

Hanford Diffusion Grid Study

Will Shaw directed tracer releases and meteorological measurements associated with a small field measurement program on the Hanford Site during July 1-9, 2002. The purpose of the study was to investigate the dynamics of a plume of ions generated by a localized source. Other participants in the study included Randy Hansen and Tony Peurrung of PNNL and Gene Allwine of Washington State University. This work has the distinction of being the last field study conducted before the final demolition and removal of the remaining towers of the historic Hanford Diffusion Grid. Only the 122-m HMS Tower now remains.

CRYSTAL-FACE

Connor Flynn, Donna Flynn, Jim Mather, Roger Marchand, Jennifer Comstock, Kevin Widener, and Terry Doherty participated in the CRYSTAL-FACE (Cirrus Regional Study of Tropical Anvils and Cirrus Layers - Florida Area Cirrus Experiment) experiment during the month of July. CRYSTAL-FACE is a NASA-sponsored field campaign to investigate tropical cirrus cloud properties and formation processes using ground-based remote sensors, satellite measurements, and in situ and remote sensing instruments located on six different aircraft platforms. The primary focus of the experiment was to measure various aspects of deep convective clouds, including anvil cirrus that are generated by outflow from

cumulus towers. The experiment also focused on the formation of high, thin cirrus clouds located just below the tropopause that are commonly observed in the tropics but are not well characterized. Understanding the role of cirrus clouds in the tropical atmosphere is important for modeling the Earth's climate. The PNNL Atmospheric Remote Sensing Laboratory (PARSL) team provided ground-based support in Everglades City on the west coast of the south Florida Peninsula.

15th Symposium on Boundary Layers and Turbulence

Jim Barnard, Chris Doran, Jerome Fast, Will Shaw, Dave Whiteman, and Shiyuan Zhong attended the 15th Symposium on Boundary Layers and Turbulence (BLT), held July 15-19, 2002, at the University of Wageningen, The Netherlands. This symposium, sponsored by the American Meteorological Society, is one of a bi-annual series of symposia on boundary layers and turbulence. Jim presented results from his research on direct numerical simulations (DNS) of turbulence. Chris gave a paper on the behavior of intermittent sensible heat fluxes at sites in Kansas, Utah, and Washington. He also attended a working meeting for people interested in the GABLS initiative (GEWEX Atmospheric Boundary Layer Study). GABLS is intended to improve the performance of climate models by evaluating boundary layer processes and their representation in models. The current focus is on mixing processes in stable conditions, and is thus highly relevant to research being conducted in EMP. He spoke with Prof. Bert Holtslag of Wageningen University, who is chairing the GABLS committee; he is interested in possible collaborations with EMP. Jerome's presentation described a comparison of turbulence data collected during the Vertical Transport and Mixing (VTMX) field campaign in Salt Lake City and predicted turbulence quantities from a

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mesoscale model. The presentation also described why the model's turbulence parameterizations fail and the step forward to improve them. Will's talk described the behavior of time scales of the turbulence decay process based on results from a direct numerical simulation (DNS) of the boundary layer driven by surface heat fluxes observed during the VTMX field study in Salt Lake City (October 2000). Time scales computed directly from turbulence observations during VTMX were also described. These and the DNS results show that previously hypothesized time scales do not fully describe turbulence decay because they do not include the effects of shear production of turbulence kinetic energy. Dave presented results from his research on cold pools that form within high-elevation basins. Shiyuan presented two papers reporting results from two DOE-funded projects; one paper explored the sensitivity of boundary layer modeling to turbulence parameterizations and another investigated the impact of forecast errors in boundary layer wind fields on surface ozone predictions. She also gave an invited seminar at the Paul Scherrer Institute (PSI) in Villigen, Switzerland. The seminar at PSI talked about the work on evaluating and testing of mesoscale meteorological models using data from the VTMX field campaign in the Salt Lake Valley. She was also engaged in discussions with several researchers from the Laboratory of Atmospheric Chemistry at PSI on sharing data and comparing observations collected from the Salt Lake Valley with those from the Riviera Valley in Switzerland. See Presentations/Publications for a list of all of the presentations.

