A brief history of the ESRL global carbon cycle observing system

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Carbon Cycle theme presentation
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Credits: Carbon Cycle Group and collaborators

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Large-Scale Atmospheric Mixing As Deduced from the Seasonal and Meridional Variations of Carbon Dioxide

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Abstract. Representative data on the variations of carbon dioxide in the atmosphere are presented. The data reveal a presumably natural source in the tropical oceanic areas and the industrial source of midlatitudes. Using a simple model of large-scale exchange, the meridional eddy exchange coefficient is computed to be about 3×10^{10} cm^2 sec^{-1}, and the meridional transport from tropical to north polar areas is computed to be about 2×10^{10} metric tons of carbon dioxide per year. An analysis of the seasonal variation shows that land vegetation north of 45°N is responsible for a net consumption of carbon dioxide of about 1.5×10^{10} tons during the vegetation period in summer. It is concluded that carbon dioxide is an excellent tracer for the study of atmospheric mixing processes. More data are needed, however, to make full use of it.

Introduction. Atmospheric CO_2 offers one of the most promising tracer constituents for elucidating atmospheric mixing processes on a global scale. The observed systematic variations of the content of CO_2 in the atmosphere with season, latitude, and altitude are the results of sources and sinks which exist only at the surface of the earth and which induce regular variations in the lowest layers of the atmosphere, the penetration of which upward and horizontally can yield quantitative information about the transfer mechanism of the atmo- total observed variation, in spite of the high risk of contamination.

We shall discuss data obtained during 5 years (1957–1962) from pole to pole, primarily over the Pacific Ocean. The data are published in part [*Keeling*, 1960]; publication of the remainder is in progress.

From these data we will (1) give an over-all picture of the large-scale transfer processes in the troposphere and information on the main features of sources and sinks of CO_2; (2) establish how sensitive our conclusions are to the

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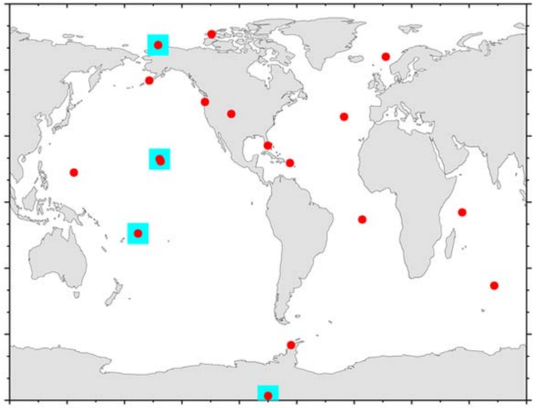
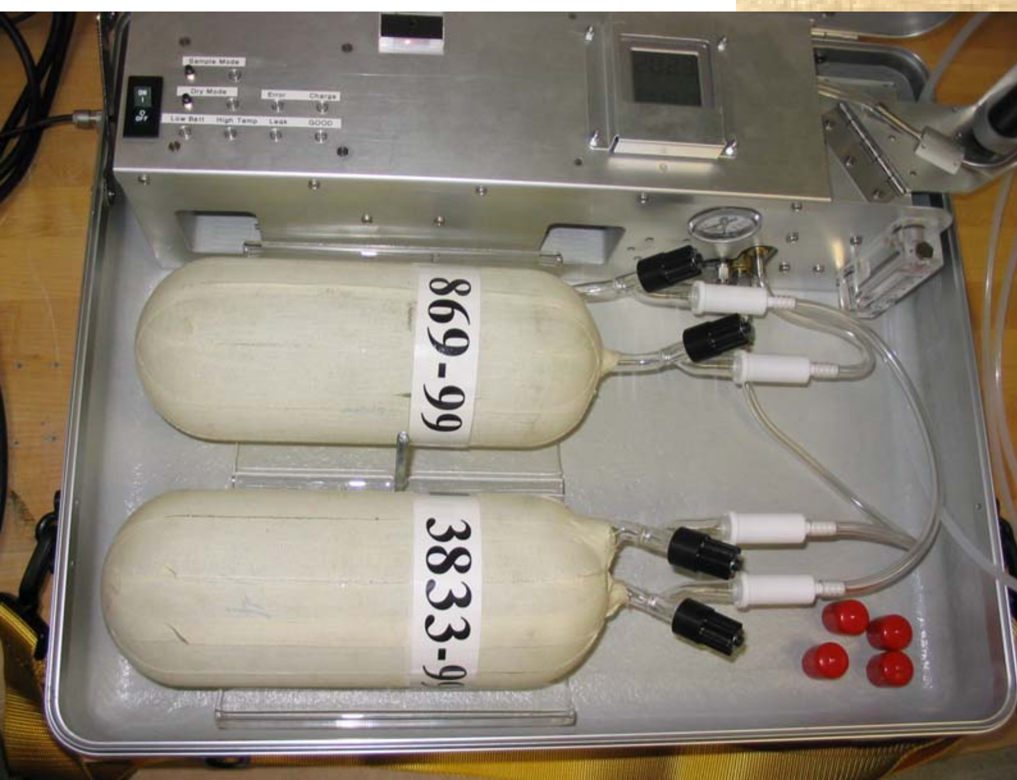
1982 18 flask sites **5000 per year**

