CH4 TM5-4DVAR & Transport

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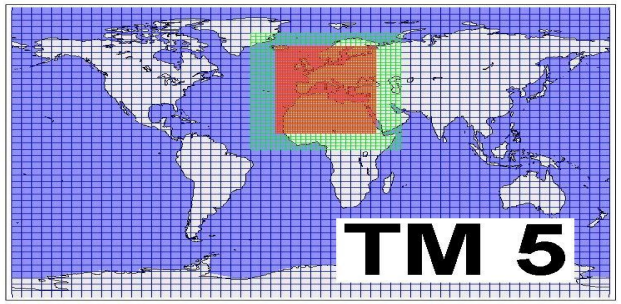
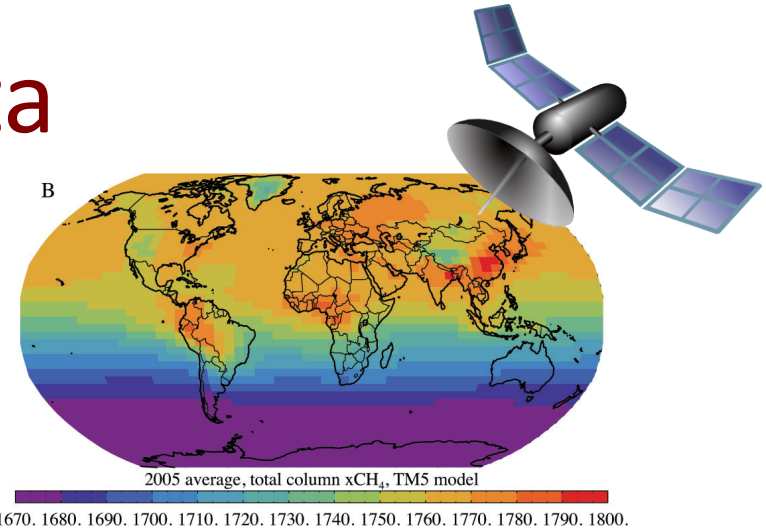
TM5 simulations

- CH4 4D-VAR 2003-2009 (3 overlapping blocks)
- In-situ / SCIAMACHY measurements
- Purpose: Estimation IAV methane sources
- Current stage: How to combine in-situ & SCIAMACHY data (bias correction algorithm)

