5. Halocarbons and Other Atmospheric Trace Species

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5.1. CONTINUING PROGRAMS

5.1.1. INTRODUCTION

The mission of the Halocarbons and other Atmospheric Trace Species (HATS) group, formerly known as the Nitrous Oxide and Halocarbons (NOAH) group, is to study trace atmospheric species that cause chemical and radiative change in the atmosphere. The goal of the HATS group is to measure and interpret the distributions and trends of many halocarbons, nitrous oxide (N_2O), sulfur hexafluoride (SF_6), fluorocarbons, perfluorocarbons (PFCs), organic nitrates (e.g., peroxyacetyl nitrate (PAN)), organic sulfur gases (e.g., OCS), and hydrocarbons (HCs) in the troposphere, stratosphere, and oceans with the best analytical tools available. The halocarbons include the chlorofluorocarbons (CFCs), chlorocarbons (CCs like CCl_4, CH_3CCl_3, $CHCl_3$, CH_2Cl_2, C_2Cl_4, etc.), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), methyl halides (CH_3Br, CH_3Cl, CH_3I), bromocarbons (CH_2Br_2, $CHBr_3$), and halons.

These trace gases affect the quality of the Earth's atmosphere. All of these trace gases, except the HCs and organic nitrates, produce direct climate forcing on the Earth's atmosphere. Many of these chemicals, including the halocarbons and N_2O, are involved in stratospheric ozone depletion. The production of some of these compounds is currently restricted for the developed countries by the Montreal Protocol and its amendments [*UNEP*, 1987]. The hydrocarbons, some sulfur gases, organic nitrates, and CCs play a major role in tropospheric air quality. Recent changes to the U.S. Clean Air Act now restrict the emissions of some CCs and HCs by certain industries and manufacturing processes.

Activities conducted by HATS in 1998 and 1999 included: (1) weekly flask sampling and analysis of air from remote and semi-remote sites, (2) operation of instrumentation for hourly, in situ measurements of trace gases at the four CMDL baseline observatories and four non-baseline sites, (3) preparation and maintenance of trace gas standards, (4) participation on airborne campaigns using in situ gas chromatographs (GCs) on aircraft and balloon payloads, and (5) investigation of oceanic processes influencing trace gas composition of the atmosphere.

Continuing programs within the group are based upon in situ and flask measurements of the atmosphere from the four CMDL baseline observatories and ten cooperative stations (Figure 5.1). Table 5.1 lists the geographic locations and other useful information on all of the sites. There are currently 13 flask sites and 10 in situ sampling sites in the HATS Atmospheric Sampling Network. Flask samples and in situ trace gas measurements obtained in cooperation with the CMDL Carbon Cycle Greenhouse Gases (CCGG) group were ceased at the WITN, Grifton, North Carolina (ITN) tower on June 12, 1999, because the laboratory layout was changed to accommodate only digital television equipment. A high tower site in Texas is being studied as its replacement. A new in situ GC was prepared for installation and operation sometime in early 2001 at Ushuaia, Argentina, with funds from the World Meteorological Organization (WMO).

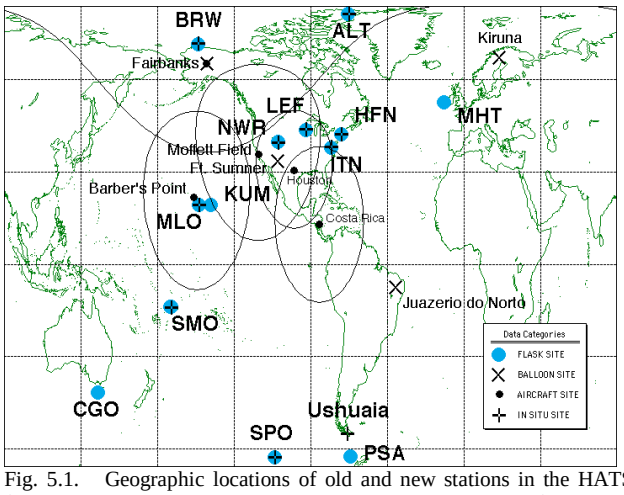

Fig. 5.1. Geographic locations of old and new stations in the HATS flask (gray circles) and in situ (crosses) networks. The sites for balloon launches are noted by "X"s. The location (small black filled circles) and the range of the aircraft operations (arcs and ovals) also are indicated.