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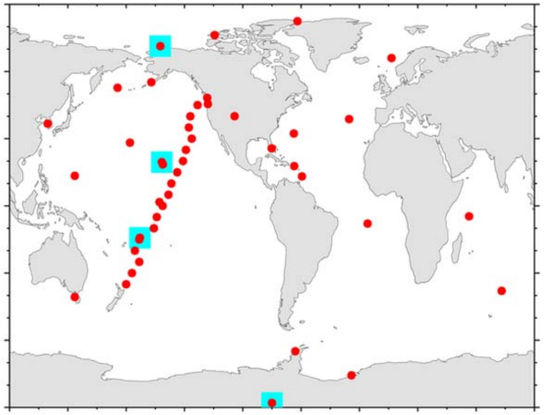

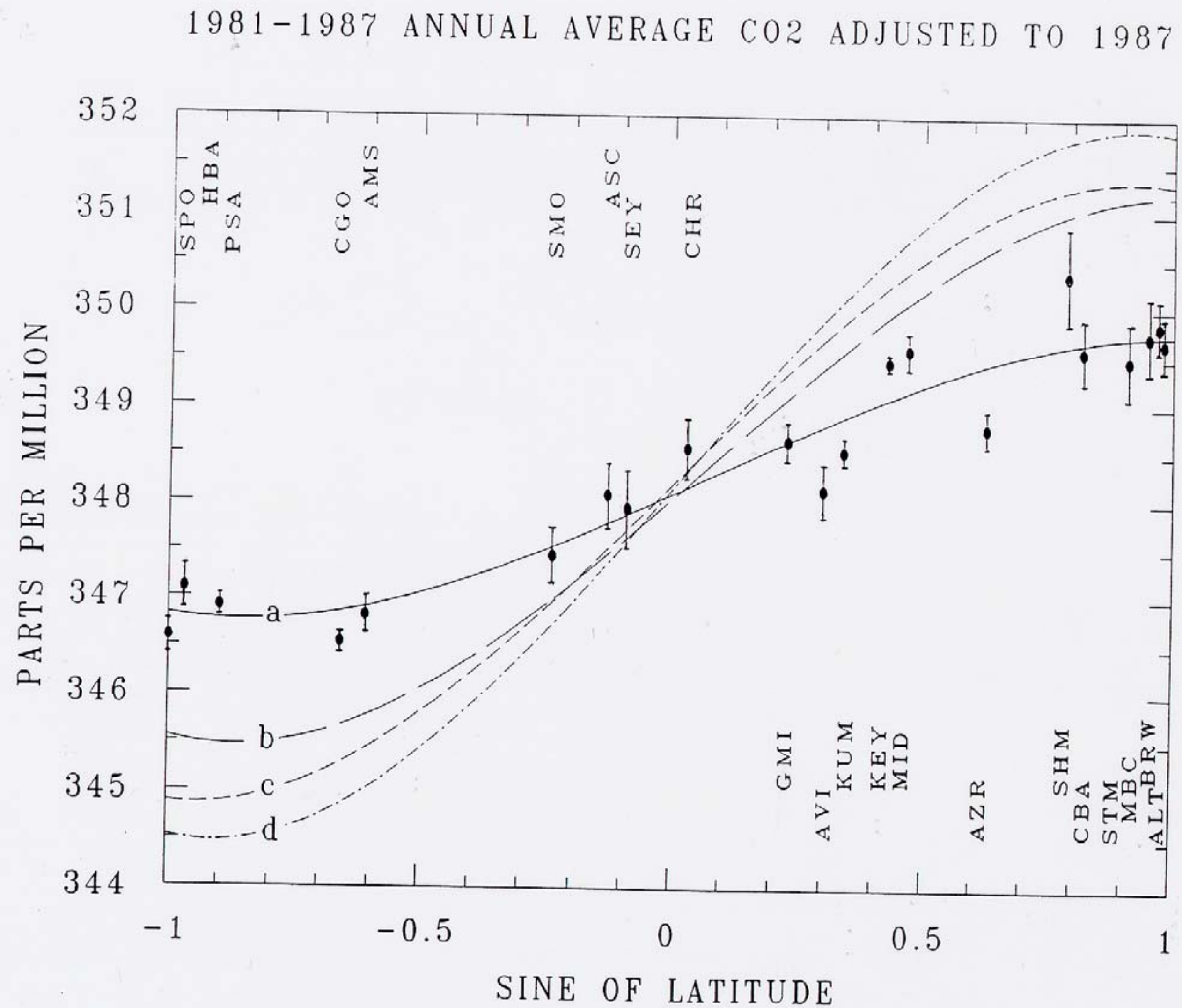

1981-1987 ANNUAL AVERAGE CO2 ADJUSTED TO 1987
PARTS PER MILLION
352
351
350
349
348
347
346
345
344
SINE OF LATITUDE
-1
-0.5
0
0.5
1
SPO
HBA
PSA
CGO
AMS
SMO
ASC
SEY
CHR
GMI
AVI
KUM
KEY
MID
AZR
SHM
CBA
STM
MBC
ALT
BRW
a
b
c
d

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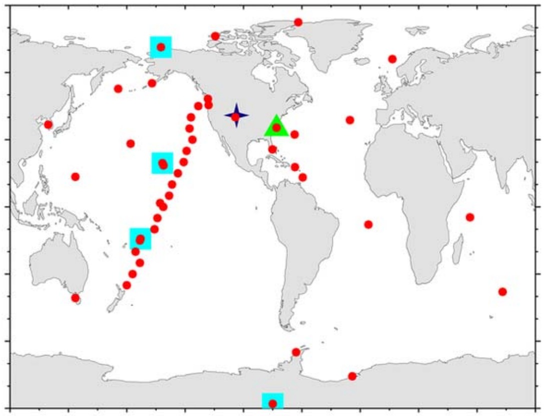

