An Update on the Atmospheric Methane Growth Rate: Growth Surges During 2014

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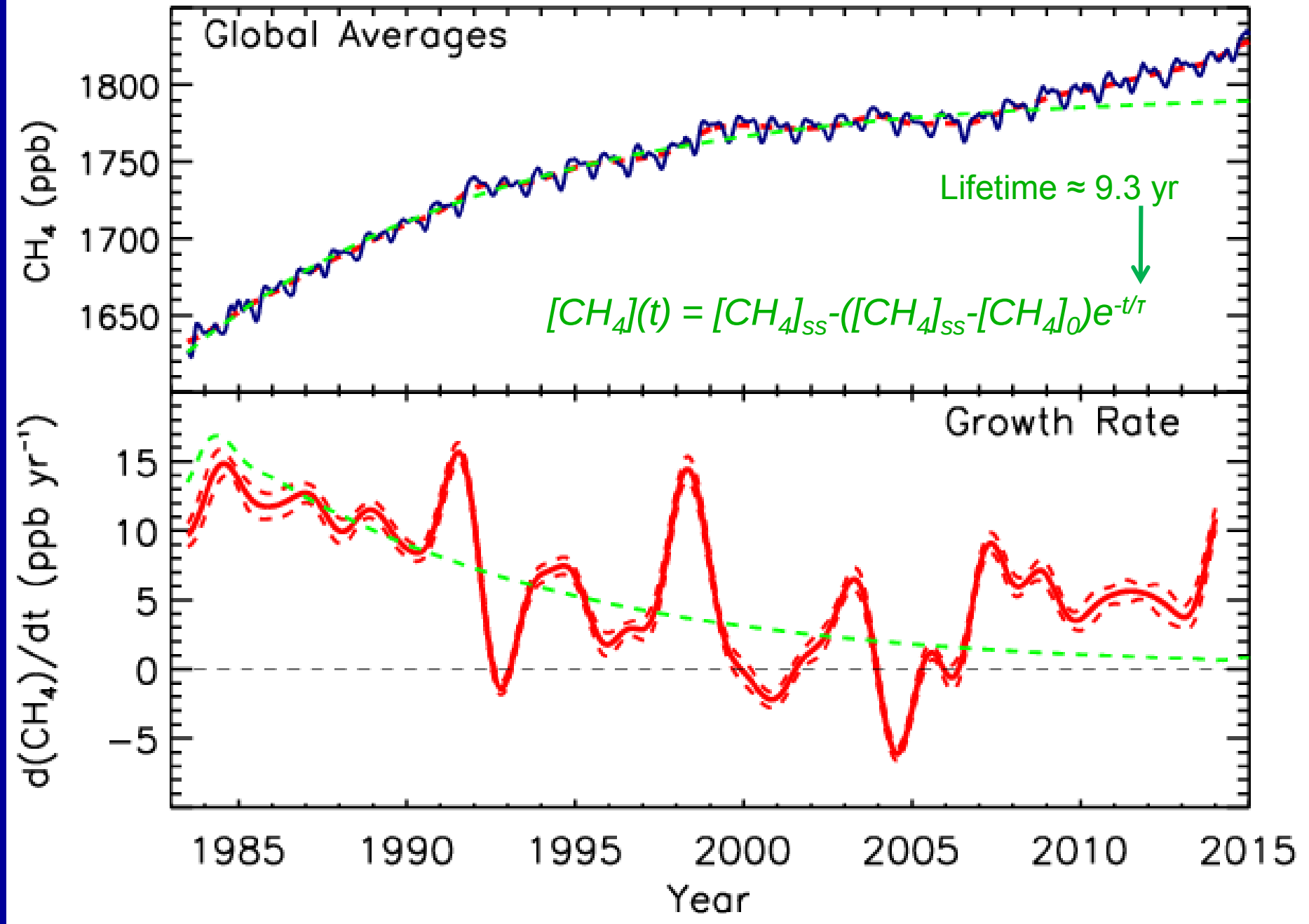
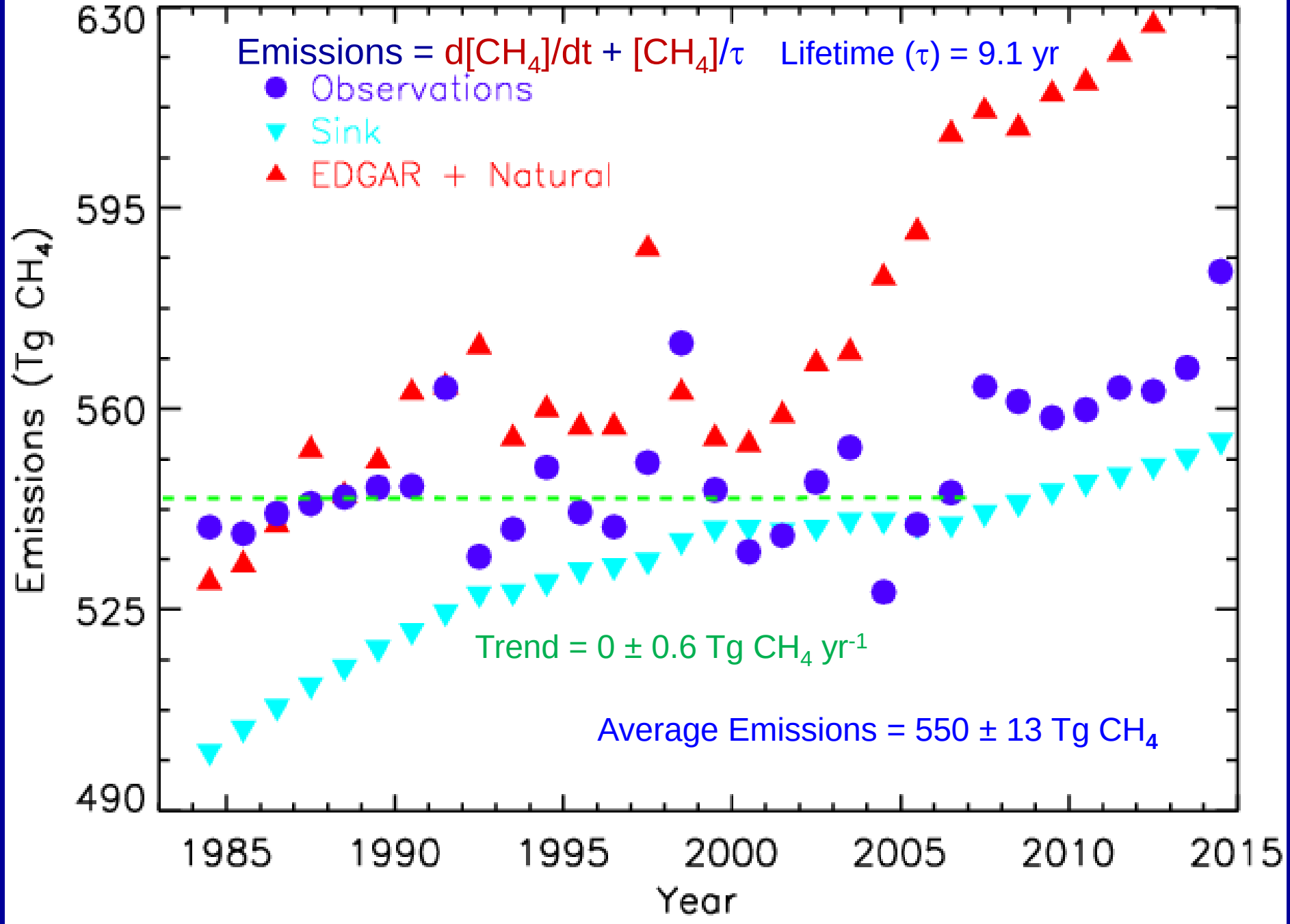
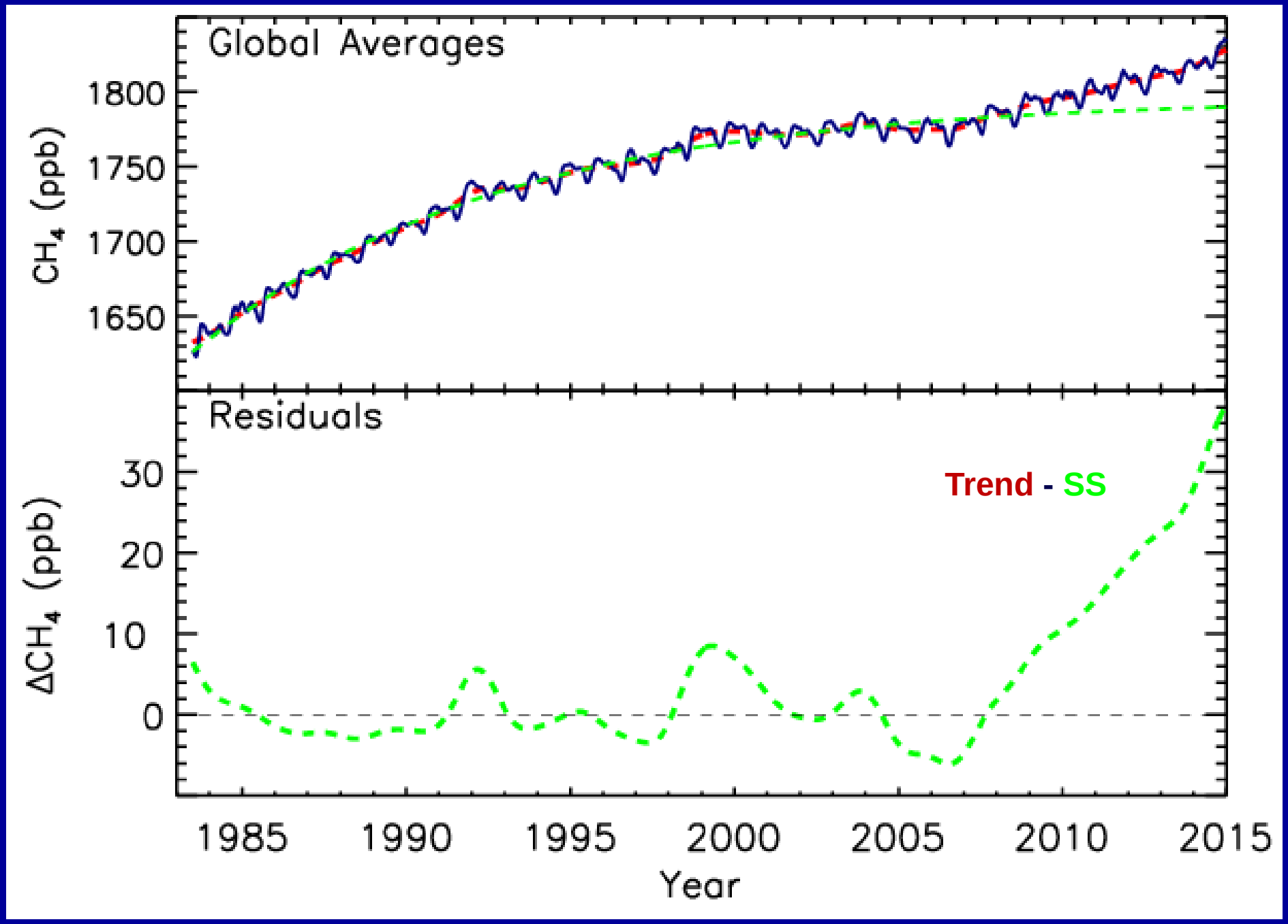
