NOAA ARL Monthly Activity Report

December 1999

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Air Resources Laboratory

Contents

Highlights

1. Program to Address ASEAN Regional Transboundary Smoke (PARTS). ARL is well advanced with work to institutionalize new smoke and haze forecasting capabilities at the South East Asian Regional Specialist Meteorological Canter in Singapore, also servicing Malaysia, Thailand, Indonesia, and Brunei. A component of the program involves the distribution of a small number of surface-based hand-held devices for measuring aerosol optical depth. A training program is being planned, for in-region technical personnel. The work has so far involved ARL staff from Silver Spring and Oak Ridge.

2. Shoaling Waves Experiment (SHOWEX). The Shoaling Waves Experiment (SHOWEX) started in early November and was successfully completed in early December. The study was conducted at the U. S. Army Corp of Engineers Field Research Facility (http://frf.usace.army.mil) located in Duck, North Carolina. The collaborative effort included Tim Crawford, Jeff French, and Jerry Crescenti (FRD), Ed Dumas (ATDD), Jielun Sun and Sean Burns (NCAR), Larry Mahrt and Dean Vickers (Oregon State University), Doug Vandemark (NASA), and Ken Melville and Peter Matusov (Scripps Institute of Oceanography). More detailed information about SHOWEX goals and objectives can be found in the November 1999 *FRD Activities Repor*t.

The LongEZ (N3R) research aircraft was used. Missions were conducted out of First Flight Airport (FFA) in Kill Devil Hills, North Carolina. When necessary, Dare County Regional Airport (MQI) was used when N3R conducted nocturnal flights. N3R's first research flight was on November 11. A total of 27 missions (105 flight hours) were flown through December 5 under various atmospheric and wave field conditions. Flight legs included parallel and perpendicular runs at various altitudes with respect to the coastline as well as numerous slant and spiral soundings. jerry.crescenti@noaa.gov (Jeff French and Tim Crawford)

Silver Spring

3. Impact on Temperature Trend of a Doubling of Record Length. Using a 63-station global radiosonde network, an estimate of the representativeness, for the longer term, of Microwave Sounding Unit (MSU) temperature trends is obtained by comparing radiosonde-station temperature trends for the period 1979-1998 of MSU data and the period 1959-1998 twice as long. All radiosonde stations indicate a cooling of the low-stratospheric 100-50 mb layer during both periods, but with the cooling significantly greater during 1979-1998 than 1959-1998 in all 5 climate zones. In the case of the 300-100 mb (tropopause) layer, the cooling in polar and temperate zones is greater during 1979-1998 than 1959-1998, but significantly so only in the south polar zone in connection with development of the Antarctic ozone hole. The warming of the tropical 300-100 mb layer (high troposphere) is similar during both periods. There is warming of the surface and tropospheric 850-300 mb layer at more than three-fourths of the radiosonde stations during 1959-1998, but at only about three-fifths of the stations during 1979-1998. In the northern hemisphere there is clearly a greater increase in lapse rate in 1979-1998 than 1959-1998, but in the southern hemisphere there is more of a uniform shift at all heights toward greater cooling, or less warming, during 1979-1998 than 1959-1998. (Jim Angell, 301 713 0295, x127)

4. AIRMoN Program. The AIRMoN-wet deposition measurement program proceeded normally at eight of the ten sites. Problems occurred at the Underhill site due to the desire of the Lake Champlain Research Consortium to release a Request for Proposals to re-examine priorities for the basin and to potentially fund some new projects. After ARL issued instructions to cease AIRMoN wet and dry measurement programs

at Underhill, the Consortium set aside some dollars and monitoring at Underhill has resumed following a four-week hiatus. Mercury measurements made alongside the AIRMoN site were not so fortunate and have not resumed. As anticipated, operation at the site at South Lido, Florida was terminated by the Sarasota Bay National Estuary Program.

