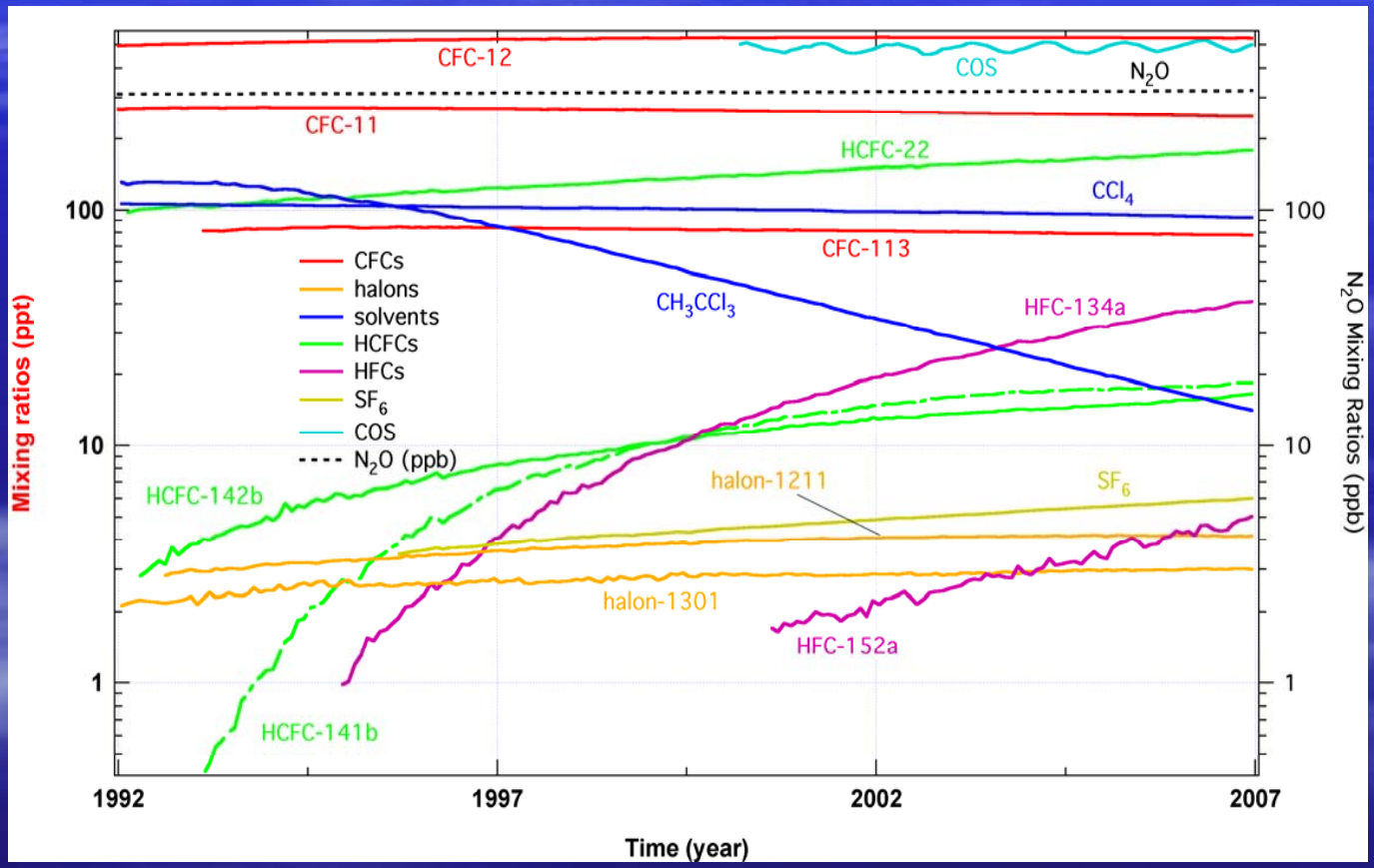
Understanding our atmosphere from non-CO_2 climate gases during HIPPO: Global network and aircraft profiles

