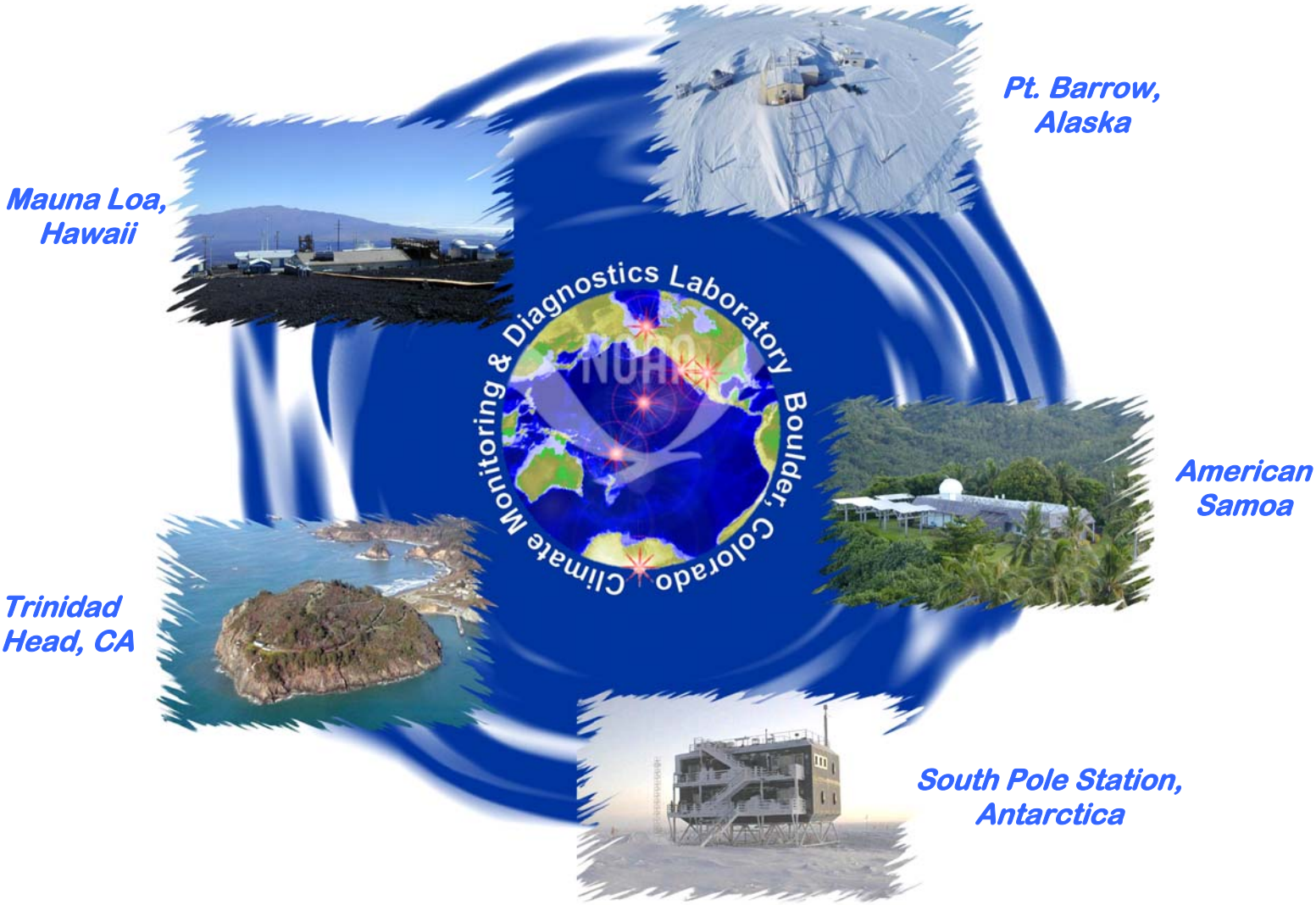
Climate Monitoring & Diagnostics Laboratory