We continue to anticipate the opening of a new station in Davis, West Virginia run by the Canaan Valley Institute. There have been a number of technical problems that should be resolved quickly after the weather breaks. richard.artz@noaa.gov

5. Atrazine Monitoring. A joint program has been initiated, at a very low level, with the U.S. Department of Agriculture in Beltsville to study triazines in the Chesapeake Bay watershed. It is planned to install a special USDA sampler near the AIRMoN Aerochem Metrics sampler on Smith Island some time in January or February. richard.artz@noaa.gov

6. Dust Storms. Work with the Army on developing a new dust storm model is reaching an end. Sensitivity tests were conducted with the Hysplit- pm10 emission module. Results were compared to daily sampling data collected at several locations in Kuwait and northeastern Saudi Arabia for the months of May through July of 1991 using ECMWF re-analysis data. Although the general magnitude and timing of the predicted concentrations corresponded to the measurements, one site exhibited substantial under prediction. Preliminary analyses attribute this to the characterization of the soil characteristics upwind of the sampler. roland.draxler@noaa.gov (and Dale Gillette, Jeff McQueen)

7. AGU Fall Meeting. Melissa Free cochaired a special session on volcanoes and climate at the American Geophysical Union meeting in San Francisco in December, and participated with Alan Robock (Rutgers University) and Stephen Self (University of Hawaii) in a press conference covering new research on that topic. She presented a paper on the effects of volcanism and solar variability over the past 600 years. melissa.free@noaa.gov

8. New Hampshire and Vermont Mesoscale Reanalysis. Work continued on creating high resolution meteorological hindcasts for Vermont and New Hampshire for the summer, 1999. Two IBM 260's have been successfully linked to the NOAA network (machines are named castor.arlhq.noaa.gov and pollux.arlhq.noaa.gov) after several configurations inside and outside the new NOAA firewall were tried. RAMS version 4.2 was installed, and the ARL operational initialization programs were modified to conform to the new RAMS simplifications for isentropic initialization. ARL improvements for computing derived products, turbulence parameterizations and READY format outputs were then incorporated in RAMS 4.2. Several modifications were needed as RAMS upgraded its surface soil and vegetation parameterizations to use the LEAF-2 scheme (Avissar and Lee, 1992) which allows for multiple land-use patches per grid cell. ARL incorporated a scheme to compute 10 m winds, 2 m RH, and mixed layer depth for output to the ARL-packed files. Also, 1 km land use and topographical databases are now available globally and interfaced with the LEAF scheme.

Single processor hindcast simulations were performed with RAMS 4.2 for the July 16-17, 1999 air pollution episodes with 36, 9 and 3 km grids with full physics. Simulations showed the Champlain valley wind flows; however 12-hour forecasts with a single processor took over 13 hours. Speed improvements are expected when parallel simulations are debugged. Large improvements in the real-time hindcasts run on arlrisc2 for

New Hampshire after substantial debugging. jeff.mcqueen@noaa.gov (Cliff Johnson, Al Taylor, Roland Draxler and Milton Smith)

Boulder

9. SURFRAD. The Office of Global Programs review of SURFRAD by Professor Earhard Raschke was moved from January 4 to January 6. John Augustine and John DeLuisi will lead him through the operation of SURFRAD and its uses, and discuss issues that he brings up. A five-year proposal for the continuation of the SURFRAD network was prepared for OGP, at their request, and submitted. At the February meeting of the Climate Observation Advisory Panel, the future of OGP's support of SURFRAD will be decided. (John Augustine, 303 497 6415)

10. AGU Fall Meeting. The results of SRRB's efforts to develop a long-term UV-wavelength stratospheric aerosol climatology were presented at the AGU Fall Meeting in San Francisco, CA. With a great number of aerosol specialists attending various sessions of the meeting, our work seemed to attract a good amount of interest. Final reports on SRRB's work on the Umkehr ozone record are currently being prepared. Amy Stevermer, 303 6417, Irina Petropavlovskikh, 303 497 6279 and John DeLuisi, 303 497 6824)

