Application of Integrated Ozone Observing System to Houston-Galveston-Gulf Shore Region and Eastern Great Lakes Region

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Air Quality Applications Workshop

Potomac, Maryland

June 20, 2007

Application of Integrated Ozone Observing System to Houston-Galveston-Gulf Shore Region and Eastern Great Lakes Region

- Proposal submitted to EPAGEO Advance Monitoring Initiative (AMI)10/05
- AMI EPA Peer Reviewed Decisions to fund AMI – 12/05
- Project integrated at LaRC with larger effort supporting TEXAQS II

Approach and Benefit

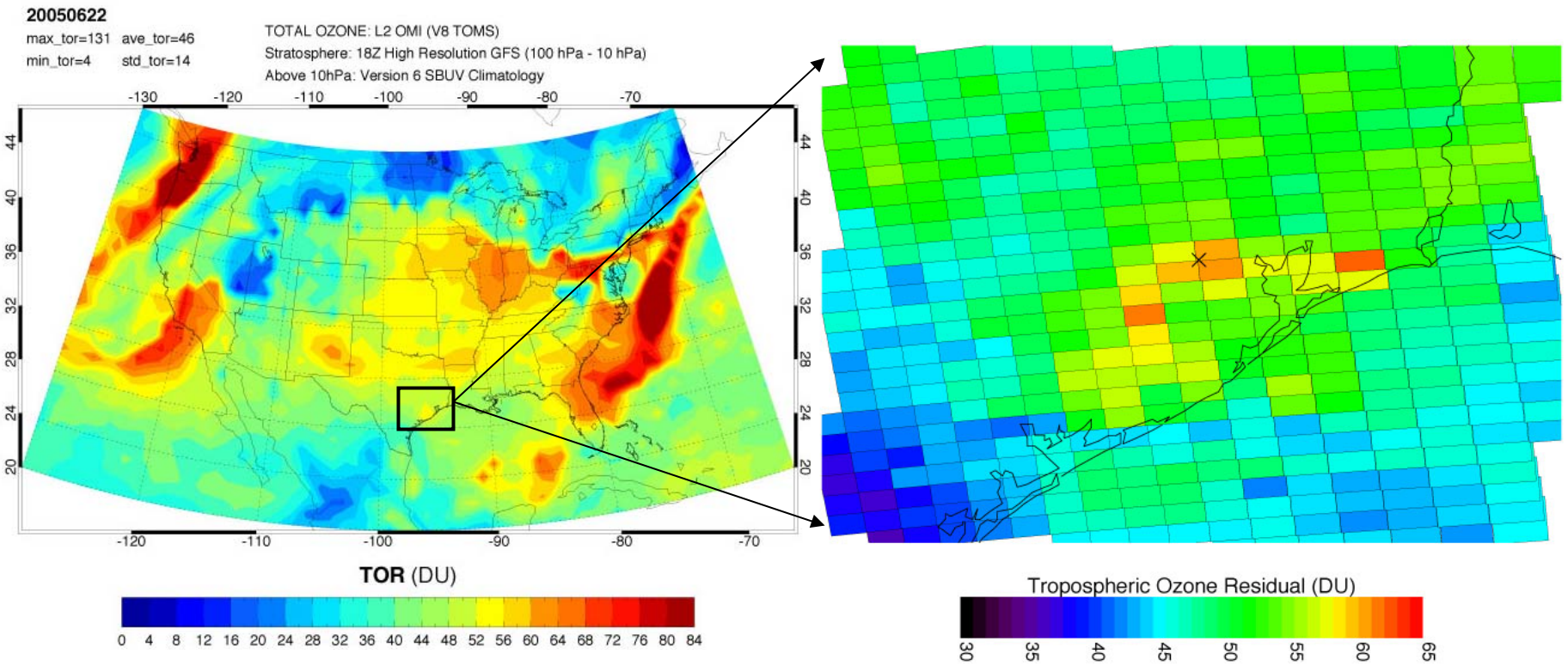
- Develop and test a methodology for use of satellite derived tropospheric trace gas measurements for air quality assessments. Focus on Houston and Western New York which are both non-attainment for ozone.

- Benefit to partner(s): Assessment of NASA models and satellite data for improved characterization of regional ozone events; and provide data for “weight of evidence” for SIPs and mid-course SIP adjustments.

Daily TOR Maps from OMI May Provide Insight into Regional Scale Tropospheric Ozone Distribution

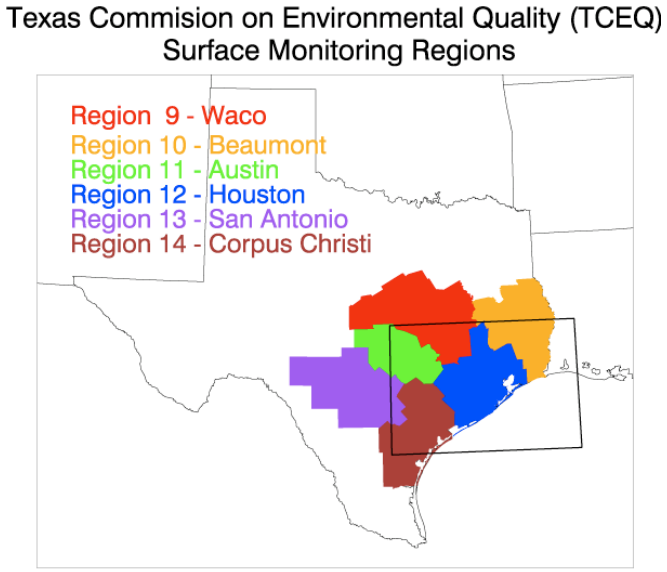
U.S. Distribution (100 km resolution)

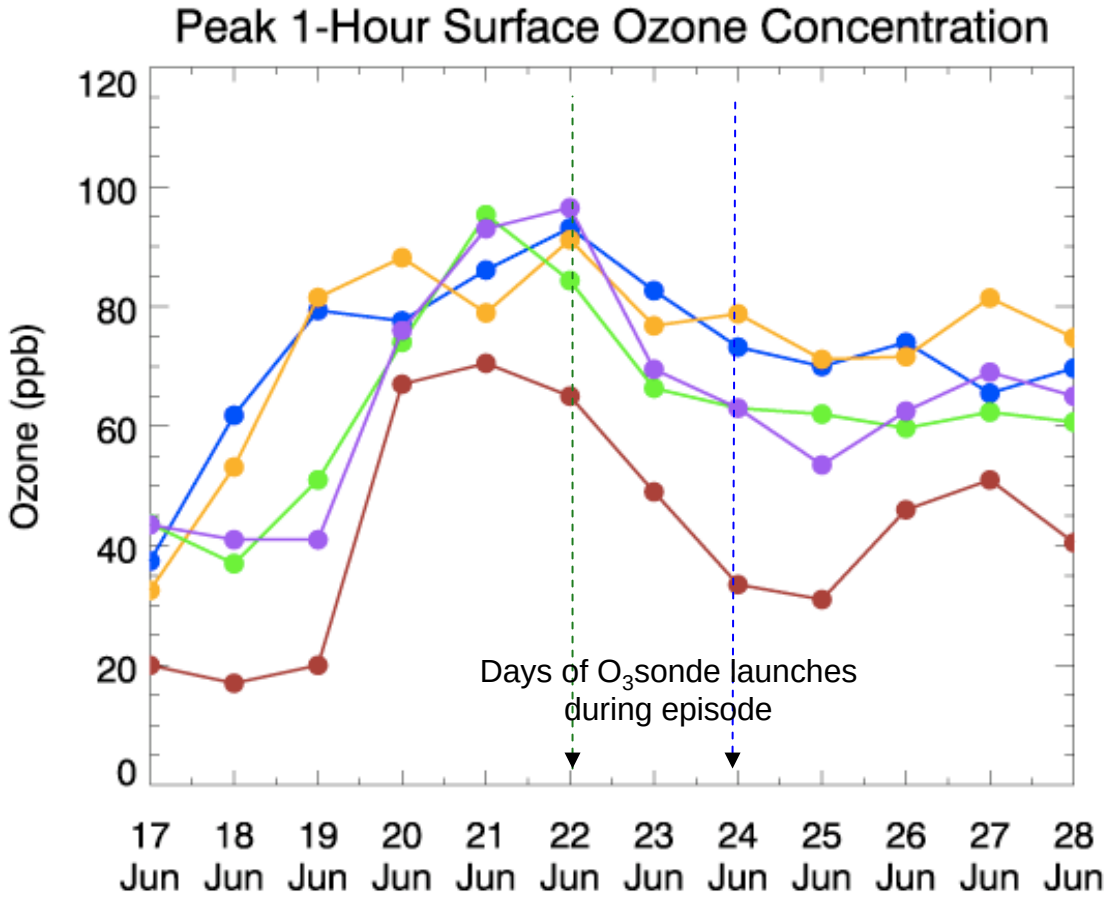
Distribution over southeast Texas (~22 x ~30 km resolution)