James W. Elkins[1], Fred L. Moore[1,2],

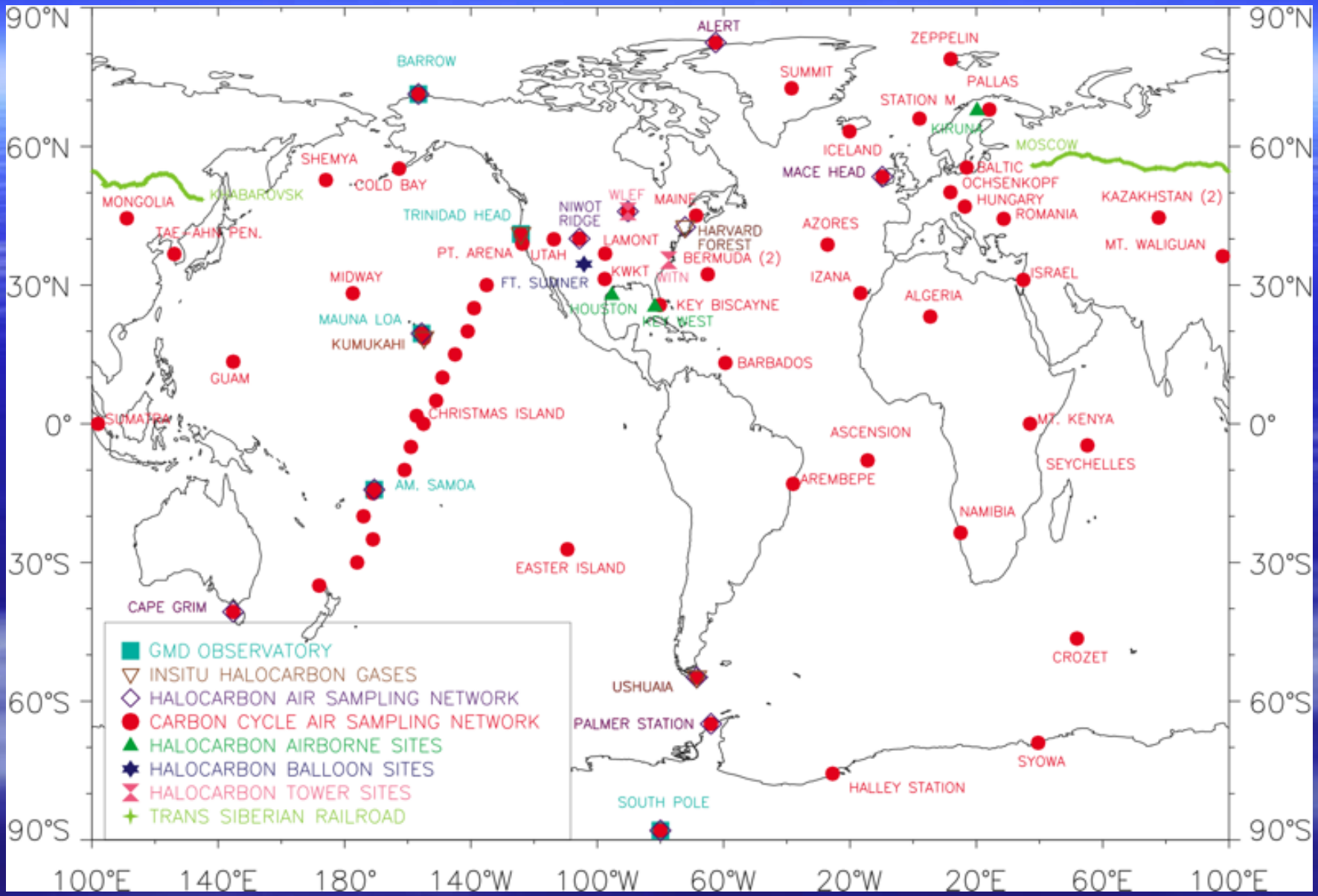
Dale F. Hurst[1,2], and Stephen A. Montzka[1]

[1]NOAA/ESRL and [2]CIRES

We measure molecules with a wide range of concentration, growth rates, sources, and lifetimes.



NOAA/ESRL Halocarbon and Carbon Cycles Stations



NOAA/ESRL in situ airborne measurements

PAN and other Trace Hydrohalocarbons ExpeRiment (PANTHER)

70 seconds:
N_2O
SF_6
CFC-12
CFC-11
Halon-1301
PAN
140 seconds:
H_2
CH_4
CO
180 seconds:
CH_3Cl
CH_3Br
CH_3I
COS
CS_2
HCFC-22
HCFC-142a
HCFC-141a
HFC-134a

Unmanned aircraft system Chromatograph for Atmospheric Trace Species (UCATS)

1 second:
H_2O
10 seconds:
O_3
70 seconds:
N_2O
SF_6
140 seconds:
H_2
CH_4
CO

NWAS Longer -lived gases

Compound	lifetime (yr)
CFC-115	1700
CFC-13	640
CFC-114	300
HFC-23	270
*CFC-12	100
*CFC-113	85
*H-1301	65
HFC-143a	52
*CFC-11	45
HFC-125	29
HFC-227ea	34
*CCl_4	26
*H-2402	20
*HCFC-142b	18
*H-1211	16
*HFC-134a	14
*HCFC-22	12
HFC-134	9.6
*HCFC-141b	9.3
HFC-365mfc	8.6
HCFC-124	5.8
*CH_3CCl_3	5

NWAS Shorter-lived gases

Compound	lifetime (yr)
*COS	2 to 3
*HFC-152a	1.4
*methyl chloride	1.0
*methyl bromide	0.7
*chloroform	*0.41*
*dichloromethane	*0.38*
*dibromomethane	*0.33*
*PCE	*0.27*
*chloroethane	*0.08*
*bromoform	*0.07*
*methyl iodide	*0.02*
*carbon disulfide	*short*
*propane	*short*
**n*-butane	*short*
*i-pentane	*short*
**n*-pentane	*short*
*benzene	*short*

