The
ATD Observer

Covering Research and Development in Observational Atmospheric and Oceanic Science

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ALOHA Lidar on Electra Maps Sodium Layers

By Chester Gardner

Supported by ATD's Research Aviation Facility (RAF) and its Lockheed Electra aircraft, the ALOHA-90 (Airborne Lidar and Observations of the Hawaiian Airglow--1990) experimental campaign was successfully conducted in March-April 1990. The program was designed to study the horizontal density and temperature structure of the upper stratosphere (25-55 km altitude) and upper mesosphere (80-105 km altitude) over the equatorial regions of the mid-Pacific Ocean. Nine research groups from institutions in the US, Canada, UK and Australia participated in the four week campaign, which was based in Maui, Hawaii.

Six nighttime scientific missions were flown with the Electra in Hawaii, and one was flown in Colorado. The weather was cooperative and excellent data were obtained. My group from the University of Illinois operated a powerful laser radar system onboard the Electra. The system included a 90 watt 200 pulse/second excimer laser, a 10 watt tunable dye laser pumped by the excimer laser, and a 35 cm diameter zenith-pointing telescope. The lidar measured atmospheric density profiles in the stratosphere and sodium density profiles near the mesopause. Also onboard the Electra were two University of Michigan spectrometers that observed hydroxyl radical and oxygen airglow emissions from the mesopause region.

According to the RAF, the installation of this sophisticated set of optical instruments was the most challenging such job ever accomplished on the Electra. Because of the very heavy weight of some of the instrument components and the need for extreme rigidity to preserve

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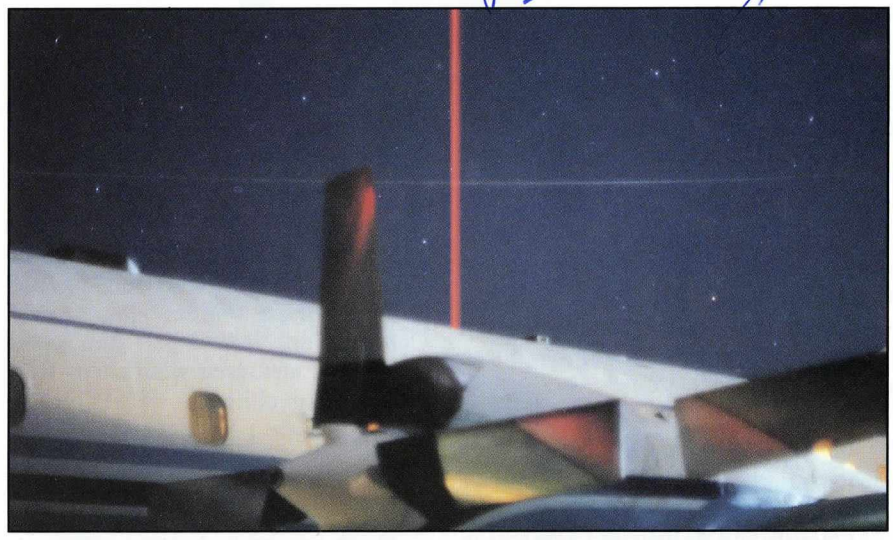

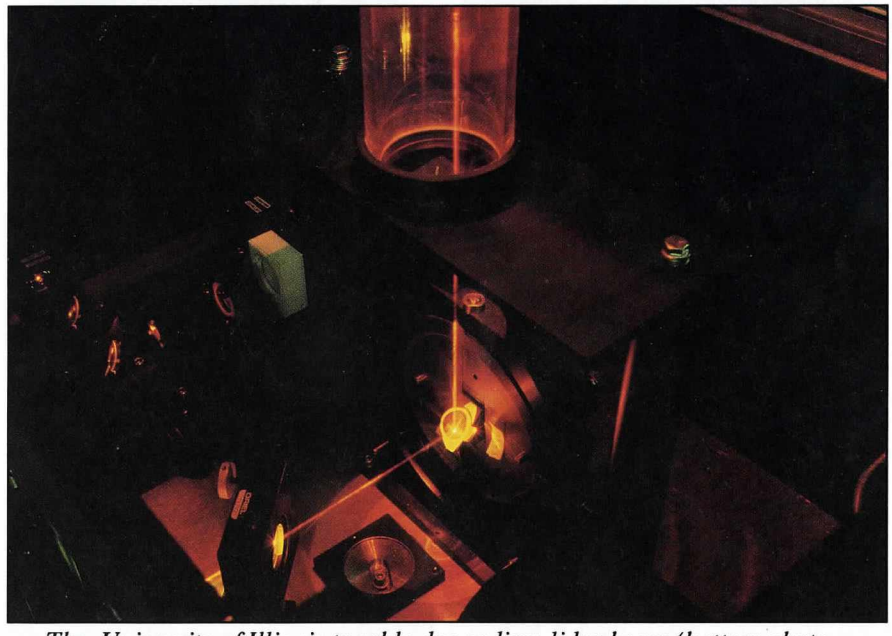

The University of Illinois tunable dye sodium lidar beam (bottom photo, by Ginger Hein) is directed through an optical port in the upper fuselage of the NCAR Electra (top photo, by Harold Barber) used in the ALOHA-90 Project.

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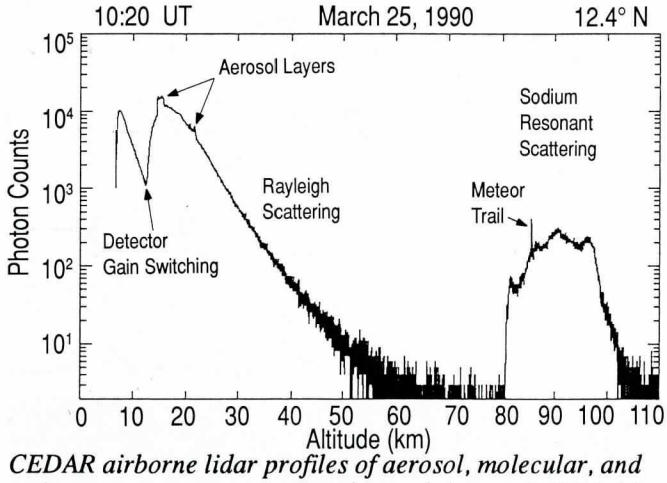
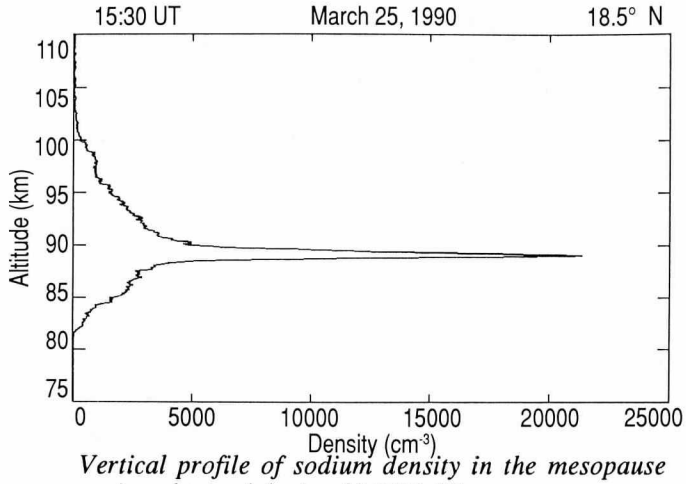


CEDAR airborne lidar profiles of aerosol, molecular, and sodium resonance scattering obtained during ALOHA-90 south of Maui.