-Keeping track of things that affect climate, the ozone layer and baseline air quality

CMDL Baseline Observatories

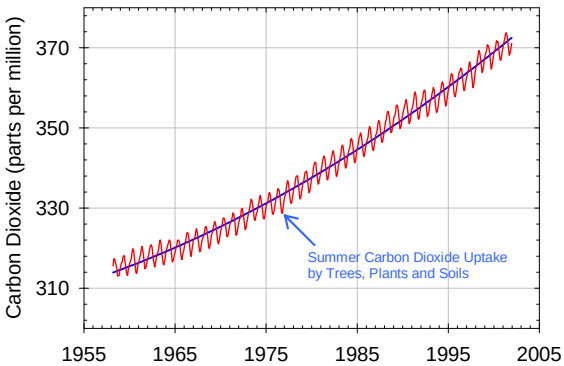


Mission: **To acquire, evaluate, and make available, accurate, long-term, continuous records of atmospheric gases, aerosol particles and solar radiation which affect *climate, the ozone layer and air quality,* in time and spatial scales that allow causes of change to be understood.**

CLIMATE MONITORING & DIAGNOSTICS LABORATORY RESEARCH GROUPS

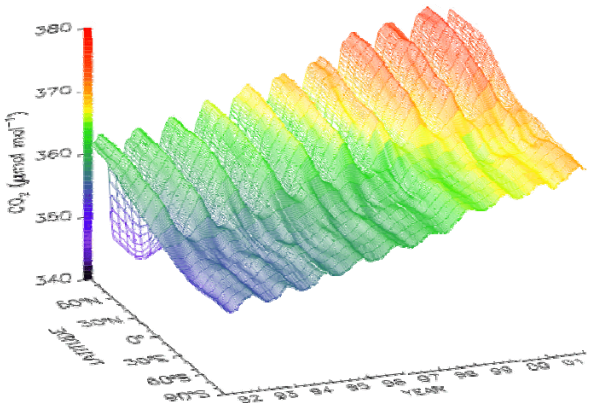
- Aerosols and Radiation
- Carbon Cycle and Greenhouse Gases
- Halocarbons and Other Trace Species
- Ozone and Water Vapor
- Observatory Operations

OUR BREATHING PLANET

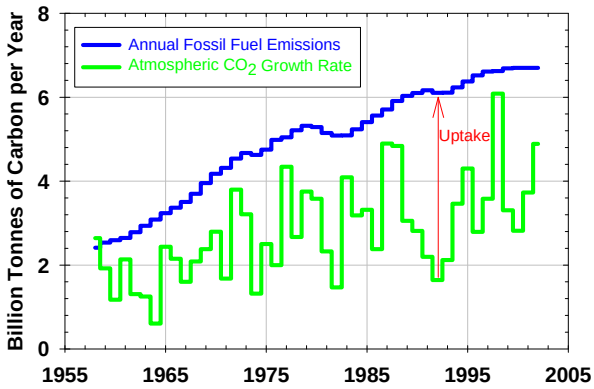


Carbon dioxide measurements at Mauna Loa Observatory since observations began in 1957. Note the uptake of carbon dioxide related to the terrestrial biosphere during the Northern Hemisphere summer.