U.S. Workshop on Climate Projections, Uncertainty, and Scenarios for Impact Assessment

Ruby Leung was invited to attend the U.S. Workshop on Climate Projections, Uncertainty, and Scenarios for Impact Assessment held July 17-19, 2002, at the National Center for Atmospheric Research, Boulder, Colorado. She gave a presentation on the development of regional climate change scenarios. The goals of the workshop were to assess needs/opportunities for the generation of user-oriented climate projections and scenarios and discuss research in quantification of uncertainty in future climate projections and impact assessments.

GEWEX Workshop

Ruby Leung attended the Global Energy and Water Cycle Experiment (GEWEX) Workshop on "The Application of GEWEX Scientific Research to Water Resources Management" on July 24, 2002, in Dresden, Germany. The workshop was held in conjunction with the International Conference on Water Resources and Environmental

Research (ICWRER) held July 22-26, 2002, in Dresden. She gave an invited presentation at the workshop on a GEWEX Continental International Program (GCIP) case study.

Summer of 2002 Field Studies

The DOE Research Aircraft Facility completed a 7-week, multiple-field study stay in Worcester, Massachusetts, on August 14. The flight crew (Bob Hannigan, Dick Hone, and Tony Robinson) carried out 21 flights totaling 62 research flight hours (not counting ferry time). The PNNL science crew (John Hubbe, Vic Morris, and John Schmelzer) assisted science teams from Aerodyne Research (John Jayne and Doug Worsnop), Brookhaven National Laboratory (BNL) (Fred Brechtel, Peter Daum, Larry Kleinman, Yin-Nan Lee, Gunnar Sennum, Stephen Springston, and Xiao-Ying Yu), and PNNL (Carl Berkowitz, Alex Laskin, Katie Shaver, and Rahul Zaveri) in testing the new Aerodyne Aerosol Mass Spectrometer (a DOE/SBIR project) from June 25 through July 8; and conducting two DOE Atmospheric Chemistry Program field studies: the daytime Northeast Aerosol and Oxidant Study (led by Pete Daum) from July 9-22, and the Nighttime Aerosol and Oxidant Experiment (led by Carl Berkowitz and Rahul Zaveri) from July 27 through August 10.

A research mission through the Boston-Washington corridor to the Leesburg Airport in Virginia on August 11-12 provided an opportunity for visitors from the DOE Office of Science (Gerry Ellwood, Todd Harding, Rick Petty), NOAA (Jim Mahoney), and staff from other DOE offices, federal agencies, and local news media to see the Gulfstream 159 (G-1) with a full complement of research instruments on board. Peter Lunn (DOE's Office of Science) hosted the event and staff from Argonne National Laboratory (ANL) (Jeff Gaffney), BNL (Peter Daum and Creighton Wirik), PNNL (Bill Pennell and the G-1 crew) and Aerodyne Research (John Jayne) were on hand to provide visitors with detailed information about the G-1, its research equipment, and its role in DOE's Atmospheric Science Program.

Flight testing of the Aerodyne Aerosol Mass Spectrometer and a new aerosol inlet system was a major milestone in this DOE/SBIR project. As part of this project, Fred Brechtel (formerly with Brookhaven National Laboratory) under contract with PNNL designed and fabricated a double diffuser cone, isokinetic aerosol inlet with active flow control to maintain isokinetic conditions at the inlet over a wide range of air speeds and altitudes. The inlet delivered aerosols to a distribution manifold from which each aerosol instrument pulled its sampling stream. Brechtel made extensive measurements of flow velocities,

turbulence levels and aerosol concentrations within the inlet and along the manifold to characterize flows and aerosol losses within the diffuser cones and manifold.

Carl Berkowitz and Rahul Zaveri led the team of scientists participating in the Nighttime Aerosol and Oxidant Plume Experiment carried out in the Boston, Massachusetts, area from July 27 through August 10. Other participants included Katie Shaver (PNNL); Rich Coulter (ANL); Tim Martin (Boston College); Tim Lachenmeier (GSSL); Andreas Geyer, Vivs Laliberte, Jochen Stutz, and Shushi Wang (UCLA); John Roadcap and Paul Tracy (USAF), and Chester Suchecki (consultant). Meteorological conditions during the field study provided the Boston area with very pleasant summer weather but failed to match the long term climatology for wind patterns in the area. Because of unexpected persistent winds from the north and east during many of the nights, tetron launches were possible on only three nights, nevertheless a total of eight flights (21 hours) over five nights enabled the team to sample both up and downwind of the Boston area and use tetrons to conduct Lagrangian sampling of the pollution plume off the New England coast.