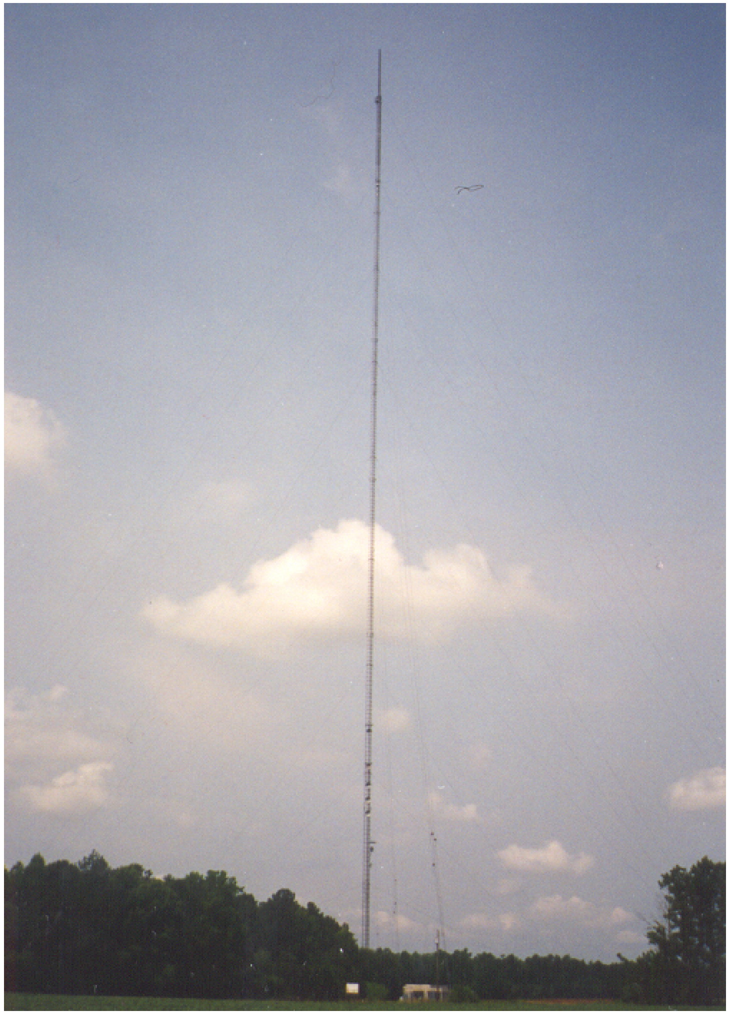

WITN TV, Grifton, N.Carolina

Carr, Colorado

