EARTH SYSTEM RESEARCH LABORATORY

Serving Society through Science

Global Monitoring: Trends and Distributions of CO_2 and CH_4

NOAA ESRL Carbon Cycle Group

ESRL Atmospheric Chemistry Review

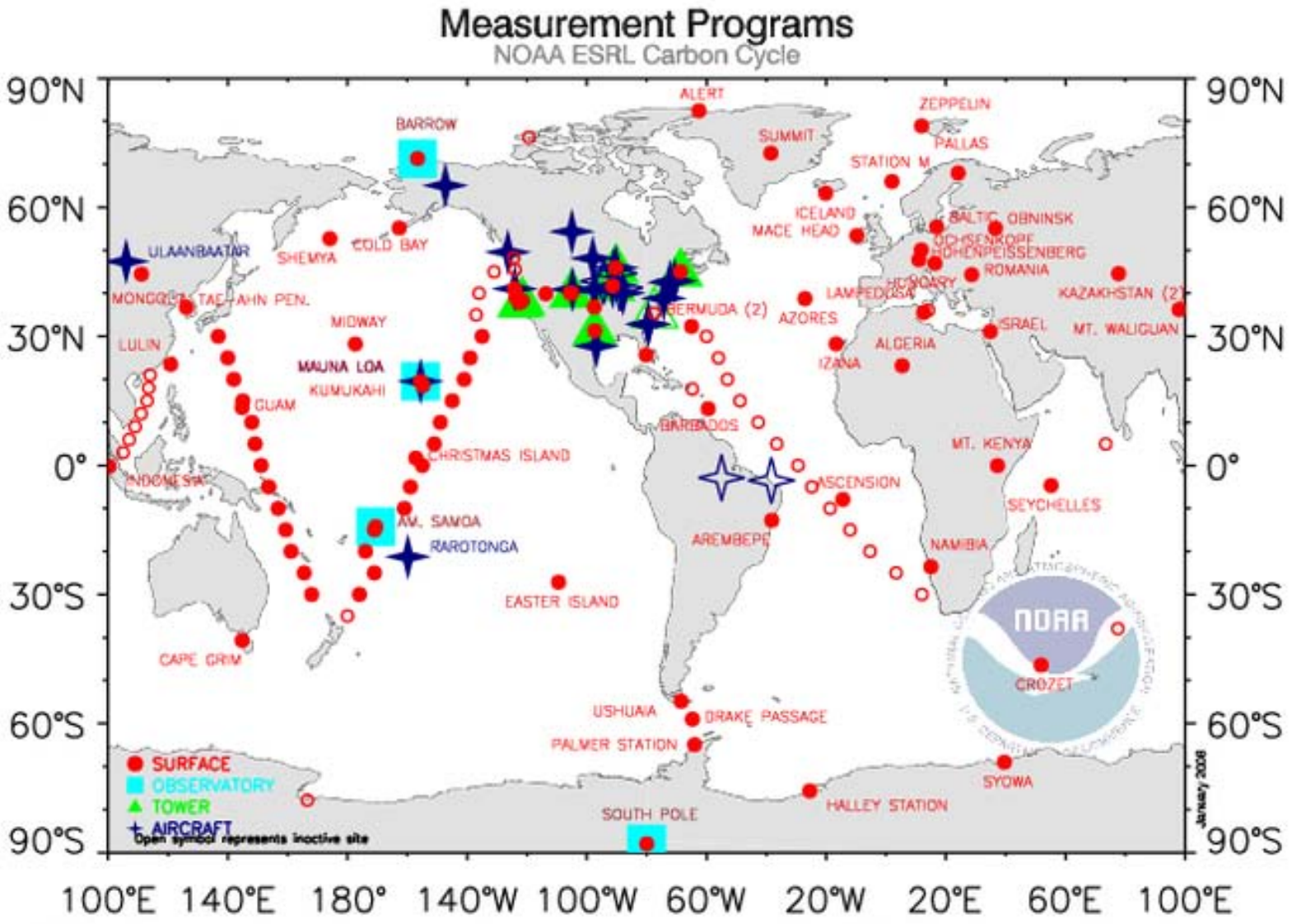
January 29-31, 2008 ~ Boulder, Colorado

Scientific Motivation

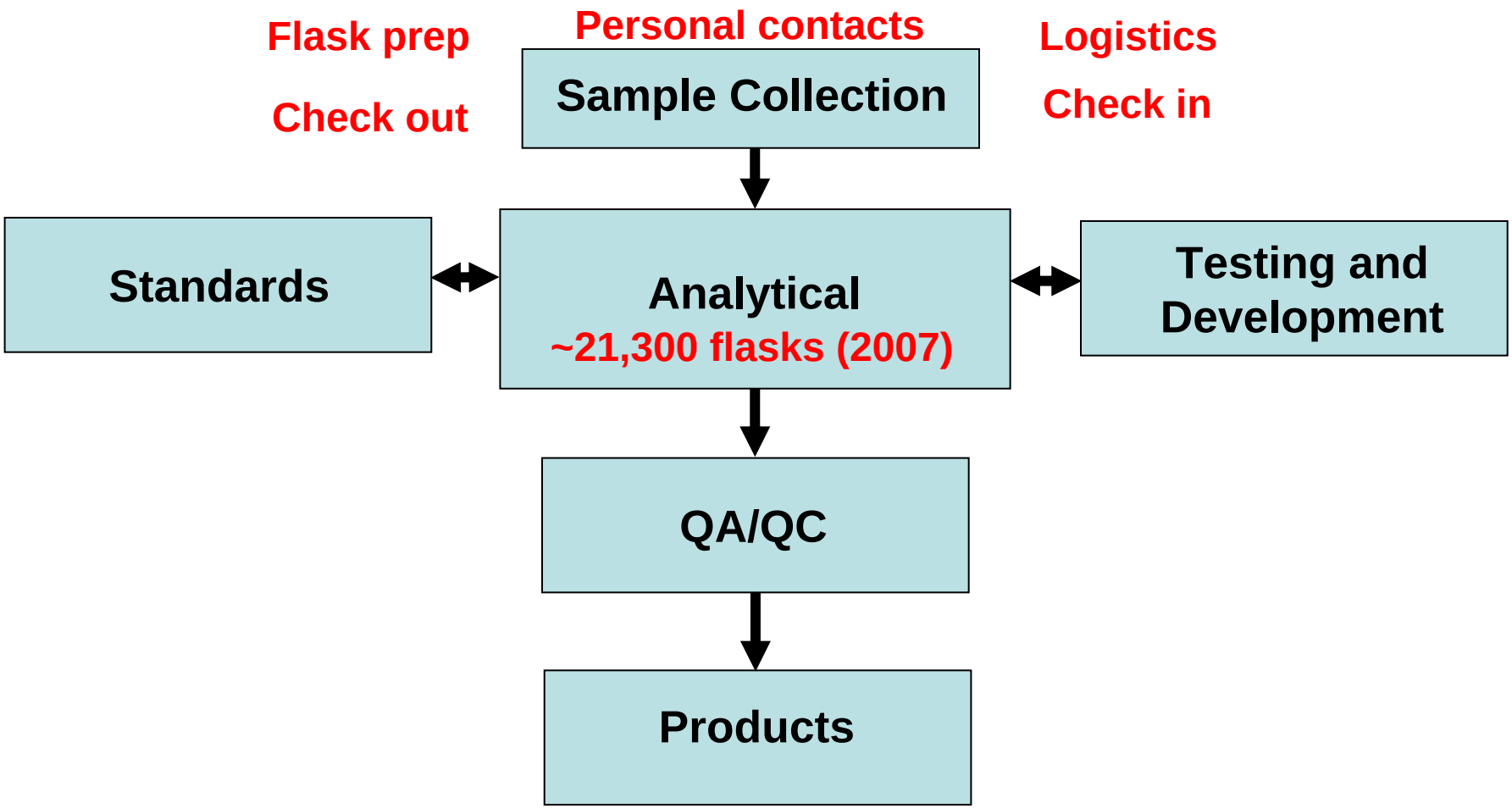
- Determine budgets
  - Sources and sinks of CO_2 and CH_4 at large to regional spatial scales

Approach

- Accurately, precisely measure spatial, temporal distributions of CO_2 and CH_4
  - Resolve small spatial gradients
  - Measure trends
  - Obtain meaningful derivatives


Measurement Programs
NOAA ESRL Carbon Cycle
90°N
60°N
30°N
0°
30°S
60°S
90°S
100°E 140°E 180° 140°W 100°W 60°W 20°W 20°E 60°E 100°E
ALERT
ZEPPELIN
PALLAS
SUMMIT
STATION M
BARROW
ICELAND
MACE HEAD
BALTIC
OBNINSK
HOHENPEISSENBERG
ROMANIA
HUNGARY
LAMPEDUSA
KAZAKHSTAN (2)
ULAANBAATAR
SHEMYA
COLD BAY
MONGOLIA
TAE-AHN PEN.
AZORES
BERMUDA (2)
ISRAEL
MT. WALIGUAN
ALGERIA
IZANA
LULIN
MIDWAY
MAUNA LOA
KUMUKAHI
GUAM
BARBADOS
MT. KENYA
CHRISTMAS ISLAND
INDONESIA
ASCENSION
SEYCHELLES
AM. SAMOA
RAROTONGA
ASCENSION
NAMIBIA
EASTER ISLAND
CAPE GRIM
CROZET
USHUAIA
DRAKE PASSAGE
PALMER STATION
SYOWA
HALLEY STATION
SOUTH POLE
SURFACE
OBSERVATORY
TOWER
AIRCRAFT
Open symbol represents inactive site
NOAA
January 2008

Components of Cooperative Air Sampling and Measurement Network



Components of Cooperative Air Sampling and Measurement Network

Flask prep

Personal contacts

Logistics

C

Standard

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Components of Cooperative Air Sampling and Measurement Network