ICCAGRA Meeting

Rich Barchet attended, as the DOE representative, a meeting of the Interagency Coordinating Committee for Airborne Geosciences Research and Applications (ICCAGRA) on August 21 at the Naval Postgraduate School's Center for Interdisciplinary Remotely Piloted Aircraft Studies facility in Marina, California. This committee brings together key users of aircraft in the research programs of the participating agencies. Rich described the DOE Research Aircraft Facility and the features and deployments of its Gulfstream 159 aircraft. Participants from the National Science Foundation, the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration, the Office of Naval Research, the Naval Research Laboratory, and the host agency described their various research platforms and summarized current and future deployments. Both NOAA and NRL are considering proposals for dedicating a P-3 to atmospheric research. ONR and the NPS stressed the value of the Small Business Innovative Research programs at various agencies as a means of developing new instruments better suited for use in airborne research. Participants also toured the CIRPAS facility and its DeHavilland Twin-Otter aircraft that was currently being used for a University of Washington study of marine stratus clouds.

Visitors from the University of Vienna

Stefan Eisenbach and Bernhard Pospichal, meteorology students from the University of Vienna, Austria, arrived on September 6 to begin fellowships at PNNL. They will be working on cold air pool formation and dissipation processes in basins with Dave Whiteman and their university advisor, Dr. Reinhold Steinacker. The students conducted meteorological experiments in high-altitude basins in the Eastern Alps in the winter of 2001-2002. These experiments led to an intensive experiment that was conducted over two nights in early June using tethered balloons and other meteorological equipment. The students are processing and analyzing the Austrian data. Bernhard will be working at PNNL through December 20 and hopes to finish his thesis next summer. Stefan will be staying through mid-February and will start his thesis next fall.

Utah's Peter Sinks Field Study

Justin Cox (University of Utah) and Stefan Eisenbach and Bernhard Pospichal (PNNL), with weather forecast support from students Todd Foisey and Jay Shafer (UU), conducted meteorological experiments in Utah's Peter Sinks basin during the period September 15-20 to obtain the data necessary to test future 3-dimensional radiative transfer simulations for confined topographies.

VTMX Workshop

Jim Barnard, Larry Berg, Chris Doran, Jerome Fast, Will Shaw, Dave Whiteman, and Shiyuan Zhong attended the annual Vertical Transport and Mixing workshop in Salt Lake City on September 17-19. Participants presented results of their research over the last year, discussed ongoing and planned collaborations with other scientists in the program, reviewed outstanding issues that have not yet been resolved and new ones that have been identified, and made recommendations for future measurement strategies. Proceedings of the workshop will be posted on the VTMX website at <http://www.pnl.gov/VTMX/>. See Presentations/Publications.

The PNNL Chemical Testing Chamber (PCTC)



The PNNL Chemical Testing Chamber (PCTC) also known as the Inert Atmospheric Reaction Chamber was developed to provide a scientific tool to track and measure volatile and semi-volatile chemicals in a controlled environment. This chamber can also be used for particles, aerosols and molds and has numerous capabilities for research.

This chamber concept evolved from previous Fate and Transport studies when it was discovered that there were so many unknowns associated with how chemicals react in the environment. An inert chamber was needed to predict and characterize suspected source emissions and chemical mixtures released to the environment. By understanding transport phenomena and chemical reactions in the atmosphere, key chemical effluents and potential signatures can be understood, modeled, and matched to the proper sensing technique. The chamber can be used to solve problems in many areas. Some of these areas include:

- Air emission measurements
- Chemical transformations
- Remote and/or continuous monitoring
- Hazardous waste treatment
- Measurements of biological organisms in air
- Worker safety and health
- National security and protection
- Predictions of chemical signatures in the environment
- Kinetic, analytical methods for chemical detection
- Automotive and catalyst research
- Aerosol and atmospheric studies
- Indoor air concerns (molds, allergens, dust loading)
- Sensor testing (false alarms and calibrations)
- Prevention and detection of chemical and biological weapons.

