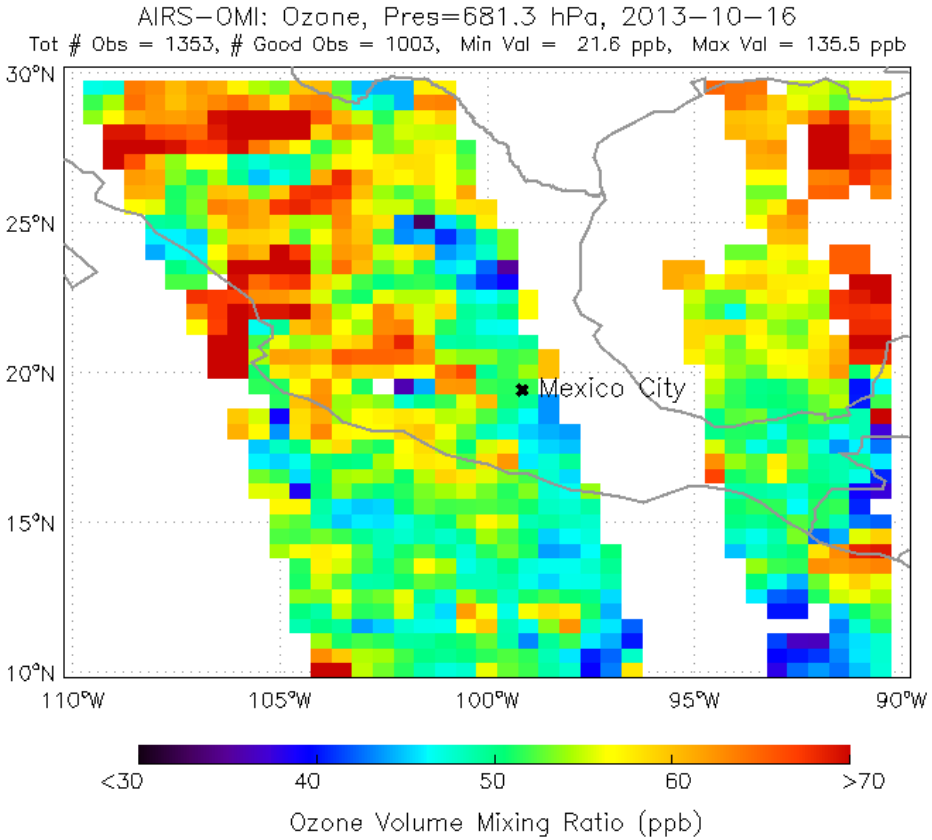

A14A-04: Utilizing Tropospheric Emission Spectrometer (TES) Special Observations to Study Air Quality Over Megacities: A Case Study of Mexico City

2016 AGU Fall Meeting

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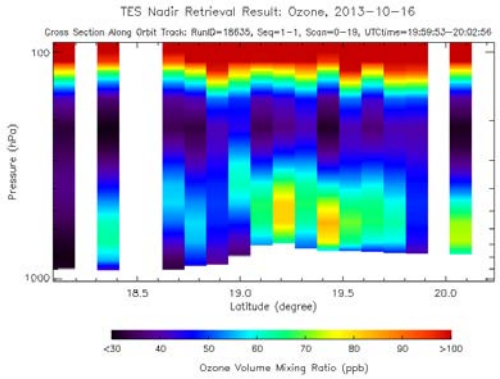
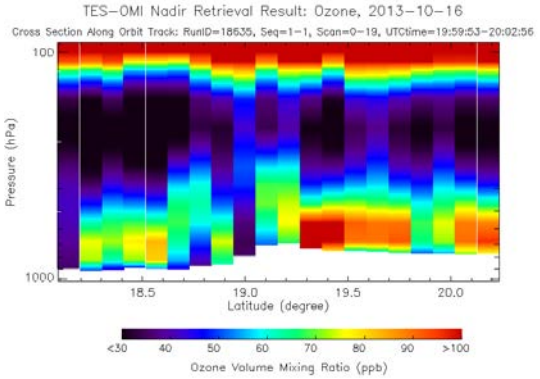
[2]Atmospheric and Environmental Research (AER)

[3]National Center for Atmospheric Research, University Corporation for Atmospheric Research, Boulder CO

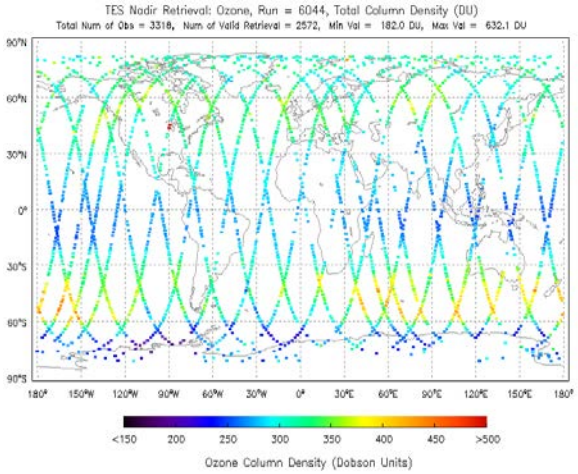




Jet Propulsion Laboratory
California Institute of Technology

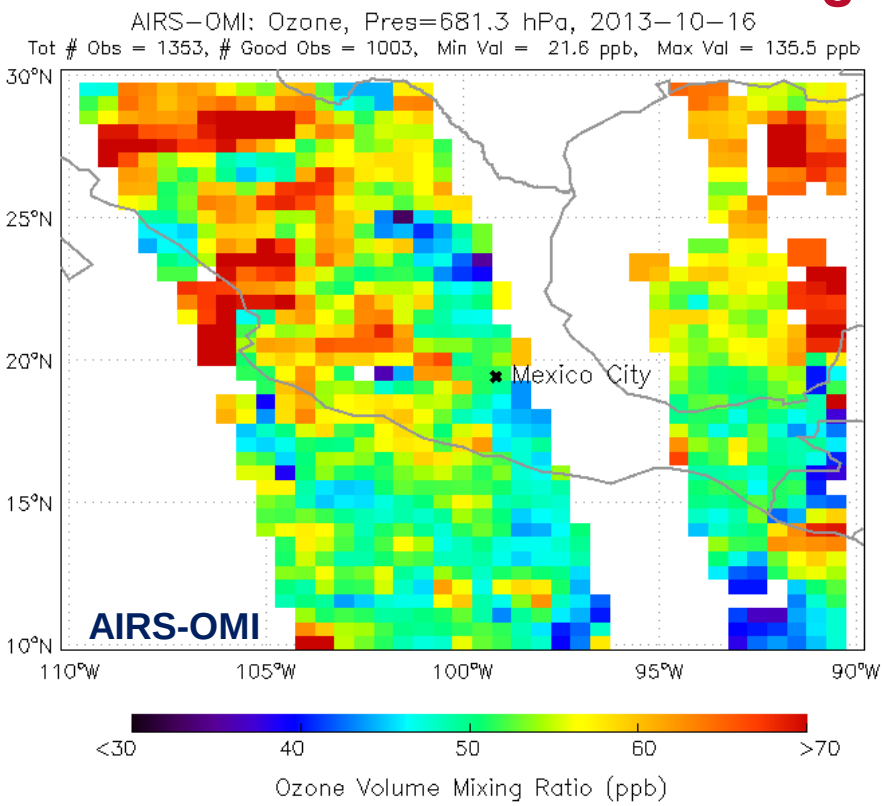
TES

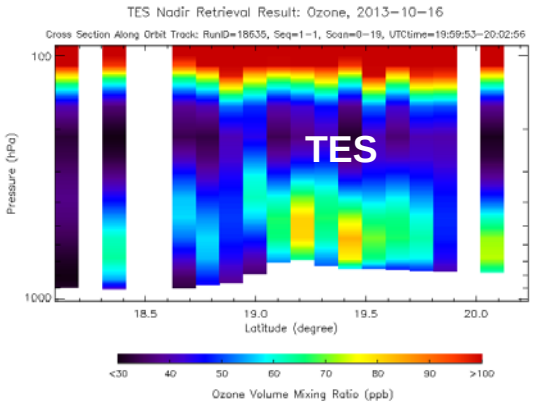
- Tropospheric Emission Spectrometer (TES) has measured ozone in the troposphere since it's launch on the NASA Aura Satellite on July 15, 2004
- Species: O_3, CO, CH_4, CO_2, NH_3, CH_3OH, HCOOH, PAN
- Nadir viewing – Footprint is 5x8 km
- Global Coverage (Global Survey from 2004 to 2010)
  - Observations ~182 km apart
- Special Observations (2004 – now)
  - Footprints ~45 km or ~12 km apart
- January 2013: Began megacity observations (Transect)
  - 19 Cities
  - Footprints ~12 km apart
  - 1-2 observations per month

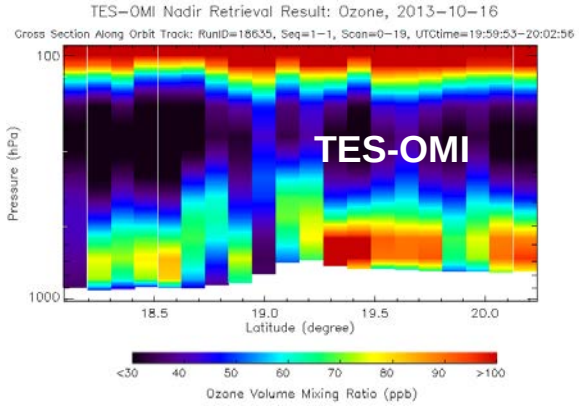


Cities Observed by TES (Transects)
Bangkok
Beijing
Buenos Aires
Delhi
Dhaka
Houston
Istanbul
Karachi
Kolkata
Lagos
Los Angeles
Mexico City
Mumbai
New York City
Paris
SW China
Sao Paulo
Shenzhen
Tokyo