Vertical profile of sodium density in the mesopause region obtained during ALOHA-90.

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optical alignments in the presence of in-flight turbulence, extensive structural framing had to be fabricated to reinforce the Electra floor and to strengthen the optical tables used. Thanks to these preparations, the instruments performed exceedingly well during the program.

In addition to the airborne instruments, groups from the University of Southampton (UK), University of Western Ontario, and Aerospace Corporation operated airglow imagers and spectrometers on Haleakala crater in Maui. These observations provided information on airglow intensities, mesopause temperatures, and horizontal structure of the airglow layers. On Christmas Island almost due south of Maui near the equator, groups from the University of Adelaide (Australia) and the University of Colorado operated upper atmosphere radars that measured wind fields from 60 to 100 km altitude.

During the scientific flight on the Mainland, a sodium temperature lidar and a meteor radar were operated at Colorado State University and at Platteville, Colorado. Finally, while wintering over at the South Pole, Rich Collins from my group operated a smaller sodium lidar during the campaign. He was able to collect data at that location simultaneously with one of the Electra flights over the Central Pacific near the equator.

Winter-over scientist Rich Collins from the University of Illinois operated a sodium lidar from this building at the South Pole concurrently with the airborne observations over the equatorial Pacific during ALOHA-90 (photo by Rich Collins).

The middle atmosphere is a region of complex photochemical and dynamic interactions. Stretching from roughly 30 to 100 km altitude, this is the transition region between the stratosphere and thermosphere, and is perhaps the least understood region of the atmosphere. Since this region is inaccessible to balloons and satellites, observations must be made by *in situ* (direct) rocket measurements or by remote sensing techniques. The density and temperature structure of the middle atmosphere is heavily influenced by gravity waves and tides. Tropospheric convection, storms, wind shears, orographic effects such as airflow over mountains, and even large-scale ocean swells are thought to be common gravity wave sources. These waves propagate through the stratosphere and mesosphere and dissipate their energy near the mesopause, making important contributions to the momentum and turbulence budgets in this region.

Although indications of gravity wave and tidal effects have been observed using a wide variety of *in situ* and remote sensing instruments, there are almost no data that provide detailed information on the geographic distribution of wave activity, the characteristics of major wave sources, or the horizontal scale sizes of the wave induced density, temperature, and wind perturbations. Almost no height resolved measurements of the horizontal structure of gravity waves and tides are currently available. ALOHA-90 was conducted to address these observational deficiencies.

A preliminary analysis of the data from the program has already produced some highly interesting results (see examples above). Sporadic sodium layers, which are closely related to sporadic ionization layers in the E region of the ionosphere, were observed on several flights. This phenomenon is characterized by the rapid formation of dense, thin sodium layers and is known to occur

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Director's Corner

By Richard Carbone

The past year has been a period of transition for the Atmospheric Technology Division and the geosciences communities as a whole. Last fall, the senior technical staff of ATD joined me in an effort to reassess the ATD's role in the atmospheric and oceanic communities. This reassessment was motivated by several factors, including new leadership at ATD and NCAR, evolving scientific priorities principally associated with global change research, and a desire to communicate more effectively with users of our observing facilities. We established a seven point plan of action and are now in the process of implementing various aspects of it. The seven points, in no particular order, are:

- Restructure, as required, to provide support to global change research.
- Bring the ELDORA (Electra Doppler Radar) Project to completion by late 1992. Make programmatic adjustments consonant with NSF FY91 funding.
- Establish the restoration and modernization of ATD's infrastructure as our highest priority for incremental funding.
- Develop a strong program of interactions with the research and educational communities.
- Bolster our contribution to atmospheric chemistry.
- Redouble our efforts to secure funding for research platforms, observing systems, and instruments.

In "restructuring for global change" we have made several changes in the organization of the Division which are described in this issue. Adjustments have been made to place greater emphasis on remote sensing, multi-platform data packaging and integration, and satellite data access and validation.

"It is imperative for ATD to move beyond ELDORA to other pressing instrumentation issues..."

Timely completion of ELDORA is a high priority to permit major programs such as STORM and TOGA-COARE to proceed on schedule, and to permit the conduct of numerous cloud and precipitation studies otherwise beyond the reach of NSF-supported microphysical and mesoscale investigators. Collaboration with the French CNET and CNRS organizations in the development of ELDORA is an exciting opportunity to achieve a mutual technical goal within the resource base of both nations. It is imperative for ATD to move beyond ELDORA to other pressing instrumentation issues -- particularly those in the area of airborne and surface based flux measurements.

After several years of declining resources for ongoing "core" activities, we must take the necessary step of consolidating the Division's activities to live within the resource base available in FY91. Careful tradeoffs must be made between the number of platforms and observing systems made available, the breadth and completeness of related services, and the balance between support of today's field programs and development of tomorrow's instruments. We have traditionally maintained high service levels and breadth of program; however, with declining funding, weaknesses are now evident in our infrastructure. These include substandard maintenance budgets, a declining staff of scientific and senior engineering appointees, and the removal of the CP-2 multi-parameter radar from service in 1987. Restoration of ATD's infrastructure, circa 1984, is crucial and must be a top priority.

"Restoration of ATD's infrastructure... is crucial and must be a top priority."

We have always highly valued our interactions with the users of NCAR's observing systems. Nevertheless, it has been brought to our attention by many of you that community interactions need to be improved in this era of global change research, when ATD must be much more than a "mesoscale shop", mainly serving the needs of small scale experimental meteorology. Thus we are initiating and planning several new communications mechanisms including this *ATD Observer*, the First ATD User's Conference, the Workshop on Atmospheric Research Measurements (WARM), and a determined effort to sponsor and host visitors from our user community. We hope that this visitors program will stimulate more frequent joint technological efforts that will be of benefit to the entire community.

"Acquisition of a high performance mid-sized jet is absolutely essential... for process studies related to global climate change."