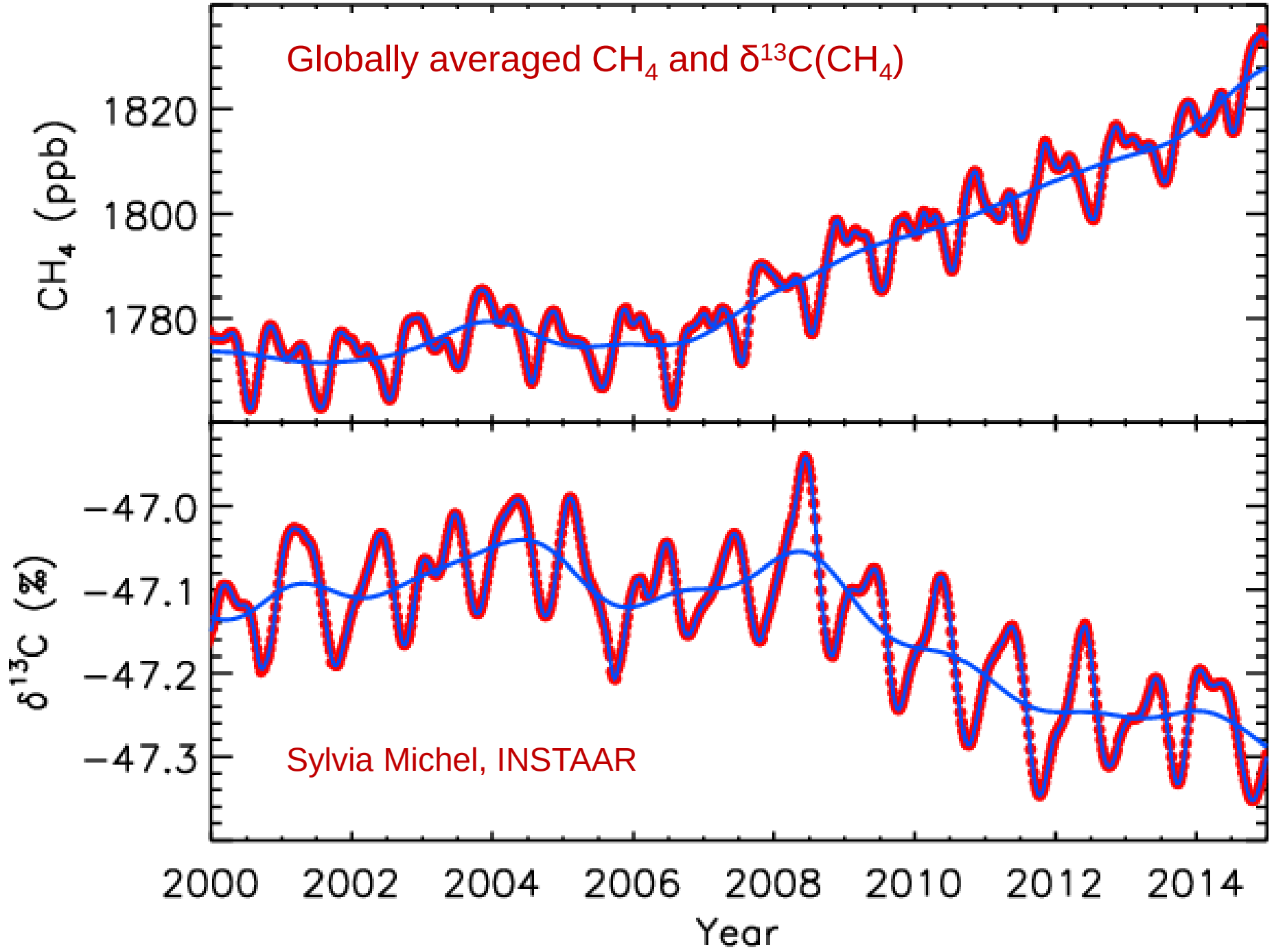
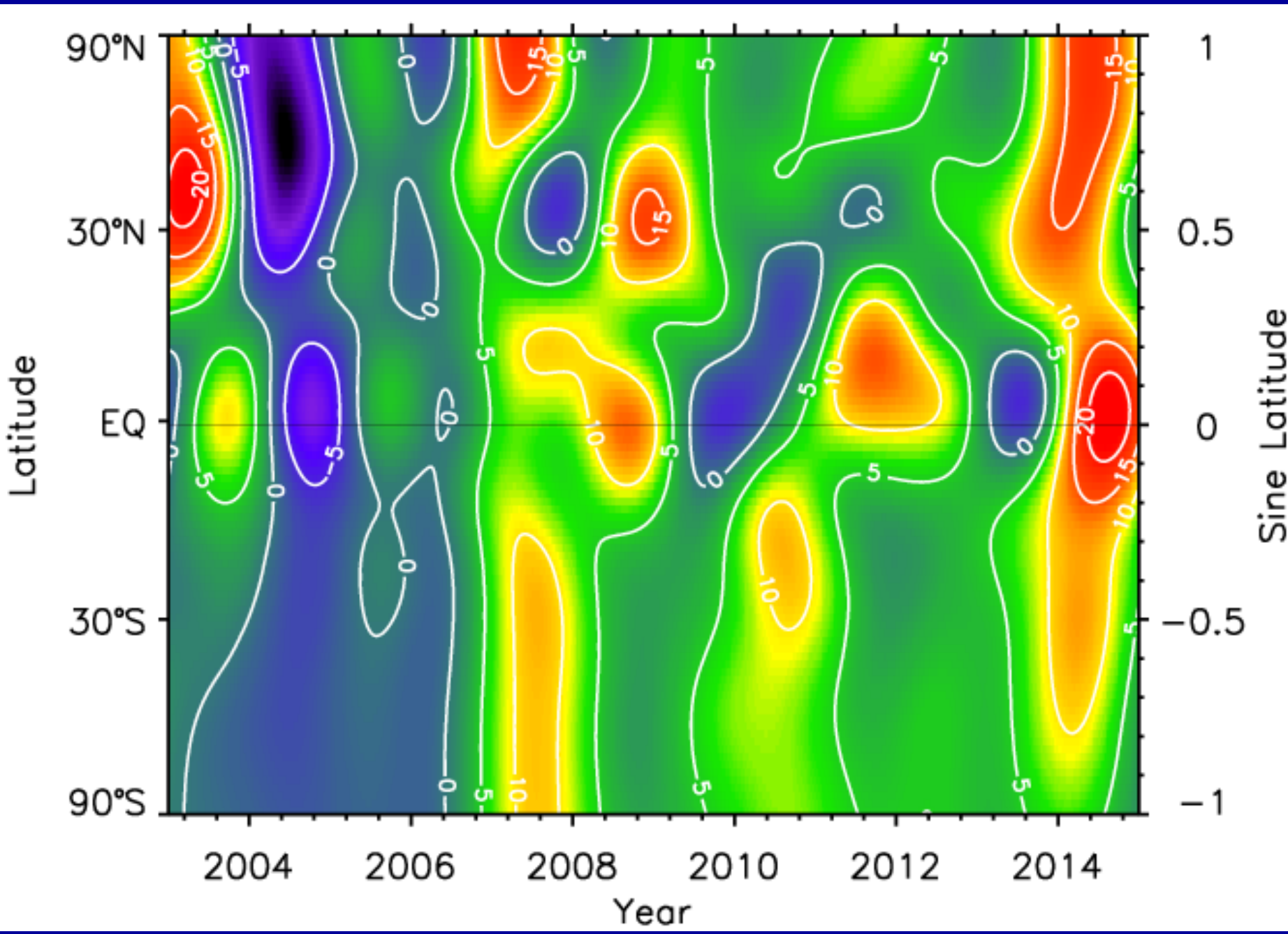
[1]NOAA ESRL GMD, [2]CIRES,