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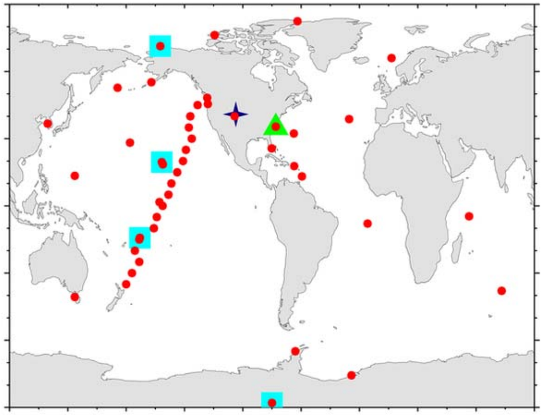
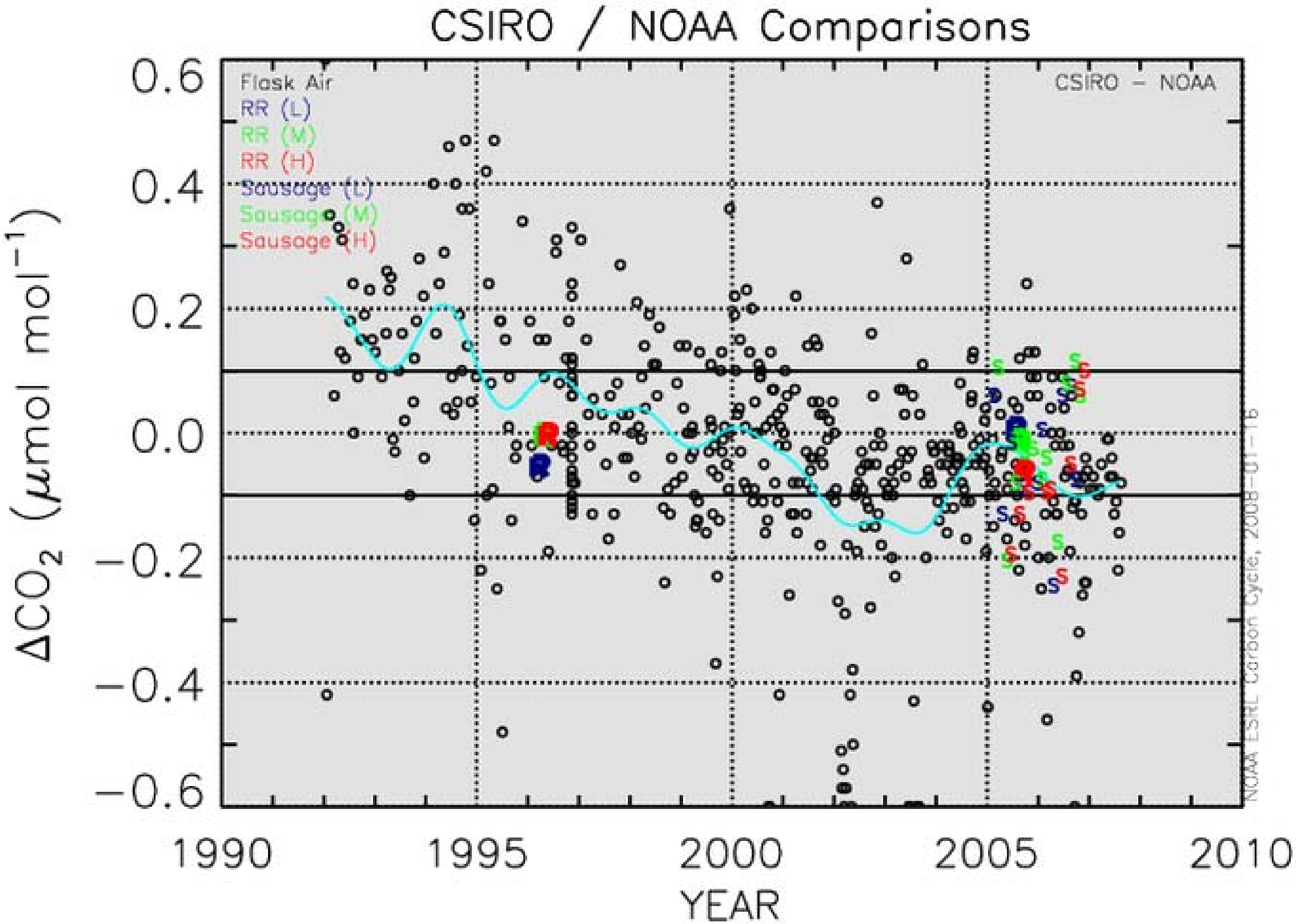




