

B.2 Office of Oceanic and Atmospheric Research (OAR)

The Office of Oceanic and Atmospheric Research (OAR) traces its roots back to the Institutes for Environmental Research, which were established in the 1960s. The primary research arm of NOAA, OAR conducts and directs research in atmospheric, coastal, marine, and space sciences through its own laboratories and programs, and through networks of university-based programs. The principal divisions of OAR are the Environmental Research Laboratories, the National Sea Grant College Program, the National Undersea Research Program, and the Office of Global Programs. OAR provides leading-edge scientific information and tools toward a clearer understanding of the oceans and atmosphere, and how human activity can affect them.

B.2.1 PACIFIC MARINE ENVIRONMENTAL LABORATORY (PMEL)/TROPICAL ATMOSPHERE OCEAN (TAO)

The Tropical Atmosphere Ocean (TAO) buoy array consists of 70 moored buoys spanning the tropical Pacific basin from 95°W to 137°E. Supported by an international consortium that includes the U.S., Japan, France, Korea, and Taiwan—the TAO array is a major component of the global climate monitoring system. Upper-ocean and meteorological data from TAO buoys are telemetered in real-time to a shore-based computer via the Argos satellite system. The buoy data are processed and quality controls are applied nightly at the Pacific Marine Environment Laboratory (PMEL). Parameters measured by the buoys—such as wind, air temperature, relative humidity, and water temperatures and currents—and calculated parameters that include dynamic height, transport, and ocean-heat content are distributed to the oceanographic and meteorological community in real-time by the Internet.

The TAO Display Software was developed to distribute TAO buoy data to remote users in real-time, with convenient procedures for display and comparison. Data are presented as graphics and animations accessible through a Web page.

Yearly submissions of TAO data are made to NOAA's National Data Centers, as well as to the TOGA Subsurface Data Center in Brest, France.



Scientist adjusting sensors on TOGA-TAO buoy. In the background is the NOAA Ship Ka'imimoana.



Navy biplane taking meteorological measurements, 1934. These flights paved the way for future weather research.

NOAA's Gulfstream IV-SP is used to obtain atmospheric observations used in climate research. Data are transmitted to the National Centers for Environmental Prediction (NCEP) and the National Hurricane Center for inclusion into global climate and hurricane models.

B.2.2 CLIMATE RESEARCH DATA CENTER (CRDC)

The Climate Research Data Center (CRDC) is a component of the Climate Diagnostics Center (CDC). CRDC focuses on global gridded atmospheric and oceanic data sets of interest to climate researchers. CRDC provides value-added versions of data sets generated at the National Centers for Environmental Prediction (NCEP) and other international forecast centers. CRDC also supports distribution of data sets generated at CDC in collaboration with other research institutes, such as the National Center for Atmospheric Research (NCAR).

All of the data sets that CRDC supports are made available in a standardized data format (known as netCDF) that is widely used in the academic research community. Additionally, all of the supported data sets are available on the Internet. By concentrating on the needs of the climate research science community, CRDC can provide tailored data subsets and data software tools to meet the specialized needs of this group of users. CRDC is a primary distribution point for the Comprehensive Ocean-Atmosphere Data Set (COADS) and for the NCEP Reanalysis Data Products, two important data sets for climate researchers. Climate Research Data Center highlights include the following:

- CRDtools released – software tools to aid data visualization
- COADS data set made available via anonymous FTP

- NCEP Climate Diagnostics Database goes on-line via Internet
- NCEP and European Centre for Medium-Range Weather Forecasts operational analyses (value-added) on-line
- World Wide Web interface to all CRDC data holdings goes on-line
- NCEP Reanalysis Data Products on-line
- Processing of 1,200 queries and 50 data downloads per day via the Web.

B.2.3 SPACE ENVIRONMENT CENTER (SEC)

The Space Environment Center (SEC) occupies a central position in the space weather community and is a member of the National Centers for Environmental Prediction operated by the National Weather Service.