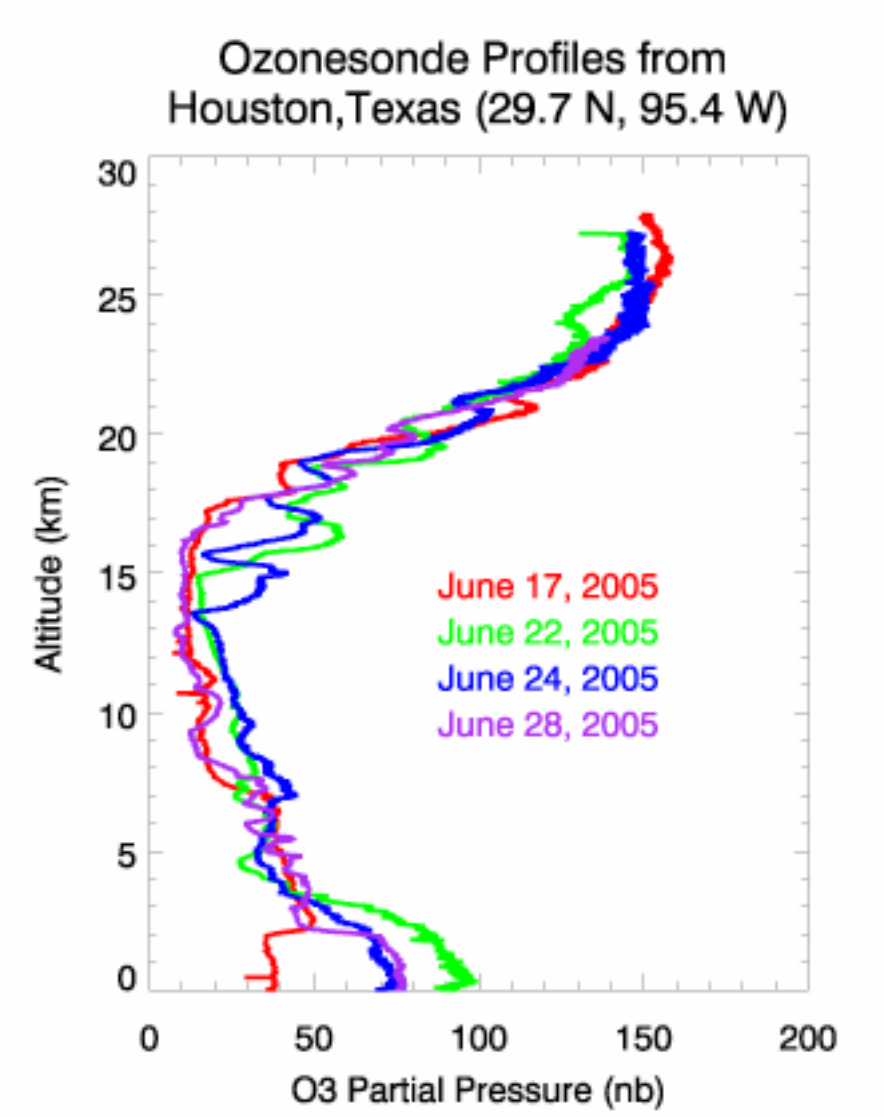
June 22, 2005

Regional Ozone Pollution Episode over Southeast Texas during late June 2005

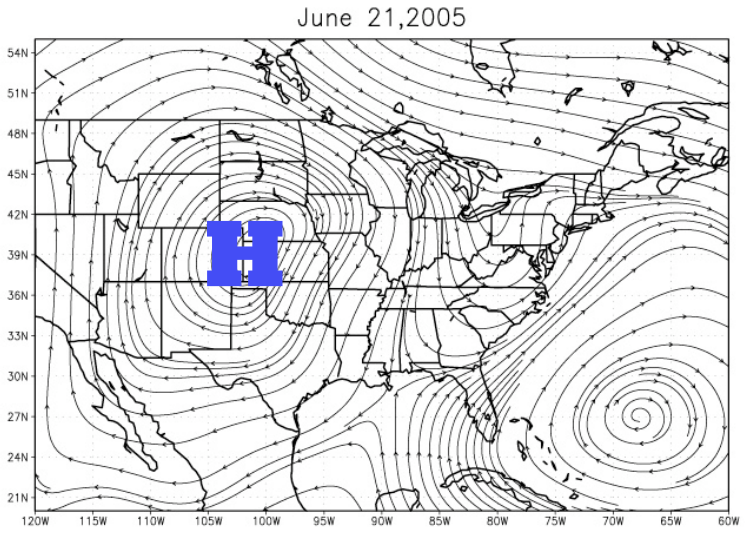


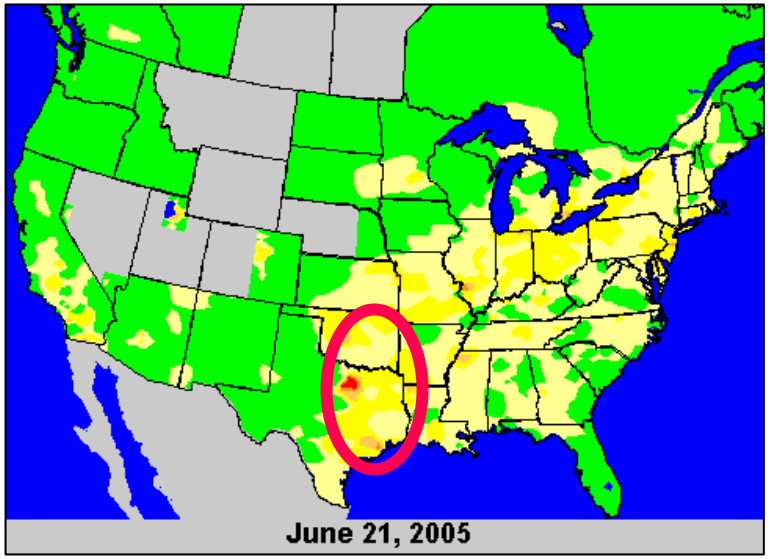


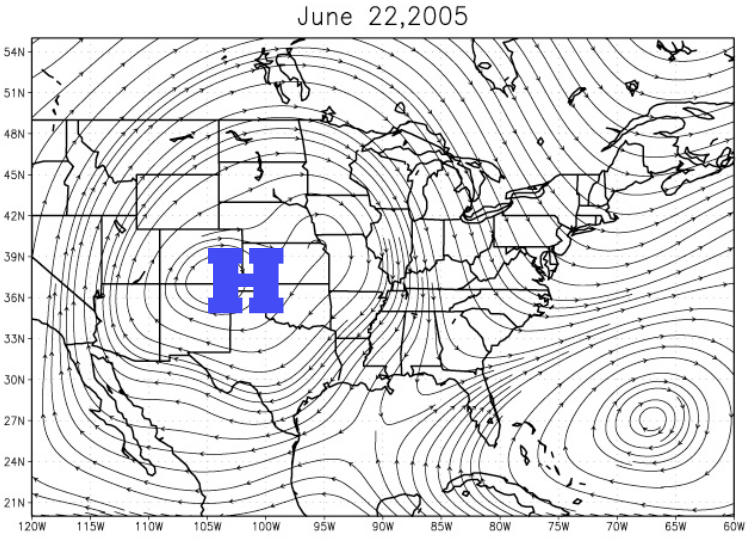
Ozonesondes Launched as Part of Aura Validation