source: Ken Masarie

GLOBAL METHANE

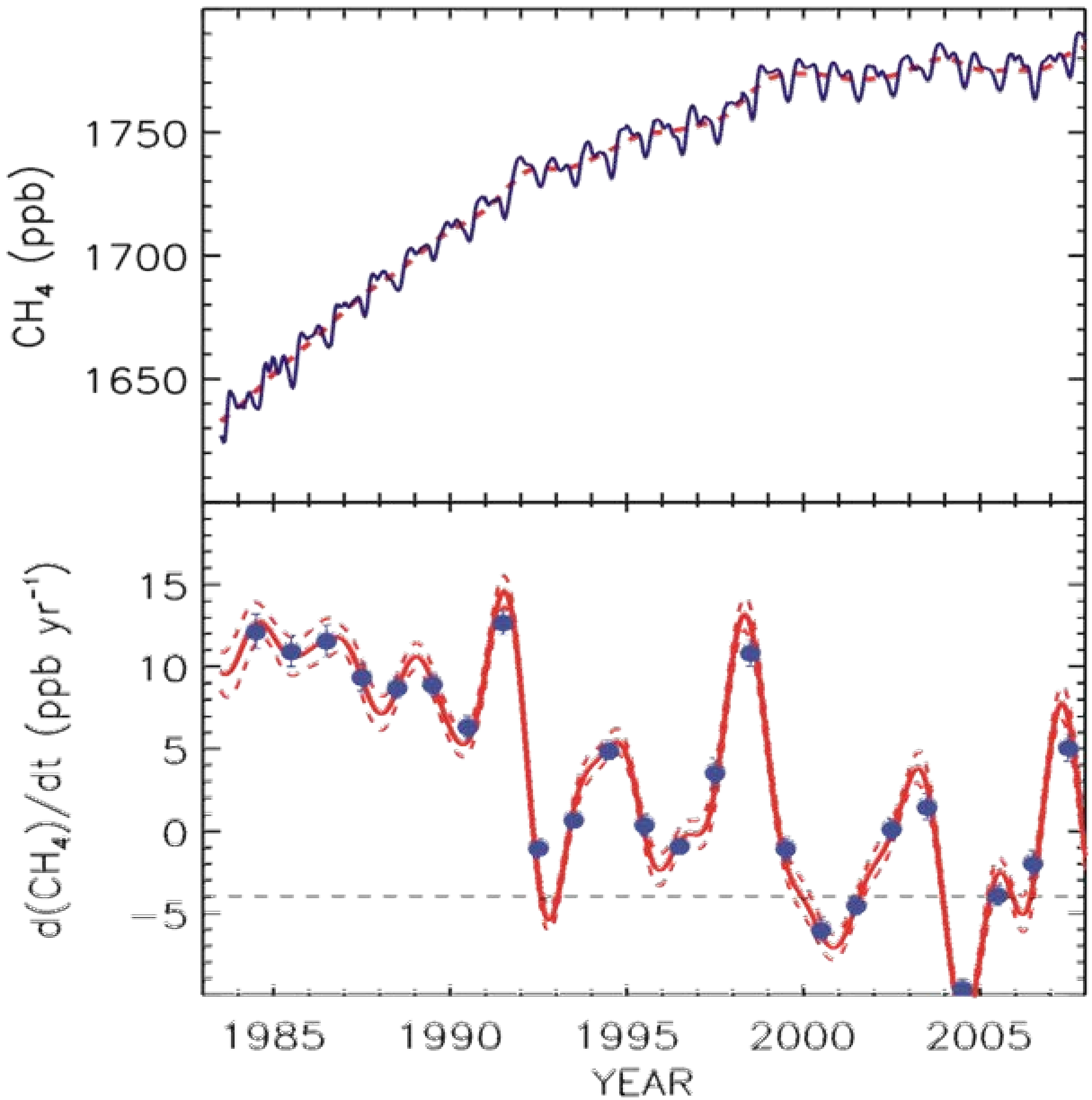
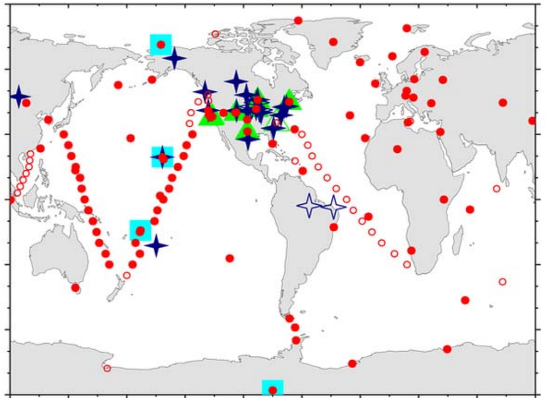


