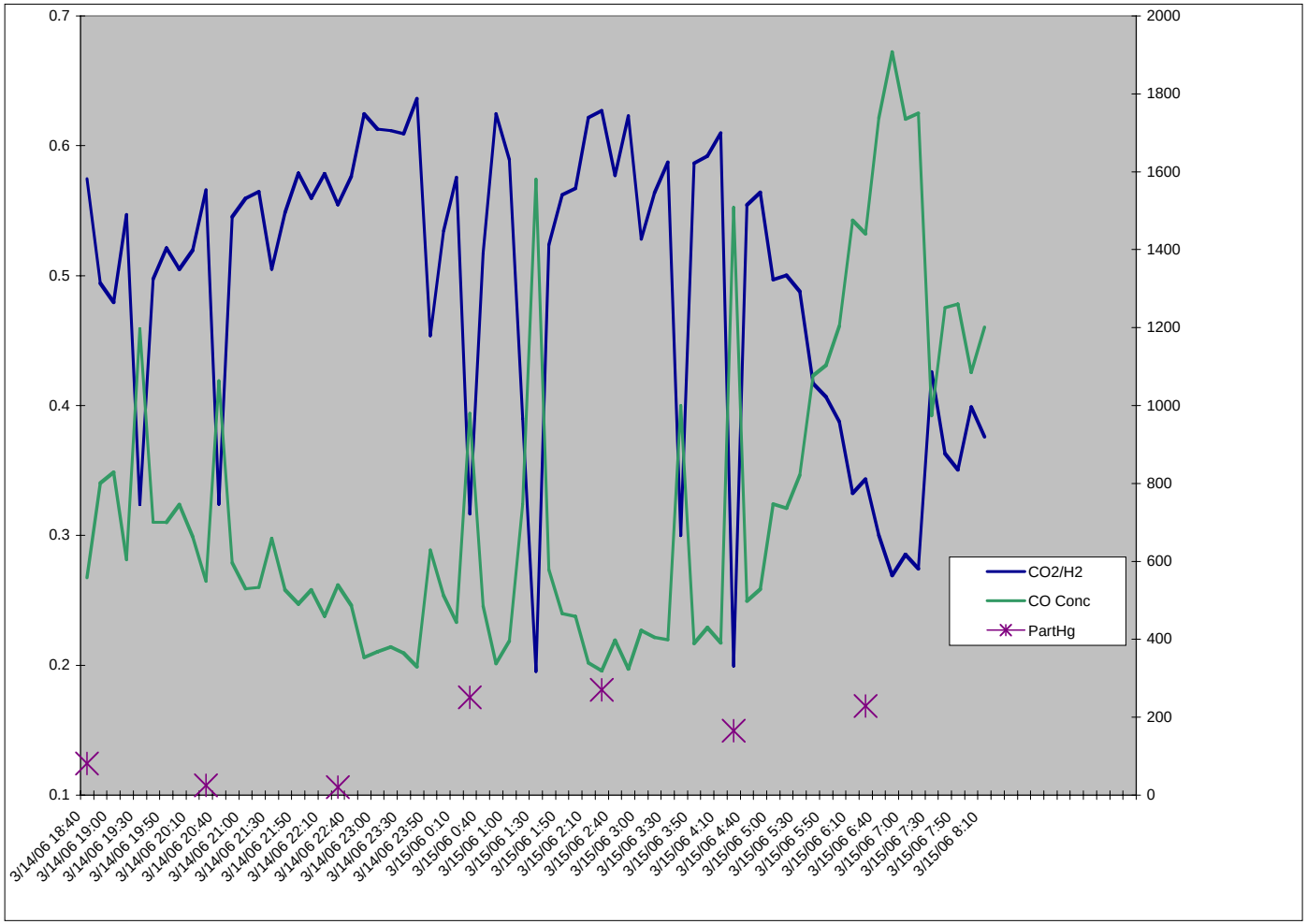


Particulate Hg (ng/m^3) at Bldg 20 IMP



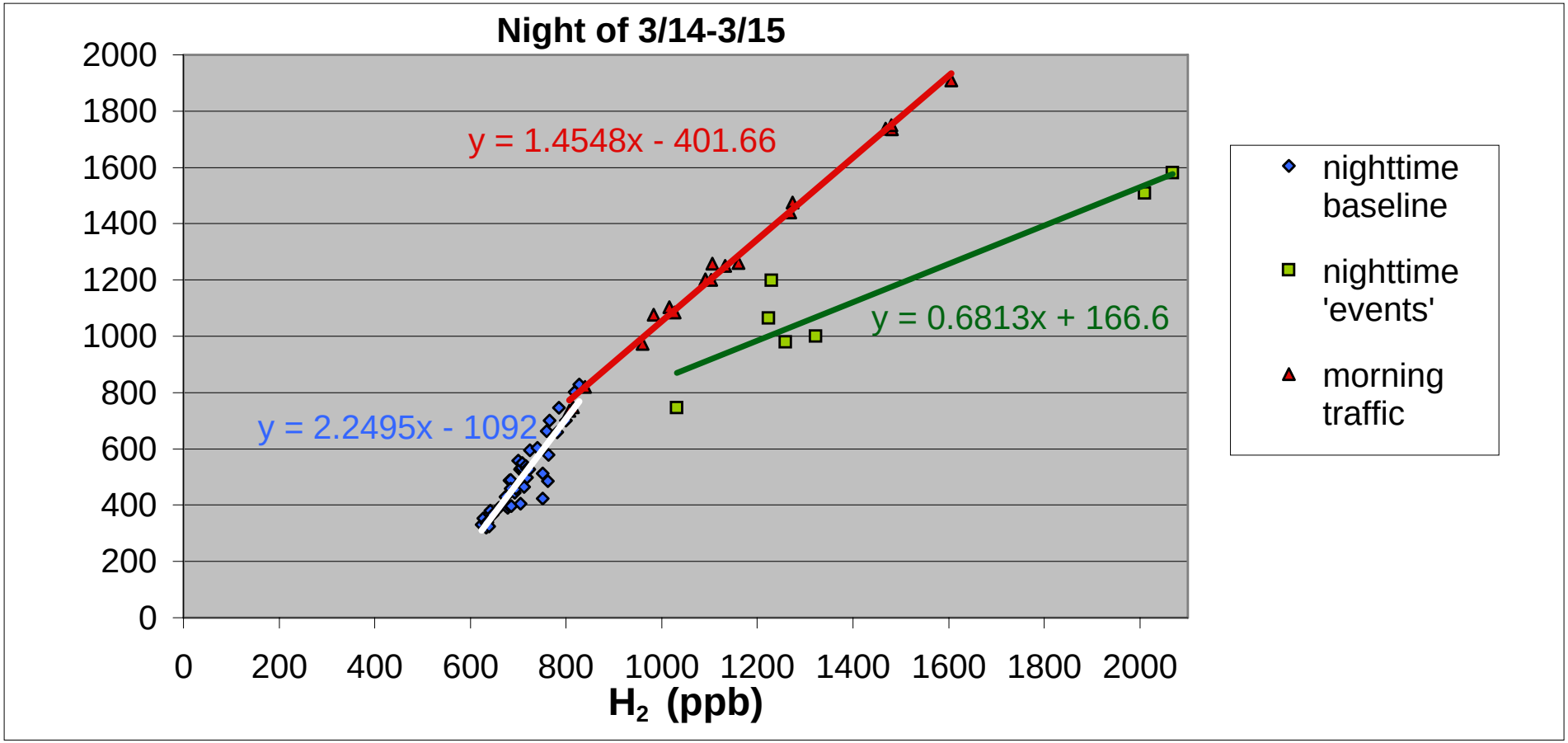
David Snyder, Andrew Rutter and Jamie Schauer (UW Madison)

Particulate Hg (ng/m^3) at Bldg 20 IMP



David Snyder, Andrew Rutter and Jamie Schauer (UW Madison)

Fingerprinting Distinct Combustion Sources



Preliminary Conclusions

- CO, CO_2, H_2 identify distinct NW (Tula, Ind., Cement) events 3/14-3/15
  - 10s of mts wide, inefficient combustion
- Corroborative Evidence
  - Tula forward and T0 back trajectories
  - High sulfate and particulate Hg
- Framework to distinguish combustion sources from stoichiometry
  - Event plumes exhibit inefficient combustion
  - Auto have more efficient combustion
  - Mixture of these end members
- Role of surface/soil sinks of H_2 and CO?