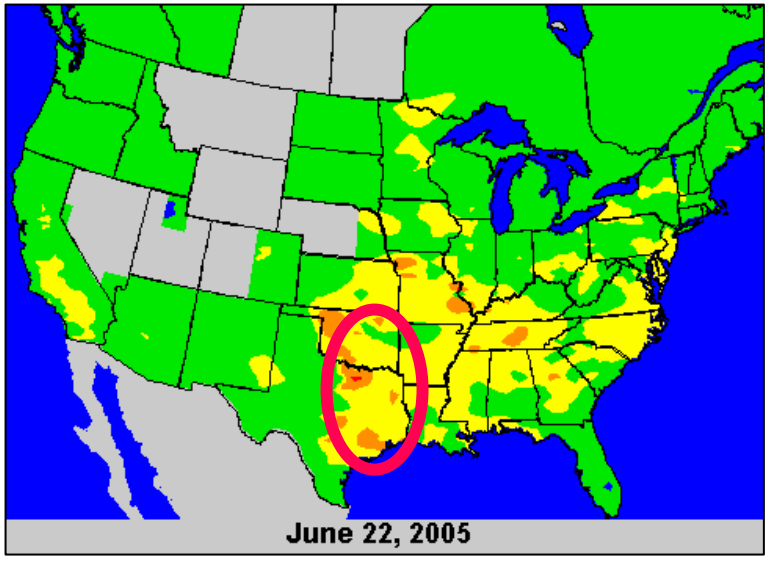


Favorable Conditions for Pollution Formation over East Texas During June 21-24, 2005

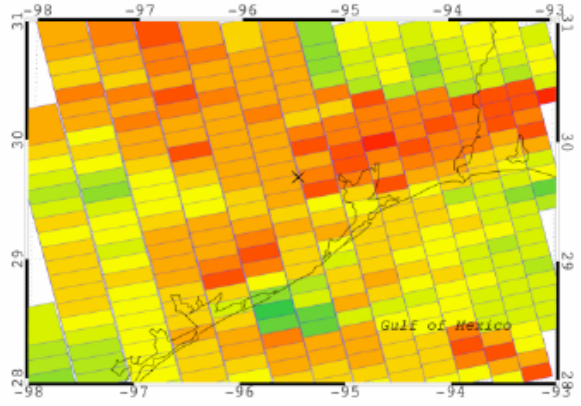




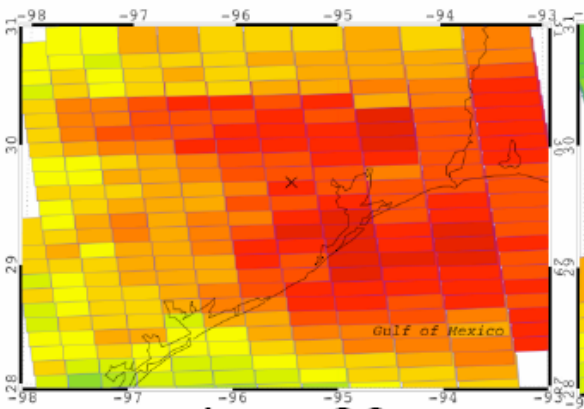




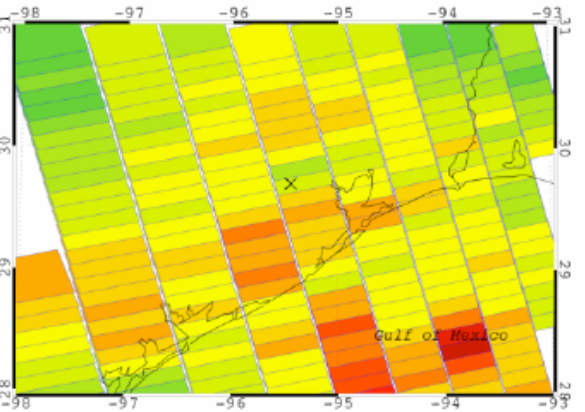
OMI/GFS TOR over Houston – June 2005



June 19



June 20



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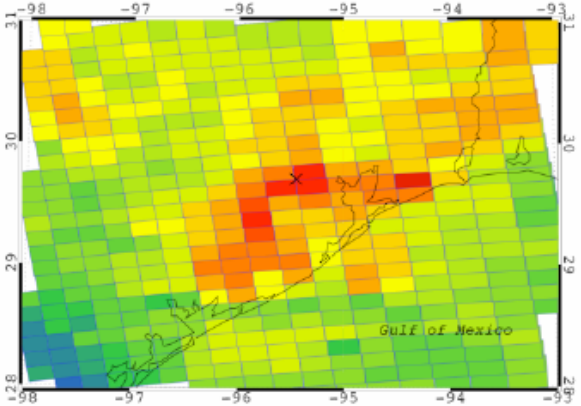
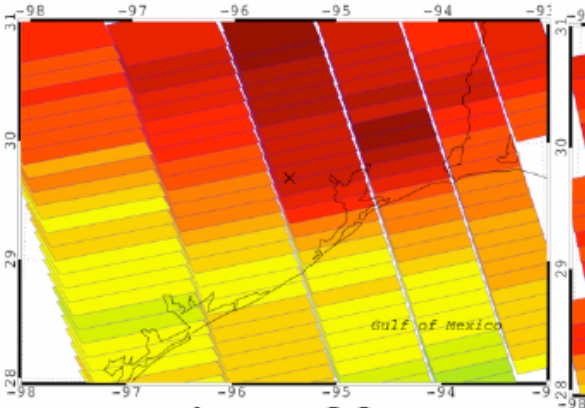


June 22



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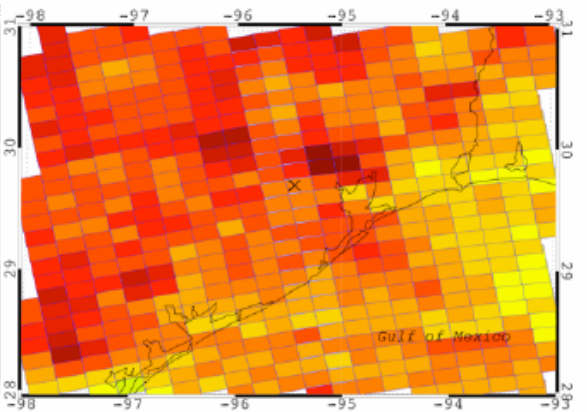
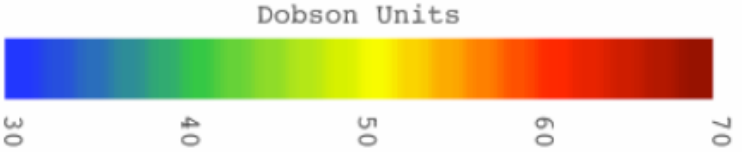
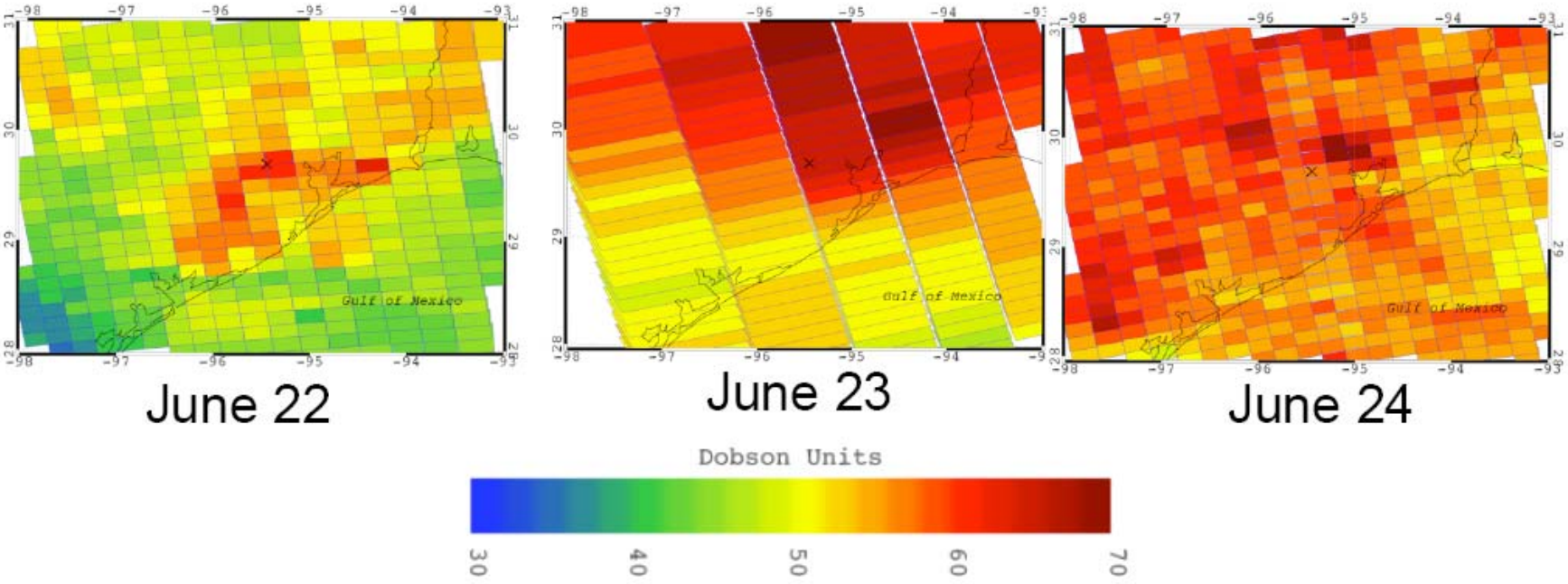


