MAUNA LOA OBSERVATORY

40th Anniversary Commemoration
and
Dedication of the NDSC Building

November 1997

"Where it all began"

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Climate Monitoring and Diagnostics Laboratory

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Mission Statements

MLO

The Mauna Loa Observatory (MLO) is an atmospheric baseline station of the Climate Monitoring and Diagnostics Laboratory (CMDL) of the National Oceanic and Atmospheric Administration (NOAA). The mission of CMDL is to measure atmospheric constituents that are capable of forcing change in the climate of the earth and those that may deplete the ozone layer. CMDL accomplishes this goal primarily through long-term tropospheric measurements of key atmospheric parameters such as CO_2, CO, CH_4, CFCs, O_3, SO_2, N_2O, radon, aerosols, optical depth, and a spectrum of solar radiation parameters.

NDSC

MLO is a primary observing site for the Network for the Detection of Stratospheric Change (NDSC). NDSC, an international activity involving scientists from around the world, is endorsed by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO). The goal of NDSC is to obtain a broad range of measurements of stratospheric chemical species and related parameters to provide the basis for the earliest possible identification of long-term changes in the stratospheric ozone layer. Most of these measurements are conducted with lidar, microwave, Fourier Transfer Infrared Radiometers (FTIRs), and solar-viewing instrumentation.

Mauna Loa Observatory

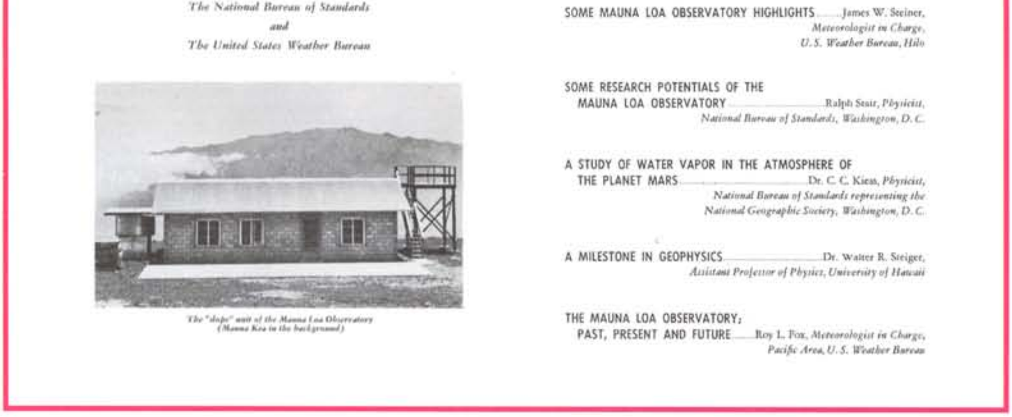
This brochure serves to commemorate the 40th anniversary of atmospheric baseline measurements at the Mauna Loa "slope" building, and to celebrate the dedication of the NDSC building. Included in this brochure are the CMDL/MLO and NDSC mission statements, a chronological history of MLO, photos and information from the original dedication, photos of the new NDSC building, some long-term data records, and a list of the current programs at the facility. MLO's slope building was constructed in 1956, and MLO attained full operational status during the International Geophysical Year (IGY) of 1957 and began continuous atmospheric carbon dioxide (CO_2) measurements in 1958. A broad history of MLO is available on the MLO web page. Of particular note is the history of the early days of MLO by Howard Ellis, the 20th anniversary report by John Miller, and the 30-year reminiscence of Judy Pereira. A CD containing historic MLO data sets in a format easily accessible for common plotting programs is included in this brochure. Continuations of these data sets for the coming years will be available for downloading through the MLO web site.

View of the MLO site from the meteorological tower, with the new NDSC building under final construction in the right foreground.