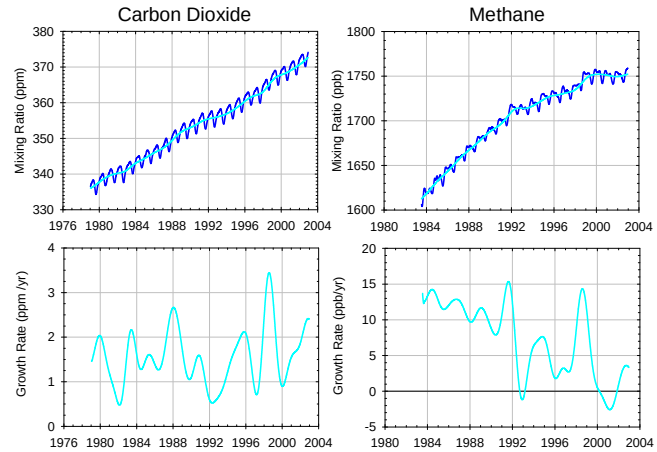
THE FLYING CO_2 CARPET



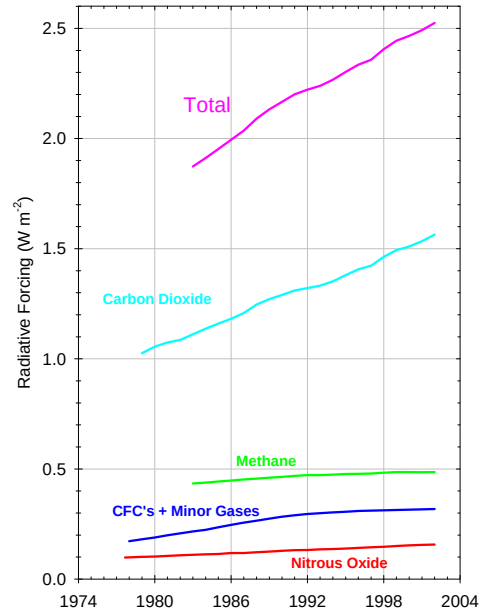
Carbon dioxide mixing ratio as a function of latitude and time since 1992 from the global sampling network.



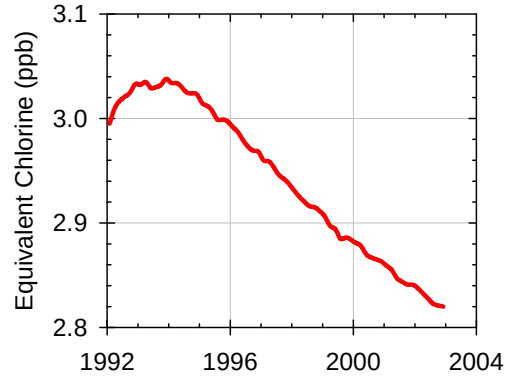
Global carbon emissions from fossil fuel burning and the annual increase in atmospheric carbon from carbon dioxide increases. The difference between the two curves gives the annual uptake of carbon by the oceans and terrestrial biosphere.



Global average carbon dioxide and methane mixing ratios and growth rates since about 1980.



Direct radiative climate forcing of four major classes of long-lived greenhouse gases measured by CMDL.



Declining total ozone-destroying potential of atmospheric halogens in terms of equivalent amounts of chlorine.

DETERMINING NORTH AMERICAN CARBON DIOXIDE SOURCES & UPTAKE

An average of 16 inverse transport models, using the CMDL- produced carbon dioxide data set, found the North American carbon sink to be 0.9 ± 0.6 billion tons of carbon per year for the 1992-1996 period (Gurney et al., *Nature, 415*, 626, 2002). Data are too sparse and inverse models are too limited in their ability to accurately represent boundary layer phenomena to improve on these model estimates. There are inadequate atmospheric data on or near the coasts of the U.S. to accurately determine the country's carbon dioxide uptake as a whole, and almost no data exist interior to the U.S. for regional carbon net source/sink assessments.

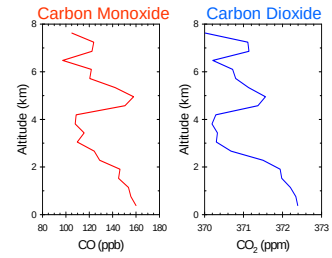
CARBON DIOXIDE MEASUREMENTS ON LAND

Problem: **Measurements of carbon dioxide at the land surface are complicated by photosynthesis and respiratory processes of vegetation and soils, and by atmospheric turbulence (day to night variations).**

Solution: **To obtain data representative of regional sources and sinks, the "fetch" (surface area coverage) of the measurements must be increased by obtaining data through and above the atmospheric boundary layer. This can be done by obtaining air samples at several altitudes from aircraft and tall communications towers.**