(Italicized numbers represent a local lifetime for short-lived gases)

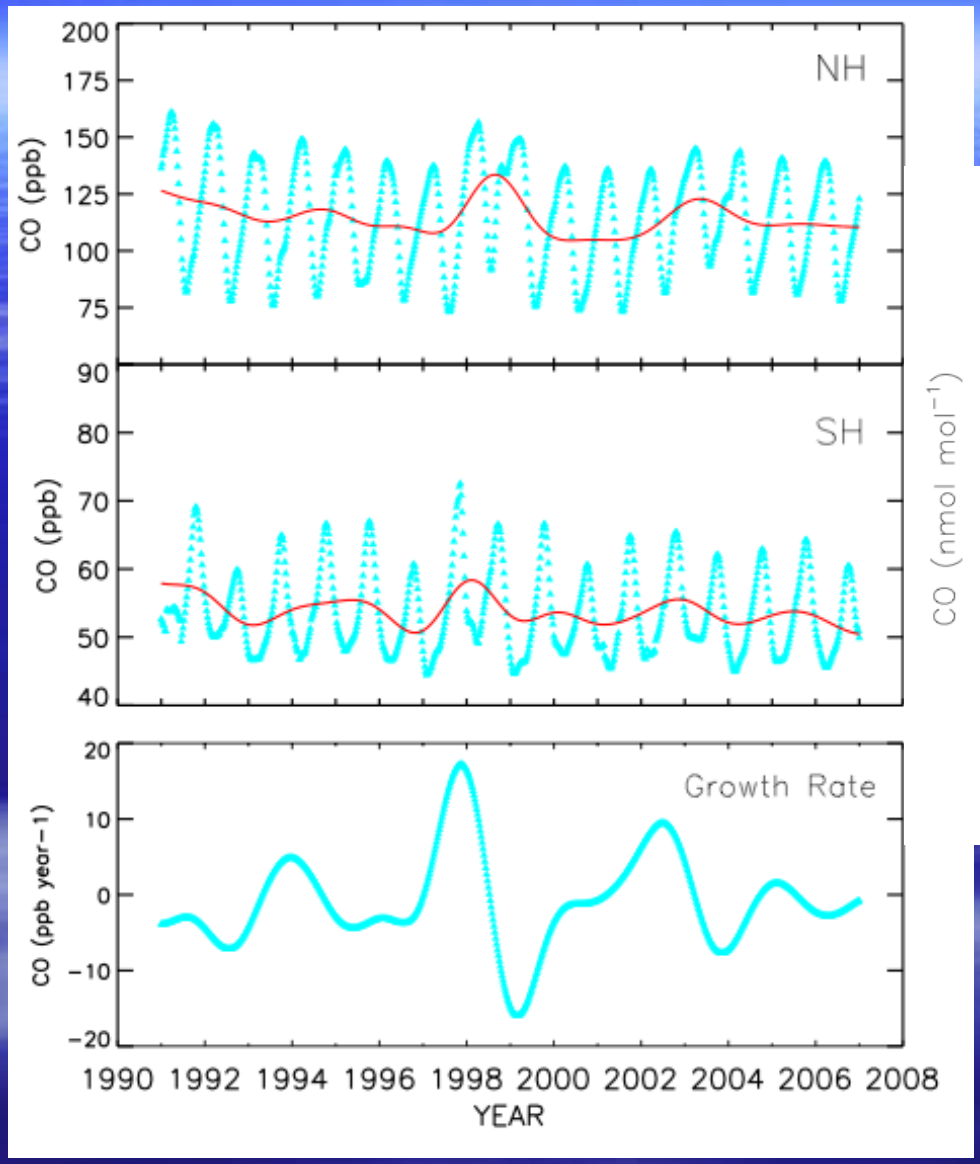
* NOAA calibration scale exists

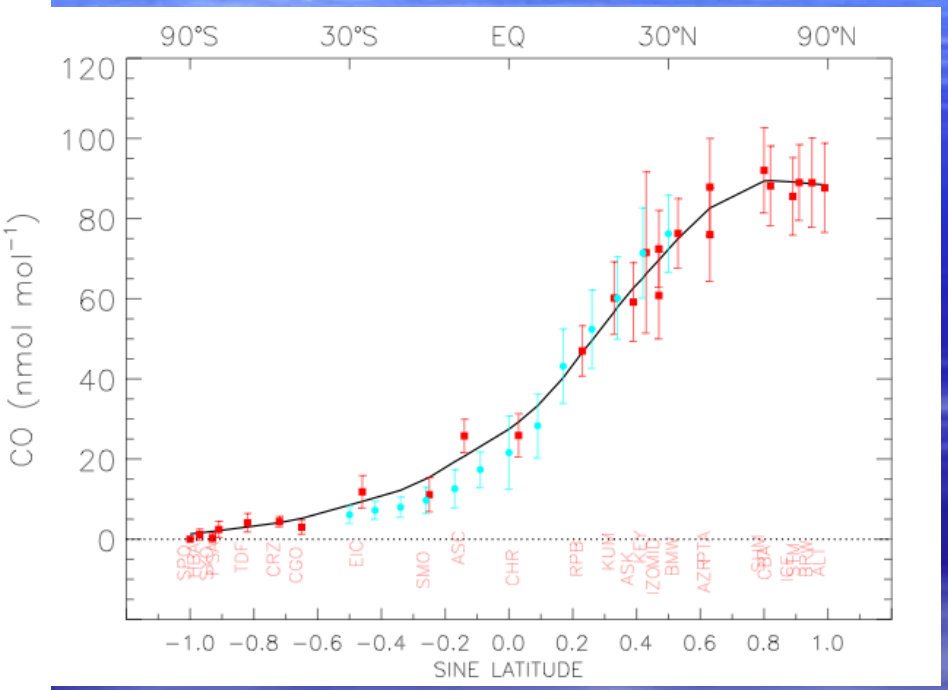
Additional Gases Measured by Carbon Cycle Group