Flask prep

Check out

Personal contacts

Logistics

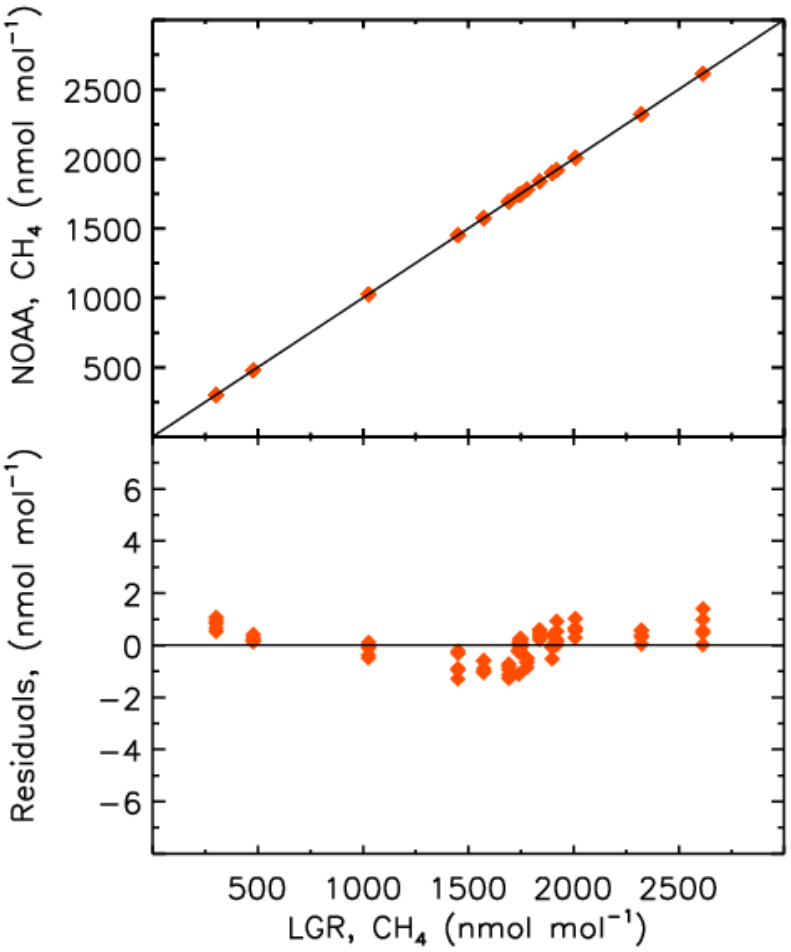
Standards

Components of Cooperative Air Sampling and Measurement Network

Flask prep

Personal contacts

Logistics



e Collection

Check in

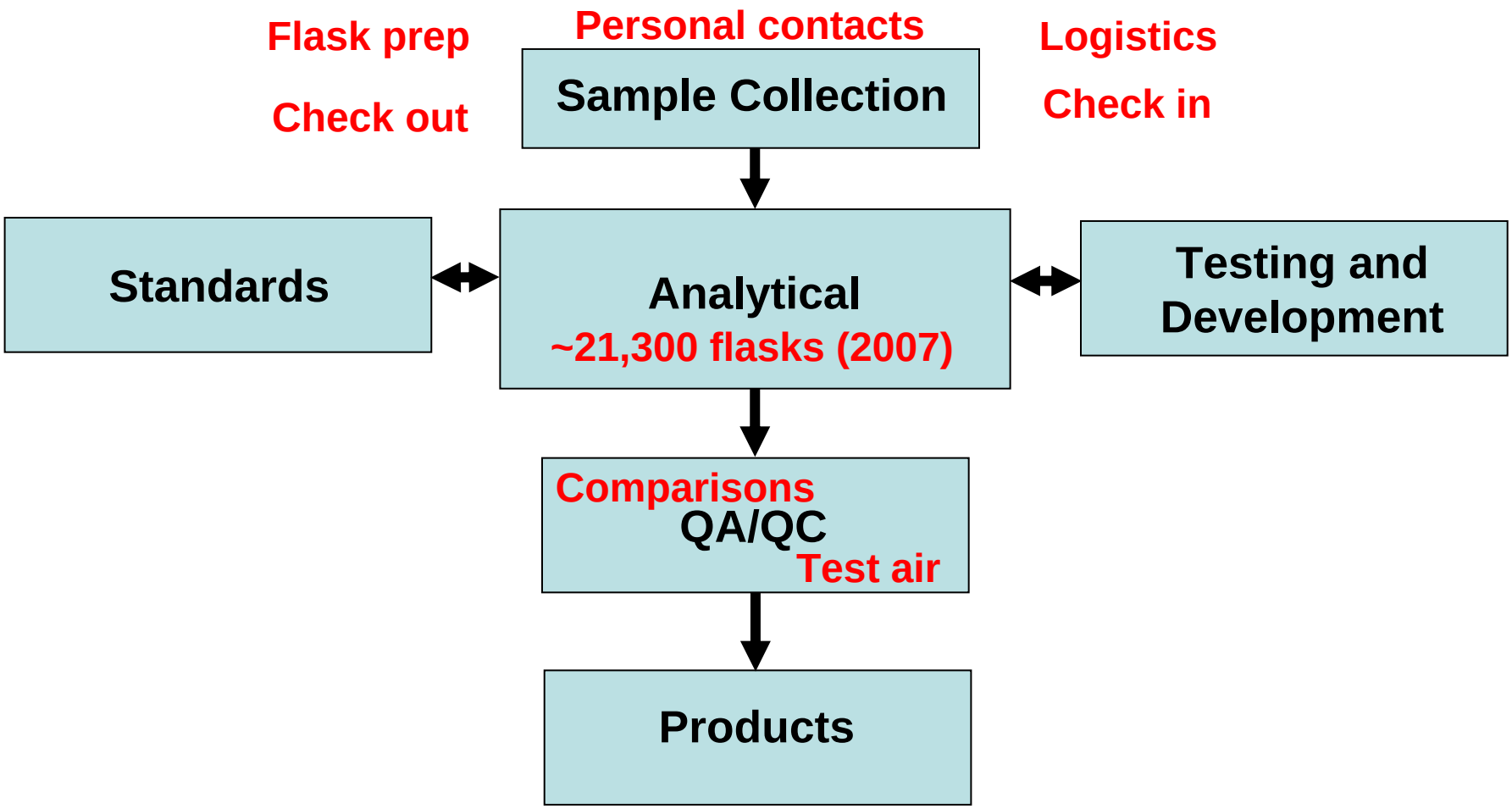
alytical
flasks (2007)