Experimental atmospheric science is burgeoning with opportunity in atmospheric chemistry. Over the past four years, ATD has been able to mount a significant development effort at the Research Aviation Facility for basic *in situ* measurements under the able leadership of Greg Kok. The Surface and Sounding Systems Facility, under the leadership of Joost Businger, Tom Horst, Tony Delany, Vim Kosiek, Steve Oncley and others has recently completed the Phase I development of the Atmospheric Surface Turbulent Exchange Research (ASTER) facility. These sound beginnings must be expanded and broadened if ATD facilities are going to meet the legitimate needs of the chemistry and related global change communities. Variable constituent profiling and remote flux estimation are candidate areas for new instruments located on both ground-based and airborne platforms. Acquisition of a high performance mid-sized jet is absolutely essential as a base from which to conduct many of these measurements for process studies related to global climate change.

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1984 ? or 1994

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only at equatorial and arctic latitudes. Prior to ALOHA-90, sporadic sodium layers were believed to be localized phenomenon extending horizontally no more than a few hundred kilometers. However, on several flights such layers were observed to extend from Maui southward to the equator and westward almost to the International Date Line, distances of almost 2,000 km. It now seems probable that some of these events may blanket the entire equatorial region.

Gravity wave activity near the mesopause was very strong on several flights and the region of greatest activity appeared to be near the equator. The radars on Christmas Island also saw considerable wave activity during the campaign. This observation is somewhat surprising since orographic forcing is believed to be the major source of waves in the mesosphere, and as a consequence, the mid-Pacific was expected to be a region of low wave activity. It is possible that tropospheric convection over the equator is the source of these waves. If so, further analysis of the lidar data should reveal evidence of concurrent large density and temperature perturbations within the stratosphere.

"...sodium layers... were observed... (over)... distances of almost 2,000 km."

The detailed analysis of the ALOHA-90 data has just begun. The campaign scientists held a workshop during the NSF Coupling Energetics and Dynamics of Atmospheric Regions (CEDAR) Meeting at NCAR in June, and are planning a special session at the fall AGU Meeting in San Francisco to report first results. There is no doubt that ALOHA-90 was an unqualified scientific success and will provide many important new insights into the structure and dynamics of the middle atmosphere.

While all of the participants and especially the staff of NCAR's RAF worked many long hours to prepare for the campaign, the experimental plan and equipment worked so well in the field that everyone managed to get in some time on the beautiful Maui beaches and golf courses during the days between flights! Several participants have already begun lobbying for ALOHA-92. Unfortunately, no one from ATD has yet volunteered to operate our South Pole lidar during the next campaign!

Chester Gardner is the Lead Principal Investigator for the ALOHA-90 Program, and is a Professor and Associate Dean in the Department of Electrical and Computer Engineering of the University of Illinois at Urbana-Champaign. ❖

NAILS Lidar Nearing Completion

By Ronald Schwiesow

If all goes well in the remaining preparations, ATD's new airborne Doppler lidar will soon get into action during the last part of the Hawaiian Rainband Project (HaRP).

The NCAR Airborne Infrared Lidar System (NAILS) being developed by ATD's Research Aviation Facility uses backscatter from particulates in the atmosphere to map air mass boundaries and atmospheric wind fields. Its development has encompassed several phases leading up the current Doppler wind measuring configuration.

In its initial configuration as an aerosol-profiling lidar, NAILS was used aboard the Electra in a study of marine stratocumulus layers off the coast of southern California to provide information on the structure of the cloud tops. These data are being used along with other meteorological measurements and satellite data to better understand the radiative properties of stratocumulus.

In addition, a sloping aerosol layer that was detected by NAILS above the inversion during this program has been related to baroclinic layers of air transported from different source regions.

Based on its successful use for profiling aerosols, NAILS has been extensively modified to a heterodyne configuration to measure the atmospheric velocity component along its beam path by determining the Doppler shift of the backscattered radiation. In addition to allowing velocity measurements, heterodyne detection should increase the sensitivity of the lidar by approximately 50 times over the previous version.

Compared to the earlier system, the heterodyne version of NAILS involves a redesigned receiver module, a new transmitter optics module, a new optical cavity for the 10.6-micrometer TEA laser, and a stabilized laser local oscillator. Also, a new digital signal processor, based on the RP7 radar processor from ATD's Remote Sensing Facility, has been built and is currently being tested.

For its first field application during HaRP, the new Doppler NAILS will be set up in various pointing configurations. For some flights, the lidar will be side looking. This will allow measurement of the horizontal wind field in a box approximately 8 km on a side when an L-shaped pattern is flown. For other measurements, the lidar will be pointed vertically to obtain turbulence profiles.

Future developments will include a new side-looking scanning system to allow moving the beam over limited ranges of elevation and azimuth to produce information on the horizontal wind from a straight flight track. Another technique to be explored is downward conical scanning, which would measure vertical profiles of the horizontal wind. Such data would be useful for studies of atmospheric transport and other boundary layer processes.

Scientists interested in using the new NAILS in future projects can request the system through normal procedures after it is operational. For further information, contact Ronald Schwiesow at (303) 497-1061.

Ronald (Ron) Schwiesow is a Research Engineer I in ATD's Research Aviation Facility. ❖

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ATD is presently pursuing resources from government agencies, private industry, private foundations, and foreign governments for various high priority projects. Our approach, while scientifically driven, is to seize such opportunities when they realize benefit to our mission and to our core research constituency. I hope, through the *ATD Observer*, the October WARM Workshop, and other media for interactions, that we will share in this effort and in the scientific rewards that surely will result.

Richard (Rit) Carbone is Director of the Atmospheric Technology Division at NCAR. ❖

Revised Allocation System in Place

By Warren Johnson

The April 1990 meetings of the new National Science Foundation (NSF) Observing Facilities Advisory Panel (OFAP) and Facilities Advisory Council (FAC) ushered in a new system for allocating and funding deployment of NSF-supported lower-atmospheric observing facilities that are available to the research community at large.

These facilities include NCAR's three research aircraft, two Doppler radars (CP-3 and 4), and sounding and flux measurement systems (portable automated mesonets, cross-chain Loran atmospheric sounding systems, lightweight Loran digital dropwindsondes, and the atmosphere-surface turbulent exchange research facility). Colorado State University's CHILL Doppler radar, the University of Wyoming's King Air aircraft, and the T-28 aircraft operated by the South Dakota School of Mines and Technology are also included under the same system.

The FAC is now responsible for allocation of these facilities and for recommending future levels of funding for their deployment. The five members of the FAC are drawn from NSF, NCAR, and the universities that operate the facilities. The OFAP is appointed by the FAC, reports to it and the facility managers, and reviews and makes recommendations on requests for use of observational facilities. Its role is similar to that of the former NCAR ATD Advisory Panels, now defunct.

Membership of the new panel is very similar to that of the former ATD panels, and the change is expected to be almost imperceptible to users. However, under the new system, there will be funds available for deployment of radars and other observing systems; researchers will no longer have to include requests for this funding in their NSF grant applications.