O_3 Observations from TES and other Instruments

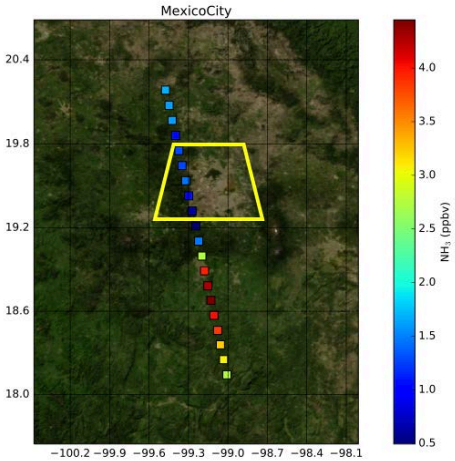






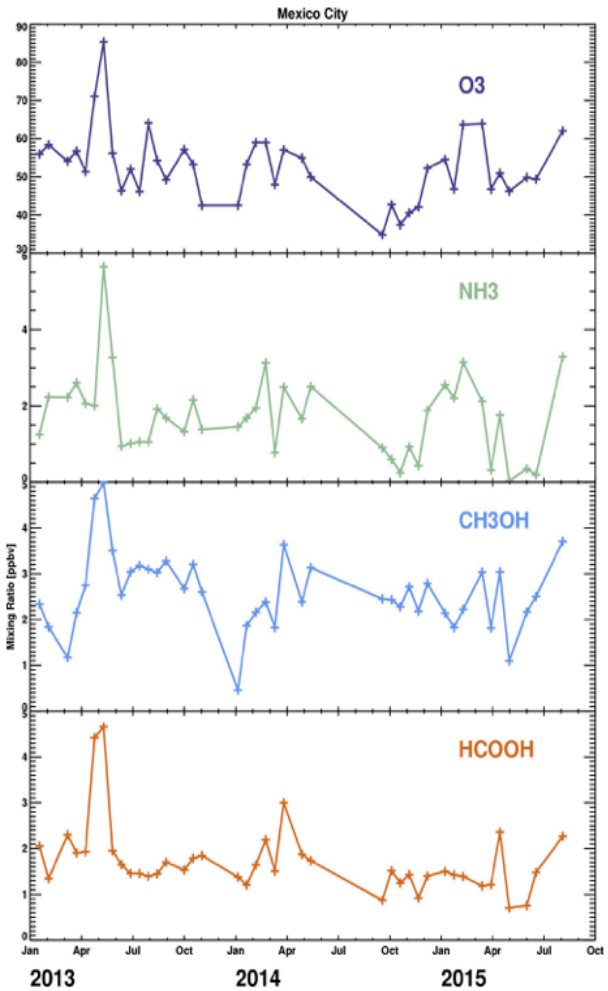
- TES observes O3 in the troposphere with some vertical resolution
- Data set retrieved using combination of TES and OMI (Ozone Monitoring Instrument also on Aura)
  - Similar vertical resolution as TES retrievals
  - Better sensitivity in the lower troposphere
- New product using TES retrieval algorithm on combined AIRS (Atmospheric Infrared Sounder on NASA Aqua satellite) and OMI radiances
  - Better spatial coverage
  - Ability to map O3 near TES Megacity observations
  - Long term: Fill in TES global survey data record

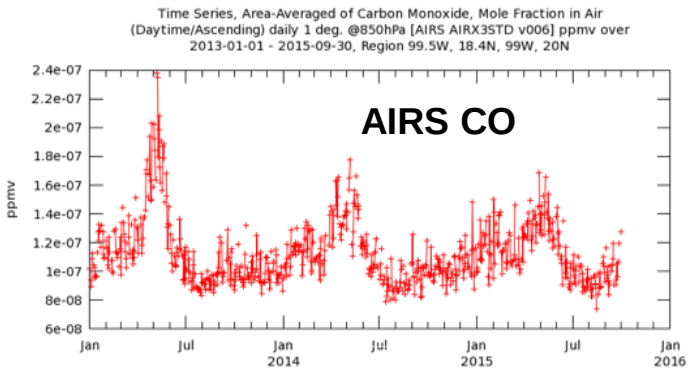
Time Series of TES Observations: Mexico City

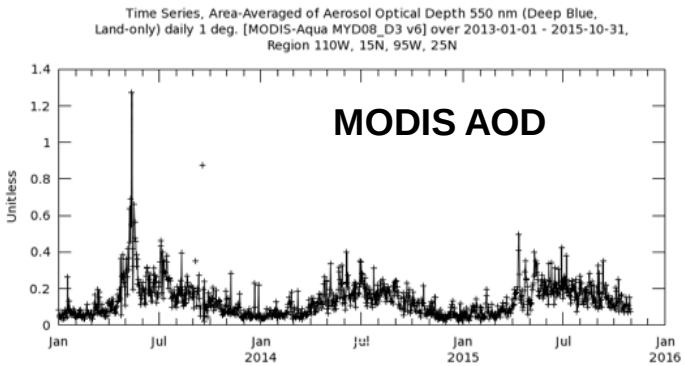


Time series over Mexico City of transect mean values for:

- TES ozone, ammonia, methanol and formic acid
- AIRS CO
- MODIS AOD







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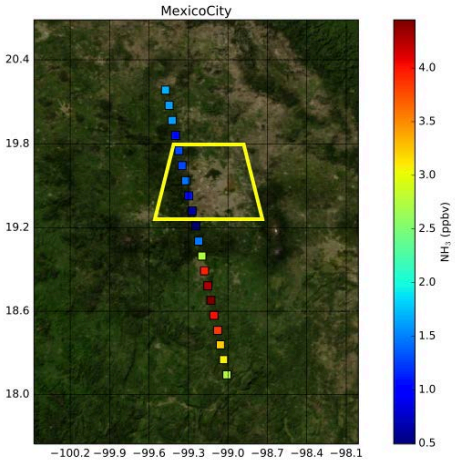

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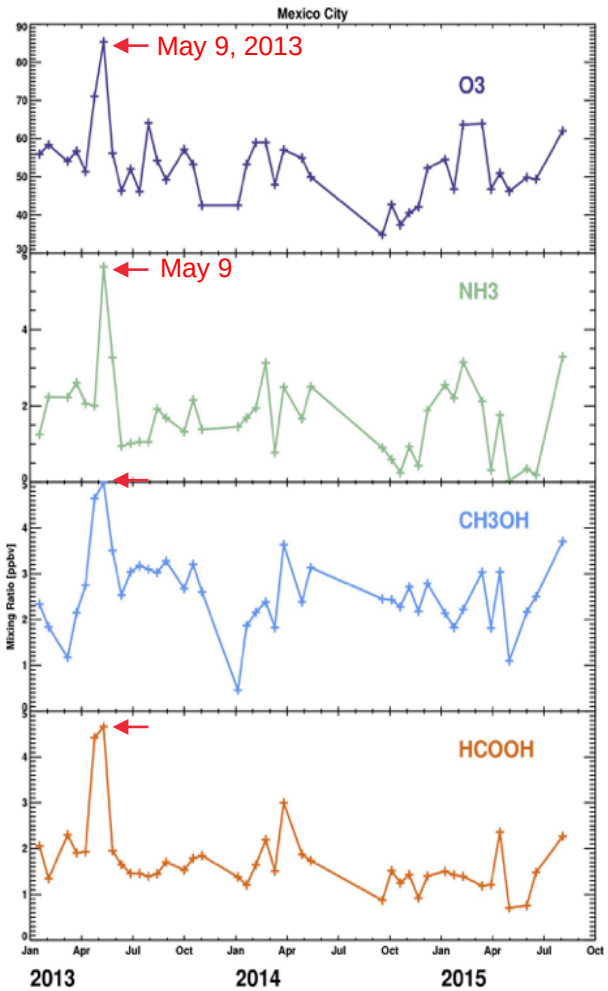
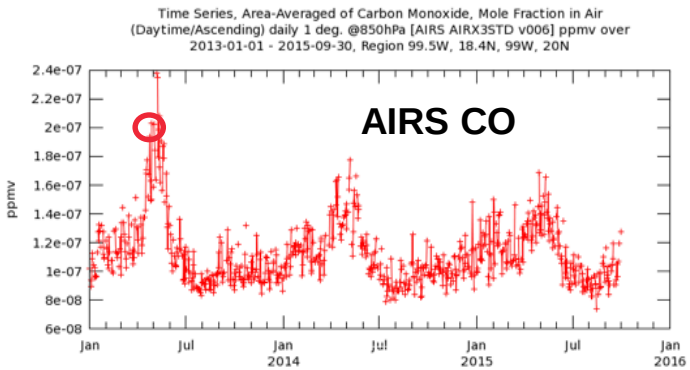
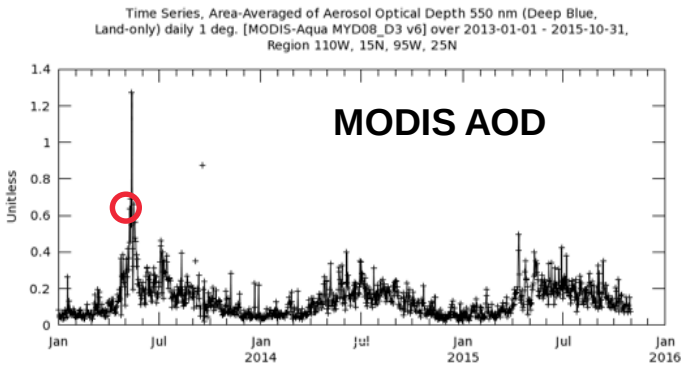
May 9, 2013







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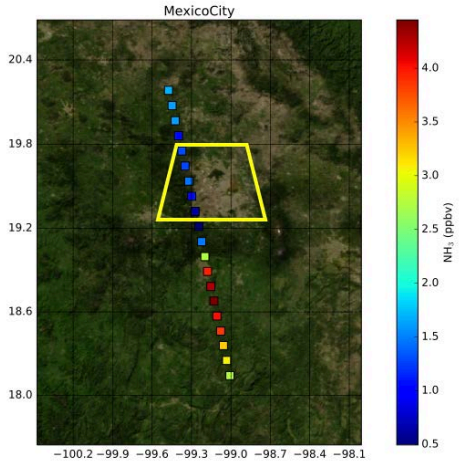