Tours of the chamber and presentations are being set up for the months of November and December. For more information on the tours, please contact Kathy Probasco. For information on the chamber, see the contacts below.

Features of the PCTC:

1. Volume – Dual chambers each approximately 10 m³
2. Surface Material – DuPont 200A FEP Teflon
3. Lighting – Uniform UV light/darkness
4. Chamber Air – Clean air pack removes: CO, CO₂, O₃, methane, HCs, NO_x, particles
5. Environmental Controls – Currently at room T and P, variable humidity.

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Presentations/Publications

The following papers were presented and published in *Preprints, AMS 15th Symposium on Boundary Layers and Turbulence*, held from July 15-19, 2002, in Wageningen, The Netherlands:

- Barnard, J. C., and J. J. Riley
"Direct Numerical Simulation of Intermittent Turbulence in the Very Stable Ekman Layer," pp. 424-427.
- Barnard, J. C., and W. J. Shaw
"The Energy Budget of Decaying Turbulence as Modeled by Direct Numerical Simulations of Turbulence."
- Doran, J. C.
"Some Properties of Intermittent Turbulence."
- Fast, J. D., and W. J. Shaw
"Observed and Simulated Turbulence Kinetic Energy and Dissipation Profiles in an Urban Valley During VTMX 2000," pp. 638-641.
- Shaw, W. J., and J. C. Barnard
"Scales of Turbulence Decay from Observations and Direct Numerical Simulation," pp. 398-401.

Whiteman, C. D., C. B. Clements, and J. Horel
"Turbulent and Radiative Flux Divergences in Cold Pools That Form Within a High-Elevation Basin," pp. 662-665.

Zhong, S., and J. D. Fast
"An Evaluation of Boundary Layer and Land Surface Parameterizations Using Data from the VTMX Field Campaign in the Salt Lake City Valley," pp. 560-563.

Zhong, S., G. Jiang, E. Yang, and S. Tanrikulu
"The Impact of Forecast Errors in Boundary Layer Wind and Fields on Predictions of Surface Ozone Concentrations," pp. 362-363.

The following papers were presented at the DOE VTMX Annual Meeting, September 17-19, 2002, Salt Lake City, Utah:

Barnard, J. C.
"Homogeneous Turbulence, Stratification, and Turbulence Decay."

Doran, J. C.
"Parameterization of Intermittent Turbulence."

Fast, J. D., K. J. Allwine, J. C. Torcolini, and R. N. Dietz
"Dispersion of Perfluorocarbon Tracers within the Salt Lake Valley."

Fast, J. D., and W. J. Shaw
"An Evaluation of Mesoscale Model Predictions of Turbulence Kinetic Energy and Dissipation."

Haiden, T., and C. D. Whiteman
"Analytical Modeling of Slope Flows."

Shaw, W. J., and J. C. Barnard
"Observations of Turbulence Decay with Comparison to Direct Numerical Simulation."

Shaw, W. J., L. S. Darby, and M. A. LeMone
"Dissipation and Short-Term Profiler Winds: Comparisons with Aircraft and Doppler Lidar."

Whiteman, C. D., S. Zhong, X. Bian, and T. Haiden
"Slope Flows and Cold Air Pools."

Zhong, S., and C. D. Whiteman
"Numerical Simulations of Downslope Flows Observed During the VTMX Slope Experiment."

Barnard, J. C., and W. J. Shaw
"Direct Numerical Simulation of Evolving Turbulence Using Surface Heat Fluxes Derived from VTMX Measurements." In *Preprints, AMS Tenth Conference on Mountain Meteorology*, June 17-21, 2002, Park City, Utah, pp. 122-125.

Disselkamp, R. S., V. Shutthanandan, L. A. Barrie, T. A. Cahill, and S. S. Cliff

"Size-Segregated Multi-Elemental Aerosol Analysis at Williams Tower During Texas 2000 Air Quality Study." Oral presentation at the American Chemical Society Meeting, August 22, 2002, Boston, Massachusetts.