The purpose of the new system is to create uniform access to all observing systems so that the best science can be supported. Funds formerly used by NCAR and NSF for the deployment of facilities on research projects have been combined into a single pool, which amounts to approximately $1.4 million for fiscal year 1990.

Current members of FAC are Richard Carbone, NCAR (Chair); Walter Dabberdt, NCAR; Clifford Jacobs, NSF; John Marwitz, University of Wyoming; and Jarvis Moyers, NSF. Members of OFAP are David Fitzjarrald, State University of New York at Albany; Brant Foote, NCAR; Gregory Forbes, Pennsylvania State University; Robert Grossman, CIRES/University of Colorado; Carl Kreitzberg, Drexel University; Mitchell Moncrieff, NCAR (Chair); David Raymond, New Mexico Institute of Mining and Technology; Brian Ridley, NCAR; Steven Rutledge, Colorado State University; and Richard Strauch, NOAA. Three OFAP vacancies are currently being filled.

The OFAP and FAC will be meeting semiannually. The requirements and schedule for receipt of facility support requests from university investigators are expected to remain substantially the same. The deadlines for receipt of requests will continue to be published well in advance in the *ATD Observer*, the UCAR Newsletter, and other publications. For information, contact Warren Johnson, NCAR/ATD, P.O. Box 3000, Boulder, CO 80307 (303-497-8848).

Warren Johnson is Assistant Director of ATD. ❖

New ATD Sensor Measures Low Humidities

By Paul Spyers-Duran

Measurements of ultra-low atmospheric frostpoints below -80°C in the upper troposphere and lower stratosphere are now possible with a new airborne cryogenic hygrometer recently developed by ATD's Research Aviation Facility.

The development of this instrument was motivated by the need for faster response and more accurate measurements in the -20 to -80°C frostpoint temperature range. Previously, aircraft-based observations relied on other chilled-mirror devices that could not measure low humidities accurately because of their slow response and inability to maintain the large frostpoint depressions required.

The new instrument is a chilled-mirror, condensation type hygrometer using optical detectors for condensate sensing. A thermo-optical servo system controls the mirror temperature to maintain condensate equilibrium. A key feature is the use of liquid nitrogen coolant as a heat sink in combination with electrical heating to change the mirror temperature. This is in contrast to the older systems which use much slower thermoelectric cooling for this purpose.

The new system is able to rapidly change the mirror temperature at rates up to 14°C s^{-1} in response to changes in the humidity of the sampled air. This results in a typical measurement response time of 2 seconds or less. The frostpoint measurement uncertainty is ±0.4°C. The new cryogenic hygrometer has been thoroughly tested and has been used on three field programs, successfully measuring frostpoints as low as -86°C. It is now operational on the NCAR Sabreliner.

A comprehensive report on the performance of this hygrometer has recently been prepared and is available upon request (NCAR Tech Note 347+TA). For further information, contact Paul Spyers-Duran at (303) 497-1036.

Paul Spyers-Duran is a Senior Manager I in ATD's Research Aviation Facility. ❖

ASTER Facility Now Operational

By Tom Horst

After being under development for the last three years, the Atmosphere-Surface Turbulent Exchange Research (ASTER) facility is now available for use by the scientific community. This new system has been developed by ATD's Surface and Sounding Systems Facility with funding furnished by the National Science Foundation and the Electric Power Research Institute.

ASTER has been specifically designed to provide tower-based measurements of turbulent fluxes of momentum, sensible heat, and water vapor in the atmospheric surface layer, and to support a broad range of observational research on the structure of the surface layer. In addition, the new system is capable of supporting user-supplied instrumentation for the measurement of fluxes of trace chemical species by a variety of methods including eddy correlation, gradient transfer, and conditional sampling.

The basic measurements furnished by ASTER sensors are eddy correlation fluxes of momentum, heat, and water vapor, and vertical profiles of wind speed and direction, temperature, and water vapor. Additional ASTER measurements of net radiation and soil fluxes of temperature, moisture, and heat allow the surface energy balance to be determined. Standard chemical instrumentation available with the new system includes relatively slow-response sensors for ozone, carbon monoxide, and condensation nuclei.

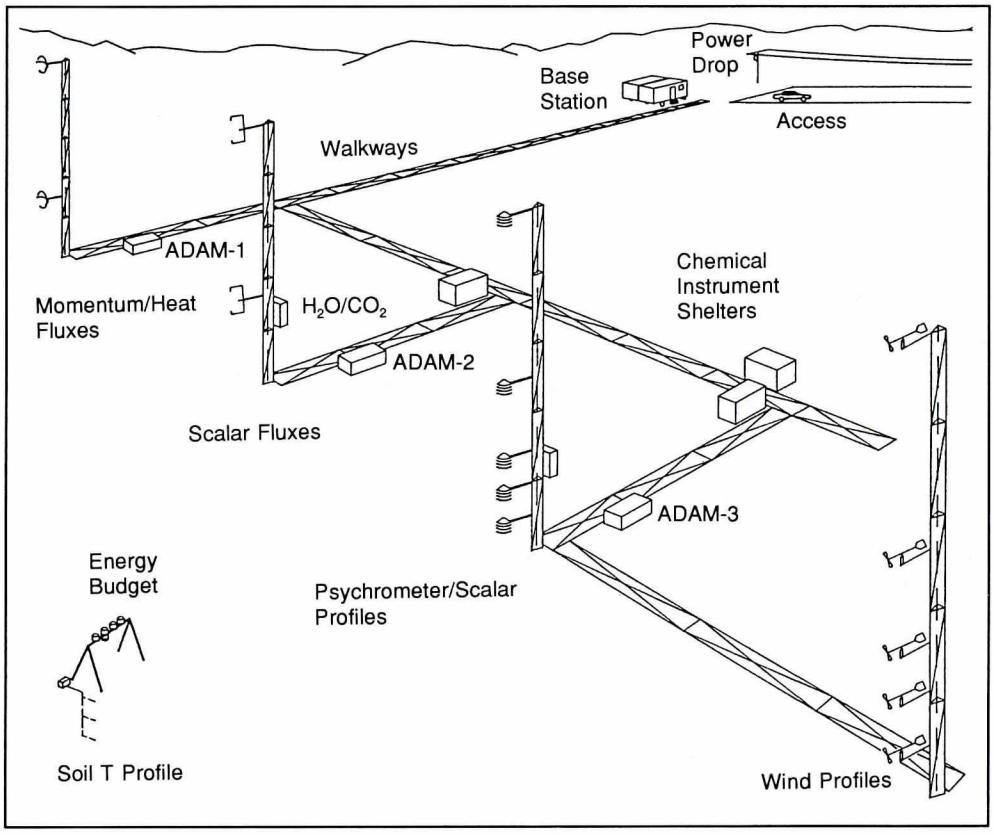
A typical application of the ASTER system is measurement of the flux of a trace chemical species by the eddy correlation technique. This is done by combining concentration data from a user-supplied, fast-response chemical sensor with fast-response vertical velocity data from an ASTER sonic anemometer. All data collection, archiving, and analysis is accomplished by the ASTER data system.

