

THE SHELL CENTER FOR SUSTAINABILITY

ENVIRONMENTAL & ENERGY SYSTEMS INSTITUTE

Houston Air Quality – Meeting the
Ozone Standards

THE SHELL CENTER FOR SUSTAINABILITY

Conference on Air Quality

Rice University Campus: October 6, 2004

Executive Summary

On October 6th, the Shell Center for Sustainability held a day-long conference on Houston's air quality, with special emphasis on the city's efforts to attain the Clean Air Act's ozone standards. The conference featured representatives from the scientific community, non-governmental organizations (NGOs), industry and state, federal and municipal political authorities. Overall, participants acknowledged that Houston's ability to achieve compliance with the CAA's ozone standards by the deadlines is possible, but will require surmounting a set of challenging factors unique to Houston's metropolitan area.

The Participants

Brief biographies of the conference participants are contained below:

SPEAKERS

David T. Allen is Reese Professor of Chemical Engineering and Director of the Center for Energy & Environmental Resources at the University of Texas at Austin. His research interests lie in environmental reaction engineering, particularly issues related to air quality and pollution prevention. He is the author of four books and over 100 papers in these areas. He received his B.S. in Chemical Engineering from Cornell University and his M.S. and Ph.D. degrees in Chemical Engineering from the California Institute of Technology.

Guy Donaldson is Air Quality Planning Coordinator in the Air Planning Section of the United States Environmental Protection Agency, Region 6 Office, in Dallas. He serves as the EPA point of contact for the Houston area ozone non-attainment plan. Mr. Donaldson has been in his current position for 13 years. Prior to that he served as an air pollution inspector for EPA and the Texas Air Control Board. He holds Bachelor and Master of Science degrees in Chemical Engineering from Texas A&M University.

Larry Soward was appointed by Governor Perry in 2003 to chair the Texas Commission on Environmental Quality. He has served as Executive Assistant to the Texas Lieutenant Governor; Deputy Land Commissioner of the Texas General Land Office and Veterans' Land Board; Deputy Commissioner of the Texas Department of Agriculture; Deputy Executive Director of the Texas Public Utility Commission, and Executive Director of the Texas Water Commission. He holds degrees in mathematics and law from the University of Texas.

Bill White is the 51st Mayor of the City of Houston, elected on December 6, 2003. Included among Mayor White's ambitious agenda is a commitment to addressing the challenges posed by the city's air quality. From 1993 to 1995, he served as Deputy Secretary of Energy of the United States and led efforts to reduce the department's annual budget by over \$1 billion. He joined the WEDGE Group in 1997 as President and CEO and led the business to record performance. He graduated magna cum laude from Harvard University and from the University of Texas Law School with highest honors.

MODERATOR

Christian Holmes serves as Executive Director of both the Rice University Shell Center for Sustainability and the Environmental & Energy Systems Institute (EESI). He has held a number of senior executive positions including Vice President for Environment, Safety and Health at Tenneco Energy; Chief Financial and Administrative Officer for the U.S. Environmental Protection Agency; Director of the U.S. Trade and Development Agency (USTDA); and Executive Director of the President's Task Force on International Private Enterprise.

PANELISTS

Ramón Alvarez is a scientist in the Global & Regional Air Program, Texas Office of Environmental Defense, promoting attainment of air quality standards in Texas cities and cleaner air in Big Bend National Park. He has worked with industries on the USMexico border to find cost-effective methods of reducing waste and pollution and serves on the Pollution Prevention Advisory Committee of TCEQ.

Daewon Byun is Professor of Geosciences and Chemistry at the University of Houston and Director of the Institute for Multidimensional Air Quality Studies. He was technical leader of the EPA Models-3 Community Multiscale Air Quality project and is a committee member for NCAR, NOAA, Community Modeling and Analysis System, TCEQ, Houston Advanced Research Center.

Neil Carman is Clean Air Director of the Sierra Club's Lone Star Chapter. He is involved in a range of Texas air quality concerns including: emissions and technical data on industrial sources of air pollution and their impacts; one-hour ozone nonattainment programs; implementation of the new EPA 8-hour ozone standard and federal air operating permit program; evaluating air toxics monitoring around industrial sources; training citizens to take air samples near industrial sources.