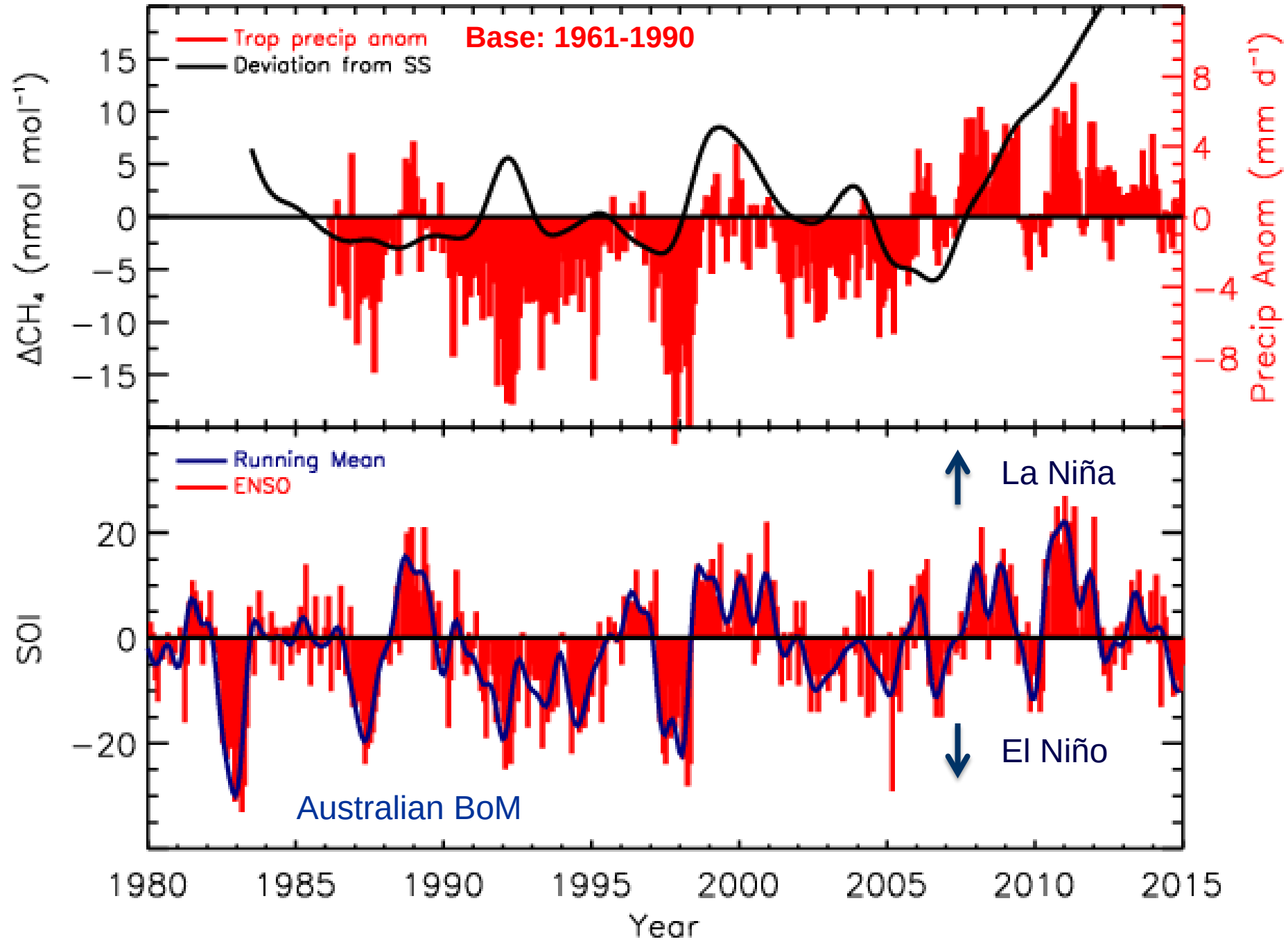

Global Averages
1800
1750
1700
1650
CH4 (ppb)
Lifetime ≈ 9.3 yr
[CH4](t) = [CH4]ss-([CH4]ss-[CH4]0)e-t/τ
Growth Rate
15
10
5
0
−5
d(CH4)/dt (ppb yr-1)
1985
1990
1995
2000
2005
2010
2015
Year