June 24

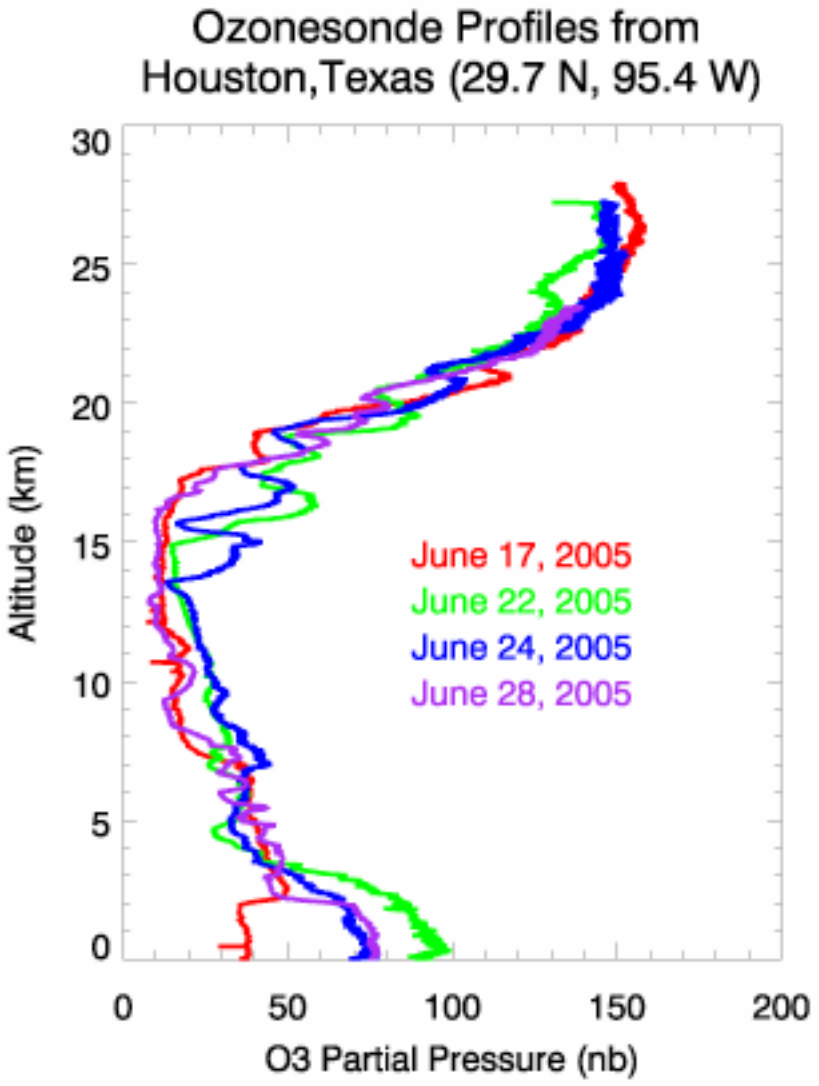


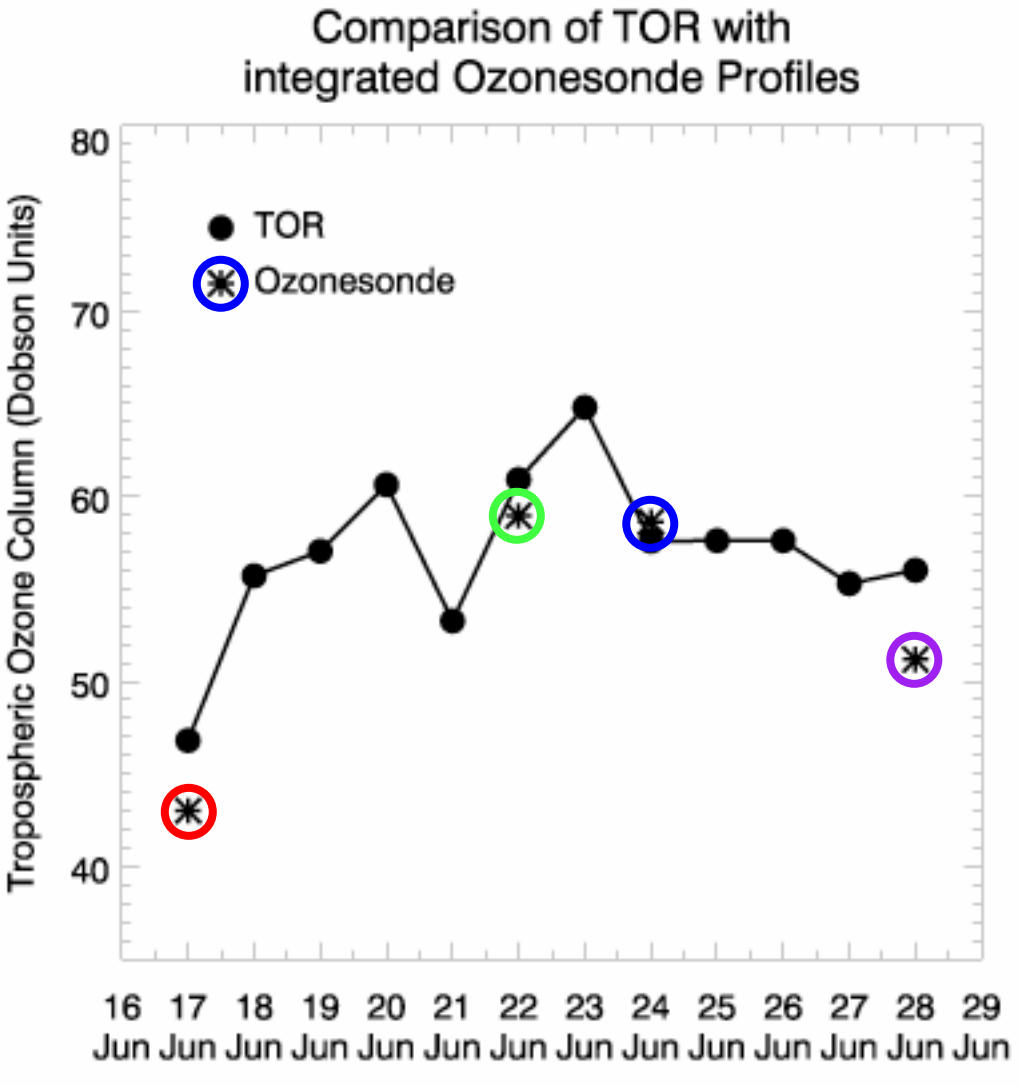
Variable OMI Pixel Size Complicates Utility of Data



Good Agreement with Few Available Ozonesonde Measurements

But Does It Tell the Whole Story?