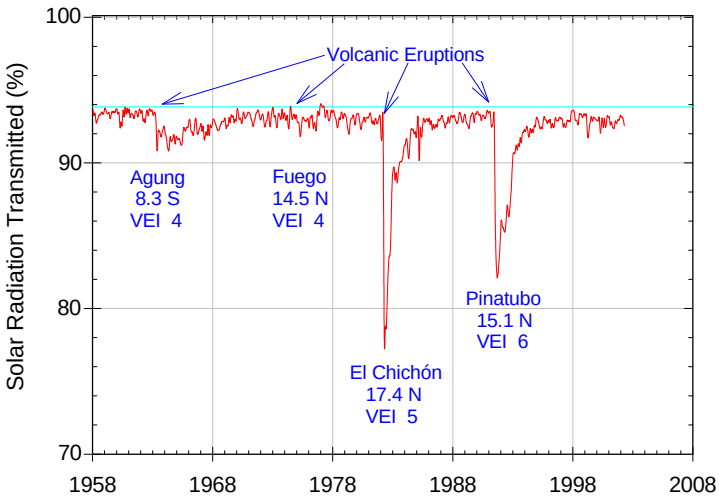
Aircraft Sampler

The vertical profiles of carbon dioxide, carbon monoxide, and methane are being measured at five aircraft and two tall tower sites in a pilot program. The expansion of this network has begun and when complete, will provide regional information on carbon dioxide sources and uptake in North America.



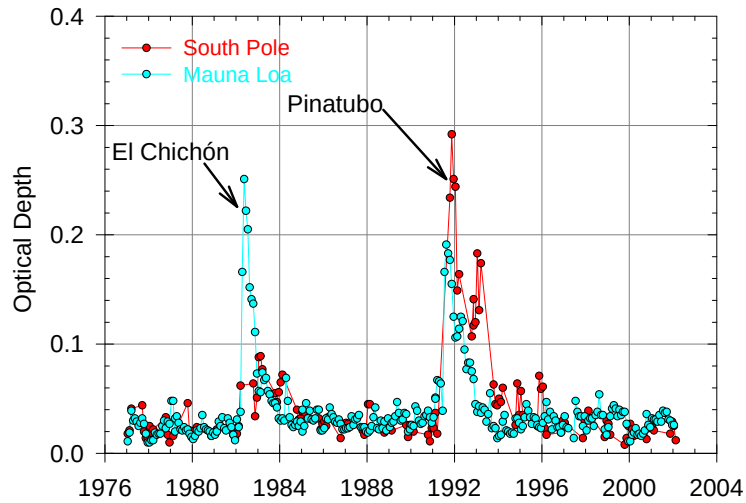
500 m Towers

SOLAR RADIATION ATMOSPHERIC TRANSMISSION



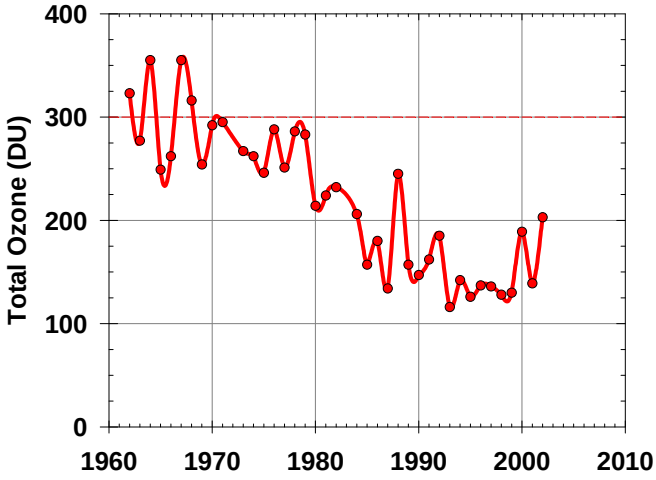
Broadband visible solar radiation transmission through the atmosphere at Mauna Loa Observatory since 1958.