Walt Crow is Senior Project Manager at URS and manages the Houston Regional Monitoring Network. He has conducted chemical fate studies used to assess environmental impacts of urban/industrial pollution, including the Houston Area Oxidant Study, Houston Aerosol Characterization Study, TNRCC Houston Oxidant Study, and the Coastal Oxidant Study for Southeast Texas.

Doug L. Deason is a Senior Staff Engineer in ExxonMobil's Environmental Engineering and Manufacturing Support. His duties include developing plans for ExxonMobil's Refining and Chemical

facilities, ensuring compliance with the Houston-Galveston Area's ozone state implementation plan at the company's five manufacturing sites in the HGA area, representing ExxonMobil Corporation's business interests in developing improvements to the Houston Ozone SIP.

Pam Giblin heads the environmental department at Baker Botts. Her range of environmental experience includes all aspects of environmental practice, ranging from air and water quality to hazardous waste. As a fluent speaker of Spanish, she helps clients understand and comply with Mexico's environmental laws and regulations. She previously served as general counsel of the Texas Air Control Board and currently as a member of the EPA's Federal Clean Air Act Advisory Committee.

Harvey Jeffries is Professor of Atmospheric Chemistry at the University of North Carolina-Chapel Hill. His research focuses on gas-phase atmospheric chemistry and mathematical modeling of urban air chemistry. He is now conducting gas-phase and particle experiments to test air quality effects on human lung cells and has been active in using these models to plan public policy. He is a scientific advisor to Houston's Business Coalition for Clean Air Appeal Group, and a member of the Science Advisory Committee of the Texas Environmental Research Consortium.

Steve Hupp is Assistant Technical Manager of Harris County Pollution Control. He manages supplemental environmental projects, assists County operations with environmental compliance, and has assisted in legislative efforts and rulemaking. He chairs the Solid Waste Management Committee of the Houston-Galveston Area Council and serves on the Harris County Natural Resource Management Committee.

Matt Kuryla is an attorney with Baker Botts LLP with an environmental practice encompassing regulatory counseling, transactional advice, litigation, and alternative dispute resolution. He has represented clients in environmental actions including criminal investigations, explosions, and releases. He has served as counsel to the BCCA Appeal Group, and led a successful judicial challenge resulting in revisions to the Houston/Galveston ozone State Implementation Plan.

Gary Morris is Assist. Professor Physics & Astronomy at Valparaiso University and Adjunct Assist. Professor at Rice University. He has spent 12 years studying atmospheric ozone using satellite data and models of atmospheric dynamics. During the summer of 2004, through funding from the Shell Center and NASA, he launched 25 ozonesounds to examine the vertical distribution of ozone, collecting data which aids in the evaluation of local and remote contributions to Houston's ozone problems.

Eduardo (Jay) Olaguer is a Senior Research Scientist at the Houston Advanced Research Center, where he directs air quality research under the aegis of the Texas Environmental Research Consortium. Dr. Olaguer holds a Ph.D. in Meteorology from MIT. He has designed and built complex 3-D models of the global atmosphere with climate dynamics, chemistry, and multi-media (i.e., air-soil-water interactions). Dr. Olaguer has been especially involved in the assessment of long-range transport of air pollution, and its implications for tropospheric ozone, climate, and air toxics.