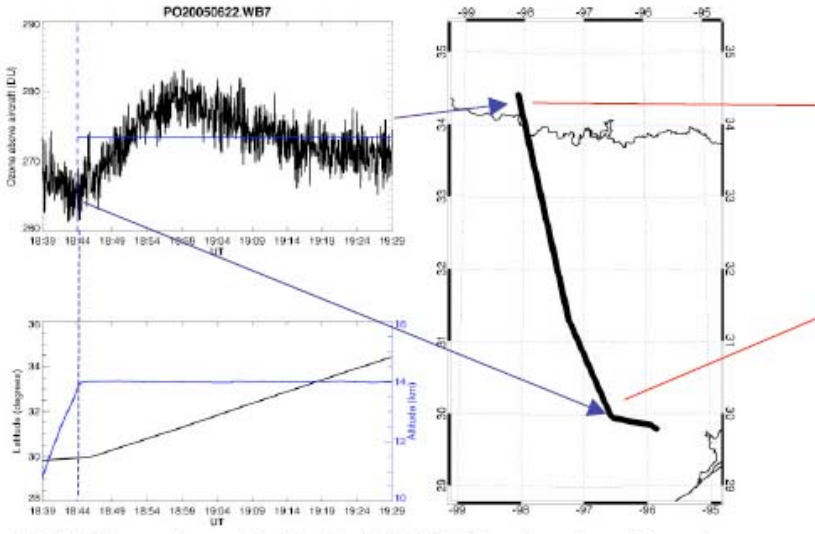


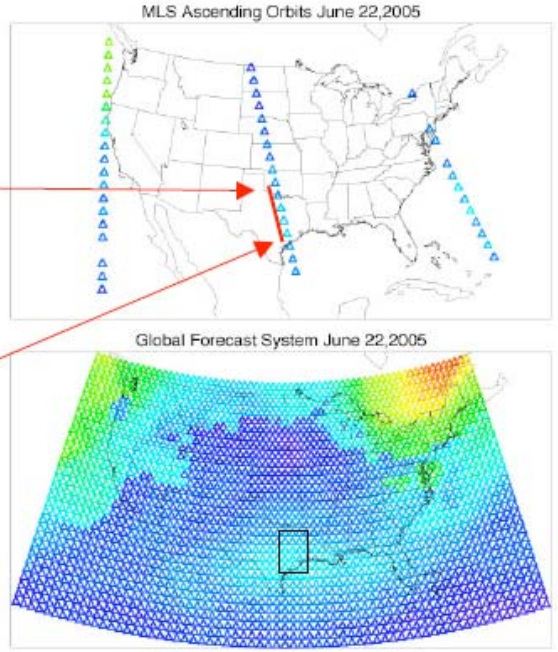
Upward-Looking Ozone Column Measurements Confirm Small Stratospheric Gradient

Data from CAFS* Instrument

Integrated O_3 above aircraft along flight path

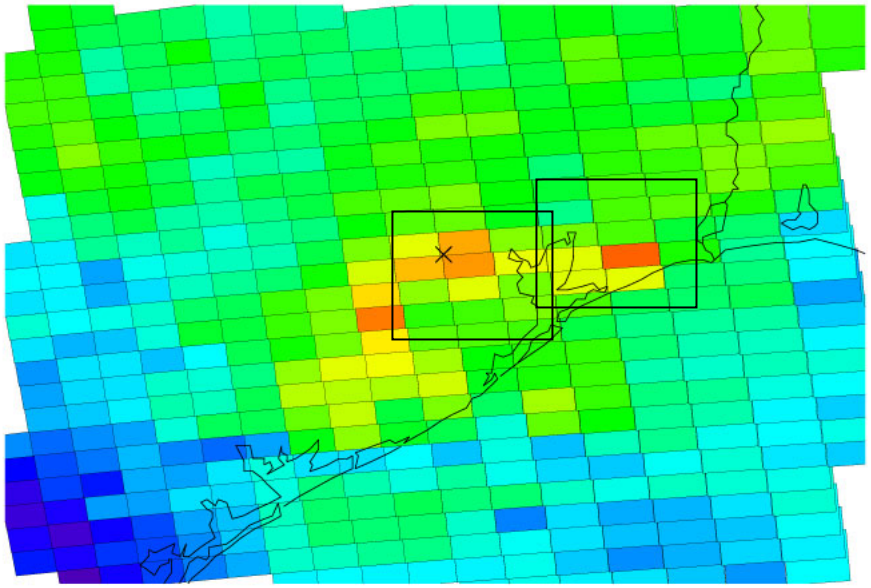
Flight path of WB-57

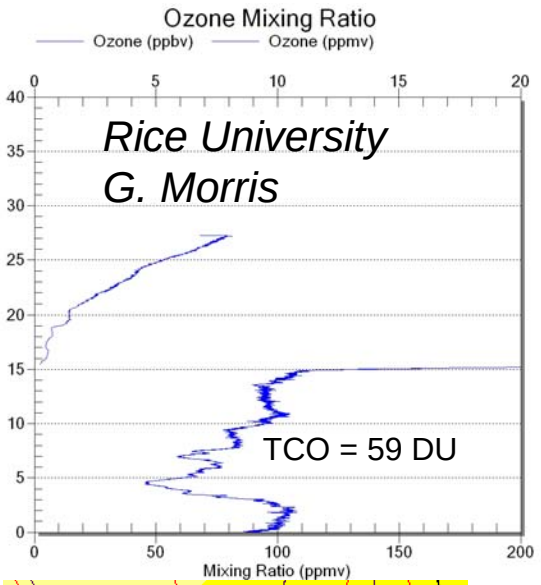




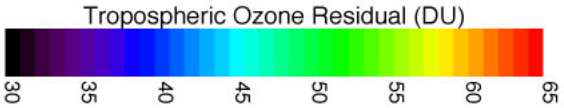
*CCD (charged-coupled device) Actinic Flux Spectroradiometer

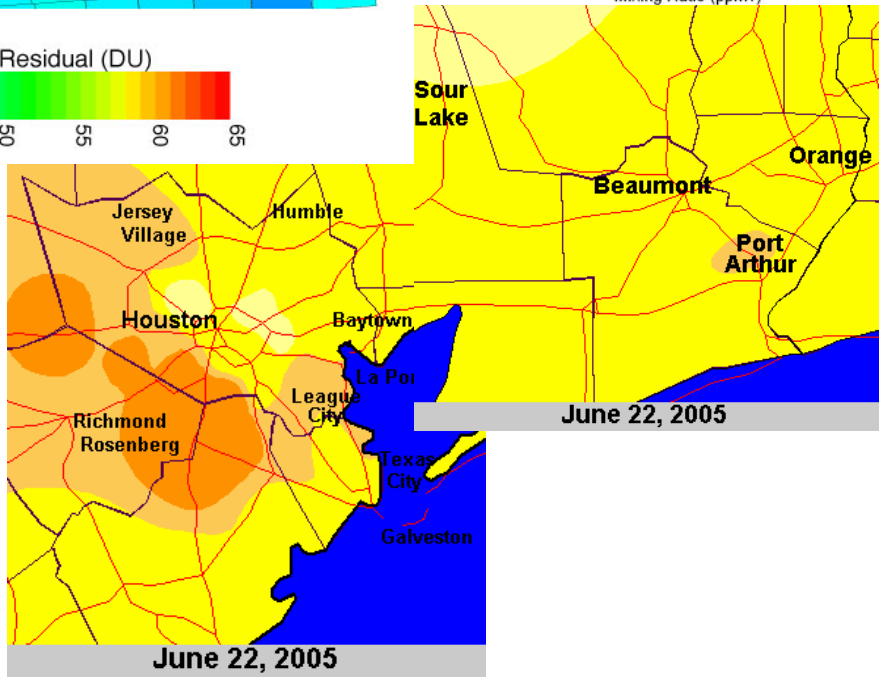
TOR Captures Mesoscale Ozone Structure in Houston Area