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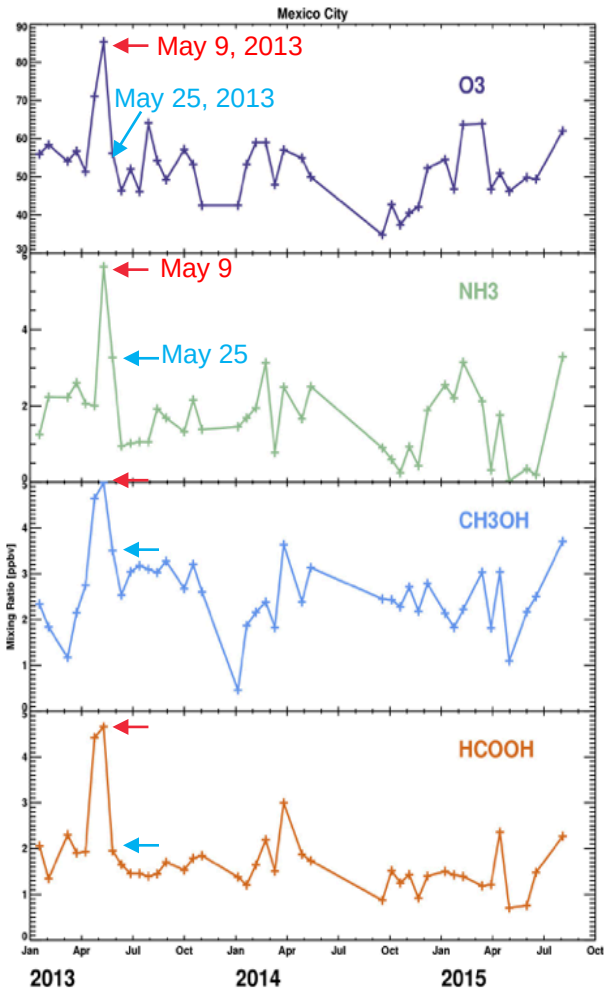
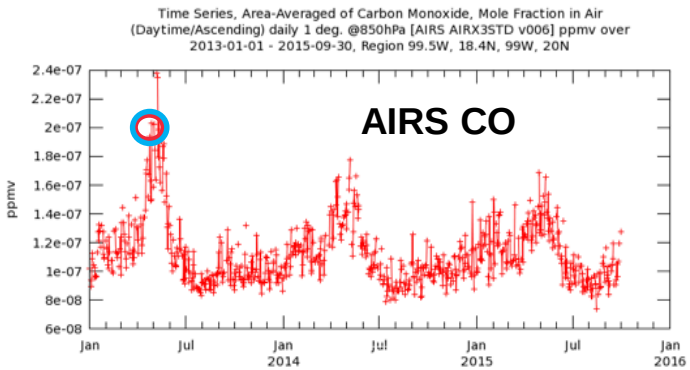
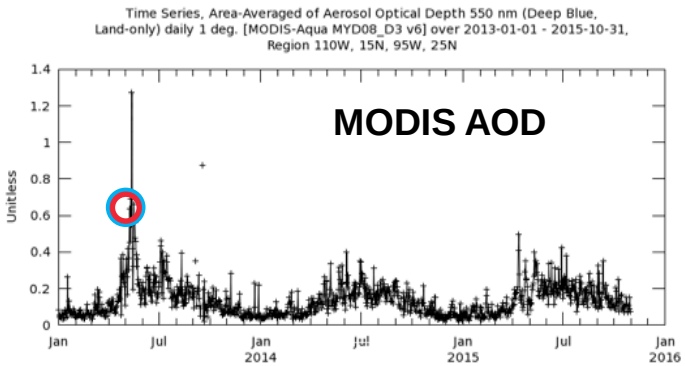
May 9, 2013

May 25, 2013







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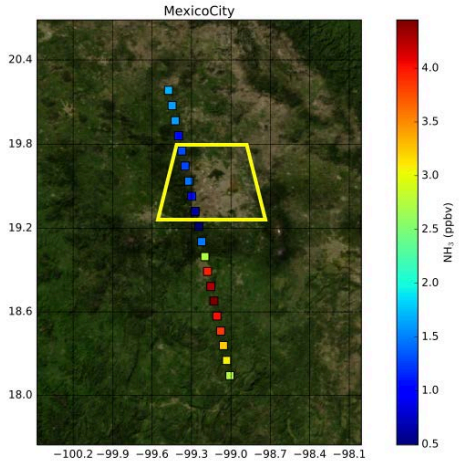

Time series over Mexico City of transect mean values for:

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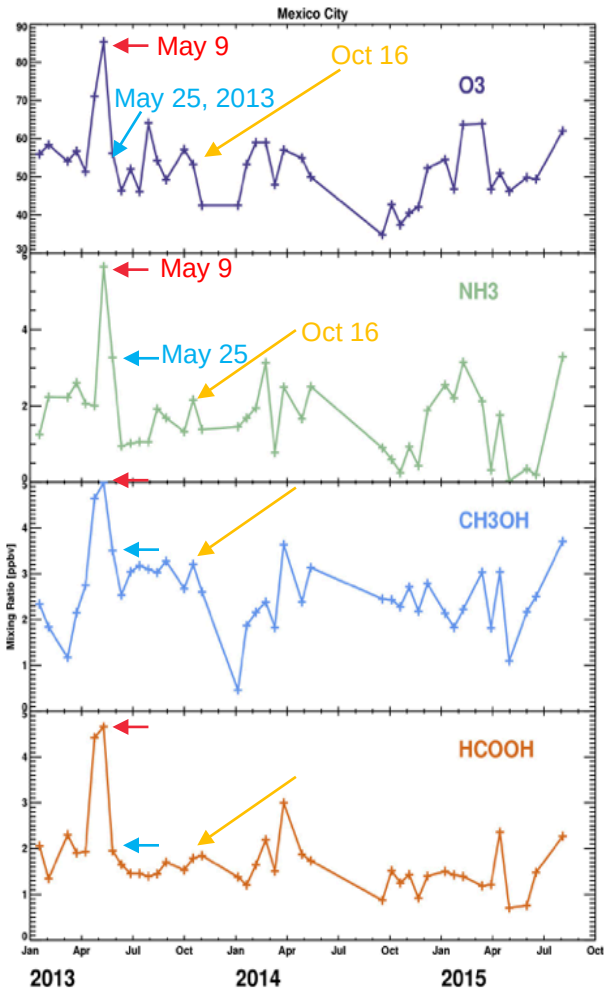
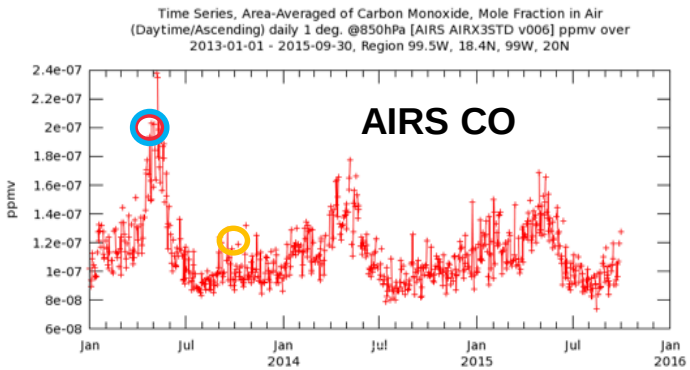
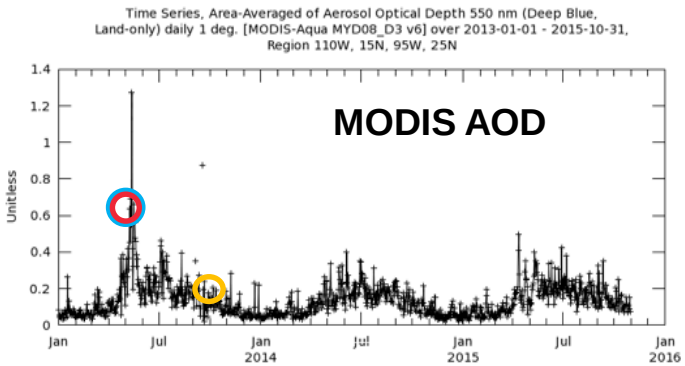
May 25, 2013

Oct 16, 2013

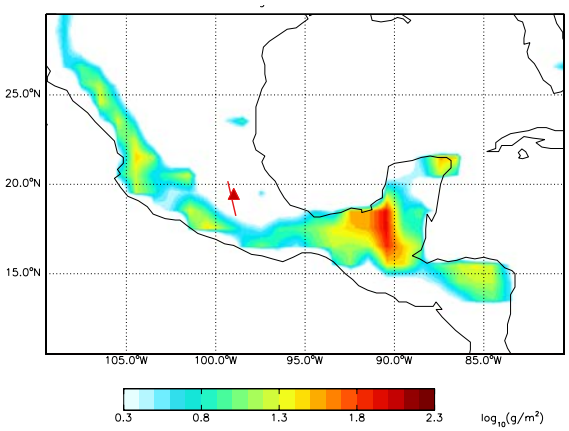




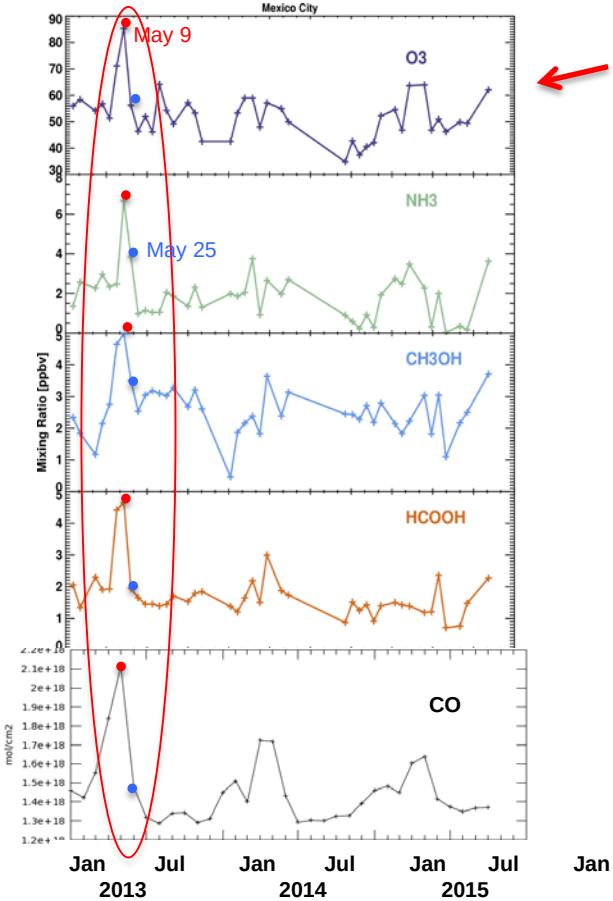


May 2013 – Analysis of Mexico City Observations

Biomass burning is strong over the Yucatan in the NH spring



Mean May GFED C emissions (1997-2010)

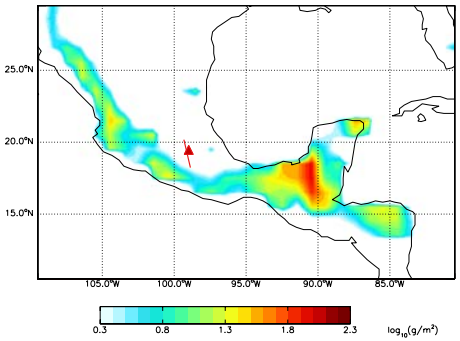


TES transect means

Concomitant biomass burning products (TES methanol, formic acid, ammonia) and CO (from AIRS) suggest that strong fires might contribute to pollution in the Mexico City area during the BB season

K. Cady-Pereira – Manuscript in preparation

May 2013 - Biomass Burning Effects?