- CO_2
- CH_4
- H_2
- CO
- N_2O
- SF_6
- C-13, C-12, and O-16, O-18 isotopes of CO_2

For HIPPO, not on START08

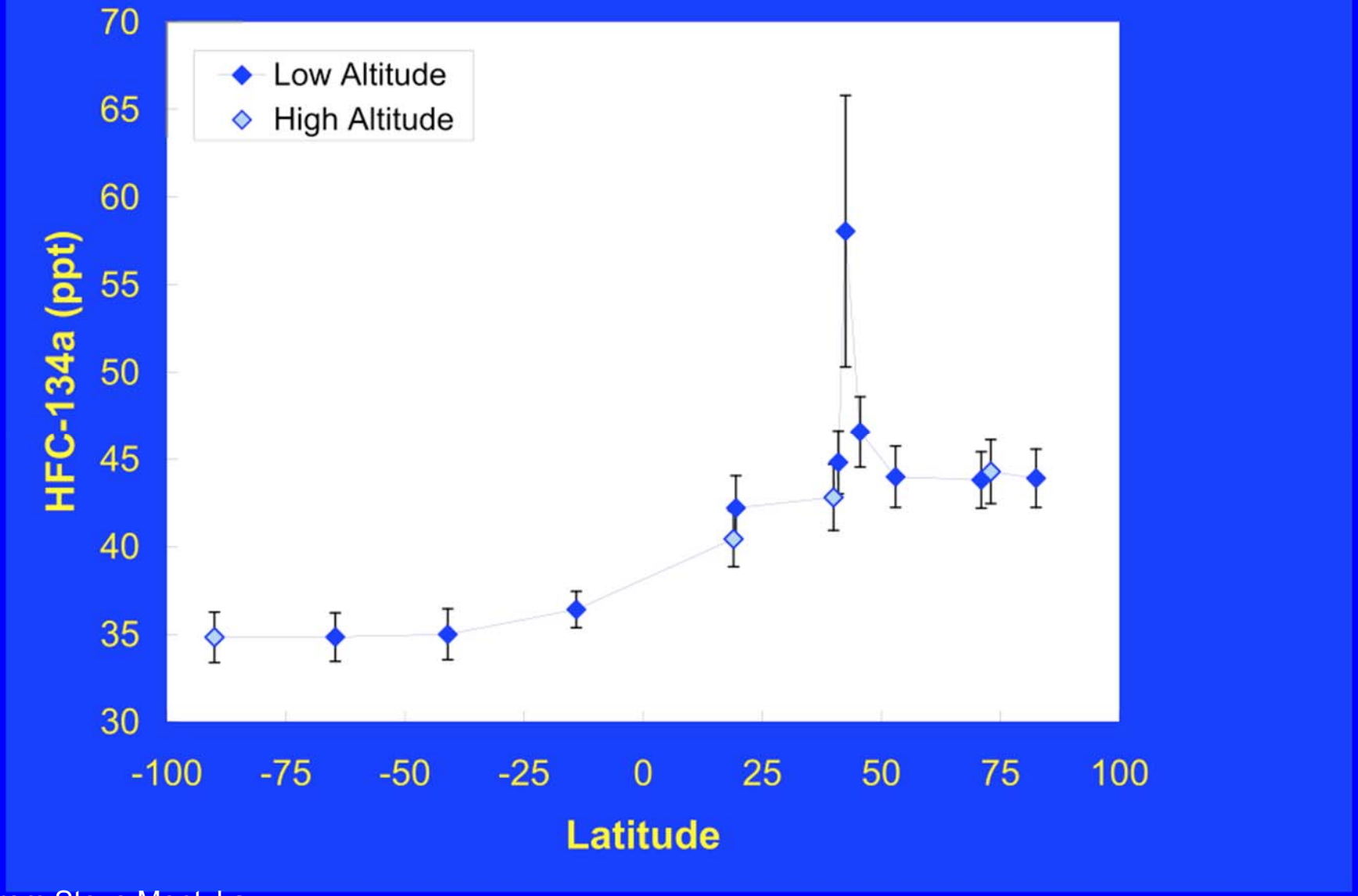
NOAA/ESRL Network Trends and Distributions of CO