Oak Ridge

11. Terrestrial Carbon Program. Analysis of measurements from the recent spatial variability study on the forest floor continues. A simple Lagrangian trajectory model has been developed to investigate the flux footprints, both at the forest floor and above the canopy. The results have been compared to established analytical solutions above the canopy. A paper, "Quantifying stomatal and non-stomatal limitations to carbon assimilation due to leaf aging and drought in mature deciduous tree species" has been accepted by *Tree Physiology*. wilson@atdd.noaa.gov

12. Canaan Valley. Work is progressing to install a NOAA AIRMoN site in Canaan Valley, WV. An instrument shelter is scheduled for installation in early January. Infrastructure for underground power service is under construction. The AIRMoN site is expected to be operational by the end of February 2000. vogel@atdd.noaa.gov

13. CASES-99. Postprocessing of the CASES-99 Long-EZ data continued in December. One area that was investigated was the computation of differential corrections for the GPS positions and velocities. This has been done for many years by a program called c3nav. However, Jeff French at FRD in Idaho Falls has recently been testing another differential-correction program called "flykin" which appears to provide more accurate positions and velocities. This program was tested with some of the CASES-99 data. The main problem with flykin is that it occasionally introduces spikes into the data. In addition to looking at the CASES-99 differential corrections, some modifications were also made in December to the program used to process the raw aircraft data. Several minor bugs were fixed, and the algorithm for interpolating over missing GPS data was improved. eckman@atdd.noaa.gov

A temperature compensation model was developed to help improve the low frequency characteristics (lower than 10^{-4} Hz) of ATDD's microbarograph instruments. auble@atdd.noaa.gov (Nappo)

14. Dynamical/Photochemical Modeling. Chemical reactions that have time scales on the order of the boundary layer turbulence time scale may be turbulent-mixing limited, reducing the effective reaction rates by partially segregating the reactants. A program was written to calculate profiles for the intensity of segregation (I_s) for 52 chosen reactant pairs. The intensity of segregation gives an indication of the relative importance of the concentration covariance for a pair of reactants compared to the product of the mean concentrations for each reactant. Most photochemical models ignore the covariance of the concentration fluctuations and compute the chemical transformations based on averaged concentrations. This assumption is fine for slow reactions where the reactants are homogeneously mixed and their concentrations are uncorrelated. Moderately fast chemistry on the order of the turbulent mixing time scale results in some reactant segregation where $-1 < I_s < 0$. Positive values of I_s occur when the reactants are transported together in the same air parcel, thereby increasing the chemical transformation rate. The I_s profiles generated from the two LESchem simulations show generally small values within the boundary layer, affecting bimolecular reaction rates by a few percent or less, with the notable exception of nitric oxide (NO) reacting with several of the organic radicals where the reaction rates can be changed by 10% or more. However, within and just above the entrainment layer between the convective boundary layer and the free troposphere, extreme values of I_s ranging from about &0.5 to %0.7 occur for several reactant pairs. Further analysis of these results is needed. herwehe@atdd.noaa.gov

15. East Tennessee Ozone Study (ETOS). The ETOS advisory group met December 16 to discuss the disposition of the 1999 ETOS datasets (surface meteorology and ozone monitoring, as well as the limited aircraft sampling conducted by ATDD). While initial plans were to distribute the full data record, this effort was put on hold until a full data report can be prepared. pendergrass@atdd.noaa.gov (White, Birdwell)

Due to the significant lead time required to plan aircraft sampling with NOAA research aircraft, much of the December meeting was dedicated to planning flight paths for two study intensives scheduled for the summer of 2000. Representatives from the State of North Carolina attended the meeting to present their planned aircraft sampling tracks. North Carolina would like to coordinate a series of sampling flights which would involve parallel paths on either side of the Appalachian Mountains between North Carolina and Tennessee. Other options discussed were near-proximity flight paths over the Asheville, North Carolina region to conduct inter-comparisons between sampling protocols. pendergrass@atdd.noaa.gov (White, Birdwell)

