Contributions of data to national and Global Earth Observing System of Systems (GEOSS)-related data bases and programs, and involvement in international quality-control activities to ensure accuracy, precision, inter-comparability, and accessibility of global data sets

Idaho National Laboratory Mesonet

ARL operates and maintains a meteorological network in Southeast Idaho called the NOAA/Idaho National Laboratory Mesonet. It covers an area of approximately 10,000 square miles and includes 35 meteorological towers ranging in height from 10 m to 76 m above ground level. Key stations in the network provide a high-quality climatological database that extends more than 60 years. The network also includes a 915 MHz radar wind profiler with Radio Acoustic Sounding System, a sodar, and a flux station for estimating surface energy balance. This network is used extensively for operations at the Department of Energy (DOE) Idaho National Laboratory, including support related to accidental releases of hazardous substances and wildfires. In addition, the National Weather Service Weather Forecast Office (NWS WFO) in Pocatello, Idaho frequently relies on the network to assess conditions during severe weather and issue warnings and watches. Data from the Mesonet are retrieved every 5 minutes and transmitted to the NOAA Meteorological Assimilation Data Ingest System (MADIS). The data are also available through MesoWest, which is operated by the University of Utah.

Nevada National Security Site Mesonet

ARL operates and maintains a 30-station meteorological network (Mesonet) on the Nevada National Security Site (NNSS) in Southern Nevada. The NNSS is federal land, approximately the size of the state of Rhode Island, where these data are used by the National Laboratories to conduct experiments relative to National Security. Data are collected at primarily 10 m heights with two 30 m height observations every 15 minutes locally and transmitted to MADIS, and are available through MesoWest. Data are routinely used by the local Las Vegas NWS WFO to verify forecasts, assess severe weather conditions, and to issue watches and warnings. Data collected are temperature, pressure, humidity, wind speed and direction, and precipitation. Daily radiosonde releases at 00Z and 12Z were conducted for many years at the Desert Rock Weather Observatory to provide upper air data to support NNSS activities and were provided to the NWS. Recently, routine releases have been replaced with experiment specific on-scene radiosonde releases. Upper air data for daily use is transitioning to the use of SOnic Detection And Ranging (SODAR) and wind profiling technologies. Due to the nature of some NNSS experiments, lightning safety is extremely important. As such, a local lightning detection network is in place on and in the area of the NNSS. This four-sensor network uses similar technology as the National Lightning Detection Network; however, it provides higher resolution lightning strike data to issue lightning alerts for the safety of workers and property.

U.S. Climate Reference Network

The U.S. Climate Reference Network (USCRN) provides the United States with a climate variation and change monitoring network that meets national commitments to monitor and document climate change and variability for the conterminous United States (CONUS), Alaska and Hawaii. ARL is one of three NOAA offices cooperating in the USCRN program. ARL provides the engineering design and measurement capabilities and expertise for the stations, including the deployment and maintenance of the sites and regular calibration of the sensors. ARL also provides analysis of emerging sensor technologies for future applications. The USCRN consists of 114 stations in the CONUS and an additional 6 stations installed in Alaska (a total of 29 stations are planned) and 2 in Hawaii.

Each station is strategically placed away from urban and suburban influences to avoid any possible misinterpretation of changes observed. The USCRN reports multiple observations per hour for surface air temperature and precipitation. This temporal resolution of the data provides additional climate information, such as precipitation intensity and duration of extreme events. Other data collected include wind speed, solar radiation, and infrared surface temperature. More recently, the USCRN stations are being equipped with soil moisture, soil temperature, and relative humidity sensors, which are supported by the National Integrated Drought Information System. High quality data for all sites in near-real time are provided by NOAA’s National Climatic Data Center.