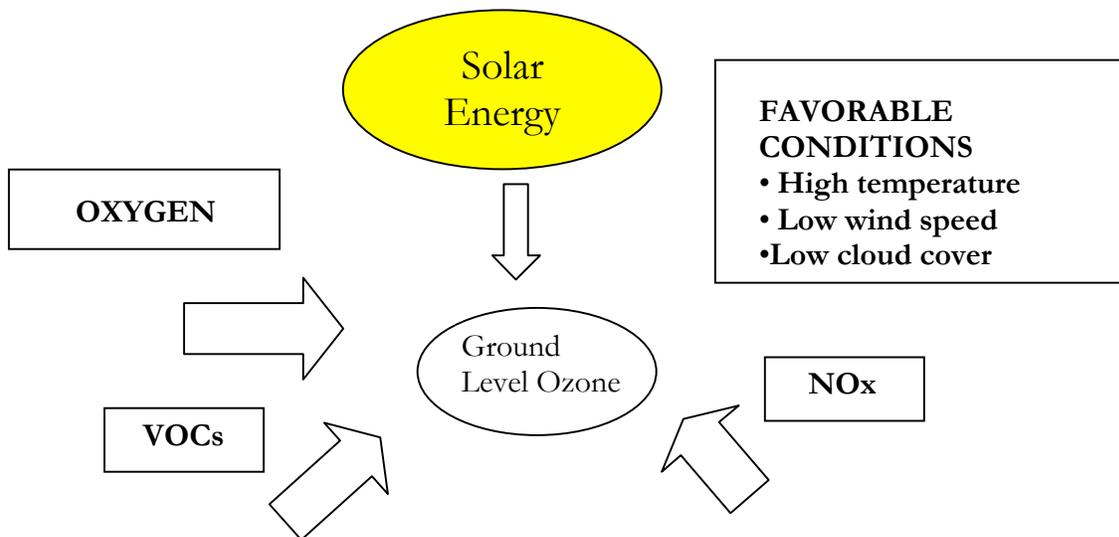
Paul L. Newman is Air Quality Permit Program Manager for the Harris County Public Health & Environmental Services Department where he performs technical reviews of TCEQ Air Quality Permit Applications, investigates industrial facilities, interprets TCEQ and EPA rules on air quality issues for regulated industry, citizens, governmental officials, Harris County Attorney and District Attorney, and assists in management of the division's emission event investigation initiative actions.

Nancy B. Rapoport is Dean and Professor of Law at the University of Houston Law Center. She received her B.A., summa cum laude, from Rice University and her J.D. from Stanford Law School. She started her academic career at Ohio State University College of Law and has held a variety of academic positions. Her specialties are bankruptcy, ethics, law and popular culture. She is admitted to the bars of California, Ohio, Nebraska, and Texas and to the United States Supreme Court. In 2001, she was elected to membership in the American Law Institute.

John D. Wilson is Executive Director of the Galveston-Houston Association for Smog Prevention (GHASP). He also serves as a leader of the Houston Foresight Program at the Houston Advanced Research Center (HARC). Houston Foresight created a comprehensive report evaluating risks associated with environmental problems facing the Houston region. Mr. Wilson has a B.S. from Rice University and Masters in Public Policy from Harvard University.

Ozone – Formation and Effects

A number of the participants provided useful background information on ozone, its formation and effects. Doug Deeson provided the following diagram which shows that ground-level (tropospheric) ozone is formed from the interaction of oxygen, volatile organic compounds (VOCs), Nitrogen Oxides (NO_x) and the sun's solar energy.



Dr. Guy Donaldson from the Environmental Protection Agency (EPA) enumerated the health problems associated with high ozone levels. Ozone has been shown to:

- pose health problems for children, asthmatics, the elderly and even healthy adults;
- cause acute respiratory problems;
- aggravate asthma, emphysema and bronchitis;
- lead to increased hospital admissions and emergency room visits; and
- impair the body's immune system defenses.

Ozone Standards Under the Clean Air Act

Under the Clean Air Act the Environmental Protection Agency is required to set standards that limit the public's exposure to potentially harmful pollutants. EPA has set standards for six so-called "criteria pollutants," ground-level ozone (smog), particulate matter, lead, nitrogen dioxide, sulfur dioxide and carbon monoxide. With the exception of ozone, Houston has met the standards for each of these pollutants. EPA is in the process of phasing-out a one-hour standard for ozone, and replacing it with an eight-hour standard.

