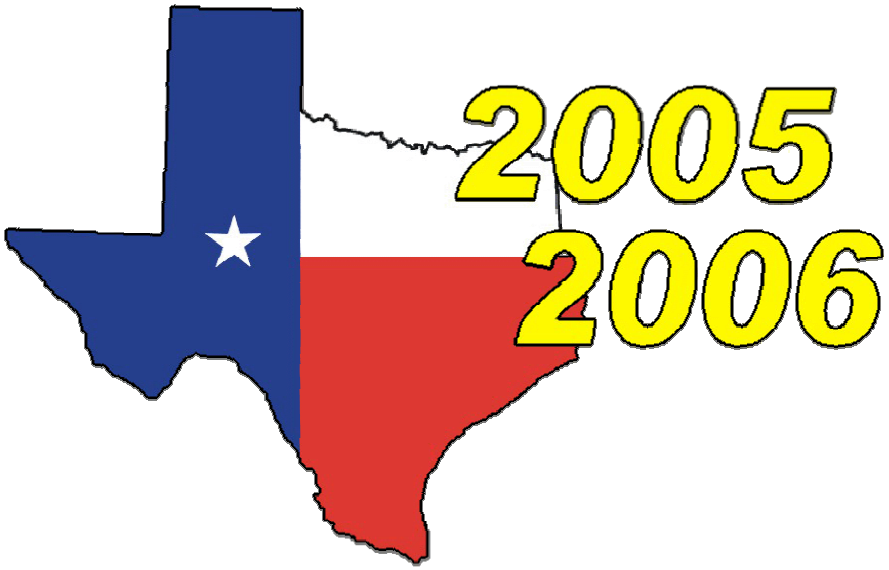
TexAQS II

Principal Finding Data Analysis Workshop

May 29, 2007 – June 1, 2007

ABSTRACTS



The Texas Air Quality Study II

TCEQ

Texas Commission on Environmental, Chief Engineer's Office, Air Quality Division

Impact of Emissions from Commercial Shipping during TexAQS II

Author(s): *Eric Williams, Brian Lerner and Paul Murphy*

Presenter(s): *Eric Williams*

Affiliation: NOAA

ABSTRACT:

Commercial marine vessels range in size from small fishing boats (20-30 meters in length) to extremely large container ships (>300 meters in length). These ships almost without exception use diesel engines for propulsion and auxiliary power generation. The larger ships, comprising bulk carriers, tankers and container carriers, utilize diesel engines that produce power in the 10 MW to 100 MW range. These engines typically consume heavy fuel oils, which are high in sulfur content (1%-4.5% by weight). These engines are also extremely efficient, converting essentially all of the carbon in the fuel to CO_2, but also emitting NO_x, CO, SO_2, VOCs, and PM.

During TexAQS 2006 our measurements on board the Ronald H. Brown allowed us to characterize the emissions from a large number of commercial marine vessels. The measurements provided the means to calculate mass-based emission factors for many of the compounds noted above. With the information broadcast by these vessels over the Automated Information System, we have unequivocally determined the emission factors for over 200 vessels both at dock and underway. Our data largely confirm published average emission factors, but also show significant variability especially with NOx. This talk will present those results and then use the data to show that emissions of NO_x and SO_2 from these vessels are not negligible in the Houston-Galveston region.

Observational Evaluation of Mobile Source Emissions

Author(s): *Gregory J. Frost*

Presenter(s): *Gregory J. Frost*

Affiliation: NOAA

ABSTRACT:

Ambient ratios of NO_x, CO, and CO_2 sampled by aircraft in Houston and Dallas during TexAQS 2000 and 2006 are compared with each other and with observations at a Houston highway tunnel. From these measurements we estimate 2000 and 2006 emissions for Houston and Dallas mobile sources. The observations demonstrate time-of-day variations in the relative contributions from gasoline and diesel combustion that are consistent with known traffic patterns. We incorporate CO_2 emissions derived from motor vehicle fuel use statistics in to the EPA's National Emission Inventory, resulting in an emission data set for NO_x, CO, and CO_2 with 4-km spatial and hourly temporal resolution. Comparison of the emission ratios derived from the TexAQS observations with this inventory allows a direct evaluation of the NEI mobile source NO_x and CO emissions.

Aircraft Measurements of Highly Reactive Volatile Organic Compounds

Author(s): *Joost de Gouw, Carsten Warneke, Elliot Atlas, Sacco te Lintel Hekkert*

Presenter(s): *Joost de Gouw*

Affiliation: NOAA

ABSTRACT:

Highly Reactive Volatile Organic Compounds (HRVOCs) were measured from the NOAA WP-3D aircraft using (1) a whole air sampler (WAS) and subsequent analysis by gas chromatography, (2) a proton-transfer-reaction mss spectrometer (PTR-MS), and (3) a laser photo-acoustic spectroscopy (LPAS) instrument for fast-response measurements of ethene. The data allow the location of the main sources to be identified and the emission fluxes to be determined. Results for ethene and aromatic species will be compared with emissions inventories and with the solar occultation flux (SOF) measurements performed by Chalmers University. Average mixing ratios of ethene and other species were lower in 2006 than in 2000. We will discuss whether these differences were due to a reduction in emissions or to the difference in meteorology between 2000 and 2006. Finally, the chemical removal of HRVOCs and the formation of secondary species could be studied on several flights that made transects at several distances downwind from the ship channel, and some initial results will be shown.

Volatile Organic Compounds (VOCs) Measured on the NOAA WP-3: Determination of Isoprene Emissions and Comparison with (1) Inventories and (2) Distinction between Urban and Industrial Sources of VOCs

Author(s): *C. Warneke, J.A. de Gouw, L. Del Negro, E. Atlas, J. Holloway, J. Gilman, J. Brioude, S. McKeen, M. Trainer, F.C. Fehsenfeld, many others*

Presenter(s): *Carsten Warneke*

Affiliation: NOAA

ABSTRACT:

Volatile organic compounds (VOCs) were measured on the NOAA WP-3 aircraft using a PTR-MS instrument and from whole air samples (WAS) using various gas chromatographic techniques.

Using the online measurements on the aircraft, isoprene emission fluxes are estimated and directly compared to the BEIS-3 inventory (EPA Biogenic Emissions Inventory System). The BEIS-3 data are also incorporated in a Lagrangian particle dispersion model (FLEXPART) and the results are compared to the measurements. In general, the comparison between measurements and inventory showed an agreement within ±50%, somewhat dependent on the day and the location.

The OH reactivity of the biogenic VOCs, which is important for the ozone production efficiency, is compared to the OH reactivity from anthropogenic VOCs separated into urban and industrial VOCs. On the flight of September 16, 2006 the Houston plume, initially including many alkenes and aromatics from the Houston industrial complex, was transported to the forested areas in northeast Texas. During this and other flights, the OH reactivity of biogenics is compared to anthropogenics near Houston and after up to one day of transport.

Overview of NOAA R/V Ronald H. Brown Measurements and Activities during TexAQS II

Author(s): *Eric Williams, Tim Bates*

Presenter(s): *Eric Williams, Tim Bates*

Affiliation: NOAA

ABSTRACT:

As part of the Texas Air Quality Study and the Gulf of Mexico Atmospheric Composition and Climate Study, the NOAA research vessel Ronald H. Brown was deployed for approximately six weeks in the Gulf of Mexico, Galveston Bay, and the Houston Ship Channel (HSC) in August and September, 2006. The ship was equipped with state-of-the-art scientific instrumentation for the continuous measurement of many atmospheric trace gas species, a large number of aerosol physical and chemical parameters, and the thermal and dynamic structure of the atmosphere. During the six week cruise the ship made a number of trips along the Texas Gulf coast from Port Arthur to Matagorda Bay, spent considerable time in the anchorage offshore from Galveston Island, spent many days and nights at the Barbour's Cut container terminal, and steamed to the turning basin at the end of the HSC on four occasions. This poster will show the capabilities of R/V Brown, the cruise track of the vessel during the study, and the measurements that were made. We will also point out where additional information on the measurements or the data can be found from the other posters (and oral presentations) that will be given.

Emissions of SO_2, NOx, and CO_2 from the Houston Ship Channel Measured Onboard the NOAA WP-3

Author(s): *Rebecca Washenfelder*

Presenter(s): *Rebecca Washenfelder*

Affiliation: NOAA

ABSTRACT:

The Port of Houston is made up of the Houston Ship Channel and Galveston Bay. Together these comprise a 25-mile long complex of diversified public and private facilities, including a petrochemical complex that is among the largest in the world. The Houston Ship Channel is a major source of industrial pollution, emitting sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), carbon dioxide (CO_2), and volatile organic compounds (VOC). Unlike a single large power plant, the Houston Ship Channel consists of numerous sources that can be difficult to quantify in inventories. In order to evaluate and predict air quality in the Houston area, it is important to understand the magnitude and variability of sources in the Houston Ship Channel, and how these sources are evolving over time.

We examine fluxes of SO_2, NO_x, CO, and CO_2 from the Houston Ship Channel observed onboard the NOAA WP-3 during September – October 2006. We report the magnitude and variability of these sources, and compare these results to aircraft measurements from 2000 to identify trends. The aircraft measurements are used to evaluate the accuracy and completeness of the [official name] Emissions Inventory.

An Examination of East Texas Power Plant Plumes

Author(s): *Jeff Peischl*

Presenter(s): *Jeff Peischl*

Affiliation: NOAA

ABSTRACT:

NOy, SO_2, and CO emission ratios to CO_2 from W.A. Parish, Big Brown, Limestone, Twin Oaks, Welsh, and Monticello power plants will be compared between the 2000 and 2006 TexAQS campaigns. The emission ratios and mass fluxes will also be compared to data reported through CEMS.

Online VOC Measurements using PIT-MS on the Ronald Brown during TexAQS II

Author(s): *Daniel Welsh-Bon, Carsten Warneke, Jessica Gilman, Joost de Gouw, Bill Kuster, Paul Goldan and Ray Fall*

Presenter(s): *Daniel Welsh-Bon*

Affiliation: NOAA

ABSTRACT:

Proton Transfer Ion Trap Reaction Mass Spectrometry (PIT-MS) was used on board the Ronald Brown for measurement of volatile organic compounds (VOC) including aromatics, oxygenates and some alkenes at a time resolution of 10 seconds. The fast time response of PIT-MS measurements compliments slower GC-MS measurements of the same compounds and routinely identified rapid, intense VOC plumes that were too brief for GC-MS during the TexAQS campaign. High time resolution measurements can be used for source apportionment, emissions verification, and the identification of rogue emissions. Examples of the application of PIT-MS measurements for each of these uses will be presented. In addition to online VOC measurements, a gas chromatograph (GC) was used to preseparate VOCs before analysis with the PIT-MS as an aid to compound identification and validation. This technique provides very detailed information useful for interpreting PIT-MS measurements and for the detection and identification of many compounds seen for the first time during TexAQS. Intercomparison of PIT-MS measurements with GC-MS measurements reveals significant interferences from industrial chemicals on masses typically reported by PIT-MS as biogenic compounds and their oxidation products. GC-PIT-MS validation of PIT-MS measurements corrects these mass assignments and provides a more accurate interpretation of fast VOC measurements made during the campaign.

Small Marine Craft Emission Factors Observed from the R/V Ronald H. Brown during TexAQS II /GoMACCS 2006

Author(s): *B.M. Lerner, E.J. Williams, P.C. Murphy*

Presenter(s): *Brian Lerner*

Affiliation: NOAA

ABSTRACT:

During the TexAQS/GoMACCS 2006 field campaign, the NOAA R/V Ronald H. Brown often encountered small marine recreational craft while sailing close to the Texas coast, especially in Galveston Bay. Measurement of a suite of trace gases at high time resolution (1 Hz) allowed us to calculate emission factors (EFs), relative to carbon dioxide, for nitrogen oxides (NO_x), sulfur dioxide (SO_2) and carbon monoxide (CO) for distinct exhaust plumes from these vessels. As previously observed along the New England coast, gasoline-powered craft showed significantly higher NO_x/CO_2 and lower CO/CO_2 EFs than current emissions inventories predict, although in agreement with the most recent published literature. These findings imply lower volatile organic compound emissions from these vessels, although this was not directly measured.

Mercury Measurements Aboard the NOAA R/V Ronald H. Brown

Author(s): *Tara J. Fortin, Thomas B. Ryerson, Eric J. Williams, Brian M. Lerner, James E. Johnson, Scott Herndon, Mark Zahniser, Daniel Welsh-Bon, Carsten Warneke, Joost A. de Gouw, and Fred C. Fehsenfeld*

Presenter(s): *Tara Fortin*

Affiliation: NOAA

ABSTRACT:

More than 95% of atmospheric mercury (Hg) is present in its gaseous elemental state (Hg^0). With a lifetime of 6 months to 2 years, this powerful neurotoxin can be transported far from source regions before it is ultimately oxidized to ionic Hg, deposited, methylated, and bioaccumulated in aquatic ecosystems. The subsequent human exposure to contaminated fish is a widespread health concern. Atmospheric Hg has both natural sources, such as oceans and volcanoes, and anthropogenic sources, such as coal combustion, waste incineration, and various manufacturing processes. Despite decades of research, questions remain about these sources and about the global Hg cycle. During the 2006 Texas Air Quality Study/Gulf of Mexico Atmospheric Composition and Climate Study (TexAQS II/ GoMACCS 2006), we deployed a Lumex RA-915$^+$ mercury analyzer aboard the NOAA research vessel (R/V) Ronald H. Brown. The instrument detects Hg^0 using cold vapor atomic absorption spectroscopy with a Zeeman high-frequency polarization background correction. This approach allows for continuous real-time operation with no preconcentration and desorption steps. The campaign provided us with an opportunity to characterize the ability of this largely untested instrument to measure Hg^0 in the field, and to observe Hg^0 distributions in both remote marine and coastal environments. Additionally, by utilizing other shipboard data and available Hg emissions inventories, we were able survey the coastal and inland waterways for sources, with particular attention paid to potential sources in the Houston Ship Channel. The instrument's behavior and our atmospheric observations will be discussed.

Volatile Organic Compounds (VOCs) Measured Aboard the Ronald H. Brown during TexAQS II

Author(s): *Jessica B.Gilman, William C. Kuster, Paul D.Goldan, Daniel Welsh-Bon, Carsten Warneke, and Joost de Gouw*

Presenter(s): *Jessica Gilman*

Affiliation: NOAA

ABSTRACT:

Volatile Organic Compounds (VOCs) are a vital ingredient in the photochemical production of ozone. Many of these compounds are also air toxics and can adversely affect local and regional air quality. Along the gulf coast of Texas there is an immense variety of industrial, urban, and natural sources of VOCs. A GC-MS (Gas Chromatograph-Mass Spectrometer) and a (GC)-PIT-MS (Gas Chromatograph-Proton Ion Trap-Mass Spectrometer) were used to collect data on a wide variety of VOCs aboard the Ronald H. Brown during TexAQS II/GoMACCS 2006 in an effort to identify and characterize their sources. An overview of the data set collected will be presented with an emphasis on the most reactive VOCs that largely contribute to photochemical ozone production in the Houston/Galveston area. Mixing ratios for ethene, propene, and isoprene will be compared for data collected at La Porte, Texas in 2000 and nearby in Barbour's Cut in 2006.

Ozone Production Efficiency in Plumes Downwind from Houston

Author(s): *J. A. Neuman, J. B. Nowak, W. Zheng, F. Flocke, T. B. Ryerson, M. Trainer, J. S. Holloway, F. Fehsenfeld*

Presenter(s): *Jonathan A. Neuman*

Affiliation: NOAA

ABSTRACT:

Measurements obtained from the NOAA WP-3 aircraft on 10 daytime flights in the boundary layer under a variety of meteorological conditions are used to determine the ozone production efficiency in plumes downwind from Houston. Over 50 crosswind transects of coalesced plumes from the Houston urban and industrial areas are examined. Nitric acid deposition affects the observed reactive nitrogen partitioning and causes an increase in the slope of the correlation between ozone and the products of NOx oxidation (often interpreted as ozone production efficiency). When wind speeds were high, nitric acid loss was enhanced, and as a consequence the ozone to NOx oxidation products correlation slope increased dramatically. By accounting for the loss of reactive nitrogen species from plumes during transport, ozone production efficiency can be determined. Although ozone production efficiency varies considerably according to the emission source, it is shown to be low (2.7 ± 1) and independent of plume age in coalesced plumes measured up to 170 km downwind from Houston.

Formaldehyde Measurements from R/V Brown during TexAQS II

Author(s): *Scott C. Herndon, Mark S. Zahniser, Timothy Onasch, Hans Osthoff, Brian Lerner, Dan Welsh-Bon, Jessica Gilman, Roberto Sommariva, Jim Roberts, Ken Aikin, Alan Brewer, Sara Tucker, Tim Bates, Patricia Quinn, Bill Kuster and Eric Williams*

Presenter(s): *Scott C. Herndon*

Affiliation: NOAA

ABSTRACT:

Formaldehyde is a product of the atmospheric oxidation of hydrocarbons, a potential source of HOx, and a contributing species to determining how HOx is partitioned between OH and HO_2. Ozone and particulate matter are health hazards. The atmospheric oxidation of volatile organic compounds leads to secondary organic aerosol production, and the atmospheric oxidation of S(IV) to S(VI) leads to the production of sulfate aerosol.

Formaldehyde was measured using pulsed quantum cascade tunable infrared differential absorption spectroscopy (pQC-TILDAS) in the 5.6 µm (1765 cm^{-1}) wavelength region. The in-field determination of detection sensitivity resulted in 1-s rms levels of 250 pptv. The sampling system, inlet calibration and an overall assessment of the systematic uncertainties will be discussed. The wavelength region used for determining HCHO also allows an opportunistic measurement of formic acid.

In the Houston Ship Channel dataset, the diurnally averaged peak concentration of HCHO precedes the observed peak concentrations of O_3 by 2.5 hours. The formic acid concentrations reach their daily peak slightly *after* that of ozone. Though this likely due to the gas phase ozonolysis of alkenes, it was frequently observed with concomitant increases in particulate organic mass.

The value of HCHO measurements together with CO_2, CO, NOx, O_3 and aerosol characterization measurements will be discussed, particularly in the context of urban air quality modeling.