Alternatively, if a fast-response chemical sensor is not available for the species of interest, estimates of the flux can be made by the gradient technique. This is done by combining accurate chemical analysis of time-integrated samples from several heights with ASTER measurements of vertical temperature profiles and heat fluxes, or with analogous measurements of water vapor profiles and fluxes. A promising new approach for this application involves conditional sampling utilizing integrated samples.

We plan to gradually extend ASTER's capabilities by adding additional instruments, particularly sensors for measuring trace chemical fluxes. Devices currently under development include a fast H_2O/CO_2 sensor based on atmospheric absorption of infrared radiation. In addition, field testing is progressing on the conditional sampling approach for flux measurement, using slow-response chemical sensors or collected samples that are analyzed later in a laboratory.

The procedures for requesting ASTER for supporting a project are identical to the request procedures for all of ATD's observational facilities (see related article in this issue).

Tom Horst is a Scientist III in ATD's Surface and Sounding Systems Facility. ❖



Schematic view of ASTER, showing one possible field-deployment configuration (ADAM is ASTER Data Acquisition Module).

Should mention the ACD connection

Mobile CLASS Hits the Road

By Harold Cole and Dean Lauritsen

A completely self-contained, mobile CLASS (Cross-chain Loran Atmospheric Sounding System) is roaming the highways and byways of the Front Range area this summer as part of a weather forecasting study being conducted by NCAR's Research Applications Program (RAP). The new van-mounted system was designed and constructed by ATD's Surface and Sounding Facility with the assistance of ATD's Design and Facilities Services group.

The RAP project, called "Nowcasting 90," is part of an ongoing effort by RAP, ATD, and the Mesoscale and Microscale Division to develop very short-range forecasting techniques for aviation purposes. The forecast region is in northeast Colorado including the Denver metropolitan area.

The role of the mobile CLASS system in Nowcasting 90 is to provide surface and upper-air wind and thermodynamic data in real-time to the project staff for their use in making experimental forecasts of thunderstorms and tornadoes. The forecasters in the project control center continuously monitor weather conditions as they develop, using radar and other techniques, and direct the mobile CLASS by radio to locations where sounding data are needed.

The new mobile system was adapted from the conventional trailer-mounted CLASS, but has these differences:

- The system electronics are considerably smaller.
- A motor-generator allows the system to be operated and the radiosonde data to be received while traveling.
- A packet-radio communications link allows real-time sounding data to be transmitted back to the control center.
- An automatic sensing system measures surface meteorological variables prior to releasing a sonde or upon request.

A unique feature of the new mobile CLASS is a collapsible, instrumented, 5-meter meteorological tower attached to a roof rack that can be quickly erected when the van arrives on station. A crew of two can set up and perform a high quality atmospheric sounding within 30 minutes of arrival at a designated launch site.

Mobile CLASS is now operational and is available to the atmospheric research community through normal request procedures. For further information, contact Harold Cole at (303) 497-8753.

The instrumented Mobile CLASS van.

Harold Cole is an Engineer V and serves as Deputy Manager of ATD's Surface and Sounding Systems Facility (SSSF). Dean Lauritsen is an Engineer IV in SSSF. ❖

RAF Eyes Aircraft Laser Navigation Systems

By Richard Friesen

Troublesome reliability problems now being experienced with the antiquated inertial navigation systems (INSs) on NCAR's aircraft should be a thing of the past when current plans come to fruition.

ATD's Research Aviation Facility (RAF) is currently evaluating the suitability of several different types of INS units for replacing the 20-year-old Litton LTN-51 systems now in use on RAF aircraft. The LTN-51s are mechanical spinning-mass systems that are no longer in production. These systems have performed well over the years, but are wearing out (RAF installed the first systems in 1968). Maintenance has become very expensive and failures have compromised some research flights on recent field projects.

The RAF is looking at modern laser strap-down INS technology that, coupled with new global positioning system (GPS) navigation, will provide highly accurate and reliable aircraft position and velocity measurements. The new INS/GPS units will be used in association with air-motion instruments on the aircraft, such as radome gust probes and Doppler lidars and radar.

This combination of equipment is expected to provide much more accurate aircraft position data and *in situ* and remote wind measurements. Position measurement accuracies of 50 m or less and mean wind accuracies of 0.3 m/s are likely with the new system.

Equipment procurement is currently in progress, and the RAF expects to install the first system in late 1990 or early 1991.

Richard (Dick) Friesen is a Software Engineer IV and serves as Chief, Computing Group at ATD's Research Aviation Facility. ❖

RAF Aircraft Get Advanced Data Display Systems

By Mary Griffith

By next January, two aircraft in the RAF fleet will be sporting sophisticated new data display systems with color capabilities and other advanced features. The King Air system has already been installed and tested, while the new system for the Electra is currently being constructed and is scheduled to be operational by the end of this year. The systems have been carefully designed by RAF's Computing and Instrumentation Groups to be easy to use, but at the same time to have considerably higher performance than the older RAF data systems.

The new King Air display system is based on a Sun 3E computer. The system is window-based using SunView, and can simultaneously display four data panels and a control/help panel. Since user interaction is largely implemented through use of a trackball, in-flight turbulence causes much less difficulty than with the older keyboard-based system. Menus provide ready access to preselected displays and allow users to quickly set up their own customized displays.

The new system was installed on the King Air in November 1989, and by June had been flown on four projects. Reports from these early users have been favorable, particularly with regard to the quality and ease of use of this new capability.

Development is now progressing on the display system to be installed on the Electra. This system will allow multiple users to share the data through an Ethernet line. In addition to the data selection and display capabilities of the King Air system, the Electra system will be able to display data from other onboard systems such as lidars and radars (e.g., ELDORA). To provide these additional displays, the windowing system is being converted from Sunview to X-Windows. A Sun Sparcstation 1 will be the system's central processor.

Besides furnishing higher performance and being easier and more flexible to use, the new data display systems have another major advantage: they are roughly half the size and weight of the older systems that they replace. They will thus free up considerable cabin volume and payload in the two aircraft for additional research instrumentation.

Mary Griffith is a Software Engineer IV in ATD's Research Aviation Facility. ❖

Mile High Radar Helps Save Lives

By Warren Johnson

One of ATD's unique observing facilities played an important role in weather events that occurred on June 6, 1990. During that evening, severe tornadoes developed over the plains of eastern Colorado, ravaging the towns of Limon and Rush and knocking out power and communications to the National Weather Service (NWS) radar station near Limon.