From Paul Novelli, NOAA/ESRL

2006 annual means at surface sites: HFC-134A



From Steve Montzka

Spatial distributions of HFC-134a, vs season and vs altitude

HFC-134a (ppt)

55
50
45
40
35
30
25
20

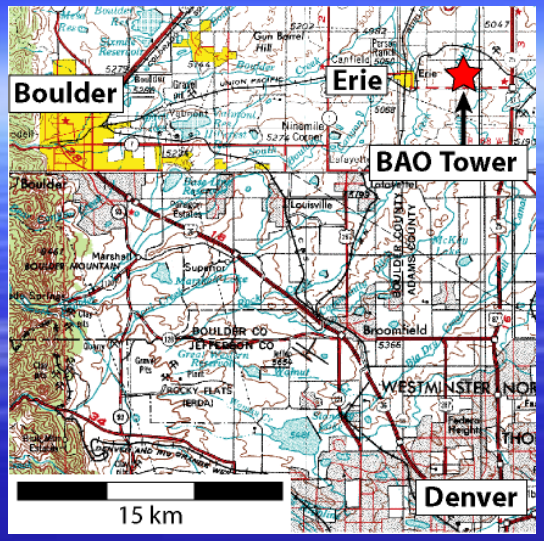
2003 2004 2005 2006 2007 2008 2009

Red--All ESRL aircraft running mean

spo
cgo
smo
mlo
kum
nwr
brw
alt
>4 km, N.America

From Steve Montzka

Air Quality, Carbon Cycle, & GHG Measurements at Tall Tower



Boulder Atmospheric Observatory (BAO)

- Height = 300 m
- Movable carriage with > 1 ton capacity
- Transit time for vertical profile ≈ 9 min

(vertical resolution = 0.6 m @ 1 Hz)

- Advantages & capabilities
- Unique facility for vertical profiling & atmospheric sampling
- Near rapidly developing suburban area
- Downwind of Denver
- Near oil and gas drilling
- Fills gap in Front Range O_3 monitoring network

Summer 2008 Measurements--local test of methods and models

NOAA ESRL/CSD: Ryerson, Holloway, …

- July-August, either surface or carriage
- $NO/NO_2/NO_y/O_3$
- CO
- SO_2

NOAA ESRL/GMD: Andrews, Tans, Oltmans, Elkins, Montzka, …

- Ongoing sampling (GMD Tall Tower network)
- Continuous CO, CO_2: 25, 100, 300 m
- Continuous O_3: surface, 300 m
- Daily flasks samples: stable isotopes, CFCs, halocarbons, COS, …
- Timing to coordinate with other measurements?
- VOCs, GHGs: location TBD