Ozone Production and Flux Downwind of Houston and Dallas

Author(s): *Christoph Senff*

Presenter(s): *Christoph Senff*

Affiliation: NOAA

ABSTRACT:

We use the airborne ozone lidar data from flight transects downwind of Houston and Dallas to compute total horizontal flux of ozone emitted by these two metropolitan areas. Fluxes are computed for each transect by integrating excess ozone in the urban plume (plume ozone – background ozone) between the surface and the top of boundary layer and between the horizontal plume edges and then multiplying the result with the horizontal wind speed. We will compare ozone flux measurements for Houston and Dallas under varying meteorological conditions and for different background ozone loadings. In addition, we plan to calculate ozone production rates in the Houston and Dallas plumes from ozone flux estimates in multiple downwind transects.

A summary of mixing heights and three-dimensional ozone structure observed during TexAQS II

Author(s): *Mike Hardesty*

Presenter(s): *Mike Hardesty*

Affiliation: NOAA

ABSTRACT:

We summarize airborne lidar observations of ozone and aerosol concentrations and boundary layer height observed during the 2006 Houston experiment. It is shown that background ozone levels were significantly higher when the source of air advected into the Houston area was continental rather than marine in origin. We also compare ozone measurements above the surface with surface ozone measurements, and show the relationship between boundary layer depth and ozone concentration downwind of source regions.

Pollution Transport and Texas

Author(s): *T. Ryerson et al.*

Presenter(s): *Thomas Ryerson*

Affiliation: NOAA

ABSTRACT:

Intra- and interstate transport of pollution is studied using observational data and transport models. Data from airborne platforms are presented to show transport from Houston, from Dallas, and from Beaumont to other parts of the State and beyond. Airborne data from the TexAQS 2000 and 2006 studies are examined to show cases of each, and to illustrate the effects of metropolitan area and point emissions sources on air quality downwind.

These airborne data sets acquired during intensive field missions provide well-documented examples but are quite limited in time. A more continuous multi-year record of measurements aloft from an instrumented 500-meter-tall tower is also presented, to provide examples of transport in Texas over longer time periods and to put the airborne intensives into some longer-term perspective.

Finally, we use examples in the available observations to evaluate trajectory and transport models – specifically Hysplit, Flexpart, and trajectories driven by the Texas profiler network – in an initial attempt to better characterize the tools needed for a more complete understanding of pollution transport in Texas.

Observations of Nitryl Chloride, $ClNO_2$, a Significant Chlorine Atom Source in the Houston-Galveston Region

Author(s): *James M. Roberts, Hans D. Osthoff, Eric J. Williams, Brian M. Lerner, Roberto Sommariva, Timothy S. Bates, Derek Coffman, Patricia K. Quinn, Harald Stark, James B. Burkholder, Ranajit K. Talukdar, A. R. Ravishankara, James Meagher, Fred C. Fehsenfeld, and Steven S. Brown*

Presenter(s): *James M. Roberts*

Affiliation: NOAA

ABSTRACT:

Nitryl chloride, $ClNO_2$, is a known product of nighttime reaction of N_2O_5 on sea salt. We report here the first ambient measurements of $ClNO_2$ by chemical ionization mass spectrometry (CIMS) onboard Ronald H. Brown during the TexAQS II/GoMACCS project. These measurements show $ClNO_2$ mixing ratios up to 1 ppbv during periods of active N_2O_5 aerosol chemistry, and that non-sea salt aerosol is involved in $ClNO_2$ formation. Preliminary laboratory results confirm that $ClNO_2$ is produced from N_2O_5 uptake on the aerosol substrates $\{(NH_4)_2SO_4, (NH_4)HSO_4\}$ that contain chloride ion concentrations observed in the TexAQS II/ GoMACCS measurements. $ClNO_2$ photolyzes upon sunrise, producing Cl atoms and NO_2. The impacts of this Cl atom source are far-reaching and include; more intense VOC-NO_x photochemistry early in the day, enhanced oxidation in NO_x plumes from ship emissions, and the preservation of NO_x that would normally be lost through nighttime chemistry. This active halogen source is different than, and in addition to, the chlorine sources (Cl_2, HOCl) recently considered in the Houston-Galveston area and is likely to be subject to different control strategies.

Nocturnal Processing of O_3, NOx & VOC in Houston

Author(s): *Steven S. Brown, William P. Dubé, and many, many others*

Presenter(s): *Steven S. Brown*

Affiliation: NOAA

ABSTRACT:

The nighttime P-3 flights during TexAQS 2006 were aimed at characterizing the nocturnal reactions, transport and loss of NO_x, VOC and O_3, with an emphasis on the role of the nighttime nitrogen oxides, NO_3 and N_2O_5. Mixing ratios of NO_3 and N_2O_5 were highly variable and occasionally very large, consistent with previous aircraft measurements of these compounds. Analysis of these data yields the following results. 1) Hydrolysis of N_2O_5, the most important reaction in the nocturnal conversion of NO_x to HNO_3, was generally inefficient in air masses around Houston and elsewhere in Texas. As a result, NO_x emissions occurring late in the day or at night could be transported overnight in the form of N_2O_5 to regions distant from the NO_x source regions. Transport of O_3 was also efficient since N_2O_5 is a reservoir for odd oxygen (O_x) as well. 2) NO_3 is a strong oxidant for highly reactive VOC (HRVOC such as alkenes, some aromatics and oxygenates). The reduced rate of N_2O_5 hydrolysis aloft in Houston enhanced the availability of NO_3 as an oxidant. This was important in plumes containing both NO_x and HRVOC from industrial sources in the Houston area. 3) Emissions of NO_x emissions and the chemical processing of NO_3 and N_2O_5 are vertically stratified at night because of lower nocturnal boundary layer heights and reduced atmospheric mixing. The nocturnal P-3 flights included multiple, low-level vertical profiles to address the issue of stratification, reduced mixing and their influence on chemical transformation of pollutants at night

In Situ Measurement of Ozone Production Rates

Author(s): *Greg Huey*

Presenter(s): *Greg Huey*

Affiliation: NOAA

ABSTRACT:

Fast time response measurements of the sum of peroxy radicals and nitric oxide were made from the NOAA P3 during the Texas Air Quality Study 2006. These observations allow for the calculation of ozone production rates ($R=k[RO_2][NO]$). Rates of more than 100 pbbv/hr were observed downwind of the Houston Ship Channel. The observed peroxy radicals levels and their dependence on NOx will be compared with the NASA Langley model to assess our understanding of the photochemistry in this region.

NMHC, Alkyl Nitrate, and Halocarbon Distributions from the NOAA WP-3D Aircraft during TexAQS II

Author(s): *E. Atlas, R. Lueb, S. Donnelly, X. Zhu, L. Pope, C. Moore, S. Schauffler, R. Hendershot, R. Washenfelder*

Presenter(s): *Elliot Atlas*

Affiliation: NOAA

ABSTRACT:

Whole air samples were collected during flights of the NOAA P3-B aircraft during the TexAQS II mission. The samples were returned to the laboratory at UM for analysis of a large suite of non-methane hydrocarbons, halocarbons (solvents, HFCs, HCFCs, etc.), methyl halides, organic nitrates, sulfur gases, and selected oxygenated VOC. This presentation will examine the distributions of some of the species in relation to source emissions, and will compare the measured concentrations and trace gas relationships to those observed during the earlier TEXAQS 2000 mission.

Preliminary Results of Formaldehyde Measurements during TexAQS II

Author(s): *D. Richter, J.G. Walega, P.Weibring, A. Fried, and M. Trainer*

Presenter(s): *Dirk Richter*

Affiliation: NOAA

ABSTRACT:

We will be presenting preliminary 1 second results of formaldehyde measurements that were obtained during the TexAQS II study using a newly developed mid-IR tunable DFG laser spectrometer. Our presentation will include discussion of general data quality and a first glance at selected flights that include elevated formaldehyde concentrations as a result of emission from various sources.

Aircraft Measurements of PANs during TexAQS II

Author(s): *Frank Flocke, Wengang Zheng*

Presenter(s): *Wengang Zheng*

Affiliation: NOAA

ABSTRACT:

PAN, PPN, PBN, and APAN were measured with a time resolution of two seconds on board the NOAA P-3 aircraft during the TexAQS 2006 campaign. MPAN was measured also but can only be used as an indicator for it's presence as the calibration factor is unknown and varies under different ambient air conditions. The poster will give an overview over the data collected and will present some preliminary findings. Some plume cases will be examined with regard to ozone production and the composition and ratios of the different PAN species.

PANs Observations from the NOAA R/V Ronald H Brown

Author(s): *James M. Roberts, Eric J. Williams, Brian M. Lerner, Joost de Gouw, Carsten Warneke, Daniel Welsh-Bon, William C. Kuster, Jessica Gilman, Paul D. Goldan, James F. Meagher, and Fred C. Fehsenfeld*

Presenter(s): *James M. Roberts*

Affiliation: NOAA

ABSTRACT:

The peroxycarboxylic nitric anhydrides (PANs) were measured onboard the Ronald H. Brown during the TexAQS II/GoMACCS project by thermal decomposition chemical ionization mass spectrometry (TD-CIMS) and by gas chromatography with electron capture detection (GC/ECD). The relative abundance of peroxyacetic nitric anhydride (PAN) and peroxypropionic (PPN), and relatively low or absent peroxymethacrylic nitric anhydride (MPAN) confirms the result from TexAQS 2000, that biogenic isoprene is not a big contributor to the VOC chemistry in the Houston-Galveston area. There were a number of observations of plumes containing unusually high PPN/PAN ratios or the presence of peroxyacrylic nitric anhydride (APAN) indicating the influence of local petrochemical VOC sources.

Peroxy Radical Abundances and Ozone Production during TexAQS II - GoMACCS 2006

Author(s): *R. Sommariva, S.S. Brown, J.M. Roberts, A.E. Parker, P.S. Monks, D.M. Brookes, H.D. Osthoff, B.M. Lerner, E.J. Williams, F.C. Fehsenfeld, A.R. Ravishankara, M. Trainer*

Presenter(s): *Roberto Sommariva*

Affiliation: NOAA

ABSTRACT:

Measurements of total peroxy radicals (HO_2+RO_2) were taken using Peroxy Radical Chemical Amplifier (PERCA) during the Texas Air Quality Study/Gulf of Mexico Atmospheric Composition and Climate Study (TexAQS II / GoMACCS 2006) field campaign. The measurements were taken on board of the NOAA ship Ronald H. Brown between July and September 2006. The ship cruised along the Texas coast and inside Galveston Bay and Houston port sampling air masses coming from the highly industrialized region of Southern Texas.

The measurements were used to study ozone photochemistry in one of the most polluted areas of the United States and to calculate the Net Photochemical Ozone Formation. The simultaneous measurements of peroxy radicals and of nitrate radical allowed for experimental verification of the relationships between these radicals at night.

Boundary Layer Aerosol Chemistry during TexAQS II / GoMACCS 2006

Author(s): *T. Bates, P. Quinn, D. Coffman, and K. Schulz*

Presenter(s): *Tim Bates*

Affiliation: NOAA

ABSTRACT:

The chemical composition of submicrometer and supermicrometer (60% RH) aerosol particles was measured in the boundary layer aboard the NOAA R/V Ronald H. Brown during TexAQS II / GoMACCS 2006. The onshore flow of background aerosol (low radon concentrations indicating no contact with land for several days) was highly impacted by Saharan dust and what appear to be ship emissions (acidic sulfate and nitrate). Mean (median) mass concentrations of the total submicrometer and supermicrometer aerosol were 6.5 (4.6) $\mu g\ m^{-3}$ and 17.2 (8.7) $\mu g\ m^{-3}$, respectively. These mass loadings of "background" aerosol are much higher than typically observed in the marine atmosphere and thus have a substantial impact on PM loading in the Houston-Galveston area. As this background aerosol moved onshore, local sources added an organic rich submicrometer component (66% particulate organic matter (POM), 20% sulfate, 14% elemental carbon). During periods of northerly flow, the mean (median) mass concentrations of the total submicrometer and supermicrometer aerosol were 20.8 (18.6) $\mu g\ m^{-3}$ and 7.4 (5.0) $\mu g\ m^{-3}$, respectively. The submicrometer aerosol fraction consisted on average of 52% $(NH_4)_2SO_4$ and 35% POM. Compliance with PM 2.5 regulations in the Houston-Galveston area may require stricter controls on upwind aerosol sources (e.g. ship emissions).

Sources of Primary and Secondary Particles in the Houston Area in 2006

Author(s): *Charles Brock, Ann Middlebrook, Tahllee Baynard, Ryan Spackman et al.*

Presenter(s): *Charles Brock*

Affiliation: NOAA

ABSTRACT:

Particle size distributions, optical properties, and chemical composition were measured on the NOAA WP-3D aircraft downwind of the Houston urban center, the Houston Ship Channel industrial region, and power plants during the TexAQS II study. Compared with secondary formation, only small amounts of submicron particulate mass were directly emitted. An exception to this was soot, which was correlated with CO emissions from vehicles in the urban area. Secondary particle mass increases were most pronounced downwind of the ship channel region when ozone was formed, and downwind of the Parish power plant, a major point source for SO_2. The particle mass fluxes from each of these sources will be calculated as a function of photochemical processing and distance, and then compared with other sources within Texas and with results from the TexAQS 2000 study.

Sources of High Aerosol Mass Loadings during the TexAQS II / GoMACCS Study

Author(s): *Middlebrook, Bahreini, Dunlea, DeCarlo, Jimenez, Hecobian, Weber, Gallar, Wollny, Brock, Baynard, Schwarz, Gao, Spackman, Watts, Fahey, de Gouw, Warneke, Holloway, Nowak, Neuman, Peischl, Huey, Tanner, Brown, Ryerson, and the rest of the NOAA WP-3D scientists and crews*

Presenter(s): *Ann Middlebrook*

Affiliation: NOAA

ABSTRACT:

For the first time, size-resolved, non-refractory (NR) aerosol composition was measured with a fast time resolution and high sensitivity aboard the NOAA WP-3D aircraft using an Aerodyne Compact Time-of-Flight Aerosol Mass Spectrometer (C-ToF AMS). Fine features in the C-ToF AMS data were highly correlated with other measurements of submicron aerosol volume and dry extinction.

The highest total NR aerosol mass loadings were measured during the day over the Houston area on Oct. 5 and 6, averaging more than 15 mg/m^3. On both days, the winds were light and generally from the north, east, or northeast and the flight tracks followed the air as it was transported southwest of Houston, the ship channel, and isolated power plants. Organic and sulfate material dominated the total NR mass on both days: on the 5th the mass concentrations of these two species were roughly the same in the upwind air and on the 6th the sulfate mass concentrations were lower. Significant growth in organic mass was observed downwind of the urban area and ship channel. Small acidic sulfate particles were observed directly downwind of power plants and the ship channel, where SO_2 emissions from point sources are fairly large. Similarities and differences in the aerosol sources and secondary aerosol processes for these two days will be discussed.

Measurements of Chemical Composition of Submicron Aerosols Onboard NOAA WP-3D during TexAQS-2006

Author(s): *Roya Bahreini, Middlebrook, A.M., Brock, C.A., DeCarlo, P.F., deGouw, J.A., Dunlea, E., Fahey, D., Flocke, F., Gallar, C., Gao, R., Holloway J.S., Kimmel, J., Neuman J.A., Ryerson, T.B., Spackman, R., Schwarz, J., Trainer, M, Warneke, C., Wollny, A., Zheng, W., Jimenez, J.L., Fehsenfeld, F.C.*

Presenter(s): *Roya Bahreini*

Affiliation: NOAA

ABSTRACT:

Mass concentrations of non-refractory inorganic (sulfate, ammonium, and nitrate) and total organics in submicron aerosols were measured by a Compact Time of Flight Aerosol Mass Spectrometer (C-ToF-AMS) onboard NOAA WP-3D. In this poster, we analyze composition changes of aerosols in different air masses that were sampled: power plant plumes, urban plumes, and industrial plumes located along the Houston ship channel. Depending on type of the plume, aerosol composition was dominated by sulfate or/and organics. We will examine the organic mass spectra in different plumes to determine the fraction of fresh hydrocarbon-like organics (HOA) and processed oxygenated-like organics (OOA). Relationships between HOA, black carbon, and CO as well as OOA, sulfate, and O_3 measured aboard the plane will be examined and compared to other urban areas. Differences in composition of organics and inorganic aerosols along with changes in gas phase concentrations of aerosol precursors will be analyzed to understand the effect of processing as plumes are advected away from sources.

In Situ Measurements of Black Carbon Aerosol during the 2006 Texas Air Quality Study

Author(s): *Ryan Spackman, Joshua Schwarz, Ru-Shan Gao, Laurel Watts, Dave Thomson, David Fahey, John Holloway*

Presenter(s): *Ryan Spackman*

Affiliation: NOAA

ABSTRACT:

Measurements of individual BC particles were acquired in the lower and middle troposphere with a Single-Particle Soot Photometer (SP2) operating aboard the NOAA WP-3D research aircraft in September–October during the 2006 Texas Air Quality Study (TexAQS II) in Houston. The SP2 frequently sampled BC from the Houston urban plume and the Houston Ship Channel and episodically detected enhanced BC emissions from biomass burning events and oil drilling platforms in the Gulf of Mexico. Summing over the individual particle data, we report BC mass loadings from the ground to ~5 km based on the particle size range of 0.1 to 0.8 micrometers volume equivalent diameter, representing ~90% of the BC mass distribution. BC mass mixing ratios spanned the range from ~1000 ng/kg in the polluted boundary layer to less than 1 ng/kg in the clean middle troposphere. Simultaneous measurements of BC and CO are positively correlated throughout the lower and middle troposphere. Near source regions, these new observations of BC together with simultaneous measurements of other tracers may help to better constrain emission inventories of BC aerosol.

Comparison of the Relationship between PM1 Water Soluble Organic Carbon, Volatile Organic Compounds, and Trace Gases in Urban, Industrial, and Power Plant Plumes in the Houston Metropolitan Area

Author(s): *Arsineh Hecobiannajjari, Rodney Weber*

Presenter(s): *Arsineh Hecobiannajjari*

Affiliation: NOAA

ABSTRACT:

A particle-into-liquid sampler (PILS) was coupled to a total organic carbon (TOC) analyzer and an Ion Chromatograph (IC) to measure the water-soluble organic carbon (WSOC) and several inorganic ions of submicron (PM1) aerosols on the NOAA WP-3D aircraft during TexAQS II. PM1 WSOC, volatile organic compounds (VOCs), and CO recorded in various plumes will be characterized and contrasted to investigate sources and processes leading to secondary organic aerosol formation. These comparisons will include; fresh Houston urban plumes, power plant plumes mixed with local emissions and plumes from industrial/petrochemical refining sources. These distinct plumes will also be contrasted with more aged plumes detected in southern Texas during TexAQS II, and plumes investigated during other field studies.