Data analysis of the ETOS 1999 observations is well underway. One significant finding from the summer's experiment includes the relative large contribution that transport plays in the ground level observations of ozone within the East Tennessee Valley. A combination of aircraft and surface observations identified a significant inflow of ozone into the Valley. Ozone measurements and meteorology observations, typically in excess of 90 ppb and northwest winds at 3-8 meters/sec, were observed to the northwest of the Tennessee Valley both at the surface and nearly uniform with height from the surface to 1500 meters above ground level. There are no significant NOx emission sources (either industrial or transportation related) northwest of the Valley. For the East Tennessee Valley, this means that surface ozone concentrations are above the new EPA ozone standard even before accounting for local production. pendergrass@atdd.noaa.gov (White, Birdwell)

As part of the exploratory work conducted during ETOS 1999, a number of ozone monitors were deployed on the Oak Ridge Reservation within a roughly 12 km x 12 km grid - essentially a grid cell for many air quality models. Comparisons between sites indicate an approximate 5 ppb variability across the grid. This work will

continue during ETOS 2000; however the 5 ppb range does define a minimum level of uncertainty associated with air quality forecasts. pendergrass@atdd.noaa.gov (White, Birdwell)

Improvements to the existing airborne measurement system were discussed this month. If funding for the NOAA Twin Otter is unavailable, the airborne measurement portion of ETOS will use a rented Cessna 172. dumas@atdd.noaa.gov (White)

16. Urban dispersion. The evaluation and refinement of the ROADWAY-2 model using the 1976 GM tracer data continued. Changes were made in the formulations for the energy components in the wake and the ABL. An iterative scheme was introduced to nudge the calculated mean winds to the observed values. A value of 0.5 for the nudging coefficient gave good results and fixed the problem of matching the velocity profile to the observed wind speed at 4.5 m height. rao@atdd.noaa.gov

Analysis of wind rose data under light winds continued for the NWS site in Cape Canaveral, Florida (providing a coastal sea-breeze environmental analysis), and for the ETOS site in Allardt, Tennessee (providing a relative flat-terrain site). In general, most of the analyses indicate that near calm winds (<1 m/s) exhibit differing wind rose characteristics than winds of slightly stronger magnitude at the same site. birdwell@atdd.noaa.gov

17. NSF Multi-User Environmental Research Aircraft. Upgrades to the MFP system continue for incorporation into three Sky Arrow aircraft, with delivery of the first system due in June, 2000. Testing of the BAT-REM module with a commercial serial card has demonstrated reliable operation, and will be incorporated into the next-generation MFP system. dumas@atdd.noaa.gov (Auble, Brooks)

18. ISIS and SURFRAD. The standard operations of the ISIS Network continued. The regular processing of December ISIS Level 1 and Level 2 data is complete. Regular processing of the SURFRAD data to match the GEWEX time records of energy balance systems installed in Ft. Peck, Montana and Bondville, Illinois also continued. All of these data are provided on the Internet. matt@atdd.noaa.gov

Research Triangle Park

19. Dispersion of Toxic Pollutants in a Convective Boundary Layer. A three-year research program is under way, using the ASMD Fluid Modeling Facility's (FMF) laboratory convection tank to study the physical processes that are important to dispersion in highly convective, daytime boundary layers. The initial phase of this work has been focused on transient buoyant releases (puffs) to simulate plume rise and dispersion from explosions, fires, or other short-lived buoyant releases of toxic materials in convective conditions.

The FMF convection tank has the approximate dimensions of that used by Willis and Deardorff (1987) in their well known experiments. The tank is approximately 124 cm on a side with a water depth of 34 cm. The convective boundary layer is simulated by first moving a heated grid through the tank to create a desired elevated temperature gradient and then uniform heating of the tank floor results in a convectively well mixed layer with stable layer above. A series of 22 successful experiments were conducted in last fall under repeated conditions with the same source buoyancy and release location, initial stratification aloft, mixed layer depth, and convective scaling velocity at the time of puff release. Although the initial conditions were nearly identical within those 22 experiments, within a few minutes of release, the location of the concentration-weighted center of the puff was found in all quadrants of the tank and the fraction of mass that

penetrated into the stable layer aloft ranged from 0.1 to 0.4 of that released in the mixed layer near the surface.