Figure: Ed Dlugokencky

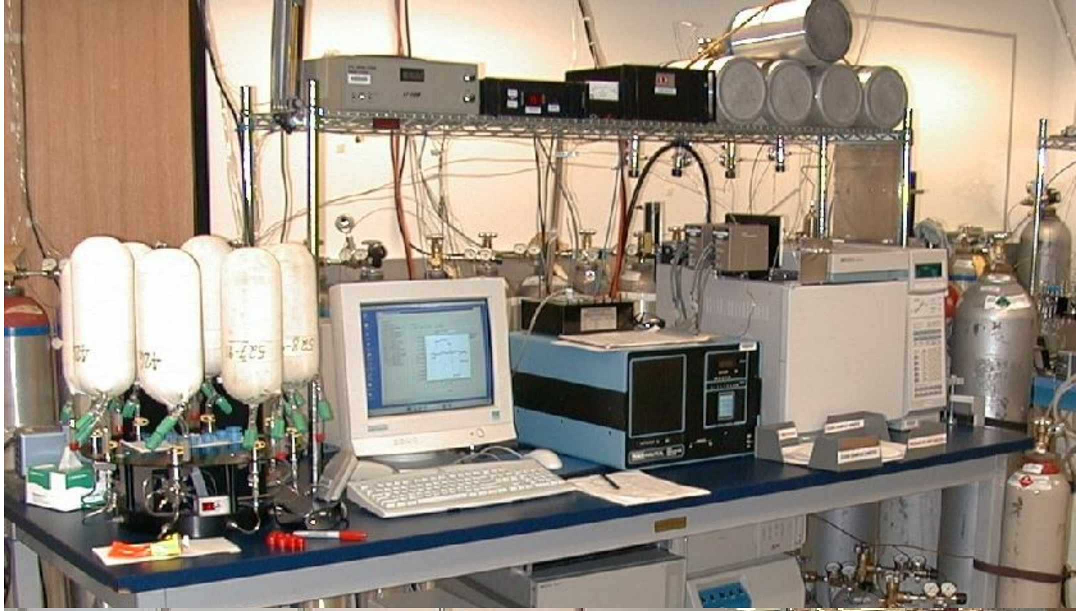
HISTORY OF NOAA/ESRL GREENHOUSE GAS OBSERVING SYSTEM

1968	Flask sampling at Niwot Ridge, CO	CO_2	
1976	4 continuous in-situ sites, 6 flask sites		
1982	12 flask sites		5000 per year
1983		CH_4	
1988	26 flask sites, container ships	CO, H_2	
1990	Science paper: N.Hem. carbon sink	$^{13}C/^{12}C$, $^{18}O/^{16}O$	
1992	In-situ CO_2 on 1^{st} tall tower, aircraft sampling		
1992	Nature paper: CH_4 increase slowing down		
1992	1^{st} comparison program, with CSIRO		
1995	WMO CO_2 and CO calibration scales		
1996	Globalview	N_2O, SF_6	
1998		$^{13}C/^{12}C$ of CH_4	
2003		$^{14}CO_2$	10,000
2004		D/H of CH_4, halocompounds	
2005	WMO calibration scale for CH4	NMHCs	
2007	CarbonTracker		20,000
2008	7 tall towers, 15 aircraft sites 11 comparison programs		