MLO Milestones

1840	Lt. Wilkes, USN, U.S. Exploring Expedition, measures trade wind inversion while climbing to the top of Mauna Loa Volcano.
1940–1944	Tom Vance, school teacher, convinces Ingram Stainback, local attorney, of the merits of a road to the top of Mauna Loa. Mr. Vance wanted to build a ski hill on the volcano and envisioned a two-lane road with a planted median of exotic plants.
1948	Mr. Stainback is now Governor, Territory of Hawaii, and Mr. Vance is Director of Institutions. Mr. Vance contacts Dr. Robert Simpson, U.S. Weather Bureau. They meet in the Governor's office, and Simpson is sold on the idea of making weather observations on the top of Mauna Loa.
1949–1951	The road from Kulani prison to the top of Mauna Loa is constructed using borrowed equipment and prison labor (the Vance connection). Regular weather observations are made at a number of fixed sites along the road now officially named the Stainback Highway.
1951	A small "summit" building is constructed with funds from the U.S. Weather Bureau, and automated weather observations are initiated. Charts are changed weekly by U.S. Weather Bureau crews from Hilo.
1953	Summit observatory measurements are terminated due to road deterioration and crew fatigue (end of year).
1955	Dr. Simpson, USWB, meets Dr. Ralph Stair, NBS, who needs a dust- and cloud-free location to conduct radiation measurements. He is introduced to the idea of measuring at MLO. In December the present MLO site is selected and title to the land received from the Governor 30 days later.
1956	The present MLO building is constructed.
1957	Programs at MLO are increased for the IGY, including establishment of total column ozone measurements.
1958	Continuous CO_2 measurements are initiated at MLO by Charles D. Keeling, Scripps Institution of Oceanography.
1959	White dog appears at MLO (see "According to Hawaiian Legend ..."); Kilauea Iki erupts 2 months later. MLO solar radiation program begins.
1963–1964	Government cutbacks reduce MLO staff from 13 to 3, and discussions are held about shutting MLO down. Dobson spectrophotometer ozone measurements begin.
1965	High Altitude Observatory (HAO) establishes a solar coronascope on the MLO site.
1967	Funding outlook for MLO improves. Commercial power is brought to MLO.
1973	Ruby lidar measurements of stratospheric aerosols and surface ozone measurements begin.
1974	NOAA continuous CO_2 measurements begin at MLO.

1983	MLO receives a special award from the American Meteorological Society for long-term atmospheric measurements related to better understanding of climate variability.
1986	MLO designated a primary site of the newly conceived "Network for the Detection of Stratospheric Change" (NDSC).
1987	Continuous chlorofluorocarbon measurements begin at MLO.
1988	Continuous SO_2 and N_2O measurements are initiated.
1991	University of Denver FTIR is installed, the first non-NOAA NDSC instrument.
1992	Fiber optic LAN is installed at MLO and Hilo offices, and is connected to the Internet.
1993	The NASA/JPL NDSC ozone and temperature lidars are installed at MLO.
1994	A new NOAA/CMDL Nd:YAG aerosol and temperature lidar begins operation at MLO.
1994–1996	The balance of the NDSC instruments are installed at MLO, including microwave ozone, water vapor, spectral UV, and NO_2 instrumentation.
1997	NDSC building is constructed and opened at MLO.
1997	Original MLO building renamed the "Keeling Building" in honor of Charles D. Keeling and his pioneering research into the global CO_2 cycle.



DEDICATION

of the "slope" building

MAUNA LOA OBSERVATORY

Thursday, June 28, 1956

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Jointly sponsored by
The National Bureau of Standards
and
The United States Weather Bureau

The "slope" unit of the Mauna Loa Observatory
(Mauna Kea in the background)

PROGRAM

MASTER OF CEREMONIES
Joel B. Cox, *President,*
Geophysical Society of Hawaii

INVOCATION……Rev. Abraham K. Akaka, *Minister, Haili Church, Hilo*

INTRODUCTORY REMARKS……The Honorable Samuel Wilder King, *Governor of Hawaii*

SOME MAUNA LOA OBSERVATORY HIGHLIGHTS……James W. Steiner, *Meteorologist in Charge, U.S. Weather Bureau, Hilo*

SOME RESEARCH POTENTIALS OF THE MAUNA LOA OBSERVATORY……Ralph Stair, *Physicist, National Bureau of Standards, Washington, D.C.*

A STUDY OF WATER VAPOR IN THE ATMOSPHERE OF THE PLANET MARS……Dr. C. C. Kiess, *Physicist, National Bureau of Standards representing the National Geographic Society, Washington, D.C.*

A MILESTONE IN GEOPHYSICS……Dr. Walter R. Steiger, *Assistant Professor of Physics, University of Hawaii*