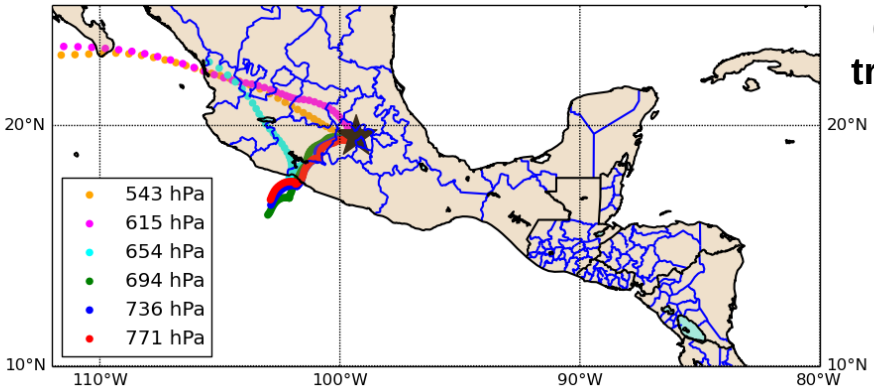


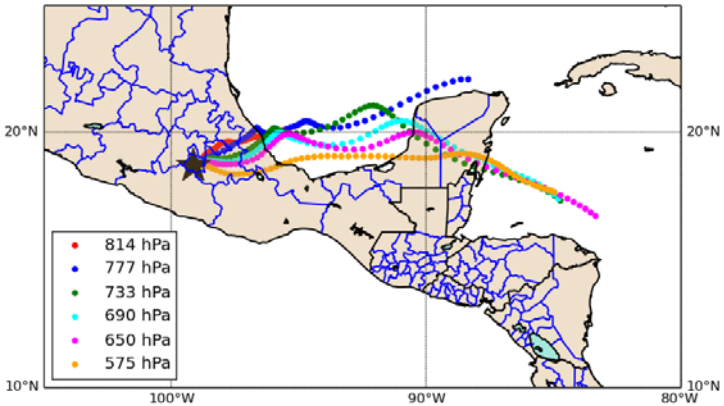
May 9

FIRMS fire counts

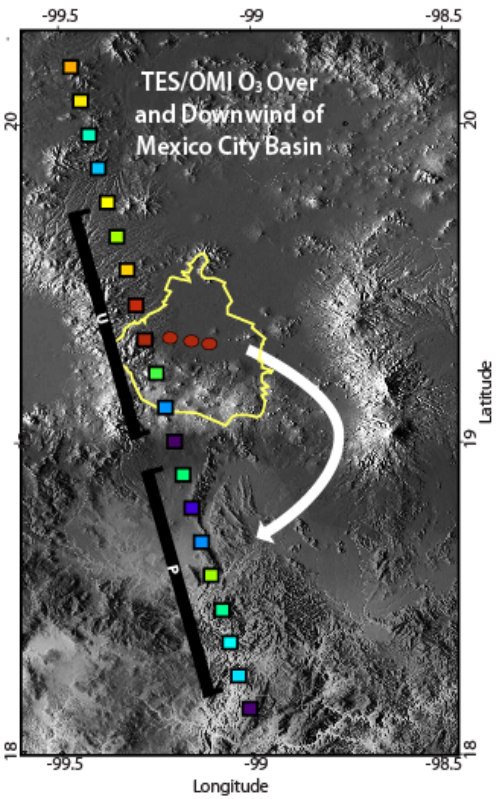
May 25

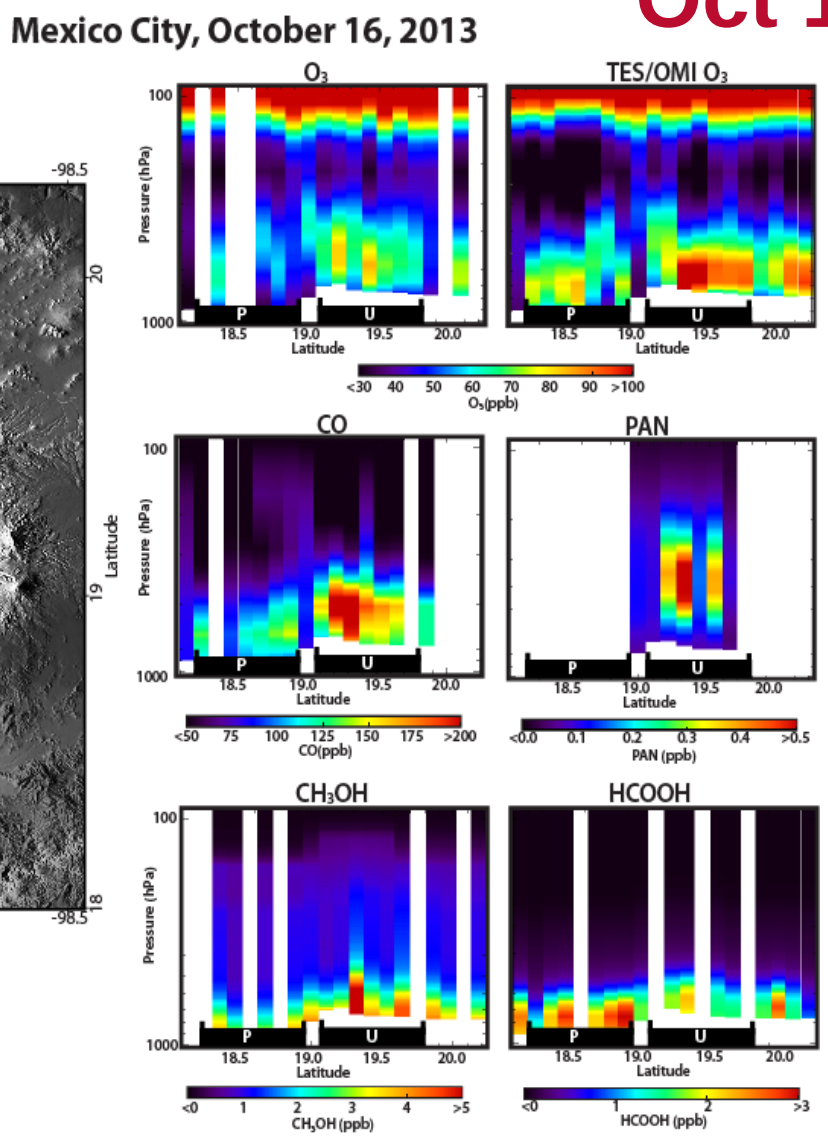
HYSPLIT four day back trajectories





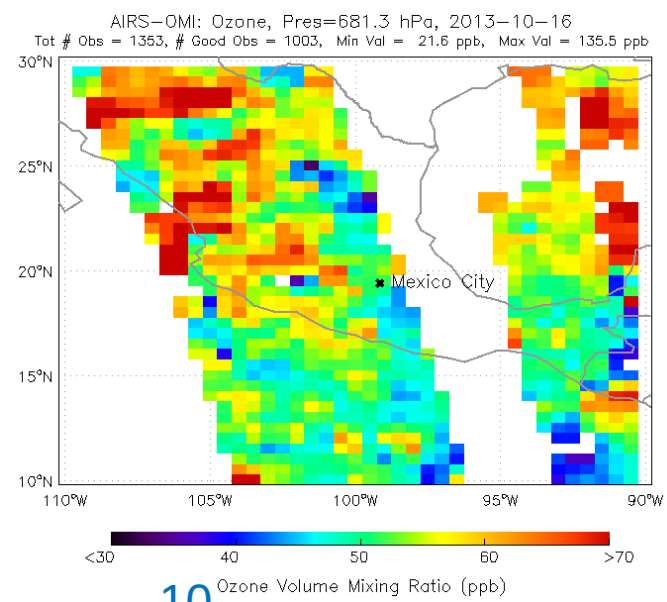
Observations Oct 16, 2013





TES Transect for Oct 16, 2013:

- TES O_3, TES-OMI, AIRS-OMI O_3, CO, PAN, methanol and formic acid
- Surface data
- AIRS CO
- MODIS AOD
- OMI NO_2