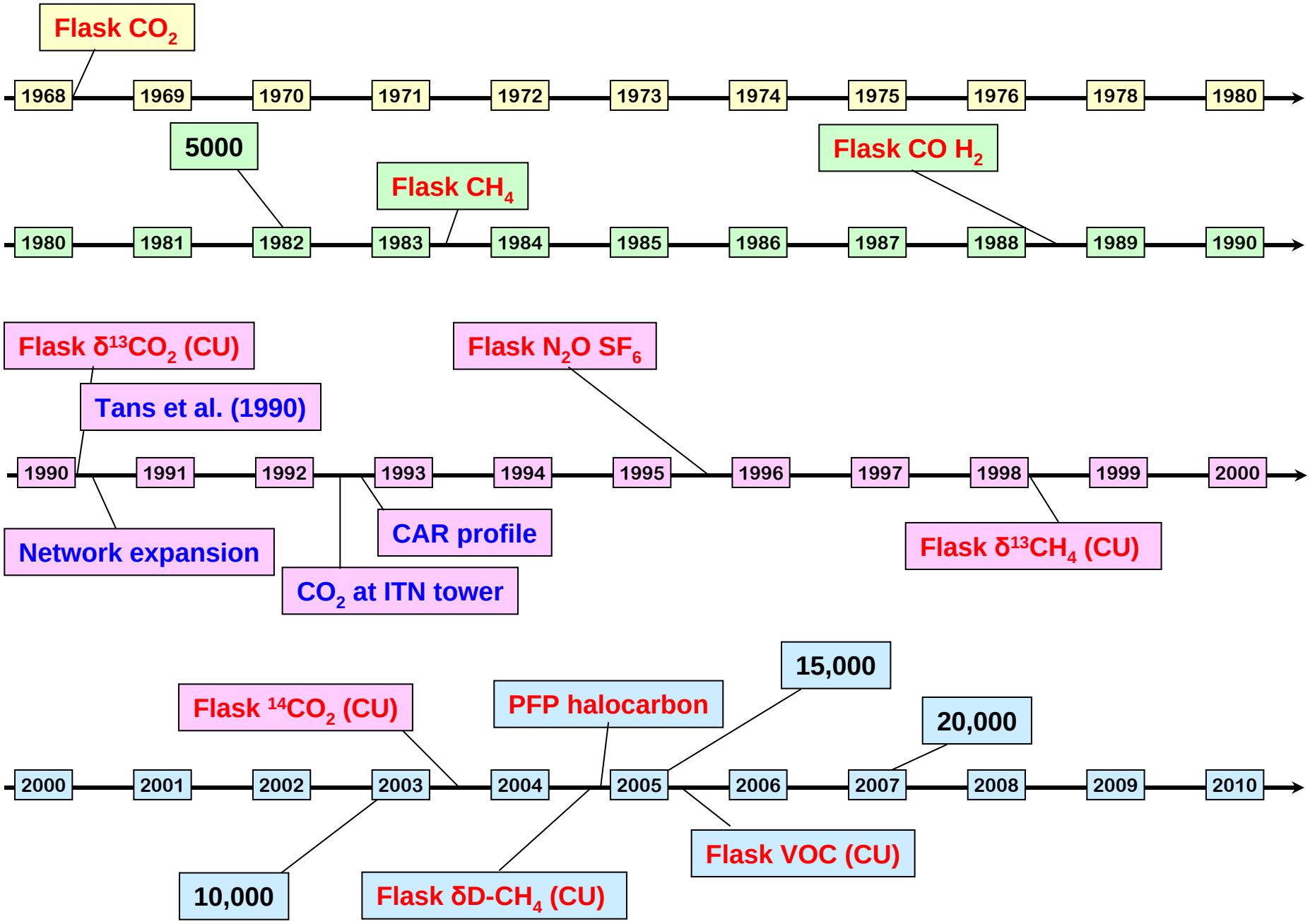
Testing and Development

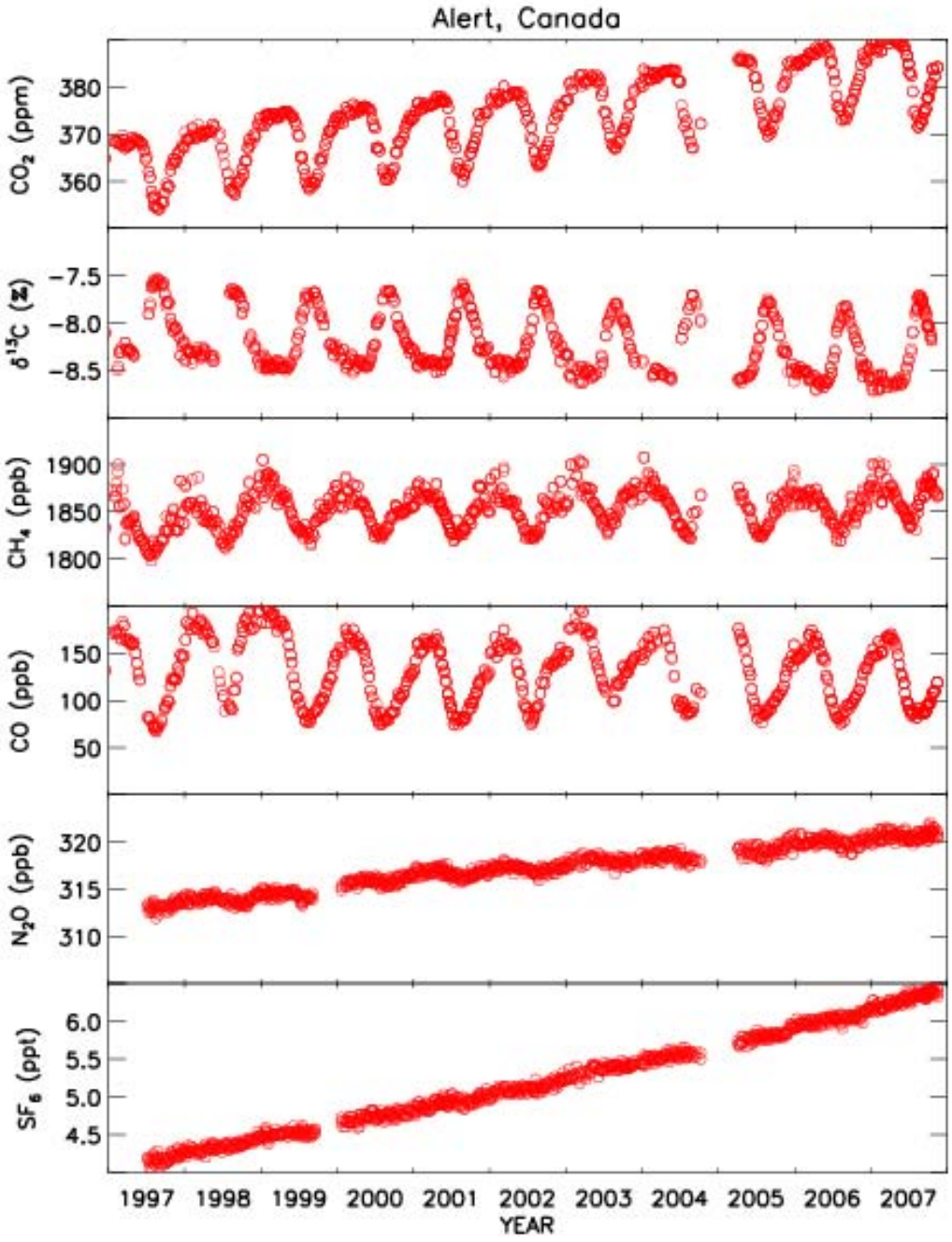
risons
QA/QC
Test air

oducts

Components of Cooperative Air Sampling and Measurement Network




Flask CO_2
1968
1969
1970
1971
1972
1973
1974
1975
1976
1978
1980
5000
Flask CH_4
Flask CO H_2
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
Flask $\delta^{13}CO_2$ (CU)
Tans et al. (1990)