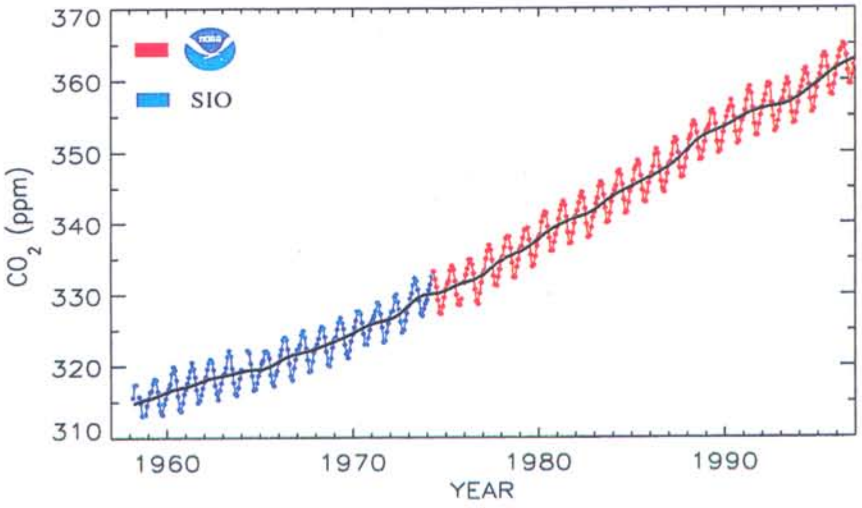
THE MAUNA LOA OBSERVATORY; PAST, PRESENT AND FUTURE……Roy L. Fox, *Meteorologist in Charge, Pacific Area, U.S. Weather Bureau*

Program for the 1956 dedication of the "slope" building.

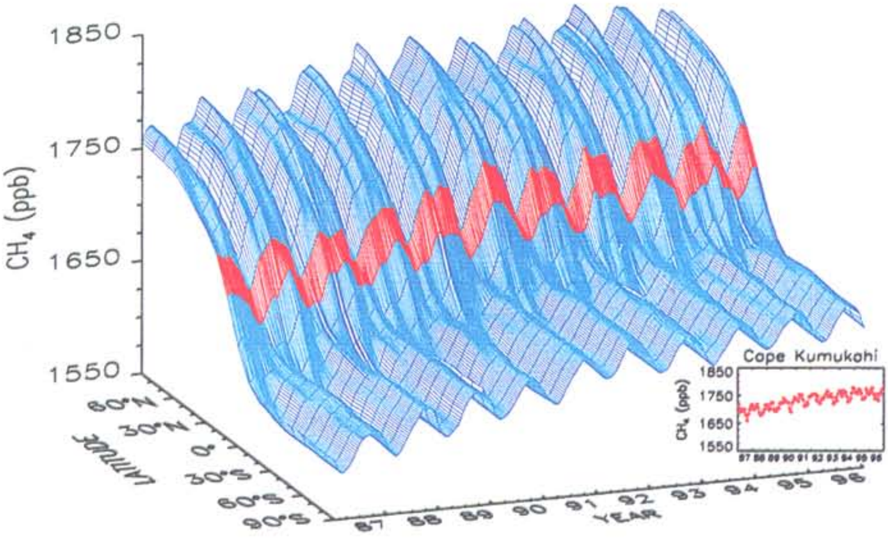
1951. The first Mauna Loa Observatory ("summit" building) was built on the rim of Mokuaweaweo caldera at 4100 m (13,453 ft) and dedicated (top and bottom photos) by Oren Long, Governor of the Territory of Hawaii, and by the Assistant Secretary of Commerce for Science and Technology, on December 12, 1951. The dedication was followed by an outdoor beef barbecue around a large bonfire in temperatures of -5.6°C (22°F) in snow squalls. Automatic weather recording instruments were operated at this site and serviced weekly until the end of 1953 when deterioration of the road forced the closure of the station. Cost of the summit building: $500.