Due to this large variability in measured puff dispersion, for each set of conditions our goal is to perform a large enough set of repeated simulations with which we can develop stable ensemble average statistics describing the dispersion for those conditions. Previous experiments have been repeated up to 33 times from which ensemble averages were obtained. We propose collecting data for up to 60 repetitions of the same conditions to determine the minimum number needed to obtain stable statistics. Experiments with same conditions and puff buoyancy as in the first 22 will continue over the next few months. Experiments with different release buoyancies, mixing heights, and stratifications aloft will follow. (Steve Perry, Roger Thompson, and Bob Lawson, 919 541 1199)

20. Advection of Trace Species in a Fluid with Non-Uniform Density. Many of the advection tests in the literature have implicitly assumed uniform air density, and therefore do not characterize the numerical schemes for non-uniform density distributions. Because of the practical utility of atmospheric models for simulating trace species, including water and moisture variables, and for assessing and controlling air quality problems, the evaluation of numerical transport algorithms must be performed under realistic weather conditions. It has been known that certain Eulerian numerical advection schemes for trace species suffer serious mass conservation problems when subject to realistic meteorological data. In particular, for cases in which meteorological data are not mass-consistent (i.e., density and wind fields do not exactly satisfy the continuity equation), this problem can grow out of bounds for a long-term simulation of trace species transport. To mitigate this problem, several mass (air density) adjustment schemes have been applied to atmospheric models. We compared different mass adjustment schemes for their characteristics, such as preservation of constant mixing ratio fields, mass conservation, and effects on linearity of advection algorithms. Two-dimensional steady-state linear flows were used for the test because analytical solutions to the advection equation are available for different combinations of the fundamental flows. It is shown that application of the proper adjustment process is essential to improve some numerical characteristics of existing numerical advection algorithms. (Daewon Byun, 919 541 0732)

Idaho Falls

21. Hurricane Balloons. The first version of the hurricane balloon software is completed and operational. Initial bench top testing has been completed. Further testing will be required as the other components for the transponder are completed and interfaced with the microcomputer. The software successfully operates with the microcomputer operating speed reduced to 5 MHZ from the standard 40 MHZ. This reduction in computer speed reduces the electric current requirements for the microcomputer from 200 ma to 50 ma which will significantly increase the life of the transponder batteries.roger.carter@noaa.gov (Randy Johnson)

22. Refractive Turbulence - High Speed Temperature Probe. High-quality turbulence measurements are difficult from aircraft because of aircraft induced flow distortion and the high flight speeds. For our high-altitude research, we reduced flow distortion and flight speed by selection of the Australian ARA's Grob G520T Egrett high-altitude research aircraft. At sea level, the Egrett flies surprisingly slow - 50m/s. But at our 50,000 ft research altitude, the density is only 15% of that at sea level and the Egrett's true airspeed increases to 100m/s. At this speed, the air temperature is increased 5 C by conversion of the free stream kinetic energy into thermal energy. The actual temperature increase or recovery depends on things such as

the sensor housing inlet design, and the rate at which heat is conducted to the housing and the free stream. Since we are measuring temperature fluctuations approaching 0.001 C, and desire fast high fidelity temperature measurement, a probe having a recovery factor close to unity and constant in value over a wide range of flight speeds and temperature conditions is required. Unfortunately, few make such measurements so no commercial probes are available. A new high-speed probe design was completed and an aluminum probe has been fabricated. Lab testing of the probe will take place over the next few months. The 7-degree diffuser section (the cone in Figure 1) will carefully slow the inlet air to 5 m/s allowing a well behaved adiabatic recovery of free stream energy. The probe will be equipped with electronics to initially test dual hot film probes, an ultra fine thermocouple probe, a low speed reference temperature probe, and a pitot static pressure transducer. randy.johnson@noaa.gov (Tim Crawford)

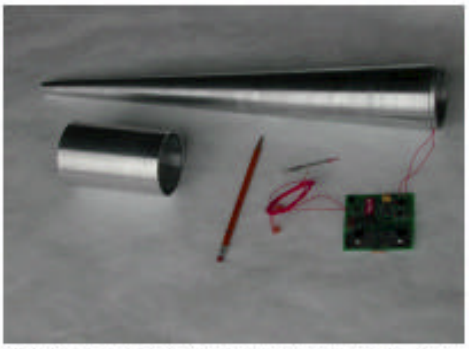

Figure 1. Refractive turbulence - high speed temperature probe.