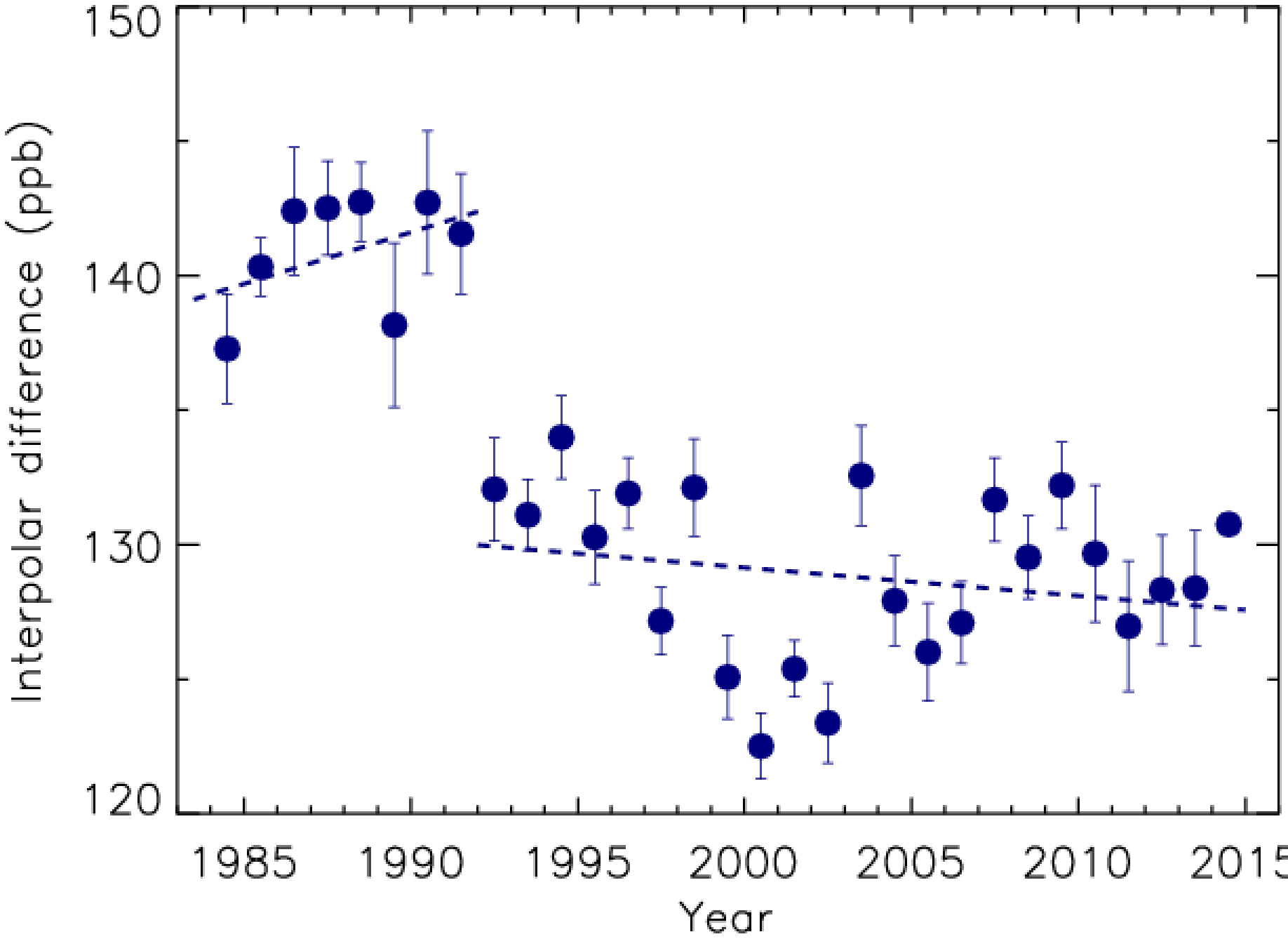

Emissions = d[CH4]/dt + [CH4]/τ
Lifetime (τ) = 9.1 yr
Observations
Sink
EDGAR + Natural
Trend = 0 ± 0.6 Tg CH4 yr-1
Average Emissions = 550 ± 13 Tg CH4
Emissions (Tg CH4)
Year
630
595
560
525
490
1985
1990
1995
2000
2005
2010
2015


Global Averages
1800
1750
1700
1650
CH4 (ppb)
Residuals
30
20
10
0
ΔCH4 (ppb)
Trend - SS
1985
1990
1995
2000
2005
2010
2015
Year


Globally averaged CH_4 and $\delta^{13}C(CH_4)$
CH_4 (ppb)
1820
1800
1780
$\delta^{13}C$ (‰)
−47.0
−47.1
−47.2
−47.3
Sylvia Michel, INSTAAR
2000
2002
2004
2006
2008
2010
2012
2014
Year

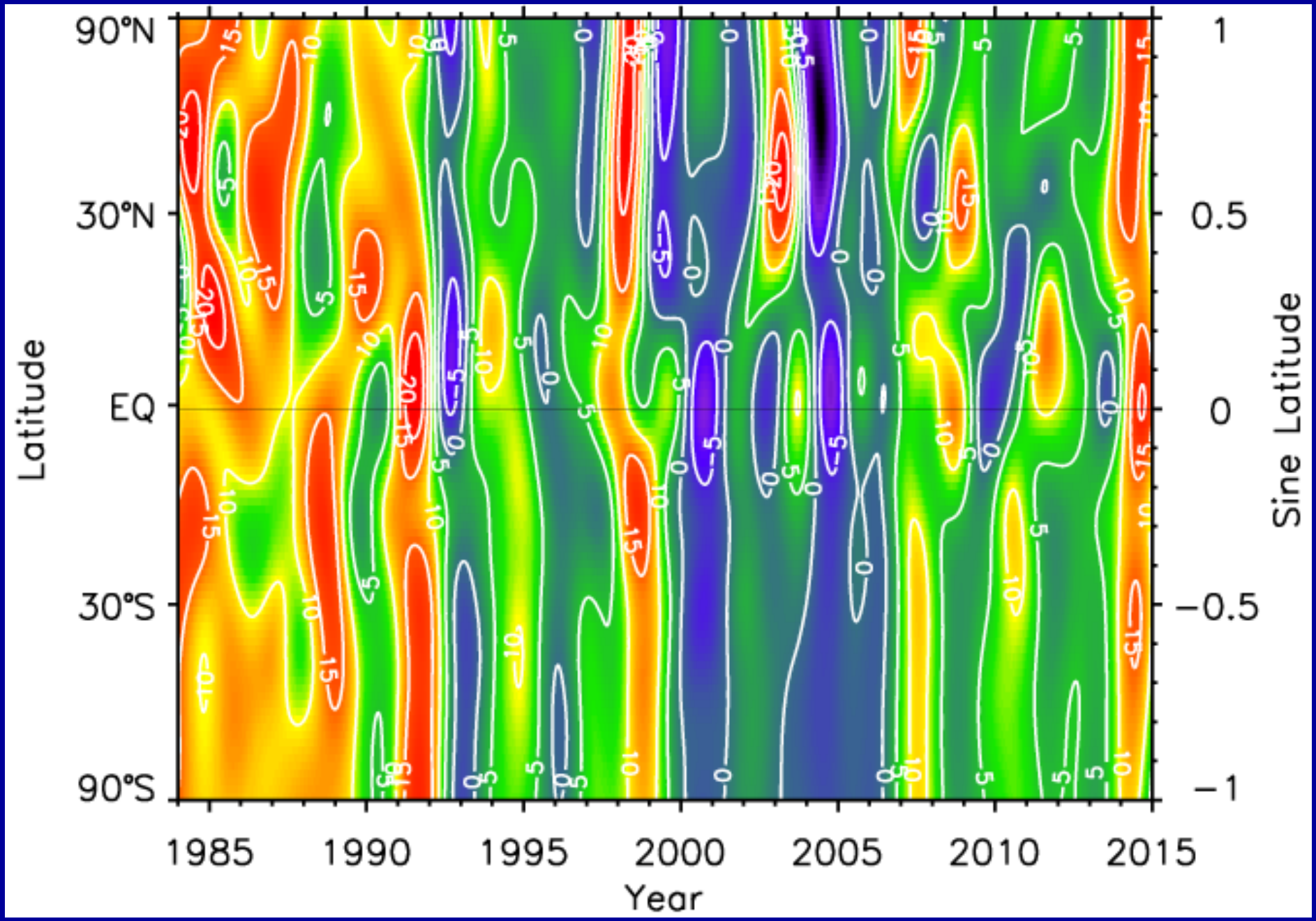

90°N
30°N
EQ
30°S
90°S
Latitude
1
0.5
0
−0.5
−1
Sine Latitude
2004
2006
2008
2010
2012
2014
Year