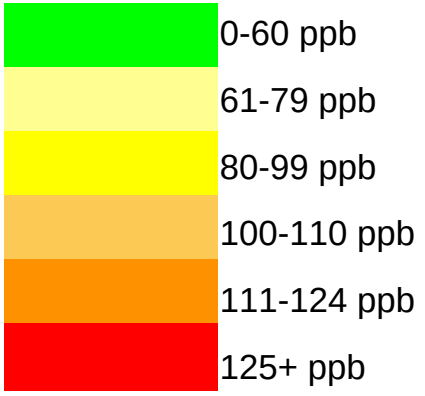




Ozonesonde confirms elevated O_3 in Houston on June 22, 2005





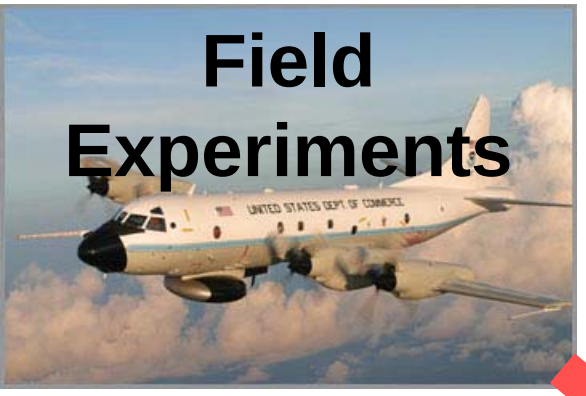


Integration of Ozone Data

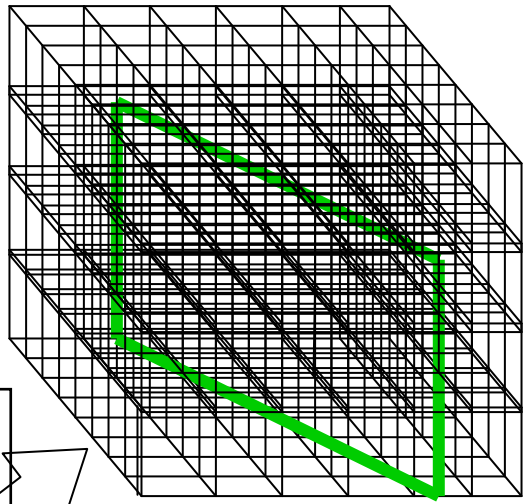
- Surface Measurements
  - Generally Only Available near Urban Areas
- Satellite Observations
  - Vertically Integrated Quantity
  - ***Relationship to Surface Concentrations not Completely Understood***
- Profile Measurements
  - Infrequent and Expensive
  - Generally Available only during Validation Campaigns

Method Developed for TexAQS II Applied to June 2006 NY Case Study Period:

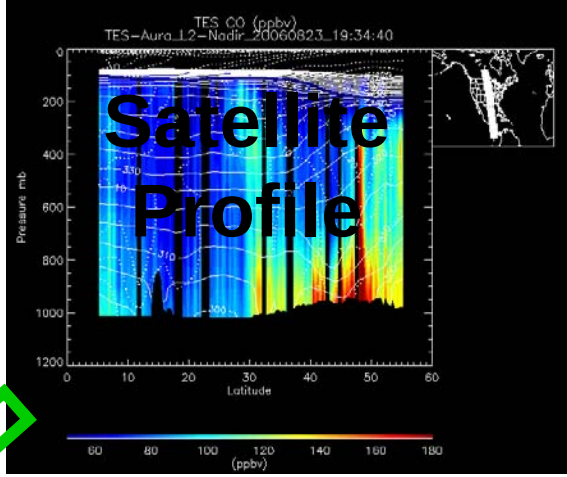
- **Surface measurements** are used to characterize receptor region and verify model forecasts on local scale
- **Satellite measurements** are used to quantify source strengths and verify model forecasts on a regional to global scale.
- **Ensemble Lagrangian trajectories** are used to identify remote source regions. Trajectories sample forecasted chemical fields to understand chemical transformation during transport.