Measurement of Aerosol Organic Compounds during TexAQS II using a Novel Collection/Thermal-Desorption PTR-ITMS Instrument

Author(s): *Troy Thornberry, Daniel M. Murphy, and David S. Thomson*

Presenter(s): *Troy Thornberry*

Affiliation: NOAA

ABSTRACT:

Organic material has been observed to comprise a significant fraction of aerosol mass in many regions of the troposphere, but detailed measurements of the individual species that comprise the organic fraction have been limited in spatial extent and temporal resolution. Knowledge of the organic species present in atmospheric aerosols is needed to understand their effect on aerosol microphysical and optical properties as well as to resolve outstanding questions about important organic aerosol sources and formation mechanisms, and to elucidate the role of aerosols in the chemistry of the atmosphere through their interaction with gas-phase compounds. The measurement of aerosol organic compounds poses a significant experimental challenge due to the complexity and large number of organic species, and the low concentration at which individual species are present. The proton-transfer-reaction mass spectrometry (PTR-MS) technique has proved to be a useful tool in the study of atmospherically important volatile organic compounds (VOCs). Its ability to sensitively detect and quantify the concentrations of many common VOCs has led to an increased understanding of the sources, transport, chemical transformations, and loss processes of these compounds through both laboratory and field experiments. A logical extension of the technique is application to semi-volatile and condensed-phase organic species in the atmosphere. A new instrument that utilizes the PTR-MS technique to probe the organic composition of atmospheric aerosols has been developed. Aerosols are collected by impaction and then thermally desorbed into a carrier gas that transports the organic analyte molecules into a drift tube where they are ionized by reaction with H_3O^+ ions. Analyte ions are detected using an ion trap mass spectrometer. The instrument was deployed for the first time during summer 2006 in the Texas Air Quality Study aboard NOAA R.V. Ronald H. Brown. Signals significantly above detection limit were observed at a number of masses during several periods when aerosol loading increased in the 0.5-1 μm size range and the aerosol mass spectrometer (AMS) measurements indicated appreciable organic mass. The different masses exhibit significantly different temporal behaviors, indicating varying composition of the aerosol organic fraction even during periods when the AMS organic mass loading is relatively constant. These results and instrument performance will be presented.

Gas-to-Particle Conversion: Observations of Ammonium Nitrate Formation above Houston

Author(s): *J.B. Nowak, Neuman, J.A., Bahreini, R., Brock, C. A., Middlebrook, A. M. and Wollny, A*

Presenter(s): *John B. Nowak*

Affiliation: NOAA

ABSTRACT:

Ammonium nitrate aerosol is formed from the reaction of gas phase ammonia (NH_3) and nitric acid (HNO_3). Anthropogenic emissions of NH_3 and NO_x ($NO + NO_2$), which in sunlight can be oxidized to form HNO_3, can result in observations of elevated ammonium nitrate levels. Ammonium nitrate formation was observed from the NOAA WP3 aircraft over Houston with fast-response measurements of NH_3, HNO_3, particle composition, and particle size distribution. Typically, NH_3 mixing ratios over the urban area ranged from 0.2 to 3 ppbv. However, several plumes with high NH_3 levels were sampled on different flights. NH_3 mixing ratios in these plumes ranged from 5 to over 50 ppbv. In these plumes, the NH_3 enhancement was accompanied by a corresponding decrease in HNO_3 mixing ratios and an increase in particulate NO_3^- concentration indicating ammonium nitrate formation. The relationship between these plumes and the location of known NH_3 sources will be examined. Finally, an initial look at the impact of these plumes on urban air quality will be made.

Aerosol Optical Properties during TexAQS II - GoMACCS 2006

Author(s): *Berko Sierau, Dave Covert, Trish Quinn*

Presenter(s): *Berko Sierau*

Affiliation: NOAA

ABSTRACT:

Aerosol optical properties were measured on the NOAA RV Ronald H Brown in the Gulf of Mexico, coastal waters and inland waterways during August and September of the TexAQS II project. The measured parameters included light scattering and light absorption coefficient at three wavelengths in the visible, segregated by particle size above and below 1 micrometer diameter with a time resolution of 10 minutes or less. Additionally the change in light scattering with relative humidity, a hygroscopic growth factor, was measured for the submicrometric aerosol fraction. The wavelength dependence of the scattering is dependent to a first degree on the particulate size distribution. The wavelength dependence of absorption and the hygroscopic growth are dependent on aerosol chemical composition; the first is related to organic composition, the second is related to the soluble fraction which is dominated by inorganic compounds. The data will be presented in the context of regional scale sources and air mass classes. The relation between optical properties and visual range will be presented in the context of relative humidity and vertical humidity gradients in the boundary layer.

Aerosol Size Distributions Measured Onboard Ronald H. Brown: Variability in Relation to Sources, Processing, and Meteorology

Author(s): *D.J. Coffman, D.S. Covert, P.K. Quinn, T.S. Bates, and B. Sierau*

Presenter(s): *Derek J. Coffman*

Affiliation: NOAA

ABSTRACT:

Aerosol size distributions were measured onboard the NOAA RV Ronald H. Brown during TexAQS II - GoMACCS 2006 to help characterize the impact of aerosols on air quality and climate. Size distributions were collected over a diameter range of 0.020 to 10 mm at a constant RH of 60% which is directly comparable to the RH of the optical and chemical measurements. Particle size distributions (modal maximum diameter, width, and integral amount) are a function of the source and atmospheric processing of the aerosol. These properties of the size distribution, in turn, affect light extinction by the aerosol as well as water uptake and ability to form cloud condensation nuclei. Measured size distributions will be presented for different aerosol compositions (sources) encountered during the study including those resulting from urban, petrochemical, and marine vessel emissions; Saharan dust; and background marine aerosol from the Gulf of Mexico. Number, surface area, and volume size distributions will be compared for these different aerosol sources. In addition, examples will be presented of how the variability in these parameters affect aerosol optical and cloud nucleating properties.

The Optical Properties of Aerosols as Measured by Cavity Ring-Down Extinction Spectrometry during TexAQS II - GoMACCS 2006: Selection of Case Studies and their Implications for Air Quality and Climate

Author(s): *Paola Massoli, Tahllee Baynard, Daniel Lack, Patricia Quinn, Tim Bates, Edward Lovejoy, Derek Coffmann and A.R.Ravishankara*

Presenter(s): *Paola Massoli*

Affiliation: NOAA

ABSTRACT:

The cavity ring down aerosol extinction spectrometer (CRD-AES) developed at NOAA ESRL was deployed on the NOAA RV Ronald H. Brown during the TexAQS II - GoMACCS summer 2006 study in the Gulf of Mexico to assess the air quality of the Houston area and evaluate the radiative impact of aerosols on local and regional scales. The CRD-AES measured the aerosol extinction coefficient at three wavelengths (355, 532, 1064 nm) and at different relative humidities for both fine and coarse aerosol sizes. The optical properties of aerosols can vary significantly if the aerosol is hygroscopic and is exposed to varying relative humidity. Accurate estimates of such dependence (i.e., fRH) are therefore critical to properly quantify the direct forcing on climate by aerosols (aerosol direct effect). This work presents selected aerosol types of different chemical composition and origin, such as ship emissions, industrial emissions, urban outflow, and continental haze. The sampled aerosols are characterized by the optical properties that determine direct forcing on climate (i.e., optical depth, single scattering albedo, Angstrom exponent and fRH), coupled with chemical composition information. Hydrophobic character is shown by fresh emissions (such as ship plumes), whereas the continental outflow exhibits some variability depending on source, composition and degree of transformation. These data will be discussed with an emphasis on the variation of the optical properties with relative humidity and how this reflects on both local air quality and regional climate.

Comparing Aerosol Properties with Actinic Flux Measurements during TexAQS II

Author(s): *H. Stark, C. Brock, D. Parrish, and F.C. Fehsenfeld*

Presenter(s): *Harald Stark*

Affiliation: NOAA

ABSTRACT:

Aerosols are one of the key components of the atmosphere. During the 2006 Texas Air Quality Campaign (TexAQS II), various aerosol properties, such as aerosol optical extinction, size distribution, and black carbon concentration were measured on board the NOAA research aircraft WP-3. All of these aerosol parameters have a major influence on solar radiation. On board the WP-3, solar radiation was measured in the form of actinic fluxes by a spectroradiometer. The actinic flux represents the number of photons impacting a spherical air parcel per time interval integrated over 4π steradians, measured at individual wavelengths. In this study, we will show correlations between measured actinic fluxes and aerosol parameters. We will present measurements taken over the urban and industrial areas of Houston and Dallas and compare them with marine air over the Gulf of Mexico and rural areas over Texas.

Nocturnal Nitrogen Oxide Chemistry on Board R/V Brown

Author(s): *Hans D. Osthoff, James M. Roberts, Tim S. Bates, Derek Coffman, Patricia K. Quinn, Eric J. Williams, Brian M. Lerner, Roberto Sommariva, A. R. Ravishankara, and Steven S. Brown*

Presenter(s): *Hans D. Osthoff*

Affiliation: NOAA

ABSTRACT:

The nitrate radical, NO_3, formed from reaction of NO_2 with O_3, and dinitrogen pentoxide, N_2O_5, formed from subsequent reaction of NO_3 with NO_2, drive several important chemical processes, including oxidation of VOCs (by NO_3) and removal of NO_x (= NO + NO_2) by the heterogeneous reaction of N_2O_5 to form either nitric acid, HNO_3, and/or aerosol nitrates. Laboratory studies have shown that heterogeneous uptake of N_2O_5 on chloride containing aerosol can produce nitryl chloride, $ClNO_2$. Photolysis of $ClNO_2$ is believed to be a potential source of Cl atoms, an important oxidant of VOCs in the marine boundary layer. In spite of the potential importance of this halogen activation mechanism, field investigations have yet to directly confirm it.

We have measured NO_3 and N_2O_5, by cavity ring-down spectroscopy, and observed $ClNO_2$, by I^- chemical ionization mass spectrometry, on board the NOAA research vessel *Ronald H. Brown* during the Texas Air Quality Study - Gulf of Mexico Atmospheric Composition and Climate Study (TexAQS II / GoMACCS) 2006. In this presentation, a few aspects of the interaction between nitrogen oxide and halogen cycles in the subtropical marine boundary layer are highlighted, including $ClNO_2$ production from heterogeneous uptake of N_2O_5.

Cloud Nucleating Properties of Aerosols during TexAQS II - GoMACCS 2006

Author(s): *P.K. Quinn, T.S. Bates, D.J. Coffman, D.S. Covert, E.J. Williams, T.B. Onasch, J.D. Allan, and D. Worsnop*

Presenter(s): *Trish Quinn*

Affiliation: NOAA

ABSTRACT:

To determine the cloud nucleating properties of aerosols during TexAQS II - GoMACCS 2006, measurements were made of the aerosol number size distribution, aerosol chemical composition, and cloud condensation nuclei (CCN) concentration onboard the NOAA RV Ronald H. Brown. Over the course of the experiment, a wide range of aerosol sources and types was encountered. These included a mixture of Saharan dust and marine aerosol during the transit around Florida and across the Gulf of Mexico, urban emissions from Houston, and emissions from the petrochemical industries, oil platforms, and marine vessels in the Gulf coast region. Highest activation ratios (ratio of CCN to total particle number concentration) were measured in anthropogenic air masses when the aerosol was composed primarily of ammonium sulfate salts and in marine air masses with an aerosol composed of sulfate and sea salt. A strong gradient in activation ratio (values decreasing from about 0.8 to less than 0.1) was measured as the ship moved from the Gulf of Mexico to the end of the Houston Ship Channel and the aerosol changed from marine to industrial. Mass fractions of particulate organic matter (POM) ranged from near 0 to near 1 over the course of the experiment. This range of POM mass fractions was found to impact the cloud nucleating ability of the aerosol such that with increasing amounts of POM, fewer particles were activated to form CCN. The relationship between POM mass fraction and CCN concentration is remarkably consistent between source regions suggesting that the data may be used to develop parameterizations for use in guiding climate models. In addition, given the large variability in activation ratio, aerosol composition, and aerosol size distribution, the data set provides a benchmark against which to test models of aerosol activation and cloud condensation nuclei (CCN) formation.

Peak Ozone Concentrations on High and Low Wind Days Within and Outside of the Surface Measurement Network

Author(s): *Bob Banta et al.*

Presenter(s): *Bob Banta*

Affiliation: NOAA

ABSTRACT:

It is well known that the Houston area produces prodigious amounts of air pollutants, which produce large amounts of ozone. On lighter-wind days characterized by a reversal of the low-level flow due to sea-breeze forcing, these pollutants accumulate over the area and appear as high concentrations in the surface air-chemistry measurement network. Under higher-wind conditions, copious ozone is still produced, but the windier conditions produce lower initial concentrations near the sources, and the winds often carry the pollutants outside the measurement network. To assess these effects on the resulting concentrations of ozone, we used both the surface network and the airborne ozone-measurement platforms (NOAA Twin Otter ozone lidar and the P3 in-situ measurements) to measure peak add-on concentrations. These concentrations were compared for the surface network and for the airborne platforms, which were able to measure values outside the network on the windier days. Comparisons showed a drop in concentration with wind speed for both types of measurements, but the drop was much less dramatic for the airborne measurements, i.e., higher concentrations were found even on the higher-wind days, but outside the area measured by the network.

Surface Fluxes and Boundary Layer Structure over Galveston Bay, the Gulf of Mexico, and the Houston area

Author(s): *Wayne Angevine, Sara Tucker, Dan Wolfe, Ludovic Bariteau, Chris Fairall*

Presenter(s): *Wayne Angevine*

Affiliation: NOAA

ABSTRACT:

During the 2006 Texas Air Quality Study II, boundary layer measurements were made by instruments on the NOAA RV Ronald H. Brown as well as by radar wind profilers on land. Brown also carried instruments to measure surface heat and momentum fluxes and mixing intensity in the boundary layer. One somewhat surprising result is that the boundary layer over water was almost always slightly unstable, with positive surface heat flux. Mixing depths were moderate, although mixing was generally weak compared to that over land. Boundary layer heights over the water were substantially shallower than daytime heights over land. Models will need to account for the varying sea surface temperature.

Shipborne Ozone Flux Measurements during TexAQS II

Author(s): *L. Bariteau, D. Helmig, C. W. Fairall, J. Hueber, D. Wolfe, L. Ganzveld*

Presenter(s): *Ludovic Bariteau*

Affiliation: NOAA

ABSTRACT:

During the past years, direct observations of ozone deposition over the ocean have been rare and uncertain. Due to the limited knowledge of the physical and chemical processes involved in the oceanic ozone destruction, climate models typically use only one singular ozone deposition value for the oceans. In order to improve these models, and to have a better understanding of the deposition process into the oceans, the NOAA ESRL/Physical Science Division (PSD) in collaboration with the INSTAAR, University of Colorado, laboratory deployed a newly developed sensor aboard the R/V Ronald H. Brown during the 2006 Texas Air Quality Study (TexAQS II). This fast response monitor is based on the chemiluminescence principle and used to measure the ozone flux over the ocean by direct eddy correlation (EC). The preliminary results show a median value for the ozone deposition in the Gulf of Mexico of about 0.05 cm/s. On the other hand, higher values were found when the ship was near land, indicating the expected higher ozone deposition rates for land footprints.

Comparison of the Urban Heat Island Signature of Two Texas Cities: Dallas and Houston

Author(s): *Lisa Darby*

Presenter(s): *Lisa Darby*

Affiliation: NOAA

ABSTRACT:

Both Dallas and Houston, Texas have comprehensive networks of surface meteorology and chemistry sensors. The similarities of the networks and lack of terrain in Dallas and Houston allow for the comparison of their urban heat islands (UHI). The Dallas UHI, unperturbed by thermal flows driven by the land/sea temperature difference, is a well-defined phenomenon over the summers of 2000-2005. Including all weather conditions, the average nighttime Turban – Trural temperature difference was between 1.5º and 2.0º C and the average daytime difference was ~ 1.0º C. Analysis of Houston temperature data, however, revealed a different picture due to the bay and gulf breezes. While the Houston UHI was a distinct phenomenon, even when including all weather conditions, the bay or gulf breeze modified the Houston UHI by cooling the city. Average nighttime Turban – Trural temperature differences in Houston were also between 1.5º and 2.0º C. However, during the day, the rural areas to the north and west of the city were warmer than the downtown area (Turban – Trural = - 0.75 º C during afternoon hours) as a result of the east-to-west march of the sea breeze.

In addition to characterizing the Dallas and Houston UHIs under different weather conditions, we will look at the UHI effects on the surface winds of both cities. For Houston, we will look at the UHI impact on boundary layer height, using backscatter measurements from TOPAZ. Changes in surface winds and boundary layer heights due to the UHI are anticipated to impact the transport and horizontal variability of surface ozone. Finally, we will assess radiometer skin temperature data taken from Twin Otter transects over urban and rural areas, and compare the urban-rural skin temperature differences with the urban-rural surface air temperature differences.

Ozone and Aerosol Profiles from a Shipborne Lidar

Author(s): *Janet Machol, Brandi McCarty, Wynn Eberhard, Richard Marchbanks, Sara Tucker*

Presenter(s): *Janet Machol*

Affiliation: NOAA

ABSTRACT:

During TexAQS II, the OPAL lidar measured profiles of ozone and aerosol backscatter from aboard the NOAA Ship Ronald H. Brown. In addition to ozone concentration, derived profiles include total uncalibrated backscatter, calibrated aerosol backscatter and aerosol extinction at 355 nm. Other products are cloud heights, and aerosol layer heights (e.g. mixed-layer and residual layer heights). Measurements from a high-ozone day and several other case studies will be shown.