AEROSOL OPTICAL DEPTH



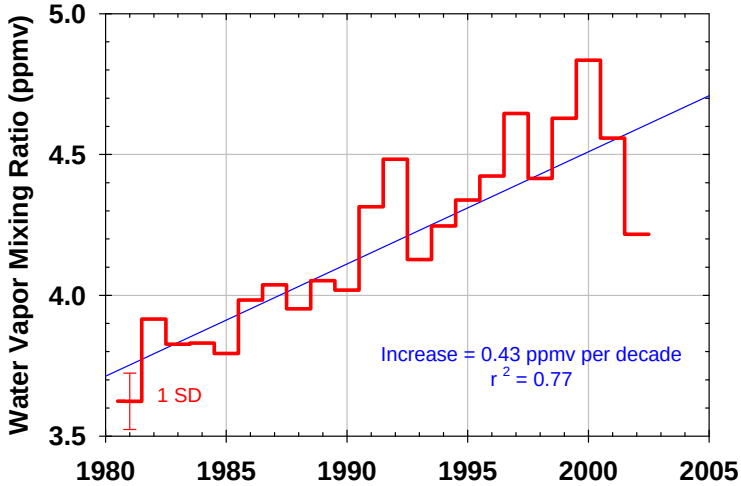
Aerosol optical depth measured at Mauna Loa Observatory and at the South Pole with pyrheliometers.