Flask N_2O SF_6
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Network expansion
CAR profile
CO_2 at ITN tower
Flask $\delta^{13}CH_4$ (CU)
15,000
Flask $^{14}CO_2$ (CU)
PFP halocarbon
20,000
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Flask VOC (CU)
10,000
Flask δD-CH_4 (CU)



Trend = 2.0 ppm yr^{-1}

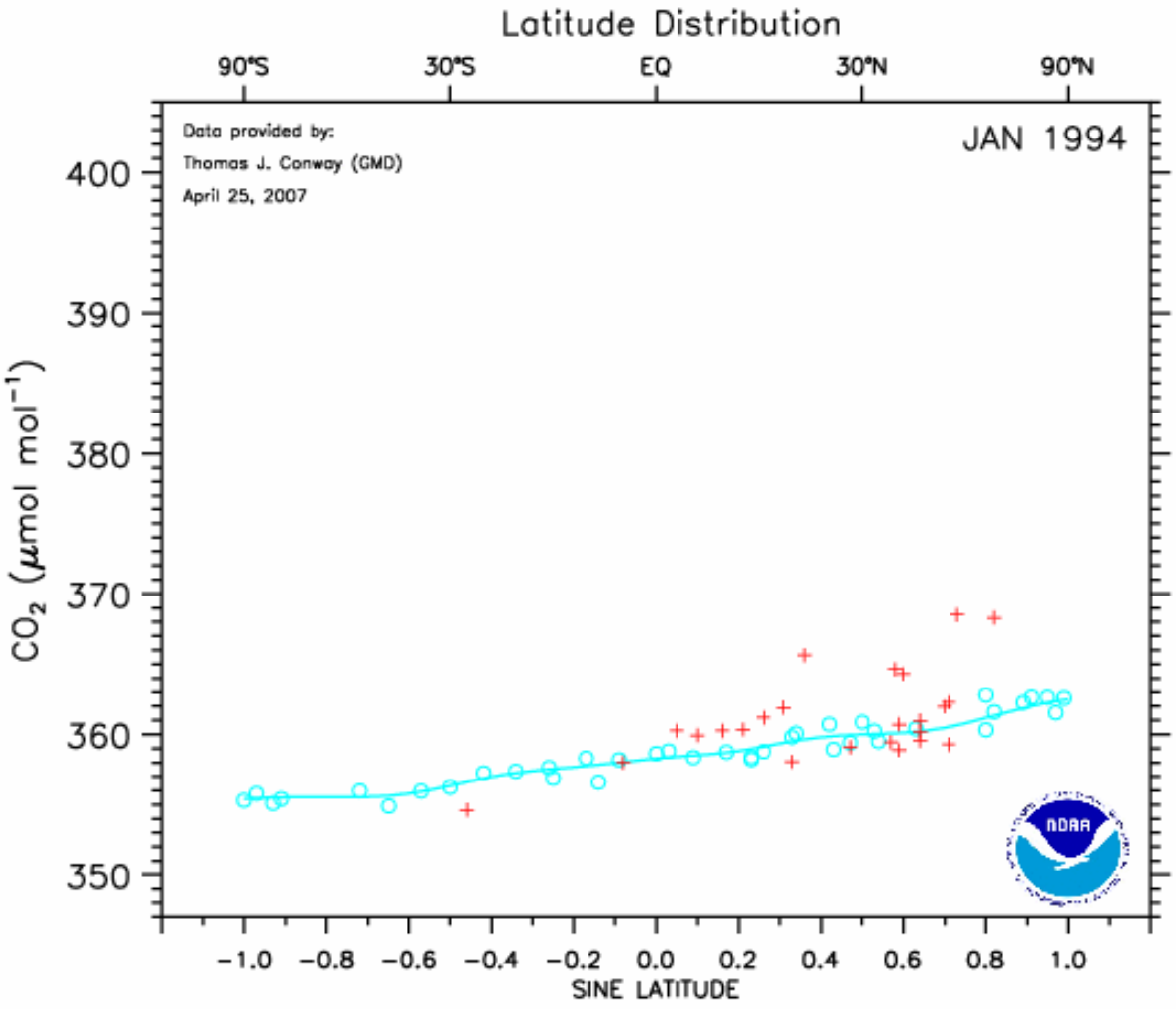
Trend = -0.03‰ yr^{-1} (INSTAAR)