Mixing Between a Stratospheric Intrusion and a Biomass Burning Plume

Author(s): *Jerome Brioude*

Presenter(s): *Jerome Brioude*

Affiliation: NOAA

ABSTRACT:

Ozone, carbon monoxide, aerosol extinction coefficient, HNO3 and acetonitrile measured by the NOAA P3 aircraft during the TexAQS II / GoMACCS 2006 experiment, indicate mixing between a biomass burning plume and a stratospheric intrusion in the free troposphere above eastern Texas. Lagrangian-based transport analysis with FLEXPART model and satellite imagery are used to investigate the transport mechanisms that bring together the tropopause fold and the biomass burning plume. A review of the available FLEXPART products for TexAQS II / GoMACCS is shown

Comparison of Air Quality Forecast Model Predictions with WP-3 Data during TexAQS II

Author(s): *S. McKeen, G. Grell, S. Peckham, J. McQueen, P. Lee, W. Gong, V. Bouchet, Y. Tang, G. Carmichael, and J. McHenry*

Presenter(s): *Stuart McKeen*

Affiliation: NOAA

ABSTRACT:

As part of the TexAQS II study, the real-time results from nine air quality forecast models predicting ozone and $PM_{2.5}$ were collected and saved for post-experiment analysis. This talk presents the products and analysis used for the initial evaluation of six of these forecast models compared to data collected by the NOAA WP-3 aircraft. The forecast models include two versions of the NOAA/ESRL/GSD WRF/Chem model, a developmental version of the NWS/NCEP CMAQ/WRF model, the Canadian Meteorological Services AURAMS model, the University of Iowa STEM-2K3 model, and the MAQSIP-RT model run by Baron AMS Corporation. A web-based display of three products was constructed to aid in the forecast-model comparisons. First, 32 chemical, aerosol, radiation, and meteorological variables are displayed on a flight-by-flight basis for individual vertical profiles and horizontal transects. The second product focuses on the comparison of upwind conditions, and downwind fluxes relative to horizontal flight transects between 300 and 650 meters AGL in the vicinity of Houston, Dallas, and stack NOx sources in east Texas. The third set of analysis products compares ratios of fluxes downwind of these same source regions in an attempt to identify model deficiencies in emissions and photochemical processing. This talk only outlines the datasets, variables, and methodologies used in the comparisons. A consensus from the individual forecasting centers is necessary in order to provide an unbiased interpretation of the model/observation comparisons.

"Black Carbon" Detailed Measurements from Houston Shipping

Author(s): *Daniel Lack*

Presenter(s): *Dan Lack*

Affiliation: NOAA

ABSTRACT:

Emission factors of light absorbing carbon (LAC), (what has been known as "black carbon") from shipping traffic were measured using a photoacoustic instrument onboard the Ronald H Brown (RHB) during TexAQS II / GoMACCS 2006 campaign. LAC Emission factors for 116 individual ship plumes were measured. LAC emission factors by vessel class speed and gas phase emission products were determined.

It was found that tug boats have the highest emission factors of any vessel class, while results indicate no relationship of LAC emission with vessel speed. Perhaps the most interesting result is the trend of increasing LAC emission as sulfate content of the fuel decreases.

These extensive direct measurements compare to a single direct measurement and a single indirect calculation used for the most recent LAC emission inventory. These results will contribute substantial information for the climate and air quality effects of the emission of LAC from commercial shipping.

Cloud Condensation Nuclei Closure during the Texas Air Quality Study of 2006

Author(s): *A. Asa-Awuku, C. Brock, R. Bahreini, A. Middlebrook, D. Tanner, G. Huey, A. Nenes*

Presenter(s): *Athanasios Nenes*

Affiliation: NOAA

ABSTRACT:

Aerosols significantly impact global and regional climate, by acting as cloud condensation nuclei (CCN) and affecting cloud albedo. CCN closure, or comparison of predictions with observations of CCN concentrations, is the ultimate test of theory linking aerosols with clouds. Closure is not always achieved (especially in polluted conditions) and is explored in this study, but using the aerosol size distributions, chemical composition and CCN measurements collected onboard from the NOAA-P3 during TexAQS II.

Marine Boundary Layer Dynamics and Heights during TexAQS II: HRDL Measurements from the RV Brown

Author(s): *Sara Tucker, Alan Brewer, Scott Sandberg, Ann Weickmann, Daniel Law, and Joanne George*

Presenter(s): *Sara Tucker*

Affiliation: NOAA

ABSTRACT:

During the Texas 2006 Air Quality Study, NOAA's High Resolution Doppler Lidar (HRDL) performed continuous measurements of boundary layer winds and relative aerosol backscatter from the aft deck of the RV Brown. Such measurements, and their derived data products, provide context and transport information, including boundary layer mixing and aerosol layer heights, for the in-situ aerosol and gas-phase chemistry measurements. Additional HRDL products include information about aerosol layering and dust events, mixing strength/velocity variance, plume detection, and characterization of marine boundary layer dynamics - including turbulence, surface streaks, rolls, and gravity waves. We present an overview of the HRDL data products and examples of their contributions to the understanding of high pollution events.

Ship-Based LIDAR Estimates of Marine Mixed Layer Heights during TexAQS II

Author(s): *Sara Tucker, Brandi McCarty, Alan Brewer, Janet Machol, Scott Sandberg, and Richard Marchbanks*

Presenter(s): *Sara Tucker*

Affiliation: NOAA

ABSTRACT:

Using data from the High Resolution Doppler Lidar (HRDL) and the Ozone Profiling Atmospheric Lidar (OPAL), acquired while on the RV Brown during TexAQS II, we are developing methods to estimate and visualize mixed layer heights as determined by aerosol layering, vertical velocity variance (mixing strength) profiles, and wind shear. Mixing is usually the result of convection and/or shear-induced mechanical turbulence. Either type of mixing can effect the blending of the surface and residual aerosol/pollution layers. We present an overview of the methods used in the estimation process and provide examples of marine mixed layer heights, as well as their interpretation, from various conditions encountered during the experiment.

[Acknowledgements: Ann Weickmann, Daniel Law, Wayne Angevine, Joanne George, Wynn Eberhard, and Mike Hardesty]

An Evaluation of NMM-CMAQ and WRF-Chem during High Ozone Episodes in TexAQS II

Author(s): *James Wilczak, Laura Bianco, Irinia Djalalova, Stu McKeen*

Presenter(s): *James Wilczak*

Affiliation: NOAA

ABSTRACT:

The skill of the NMM-CMAQ and WRF-Chem models in predicting high-ozone episodes occurring during the TexAQS II field program are evaluated using both meteorological and surface ozone observations. In particular, wind and RASS temperature profiles and boundary layer depths from a network of 9 wind profilers are used to document geographical variations in the mean boundary layer structure across east Texas, and to assess the ability of the models to replicate these variations. Deviations of the meteorology from the mean boundary layer structure are then calculated for high ozone episodes in both the observations and models. The impact of meteorological errors on ozone predictive skill is assessed by comparing the observed and model deviation fields.

VOCs Measured with a GC-MS aboard the Ronald H. Brown during TexAQS II and their OH Reactivity

Author(s): *Jessica B. Gilman, William C. Kuster, Paul D. Goldan, and Joost de Gouw*

Presenter(s): *Jessica B. Gilman*

Affiliation: NOAA

ABSTRACT:

Volatile Organic Compounds (VOCs) are a vital ingredient in the photochemical production of ozone. Many of these compounds are also air toxics and can adversely affect local and regional air quality. Along the gulf coast of Texas there is an immense variety of industrial, urban, and natural sources of these compounds. A GC-MS (Gas Chromatograph-Mass Spectrometer) was used to fully speciate and quantify a wide variety of VOCs aboard the Ronald H. Brown during TexAQS II / GoMACCS 2006 in an effort to identify and characterize their sources. An overview of the data set collected will be presented with an emphasis on the most reactive VOCs that largely contribute to photochemical ozone production in the Houston/Galveston area. Mixing ratios for ethene, propene, and isoprene will be compared for data collected at La Porte, Texas in 2000 and nearby in Barbour's Cut in 2006.

Verification of Ozone Forecast Modeling during TexAQS II

Author(s): *Bryan Lambeth*

Presenter(s): *Bryan Lambeth*

Affiliation: Texas Commission on Environmental Quality (TCEQ)

ABSTRACT:

Ozone forecast model output from the University of Houston and from the National Weather Service are compared on a daily basis for the intensive study period in August and September of 2006. The peak 8-hour ozone forecasts are compared to a mid-day weather map and to measured peak 8-hour ozone for the day. Several individual daily episodes are also examined on an hourly basis in comparison to measured data including estimated plume positions from major industrial facilities and urban areas.

Modeling and Measurements of Biogenic Isoprene in Southeast Texas

Author(s): *Mark Estes, Clint Harper, and Jim Smith*

Presenter(s): *Mark Estes*

Affiliation: Texas Commission on Environmental Quality (TCEQ)

ABSTRACT:

Biogenic isoprene usually contributes to ozone formation in Houston, and occasionally plays a dominant role. Therefore, much effort has been expended to improve estimates of biogenic isoprene emissions in southeastern Texas. A new land cover and vegetation data set has been developed for this area in order to update and refine the biogenic emissions inventory. The new data sets will be described and contrasted to their predecessors.

In order to evaluate biogenic isoprene emissions estimates, isoprene measurements have been made using automated gas chromatography at twelve sites in the greater Houston area. Isoprene measurements have been analyzed in order to identify which monitoring sites are most strongly affected by anthropogenic and biogenic isoprene emissions, to study the diurnal cycle of isoprene in different environments, and to study the seasonal and inter-annual variation of isoprene during 1997-2006.

Comparison of Speciated $PM_{2.5}$ Measurements in 2006 versus 2002-2005

Author(s): *Bryan Lambeth*

Presenter(s): *Bryan Lambeth*

Affiliation: Texas Commission on Environmental Quality (TCEQ)

ABSTRACT:

Time series of daily 8-hour ozone peak, $PM_{2.5}$ daily average, and speciated $PM_{2.5}$ sulfate, organic carbon, and silicon daily averages are compared for the May-September period for each year from 2002 through 2006. The highest and lowest ozone and $PM_{2.5}$ daily values for the Houston area are shown, with the lowest values serving to show a conservative estimate of the regional background levels. The silicon measurements help to identify Saharan dust episodes and the sulfate measurements indicate relative impacts from industrial sulfur dioxide sources. The organic carbon measurements may in some cases help to identify smoke contribution from controlled burning and wildfires.

Dust Storms as Natural Events for Regional Haze and Particulate Matter in West Texas

Author(s): *Stuart Dattner*

Presenter(s): *Stuart Dattner*

Affiliation: Texas Commission on Environmental Quality (TCEQ)

ABSTRACT:

Dust storm events are recurring natural air pollution episodes that are not controllable by Texas. Dust storms are contributing factors of many of the highest regional haze and particulate matter (PM) events measured in West Texas. West Texas is one of the areas of the continental United States with a high probability of dust storms due to the combination of eroded soils and high wind speeds in the Chihuahuan Desert. It is likely that these dust storms will continue in the future. Texas cannot control these events, and dust events should be considered part of the natural conditions in the Regional Haze State Implementation Plan (SIP).

This document proposes the use of a set of explicit scientific criteria to identify individual dust storms. These criteria use a wide variety of publicly available air quality data, satellite images, photographic images, and meteorological measurements. Full documentation of a single episode day shows that these criteria reinforce one another. Using these criteria, we have identified all the major dust storm days in the 2000 through 2004 base period for regional haze planning.

Assuming that the dust storms are major natural events in West Texas, one way of estimating natural conditions at Guadalupe Mountains National Park derives a value of 14 deciviews. This result compares with the EPA default estimate of 7 deciviews. The glide slope for determining progress would be less steep using the estimate of natural conditions derived from dust storm data than it would using EPA's default estimate.

One way of estimating natural conditions for Big Bend National Park based on only dust storms appears to produce too low an estimate (4 deciviews) of natural conditions to be plausible. Further studies will be needed to accurately estimate Big Bend's natural conditions. Recent studies of Big Bend have indicated that international transport of air pollutants is a major source of haze at the park. For this reason there are limits on the amount of progress achievable by reducing anthropogenic emissions from Texas and the rest of the U.S.

A Look at Reported VOC Emissions in the 2006 Houston Hourly EI

Author(s): *John Jolly and Danielle Nesvacil*

Presenter(s): *John Jolly*

Affiliation: Texas Commission on Environmental Quality (TCEQ)

ABSTRACT:

In spite of the well-documented finding that point source VOC emissions were heavily underreported in the 2000 and earlier HGB emission inventories, the most recent complete TCEQ EI (from 2004) shows little change in reported VOCs. In the present study, VOC emissions data from the HGB 2006 hourly EI, the first publicly-available inventory from the area containing numerous emissions estimates based on HRVOC process flow monitoring data, are examined and compared to data from the TCEQ annual EI. We analyze emissions from different process unit types (such as flares and cooling towers), different facility types (e.g. refineries), and different VOC species in an effort to see how the VOC EI is responding to the regulations requiring the HRVOC flow monitoring.

Applications of Satellite Remote Sensing Data for Estimating Dry Deposition in Eastern Texas

Author(s): *Michael S. Feldman, Teresa Howard, Elena McDonald-Buller, Gayla Mullins, David T. Allen, Alba Webb, and Yosuke Kimura*

Presenter(s): *Michael S. Feldman*

Affiliation: University of Texas at Austin, Center for Energy and Environmental Resources

ABSTRACT:

The sensitivity of dry deposition velocities and air quality model predictions in Eastern Texas to land use/land cover (LULC) data is examined. Four LULC datasets are employed; three of the datasets are derived from recent satellite imagery and the fourth dataset is the LULC database currently used in air quality models by the State of Texas. Effects of the land cover data on estimates of dry deposition velocities and modeled ozone concentrations are examined using the Comprehensive Air Quality Model with extensions (CAMx) during an August 22-September 6, 2000 episode developed for the Houston/Galveston area. The purpose of this effort is not only to provide more accurate data for emissions and air quality modeling, but also to assess the overall sensitivity of model predictions to land cover data and to provide recommendations to the State of Texas regarding the frequency and methodology for future updates. All land cover datasets showed good general agreement with a few significant differences in classification and spatial extent of certain land cover categories. Dry deposition decreased in urban areas with the new land cover data during peak hours on some days, leading to ozone concentrations that were approximately 2 ppb higher in the Houston area. Ozone concentrations were lower west of Houston due to increased stomatal uptake by increased agricultural land coverage in the new data sets. These results indicate that the satellite-based LULC data, specifically the data derived from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument, can be used to provide periodic updates to land cover information used in CAMx and similar photochemical models.

Applications of Satellite Remote Sensing Data for Estimating Biogenic Emissions in Southeastern Texas

Author(s): *Michael S. Feldman, Teresa Howard, Elena McDonald-Buller, Gayla Mullins, and David T. Allen*

Presenter(s): *Michael S. Feldman*

Affiliation: University of Texas at Austin, Center for Energy and Environmental Resources

ABSTRACT:

Biogenic hydrocarbons are emitted in substantial quantities by vegetation and dominate the overall volatile organic compound emission inventory in eastern Texas. Spatial distributions of biogenic emissions in Texas are heterogeneous, and biogenic emission processes are affected by the characterization of land cover, leaf area index, drought stress, and surface temperatures. The sensitivity of biogenic emission estimates and air quality model predictions to the characterization of land use/land cover (LULC) in southeastern Texas is examined in this study. A LULC database has been developed for the region based on source imagery from the United States Geological Survey collected by the Landsat 7 Enhanced Thematic Mapper-Plus (ETM+) sensor between 1999 and 2003, and data from field studies used for species identification and quantification of leaf biomass. This database and the LULC database currently used in regulatory air quality models by the State of Texas are compared. Effects of the LULC data on biogenic emission estimates and modeled ozone concentrations are examined using the Global Biosphere Emissions and Interactions System (GloBEIS) and the Comprehensive Air Quality Model with extensions (CAMx) during an August 22-September 6, 2000 episode developed for the Houston/Galveston area. Biogenic emissions estimated from the new LULC dataset showed good general spatial agreement with those from the current LULC dataset but significantly lower emissions (~40% less hourly emissions across the modeling domain), primarily due to differences in biomass density of key emitter species like Quercus (Oak). Predicted ozone concentrations using the biogenic emissions produced from the new LULC dataset are as much as 25 ppb lower in some areas on some days, depending on meteorological conditions. Satellite data and image classification techniques provide a useful tool for the mapping and monitoring of changes in LULC. However, field validation is necessary to link species and biomass densities to the classification system used for accurate biogenic emissions estimates, especially in areas such as riparian corridors that contain concentrations of key emitter species.

Evaluation of the 2005/2006 Eastern Texas Air Quality (ETAQ) Forecasting System for Ozone and Particulate Matters

Author(s): *D. W. Byun, M.-D. Jang, X. Li, D. Lee, S. T. Kim, H.C. Kim, F. Ngan, I.B. Oh, and F. Cheng*

Presenter(s): *Daewon Byun*

Affiliation: Institute for Multidimensional Air Quality Studies, College of Natural Sciences and Mathematics, University of Houston

ABSTRACT:

Numerical forecasting of meteorological and photochemical conditions was performed to support the Second Texas Air Quality Study (TexAQS II), June 2005-October 2006, whose main objective was to understand the meteorological and chemical processes of high ozone and regional haze events in the Eastern Texas, including the Houston-Galveston area (HGA), Texas, USA. The real-time forecasting was used for planning of daily field program operations, and to provide information on the suitability of particular cases for future modeling activities.

The air quality forecasting system was based on the MM5/SMOKE/CMAQ modeling system. We performed two independent 54-hour air quality forecasting simulations with the 12-km Eastern Texas regional domain, and the 4-km HGA and Dallas-Fort Worth (DFW) domains for different meteorology and emissions inputs. The dynamic boundary conditions were provided by the 36-km resolution conterminous US (CONUS) domain CMAQ simulations. Initial meteorological conditions were provided by the NCEP's daily NAM forecast results. The nature of these forecasts and the time at which the initial data was available necessitates that models be executed within tight deadlines. A set of complex operational scripts was used to allow automatic operation of the data download, sequencing processors, performing graphical analysis, building database archives, and presenting on the web.

The ozone and PM forecasting results for 2005/2006 are evaluated daily with meteorological and air quality measurements from the surface stations, tower, ozonesonde, and aircraft. Sensitivity studies have been performed to establish optimal model configurations and emissions inputs for the improved forecasting

Sensitivity of the 2006 TexAQS II Air Quality Simulations to Model Inputs: ICs, BCs, Emissions, and Meteorology

Author(s): *D. W. Byun*, S. T. Kim, F. Ngan, X. Li, D. Lee, H.C. Kim, I.B. Oh, and F. Cheng*

Presenter(s): *Daewon Byun*

Affiliation: Institute for Multidimensional Air Quality Studies, College of Natural Sciences and Mathematics, University of Houston

ABSTRACT:

Whether it was real or just perception, forecasting of air quality for year 2006 seemed more difficult than 2005. One apparent difference in the model inputs from 2005 was that NCEP WRF/NMM forecasting result, instead of Eta, was used since June 1, 2006. There was some unconfirmed report that WRF/NMM generated too strong tropical storms during summer 2006 in the Gulf of Mexico, which resulted in rather too strong North-Easterly flows occasionally.