23. Remote-Probing Systems Intercomparisons. Wind velocity data acquired by the 915-MHZ radar wind profiler located at the Grid-III research facility have been checked against data obtained by radiosondes during the 1996 and 1997 ROS field studies. Five radiosonde profiles of U and V wind velocities are shown in the accompanying diagram against U and V profiles from the radar. The top two graphs of Figure 2 show very good qualitative agreement between the radically different technologies. The graphs below show the bias (mean offset) and precision (standard deviation of the difference) for U and V. While five independent comparisons is hardly enough to form statistically significant results, the profiler and radiosonde agree quite well. Precision values between 1 and 2 m/s are comparable to other s intercomparison studies.

Virtual temperature data acquired by the radio acoustic sounding system (RASS) located at the Grid-III research facility has been checked against data obtained by radiosondes during the 1996 and 1997 ROS field studies. The mean virtual temperature acquired by the RASS and radiosonde are shown in Figure 3. Also shown is the bias, comparability (rms difference), precision (standard deviation of the difference), and correlation coefficient. The RASS shows a nearly constant bias with height of about 0.7C with a precision of 0.5C. The correlation coefficient exceeds 0.95 for all measurement levels. These statistical values are comparable, and in many instances, exceed those determined by other investigators.

A similar examination of a doppler sodar has also been conducted. A "high-power" Remtech PA1-LR Doppler sodar has been permanently installed and in operation at the Grid-III research facility for more than a year. Questions have been raised about the overall reliability and accuracy of this system. Wind profiles acquired by the sodar have been compared against those obtained by the 915-MHZ radar wind profiler. The results are not good. Figure 4 displays the bias, precision, and correlation coefficient for wind speed, wind direction, U (eastward wind velocity) and V (northward wind velocity) for May 1999. The values for the bias (mean offset) are unremarkable. However, the precision (standard deviation of the difference) shows considerable scatter. For the wind speed, U and V, the precision varies from 4 to 6 m/s. For the wind direction, the precision varies from 90 to 120 degrees! The correlation coefficients for all four variables ranges from 0.2 to 0.6. Ordinarily, values determined in various intercomparison experiments for precision range between 1 to 2 m/s and 20 to 30 degrees for speed and direction, respectively. Correlation coefficients should exceed 0.8 to 0.9. It is hypothesized that the proprietary data acquisition software used by the

Remtech software is not reliable. Most Doppler sodars use single-frequency pulses and straight-forward vector averaging techniques to derive wind profiles. However, the Remtech sodar uses a series of multi-frequency pulses and smoothing techniques in time and space. Other investigators have reported strange behavior by similar Remtech sodars. This intercomparison is the first known quantitative study for evaluating the Remtech PA1-LR Doppler sodar. Investigators who have used this system in the past without the benefit of an independent comparison or audit should be wary of the reliability of the data, including the MVP studies and the early SHOWEX pilot study of 1997. jerry.crescenti@noaa.gov