OZONE STANDARDS - 1 HOUR

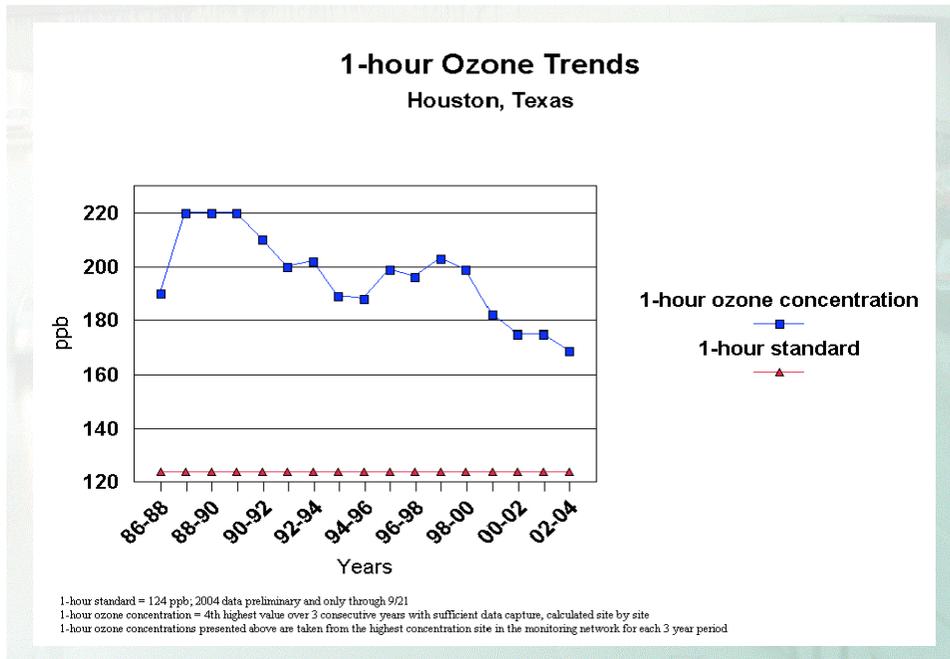
Ozone, under the one-hour standard, cannot exceed 125 parts per billion (ppb) in any region of the country. To show compliance the region cannot exceed 125 ppb on more than 3 days in a consecutive 3-year period. Houston has never been in compliance with the ozone standard, though it has developed plans to attain the standard since it was first promulgated. Under the most recent plan submitted to EPA, referred to as a state implementation plan (SIP), Houston envisions attaining the standard by the required deadline of 2007.

OZONE STANDARDS - 8 HOUR

EPA's new standard is commonly referred to as the 8-hour ozone standard. Under the new standard, a violation occurs if the three-year average of the fourth highest recorded levels of ozone at any monitor is greater than or equal to 85 ppb. Should an area(s) within a state fail to comply with the new 8-hour standard, the State must recommend to EPA the boundaries of the area(s) that are not in compliance with the ground-level ozone standard, and must submit a plan to EPA that demonstrates how the State will bring the area(s) back into attainment.

THE 1- HOUR STANDARD -- PAST EFFORTS & CONDITIONS UNIQUE TO HOUSTON

Houston, as noted above, has never been able to attain the Clean Air Act's ozone standard. Moreover, the ozone peaks recorded in Houston often exceed those found elsewhere in the United States. The graph below, taken from Guy Donaldson's presentation, shows that Houston has made progress, but has yet to achieve the EPA's one-hour standard.



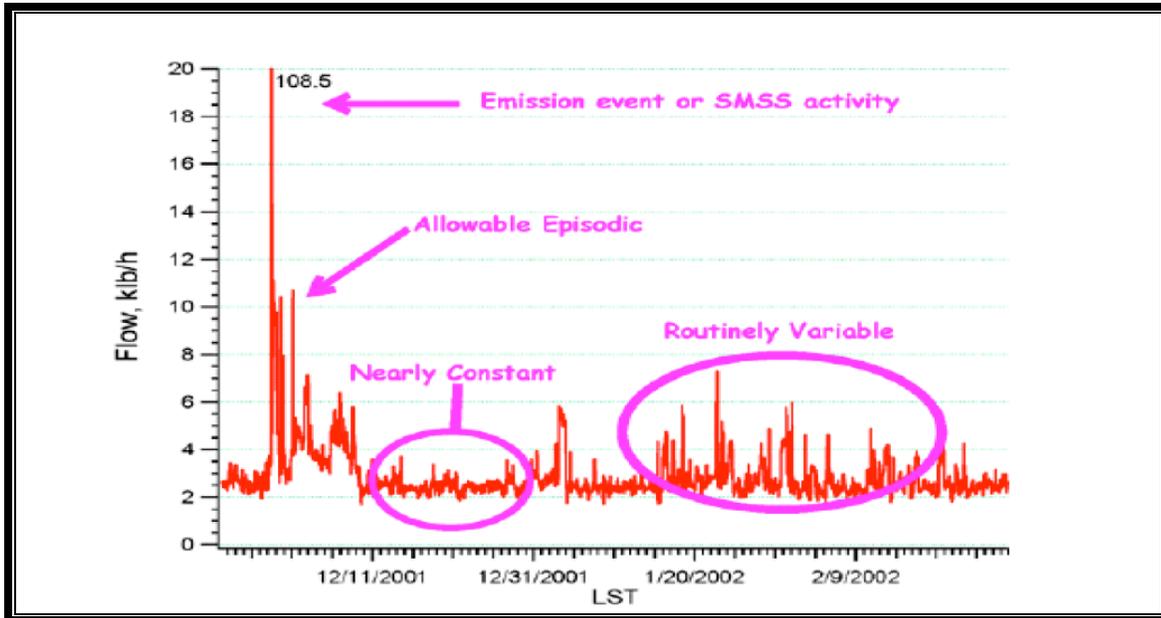
How do we account for the levels recorded and Houston's continued inability to achieve the standard?