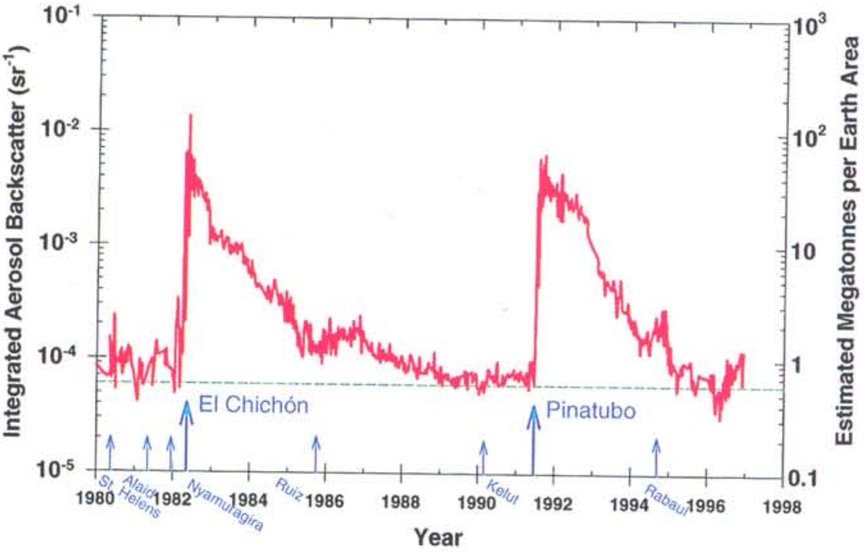
1956. A cinder block building was built on a concrete pad at 3396 m (11,140 ft) at the end of the "good" portion of the road to the summit and dedicated on June 28, 1956, as the Mauna Loa "slope" building by Samuel Wilder King, Governor of Hawaii. Note the more auspicious weather for the 1956 dedication (top) afforded by both the season and the elevation, and the fresh baked buns and the home preserves for the dedication day luncheon (bottom). The slope building was equipped with a variety of meteorological and atmospheric instrumentation attended to by a growing permanent staff in preparation for the 1957 IGY. Cost of the slope building including water system, heating, outdoor toilet, kitchen, bedroom, and all furnishings: $25,000.

1997. The top photo shows the modular NDSC building being constructed in a factory in Oregon, and the bottom photo shows one of seven units being inserted on its foundation at the MLO site. Cost of the NDSC building and installation: $1.6 million.

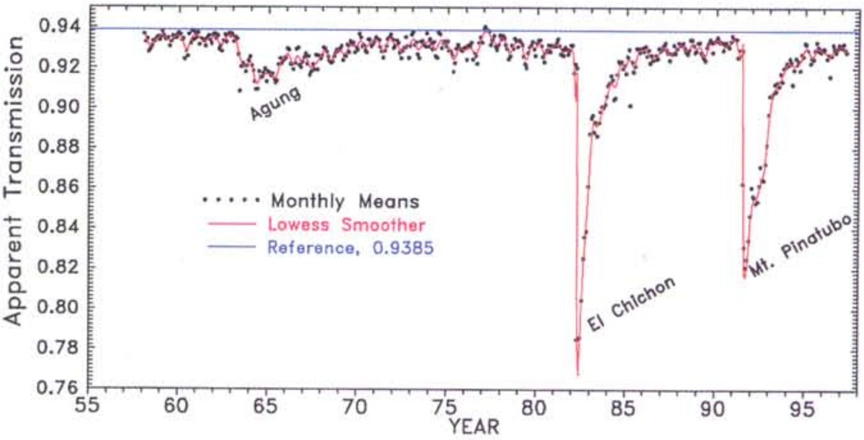


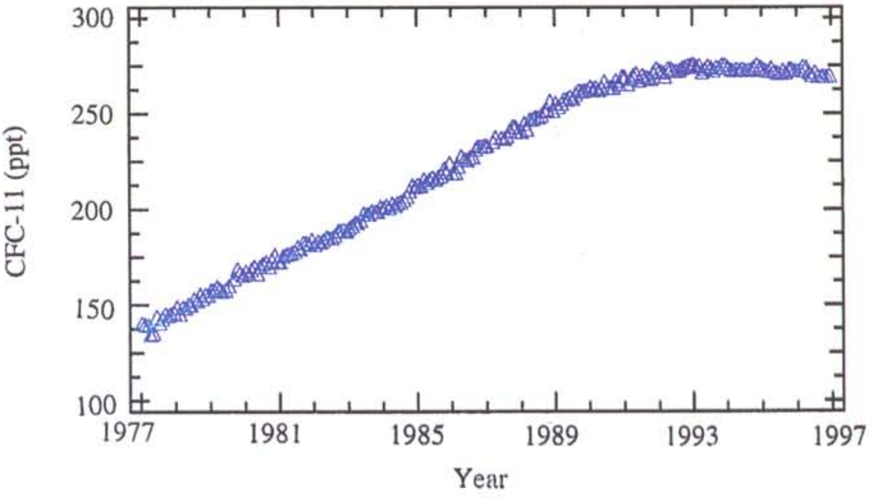
The upper graph is the continuous record of monthly-mean, global atmospheric CO_2 concentrations measured at MLO. Data prior to May 1974 are from the program initiated in 1958 by Charles D. Keeling, Scripps Institution of Oceanography. The annual spingtime drawdown in CO_2 concentration is apparent in the figure. The lower graph is a three-dimensional representation of the latitudinal distribution of atmospheric methane (CH_4) in the marine boundary layer. Data from the CMDL cooperative air sampling network were used. The surface represents data smoothed in time and latitude. The contribution from the CMDL MLO flask sampling effort at Cape Kumukahi is shown inset as flask monthly means. The 10° latitude zone in which Cape Kumukahi resides is highlighted.