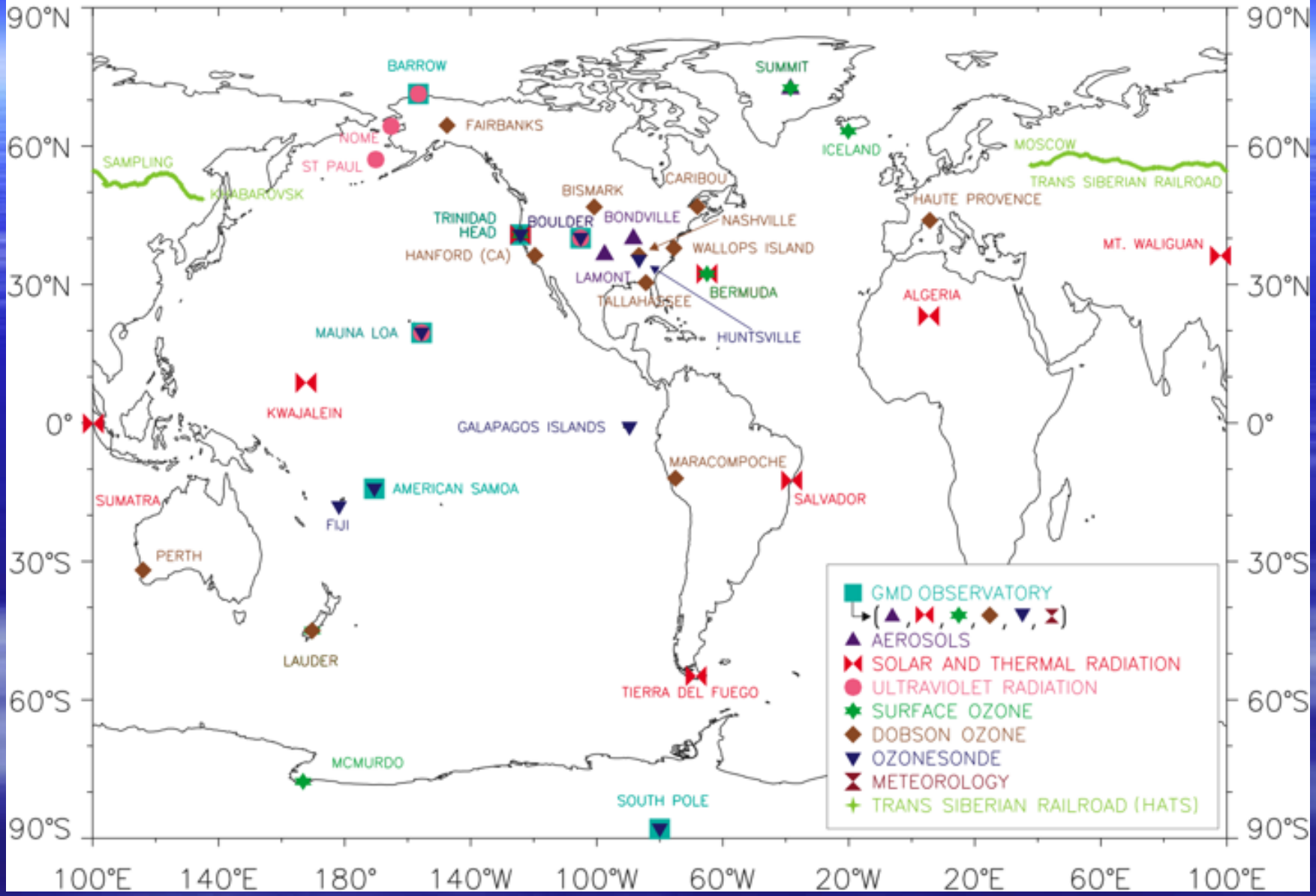
From Greg Frost

Summary

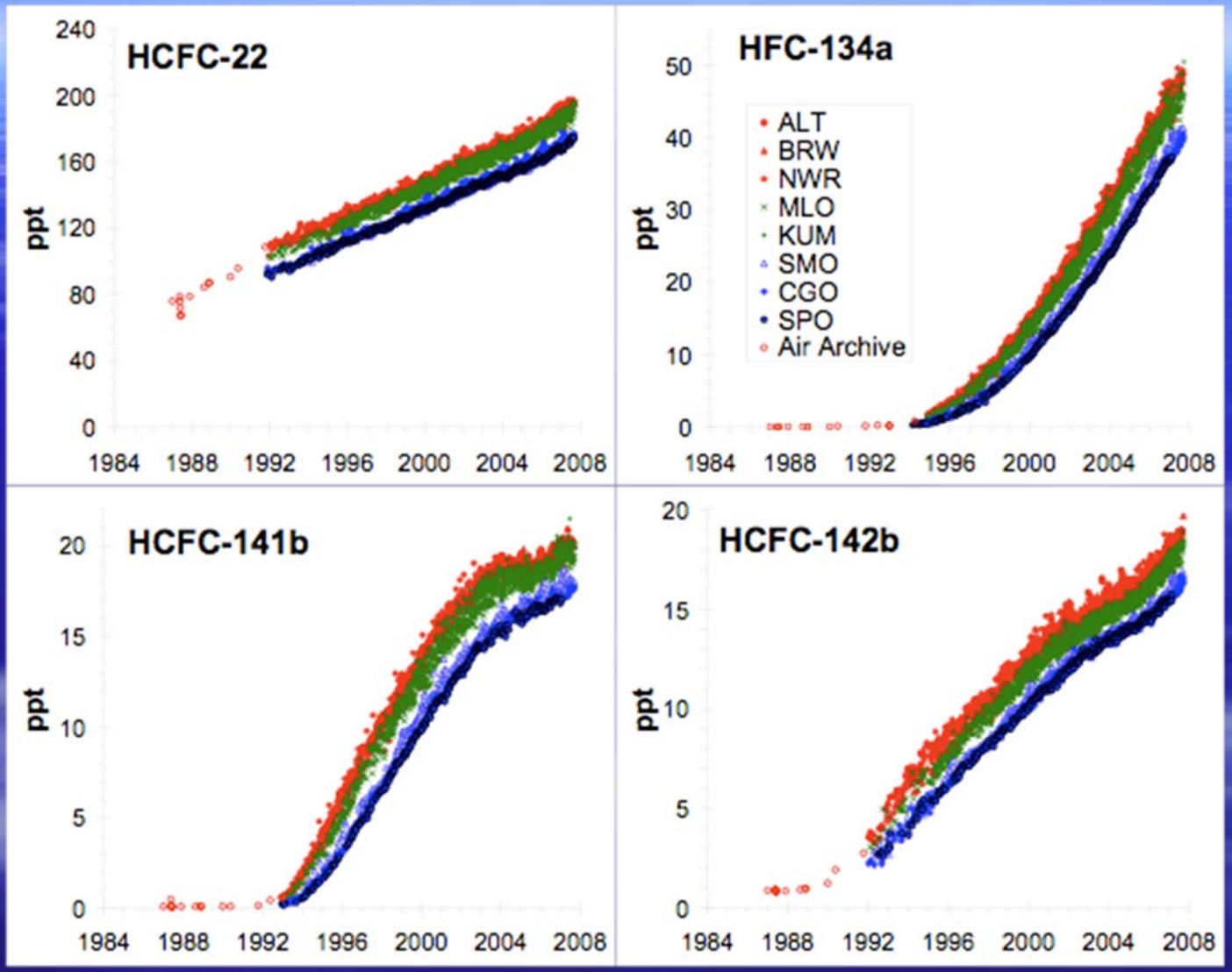
- Stratospheric Incursions and Folds (Hurst)
- Diversity in interhemispheric gradients (CO, SF_6, COS) (Moore)
- Stratospheric (O_3) and tropospheric tracers
- Transport and Age Tracers (SF_6, HCFCs, HFCs)
- Emission Studies and Source Types
- Link to NOAA/ESRL Network and Standards