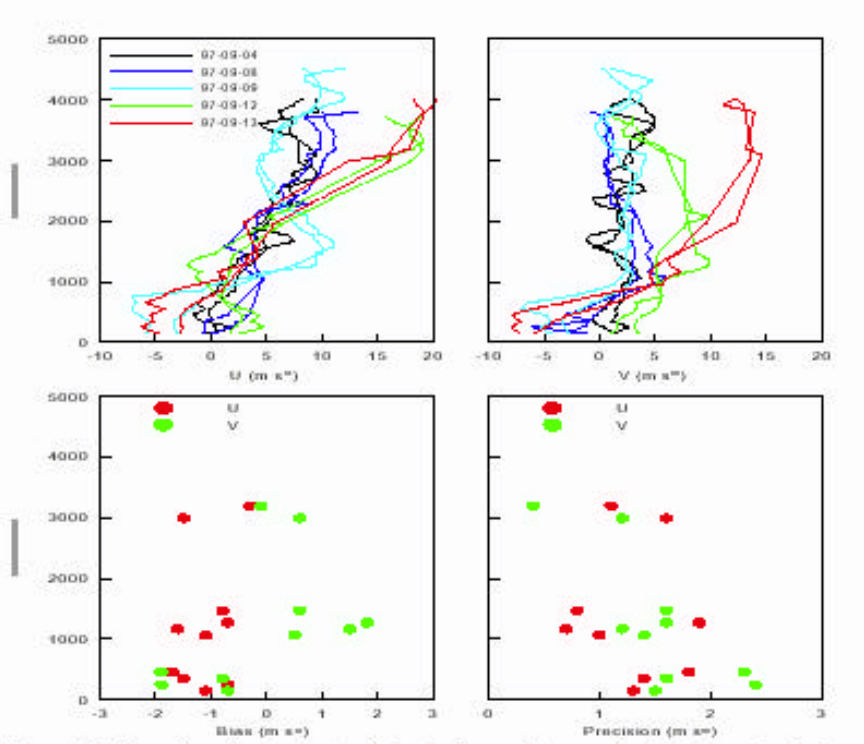

Figure 2. Five pairs of component wind velocity profiles acquired by the radar wind profiler and radiosonde. The bias and precision for U and V are also shown.

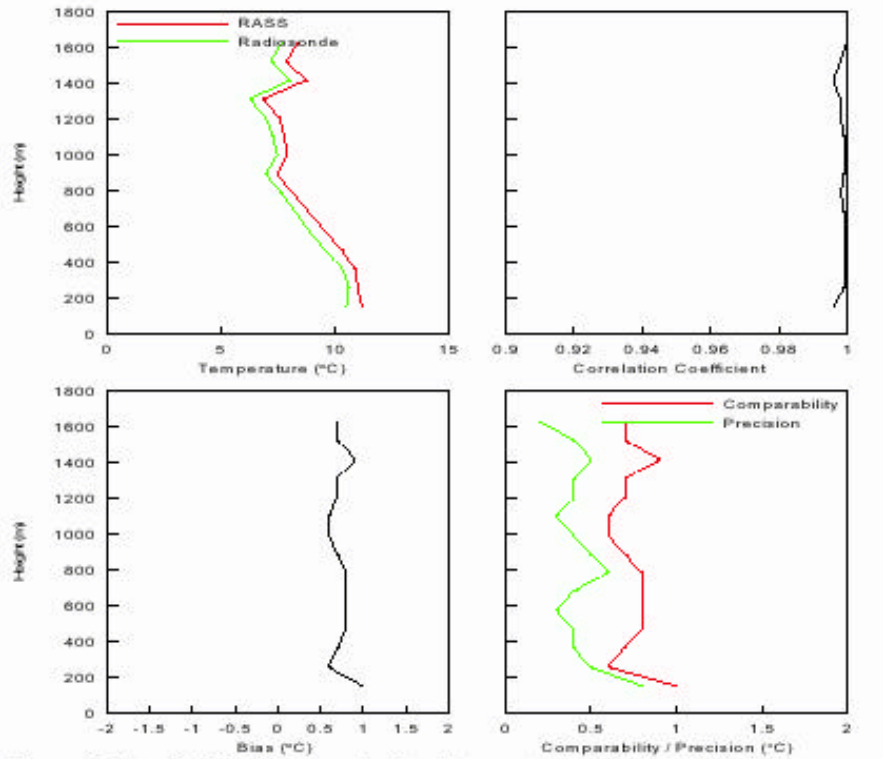

Figure 3. Mean RASS and radiosonde virtual temperature profiles, correlation coefficient, bias, comparability and precision.