To be able to continue to issue timely warnings on movements of the severe storms, the NWS Denver Forecast Office turned to ATD's Mile High Radar (MHR) facility located just northeast of Denver. Under an agreement with NWS, data from the MHR are routinely supplied to the Forecast Office during prescribed time periods.

Because of the urgency of the situation, the MHR daytime crew of Gary Blair and Bob Chubrilo extended their shift to 12 hours, and a follow-on crew of Don Ferraro and Byron Gerke worked a special all-night shift until the severe weather dissipated.

In a letter from Michael Looney, the NWS Forecast Office supervisor, to ATD Director Richard Carbone, Looney says "After reviewing the damage, it is simply incredible that no lives were lost...Teamwork was the key to the success of the warning process on June 6. I wish to extend my most sincere appreciation to your staff at the Mile High Radar facility...the process worked--lives were saved. Your staff should be proud of their efforts and fully realize that their support may very will have meant the difference between life and death."

In response to the letter, Carbone remarked "We're very proud of the guys at Mile High Radar — they really 'went the extra mile' in this case. Although our facilities exist primarily to support research, it's great when we get a chance like this to help out operationally in protecting the public."

Warren Johnson is Assistant Director of ATD. ❖

ATD Reorganizes; Names Two New Groups

By Warren Johnson

The Atmospheric Technology Division (ATD) of NCAR has reorganized. Under the new structure, ATD's Field Observing Facility (FOF) has been replaced by a new Remote-Sensing Facility (RSF). RSF's responsibilities include the current FOF Doppler radars as well as ELDORA, the airborne Electra Doppler radar now under development. The new facility, headed by Peter Hildebrand, also develops optical sensors, such as lidar, and other remote systems.

A new Research Data Program (RDP) coordinates data processing, distribution, and archiving among all of ATD's facilities. These centralized data services produce standardized, integrated data sets from major field programs that use ATD's diverse observational tools. RDP also develops new software for analyzing data. Paul Herzegh manages the new program.

Changes in the ATD Directorate include the appointment of Warren Johnson as Assistant Director. ATD's Research Aviation Facility and Surface and Sounding Systems Facility remain substantially unchanged.

Warren Johnson is Assistant Director of ATD. ❖

Integrated Sounding System Development Underway

By Walter Dabberdt

Atmospheric scientists in the future will be able to obtain highly detailed wind, temperature, and humidity profiles using a sophisticated new instrumentation system being developed by NCAR and NOAA staff.

The new system, called an Integrated Sounding System (ISS), is being developed jointly by ATD's Surface and Sounding Systems Facility and NOAA's Aeronomy Laboratory. Initial funding is being supplied by the NOAA TOGA (Tropical Ocean - Global Atmosphere) Program.

The purpose of ISS is to obtain high-resolution profiles of atmospheric variables through the troposphere and stratosphere. The ISS concept involves integrating the measurements from a diverse suite of active and passive remote sensors, together with ground-based and upper-air *in situ* sensors. A comprehensive Integrated Sounding System would consist of the following candidate sensors (and could accommodate additional sensors as well):

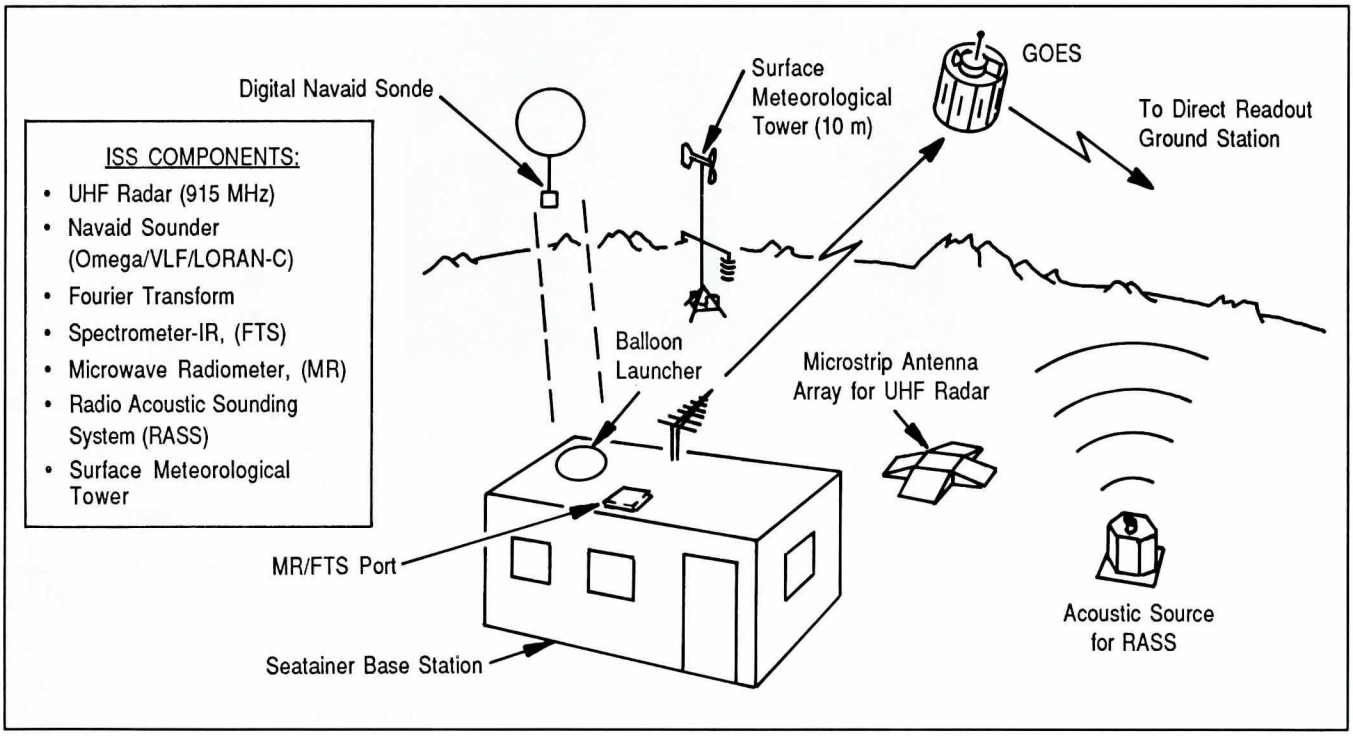
- UHF and VHF Doppler radar wind profilers to measure vertical profiles of horizontal and vertical wind through the troposphere.
- Radio Acoustic Sounding System (RASS) to obtain vertical profiles of virtual temperature.
- Microwave radiometer to measure integrated humidity and liquid water.
- High resolution interferometric sounder for vertical profiling of temperature, humidity and trace gases.
- Upper-air sounding system using NAVAID equipped balloons to obtain periodic profiles of pressure, temperature, humidity, and wind through the troposphere and stratosphere.
- Surface meteorological system to measure wind, pressure, temperature, humidity, precipitation, and solar and infrared radiation.