It is desired to use relatively accurate initial concentration fields of ozone and its precursors at the start of the model simulations. However, currently the ETAQ forecasting systems utilize the results of the last hour of the previous day's forecast as the initial conditions for the simulation day. Therefore, the forecasting of the following day can be unduly influenced by the inaccurate simulation results caused either by the bad meteorological forecasts or by the real-life emissions upset events.

In the first part of presentation, we will discuss results of two sensitivity CMAQ simulation results; one that addresses uncertainty in the initial conditions for the daily forecasting and the other that compares differences in ozone and NOx concentrations between the CB-4 and SAPRC chemical mechanisms.

In the second part, we will discuss how a multi-step nested four-dimensional data assimilation (MS-FDDA) method improves the meteorological simulations. The MS-FDDA is repeatedly applied at multiple nest domains to minimize the forecasting errors at the target domains. The scheme needs to be refined and evaluated further but the preliminary results seem very promising. Although it may not be an innovative scheme but the end result is very beneficial for correcting the meteorological forecasting errors.

Moody Tower Measurements - Overview

Author(s): *Bernhard Rappenglueck, Barry Lefer, Dean Atkinson, Sarah Brooks, Steve Brooks, Bill Brune, Patrick Chuang, Don Collins, Jack Dibb, Connor Flynn, Matt Fraser, Rob Griffin, Winston Luke, Jochen Stutz, Rodney Weber, Renyi Zhang*

Presenter(s): *Bernhard Rappenglueck*

Affiliation(s): University of Houston, Portland State University, Texas A&M, NOAA-ARL, Penn State University, University of California Santa Cruz, University of New Hampshire, PNNL, Rice University, UCLA, Georgia Tech

ABSTRACT:

During August and September 2006 the University of Houston (UH) contributed to the Texas Air Quality Study II (TexAQS II) through a broad variety of activities. Supported by the Houston Advanced Research Center (HARC) UH set up and coordinated the Moody Tower supersite on the UH campus which included about 50 scientists. At this site a comprehensive data set was collected covering meteorological parameters, gas-phase chemistry using in-situ and long path instrumentation, physical and chemical aerosol properties including analysis of inorganic and organic aerosol content, and highly resolved measurements of the atmospheric radiation field including a wide range of photolysis rates which are critical for photochemical processes.

Ozone data obtained at the Moody Tower indicate a large variability ranging from low background values (about 30 ppb) associated with air masses coming from SW (Gulf of Mexico) to peak values up to 160 ppb under E conditions pointing to the Ship Channel. Preliminary data obtained on the Moody Tower during TexAQS II indicate that on various occasions elevated levels of HONO and formaldehyde were observed, which may likely serve as important sources for OH, in particular during the morning hours. During nighttimes quite frequently OH and HO_2 were found in considerable amounts, especially under high nighttime ozone levels. It is suggested that subsequent reaction of HO_2 and NO may enhance O_3 formation. Preliminary analysis of particulate matter (PM) shows that mass concentrations were dominated by organic material and sulfate aerosol. Organic aerosol concentrations often showed a large increase in the morning and again late in the day. Total number concentrations seemed to follow organic aerosol species. At times large spikes in nitrate aerosol were observed that appeared to be associated with organic aerosol material. The increase may likely correspond to a rapid decrease in gas-phase concentrations of nitric acid. Diurnal concentration pattern of water soluble organics appeared to compare well with data determined by the aerosol mass spectrometer. Preliminary analysis showed that observed midday peaks appeared to be due to oxidation of primary organic emissions, which increases the solubility of the organic compounds.

So far there is no clear indication of a single dominant source of PM in Houston. Emissions from local industries often contribute dramatically, if episodically, including impacts from power plants as indicated by elevated SO_2 levels, however also the influence of traffic was evident.

Analysis of Vertical Ozone Distribution Above the University of Houston

Author(s): [1]*Ryan Perna,* [1]*Bridget McEvoy-Day,* [1]*Renee Boudreaux,* [1]*Bernhard Rappenglueck,* [2]*Gary Morris*

Presenter(s): *Ryan Perna*

Affiliation: [1]University of Houston, [2]Valparaiso University

Abstract:

During TexAQS II ozonesondes were launched on 20 days during August 2006 and 11 days during September 2006 from UH campus to retrieve information about the vertical distribution of ozone. Launches occurred at approximately 1300 CDT. On intensive operation periods, two launches were performed; at 700 and approximately 1300 CDT.

First results from these soundings address (1) the relation of the vertical ozone structure to surface ozone observations, (2) the identification of the relative role of regional transport and local concentration in determining the vertical ozone distribution and (3) the description of ozone distribution within the free troposphere, and how it varies with regional transport patterns.

Preliminary analysis suggests that about 10 ppbv of ozone may be considered as left-over O_3 from the previous day and remain in the residual layer. In addition, preliminary analysis of ozonesonde data also shows that regional-scale transport may have an impact on local O_3 levels. Depending on the air mass origin background ozone levels may range from 30 ppbv (marine) to close to 60-70 ppbv (continental).

Vertical O_3 profiles frequently showed specific layers with enhanced values. In most cases these layers occur above 3.000 m a.g.l. and do not have a vertical extension larger than 500 m. Often, O_3 enhancement is about 10-20 ppbv, but can also reach up to 40 ppbv. Possible source areas are Mexico and the Rocky Mountains and may be associated with biomass burning or eventually urban sources. So far, the preliminary analyses do not show impacts coming from the industrial areas in the northeast of the US.

The results so far indicate that PBL effects on ozone levels cannot be considered as an isolated process. Various effects likely superimpose and require further analysis. In particular, the contribution from ozone in the residual layer, free troposphere and from the continental/marine background may be important.

An Insight into the Vertical Structure of the Atmosphere during TexAQS-II: Understanding the Effect of the Upper-Level Meteorology on Houston's Surface Ozone Levels

Author(s): *Ryan Perna*[1], *Bernhard Rappenglueck*[1], *Sharon Zhong*[2]

Presenter(s): *Ryan Perna*

Affiliation: [1]University of Houston, [2]Michigan State University

ABSTRACT:

Despite reductions in automobile and industrial emissions, Houston continues to be designated as a non-attainment area for ozone (O_3) by the Environmental Protection Agency (EPA). Upper-level synoptic maps and vertical atmospheric temperature structures associated with Houston's ozone episodes were analyzed in order to assist with better air quality forecasts in the future. This study focuses on ozone episodes where the peak 8 hour average exceeded 85 ppb which occurred in August and September 2006 during the Texas Air Quality Study II (TexAQS II). Synoptic composite maps of geopotential height show that a close proximity of an upper-level ridge can increase the probability that Houston will experience elevated ozone levels. Also, rawinsonde soundings were launched twice daily at 0700 and 1900 central daylight time (CDT), with 4 additional soundings on intensive operations days. These soundings revealed a contrast between the episode days of August and those of September. It is demonstrated that most ozone episodes occurred in a post-frontal environment. The northerly or northeasterly winds behind a cold front helped to increase background ozone levels which contribute to an increase in Houston's average 8 hour ozone peak. Analyses of inversions present in the soundings revealed that the strength of the morning radiation inversion is not a major factor in Houston's ozone concentration. However, September episode days usually exhibited an elevated inversion. This inversion may not have a direct effect on Houston's ozone concentration; however it could be a sounding feature which could assist air quality forecasters in the future.

Measurements of VOC, PAN, Formaldehyde, and Hydrogen Peroxide at the Moody Tower Site, Houston

Author(s): *Michael Leuchner, Bridget McEvoy-Day, and Bernhard Rappenglück*

Presenter(s): *Michael Leuchner*

Affiliation: University of Houston

ABSTRACT:

During the TexAQS II campaign in summer 2006 continuous online air quality measurements including a large suite of volatile organic compounds (VOCs), peroxycarboxylic nitric anhydrides (PANs), formaldehyde, and hydrogen peroxide were performed at the Moody Tower supersite (60 m a.g.l.) on the University of Houston main campus.

First analysis of VOC results indicates complex mixtures from traffic, industrial, and biogenic sources. Formaldehyde measurements mainly reflect secondary production due to the degradation of VOCs, but also primary sources may contribute, mostly visible during nighttime and early morning hours. PANs show distinctive peaks. Ratios of peroxiacetic nitric anhydride (PAN) and peroxipropionic nitric anhydride (PPN) occasionally varied indicating different precursor pools for these species. VOCs, PANs, and formaldehyde showed a wide dynamic range basically due to the mixing layer height, photochemical processes and location of emission sources. Distinctive dependence on wind direction was observed. Higher levels of VOCs, PANs, and formaldehyde are closely associated with air masses originating from the Houston Ship Channel. Typical diurnal variations of hydrogen peroxide show minimum values in the early morning and maxima in the late afternoon ranging up to 1.4 ppbv.

A first principal component analysis of a set of C2-C8 VOCs was performed. Distinct factors could be extracted supporting the differentiation among contributing anthropogenic and biogenic sources.

Measurements of Ozone, CO, NO, NO_2, NO_x, and Photolysis Frequencies at the Moody Tower

Author(s): *James Flynn, Barry Lefer, Bernhard Rappenglück*

Presenter: *James Flynn*

Affiliation(s): University of Houston

ABSTRACT:

Ozone is a recognized tropospheric pollutant which leads to reductions in agricultural yields and is a respiratory irritant. Ozone and CO were measured with standard TEI 49c and 48c-TLE instruments, respectively. Measurements of NO, NO_2, and NOx were made with a TEI 42c-TL instrument coupled with a NO_2 specific photolytic converter from DMT. Photolysis frequencies were calculated using actinic flux measured with an NCAR Scanning Actinic Flux Spectroradiometer (SAFS) and a Metcon Diode Array Actinic Flux Spectroradiometer (DAAFS). These measurements were taken on the roof of the North Moody Tower on UH main campus as part of the TexAQS II Radical Measurement Project (TRAMP). Spatial and temporal dependencies of ozone and precursors are examined as well as the variability in photolysis frequencies under varying sky conditions.

Atmospheric OH, HO_2 and OH Reactivity Measurements at the Moody Tower

Author(s): *Bill Brune, Xinrong Ren, Jingqiu Mao, Zhong Chen, Chris Beatty, Maria Cazorla-Andrade, Bernhard Rappenglueck, Barry Lefer, James Flynn, Michael Leuchner*

Presenter(s): *Bernhard Rappenglueck*

Affiliation: Pennsylvania State University / University of Houston

ABSTRACT:

Oxidation chemistry in the atmosphere is dominated by the hydroxyl radical, OH, but involves the hydroperoxyl radical, HO_2, together called HOx. Measurements of OH, HO_2 and OH reactivity were made with our Ground-based Tropospheric Hydrogen Oxides Sensor (GTHOS) and Measurement of Atmospheric OH Reactivity (MAOHR) as part of a much larger measurement suite from the Moody Tower during TRAMP in the summer of 2006. This study provided an excellent test of photochemical oxidation chemistry in an urban environment. Measured HOx and OH reactivity are compared to values calculated with a box model and using other measured chemical species which can react with OH. HOx behavior in different air masses is examined and the discrepancies between observations and models will be discussed.

Overview of the Baylor University Airborne Measurements Collected in 2006

Author(s): *Martin Buhr[2], Sergio Alvarez[1], Maxwell Shauck[1], Grazia Zanin[1], Greg Yarwood[3]*

Presenter(s): *Martin Buhr*

Affiliation: [1.]Baylor University, [2.]Air Quality Design, Inc., [3.]Environ, Inc.

ABSTRACT:

Measurements of ozone and ozone precursors were collected using the Baylor University Piper Aztec aircraft in the Houston area and in northeast Texas during the summer and fall of 2006. The measurements included 5-second average data for O_3, NO, NO_2, NOy, SO_2, CO, HCHO, integrated particle light scattering (3λ), and meteorological parameters over the course of 90 flight hours (40 flight hours in Houston and 50 flight hours in northeast Texas). An overview of the flights conducted will be presented. A more detailed evaluation of the impact of interstate transport of pollutants into northeast Texas and the sources of formaldehyde observed in the Houston area will be discussed.

A Case Study using Aircraft Measurements and NOAA Hysplit Trajectory Analysis to Identify Unknown Emission Sources in Northeast Texas and Louisiana

Author(s): *Sergio Alvarez[1], Martin Buhr[2], Maxwell Shauck[1], Grazia Zanin[1], Greg Yarwood[3]*

Presenter(s): *Sergio Alvarez*

Affiliation: [1.] Baylor University, [2.] Air Quality Design, Inc., [3.] Environ, Inc.

ABSTRACT:

During the 2005 and 2006 monitoring seasons, plumes from unknown emission sources in the northeast Texas were sampled by the Baylor University Piper Aztec. Some unexpected sources (e.g., forest fires) were identified. However, the most prominent ones, detected on both years on five different occasions, were plumes on the transit leg from Waco, Texas to the Texas-Louisiana border (North of the Toledo Band Reservoir) and plumes on the flight path along the Texas-Louisiana border. The unidentified plumes on the transit leg were detected on September 2nd, 4th and 5th, 2005. They appeared to be advected from the Mansfield, Louisiana, surrounding area. A monitoring mission was dedicated to investigate this matter with one science flight flown from Waco to the Dolet Hills electric generating unit (EGU) near Mansfield, on September 8, 2005. NOAA Hysplit trajectory analyses suggest that the unidentified plume may be emitted by the Mansfield paper mill on at least this occasion. Additional analyses of these plumes from unidentified point sources will be presented as well as two episodes in 2006.

Characterization of the Local Wind Circulations and Planetary Boundary Layer Development in the Houston-Galveston Area

Author(s): *Monica Patel, Barry Lefer, Craig Clements, Fong Ngan, DaeGyun Lee*

Presenter(s): *Monica R. Patel*

Affiliation: University of Houston

ABSTRACT:

During the summer season, a driving factor of pollutant buildup and transport is due to local circulations, including the sea-land and bay breezes produced by the temperature contrasts between land and the Gulf of Mexico or Galveston Bay in the Houston-Galveston Area. Pollutant dispersion and transport from a major source area like the Houston Ship Channel (HSC) is of particular importance because it is a major distributor of ozone and its precursors from its many petrochemical refineries to more populated areas of Houston. Local wind circulation and the height of the planetary boundary layer are the two primary meteorological controls on the concentration of pollutants. This study focuses on mesoscale circulations during ozone episode day September 26, 2006 when rawinsonde soundings were conducted inside the HSC and on the University of Houston campus. Analysis of the vertical wind structure from these datasets can indicate the strength of the sea-land and bay breezes. The sea breeze primarily is a southerly wind component occurring in the late afternoon or early evening whereas the bay breeze has a more southeasterly wind occurring earlier in the day. The breezes are most prominent when the ambient winds are weak, or when the large scale pressure gradient is not strong. The onset of sea and bay breeze circulation is indicated by the decrease of temperature, the rise of relative humidity, and the increase in wind speed from the corresponding wind direction. Observing the potential temperature and water vapor mixing ratio vertical profiles from the soundings can help determine the boundary layer height throughout a day. Typically, the boundary layer height is much lower at the HSC site compared to the UH site due to less convective mixing over water surfaces. Model verification will also be conducted using the meteorological inputs to the UH CMAQ Air Quality model, specifically boundary layer height and local wind circulation in the HSC.

Ambient Observations of Aerosol Optical Properties during TexAQS II Using Cavity Ring-Down

Author(s): *Monica E. Wright, Dean B. Atkinson*

Presenter(s): *Monica E. Wright*

Affiliation: Portland State University

ABSTRACT:

High levels of fine aerosols in the urban atmosphere can impact both human health and the regional climate. Exposure to ambient aerosol at any level increases the risk of cardiovascular disease and certain types of cancer. In addition, aerosols are a major contributor to regional haze and affect cloud formation. Measurements of aerosol extinction and scattering made using a tandem cavity ring-down transmissometer/nephelometer (CRDT/N) instrument during the TexAQS II study can test and refine the accuracy of atmospheric models used to estimate urban PM exposure levels. The daily average particle extinction at 532 nm in Houston from August 14 to September 28, 2006 varied between 79.1 ± 4.8 Mm^{-1} and 126.7 ± 7.5 Mm^{-1} depending on the day of the week. The daily average scattering at 530 nm was 56.3 ± 1.1, which corresponds to an average concentration of 8.4 $\mu g/m^3$ scattering particles over the course of the study. The 532 nm particle absorption and single scattering albedo (SSA) are also derived from the measured extinction and scattering coefficients. The average SSA during the study period was 0.55. Daily average absorption coefficients ranged between 33.6 Mm^{-1} and 57.5 Mm^{-1}. The study period average was 47.8 Mm^{-1}, which corresponds to a mass concentration of 6.3 $\mu g/m^3$ for light absorbing carbon. The calculated scattering and absorbing particle concentrations indicate that the Houston Area had an average particle concentration of 14.7 $\mu g/m^3$ during the six week TexAQS II study. This value is just shy of the annual National Ambient Air Quality Standard (NQAAS) 24 hour average of 15$\mu g/m^3$ for $PM_{2.5}$.

Vertical Profiles of O_3, NO_2, SO_2, HCHO, HONO, and NO_3 in Houston

Author(s): *Jochen Stutz, Olga Pikelnaya, Hoon-Ju Oh, and Stephen C. Hurlock*

Presenter(s): *Bernhard Rappenglueck*

Affiliation: Dept. Atmospheric and Oceanic Sciences, UCLA

ABSTRACT:

Nocturnal chemistry in urban areas can considerably influence the composition of the boundary layer by removing pollutants, and changing the size and composition of aerosol particles. Studying the mechanisms determining the chemical composition of the nocturnal BL is, however, difficult because of the interplay of chemical processes and weak turbulent mixing. This interaction, together with direct emissions of NO and hydrocarbons at the ground leads to strong vertical variations of trace gas concentrations, thus making the chemistry in the nocturnal boundary layer altitude dependent. In addition, various chemical transformations can occur on the ground or buildings. Their importance again depends on the turbulent transport to and from these surfaces.

To investigate the composition of the nocturnal boundary layer we performed Long-Path Differential Optical Absorption Spectroscopy measurements during the 2006 TRAMP experiment in Houston. Path-integrated measurements were performed between the Moody Tower site and three buildings in downtown Houston. Three absorption light paths were set up, covering the height intervals from 20-70m, 70-130m, and 70 – 300m. Here were present the preliminary results of these measurements. The observations show strong opposite nocturnal vertical gradients of ozone and NO_2, caused by the emissions of NO and slow vertical transport. Higher HCHO mixing ratios near the ground point to a surface source of HCHO, most likely traffic emissions. NO_3 levels of up to 120 ppt show that active radical chemistry occurs night, which potentially affects hydrocarbon and NO_x levels. HONO gradients with high mixing ratios of up to 2 ppb near the surface were also observed. Finally, simultaneous plumes of SO_2 and HCHO indicate that industrial emissions could be a source of HCHO in Houston.