Trend = 1.8 ppb yr^{-1}

Trend = -1.1 ppb yr^{-1}

Trend = 0.7 ppb yr^{-1}

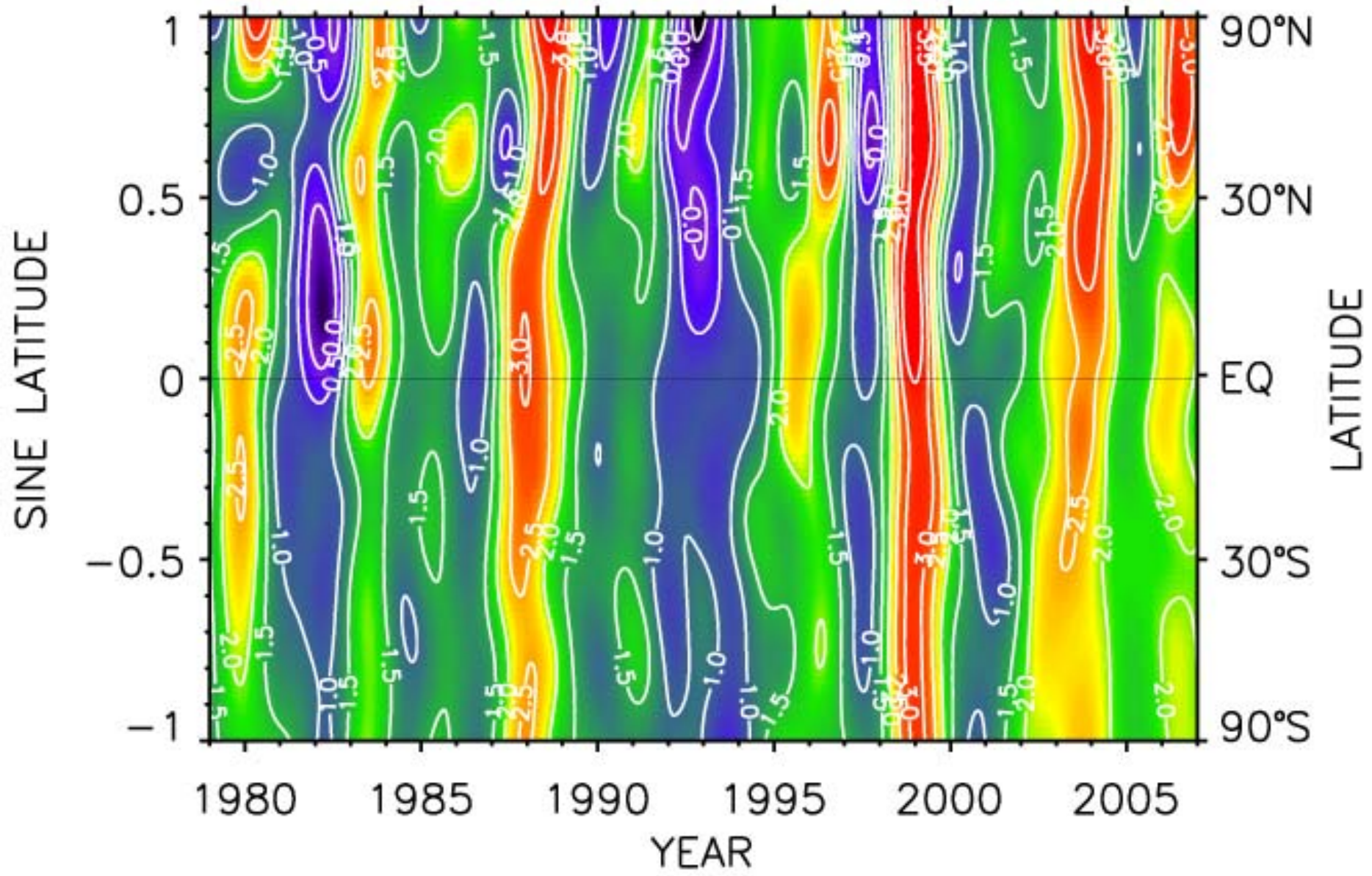
Trend = 0.2 ppt yr^{-1}



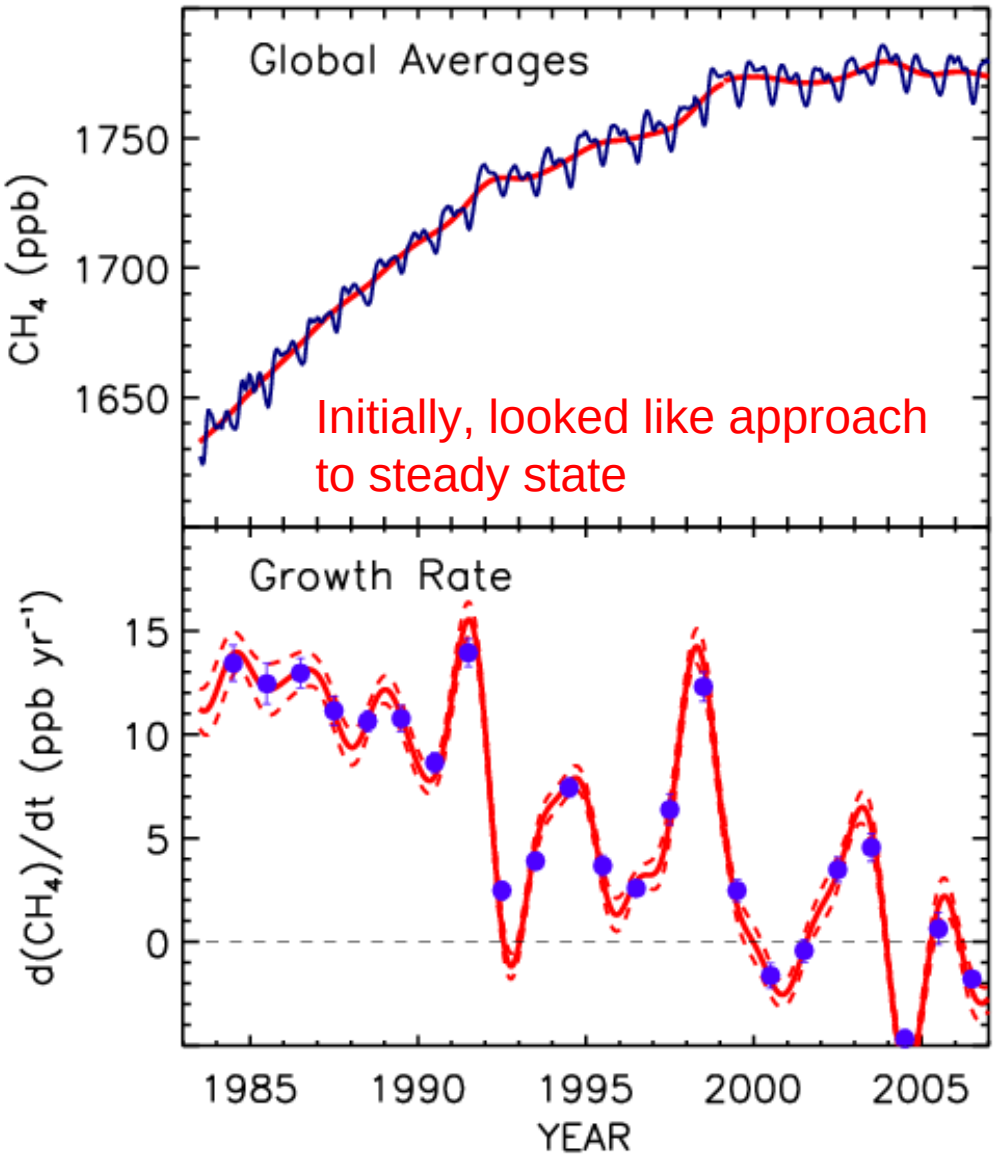
Le Quéré et al. SCIENCE, 316, 2007: S. Ocean