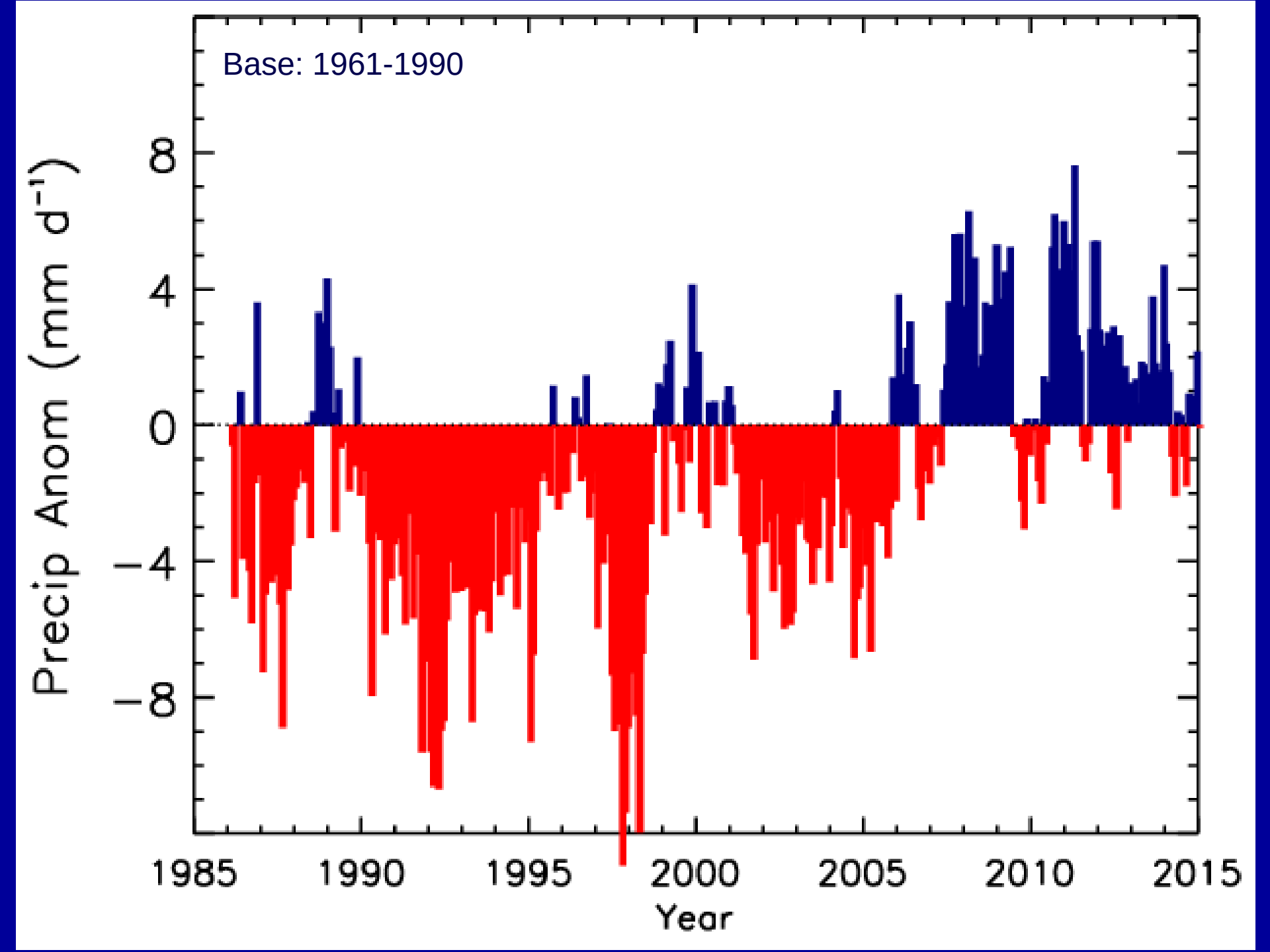

Trop precip anom
Deviation from SS
Base: 1961-1990
ΔCH4 (nmol mol-1)
Precip Anom (mm d-1)
Running Mean
ENSO
SOI
La Niña
El Niño
Australian BoM
Year
1980
1985
1990
1995
2000
2005
2010
2015