Solar Occultation Flux Method- Overview

Author(s): *Johan Mellqvist[1], Jerker Samuelsson[1], Claudia Rivera[1], Barry Lefer[2] and Monica Patel[2]*

Presenter(s): *Johan Mellqvist*

Affiliation:
[1)]Chalmers University of Technology, Department of Radio and Space, [2)] Department of Geosciences, University of Houston

ABSTRACT:

In this study the objectives has been to pin-point and quantify the largest industrial emission sources of highly reactive volatile organic compounds, alkanes, NH_3, NO_2 and SO_2 in the vicinity of Houston and south-eastern Texas. The work is part of the extensive summer campaign TexAQS 2006, included in the Second Texas Air Quality Study (TexAQS II). The measurements and the major findings during the campaign are discussed.

The measurements have been conducted using the solar occultation flux (SOF) method and mobile DOAS. The SOF technique is an optical method utilizing the absorption of direct solar infrared radiation in the 1.8-14 micrometer range for retrieval of total columns of various species such as ethylene, propylene, ammonia and alkanes. Mobile DOAS instead utilizes zenith scattered UV/visible light for measurements of NO_2 and SO_2.

The SOF and mobile DOAS instruments are carried out from a moving vehicle, making it possible to traverse the emission plume downwind an industry, and thus integrate all the molecules of the plume cross section in real time. By multiplying with the plume wind speed, the total flux emerging from the source is obtained. The wind data have been obtained from balloon sonde launches carried out within the project, wind profiler measurements at the La Porte airport and SODAR measurements in the eastern and northern part of the Houston ship channel, respectively.

Flux estimates were obtained for the large petrochemical and refining complexes around the Houston Ship Channel, Channelview, Mont Belvieu, Freeport, Choc Bayou and Sweeny. This was done in parallel with airborne plume studies by other parties (NOAA, Baylor University). The measurements shows that the Houston Ship Channel area emits about 1 ton of ethylene and 10 tons of straight chained alkanes per hour. This is one order of magnitude or more, larger than reported VOC emissions in 2004. The observed NO_2 and SO_2 values, on the other hand are more consistent with the reported values.

Measurements of Industrial Emissions of Alkanes in Houston and Southeastern Texas using the Solar Occultation Flux Method

Author(s): *Jerker Samuelsson[1], Johan Mellqvist[1], Claudia Rivera[1], Barry Lefer[2] and Monica Patel[2]*

Presenter(s): *Johan Mellqvist*

Affiliation: [1)] Chalmers University of Technology, Department of Radio and Space, [2)] Department of Geosciences, University of Houston

ABSTRACT:

Solar Occultation Flux (SOF) measurements of alkanes have been conducted to pin-point and quantify the largest sources of alkanes in the vicinity of Houston and in southeastern Texas during September 2006. The SOF measurements were part of the extensive summer campaign TexAQS 2006, included in the Second Texas Air Quality Study (TexAQS II). The SOF technique and the major findings during the campaign are discussed. The SOF technique is an optical method utilizing the absorption of direct solar infrared radiation. Total columns of alkanes are retrieved in the 3.3-3.7 micrometer range by FTIR (Fourier Transform InfraRed) spectrometry. The instrument is carried on a mobile platform, making it possible to traverse the emission plume downwind an industry, and thus integrate all the molecules of the plume cross section in real time. By multiplying with the plume wind speed, the total flux emerging from the source is obtained.

Alkane flux estimates with SOF were obtained for the large petrochemical and refining complexes around the Houston Ship Channel, Texas City and Sweeny. This was done in parallel with airborne plume studies by other parties (NOAA, Baylor University), providing plume canister sampling for precise VOC speciation. The primary research goal was to supply a data set for emission inventory comparisons and for input to models looking at the strong ozone production in Texas. The SOF measurements showed that the Houston Ship Channel area emitted about 11 tons of alkanes per hour, whereas The Texas City complex emitted around 3 tonnes per hour. This is one order of magnitude or more, larger than reported VOC emissions in 2004.

Measurements of Industrial Emissions of HRVOCs in Texas using the SOF Method

Author(s): *Johan Mellqvist[1], Jerker Samuelsson[1], Claudia Rivera[1], Barry Lefer[2] and Monica Patel[2]*

Presenter(s): *Johan Mellqvist*

Affiliation: [1)] Chalmers University of Technology, Department of Radio and Space, [2)] Department of Geosciences, University of Houston

ABSTRACT:

In this study the objectives has been to pin-point and quantify the largest industrial emission sources of highly reactive VOCs (HRVOCs) in the vicinity of Houston and south-eastern Texas. The work is part of the extensive summer campaign TexAQS 2006, included in the Second Texas Air Quality Study (TexAQS II).

The emission measurements have been conducted using the solar occultation flux (SOF) method. This method is based on recording broadband infrared spectra of the sun with an infrared spectrometer (FTIR) that is connected to a solar tracker. The latter is a mirror device that tracks the sun and reflects the light into the spectrometer independent of its position. From the solar spectra it is possible to retrieve the path-integrated concentration (molecules/cm^2) of various species between the sun and the spectrometer. To obtain the gas emission from a source, the car is driven in such way that the detected solar light cuts through the emission plume. To calculate the gas emission the wind direction and speed is also required. The wind data in this study have been obtained from balloon sonde launches carried out within the project, wind profiler measurements at the La Porte airport and SODAR measurements in the eastern and northern part of the Houston ship channel, respectively.

The HRVOC species detected in this study were ethene and propene. We also tried buten and butadiene but were unable to detect these at significant levels. The retrieval of ethene is conducted in the wavelength region between 945 and 979 cm^{-1} (10.21-10.58 μm) while propene is retrieved between 900 and 920 cm^{-1} (10.87-11.11 μm).

Flux estimates were obtained for the large petrochemical and refining complexes around the Houston Ship Channel, Channelview, Mont Belvieu, Freeport, Choc Bayou and Sweeny. This was done in parallel with airborne plume studies by other parties (NOAA, Baylor University). The measurements show that the Houston Ship channel area emits about 1 ton of ethylene. This is one order of magnitude or more, larger than reported VOC emissions in 2004.

Measurements of Industrial Emissions of NO_2 and SO_2 in Texas using Mobile DOAS

Author(s): *Claudia Rivera[1] Johan Mellqvist[1], Jerker Samuelsson[1], Barry Lefer[2] and Monica Patel[2]*

Presenter(s): *Johan Mellqvist*

Affiliation: [1)]Chalmers University of Technology, Department of Radio and Space, [2)] Department of Geosciences, University of Houston,

ABSTRACT:

In this study the objectives has been to pin-point and quantify the largest industrial emission sources of NO_2 and SO_2 in the vicinity of Houston and south-eastern Texas. The work is part of the extensive summer campaign TexAQS 2006, included in the Second Texas Air Quality Study (TexAQS II).

During September 2006, a campaign in the Houston-Galveston area was performed. Emissions of NO_2 and SO_2 were quantified using a mobile UV/visible measurement system denoted "mobile DOAS." This system has originally been developed for volcanic measurements and it is based on the DOAS technique. The system collects scattered ultraviolet light by means of a telescope coupled to a quartz fiber and the light is transferred into either of two spectrometers with spectral resolution 0.6 nm and spectral ranges 280-420 nm (SO_2) and 336-480 nm (NO_2), respectively. The acquired spectra are evaluated in realtime using a custom-built software. The mobile mini-DOAS instrument is mounted in a vehicle and measurements are performed traversing the plume, at different distances from the source, perpendicularly to the plume direction. To calculate the gas emission, the wind direction and speed is also required.

Measurements were conducted in the Houston Ship Channel (HSC), Baytown, Texas City, Battleground-225-Miller´s cut off circuit, Channelview, Sweeny, Freeport, Mt Belvieu, Bayport and Chocolate Bayou areas. The wind data have been obtained from balloon sonde launches carried out within the project, wind profiler measurements at the La Porte airport and SODAR measurements in the eastern and northern part of the Houston ship channel, respectively. The emissions correspond relatively well to the ones reported in the TCEQ emission database.

An Analysis of Meteorological Factors That Influence Boundary Layer Ozone Concentrations Using Ozonesonde Data from Houston, Texas

Author(s): *Ashley D. Mefferd, Gary A. Morris, Craig Clark, Stephen Holcomb, Bonne Ford, Marc Taylor*

Presenter(s): *Ashley D. Mefferd*

Affiliation: Valparaiso University

ABSTRACT:

As part of NASA's IONS 04 and IONS 06 campaigns and the Texas Air Quality Study II, the Tropospheric Ozone Pollution Project has launched 170 ozonesondes from Houston and other sites in Southeast Texas during the period July 2004 – November 2006. In this study, the data from the lowest 3 km of each profile of a subset of 133 launches is examined to identify the impacts of mixed layer heights and meteorological variables, such as wind speed and relative humidity, on boundary layer ozone concentrations. A linear regression was performed with surface ozone data taken from 5 different CAMS locations across the Houston metropolitan area. The model assessed that meteorology is a major factor in the variability of ozone. The diurnal evolution of the boundary layer, which largely influences ground-level ozone concentrations throughout the day, is observed on days with multiple launches. Ozonesonde data are classified in three ozone categories: high, mid and low ozone days. These categories are determined by adding or subtracting a standard deviation from the mean ozone concentration at the surface. Values less than 28 ppbv are classified as low ozone days while readings greater than 73 ppbv are classified as high ozone days. Any surface concentration between these values is classified as a mid ozone day. By determining the mixed layer height for each launch day and using the designated categories, it was found that days with higher surface ozone concentration had higher mixed layer heights.

Analysis of Houston Ozonesonde Data

Author(s): *Gary A. Morris[1], Scott Hersey[2], Stephen Holcomb[1], Anne M. Thompson[3], and John E. Yorks[3]*

Presenter(s): *Gary A. Morris*

Affiliation: [1] Valparaiso University; [2] California Institute of Technology; [3] Penn State University

ABSTRACT:

The Tropospheric Ozone Pollution Project has coordinated 170 ozonesonde launches from Southeast Texas during the period July 2004 – November 2006, with the majority of the launches occurring in July and August from the campuses of Rice University and The University of Houston. Two to three launches per year have also occurred at the following sites: Stephen F. Austin State University in Nacogdoches, Lamar University in Beaumont, and Texas A&M University in College Station. An overview of the vertical profile data is presented in this talk, including annual variability, seasonal variability, and geographic variability. The representativeness of the data set is addressed through comparisons of climeatological meteorological profiles with those seen on launch days.

Review of Fine Particulate Matter Emissions Inventories and Comparisons of Emissions Estimates with Observations from Recent Field Studies

Author(s): *Heather Simon, Ann E. Wittig, David T. Allen*

Presenter(s): *Heather Simon*

Affiliation: University of Texas at Austin, Center for Energy and Environmental Resources

ABSTRACT:

Emissions inventories of fine particulate matter ($PM_{2.5}$) were compared with estimates of emissions based on data emerging from U.S. Environment Protection Agency Particulate Matter Supersites and other field programs. Six source categories for $PM_{2.5}$ emissions were reviewed: onroad mobile sources, nonroad mobile sources, cooking, biomass combustion, fugitive dust, and stationary sources. Regional emissions inventories of PM in the exhaust from on-road and nonroad sources were generally consistent with ambient observations, though uncertainties in some emission factors were twice as large as the emission factors themselves. In contrast, emissions inventories of road dust were up to an order of magnitude larger than ambient observations, and estimated brake wear and tire dust emissions were half as large as ambient observations in urban areas. This discrepancy between top-down and bottom up emissions estimates is especially concerning for fugitive dust, since the National Emissions Inventory predicts that up to 40% of total fine PM emissions come from fugitive dust sources. Observational data in urban areas suggest that cooking sources account for approximately 5–20% of total primary emissions (excluding dust), and biomass burning sources are highly dependent on region. Finally, relatively few observational data were available to assess the accuracy of emission estimates for stationary sources. Overall, the uncertainties in primary emissions for $PM_{2.5}$ are substantial. Because of these uncertainties, the design of $PM_{2.5}$ control strategies should be based on inventories that have been refined by a combination of bottom-up and top-down methods.

Processing a Model-Ready Emissions Inventory for Primary PM

Author(s): *Heather Simon, Yosuke Kimura, David Allen*

Presenter(s): *Heather Simon*

Affiliation: University of Texas at Austin, Center for Energy and Environmental Resources

ABSTRACT:

A model-ready emissions inventory has been prepared for primary particulate matter (PM) in Texas. This will aid further investigations of the heterogeneous chemistry observed in TexAQS II. County-wide annual emissions estimates of fine PM were received from Environ. These data were originally developed for regional haze planning by Central Regional Air Planning Association (CENRAP). Photochemical modeling requires emissions inventories to be resolved on a much finer spatial and temporal resolution than was done for this data. In addition, modeling requires chemical speciation and size distribution information. The Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system was used to process the emissions files from Environ into a model-ready format. SMOKE includes modules to distribute emissions spatially and temporally and to chemically speciate the PM. Spatial surrogates were created for 36, 12, and 4 km grid cells using the EPA MIMs tool. Default EPA temporal and chemical speciation profiles were use for most sources. However, for a few sources more accurate data were available in the literature. In these cases, new profiles were created. Finally, PM emissions, which were originally reported as coarse and fine, were further distributed into 4 size bins. The EPA does not provide any default profiles of PM size distributions. There have been very few published studies which fully characterize source emissions size profiles. Due to the limited data in the literature, size profiles were only developed for four major sources categories: diesel vehicles, commercial cooking, wood smoke, and fugitive dust. One of these four size profiles was assigned to each emission source category in the emissions inventory. Anyone who is interested in using this data should contact us.

Source Apportionment for $PM_{2.5}$ at Houston Clinton Drive

Author(s): *David W. Sullivan, Richard Tropp*

Presenter(s): *David W. Sullivan*

Affiliation: University of Texas at Austin, Center for Energy and Environmental Resources

ABSTRACT:

The 2004-2006 design value for particulate matter with aerodynamic diameter 2.5 microns or smaller ($PM_{2.5}$) for the Clinton Drive sampler near the west end of the Houston Ship Channel is 15.4 micrograms per cubic meter ($\mu g/m^3$). The design value exceeds the 15.0 $\mu g/m^3$ level of the National Ambient Air Quality Standard (NAAQS), making it the only site in South, Central, and East Texas to not comply with the NAAQS. A number of methods have been employed to determine the causes of elevated $PM_{2.5}$ at this site. Filter-based $PM_{2.5}$ speciated sampling data, continuous $PM_{2.5}$ mass monitoring data, filter-based PM_{10} mass sampling data, meteorological monitoring data, and aerial images have been analyzed to show that soil and possibly other dry bulk materials from nearby industrial and port areas are responsible for an approximate 2 $\mu g/m^3$ difference between the annual average concentration at Clinton and other nearby sites. The balance of the mass composition at Clinton closely resembles the chemical make-up at other Houston-area sites, suggesting that a combination of local and regional emissions reductions may be helpful in bringing the site under the 15.0 $\mu g/m^3$ standard and keeping other sites below the level of the NAAQS.

Regional Trends in Ozone Concentrations: Assessing the Representativeness of 2006

Author(s): *David W. Sullivan*

Presenter(s): *David W. Sullivan*

Affiliation: University of Texas at Austin, Center for Energy and Environmental Resources

ABSTRACT:

In order to effectively employ monitoring results from TexAQS II, it is important to assess the meteorology and photochemistry from the summer of 2006 in comparison to other years to see to what extent that summer was a "typical" summer. To assess meteorology, the NOAA Hysplit trajectory tool has been used to characterize synoptic air flow patterns in August and September 1997-2006. Also, local surface temperature time series in eastern Texas have been analyzed. To assess photochemistry, the time series for ambient ozone eight-hour average daily maxima concentrations from the eastern part of EPA Region 6 have been assessed for regional trends from 1993-2006. The preliminary conclusion is that regional ozone concentrations have declined in recent years, and 2006 compares better with the period from 2001-2005 than with earlier years.

Impacts of Regional Aerosol Events on Houston Air Quality during TexAQS II

Author(s): *Chieko Kittaka, R. Bradley Pierce, Todd Schaack, Jay Al-Saadi, Amber Soja, Arlindo da Silva, Dave Winder, Chris Hostetler, Jim Szykman, Bryan Lambeth, Tahllee Baynard, Ryan Spackman, Greg Tripoli*

Presenter(s): *Chieko Kittaka*

Affiliation: SSAI

ABSTRACT:

The field experiments TexAQS II/GoMACCS coincided with intensive fire activities over the Pacific Northwest, persistent sulfate pollution in the eastern US and transport of Saharan dust. This study assesses the influence of these regional and hemispheric-scale aerosol events on local air quality in Houston during the field experiments using the Real-Time Air Quality Modeling System (RAQMS) and satellite observations. The model used for this study is the regional component of RAQMS with a MODIS aerosol optical depth (AOD) assimilation. The model performance over the Houston area is evaluated with respect to aircraft and ground-based measurements obtained during TexAQS II/GoMACCS. The regional aerosol distributions are compared with the AOD retrieval obtained from MODIS on the Terra satellite and EPA surface measurements. The observations from the CALIPSO satellite, which depict vertical aerosol distributions, allow us to evaluate the altitudes of aerosol layers simulated by the model for the first time. The implication of these model evaluations is discussed. Finally aerosol distributions at a synoptic scale during the field experiments are summarized and the consequent influence on Houston air quality is discussed.