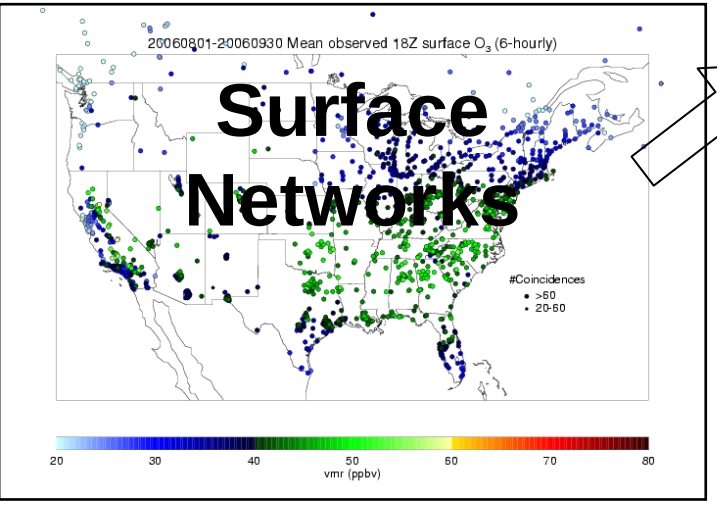
Local Characterization



3D Model
Trajectory Model

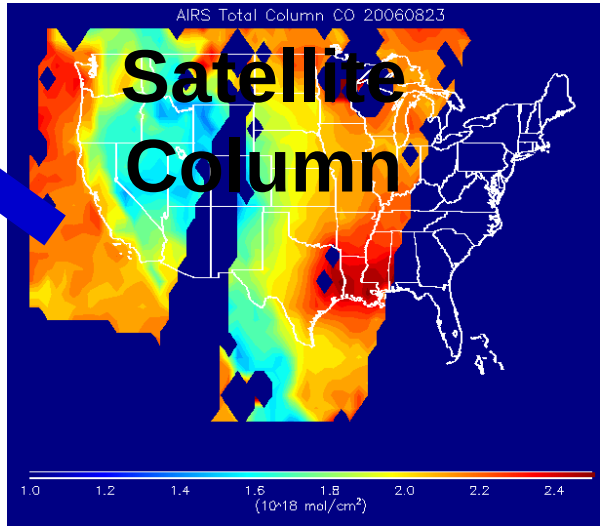


Vertical Structure



Regional Characterization

Analysis and Prediction

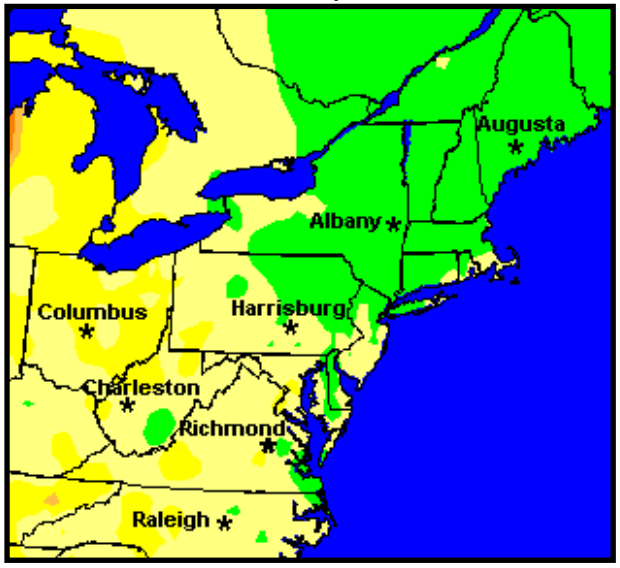


Column Abundances

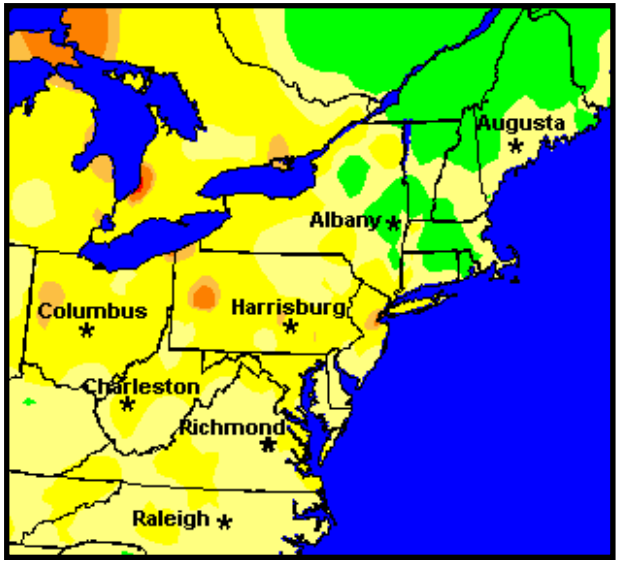
Use chemical/aerosol forecast models and trajectory analysis to link local airborne lidar and insitu observations within receptor regions (Texas) to satellite observations in source regions (CONUS)

June 2006 Eastern Great Lakes Case Study
Ozone: 1-Hour Average Peak Concentration

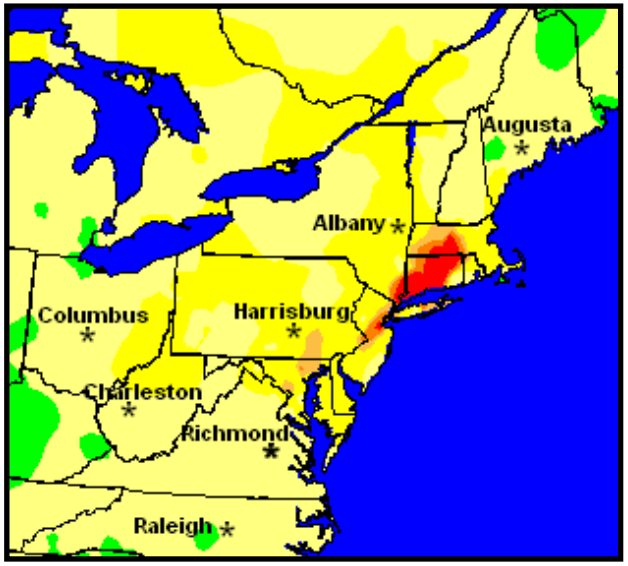
June 16, 2006



June 17, 2006



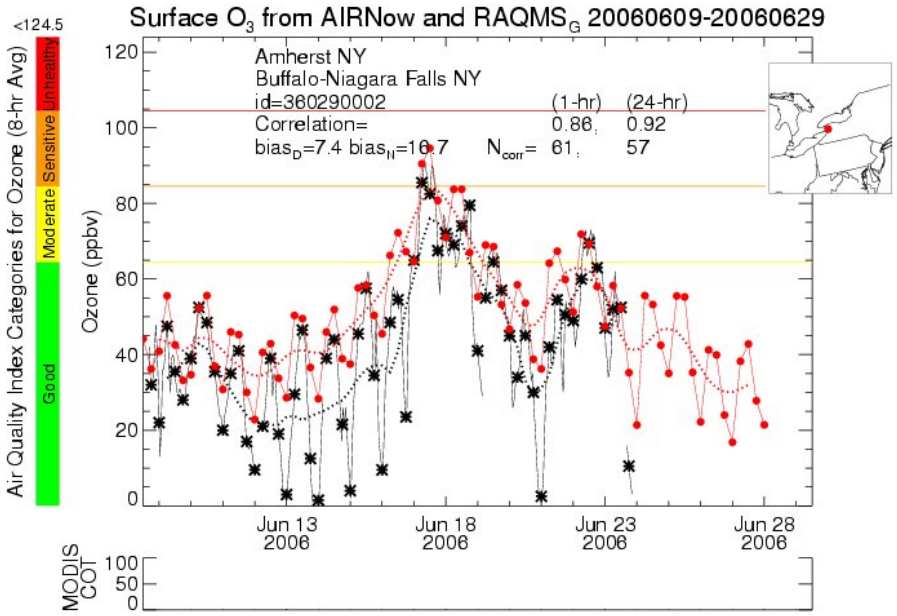
June 18, 2006

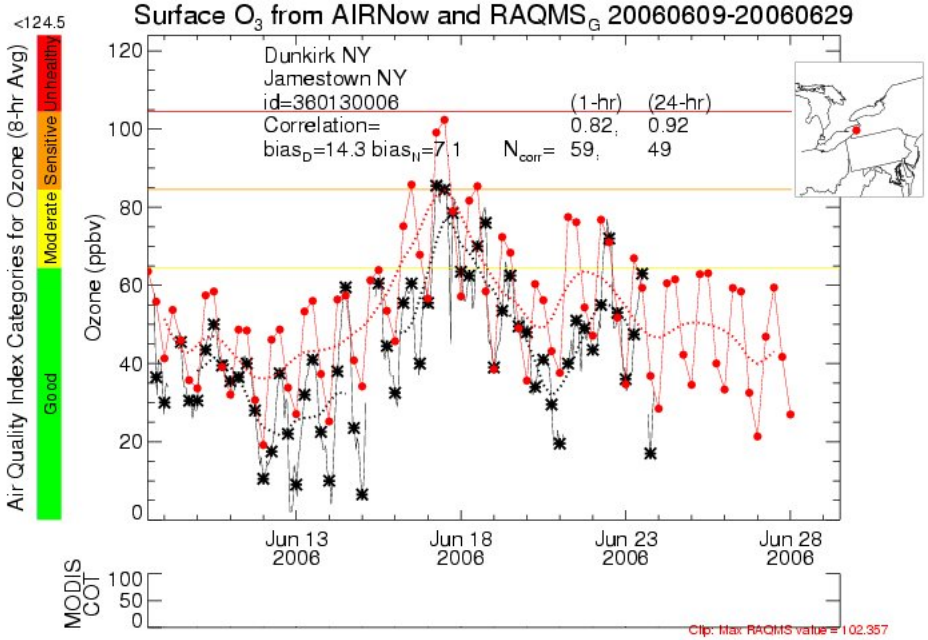


Ozone Concentration (ppb)
0-60
61-79
80-99
100-110
111-124
125+

Spatial distribution of 1-hr average peak ozone monitors show large scale regional ozone event. Ozone values in SW New York peak at ~80 ppb on June 17.

June 2006 Time Series of New York State Ozone Surface Station along Lake Erie

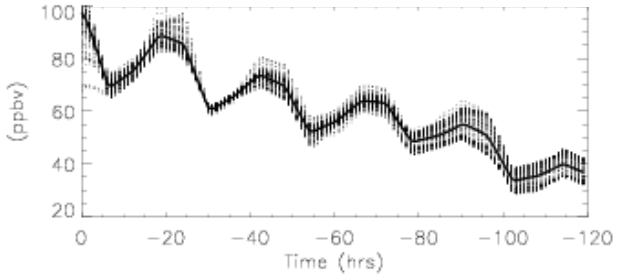




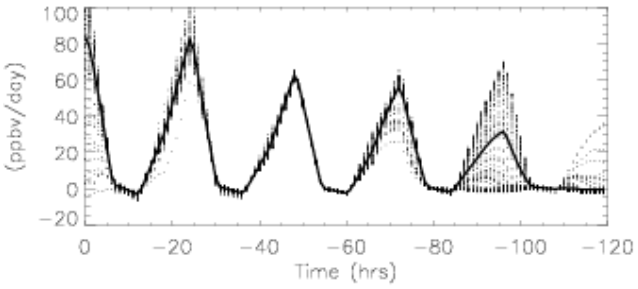
Great Lakes 2006 Ensemble Lagrangian Trajectory Analysis