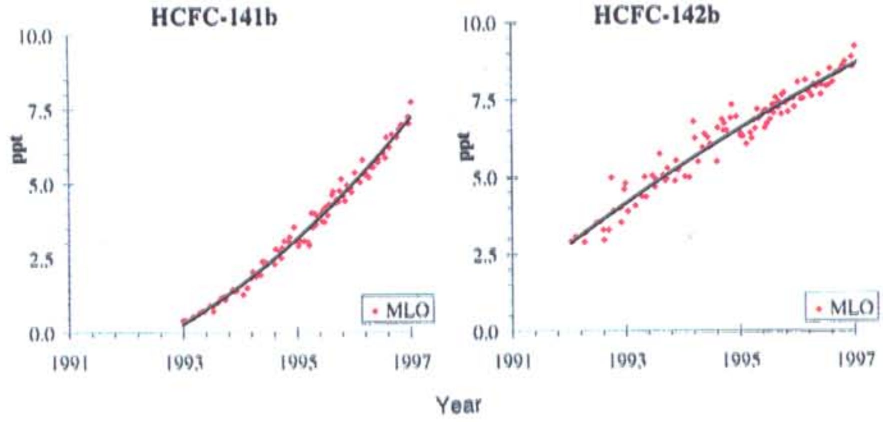


The ruby lidar (laser radar), operated at MLO since 1975, measures backscatter from volcano particles and other aerosols high in the atmosphere (15.8-33 km), as shown in the upper graph (left scale). The right scale indicates the estimated mass of aerosols in that region above the earth. The volcanic particles are composed mainly of water and sulfuric acid and persist for up to a decade following major eruptions such as occurred in 1982 and 1991. These particles influence the ozone layer, and as illustrated in the graph below of apparent solar transmission, reduce the amount of sunlight reaching the earth.





The leveling of atmospheric chlorofluorocarbon (CFC) concentrations at MLO in the early 1990s and a decrease in 1996 in response to the Montreal Protocol (1987) is presented in the upper graph of monthly-mean CFC concentrations. As CFCs are phased out, replacements that are less harmful to the atmosphere (such as HCFC-141b and HCFC-142b) are being produced. These subsequent leak into the atmosphere, as shown below.