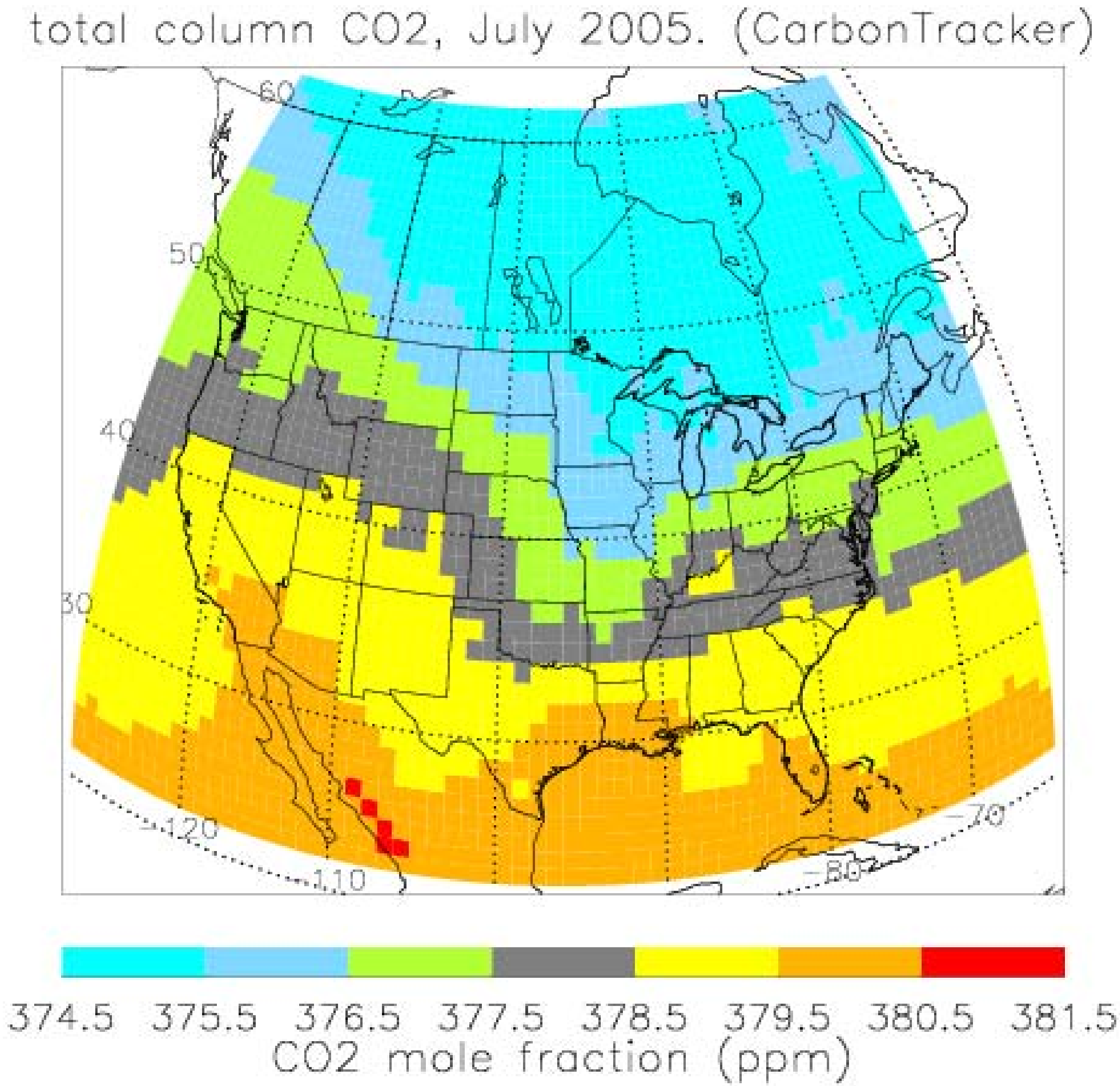


WMO goals for laboratory Intercomparability.

	target:	background
CO2	0.1 ppm	(385)
$^{13}C/^{12}C$	0.01 ‰	
$^{18}O/^{16}O$	0.05 ‰	
$^{14}C/C$	1 ‰	(1050)
CH4	2 ppb	(1780)
N2O	0.1 ppb	(322)
CO	2 ppb	(40-170)
H2	2 ppb	(480-550)
SF6	0.02 ppt	(6)



WHY HIGH ACCURACY MEASUREMENTS?