CO_2 sink decreased by 0.03 Pg C yr^{-1} decade^{-1} from 1981-2004.

http://www.esrl.noaa.gov/gmd/ccgg/globalview/

CO_2 Growth Rate



Globally Averaged CH_4

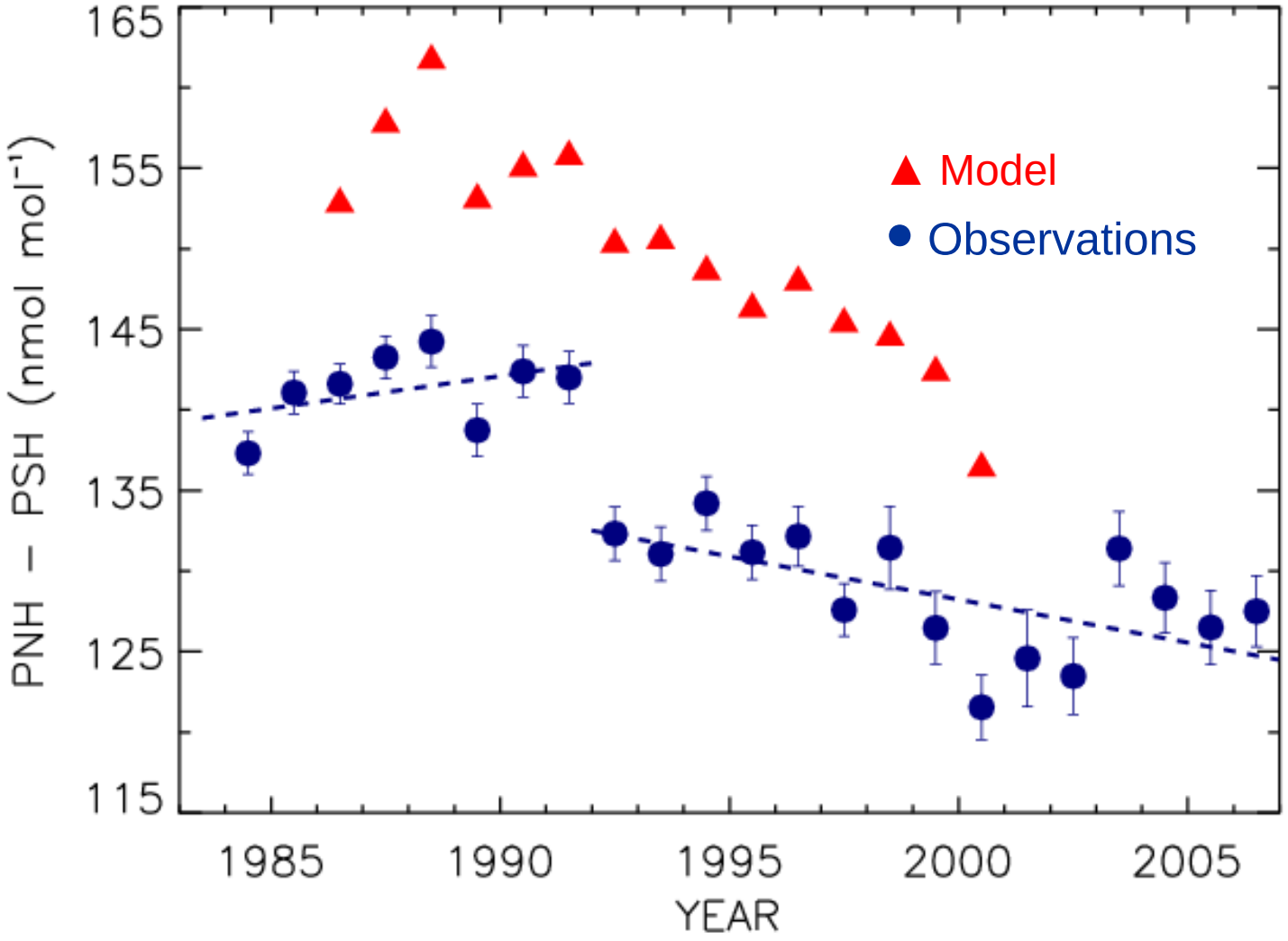


Little increase since 1999.