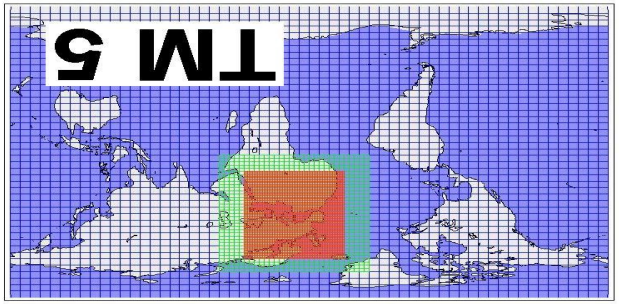
TM5 4D-VAR data assimilation



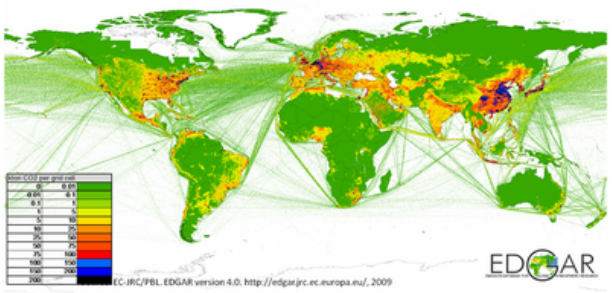
Transport model



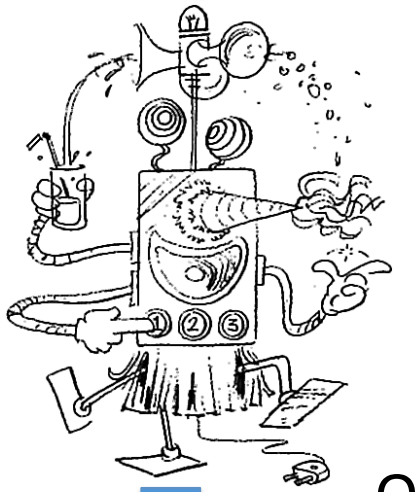
Model ⇔ measurements



Adjoint Transport model



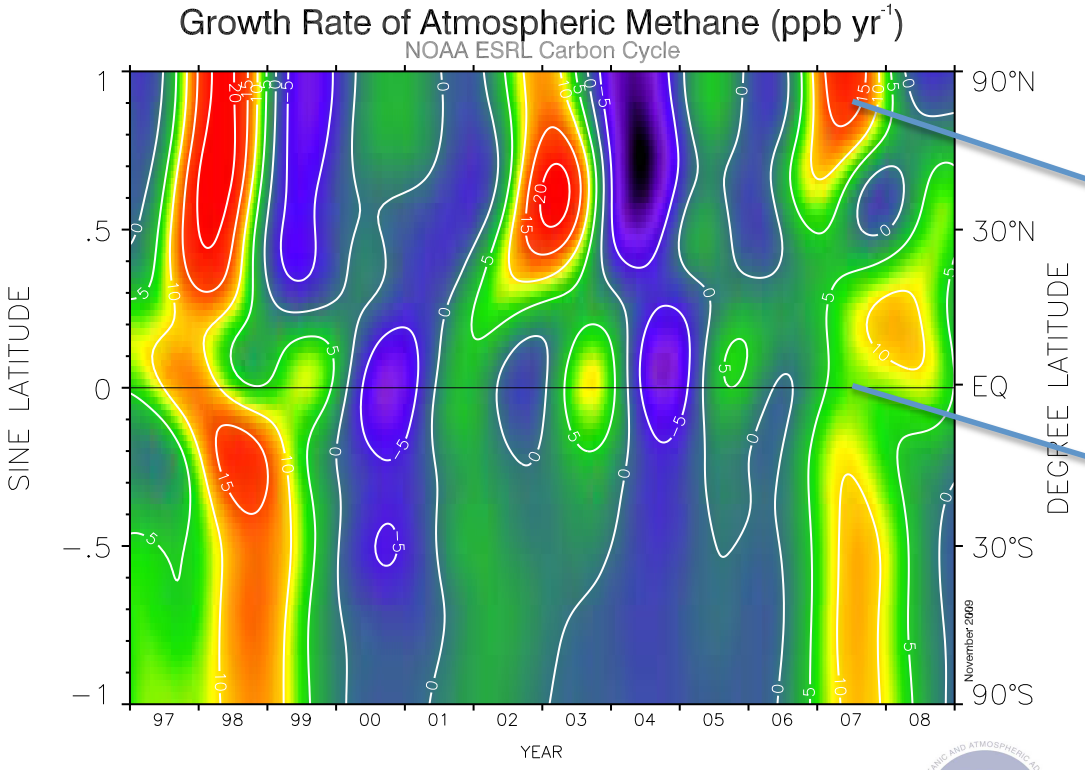
Emissions



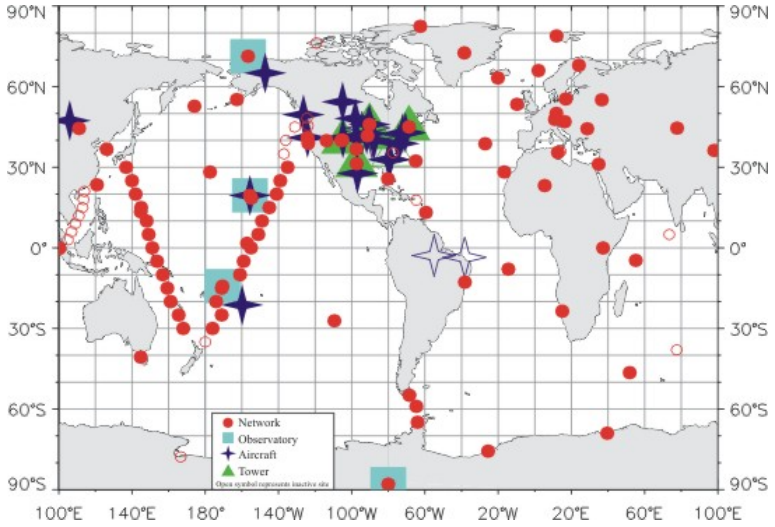
Optimization algorithm

Ingredient 1:

Dlugokenky et al., 2009 (NOAA flask network):



Contour plot showing the temporal and spatial variations in the atmospheric increases of methane. The cooler colors (green, blue, violet) represent periods of lower than average growth rates and the warmer colors (yellow, orange, red) represent periods of higher growth rates. The plot is derived from measurements of samples collected at the Carbon Cycle cooperative air sampling network sites. The variations in the growth rate of this climatically important gas are due to interannual variations in the imbalance between sources and sinks, and also to variations in atmospheric transport. Contact: Dr. Ed Dlugokencky, NOAA ESRL Carbon Cycle, Boulder, Colorado, (303) 497-6228, ed.dlugokencky@noaa.gov, http://www.esrl.noaa.gov/gmd/ccgg/.