CMDL and Cooperative Measurement Programs at MLO in 1997

Program	Instrument	Sampling Frequency
Gases		
CO_2	Siemens Ultramat-3 IR analyzer	Continuous
	0.5-L glass flasks, through analyzer	1 pair wk^{-1}
CO	Trace Analytical RGA3 reduction gas analyzer no. R5	Continuous
CO_2, CH_4, CO, ^{13}C, ^{18}O of CO_2	2.5-L glass flasks, MAKS pump unit	1 pair wk^{-1}
	3-L evacuated glass flasks	1 pair wk^{-1}
CH_4	HP6890 GC	Continuous
	AIRKIT pump unit, 2.5-L glass flasks	1 pair wk^{-1}
SO_2	TECO model 435 pulsed-fluorescence analyzer	Continuous
Surface O_3	Dasibi ozone meter	Continuous
Total O_3	Dobson spectrophotometer no. 76	3 day^{-1}, weekdays
O_3 profiles	Dobson spectrophotometer no. 76	2 day^{-1}
	Balloonborne ECC sonde	1 wk^{-1}
N_2O, CFC-11, CFC-12, CFC-113, CH_3CCl_3, CCl_4	300-mL stainless steel flasks	1 sample wk^{-1}
N_2O, CFC-11, CFC-12, CFC-113, CH_3CCl_3, CCl_4, SF_6, HCFC-22, HCFC-141b, HCFC-142b, CH_3Br, CH_3Cl, CH_2Cl_2, $CHCl_3$, C_2HCl_3, C_2Cl_4, H-1301, H-1211, H-2402, HFC-134a	850-mL stainless steel flasks	1 sample wk^{-1}
CFC-11, CFC-12, CFC-113, N_2O, CCl_4, CH_3CCl_3	HP5890 automated GC	1 sample h^{-1}
N_2O	Shimadzu automated GC	1 sample h^{-1}
Radon	Two-filter system	Continuous integrated 30-min samples
Aerosols		
Condensation nuclei	Pollak CNC	1 day^{-1}
	TSI CNC	Continuous
Optical properties	Four-wavelength nephelometer: 450, 550, 700, 850 nm	Continuous
	Three-wavelength nephelometer: 450, 550, 700 nm	Continuous
Aerosol light absorption (black carbon)	Aethalometer	Continuous
Stratospheric and upper tropospheric aerosols	Lidar: 694.3 nm, 532 nm	1 profile wk^{-1}
Solar Radiation		
Global irradiance	Eppley pyranometers with Q, OG1, and RG8 filters	Continuous
Direct irradiance	Eppley pyrheliometer with Q filter	Continuous
	Eppley pyrheliometer with RG8 filter	
	Eppley pyrheliometer with Q, OG1, RG2, and RG8 filters	3 day^{-1}
	Eppley/Kendall active cavity radiometer	1 mo^{-1}
Diffuse irradiance	Eppley pyrgeometer with shading disk and Q filter	Continuous

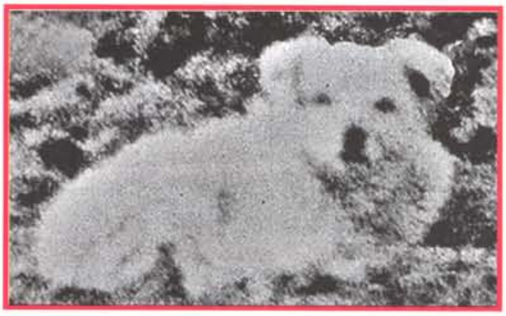
Program	Instrument	Sampling Frequency
***Solar Radiation** — continued*		
UV solar radiation	Yankee Environmental UVB pyranometer	Continuous
Terrestrial (IR) radiation	Global downwelling IR pyrgeometer	Continuous
Turbidity	J-202 and J-314 sunphotometers with 380-, 500-, 778-, 862-nm filters	3 day^{-1}, weekdays
	PMOD three-wavelength sunphotometer: 380, 500, 778 nm; narrowband	Continuous
Column water vapor	Two-wavelength tracking sunphotometer: 860, 940 nm	Continuous
Meteorology		
Air temperature	Aspirated thermistor, at 2, 9, 37 m	Continuous
	Max.-min. thermometers, at 2 m	1 day^{-1}
Air temperature (30-70 km)	Lidar	1 profile wk^{-1}
Temperature gradient	Aspirated thermistors, at 2, 9, 37 m	Continuous
Dewpoint temperature	Dewpoint hygrometer, at 2 m	Continuous
Relative humidity	TSL, at 2 m	Continuous
Pressure	Capacitance transducer	Continuous
	Mercurial barometer	5 wk^{-1}
Wind (speed and direction)	Std. instruments, at 8.5, 10, 38 m	Continuous
Precipitation	Rain gauge, 20-cm	5 wk^{-1}
	Rain gauge, 20-cm	1 wk^{-1}
	Rain gauge, tipping bucket	Continuous
Total precipitable water	Foskett IR hygrometer	Continuous
Precipitation Chemistry		
pH	pH meter	wk^{-1}
Conductivity	Conductivity bridge	wk^{-1}
Cooperative Programs		
CO_2 (SIO)	Applied Physics IR analyzer	Continuous
CO_2, ^{13}C, N_2O (SIO)	5-L evacuated glass flasks	1 pair wk^{-1}
CO_2, CO, CH_4, $^{13}C/^{12}C$ (CSIRO)	Pressurized glass flask sample	1 mo^{-1}
CH_4, CH_3CCl_3, CH_3Cl, F-22, F-12, F-11, F-113, CO, CO_2, N_2O, $CHCl_3$, CCl_4 (OGIST)	Pressurized stainless steel flasks	3 wk^{-1}
O_2 analyses (SIO)	5-L glass flasks through tower line	3 (2 mo)$^{-1}$
O_2 analyses (URI)	3-L glass flasks through tower line	2 (2 mo)$^{-1}$
CH_4 ($^{13}C/^{12}C$) (Univ. of Washington)	35-L evacuated flask	2 mo^{-1}
Total suspended particulates (DOE)	High-volume sampler	Continuous, (1 filter wk^{-1})
Precipitation collection (DOE)	Exposed collection pails	Integrated monthly
Aerosol chemistry (Univ. of Calif.-Davis)	Programmed filter sampler	Integrated 3-day
Sulfate, nitrate, aerosols (Univ. of Hawaii)	Filter system	Daily, 2000-0600 LST
Radon (ANSTO)	Aerosol scavenging of Rn daughters	Continuous
GPS corrections (Stanford Univ. and FAA)	Dual-frequency GPS, meteorology	Continuous
UV-B (Colorado State Univ.)	Multiwavelength shadow radiometer	Daily
Optical depth (NASA)	AERONET sunphotometers	Daily