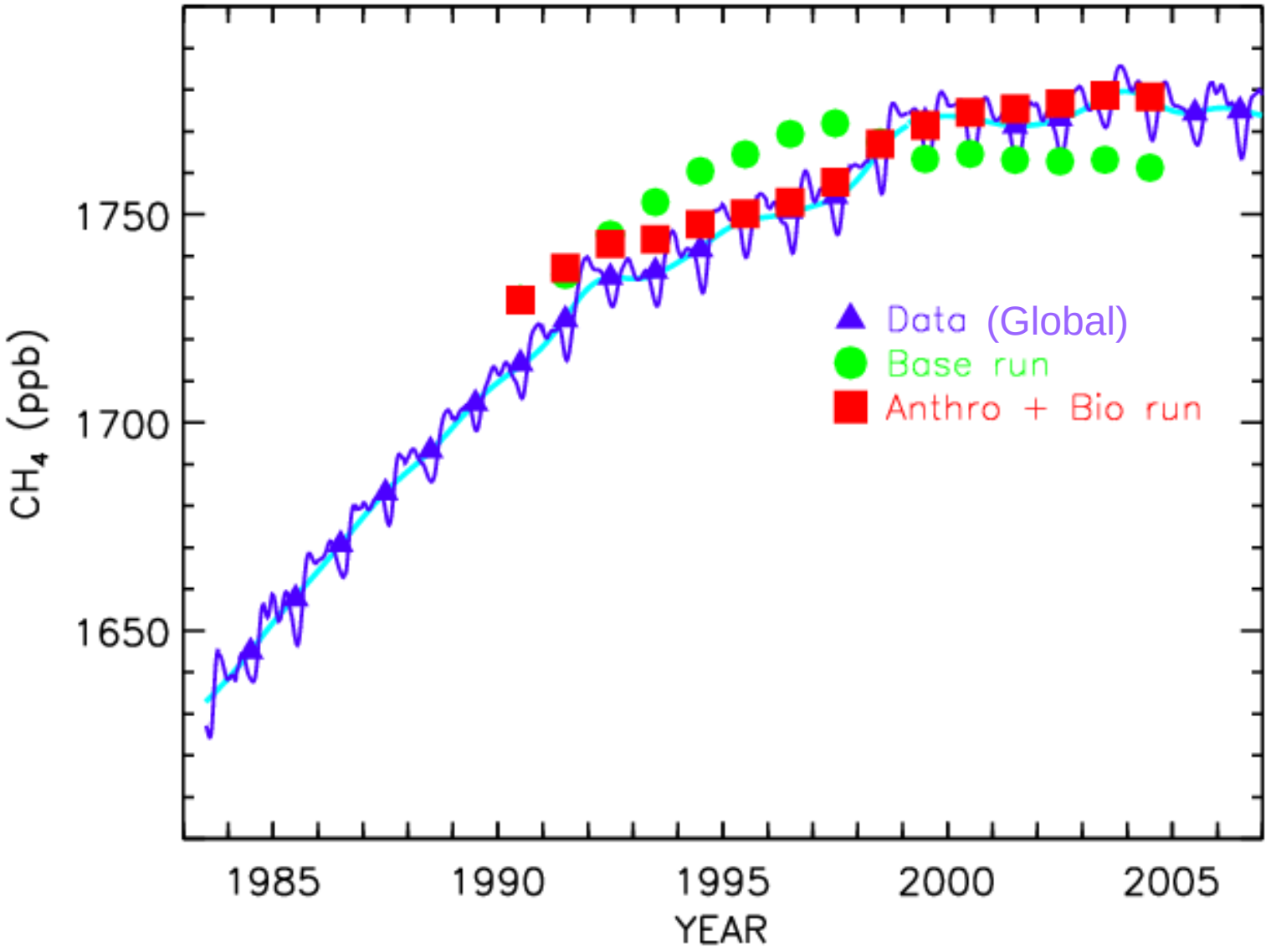
Growth rate continues to decrease.

Will this continue?

Interpolar difference



Updated from: Dlugokencky et al., Geophys. Res. Lett., 30 (19), 1992, doi:10.1029/2003GL018126, 2003.



Fiore et al., GRL, 33, 2006: Suggests significant impact of climate change (T and lightning) on CH_4 trend.

Scientific Payoff

- NOAA ESRL program forms core of WMO GAW and GEOSS GHG networks
  - Data used in GHG budget studies
- Sufficient coverage to establish surface boundary conditions and large scale budgets
  - Verify satellite retrievals

Future of Network

- Enhance background network
  - Increase sampling from ships (Atlantic, S. Ocean)
  - Improve existing methods
- Detect changes in Arctic CH_4 emissions
  - CH_4, CO_2 measurements planned for Siberia
  - New flask site in La Biche, Alberta (isotopes)
  - Discussions with USGS for Yukon Basin
- Verify North American CH_4 emissions
  - Add CH_4 measurements to tall towers