The Space Weather Operations (SWO) at SEC operates the national and world warning centers for space weather that can affect people and electronic equipment and provides real-time monitoring and forecasting of solar and geophysical events to customers. The 55th Space Weather Squadron of the U.S. Air Force in Colorado Springs, Colorado, provides services to U.S. military customers and works closely with SWO. NOAA civilian employees, uniformed NOAA Corps staff, and U.S. Air Force personnel jointly operate SWO.

The Space Environment Center also conducts research in solar-terrestrial physics, develops techniques for forecasting solar and geophysical disturbances, transitions academic research (including numerical models) into operations, and prepares data to be archived by the National Geophysical Data Center (NGDC). It often provides advice on solar-terrestrial phenomena and their adverse effects to government agencies and industry. Research scientists at SEC are working toward a better understanding of the Sun-Earth connection by studying solar electromagnetic, particle, magnetic field, and plasma emissions and the processes that affect the space environment around Earth.

SEC products include daily forecasts, alerts, warnings, and watches about disturbances in the solar-terrestrial environment. They are distributed by Internet, NOAA Weather Wire, email, and in technical reports. At times of high solar activity, SEC Web pages are recording over one million queries per day.



Aurora borealis, Anchorage, Alaska, 1977.

Data gathered by SEC come from a wide range of sources. Most data are observed in real time, and primary data streams include:

Space Environment Monitors (SEM) Data

SEM data are from the GOES and POES satellites. The data are received in real time, processed, used in space weather operations and research, and passed to NGDC for archive.

Solar Wind Data

These data are collected by a SEC real-time tracking network from the NASA Advanced Composition Explorer (ACE) satellite. The data are used in real time in space weather services. The versions of the data for archive and research are collected and maintained by NASA.

Solar-Terrestrial Data

SEC collects observations of the solar-terrestrial environment from the Regional Warning Centers of the International Space Environment Service (ISES). In its role as World Warning Agency, SEC uses the data for its own routine space weather services and issues alerts and warnings for the ISES center. The data provided by the ISES centers are archived in the country of origin, often through the World Data Center System.

Also, data from other research satellites, such as the NASA Solar Heliospheric Observer Satellite are used in SEC operations. NASA maintains the research and archive data.

The wind profiling radar site at Biak, Indonesia (one of the sites in the Trans-Pacific Profiler Network).



B.2.4 AERONOMY LABORATORY (AL)

Aeronomy Laboratory / Trans-Pacific Profiler Network (TPPN)

The Trans-Pacific Profiler Network (TPPN) consists of Doppler radars, called wind profilers, located on seven remote island sites spanning the data-sparse region of the tropical Pacific Ocean. The Aeronomy Laboratory operates the TPPN in collaboration with the Joint Institute at the University of Colorado, the Cooperative Institute for Research in Environmental Sciences (CIRES). The instruments, developed in collaboration with the NOAA Environmental Technology Laboratory, use “clear air” atmospheric echoes to measure a “profile” of both horizontal winds and vertical motions, at heights from the surface to 5–15 kilometers (depending on the frequency of the instrument). In addition to the wind profile, information about precipitation and atmospheric turbulence is also obtained.

The global tropics are mostly covered by ocean and therefore sparsely observed. Observations from the tropics are critical for day-to-day global weather forecasting, and also for understanding and predicting phenomena such as El Niño, which can affect year-to-year climate variability over large regions of the globe. Examples of TPPN accomplishments include: high spatial and temporal resolution wind profiles from remote island sites in the tropics; detailed observations of El Niño signals over the equatorial Pacific; first direct measurement of vertical motions and their diurnal variability in the tropics; improved methodology for classifying precipitating cloud systems; and observations that have improved scientific understanding of marine boundary layer winds, moisture budgets, diurnal, annual, and interannual variability of atmospheric circulation, and atmospheric heat budgets.

The near real-time wind observations from the TPPN are provided on the Aeronomy Laboratory Web site. In addition, the TPPN data stream is provided to the meteorological community for forecasting purposes. The communication of TPPN station data from the Pacific basin is accomplished primarily through the Geostationary Operational Environmental Satellite (GOES) system.

Properly coded and authorized data are also sent to the National Weather Service (NWS) Gateway for placement on the Global Telecommunication System. More detailed observations are recorded at each TPPN site to support tropical dynamics and climate research. These observations are recorded on removable media and sent back by mail to the Aeronomy Laboratory for post processing. The Aeronomy Laboratory maintains an archive of historical profiler observations from the TPPN.