Regional United States Climate Reference Network

Following the successful implementation of the USCRN, ARL has begun assisting with the modernization of the U.S. Historical Climatology Network, known as the Regional United States Climate Reference Network (RUSCRN). This Network was established more than 100 years ago to assist in the detection of regional climate change by collecting monthly averages of maximum, minimum, and mean temperatures and total precipitation. As the network has matured, NOAA designated the RUSCRN for modernization to better meet its mission of providing the nation with data regarding the state of a region's climate quality. To ensure the most accurate data are collected throughout the network, ARL is participating in a pilot project to add 141 new stations in the southwest climate region. The pilot project is part of NOAA's goal to modernize 1,000 of its existing 1,221 stations. ARL is leading the installation, calibration and maintenance of the new, automated stations that will collect temperature and precipitation data every 5 minutes. Each new station includes triple redundant temperature and precipitation sensors for reliability. Additionally, the station is expandable to allow for any future interest in measuring soil temperature, soil moisture, snowfall and snow depth. The first 10 stations were turned on in October, 2009 with additional stations expected to come online bi-monthly through 2011. The ultimate goal is for both the RUSCRN and the USCRN to work together to deliver accurate, high-quality data to users studying climate trends.

Surface Energy Budget Network

Measurements of the components of the surface energy budget are obtained at a total of seven sites, representing the most dominant ecosystems in the climate zones of the U.S. Observations from these sites are needed to understand how the various regional surface types (forest, grasslands, crops, deserts, water) absorb and/or reflect the solar and infrared radiant energy and how that energy is partitioned into sensible, latent and ground heat fluxes. Observing these fundamental processes will provide a predictive understanding of the role of land-surface feedbacks in the global climate system and will guide regional and global modeling activities. Improvements in prediction capabilities will provide better information for management of water resources as well as improved planning in managing typical power generating resources in the U.S. and contribute to the development of solar alternative energy capabilities for the nation.

Observations include the measurement of all important variables that describe the climate processes at the land surface interface. This includes the measurement of all radiative components (short and longwave radiation), heat fluxes including evapotranspiration and CO_2 fluxes, and other terrestrial measurements such as soil moisture and soil temperature.

National Atmospheric Deposition Program Networks

The National Trends Network (NTN) of National Atmospheric Deposition Program (NADP) began operation in 1978 with the goal of providing data on the amounts, trends, and geographic distributions of acids, nutrients, and base cations in precipitation. The NTN network currently has 250 sites that collect data using a weekly sampling protocol. ARL joined the NTN in 1980 and sponsored a number of stations over the years. ARL has been an active partner for the past 30 years and is currently sponsoring 2 NTN stations.

The Atmospheric Integrated Research Monitoring Network (AIRMoN) is another network of NADP. It is supported by ARL and joined NADP in 1992. Currently AIRMoN consists of seven sites measuring the same chemical constituents as NTN but on a daily sampling protocol rather than weekly. These higher temporal resolution samples enhance researchers' ability to evaluate how emissions affect precipitation chemistry using computer simulations of atmospheric transport and pollutant removal. AIRMoN also allows for evaluation of alternative sample collection and preservation methods. Five of the seven sites have been in operation since 1976, when they operated under a different federal program.

The Mercury Deposition Network (MDN) is a third network that joined NADP in 1996. MDN consists of over 100 sites across the United States and Canada, measuring total mercury, and for some sites methyl mercury as well, in precipitation. Researchers use MDN data to evaluate the role of precipitation as a source of mercury in water bodies with high concentrations of mercury in fish. ARL collaborates directly with MDN through the deliberate arrangement of several co-located, NOAA-sponsored, mercury dry deposition stations (part of the Atmospheric Mercury Network) with MDN stations.

The Atmospheric Mercury Network (AMNet) is the most recent addition to NADP. AMNet measures atmospheric mercury fractions which contribute to dry and total mercury deposition. ARL established and operates five of the current 21 stations in AMNet. ARL stations also collect additional trace gas measurements (sulfur dioxide, carbon monoxide, oxides of nitrogen), as well as meteorological information. All AMNet stations have automated continuous measuring systems that collect concentrations of atmospheric mercury species, concentrations of total mercury in precipitation, and meteorological measurements. Data are collected with standardized methods, with quality assured data archived in an online data base. ARL was a key contributor to the development and acceptance of AMNet as a formal network of NADP.