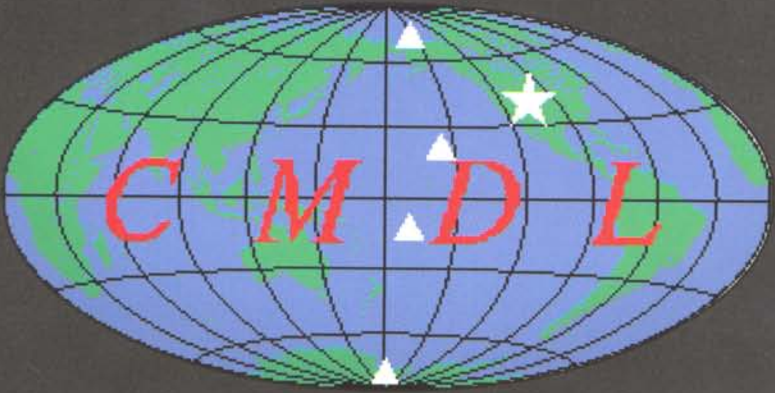
NDSC Measurement Programs at MLO in 1997

Program	Instrument	Sampling Frequency
Ultraviolet radiation (spectral) (NIWA, New Zealand, and NOAA)	UV spectrometer (290-450 nm), 1-nm resolution	Continuous
Stratospheric ozone profile, 20-70 km (Univ. of Mass.)	Microwave spectroscopy, Millitech Corp, 110.8 GHz	3 profiles h^{-1}
Stratospheric ozone profiles, 15-55 km; temperature, 20-75 km; aerosol profiles, 15-40 km (JPL/NASA)	UV lidar	3-4 profiles wk^{-1}
Solar spectra (Univ. of Denver)	FTIR spectrometer, automated	5 wk^{-1}
Stratospheric water vapor profiles, 40-80 km, 10-15 km resolution (Naval Research Laboratory)	Microwave spectroscopy	Continuous
UV/visible radiation (NIWA and NOAA)	Slant column NO_2	Continuous, day
Ozone (NOAA)	Balloonborne EEC ozonesondes	1 wk^{-1}
Total ozone (NOAA)	Dobson spectrophotometer	3 day^{-1}, weekdays
Stratospheric aerosols, stratospheric temperatures (NOAA)	Ruby and Nd:YAG lidars	1 wk^{-1}
O_3, UV (AES Canada)	Brewer spectrophotometer	Daily

According to Hawaiian Legend ...

Pele, the fiery goddess of the volcanoes in Hawaii, would send her white dog as a messenger to alert the people whenever an eruption was imminent. A white dog (below) was first noticed by the MLO staff during the latter part of 1959 about 2 km below the observatory. At that time, the staff lived at the site for up to a week on rotating shifts. Because of this housekeeping, a rubbish dump soon developed to the west of the observatory. The contention of the staff was that the stray dog had discovered the dump and foraged there for food. Attempts to befriend or capture this mysterious dog, no matter how persistent, failed. The dog for some reason would have nothing to do with the observatory staff. In December 1959, Kilauea Iki erupted and the dog disappeared. The dog reappeared at the observatory several months later and again was spotted periodically for a month or so and then disappeared again. This pattern of appearances and disappearances continued until 1966. Since then, no one has seen this mysterious white dog.





DEPARTMENT OF COMMERCE
UNITED STATES OF AMERICA

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