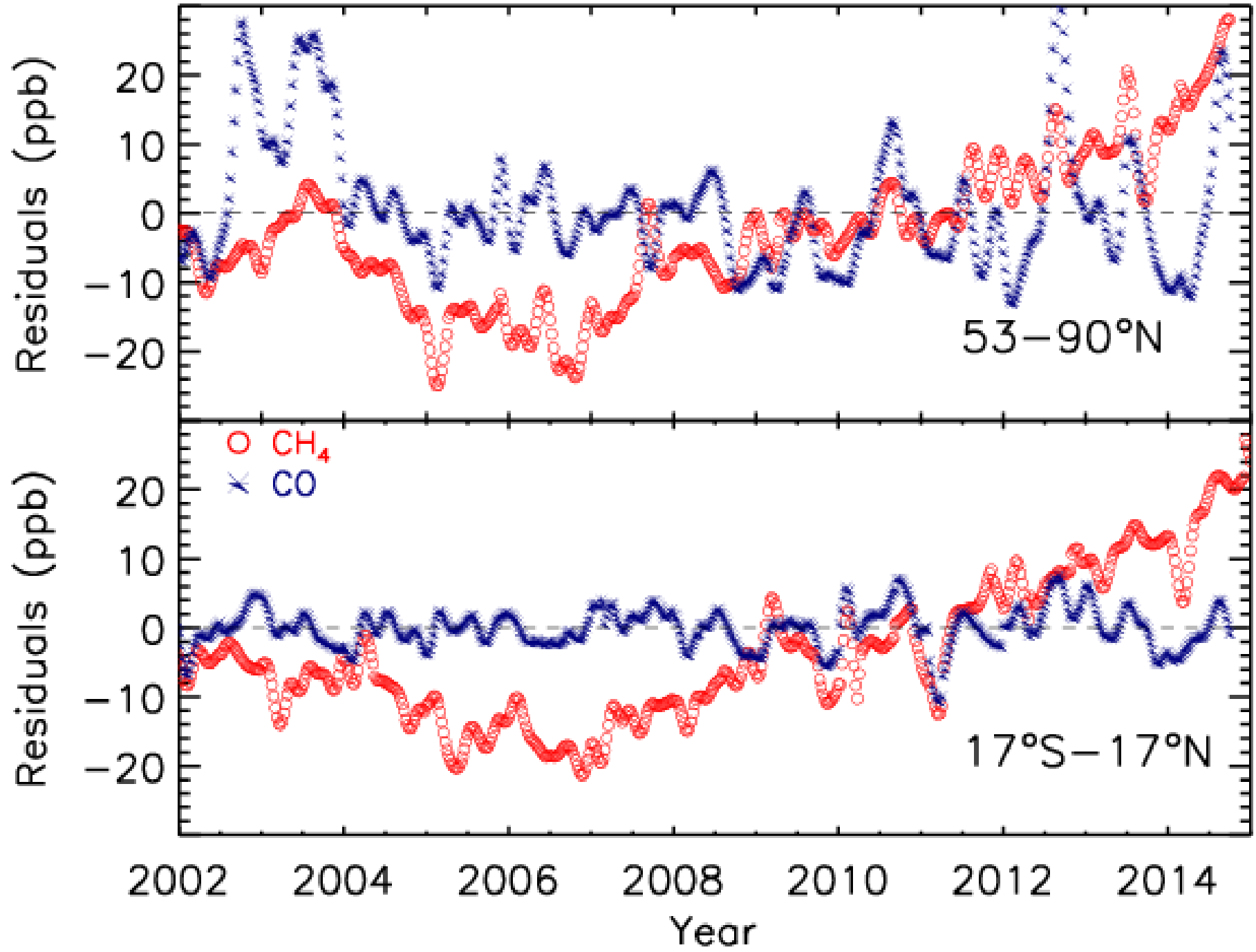

150
140
130
120
Interpolar difference (ppb)
1985
1990
1995
2000
2005
2010
2015
Year

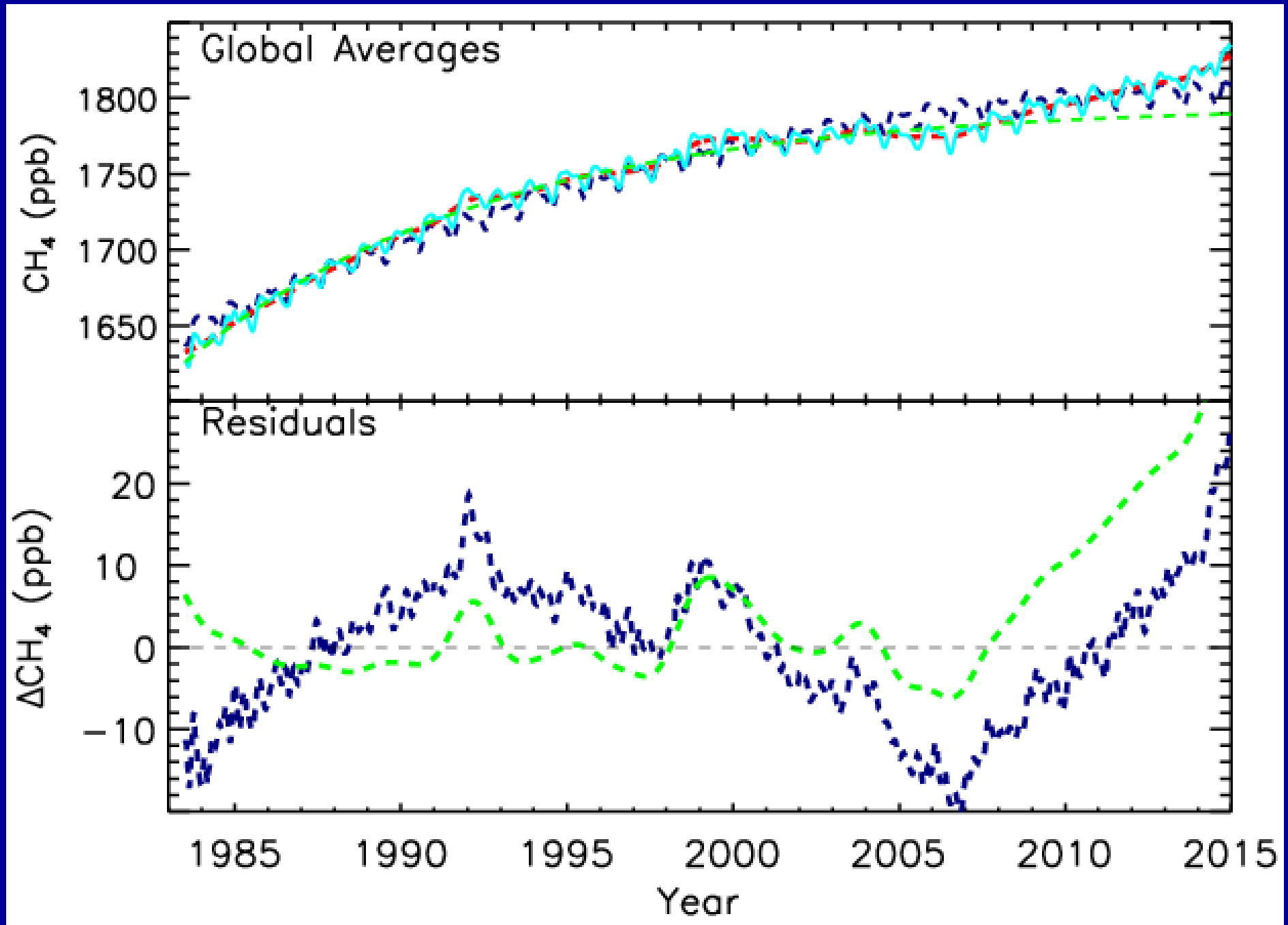
Conclusions

- Constant global emissions: 1984-2006
  - Emissions from some sectors changing
  - Changes in WL emissions may have masked increased anthropogenic emissions
- Increased GR and emissions since 2007
  - Changes in tropical precipitation (ENSO)
    - Caused sea level to measurably decrease
  - $\delta^{13}C$ (CH_4) indicates microbial source
- 2014: CH_4 GR surged (~11 ppb)
  - Globally warm, but reasons unclear