Data from the NADP wet deposition networks are quality assured and made available for electronic downloading free of charge by NADP. These data form the backbone of U.S. precipitation chemistry information and are used by the U.S. Environmental Protection Agency for regulatory decisions and policymaking, as well as by a host of users from Academia, Industry, and non-governmental organizations, and the World Meteorological Organization Global Atmosphere Watch. Data from the AMNet are made available via NADP with restrictions. For more information about this see: http://nadp.sws.uiuc.edu/amn/data.aspx

World Meteorological Organization (WMO) Committee on Instruments and Methods of Observation

The Director of the ARL Atmospheric Turbulence and Diffusion Division was elected for a 4-year term as Vice President of the WMO Committee on Instruments and Methods of Observation (CIMO) at the 2010 CIMO management meeting held in Helsinki, Finland. The CIMO's mission is to promote and facilitate international standardization and compatibility of meteorological observing systems used by members within the WMO Global Observing System and to improve the quality of products and services of members. Over the next 4 years, CIMO will improve the quality and cost-effectiveness of surface based and upper air observing systems by initiating and participating in national tests and performing global intercomparisons. CIMO will provide recommendations on system performance, and guidance concerning improvements of instruments and methods of observation as well as suitable working references to WMO members and instrument manufacturers. These principles are facilitated by having international expert teams perform international standard intercomparisons, updating and contributing new technology used for meteorological measurements, and helping developing countries with capacity building and sustainability of long-term meteorological measurements.

Manual for the WMO, Global Atmosphere Watch (GAW) Precipitation Chemistry Program

The GAW Precipitation Chemistry Program was developed to assure the harmonization of measurements conducted globally by various regional and national programs. Ultimately, this information should enable quantification of patterns and trends in the composition of atmospheric precipitation at global and regional scales, contributing to the improvement of our understanding of biogeochemical cycles of major chemical species and our assessment of long-range transport from major source areas. Late in 2004, a guidance manual was published to provide a full compendium of the information required to address problems with the quality of global data by global program participants. Standard operating procedures were developed including all on-site, laboratory, data management, quality assurance, and data dissemination aspects of the measurement system. Data are presently archived at the GAW World Data Centre for Precipitation Chemistry, collocated with the Quality Assurance/Science Activity Centre (QA/SAC) in Champaign, Illinois. ARL scientists lead the GAW Precipitation Chemistry Science Advisory Group and were key contributors to the coordination of the guidance manual, as well as the pending global assessment. ARL sponsors the WMO QA/SAC, and the WMO Precipitation Chemistry Data Center. All products are freely available via the Web.

Global Climate Observing System (GCOS) Reference Upper Air Network

Climate change research at ARL has long focused on analysis of upper-air variables, including ozone, temperature, and water vapor, beginning with pioneering analyses of radiosonde and ozonesonde data by ARL in the 1970s. In the 1990s, ARL research identified serious problems with the quality of operational radiosonde observations for climate research, including the poor performance of humidity sensors in the upper troposphere and stratosphere and the very significant effects of instrument changes and associated time-varying biases on estimated long-term trends. The need for reference observations of upper-air variables for understanding climate change became clear, and over the past 15 years, ARL has been in the forefront of calls for the establishment of a reference upper-air network for climate purposes and development of reference-quality instrumentation. ARL scientists have worked with others in the U.S. and internationally to organize workshops that successfully developed the scientific requirements for a reference network and evaluated potential instrument technologies. These activities laid the groundwork for the eventual establishment of the GCOS (Global Climate Observing System) Reference Upper Air Network (GRUAN), as explained in a 2009 paper in the *Bulletin of the American Meteorological Society* (Seidel et al., 2009). As the GRUAN has moved from concept to reality, ARL's involvement has focused on providing scientific leadership and GRUAN-related research. ARL scientists are members of several GCOS working groups and have been lead authors of at least three GRUAN-related papers since 2006.