One of the highlights of this report is that the total Effective Equivalent Chlorine (EECl) continues to decrease at about 1% yr^{-1} as a result of the Montreal Protocol. The main reason for this decline is that methyl chloroform (CH_3CCl_3) concentrations continued to decline to less than half of the peak levels present in 1992. However, atmospheric concentrations of the halons and CFC-12 are still increasing because of allowed production in the developing countries and the large bank of chemicals present in the developed countries. After CH_3CCl_3 concentrations drop to near zero, continued production and release of the halons may introduce a significant change in the trend of EECl. Other significant results include the observed global increases in atmospheric N_2O and SF_6 (identified through both flask and in situ monitoring), the continued growth of the CFC replacements (HCFCs and HFCs), and the decline in the northern hemispheric concentrations of $CHCl_3$, CH_2Cl_2, and C_2Cl_4 as a result of the U.S. Clean Air Act.

Airborne measurements were conducted in the upper troposphere and lower stratosphere in tropical, midlatitude, and polar regions during 1998 and 1999 (Figure 5.1). The exchange of air between the lower stratosphere and the troposphere and midlatitude upper stratosphere was quantified. The development and deployment of the next generation airborne gas chromatograph with electron capture and mass selective detection was funded by the National Aeronautic and Space Administration's (NASA) Instrument Incubation Program to measure trace gases, including acetone and PAN that influence atmospheric chemistry in the upper troposphere.

TABLE 5.1. Geographic and Network Information on HATS Network Sites

Code	Station	Latitude	Longitude	Elevation (m)	LST-GMT (hr)	Type
ALT	Alert, Northwest Territories, Canada (AES)*	82.45°N	62.52°W	210	-4	F, I
BRW	Point Barrow, Alaska	71.32°N	136.60°W	11	-9	F, I
MHT	Mace Head, Ireland (University College)	53.33°N	9.90°W	42	0	F
LEF	WLEF tower, Wisconsin (CMDL-CCGG)	45.95°N	90.28°W	470	-6	F, I
HFM	Harvard Forest, Massachusetts (Harvard University)	42.54°N	72.18°W	340	-5	F, I
NWR	Niwot Ridge, Colorado (University of Colorado)	40.04°N	105.54°W	3013	-7	F, I
ITN†	WITN tower, North Carolina (CMDL-CCGG)	35.37°N	77.39°W	9	-5	F, I
MLO	Mauna Loa, Hawaii	19.54°N	155.58°W	3397	-10	F, I
KUM	Cape Kumukahi, Hawaii	19.52°N	154.82°W	3	-10	F
SMO	Tuluila, American Samoa	14.23°S	170.56°W	77	-11	F, I
CGO	Cape Grim, Tasmania, Australia‡	40.41°S	144.64°E	94	+10	F
TDF	Ushuaia, Tierra Del Fuego, Argentina (WMO GAW station)§	54.82°S	68.32°W	10	-3	I
PSA	Palmer Station, Antarctica**	64.92°S	64.00°W	10	+12	F
SPO	South Pole, Antarctica	89.98°S	102.00°E	2841	+12	F, I

Cooperative sites (F = flasks, I = in situ) with:

*In situ GC: Only N_2O and SF_6; flask sampling for all gases, however.

†ITN site's flask and in situ GC were discontinued on June 12, 1999 (see text).

‡Commonwealth Scientific and Industrial Research Organization (CSIRO) and Bureau of Meteorology, Australia

§Starts collecting data in March 2001.

**Only glass flasks used.

Oceanic measurements of CH_3Br and other gases were obtained on two research cruises during 1998-1999. Measurements in marine air and surface seawater showed that the oceans are still a significant sink for atmospheric CH_3Br, but the magnitude of the sink is slightly smaller than previously determined.