Backup Slides

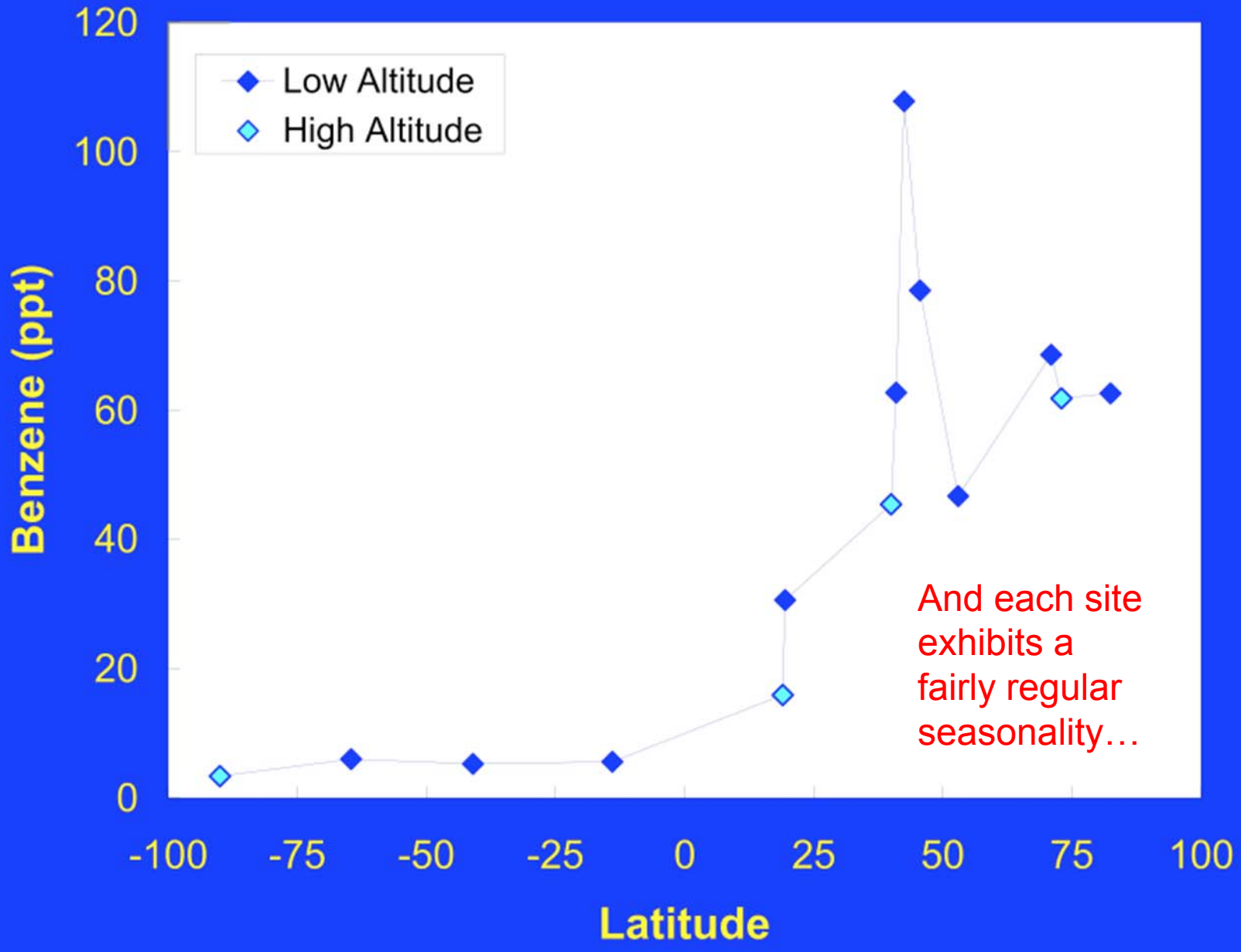
Ozone, Aerosols, Solar Radiation, and Meteorology