Dr. Allen noted that Houston differs from other major urban areas in the daily variability of its emissions. In most areas the level of ozone experienced throughout the day follows a diurnal pattern. Ozone levels rise gradually in the morning hours, peak near the middle of the day, and fall gradually with the approach of evening and the drop in temperatures. In addition, again in most areas, industrial and other stationary source emissions are relatively constant. Given these characteristics, variations in weather explain to a large degree the ozone levels in areas other than Houston.

In Houston, given the world-scale size of its petrochemical base, emission levels are more variable than in other U.S. cities. Further, again as a result of its petrochemical complex, Houston has a large quantity of so-called highly reactive volatile organic compounds (HRVOCs), specifically, low molecular weight olefins like ethylene, propylene, butylenes and 1,3, butadiene.

These features, as both Dr. Allen and Dr. Jeffries noted, contribute to uniquely high ozone peaks, referred to as Transient High Ozone Events (THOEs). These sharp spikes in ozone levels far exceed the standard required for attainment. THOEs are difficult to predict. While ozone models continue to improve, there remains a significant gap between the levels of ozone actually measured and the model output.

The graph below, taken from Dr. Allen’s presentation, shows an example of an ozone spike observed in the Houston-Galveston in 2001, and other ozone levels in the 2001-2002 timeframe.



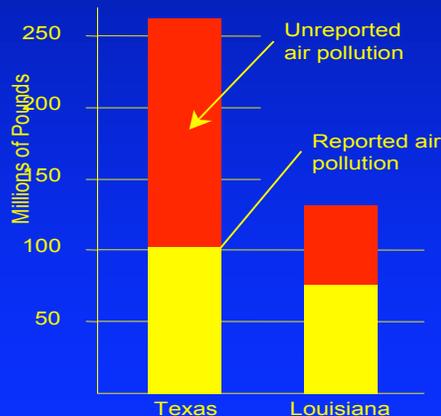
Houston’s SIP had at one point relied more on NO_x than on HRVOCs. Both the TCEQ and the EPA believed that a focus on NO_x reductions would demonstrate attainment. This strategy was modified, largely as a result of a lawsuit against the agencies. The resulting consent decree decreased the focus on NO_x emission reductions (from 90% to 80%) and proposed implementation of a strategy to regulate HRVOCs from industrial point sources.

Commissioner Soward noted that, although the current plan focuses on HRVOC reductions, the amount of HRVOCs emitted from facilities in the Houston-Galveston area is unknown:

Let’s face it. Our emissions inventory must be comprehensive, complete and accurate. It’s not. There’s no question that monitors are expensive, and maintaining and analyzing the data costs a great deal of money and human resources – but surely the price of ignorance will far exceed the costs of knowledge.

John Wilson provided data related to the toxic release inventory (TRI) the aim of which was to demonstrate a disparity between actual and reported emission levels. The graph below displays disparity in the data from two leading petro-chemical manufacturing states, Texas and Louisiana.

Unreported VOC Emissions (TRI)



Similarly, Dr. Daewon Byun and his colleagues at the University of Houston emphasized the “uncertainties in the HRVOC emissions data” and noted that [they] must be evaluated in conjunction with all other key modeling factors” before the gap between model output and actual observations can be closed.

On the other hand, Matt Kuryla noted that, while science serves as a “good compass for control measures, it doesn’t provide all the answers.” Kuryla noted that many elements of the 2000 SIP proved to be unenforceable (e.g., early morning law care ban), and that air quality goals have to be buttressed by enforceable SIP provisions.

Given the uncertainty, Commissioner Soward maintained that “we have a SIP for the Houston-Galvest area that may demonstrate attainment of the 1-hour standard by, at best, a razor-thin margin – and that’s with full use of weight-of-evidence arguments.”