B.2.5 FORECAST SYSTEMS LABORATORY (FSL)

The Forecast Systems Laboratory (FSL) operates and maintains the NOAA Profiler Network comprising 32 tropospheric wind profilers located in the central U.S. The profilers are upward looking, sensitive Doppler radars working in the 400 MHz frequency range that measure the vertical profile of winds up to 16 km above the profiler site. Hourly average wind data are provided to operational NWS forecast offices and both hourly and six-minute data are made available to researchers. FSL operates an automated surface observation station measuring wind speed and direction, temperature, relative humidity, and barometric pressure.



Instruments are loaded onboard a high-altitude research aircraft to study the ozone layer.



A research balloon is launched to study the Antarctic ozone hole.

B.2.6 CLIMATE MONITORING AND DIAGNOSTICS LABORATORY (CMDL)

The Climate Monitoring and Diagnostics Laboratory (CMDL) collects *in situ* samples from a large variety of sources at numerous locations around the world and generates data from the analyses of air and aerosol samples collected at these and other global sites. The remote sites include manned stations at Barrow, Alaska; Mauna Loa, Hawaii; American Samoa; South Pole; Bondville, Illinois; Lamont, Oklahoma; and automated solar radiation measurement sites at Nome and Saint Paul Island, Alaska; Bermuda; and Kwajalein Island. In addition, weekly flask samples of air collected from 45 sites around Earth are analyzed for up to 25 trace gas species at the Boulder laboratories.

Daily ozone column measurements are conducted through cooperative programs at 11 locations in the United States ranging from Hanford, California, to Wallops Island, Virginia, and at 11 international locations ranging from Greenland to New Zealand. Other data are collected from weekly aircraft profile flights flying from locations in Alaska, Hawaii, Colorado, and the Cook Islands, among others. Finally, periodic field programs using instruments carried aloft by high altitude balloons or flown on aircraft (such as the NOAA WP-3, NASA ER-2, and NCAR C-130) generate large amounts of data over relatively short periods of time. In total, CMDL collects data on approximately 380 different scientific items of environmental interest from stations and locations in 20 States and 37 countries, plus Antarctica and occasionally the north polar cap.

Data collected vary in format and quantity from a single data point per week up to huge electronic data files of hundreds of megabits per hour (from gas chromatographs and lidars). Some data are collected on paper traces (now rare), and some on high-density optical disks. Each measurement system has its own particular format, method of data transfer, and manner of archiving. Raw data collected by CMDL dating back to the 1970s are stored on several tape mediums including 3890, 8mm, 4mm, and high density tapes.

Generally, data are collected digitally and integrated into the CMDL data system, where they are edited and processed. The final archive for processed data sets may be outside of NOAA. For example, ozone data are archived at the World Meteorological Organization Ozone World Data Center in Downsview, Canada.



B.2.7 NATIONAL SEVERE STORMS LABORATORY (NSSL)

The National Severe Storms Laboratory (NSSL) is one of NOAA's internationally known research laboratories, leading the way in investigations of all aspects of severe weather. NSSL is headquartered in Norman, Oklahoma, with staff in Colorado, Nevada, Washington, Utah, and Wisconsin. In its partnership with the National Weather Service, NSSL is dedicated to improving severe weather warnings and forecasts in order to save lives and reduce property damage.

The goal of NSSL research is the advance the understanding of weather processes, improve forecasting and warning techniques, and develop operational applications. NSSL transfers this new knowledge to the National Weather Service and other public and private sector agencies.

NSSL archives data collected during numerous field programs. The data archived includes special upper-air soundings, mobile mesonet observations, and electric field meter observations. Many data sets are available on the Internet through NSSL's data cataloging and delivery system.

Other data used at NSSL are obtained from third parties, primarily NCEP and the co-located Storm Prediction Center (SPC), or obtained from NOAA's National Climatic Data Center (NCDC). Archives of these data sets are maintained for the convenience of NSSL and SPC researchers, and are generally available to users outside NSSL directly from the primary archive agency.