The Houston Lightning Detection and Ranging (LDAR) Network

Author(s): *Richard E. Orville, Larry D. Carey, Brandon L. Ely, John Nielsen-Gammon, Renyi Zhang, and Don Collins*

Presenter(s): *Richard E. Orville*

Affiliation: Texas A&M University

ABSTRACT:

An array of 12 VHF time-of-arrival (TOA) sensors is operating around Houston providing real-time mapping of lightning channels in 3D. The network began operation in July 2005. The average distance between sensors is 25 kilometers with a network diameter of ~80 km. Sensors are tuned to a 5 MHz band with a center frequency that varies between 69 and 71 MHz (upper edge of TV channel 4) depending on RF noise conditions at each site. Strongest VHF pulse in a 100μs interval is received giving a maximum data rate of 10,000 VHF sources per second. All lightning channels, i.e. intracloud and cloud-to-ground (total lightning) within 130 km of the city center are mapped in real-time and archived for later analyses with meteorological and atmospheric chemistry data. Real-time data (i.e. the last 40 minutes) can be monitored over the Internet at: http://www.met.tamu.edu/ciams/ldar/index.html

Measurements of Temperature, Water Vapor, Ozone and Carbon Monoxide from AIRS

Author(s): *F.W. Irion, W.W. McMillan, G.B. Osterman*

Presenter(s): *Wallace McMillan*

Affiliation: University of Maryland Baltimore County

ABSTRACT:

The Atmospheric Infrared Sounder (AIRS) on the EOS-Aqua satellite retrieves temperature, water vapor, ozone, and carbon monoxide profile data from nadir viewing. Combining information from co-located microwave and infrared spectrometry, AIRS retrieves data on ~45 km diameter footprints, under up to 80% cloudy conditions. We describe retrievals and sensitivities using the upcoming Version 5 processing scheme which can be of use to local air quality monitoring and modeling efforts.

Transport of Carbon Monoxide and Ozone into the Texas AQS II region as observed by the Atmospheric InfraRed Sounder (AIRS)

Author(s): *W. W. McMillan, K. Evans, J. Warner, C. Barnet, W. Wolf*

Presenter(s): *Wallace McMillan*

Affiliation: University of Maryland, Baltimore County

ABSTRACT:

Launched into orbit on May 4, 2002, onboard NASA's Aqua satellite, the Atmospheric InfraRed Sounder's (AIRS) cross-track scanning grating spectrometer covers the thermal infrared spectrum (3.7 to 15.4 μm) with 2378 discontinuous channels across a 1600 km wide swath. Coupled with the Advanced Microwave Sounding Unit (AMSU), AIRS' unparalleled horizontal resolution, 45 km AMSU field-of-regard (FOR); high spectral resolution; low noise, and excellent stability and radiometric accuracy enable accurate high-vertical resolution retrievals of tropospheric temperature and water vapor profiles as well as determination of surface temperatures and cloud parameters. AIRS' broad spectral coverage includes absorption features of ozone (O_3), carbon monoxide (CO), carbon dioxide, and methane. Multiple AIRS fields-of-view within a single AMSU FOR enable retrievals for conditions up to 80-90% cloudy. We will present an overview of AIRS operations and observations made during TexAQS II and also on a routine basis. Focusing on the August 31-September 2, 2006, O_3 exceedance event, we will illustrate the large-scale and integrated composition view AIRS can provide using the latest Version 5 AIRS processing algorithms.

Ozone and Carbon Monoxide Measurements Made by TES during TexAQS II

Author(s): *G.B. Osterman and K.W. Bowman*

Presenter(s): *Greg Osterman*

Affiliation: Jet Propulsion Laboratory/California Institute of Technology

ABSTRACT:

The Tropospheric Emission Spectrometer (TES) measures ozone, carbon monoxide and other atmospheric constituents from the NASA Aura satellite. TES makes its standard measurements in the nadir mode and the profiles typically have the sensitivity to vertically resolve ozone and carbon monoxide in the troposphere. We present an overview of TES, the measurements it makes and the data product status. During July, August and September 2006, TES augmented its standard observational mode with a series of special observations focused on the Continental United States and Gulf of Mexico. This increased the spatial resolution of the measurements obtained during TexAQS II / GoMACCS. We will show the TES observations of ozone and carbon monoxide during this time frame and relate how the vertical resolution of TES can be used to distinguish between different processes controlling tropospheric ozone. We will also show backward trajectory analysis from the location of the TES measurements to demonstrate potential effects of transport.

Evaluation of Near-Real-Time Biomass Burning Emissions Estimates derived from MODIS and GOES Active Fire Detections during 2006

Author(s): *Jay Al-Saadi[1], Amber Soja[2,1], Brad Pierce[1], Shobha Kondragunta[3], Xiaoyang Zhang[3], Chieko Kittaka[4,1], Louisa Emmons[5], Christine Wiedinmyer[5], Todd Schaack[6], Jim Szykman[7,1]*

Presenter(s): *Jay Al-Saadi*

Affiliation: [1] NASA Langley Research Center,[2] National Institute of Aerospace; [3] NOAA NESDIS, [4] SSAI; [5] NCAR, [6] Space Science and Engineering Center, University of Wisconsin, [7] US EPA, Research Triangle Park

ABSTRACT:

We intercompare estimates of biomass burning area burned and CO emissions derived from four different techniques using satellite active fire detections over the continental US during 2006. Two techniques use daily detections from MODIS Terra and Aqua, one technique uses the 8-day MODIS Climate Modeling Grid product, and one uses the half-hourly detections from current GOES platforms. Over CONUS there is a wide spread in area burned estimates with a significant fraction of GOES area-burned estimates smaller than 1 km^2. The GOES technique employs a sub-pixel algorithm to infer instantaneous fire sizes while the MODIS-based techniques assume a burn area on the order of 1 km^2 is associated with fire detections. Estimates of total area burned are strongly influenced by large fires and the techniques show a high degree of consistency during months when large fires occur. CO emissions are generally more consistent than area estimates over CONUS. This is a result of significant differences among the models in net CO emission rates per unit area within particular vegetation classes. Global meteorological/chemical analyses conducted with the RAQMS model allow us to evaluate the CO emissions with respect to MOPITT and TES observations over regions where the CO variability is dominated by burning. The RAQMS biomass burning CO emissions have a low bias over southeastern CONUS, including most of Texas, during spring and summer 2006. A low bias is also found during the large fires occurring in the Northwestern US during mid to late summer. At this time we have not determined whether the biases are associated with area burned, fuel/combustion estimates, or a combination of factors. Overall these results suggest that biomass burning influences on Texas air quality are likely underestimated during TexAQS II / GoMACCS.

The Representativeness of Ozone Meteorology during TexAQS II

Author(s): *John W. Nielsen-Gammon*

Presenter(s): *John W. Nielsen-Gammon*

Affiliation: Texas A&M University

ABSTRACT:

The primary TexAQS II Field Intensive included the period August 1, 2006 through October 14, 2006. Conditions during that period were broadly consistent with past years. Major ozone events occurred primarily under very light synoptic wind conditions or transport from the east or northeast. This is unlike TexAQS 2000, when most ozone events occurred under southeasterly or southwesterly transport. With light easterly flow, the background ozone levels tend to be high, and stagnation is favored during early to mid-morning, with possible transport out over Galveston Bay. By noon, winds shift to northeasterly and then easterly, causing ozone exceedances near, south, and west of downtown Houston. On possibly two days, Houston emissions from the previous day contributed to high ozone levels. Clouds and precipitation tended to prevent ozone formation under light southeasterly flow, as Houston was not under drought conditions as in 2000. At least one transient high ozone event occurred under southeasterly flow in the absence of an eight-hour exceedance.

Recent Ensemble Simulations for Data Assimilation and Photochemistry Sensitivity to Meteorology

Author(s): *Fuqing Zhang, Altug Aksoy, John W. Nielsen-Gammon, Amy L. Stuart, Naifang Bei, Richard T. McNider, Wayne M. Angevine, Allen B. White, Guohui Li, Renyi Zhang, and Kevin Knupp*

Presenter(s): *John W. Nielsen-Gammon*

Affiliations: Texas A&M University, National Center for Atmospheric Research, University of South Florida, University of Alabama at Huntsville, and NOAA Earth System Research Laboratory

ABSTRACT:

Using a combination of idealized models and simulations of the TexAQS 2000 Houston ozone episode, we have published several papers addressing issues of data assimilation, model accuracy, and parameter estimation. Optimal parameter settings for Newtonian relaxation of wind profiler data have been identified and the accuracy of the resulting simulations determined. Proof-of-concept has been demonstrated for data assimilation using the Ensemble Kalman Filter. In tests with an idealized model as well as the MM5, the ability of the EnKF to properly assimilate data under sea breeze conditions has been demonstrated, even when the observations are entirely chemical or when the model is inherently inaccurate. By including model parameters as part of the model state vector, data assimilation can be used to objectively improve model parameterizations such as vertical mixing. However, even within the expected range of accuracy of meteorological simulations, the resulting photochemical simulations can be expected to produce peak point ozone uncertainties of as much as 30%-40%, suggesting that an ensemble-based approach is more appropriate for photochemical simulations.

The Sea-Breeze Low-Level Jet: Real or a Model's Imagination?

Authors: *Arthur J. Weissmann and John W. Nielsen-Gammon*

Presenters: *Arthur J. Weissmann (Tues) and John W. Nielsen-Gammon (Wed-Thu)*

Affiliations: Tom Clark High School and Texas A&M University

ABSTRACT:

During the Texas Air Quality Study, the MM5 high-resolution weather forecast model often predicted a "Sea Breeze Low-Level Jet," a band of stronger winds surrounded by weaker winds that occurs in the evening, is located between 100 and 600m above ground level parallel to the coast, and often moves inland. This research project had two objectives: (1) to characterize a previously unknown meteorological phenomenon (the sea-breeze low-level jet), and (2) to obtain and analyze data to determine if this phenomenon really exists. The first objective required defining several descriptive and quantitative characteristics totaling 616 data points. The latter objective was accomplished by comparing 203 model forecasts to corresponding wind profiler observations. This comparison found 83.3% direction matches and over 63% speed interval and direction matches. Linear regression was used to fit a zero-intercept line to the predicted and observed wind speeds, resulting in a 96% adjusted R^2 for a fitted line with slope of 1.078. Additional research is necessary to confirm these initial results and then to investigate the impacts of the sea-breeze low-level jet on pollution transport and sensible weather.

Multi-Sensor Estimation of Mixing Heights over Houston during TexAQS 2000

Author(s): *John W. Nielsen-Gammon, Christina L. Powell, M. J. Mahoney, Wayne M. Angevine, Christoph Senff, Allen White, Carl Berkowitz, Christopher Doran, and Kevin Knupp*

Presenter(s): *John W. Nielsen-Gammon*

Affiliations: Texas A&M University, Wright State University, Jet Propulsion Laboratory, NOAA Earth System Research Laboratory, Pacific Northwest National Laboratory, and University of Alabama in Huntsville

ABSTRACT:

An airborne Microwave Temperature Profiler (MTP) was deployed during the Texas 2000 Air Quality Study (TexAQS 2000) to make measurements of boundary layer thermal structure. An objective technique was developed and tested for estimating the mixed layer (ML) height from the MTP vertical temperature profiles. The technique identifies the ML height as a threshold increase of potential temperature from its minimum value within the boundary layer. In order to calibrate the technique and evaluate the usefulness of this approach, coincident estimates from radiosondes, radar wind profilers, an aerosol backscatter lidar, and in situ aircraft measurements were compared with each other and with the MTP. Relative biases among all instruments were generally less than 50 m, and the agreement between MTP ML height estimates and other estimates was at least as good as the agreement among the other estimates. The ML height estimates from the MTP and other instruments are then utilized to determine the spatial and temporal evolution of ML height in the Houston area on 1 Sept. 2000. An elevated temperature inversion was present, so ML growth was inhibited until early afternoon. In the afternoon, large spatial variations in ML height developed across the Houston area. The highest ML heights, well over 2 km, were observed to the north of Houston, while downwind of Galveston Bay and within the late afternoon sea breeze ML heights were much lower. The spatial variations that were found away from the immediate influence of coastal circulations were unexpected, and multiple independent ML height estimates were essential for documenting this feature.

VOCs Measurements in the Houston Triangle Campaign

Author(s): *Jun Zheng and Renyi Zhang*

Presenter(s): *Jun Zheng*

Affiliation: Texas A&M University

ABSTRACT:

A commercial compact PTR-MS (IONICON ANALYTIK) was deployed at the Aldine site from September 13 to 30, 2006 to participate in the Houston Triangle Campaign, which was designed to characterize the outflow from the ship-channel area in both gas phase and aerosol phase compositions. The PTR-MS was continuously monitoring about 20 VOC species and the detection limits ranged from a few hundred pptv (e.g. benzene) to a few ppbv (e.g. propene). Unlike the UH Moody Tower, the Aldine site was about 20 miles to the NW of the ship-channel area. Thus no tremendous propene peaks were observed at the Aldine site. However acetaldehyde, a major oxidation product from olefin, did show good correlations with propene. Isoprene and nighttime monoterpenes were recorded at this surface site. Aromatic VOCs also showed traffic influences. During late nights of September 19 and 20, good correlations were found between VOCs (including isoprene, toluene, MVK, MACR, MEK, and methylglyoxal) and the organic aerosol mass loading, which indicated that VOC oxidation processes could contribute to the SOA formations.

VOCs and HNO_3 Measurements at the Moody Tower

Author(s): *Jun Zheng and Renyi Zhang*

Presenter(s): *Jun Zheng*

Affiliation: Texas A&M University

ABSTRACT:

An ID-CIMS developed at the Texas A&M University and a commercial PTR-MS were deployed at the UH Moody Tower from August 17 to October 15, 2006 to measure gaseous HNO_3 and VOCs. The ID-CIMS was set to collect data at 0.1 Hz corresponding to a detection limit of 30 pptv. Daytime HNO_3 followed the solar cycle and was consistent with its role in the photochemical processes. HNO_3 daily high ranged from 0.2 to 2 ppbv in the early afternoon and occasionally nighttime peaks were also observed, which could be originated from either NO_3 / N_2O_5 + H_2O(g) reaction or transported aged plumes. The PTR-MS was continuously monitoring about 20 VOC species and the detection limits ranged from a few hundred pptv (e.g. benzene) to a few ppbv (e.g. propene). Observations at the UH site showed influences from the ship-channel petrochemical industries. Propene was the major alkene species detected and a record of 1.1 ppmv was observed in the morning of August 20. Aromatic VOCs were consistent with the local traffic conditions. Oxygenated VOCs (e.g. acetaldehyde and ketones) showed correlations with ozone productions. Biogenic VOCs (e.g. isoprene and monoterpenes) were not significant at the UH site.

Size-Resolved Particle Concentration and Hygroscopicity Measurements at Multiple Surface Sites during TexAQS-II

Author(s): *Crystal C. Reed, Chance W. Spencer, and Don R. Collins*

Presenter(s): *Crystal C. Reed*

Affiliation: Texas A&M University

ABSTRACT:

Tandem differential mobility analyzers (TDMAs) were operated at the Moody Tower and the Aldine, Bayland Park, and Deer Park sites of the Houston Triangle during TexAQS II. These instruments were used to continuously measure submicron particle size distributions and size-resolved particle growth in response to increased relative humidity. Such hygroscopic growth measurements provide insight into both the size-dependent particle composition and the compositional variability within a particle population. This poster is focused on those measurements made as part of the Houston Triangle, which were coordinated with those of an array of gas and particulate properties made by other researchers supported by HARC. Beyond characterization of the spatial variability and evolution of particulate concentration and properties, these measurements were designed to provide details of the liquid water content present in the particulate populations, which is needed to estimate the conversion rate of N_2O_5 to HNO_3, both of which were concurrently measured.

All collected data have been processed, quality checked, and posted on a project website at http://www.met.tamu.edu/research/aerosol/Webpage/Houstontriangledata/September2006.html

Consistent with measurements made during previous studies, the size-resolved hygroscopic growth factor distributions were frequently bimodal, reflecting the presence of distinct particle types in an external mixture. Ongoing work is directed at examining study-averaged and time-dependent variability among the distributions measured at the three sites and at integrating our data with those collected by the other project participants.

MISR Observations of Houston Aerosol Pollution and Aerosol-Cloud Interaction Processes

Author(s): *Michael J. Garay, Ralph A. Kahn, John H. Seinfeld, Miao-Ling Lu, Graham Feingold, Athanasios Nenes*

Presenter(s): *Michael J. Garay*

Affiliation: Jet Propulsion Laboratory, California Institute of Technology

ABSTRACT:

During the TexAQS II / GOMACCS 2006 field campaign, the MISR instrument on the NASA Earth Observing System's Terra satellite passed directly over the Houston study region eight times making special, very-high-resolution observations. Additional sites to the west and east of the city were also imaged multiple times during this period within the 360 km wide MISR swath. These data provide unprecedented detail about the spatial distribution of aerosol pollution from regional sources. It also happened that on two of the days when MISR passed directly over Houston, the presence of aerosol pollution from distant sources was apparent. On 29 August, airborne dust that originated in the Sahara ten days earlier was observed by MISR and ground-based $PM_{2.5}$ sensors throughout Texas. On 7 September, smoke from forest fires burning in the Pacific Northwest reached Houston at mid-levels, and was detected by MISR and airborne sensors. We will discuss selected local and long-range transport cases in greater detail.

The influence of aerosols on clouds is another topic of great interest in the climate community because it is currently one of the largest sources of uncertainty in predictions of future climate change. Coordinated surface-based, airborne and satellite measurements made during the TexAQS II / GOMACCS 2006 field campaign provide unique information for exploring aerosol-cloud interactions. We will describe some preliminary work aimed at extracting the information content of these multi-platform data.

This research was performed at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

Assimilation of OMI and TES O_3/CO Measurements during TexAQS II

Author(s): [1.] *R. Bradley Pierce,* [2.] *Jassim Al-Saadi,* [2.] *Chieko Kittaka,* [3.] *Todd Schaack,* [4.] *Kevin Bowman,* [4.] *Greg Osterma,*[5.] *Jim Szykman,* [2.] *Amber Soja,* [6.] *Ann Thompson*

Presenter(s): *R. Bradley Pierce*

Affiliation: [1.]NOAA/NESDIS, [2].NASA LaRC, [3.]UW SSEC, [4.]NASA JPL, [5.]US EPA, [6.]PSU

ABSTRACT:

This poster presents a summary of the verification studies that were conducted during TexAQS II to determine the fidelity of the Real-time Air Quality Modeling System (RAQMS) chemical analyses at local (Houston), continental, and global scales. Verification of the RAQMS analyses is critical since they were used to address Questions G and H of the TexAQS II Rapid Science Synthesis:

How do emissions from local and distant sources interact to determine the air quality in Texas, and which areas outside of Texas adversely affect the air quality of non-attainment areas within Texas?