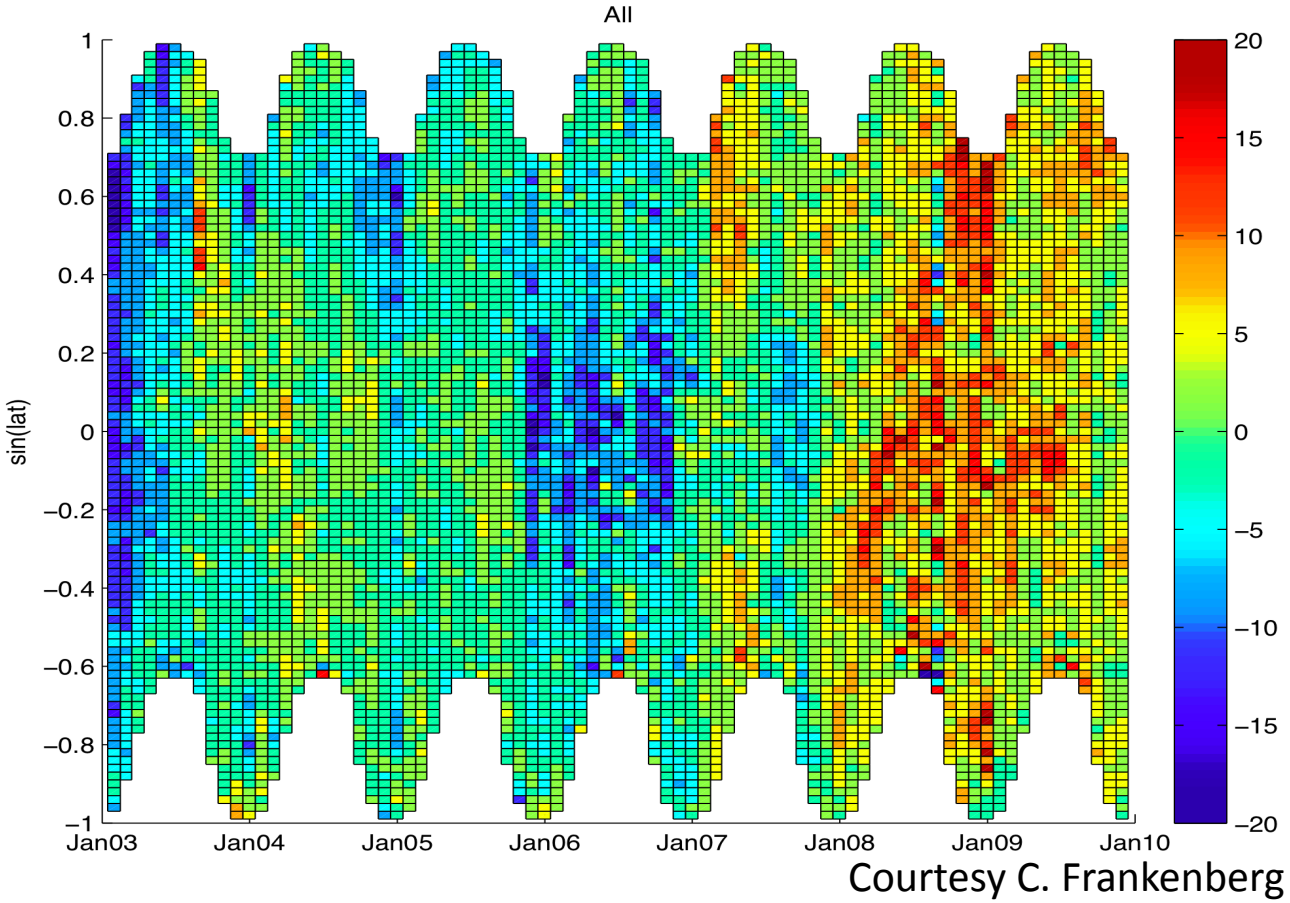
Northern wetlands (2007: Record low Arctic sea ice cover)

Tropical emissions?

Ingredient 2:

Frankenberg et al. (in preparation):

8 years of SCIAMACHY data (2003-2009)