Surface Great Lakes Back trajectory Chemistry June 17, 2006 18Z

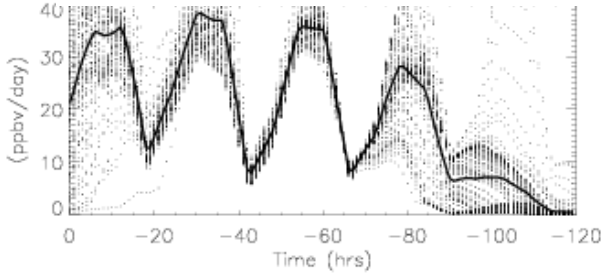
O3



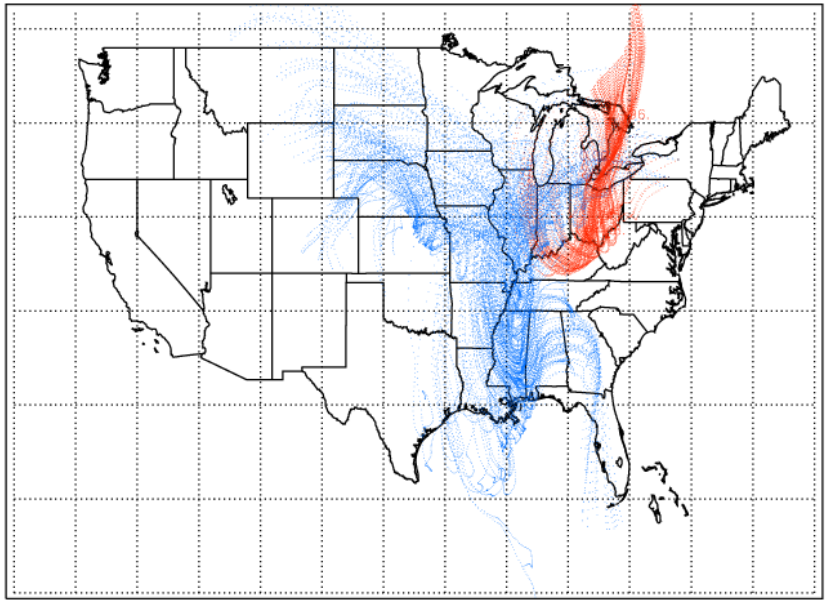
O3 Production-Loss



NOy Emissions



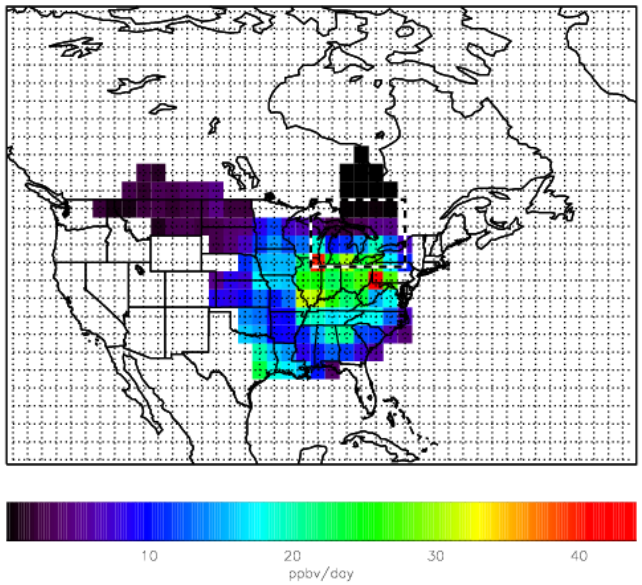
SFC (red)/850mb (blue) Great Lake Back-trajectories June 17, 2006 18Z



•Chemical histories for each class are binned in latitude and longitude to identify dominate source regions.

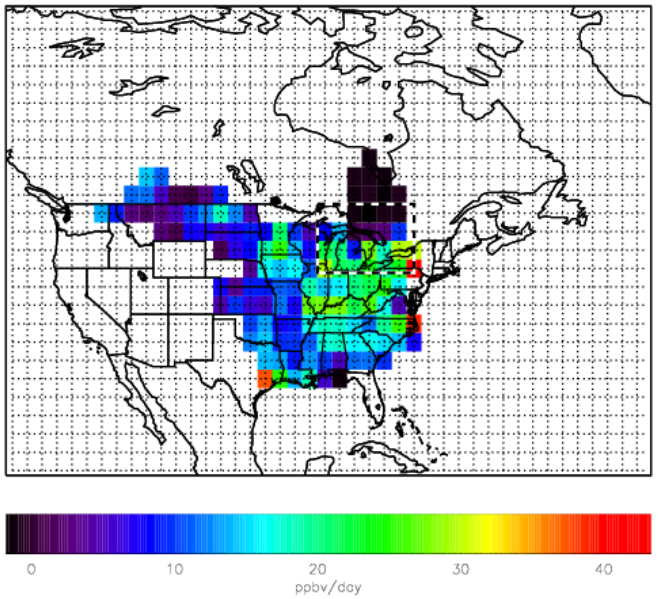
Source Attribution for Great Lakes Region June 14-June 22, 2006
Class: High Lagrangian Mean O3 Production (P-L > 10ppbv/day)

NOY emissions

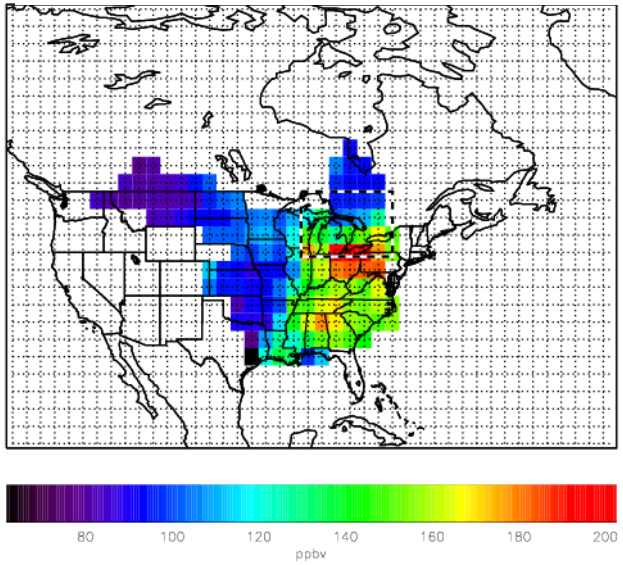


52% of Great Lake Back trajectories

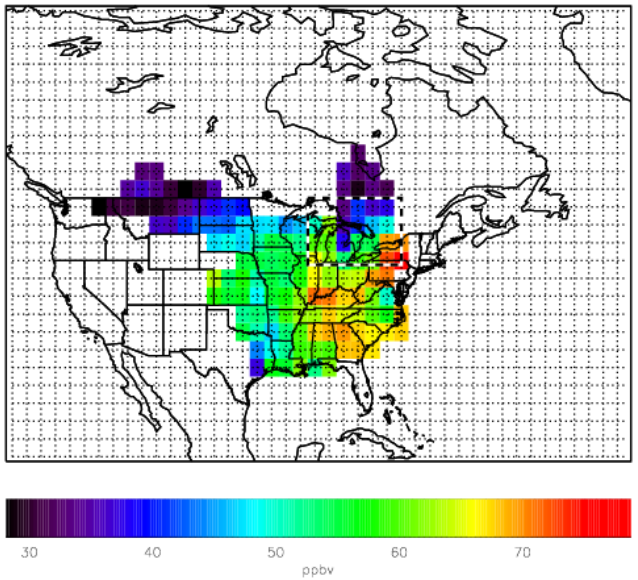
O3 production



CO mixing ratio



O3 mixing ratio



Summary/Conclusion

- Houston-Galveston-Gulf Shore Region work integrated at LaRC with larger effort supporting TexAQS II.

- General method developed for TexAQS II RSS being applied to Great Lakes Region. Redoing analysis with a focus on SW New York Region along Lake Erie.

- Use results from TexAQS RSS and Eastern Great Lakes Case Study to determine if alternative approach can be developed without RAQMS forecast assimilation. Focus on routine available models like NOAA/ARL Hysplit and daily trace gas /meteorological measurements.