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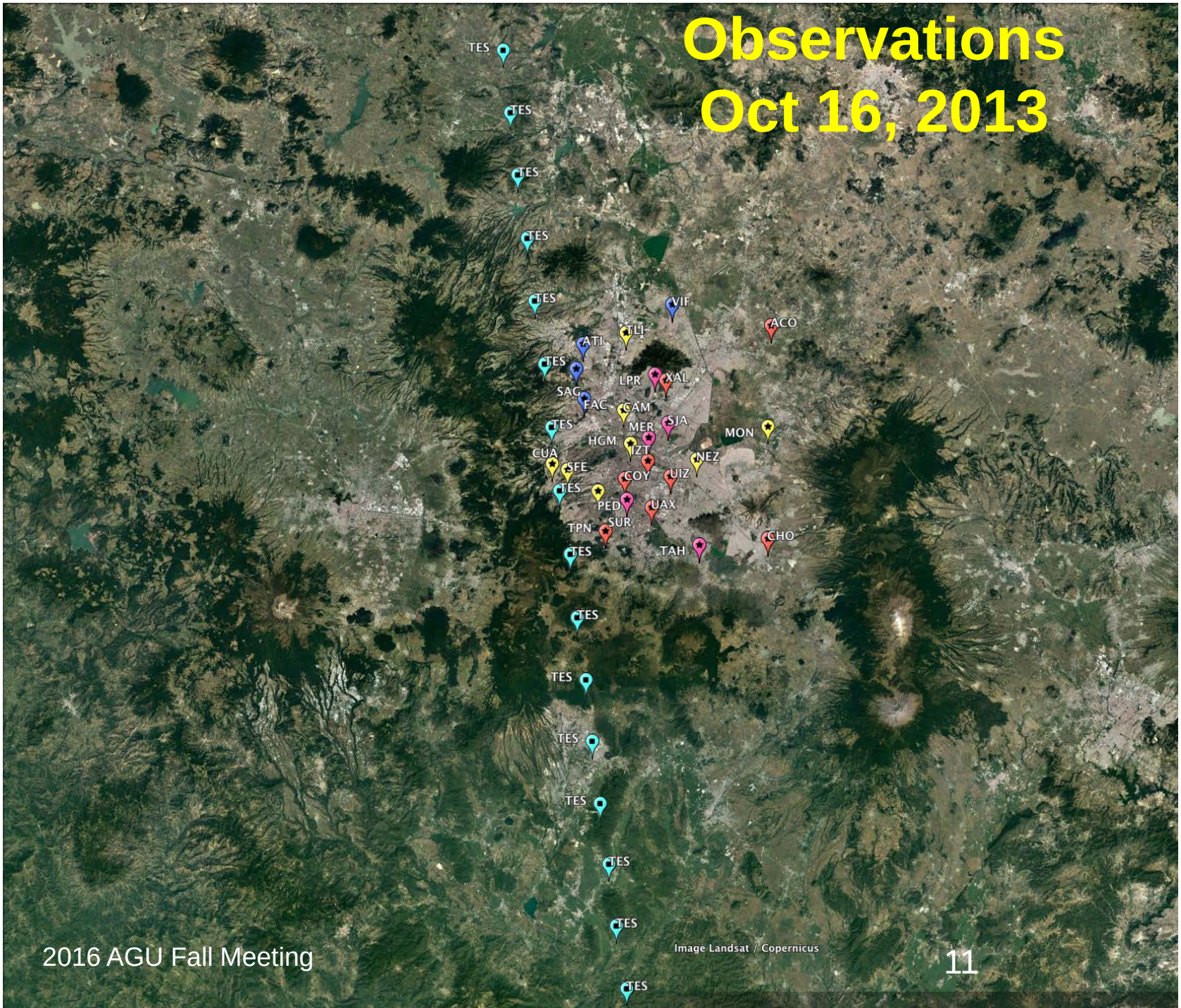

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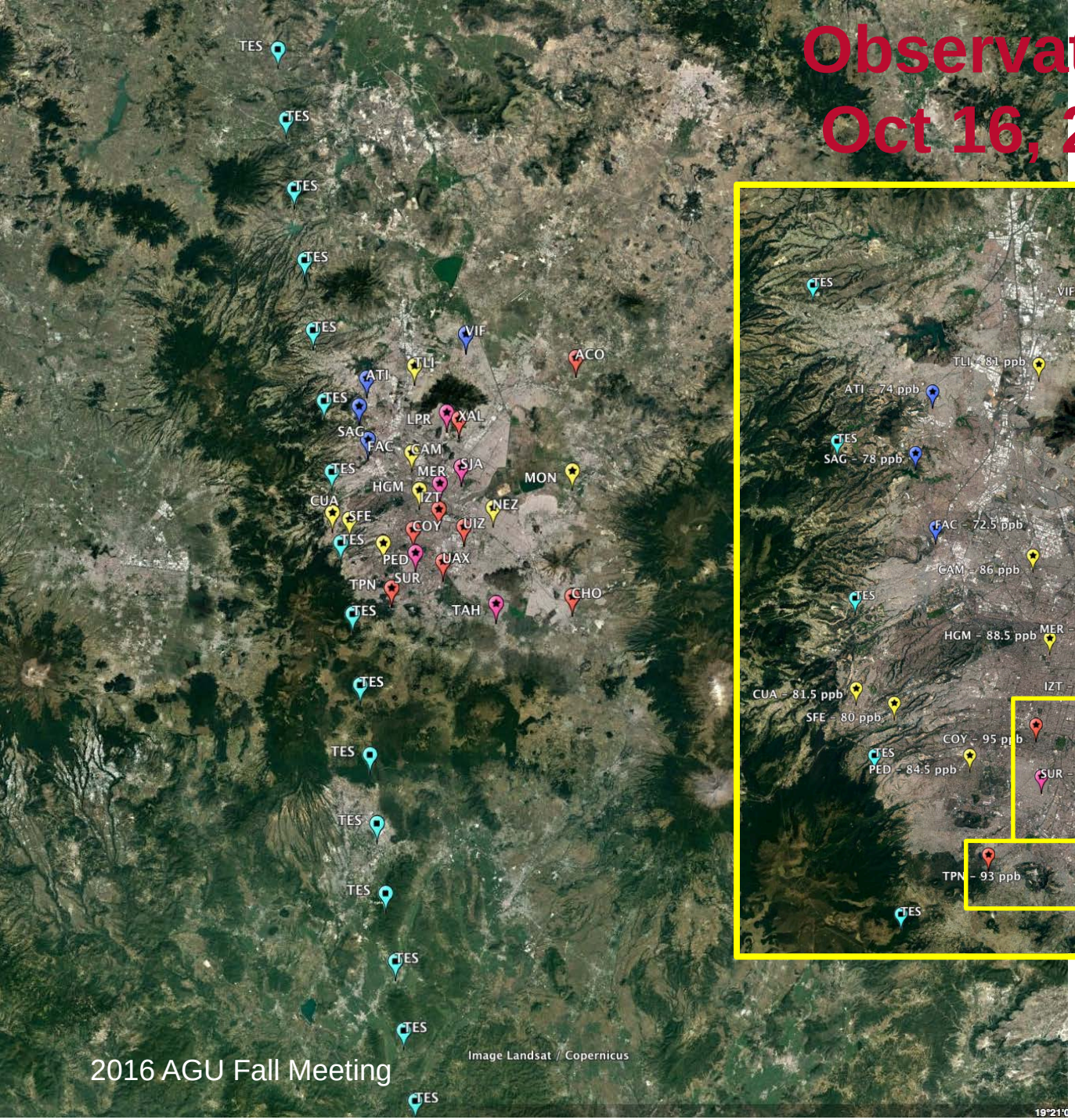