Data from the various components of the ISS will be combined synergistically to enhance the quality of the measurements. For example, RASS and *in situ* measurements of temperature profiles will be used to improve the retrieval of temperature profiles from the high-resolution interferometric sounder. In addition, mesoscale networks of integrated sounding systems will be used with four-dimensional data assimilation models to provide highly resolved meteorological fields.

The initial ISS development now underway is focusing on a limited system that will meet the basic requirements of the TOGA Coupled Ocean Atmosphere Response Experiment (COARE). The limited ISS for COARE will consist of a UHF Doppler wind profiler with RASS, an Omega upper-air sounding system, and a surface meteorological system.

COARE requires that ISS be available for deployment on ships as well as on land. The shipboard application will involve development of a stabilized platform and a system for measurement of ship motions. Preliminary shipboard testing will take place later this year. Completion of the overall development is anticipated in 1992.

Walter Dabberdt is a Scientist III and serves as Manager of ATD's Surface and Sounding Systems Facility. ❖



Schematic view of the Integrated Sounding System (illustration by Lee Fortier, NCAR Graphics).

ATD Field Project Support

Field projects supported by the ATD during the past year include:

North Dakota Thunderstorm Project

Objective: To study three-dimensional wind fields and precipitation formation around and within convective systems, using real-time data from radars, aircraft, and ground stations.
PI/Institution: R. Dickerson/U. of Maryland, P. Smith/SDSMT, and others
Location: Bismark, ND
Facilities: CLASS, PAM, CP-3, CP-4, MOCCA, Sabreliner
Period: June - July 1989
NCAR Project Leaders: V.Glover, G.Albright, J.Wilson
Successes/Problems: Successful studies conducted included SF_6 tracer, chemistry, chaff experiments, lightning-radar-satellite correlations, first echo photography, and cloud model forecasts.
Of Special Interest: Radars, aircraft, and ground operations were all controlled via communications consoles and work stations located in MOCCA.

Cloud Droplet Chemistry, Aerosol Physics, and Instrument Testing

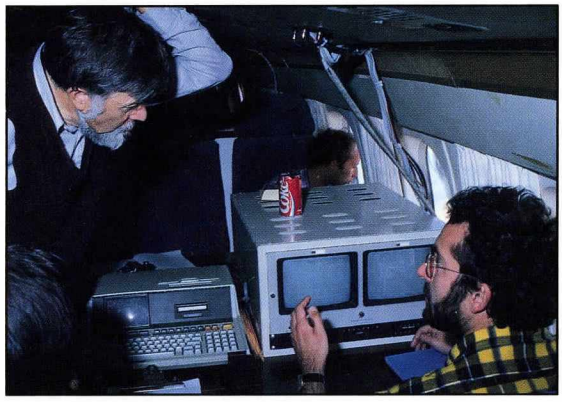
Objective: To study droplet chemistry and aerosols in and around stratocumulus clouds using Mohnen slotted rod, counterflow virtual impactor (CVI), and bulk filter sampler methods.
PI/Institution: C. Twohy/NCAR, B. Huebert/URI, R. Charlson/U of Washington
Location: Monterey, CA
Facilities: King Air
Period: September - October 1989
NCAR Project Leader: C. Twohy
Successes/Problems: Several instruments were successfully used in conjunction with CVI to measure droplet water content and physical and chemical properties of residue particles from droplets.
Of Special Interest: Particulate losses just inside tip of isokinetic bulk sampler averaged 50% by mass.

Spontaneous Ice Nucleation

Objective: To obtain air samples from lenticular and cirrus clouds for aerosol analysis and nucleation studies.
PI/Institution: D. Hagen/U. of Missouri-Rolla, A. Heymsfield/NCAR
Location: Denver, CO and St. Louis, MO areas
Facilities: Sabreliner
Period: November - December 1989
NCAR Project Leader: E. Brown
Successes/Problems: Ice crystal samples were also obtained for later laboratory studies.

Aircraft Research Training

Objective: To provide practical training in observational methods and data analysis for students from UCAR universities in the areas of atmospheric measurements and instrumentation.
PI/Institution: J. Hallett/DRI, J. Hudson/DRI, A. Schanot/NCAR
Location: Buckley ANG, Denver, CO
Facilities: Electra
Period: November - December 1989
NCAR Project Leader: A. Schanot



Professor John Hallett and students on the RAF Electra during a training flight.

Terminal Doppler Weather Radar Operational Support

Objective: To make Mile High Doppler Radar operational for forecasting winter and summer storm activity in support of National Weather Service, and to assist FAA in providing detection of wind shear events near Stapleton Airport.
PI/Institution: J. Wilson/NCAR, J. Moore/NCAR
Location: Denver, CO area
Facilities: Mile High Radar
Period: October 1988 - October 1989
NCAR Project Leader: J. Wilson
Successes/Problems: Radar system was successful in automated detection and dissemination of windshear events to air traffic control facilities. This capability coupled with advanced nowcasting techniques of convective storm development and evolution are considered major improvements in safety and efficiency of the air traffic system.

Winter Icing and Storms Program (WISP)

Objective: To increase understanding of meteorological processes for production and depletion of supercooled liquid water in winter storms. Development of improved understanding of winter storms will form basis for improving aircraft icing and snow forecasts in eastern Colorado area.
PI/Institution: W. Sand/NCAR, and others
Location: Denver, CO area
Facilities: CLASS, PAM, CP-3, Mile High Radar
Period: February - March 1990
NCAR Project Leader: R. Rasmussen
Successes/Problems: Excellent data set for study of shallow upslope systems was acquired. Good comparisons of remotely sensed storm characteristics and in-situ measurements were obtained. Large drops were detected on 3 of 10 flights indicating that this is not unique to California and is not a rare occurrence.

Atmospheric Convective Waves Over the Ocean

Objective: To investigate formation of atmospheric gravity waves caused by cold air advection over the warm surface water of Gulf Stream, in conjunction with NASA's lidar equipped Electra.
PI/Institution: R. Grossman/U. Colorado-CIRES, J. Kuettner/NCAR

Location: Wallops Island, VA
Facilities: King Air, Sabreliner
Period: January - February 1990
NCAR Project Leader: A. Schanot
Successes/Problems: Cloud street patterns normally associated with the gravity wave phenomenon failed to materialize, but several case studies were flown resulting in valuable data.