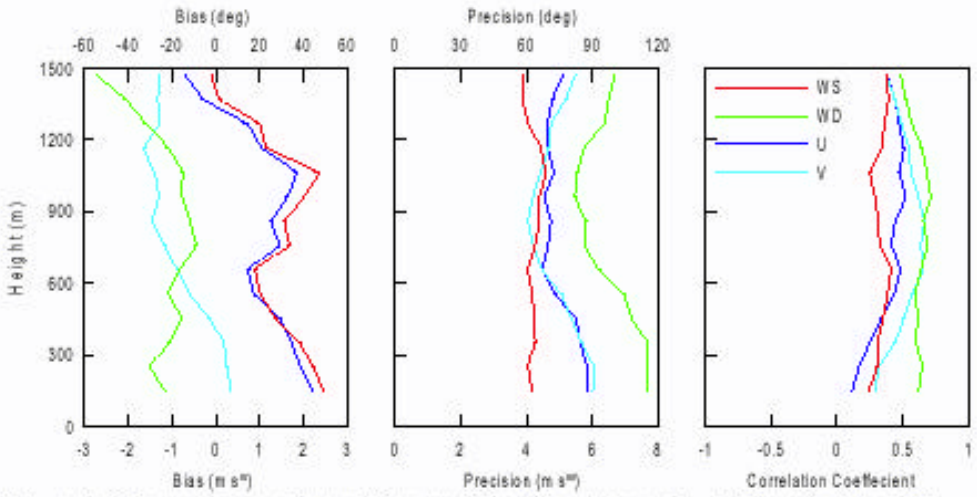

Figure 4. Bias, precision, and correlation coefficient for wind speed, wind direction, U and V.

24. Evaluation of ARL use of the NOAA Lake. Tom Watson made a trip to the Aircraft Operations Center in Tampa, Florida on December 1, 1999. The purpose of the trip was to evaluate the feasibility of permanently basing the NOAA Lake amphibious aircraft at the ARL Field research Division in Idaho Falls, ID.

The conclusions reached as a result of this trip were:

1. The Lake is a suitable airframe for making air-surface exchange, flux and turbulence measurements. Air quality, remote sensing and other measurements can be made as well. An instrument payload of 450 lbs. is possible, but must be carefully planned to meet weight and balance requirements.

2. The Lake is a compromise. The Velocity SUV, originally proposed for the Small Environmental Research Aircraft (SERA), is superior for ARL research. The Velocity has better aerodynamics for flux and turbulence research, more payload capability, is easier to modify, and is safer to operate at low altitudes and in slow flight. It is also cheaper to operate.

3. The Lake must be viewed as a means of making a transition from the LongEZ to the SERA, not as the final solution. tom.watson@noaa.gov

Las Vegas

25. First Post-Monitoring Big Bend Regional Aerosol and Visibility Observational (BRAVO) Study Meeting. The status of data processing and plans for data interpretation by the participants in the BRAVO Study were the primary topics discussed at a two day meeting held in Austin, TX (December 7-8). The four month long regional scale field-monitoring and tracer-release program in Texas was completed at the end of October. Expectations are that most of the continuously monitored data (i.e., upper air meteorology, optical and gaseous measurements) will be available for submission to the BRAVO Study database by the end of February, while data involving laboratory analysis of samples (i.e., particle composition and tracer concentration) will be available by mid-summer. Data analysis is expected to take 12 to 18 months followed by 6 months for report preparation. NOAA provides technical management as well as some of the field monitoring for the BRAVO Study, which is sponsored by EPA and NPS and includes other government, academic, and industry participants. (Marc Pitchford, 702 895 0432)

26. SORD Web News. The output from the daily 00Z RAMS model run over the Las Vegas Valley has been added to the SORD web page. In addition, a table of the 2km resolution wind vectors has been set up to display data in 3 hour increments. The data displayed include the initial data at 00Z out to 30 hours at the 2km resolution. A user just needs to click in the appropriate cell and then can view the output for that time. (Jim Sanders, 702 295 2348)