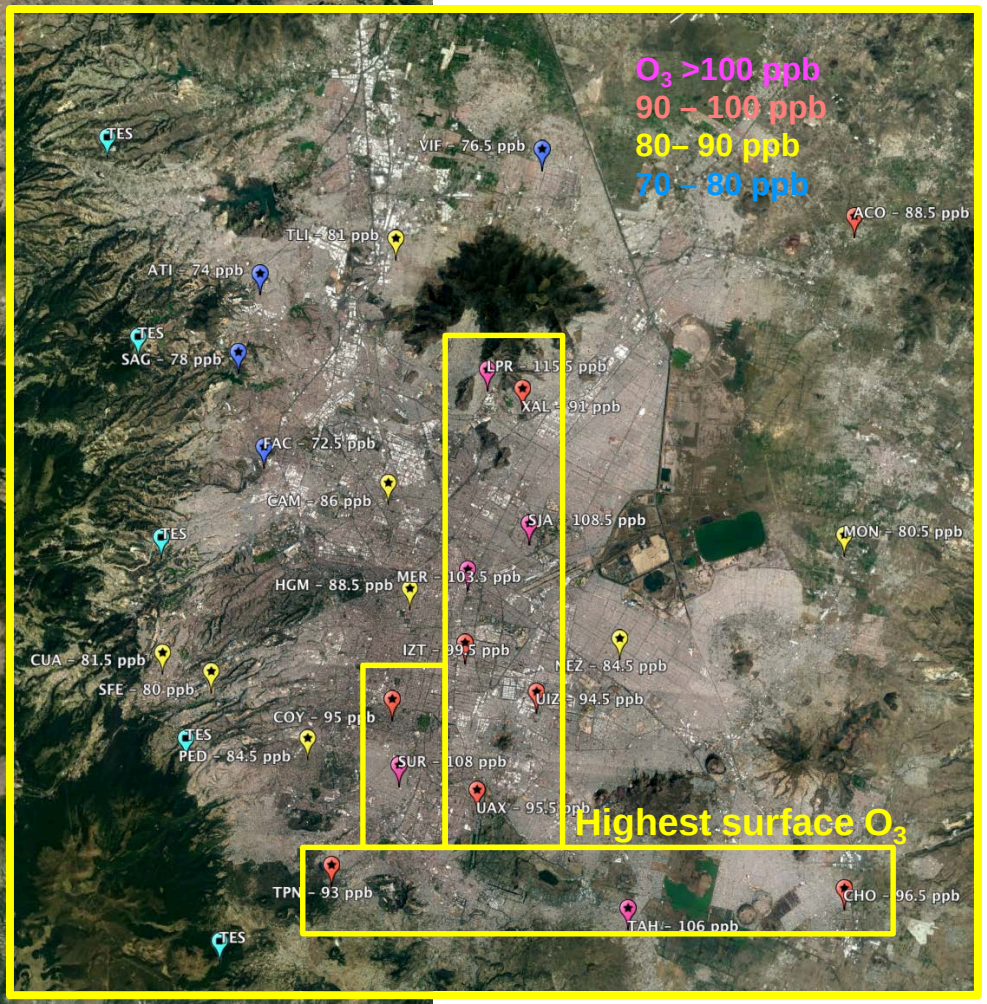

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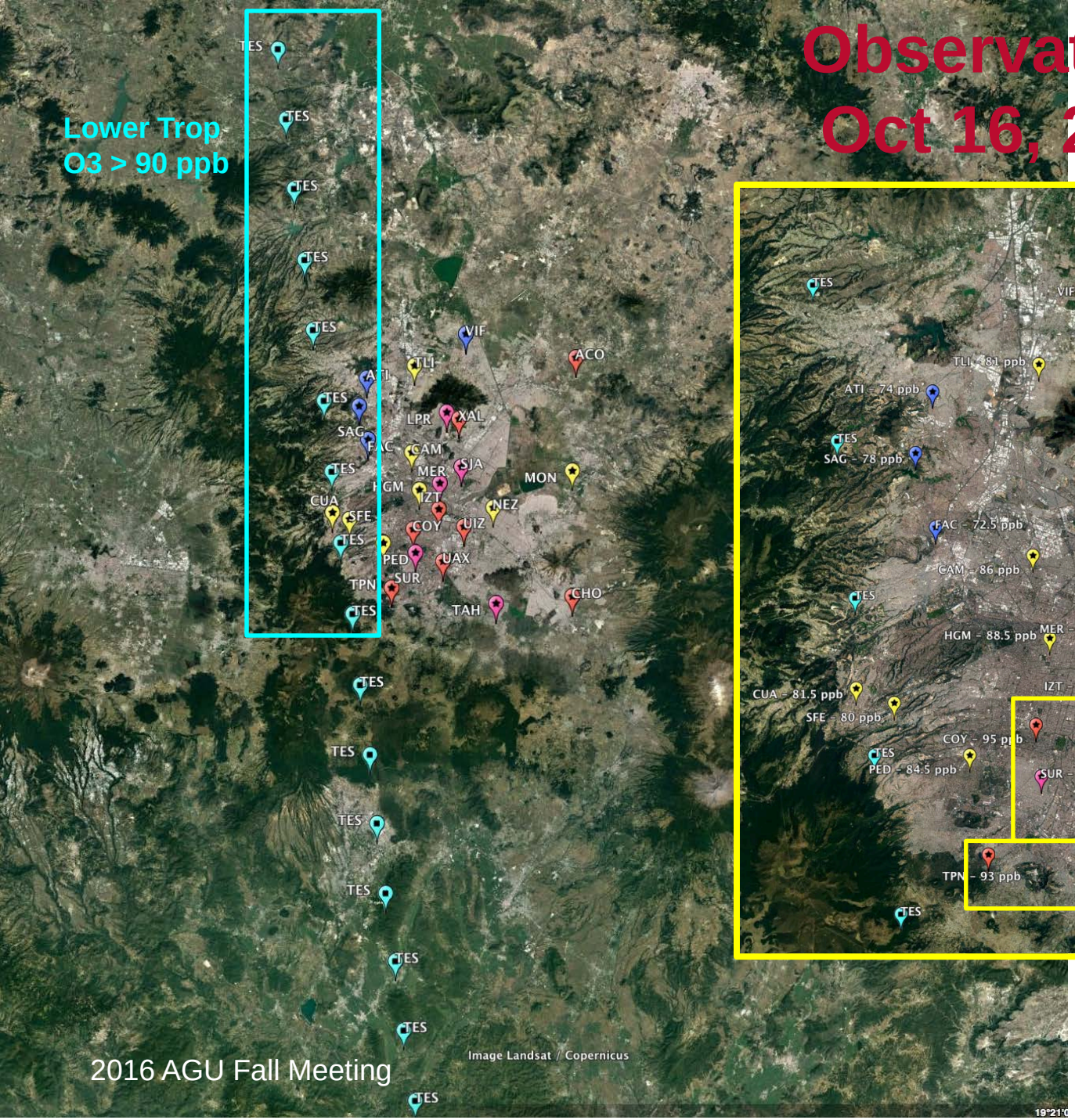

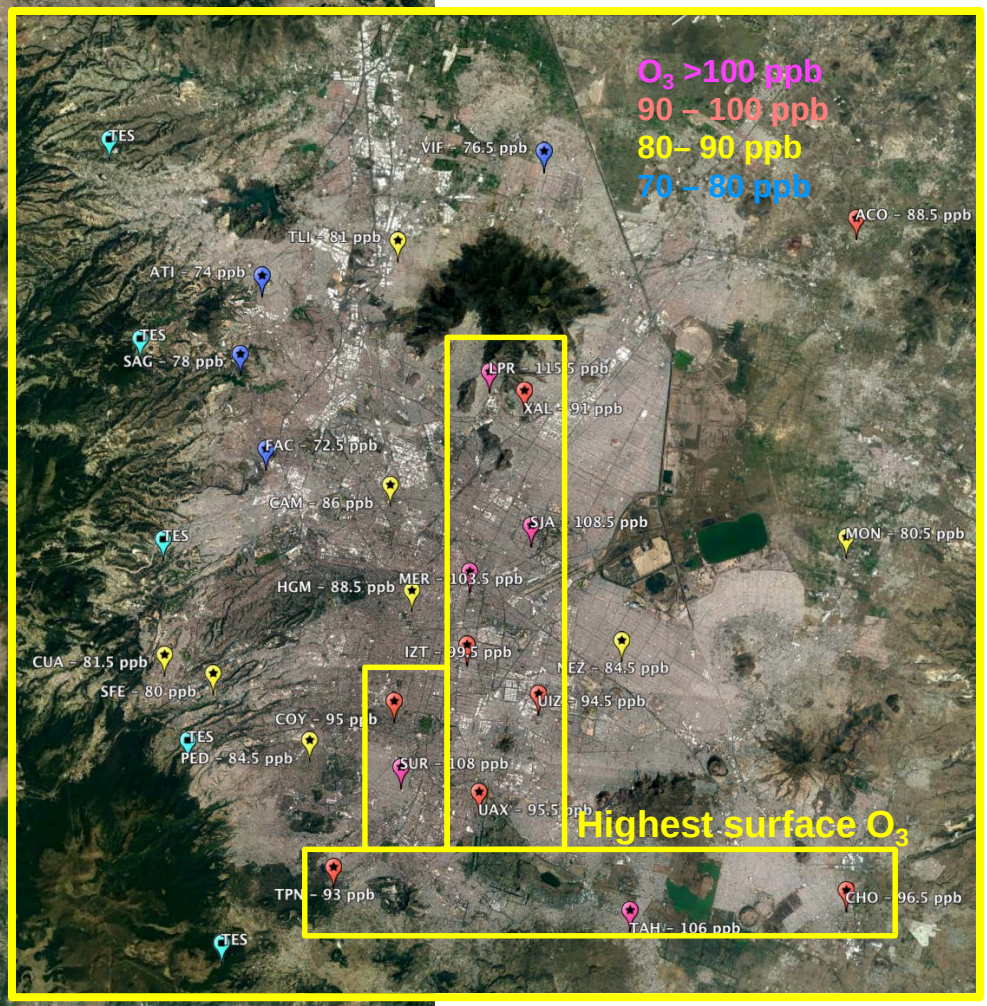

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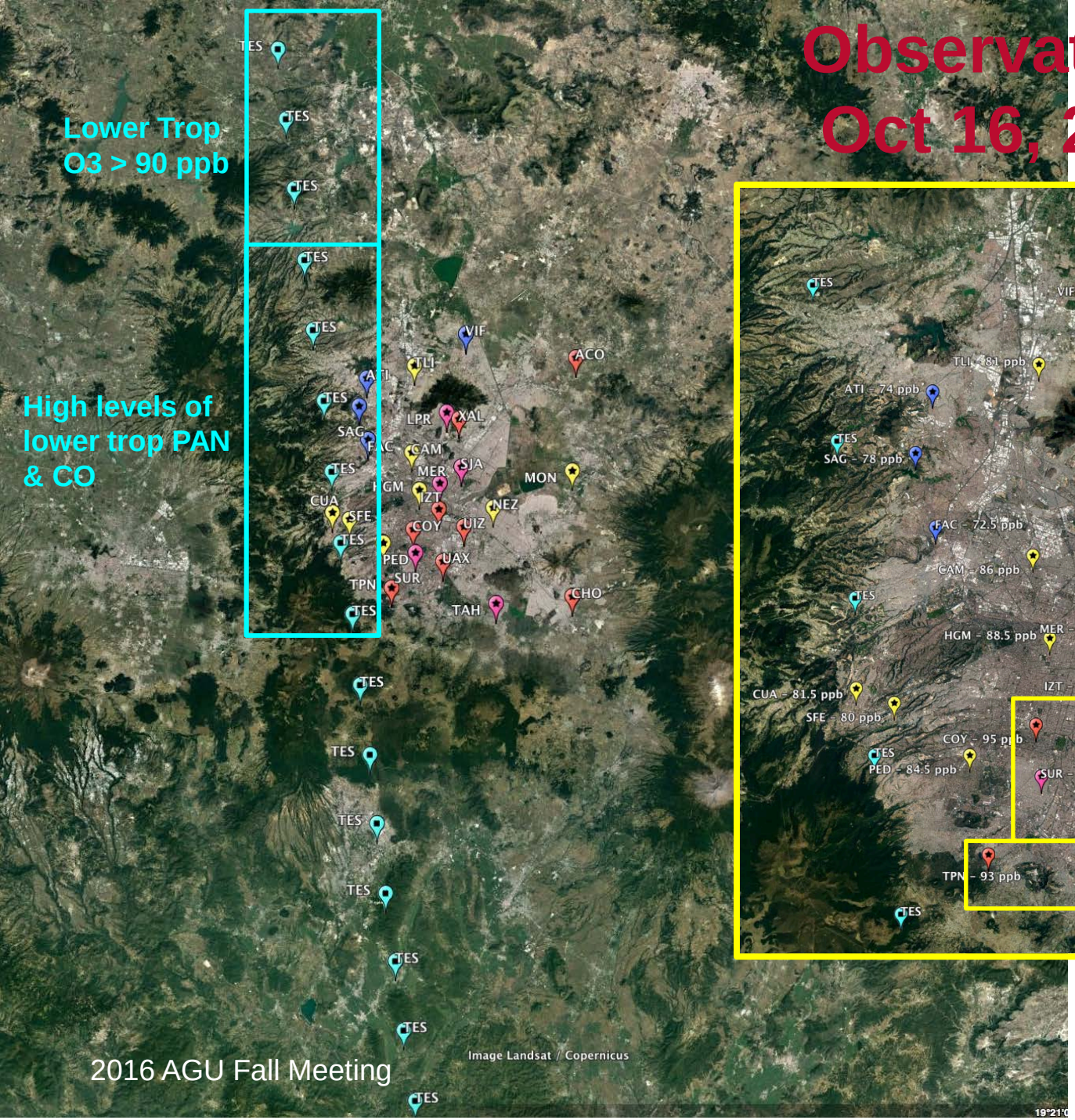