CFC Replacement Compounds

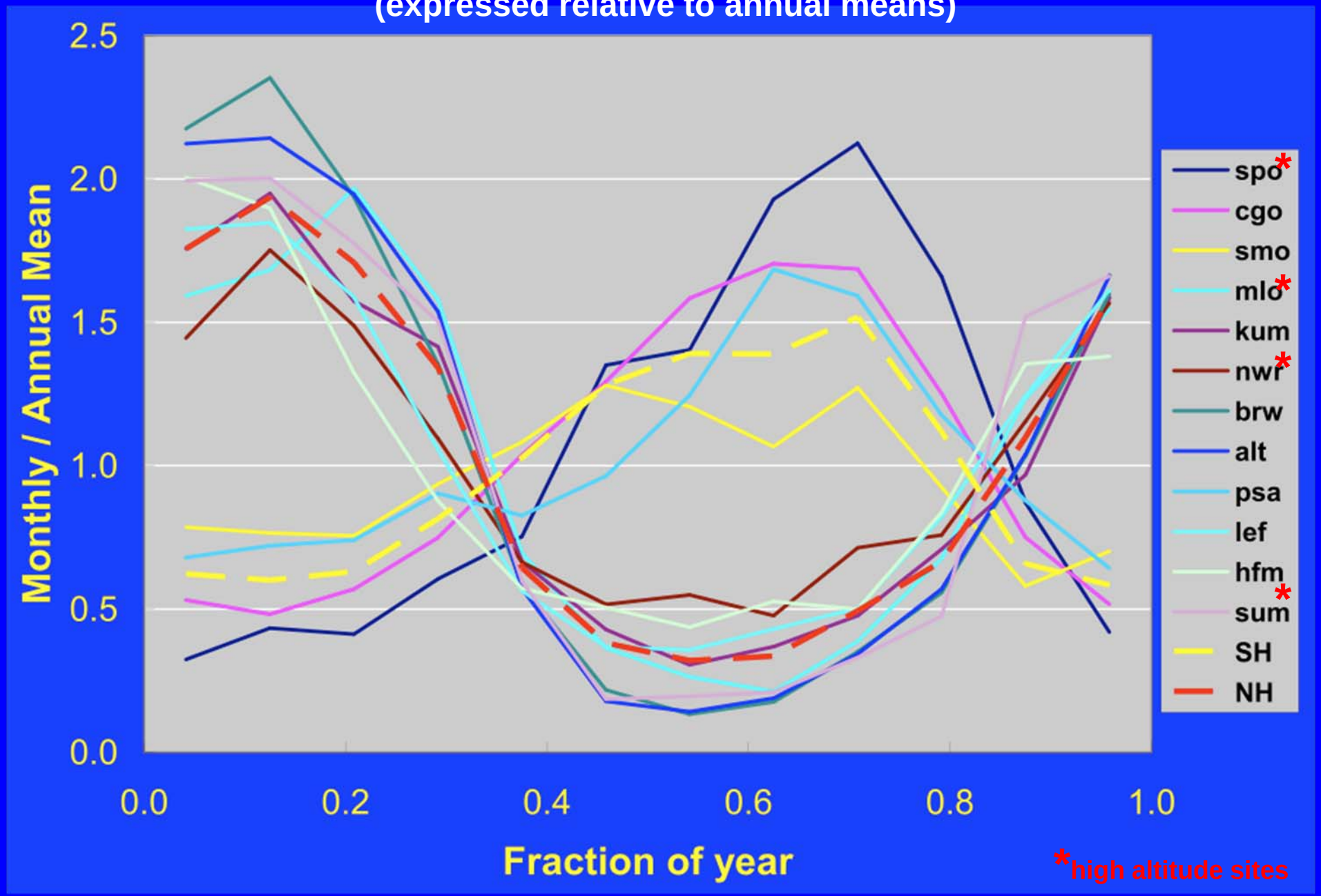


2006 annual means at surface sites: BENZENE



Benzene seasonality across the globe at surface sites

(expressed relative to annual means)



Front Range Ozone Transport & Vertical Structure

Ozone Differential Absorption Lidar: TOPAZ = **T**unable **O**ptical **P**rofiler for **A**erosol and **O**zone

NOAA ESRL/CSD: Hardesty, Senff, et al.

- TOPAZ installed on NOAA Twin Otter
- Twin Otter @ JeffCo Airport: 15 July - 15 August 2008
- Science flights: 20 July - 15 August 2008
- Operational area: Front Range plains & mountains
- Flight altitude: ~ 16,000 ft
- Flight hours: ~ 40 , 8 - 10 flights
- Additional potential instrumentation:
- nadir-looking IR radiometer (surface skin T)
- in situ O_3 sensor
- DOAS (NO_2 and other species)?
- Doppler lidar?

21 August 2007 flight over Front Range

- Transport of Denver urban plume and resulting high O_3 over Rocky Mountain Park