The Environmental Monitoring & Response System (EMRS)

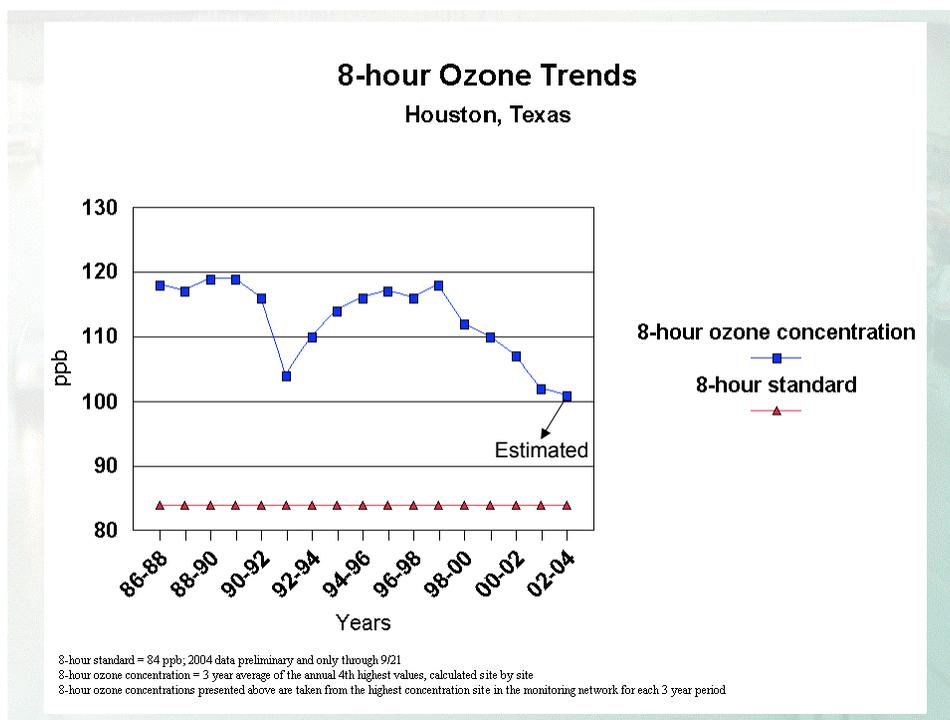
TCEQ has an initiative to gather actual data that is poised to set a precedent for the future. This initiative, referred to as the Environmental Monitoring and Response System (EMRS), is designed to alert industry participants when elevated pollutant levels are in the atmosphere. The system, which is not intended as an enforcement tool, relies on strategically placed monitors that provide wind-direction together with HRVOC monitoring capability. Walt Crow noted that this system should enable TCEQ and industry to identify “best management practices” for the reduction of facility emission releases.

In a similar vein, representatives from Harris County Pollution Control, Mr. Steve Hupp and Mr. Paul Newman pointed out the community monitors put in place by this organization. Hupp informed the audience about the increase in the number of monitors and how to receive e-mail ozone alerts.

THE NEXT CHALLENGE - THE 8-HOUR OZONE STANDARD

Houston, as noted above, faces two, relatively near-term ozone compliance deadlines. Compliance with the one-hour standard is required by 2007, while compliance with the forthcoming eight-hour standard is required by 2010. The 8-hour standard emerged after EPA conducted a review of the adequacy of the 1-hour standard. On April 15, 2004 EPA designated and classified the Houston-Galveston Area (HGA) as an 8-hour nonattainment area.

The graph below, taken from Guy Donaldson’s paper, shows how Houston is performing relative to the 8-hour standard:



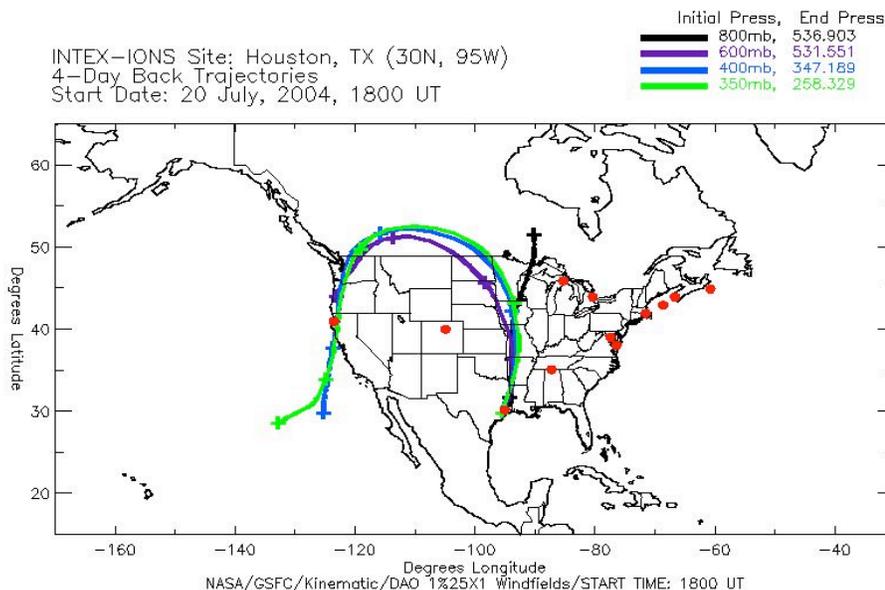
Fortunately, as several speakers noted, the steps being taken today to comply with the one-hour standard should contribute to Houston’s ability to achieve the eight-hour standard by 2010. However, the 8-hour standard poses problems quite distinct from the 1-hour standard. For one thing, as Jay Olaguer noted, the “current air quality models used for [the 1-hour SIP] are barely sufficient for [the 1-hour compliance

standard], let alone the 8-hour standard.” In addition, Olaguer pointed out that “transport yields background [ozone levels] of up to 80 ppb.” Doug Desson maintained that some of the 8-hour exceedances may actually be the result of ozone transport.

Because the regional transport of ozone can significantly affect compliance with the 8-hour standard, Dr. Gary Morris argues it is essential to know more about factors involving in ozone transport, especially the atmospheric chemistry involved in vertical mixing in the area.

Dr. Morris discussed the preliminary results of research funded by the Shell Center for Sustainability, referred to as the Rice University Tropospheric Ozone Pollution Project. This project involved launching light-weight weather balloons into the atmosphere above Houston with instruments that permit the assessment of the vertical distribution of ozone. Ozone aloft can contribute to high, persistent ozone at ground level.

The map below shows the significance of ozone transported into the Houston area, in this case from the Western part of the United States.



The map shows the results of sampling taken on July 19th and July 20th of 2000, days during which Houston experienced high ozone levels. These were The ballon generated data reveal air mass trajectories originating on the West Coast and reflective of the forest fires in the region at the time. These data make clear, according to Dr. Morris, that understanding the impact of long-range transport and vertical mixing will become even more critical under the 8-hour standard.

Concluding Observations.....

1. Overall, panelists and speakers agreed that the Houston-Galveston Area has made significant strides towards achieving the ozone standard under its SIP. Monitored ozone levels have been decreasing by both calculation methods as seen in the graphs from Guy Donaldson's presentation above. However, the current standard has not yet been achieved and the future eight-hour will very likely prove challenging for the area.
2. A recurring major conclusion of the conference is the lack of accurate and dependable ozone models, despite improvements over time. It is difficult to predict what the ozone level may be in 2010 using meteorological data from 2000. In addition, emission inventories used in the models are based on calculated estimates, as opposed to real-time monitoring. Dr. Allen, Dr. Jefferies and Dr. Byun each strongly supported the need continually to compare model results from different simulations; as well as continued manipulation of model variables to try and gain a better/more accurate representation of the monitored ozone levels.
3. Stakeholder involvement is critical. Nancy Rapoport advocated that, at least in theory, a "community round-table" discussion ought to be held to ensure community awareness and involvement on air quality issues (and environmental issues in general). Her idea outlined a format where all parties would agree to a set of given conditions that were background factors. Then, given those conditions work together to come up with the best and most viable solution for all parties. Panelists also agreed that for control strategies/corrective actions to be viable, they must be enforceable. It was seen with some prior SIP revisions that the actions adopted just were not feasible, such as the ban on early morning lawn care, and therefore could not be expected to produce a significant decrease in ozone formation. If the Houston area wishes to meet the deadlines set for ozone attainment, panel members uniformly felt there had to be increased cooperation and collaboration between the public, regulatory community and industry.