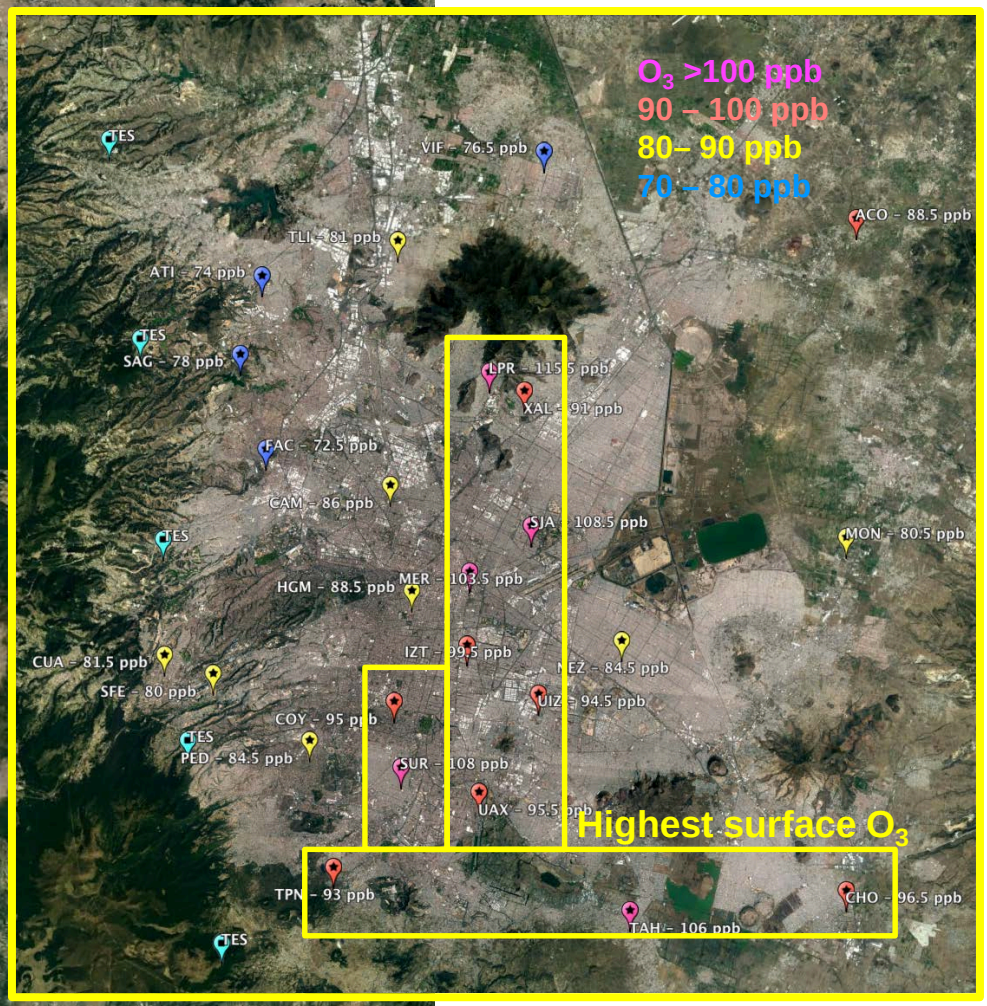

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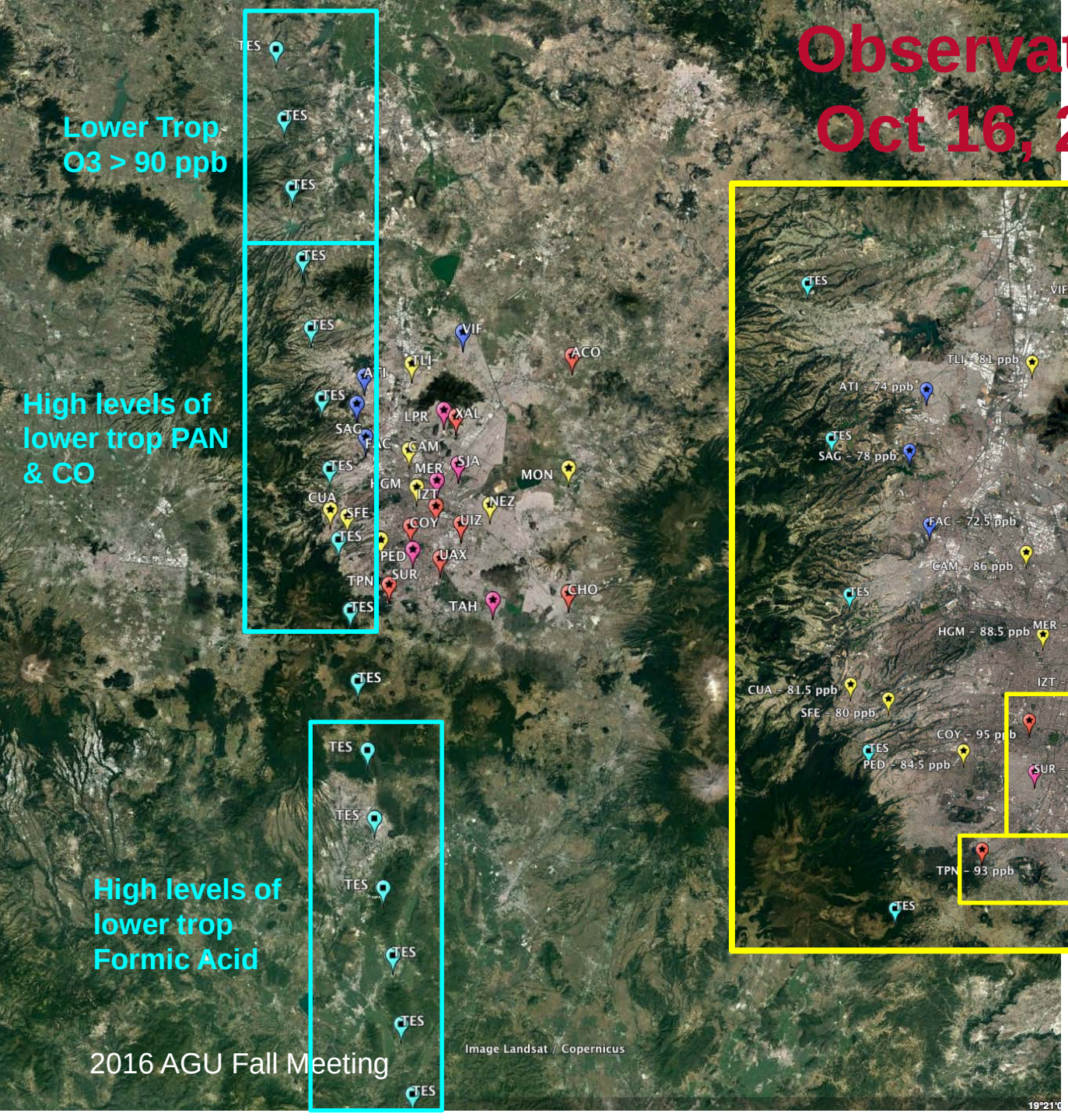
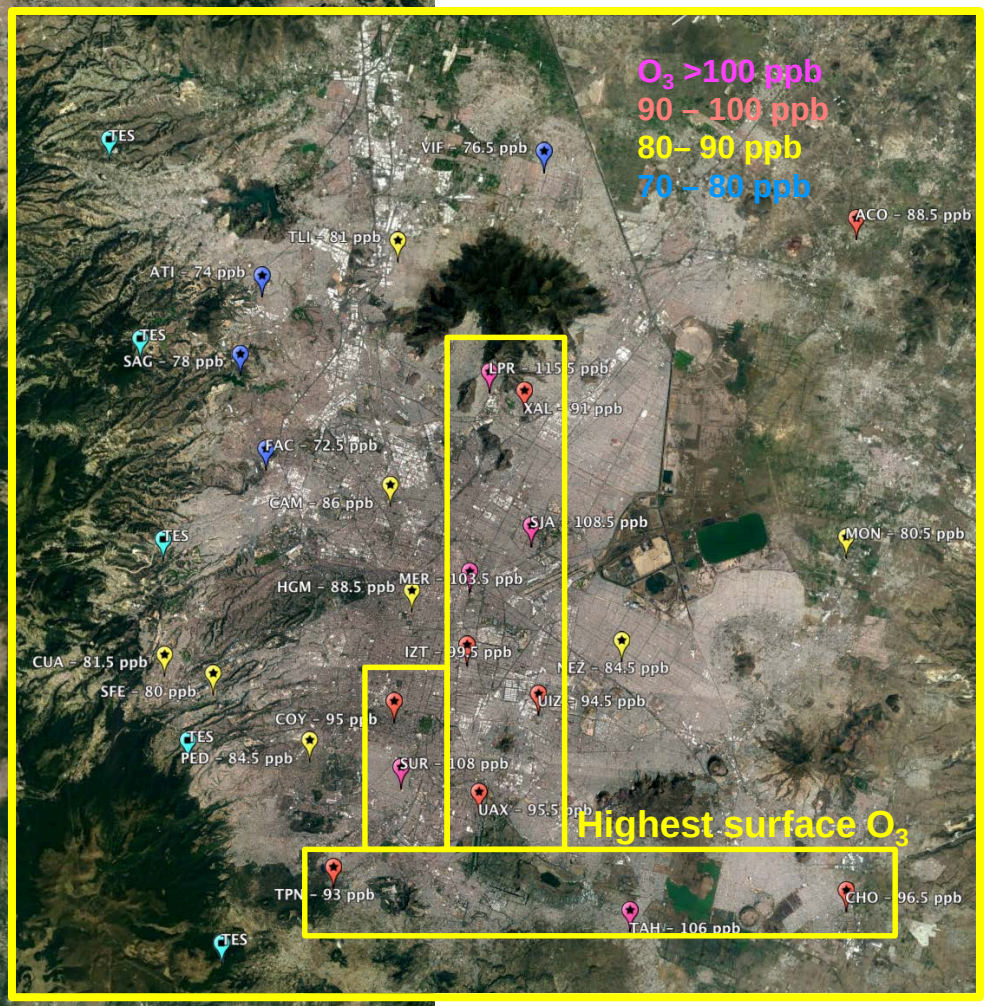
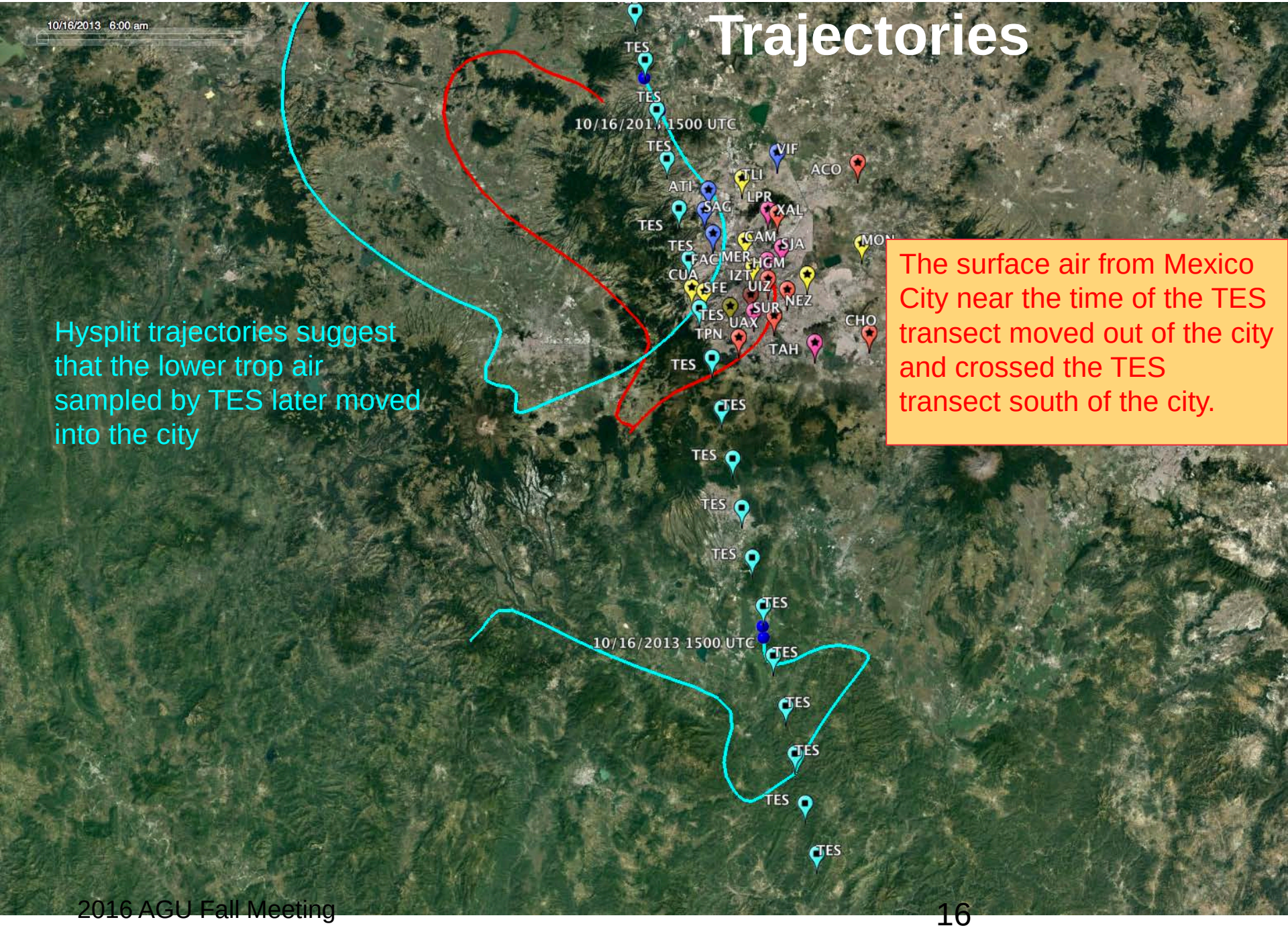