carbontracker.noaa.gov

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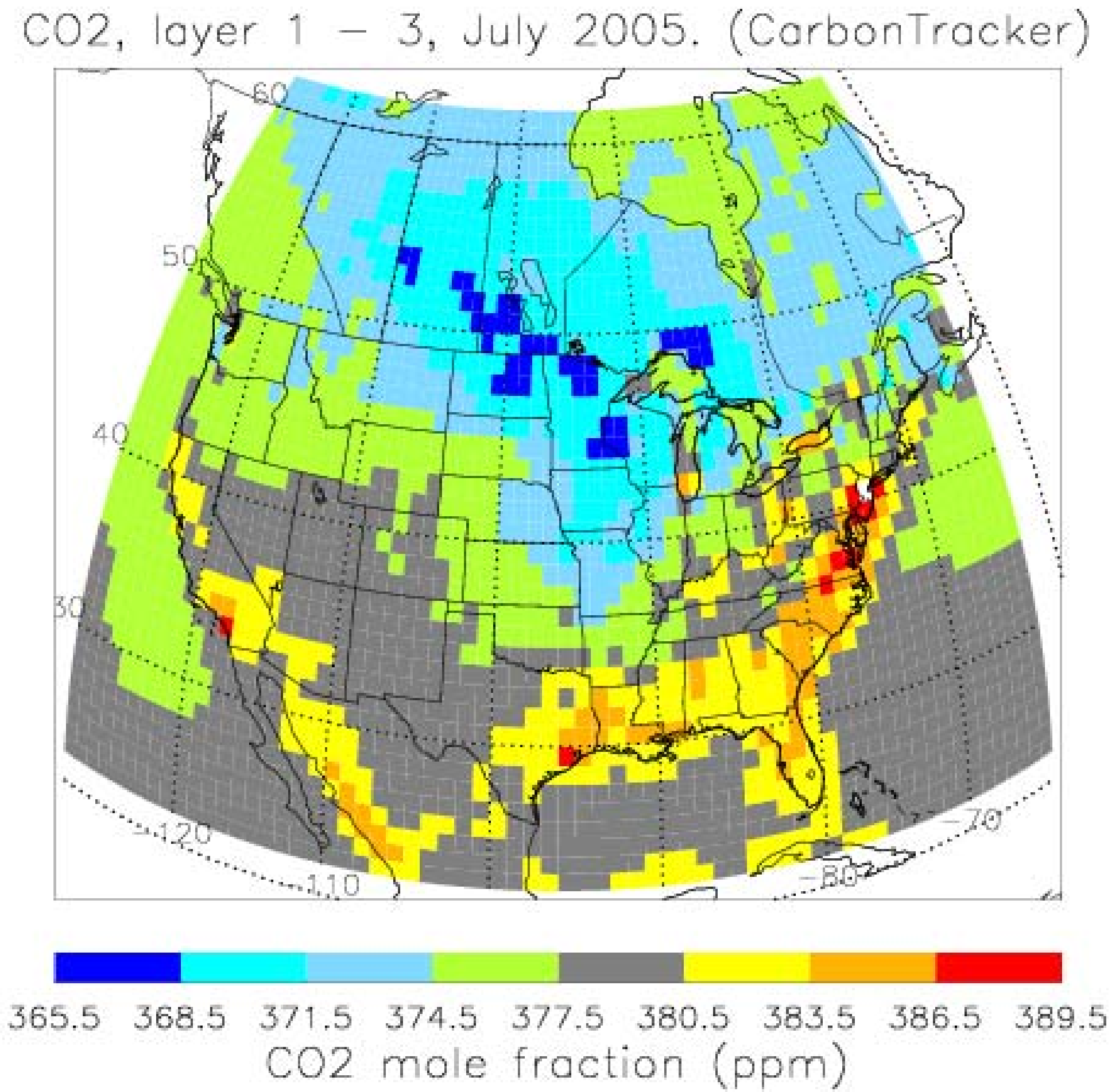

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We have built an observing system combining *high accuracy measurements* and a *data assimilation* system. The observing system quantifies emissions and uptake or loss of greenhouse gases on the spatial scale of continents.

We play the central role in the international GHG monitoring program coordinated by the World Meteorological Organization (WMO).

There will be a need for objective quantification at smaller spatial scales, individual states and metropolitan areas. This requires a much denser measurement network, and much higher resolution transport models, especially surrounding observing sites.

There will likely be many institutions involved, and we are trying to get ready to take on an essential quality control and educational role.

A second essential task is to keep a close watch on climate feedbacks such as destabilization of Arctic permafrost. We need to intensify our observations in the Arctic.