90°N
30°N
EQ
30°S
90°S
Latitude
1
0.5
0
−0.5
−1
Sine Latitude
1985
1990
1995
2000
2005
2010
2015
Year


Base: 1961-1990
Precip Anom (mm d⁻¹)
8
4
0
−4
−8
1985
1990
1995
2000
2005
2010
2015
Year


Residuals (ppb)
20
10
0
−10
−20
53−90°N
CH4
CO
17°S−17°N
2002
2004
2006
2008
2010
2012
2014
Year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Residuals
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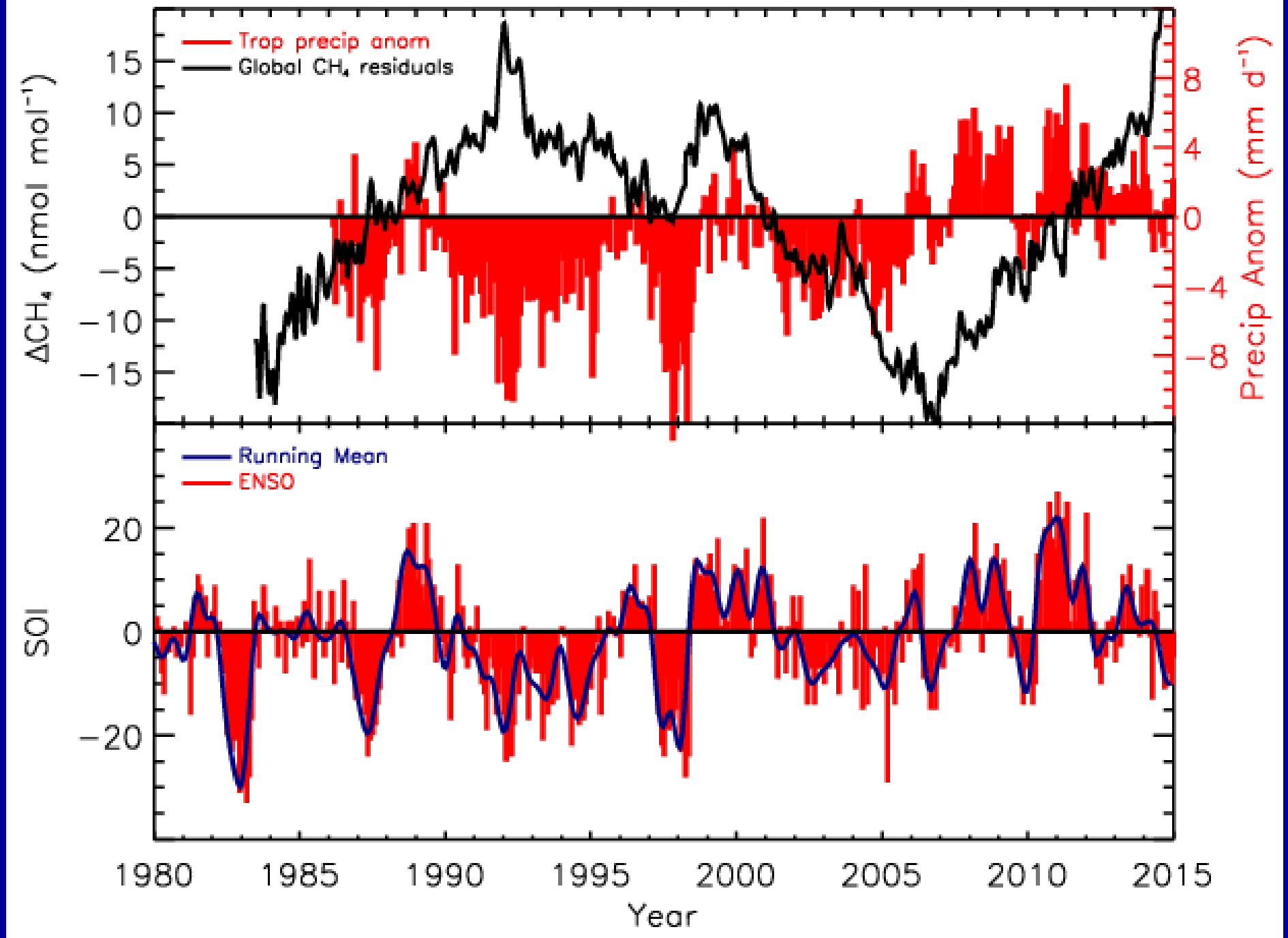
−10
ΔCH4 (ppb)
1985
1990
1995
2000
2005
2010
2015
Year


Trop precip anom
Global CH4 residuals
ΔCH4 (nmol mol-1)
Precip Anom (mm d-1)
Running Mean
ENSO
SOI
Year
1980
1985
1990
1995
2000
2005
2010
2015

Possible changes to CH_4 emissions

- Rice: changing water management ↓
- FF sector: decreased venting and flaring ↓
- Emissions mitigation: M2M ↓
- FF emissions: hydraulic fracturing ↑
- Arctic permafrost and hydrates ↑

Global CH_4 Budget by Source

Source	Bousquet (Tg/yr)	IPCC Range (Tg/yr)
Anthropogenic		
Energy	110±13	74-106
Enteric fermentation	90±14	76-92
Rice agriculture	31±5	31-112
Biomass burning	50±8	14-88
Waste	55±11	35-69
Natural		
Wetlands	147±15	100-231
Termites	23±4	20-29
Oceans	19±6	4-15
Total	**525±8**	**503-610**

Sinks	Bousquet (Tg/yr)	IPCC (Tg/yr)
Troposphere	448±1	428-511
Stratosphere	37±1	30-45
Soil	21±3	26-34
Total	**506**	**492-581**

Bousquet et al., 2006, *Nature*, **443**, 439-443, doi:10.1038/nature05132.