Trajectories

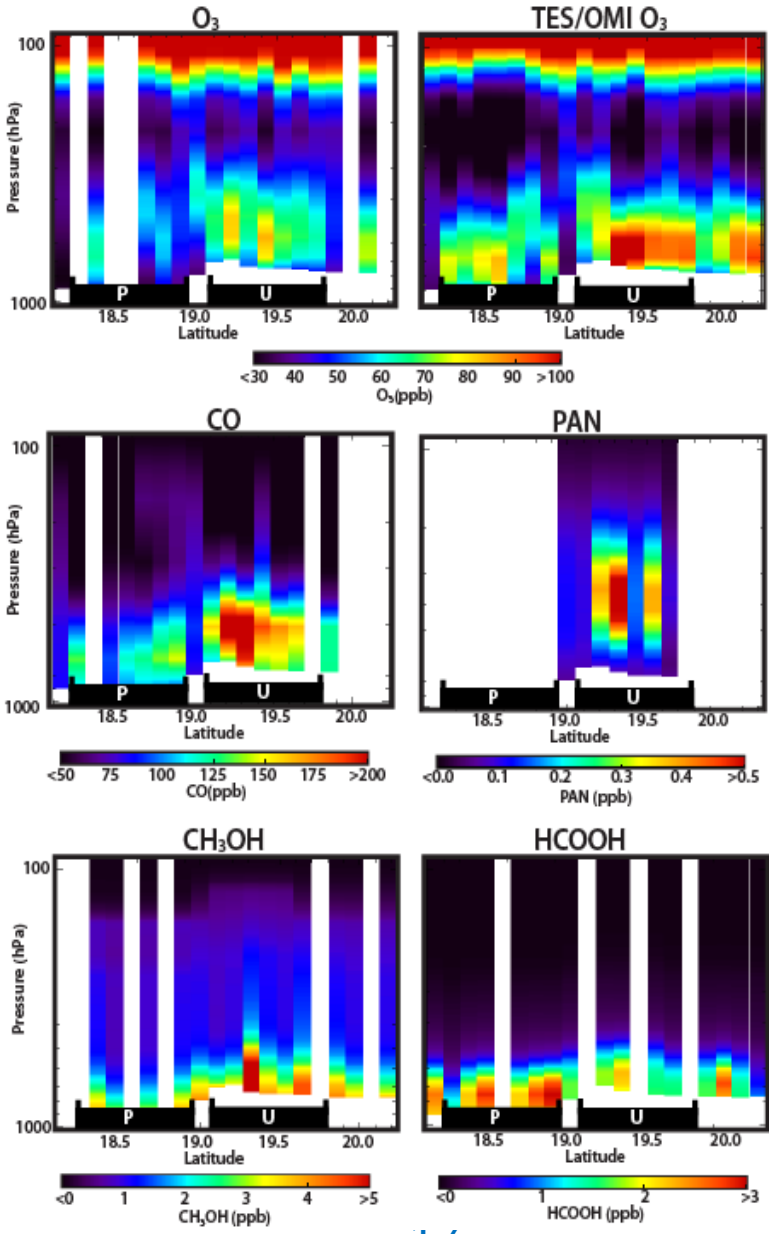


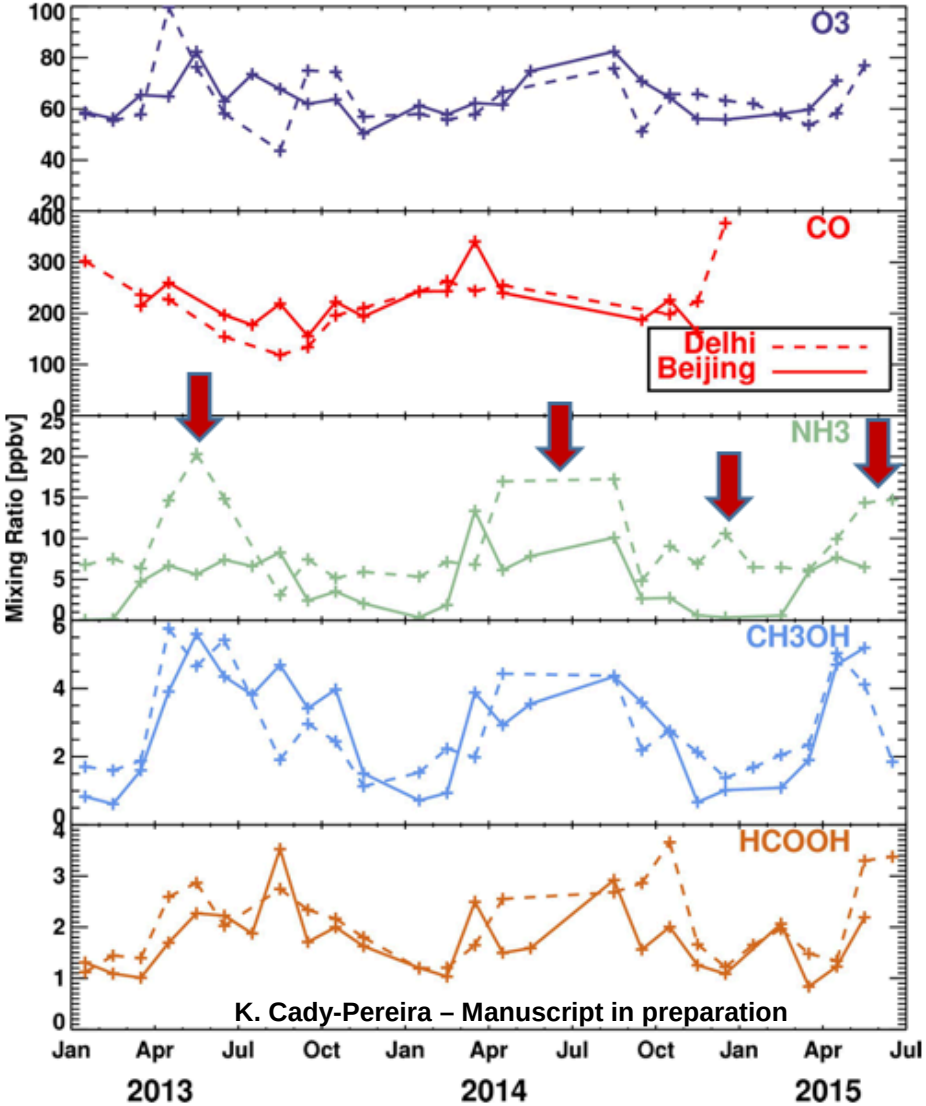
Hysplit trajectories suggest that the lower trop air sampled by TES later moved into the city

The surface air from Mexico City near the time of the TES transect moved out of the city and crossed the TES transect south of the city.

Summary and Questions

- TES began targeted observations of 19 megacities in Jan 2013 in response to instrument aging
- The joint TES/OMI near-surface ozone product shows significant ozone (~120 ppb)
- Ozone precursors CO, methanol, and formic acid are also elevated, as is PAN (a nitrogen reservoir)
- TES intersects the urban plume as it is transported out of the city.
- Most trace gases are diluted in the plume, but formic acid concentrations are higher than in the city
  - ➢ Could indicate secondary production from organic aerosol
- PAN drives ozone production far from source regions, so the large PAN concentrations suggest that Mexico City pollution may have larger-scale impacts



Future Work

- More analysis with the AIRS-OMI data (suggests high ozone to NW of Mexico City)
- Other data sets: OMI NO_2, Aerosols, Boundary layer heights
- Modeling: Working with Gabi Pfister running WRF-Chem
- Examining other TES transects for Mexico City (K. Cady-Pereira manuscript shows examples of this)
- Comparing TES observations of Mexico City to other megacities (Example a comparison of Dehli and Beijing)