Ice Formation in Wave Clouds

Objective: To document manner of ice formation along airflow trajectories and to collect data to study responsible nucleation processes.
PI/Institution: A. Cooper/NCAR
Location: Jefferson County Airport, Broomfield, CO
Facilities: King Air
Period: November 1989 and March 1990
NCAR Project Leader: A. Cooper
Successes/Problems: Good documentation of ice formation from -15°C to -40°C. Tested new small-ice detector.

Midwest Winter Storms

Objective: To investigate mesoscale and microscale structure and evolution of precipitation bands and stratiform regions within mid-latitude storm systems over central Illinois.
PI/Institution: R. Rauber/U. of Illinois, Champaign-Urbana
Location: Champaign, IL
Facilities: CLASS
Period: January - March 1990
NCAR Project Leader: G. Albright
Successes/Problems: Project was hampered by lack of storms during January / early February. No data were collected on most intense storm of experiment as storm caused extended power outage in Champaign area.

ALOHA-90

Objective: Lidar study of mesopheric gravity waves (see cover story).
PI/Institution: C. Gardner/U. of Illinois
Location: Maui, Hawaii
Facilities: Electra
Period: January - March 1990
NCAR Project Leader: V. Glover
Of Special Interest: N. Zrubek (RAF) and J. Fox (DFS) designed complex installation of massive laser systems. ❖

Deadlines for Facilities Requests

The NSF Observing Facilities Advisory Panel (OFAP) will meet in October 1990 and April 1991 to consider requests for use of all NSF-sponsored lower atmospheric observing facilities. These include facilities at NCAR, University of Wyoming, Colorado State University, and South Dakota School of Mines and Technology, as described on this page and in the related story on page 5. OFAP evaluates requests and makes recommendations on allocations to the NSF Facilities Advisory Council.

The deadlines for receipt of requests prior to these meetings are as follows: **17 August 1990** (for requested facility use between 1 April 1991 and 1 October 1991); and **22 February 1991** (for requested use between 1 October 1991 and 1 April 1992).

Scientists requesting facility support in conjunction with NSF grants should include those requirements in their grant applications, which are due at NSF four months prior to the OFAP meeting.

Requests for use of NCAR aircraft should be sent to Norm Zrubek, for radars to Peter Hildebrand, for surface and sounding systems to Walter Dabberdt, and for data services to Paul Herzegh, all at NCAR, P.O. Box 3000, Boulder, CO 80307 (303-497-1000). Addresses for other requests are listed below. Wyoming King Air: John Marwitz, Department of Atmospheric Science, University of Wyoming, Laramie, WY 82071 (307-766-4947); T-28: Paul Smith, Institute of Atmospheric Science, South Dakota School of Mines and Technology, Rapid City, SD 57701 (605-394-2291); CHILL radar: Steven Rutledge, Department of Atmospheric Science, Colorado State University, Fort Collins, CO 80523 (303-491-8283). ❖

ATD Observational Support Facilities

The ATD provides specialized facilities and analysis support for atmospheric research in several areas. These include remote sensing via radar and lidar, in situ sounding systems, instrumented aircraft, and surface observing systems. ATD furnishes this support through the organizational units listed below. Each Organization also engages in related scientific research and sensor development to maintain a leadership role in the operation and development of state-of-the-art measurement systems.

• **Research Aviation Facility (RAF).** The RAF operates three aircraft in support of research studies of atmospheric chemistry, cloud physics, mesoscale meteorology, boundary-layer dynamics, air-sea interactions, oceanography, and other fields. These aircraft are equipped to measure a broad range of atmospheric properties including state variables, winds, turbulence, and cloud variables.

• **Remote Sensing Facility (RSF).** The RSF provides support to the research community in the area of advanced radar observations. The RSF operates three Doppler radars and is developing the Electra Doppler Radar (ELDORA).

• **Surface and Sounding Systems Facility (SSSF).** The SSSF provides surface-based *in situ* and sounding measurements in support of atmospheric research. Available sensors include a network of surface meteorological stations, balloon sounding and dropsonde systems, and a surface flux-measuring system.

• **Research Data Program (RDP).** The RDP serves both the user community and ATD with development and support of advanced analysis software tools; field experiment control facilities; archival, packaging, and distribution; and coordination of ATD network and distributed computing activities.

• **Design and Fabrication Services group (DFS).** The DFS provides mechanical engineering and design service, mechanical fabrication services, and field logistics and maintenance support to NCAR, and by special arrangement, to outside researchers.

Both the RDP and DFS have a matrix-like relationship to the ATD facility organizations. ❖

MEETING ANNOUNCEMENTS

NCAR Atmospheric Technology Division Users' Conference

The first *ATD Users' Conference*, sponsored by the NCAR Atmospheric Technology Division (ATD), will be held at the Hyatt Regency at Beaver Creek, Colorado, on 2 October 1990. The objectives of the meeting are to obtain the views of the users of ATD's existing observational platforms and instrumentation systems about the capabilities and performance of these facilities, to review current progress and plans regarding the development of new ATD facilities, and to obtain advice from users on these and other new developments. Thus the meeting will be both retrospective and prospective in nature.

The Conference will also include discussion of the new allocation procedures for NCAR and other NSF observational facilities for atmospheric research. All interested past and future users of ATD facilities are urged to attend this important meeting. Provided that participants support the concept of a periodic Users' Conference, such meetings will be held on a biennial or similar schedule in the future.

This meeting will be held in conjunction with the *Workshop on Atmospheric Research Measurements*, which follows on 3-4 October 1990 in the same location. For further information, please contact the Conference Administrator, Ms. Shelley Zucker, at (303) 497-8833. ❖

Workshop on Atmospheric Research Measurements

A *Workshop on Atmospheric Research Measurements*, hosted jointly by the NCAR Atmospheric Technology Division and the NOAA Aeronomy Laboratory, will be held at the Hyatt Regency at Beaver Creek, Colorado, on 3-4 October 1990. The sponsors of the meeting are NCAR, NSF, NOAA, and NASA. The co-conveners are Richard Carbone (NCAR), Adrian Tuck (NOAA), and Stephen Cox (Colorado State University).

The objectives of the meeting are to assess the scientific needs for measurements in selected atmospheric research areas, to identify gaps in the measurement systems currently available for filling these needs, and to recommend the development of needed new systems. The Workshop will feature reviews of measurement needs in the following research areas:

- Tropospheric and Stratospheric Chemistry and Physics
- Precipitation and Hydrological Processes
- Clouds - Physics, Chemistry, Electrification, and Radiative Effects
- Mesoscale Dynamics and Scale Interactions
- Climate Observing Systems
- Boundary Layer Chemistry and Physics

All interested atmospheric scientists, instrumentation developers, and research managers are invited to attend this important meeting. This workshop will be held in conjunction with the *NCAR Atmospheric Technology Division Users' Conference*, which will take place on 2 October 1990 in the same location. For further information, please contact the Workshop Administrator, Ms. Shelley Zucker, at (303) 497-8833. ❖

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