THE ANTARCTIC OZONE HOLE

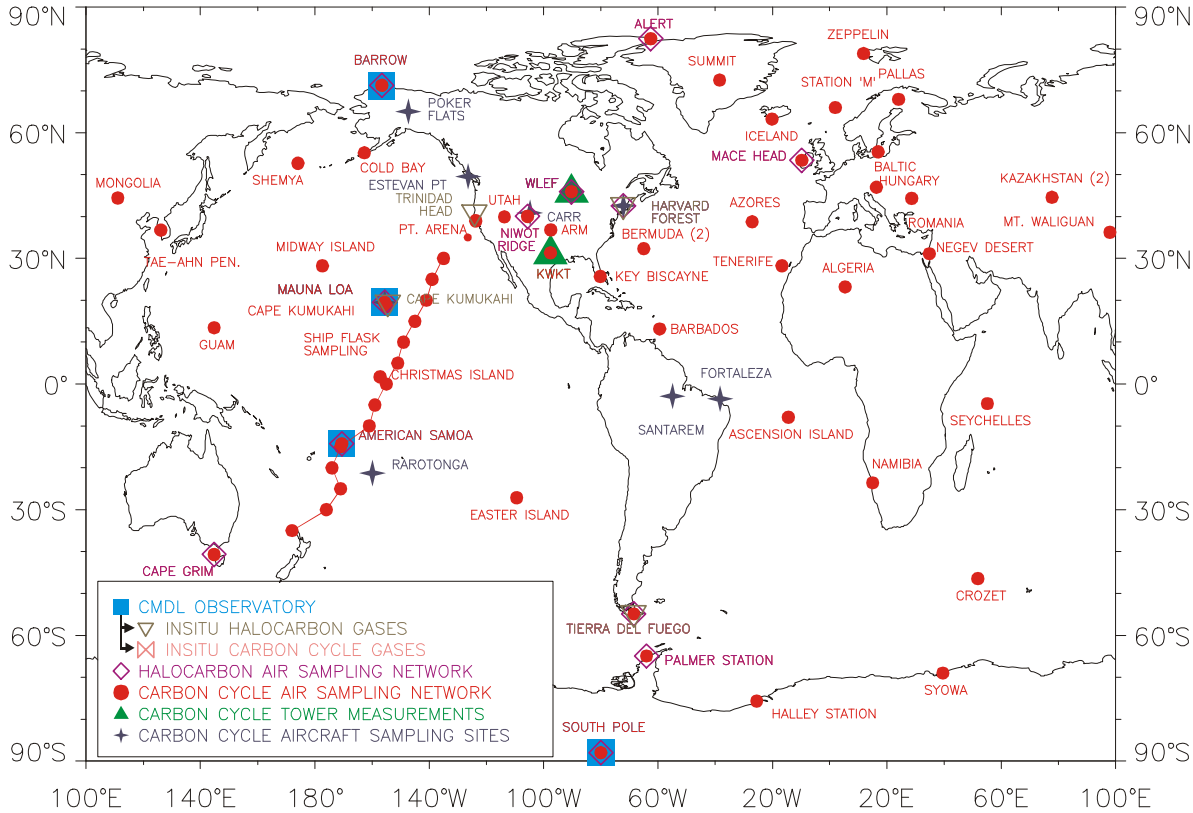


Total column ozone at the South Pole Station following springtime sunrise during the early October period showing the loss of over half of the ozone since about 1970.

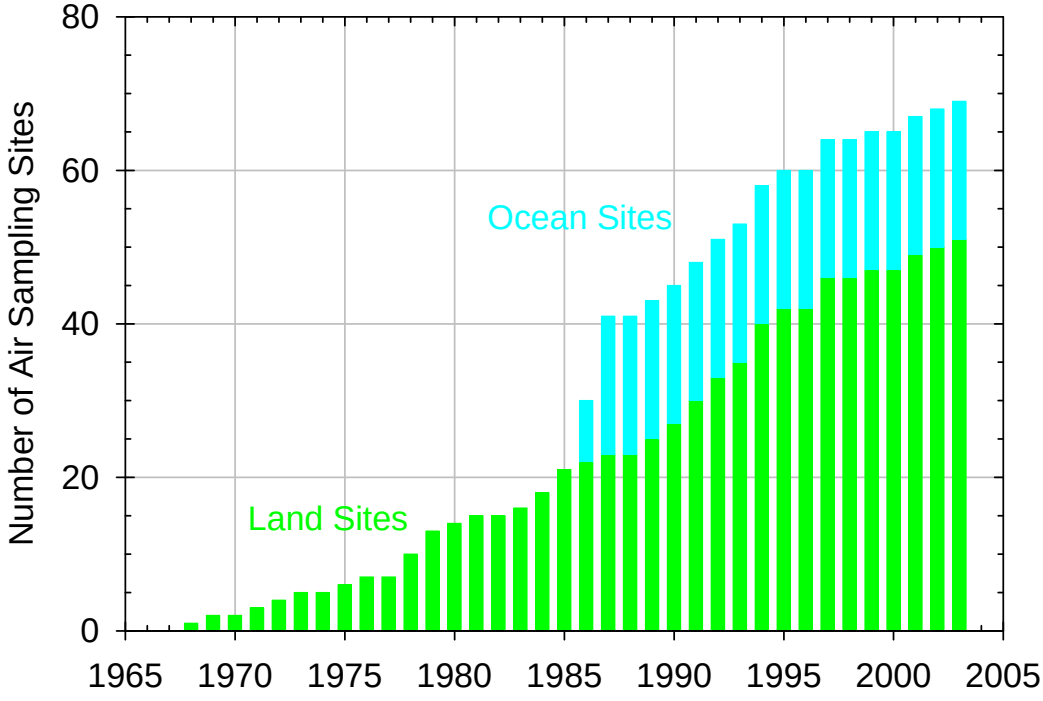
STRATOSPHERIC (18-22 KM) WATER VAPOR



Stratospheric water vapor measured at Boulder, Colorado with a balloonborne frost-point hygrometer since 1980 showing the increase over this period.



The current global network for carbon cycle and halocarbon gas monitoring with continuous measurements at the Observatories and tall towers and weekly flask samples from surface air sampling network and aircraft sites.



Growth in the number of cooperative carbon dioxide sampling sites in CMDL's network throughout the world.