The RAQMS TexAQS II 2x2 degree ozone and carbon monoxide chemical analysis included assimilation of cloud cleared OMI total column ozone measurements and ozone and carbon monoxide profiles from TES nadir global survey measurements. The assimilation of column ozone observations provides an overall constraint on the total column ozone abundances, while the assimilation of profile retrievals provides observational constraints on the lower stratospheric and tropospheric ozone and carbon monoxide. The RAQMS analyses are compared with in situ measurements from the NOAA P3 within the Houston area, hourly surface ozone measurements from the EPA AIRNOW network, daily ozonesonde measurements from the IONS06 campaign, and satellite retrievals of CO and NO_2 from MOPITT and OMI onboard the NASA Terra and Aura satellites. These verification studies show that the RAQMS chemical analysis tends to overestimate NO_2 and O_3 and underestimate CO near Houston relative to in situ measurements from the NOAA P3. The overestimate in Houston ozone mixing ratios is generally consistent with comparisons between the RAQMS analyses and AIRNOW and IONS06 ozonesondes. RAQMS tends to underestimate O_3, NO_2 and CO relative to remote measurements from OMI and MOPITT, respectively.

Impacts of Background Ozone Production on Houston and Dallas, TX Air Quality during the NOAA 2006 TexAQS Field Mission

Author(s): [1.] *R. Bradley Pierce,* [2.] *Jassim Al-Saadi,* [2.] *Chieko Kittaka,* [3.] *Todd Schaack,* [4.] *Kevin Bowman,* [4.] *Greg Osterma),* [5.] *Jim Szykman,* [2.] *Amber Soja*

Presenter(s): *R. Bradley Pierce*

Affiliation: [1.]NOAA/NESDIS, [2.]NASA LaRC, [3.]UW SSEC, [4.]NASA JPL, [5.]US EPA

ABSTRACT:

In this presentation we utilize the global component of the Real-time Air Quality Modeling System (RAQMS) to investigate the impact of continental scale ozone production on Houston and Dallas air quality from July 15 through October 15, 2006. A unique aspect of the RAQMS study is the incorporation of satellite data to improve the chemical analysis, including assimilation of column ozone observations from OMI and ozone and carbon monoxide profile observations from TES onboard the NASA Aura satellite and the use of fire counts from the MODIS instrument onboard the NASA Terra and Aqua satellites to generate biomass burning emissions. The objective of this analysis is to address Questions G and H of the TexAQS II Rapid Science Synthesis:

How do emissions from local and distant sources interact to determine the air quality in Texas, and which areas outside of Texas adversely affect the air quality of non-attainment areas within Texas?

Lagrangian trajectory analysis provides the link between RAQMS chemical analyses, continental scale satellite observations, surface networks, and airborne measurements during the study period. 5-day ensemble back-trajectories sample initialized from EPA AIRNOW sites within the Houston and Dallas MSA sampled 6hr RAQMS chemical analyses. Three distinct regional influence classifications are developed based on the AIRNOW ensemble mean 5-day Lagrangian averaged O_3 P-L:

Class 1 (Background O3 P-L > 10ppbv/day) events account for 10% (12%),
Class 2 (Background 0<O3 P-L<10ppbv/day) events account for 42% (60%), and **Class 3 (Background O3 P-L<0ppbv/day)** events account for 48% (28%) of the Houston (Dallas) back trajectories during the study period.

Principle findings of this analysis show that periods of enhanced regional ozone production (**Class 1**) preceed 66% (6 out of 9) and 46% (7 out of 15) of the periods with elevated (Mean >60ppbv) AIRNOW ozone within the Houston and Dallas MSAs respectively.

Synthesis of NASA King Air, MODIS, and CALIPSO Aerosol Observations during TexAQS II

Author(s): [1.] *R. Bradley Pierce,* [2.] *Jassim Al-Saadi,* [3.] *Chieko Kittaka,* [2.] *Richard Ferrare,* [2.]*Chris Hostetler,* [2.]*John Hair,* [2.]*Dave Winker,* [4.] *Bryan Lambeth*

Presenter(s): *R. Bradley Pierce*

Affiliation: [1.]NOAA/NESDIS, [2].NASA LaRC, [3.]SSAI, [4.] TCEQ

ABSTRACT:

In this presentation we synthesize remote and in-situ measurements from multiple observational platforms to address Questions G and H of the TexAQS II Rapid Science synthesis:

How do emissions from local and distant sources interact to determine the air quality in Texas, and which areas outside of Texas adversely affect the air quality of non-attainment areas within Texas?

The impact of remote sources on aerosol distributions near Houston during late August-early September, 2006 is investigated using a combination of surface observations from the TCEQ Deer Park speciated monitoring station, airborne observations from the High Spectral Resolution Lidar (HSRL) onboard the NASA King Air, and MODIS and CALIPSO measurements from the NASA A-Train satellites. During the study period, periods of elevated dust, sulfate, and carbonaceous aerosol were observed at Deer Park. Trajectory studies, in conjunction with MODIS and CALIPSO observations, are used to determine the role of continental scale transport of Pacific NW wildfire emissions and intercontinental transport of Saharan dust on the observed aerosol composition at Houston. This analysis illustrates the influence of remote emissions from the Southeastern US, Northwestern US, and Africa on Houston air quality and demonstrates the utility of satellite aerosol and trace gas observations in tracking long-range transport of pollutants, particularly when regional column measurements are combined with profile information.

Satellite Based Characterization of Influences of Agricultural and Wildfires on Continental US O_3 and CO Transport during TexAQS II

Author(s): [1.] *R. Bradley Pierce,* [2.] *Jassim Al-Saadi,* [3.] *Chieko Kittaka,* [1.] *Shobha Kondragunta*

Presenter(s): *R. Bradley Pierce*

Affiliation: [1.]NOAA/NESDIS, [2].NASA LaRC, [3.]SSAI

ABSTRACT:

In this presentation we use trajectory mapping techniques, CO observations from MOPITT onboard the NASA Terra satellite and O_3 observations from OMI onboard the NASA Aura satellite to determine the contributions from agricultural and wildfire emissions to the distribution of column CO and tropospheric column O_3 over the Continental US Air Quality during late August and early September, 2006.

This study addresses Questions G and H of the TexAQS II rapid science synthesis:

How do emissions from local and distant sources interact to determine the air quality in Texas, and which areas outside of Texas adversely affect the air quality of non-attainment areas within Texas?

Characterization of Regional Ozone in East Texas

Author(s): *Mariana Dionisio, David W. Sullivan*

Presenter(s): *Mariana Dionisio*

Affiliation: University of Texas at Austin, Center for Energy and Environmental Resources

ABSTRACT:

In 2005 and 2006, several new rural ozone monitors were operated in East Texas with the primary goal of assessing air pollution transport into the state and between cities. In addition, these sites provide estimates of background concentrations from which estimates of ozone fluxes and regional ozone production can be assessed. Furthermore, the background concentrations provide a basis for assessing the accuracy of the performance of photochemical models. Specific results to date include the finding that nighttime ozone concentrations are surprisingly low over a large part of rural northeast Texas, and these low concentrations are not reflected in the photochemical model. Also, a comparison of ozone flux calculation methods using aircraft data, surface monitor data, and output from photochemical modeling has been performed.

Comparison of the Carbon Bond and SAPRC Photochemical Mechanisms under Conditions Relevant to Southeast Texas

Author(s): *Maedeh Faraji, Yosuke Kimura, Elena McDonald-Buller and David Allen*

Presenter(s): *Maedeh Faraji*

Affiliation: University of Texas at Austin, Center for Energy and Environmental Resources

ABSTRACT:

Two commonly used photochemical reaction mechanisms in air quality models are the [California] Statewide Air Pollution Research Center (SAPRC) mechanism and the Carbon Bond (CB) mechanism. When the mechanisms are compared in a regional photochemical model, the Comprehensive Air Quality Model with Extensions (CAMx), under the high reactivity conditions observed in Houston, Texas, the SAPRC mechanism leads to concentrations of ozone that are up to 30-50 ppb higher than in CB, version IV (CB-IV). The magnitude of the difference is scaled with ozone concentrations: the higher the ozone concentrations, the greater the difference between SAPRC and CB-IV. Analyses in both a box model and the three-dimensional gridded model, CAMx, were conducted to identify the causes of differences between the mechanisms. Differences between SAPRC and CB-IV were determined not to be due to a single reaction pathway, but rather are attributed to three inter-related sets of pathways. The three sets of pathways are aromatics oxidation, free radical sinks, and higher aldehyde formation. Specifically, differences in the ring opening branching ratios between CBIV and SAPRC, the free radical termination reaction of hydroxyl radical with NO_2, and additional source terms for higher aldehydes, included in SAPRC, but not CBIV, lead to differences in ozone predictions. In order to identify the mechanism that most accurately represents ozone formation chemistry under Houston conditions, specific measurements were designed as part of a large air quality field program, the Texas Air Quality Study II (TexAQS II).

The Effect of Variability in Industrial Emissions on Ozone Formation in Houston, Texas

Author(s): *Junsang Nam[1], Mort Webster[2] Yosuke Kimura[1], Harvey Jeffries[3], William Vizuete[3], David T. Allen[1]*

Presenter(s): *Junsang Nam*

Affiliation: [1]University of Texas, Center for Energy and Environmental Resources, [2]Massachusetts Institute of Technology, Department of Earth, Atmosphere, and Planetary Sciences, [3]University of North Carolina, Department of Environmental Sciences and Engineering, School of Public Health

ABSTRACT:

Ambient observations have indicated that high concentrations of ozone observed in the Houston/Galveston (HG) area are associated with plumes of highly reactive hydrocarbons, mixed with NO_x, from industrial facilities. Ambient observations and industrial process data, such as mass flow rates for industrial flares, indicate that the VOCs associated with these industrial emissions can have significant temporal variability. To characterize the effect of this variability in emissions on ozone formation in Houston, data were collected on the temporal variability of industrial emissions or emission surrogates (e.g., mass flow rates to flares). The observed emissions variability was then used to construct region-wide emission inventories with variable industrial emissions, and the impacts of the variability on ozone formation were examined for two types of meteorological conditions, both of which lead to high ozone concentrations in Houston. The air quality simulations indicated that variability in industrial emissions has the potential to cause increases and decreases of 10-50 ppb, or more, in ozone concentration. The largest of these differences are restricted to regions of 10-20 km^2, but the variability also has the potential to increase region wide maxima in ozone concentrations by up to 12 ppb.

Heterogeneous Chemistry Research

Author(s): *Heather Simon and, David Allen*

Presenter(s): *Heather Simon*

Affiliation: University of Texas at Austin, Center for Energy and Environmental Resources

ABSTRACT:

Over the past several years, researchers at the Center for Energy and Environmental Resources have been investigating the effects of heterogeneous chemistry on urban air pollution in Southeast Texas. Data collected from TexAQS 2000 was used to study these reactions on the surface of fire particles. Measurements indicated a large increase in sulfate particles in fire plumes. Direct emissions of sulfate, displacement of chloride in fire emissions by sulfate, gas phase SO_2 oxidation, and aqueous phase SO_2 oxidation were all ruled out as sources of this sulfate. Modeling showed that heterogeneous sulfate oxidation on fire particle surfaces could reasonably explain the observations. In the same fire plumes, measurements indicated an increase in secondary formation of organic carbon particles. Temporal and spatial patterns predicted by photochemical modeling runs showed a correlation between predicted heterogeneous aldehyde condensation and measured SOA increases. Although this suggests heterogeneous chemistry as an important SOA formation mechanism, more research is needed to confirm these findings.

In addition to the work on fire plume measurements from TexAQS I, there has been photochemical modeling performed to predict the effect of heterogeneous N_2O_5 hydrolysis on ozone concentrations in Southeast Texas. N_2O_5 acts as a nitrogen reservoir at night, but is rapidly converted to NO_2 and NO_3 at sunrise. At night, hydrolysis to nitric acid (HNO_3) is the main loss mechanism for N_2O_5. The gas phase hydrolysis reaction is fairly slow, but there have been a range of laboratory studies which indicate that hydrolysis on aerosol surfaces may be significant. To evaluate the effect of this chemistry, photochemical modeling was performed for a well studied episode in Houston during the summer of 1999. The modeling was performed using the both the Comprehensive Air Quality Model with extensions (CAMx) and the Community Multiscale Air Quality (CMAQ-MADRID) model. The CMAQ model runs showed that this chemistry is potentially quite significant, while the CAMx model runs predicted that this chemistry was of limited importance. The results of these modeling runs will be re-examined once the chemistry is better defined through TexAQS II field measurements.

New tools will allow us to further investigate atmospheric heterogeneous chemistry in Houston. These tools include ambient measurements made in TEXAQS II and a recently developed model-ready primary particulate matter (PM) emissions inventory for Texas. In the next year we will pursue several projects which may shed light on the importance of heterogeneous chemistry to urban air pollution in Houston. First, we will investigate the source of unexplained SOA (heterogeneous condensation of aldehydes or unreported semivolatile VOC emissions from mobile sources). Second, we will refine the modeling used to investigate the importance of heterogeneous N_2O_5 hydrolysis. Finally, if any fire plumes are identified in the TexAQS II data, we will further investigate heterogeneous sulfate formation on fire particles.

Aerosol Classification during TexAQS using HSRL Measurements

Author(s): [1.] *Richard Ferrare,* [1.] *Chris Hostetler,* [1.] *John Hair,* [1.] *Anthony Cook,* [1.] *David Harper,* [1.] *Sharon Burton,* [1.] *Chieko Kittaka ,* [2.] *R. Bradley Pierce* [3.] *Larry Kleinman*

Presenter(s): *R. Bradley Pierce*

Affiliation: [1.] *NASA Langley Research Center,* [2.] *NOAA,* [3.] *Brookhaven National Lab*

ABSTRACT:

The Texas Air Quality Study II / Gulf of Mexico Atmospheric Composition and Climate Study (TexAQS II / GoMACCS) conducted during August and September 2006 provided the opportunity to investigate the variability of aerosol properties near Houston and the impacts of these aerosols on air quality and radiative transfer. During this mission, the new NASA Langley Research Center (LaRC) airborne High Spectral Resolution Lidar (HSRL) was deployed on the LaRC B200 King Air aircraft and collected approximately 90 hours of data during 22 science flights. These B200 flights were coordinated with flights made by the NOAA WP-3 and Twin Otter aircraft and the Center for Inter-Disciplinary Remotely Piloted Aircraft Studies (CIRPAS) Twin Otter and included segments over the NOAA research ship Ronald V. Brown. Ten flights included segments coordinated with NASA "A-train" overpasses to validate Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) lidar measurements and to investigate combined aerosol retrieval algorithms. The majority of the flights were over land; approximately 60% of the HSRL measurements were within 200 km of Houston and about 80% of the measurements were within 400 km of Houston.

The HSRL technique takes advantage of the spectral distribution of the lidar return signal to discriminate aerosol and molecular signals and thereby measure aerosol extinction and backscatter independently. The LaRC airborne HSRL measures aerosol backscatter and depolarization at 532 and 1064 nm and aerosol extinction at 532 nm. The HSRL measurements acquired during TexAQS II / GoMACCS and other missions have been used to identify aerosol types and apportion aerosol optical thickness to these aerosol types. In these analyses, the HSRL measurements of aerosol depolarization, backscatter color ratio, extinction/backscatter ratio, and wavelength dependence of aerosol depolarization are grouped into major categories using cluster analyses. The average aerosol properties of these groups are then used to identify which major aerosol type(s) most closely matched each cluster. For example, large nonspherical dust particles typically have low backscatter color ratio and high depolarization values, in contrast to smaller, spherical urban aerosols that have high backscatter color ratios and low depolarization values. The aerosol categories derived from the HSRL data were found to be consistent with aerosol properties derived from coincident airborne aerosol in situ measurements.

During TexAQS II/GoMACCS, urban/biomass aerosols accounted for about 80% of the aerosol optical thickness (AOT) measured by the HSRL. Aerosol types containing dust

accounted for about 15% of the AOT, and oceanic aerosols accounted for about 5% of the AOT. This apportionment is in contrast to the results derived from HSRL measurements acquired over Mexico during the March 2006 Megacity Initiative: Local and Global Research Observations (MILAGRO) mission; in this earlier mission, the aerosol type consisting of a mix of dust and urban aerosols accounted for over half of the AOT, while the urban/biomass mix contributed to less than a third of the AOT. Backtrajectories, aerosol transport model simulations, and CALIPSO lidar observations confirmed the presence of Saharan dust inferred from the HSRL measurements acquired during two TexAQS II / GoMACCS flights.

The HSRL aerosol measurements are also being used to assess aerosol/chemical model forecasts and simulations of aerosol amount (e.g. extinction) as well as type. During TexAQS II / GoMACCS, HSRL aerosol measurements have been used to assess Real-Time Air Quality Modeling System (RAQMS) assimilation/predictions of aerosol parameters along the B200 flight paths.

Interstate Transport of Ozone and Aerosols: the View from Satellites and Models

Author(s): *G.B. Osterman*

Presenter(s): *Greg Osterman*

Affiliation: Jet Propulsion Laboratory/California Institute of Technology

ABSTRACT:

The current understanding regarding background ozone levels and transport effects based on data from the satellites and the RAQMS model results will be provided. Updates on the analyses performed by the different satellite teams will be shown. Future plans for studies that emphasize improving our understanding of the effects of air transported from other regions into non-attainment areas will be discussed.

An Observational Approach to Determining Ozone Sensitivity and its Variation within the HGB Non-Attainment Area

Author(s): [1.] *Basil Dimitriades and* [2.] *Deborah Luecken*

Presenter(s): *Basil Dimitriades*

Affiliation: [1.] North Carolina State University, and, [2.] US-EPA, Research Triangle Park, NC.

ABSTRACT:

This report is relevant to TCEQ's High Priority Science Questions F and K.

An observational approach is described and used in an effort to investigate the sensitivity of ozone production in HGB to VOC and NOx controls and the spatial/temporal variation of such sensitivity. Our specific objective was to assess the utility of ozone sensitivity evidence in development of correctly directed control strategies for ozone attainment and thereby assess the need for comprehensive modeling or observational studies to answer TCEQ's Questions F and K.

Key features of this observational approach are different definitions of "VOC limitation" and "NOx-limitation" than the definitions traditionally used, and the use of an Empirical Kinetic Modeling Approach for characterizing ambient precursor conditions with respect to their potential for causing VOC-limited or NOx-limited ozone exceedances. The approach requires daily observational data of ambient precursor conditions, i.e., including ambient VOC and NOx concentrations and VOC composition, at as many sites in the HGB area for as long a study period as practical.

For illustration purposes, the approach was applied to Harris County. Results showed that conditions occur in Harris County that are conducive to development of both VOC-limited and NOx-limited ozone exceedances. It was also shown that VOC-limited exceedance conditions occur frequently, under which conditions exceedances cannot be prevented through VOC control, and that; in consequence, the optimum control strategy may be drastic control of NOx

The findings from this investigation indicate the validity and importance of TCEQ's Question F and emphasize the urgent need for modeling or observational studies to answer this very important SIP-relevant Question.