Doran, J. C., S. Zhong, J. C. Liljegren, and C. Jakob
"A Comparison of Cloud Properties at a Coastal and Inland Site at the North Slope of Alaska." *J. Geophys. Res.* 107(D11):1029/2001JD000819, 2002

Fast, J. D., and W. E. Heilman
"The Effect of Lake Temperatures and Emissions on Ozone Exposure in the Western Great Lakes Region." *J. Appl. Meteor.* (in press).

Fast, J. D., R. A. Zaveri, X. Bian, E. G. Chapman, and R. C. Easter

"The Effect of Regional-Scale Transport on Oxidants in the Vicinity of Philadelphia During the 1999 NE-OPS Field Campaign." *J. Geophys. Res.* 107(D16):10.1029/2001JD000980.

Jobson, B. T.
"Chemical Kinetic Analysis of VOC Measurements from Houston." Presented at the Telluride Atmospheric Chemistry Workshop, August 4-11, 2002, Telluride, Colorado.

Kassianov, E. I.
"Stochastic Radiative Transfer in Multilayer Broken Clouds. Part I: Markovian Approach." *J. Quant. Spect. & Radiative Transfer* (in press).

Kassianov, E. I., T. P. Ackerman, R. T. Marchand, and M. Ovtchinnikov
"Stochastic Radiative Transfer in Multilayer Broken Clouds. Part II: Validation Tests." *J. Quant. Spect. & Radiative Transfer* (in press).

Kassianov, E. I., T. P. Ackerman, R. T. Marchand, and M. Ovtchinnikov
"Satellite Multi-Angle Cumulus Geometry Retrieval: Case Study." *J. Geophys. Res.* (in press).

Kassianov, E., and Y. Kogan
"Spectral Dependence of Radiative Horizontal Transport in Stratocumulus Clouds and Its Effect on Near-IR Absorption." *J. Geophys. Res.* (in press).

Kinne, S., U. Lohmann, S. Ghan, R. Easter, M. Chin, P. Ginoux, T. Takemura, I. Tegen, D. Koch, M. Herzog, J. Penner, G. Pitari, B. Holben, T. Eck, A. Smirnov, O. Dubovik, I. Slutsker, D. Tanre, O. Torres, M. Mishchenko, and I. Geogdzhayev

"Monthly Averages of Aerosol Properties: A Global Comparison Among Models, Satellite Data and AERONET Ground Data." *J. Geophys. Res.* (in press).

Leung, L. R.

"Application of Seasonal Climate Forecasts to Water Management in the Tennessee River." Invited presentation at the GEWEX Workshop on the Application of GEWEX Scientific Research to Water Resources Management, July 24, 2002, Dresden, Germany.

Leung, L. R.

"On the Development of Regional Climate Change Scenarios." Invited presentation at the U.S. Workshop on Climate Projections, Uncertainty, and Scenarios for Impact Assessment, July 17-19, 2002, Boulder, Colorado.

Shaw, W. J., and J. M. Hubbe

"Structure of the Atmospheric Boundary Layer in the Central Salt Lake Valley During the Afternoon-to-Evening Transition." In *Preprints, AMS Tenth Conference on Mountain Meteorology*, June 17-21, 2002, Park City, Utah, pp. 112-115.

Thomson, A. M., R. A. Brown, S. J. Ghan, R. C. Izaurralde, N. J. Rosenberg, and L. R. Leung

"Elevation Dependence of Winter Wheat Production in Eastern Washington State with Climate Change: A Methodological Study." *Climatic Change* 54:141-164.

Zhong, S., and J. D. Fast

"An Evaluation of MM5, RAMS, and Meso Eta at Sub-Kilometer Resolution Using VTMX Field Campaign Data in the Salt Lake Valley." *Mon. Wea. Rev.* (in press).

Zhong, S., and J. D. Fast

"An Evaluation of Fine-Scale MM5, RAMS, and Meso Eta Simulations Using Data from VTMX 2000 Field Campaign in the Salt Lake Valley." Invited presentation at the Paul Scherrer Institute, July 12, 2002, Villigen, Switzerland.