Courtesy C. Frankenberg

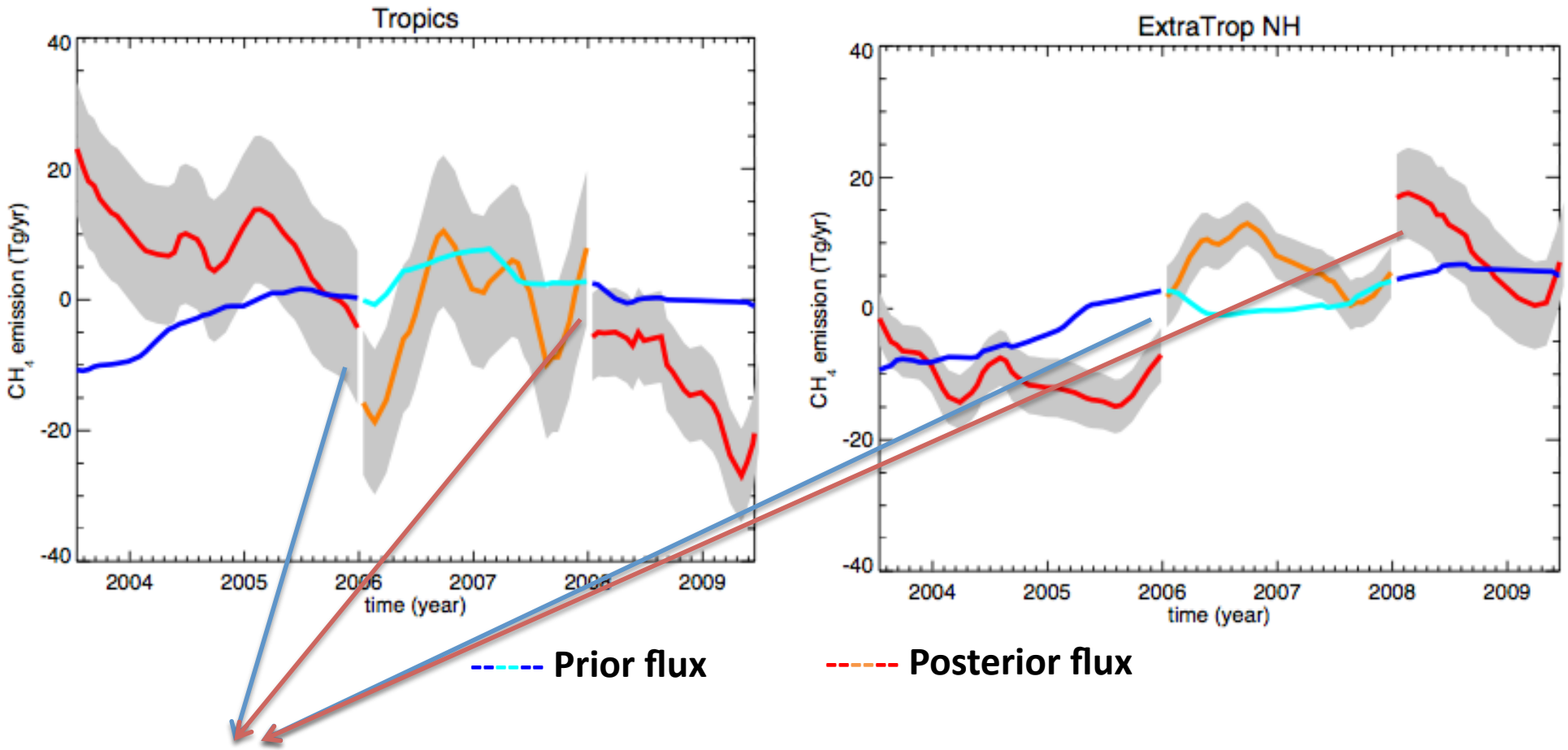
Good coverage in the Tropics!

Alternative view:

- Monotonic Anthropogenic Increase

- Negative tropical anomaly in 2006

Results: Tropics v. Extra tropics



- Jumps between inversion blocks
- Trading off tropics v. extratropics

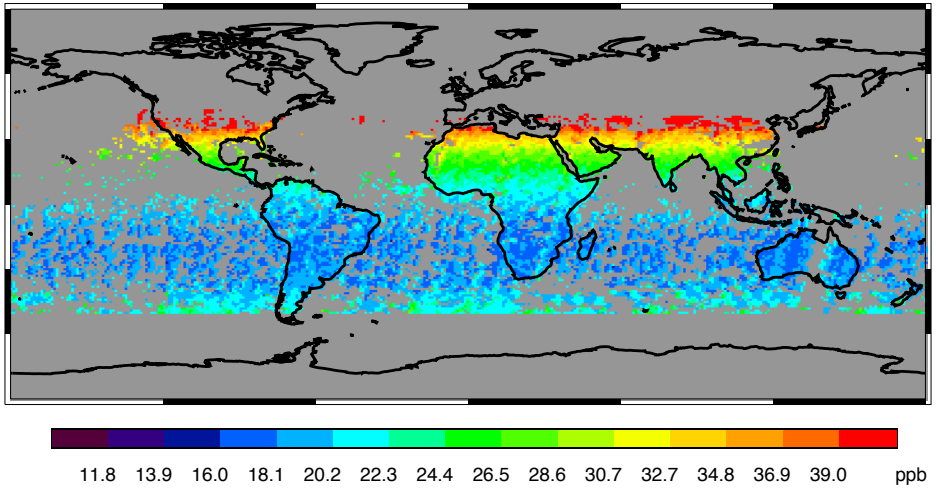
Bias correction

- Solve for: $BIAS_{block} = A.CH4 + B.(AMF - 2)$

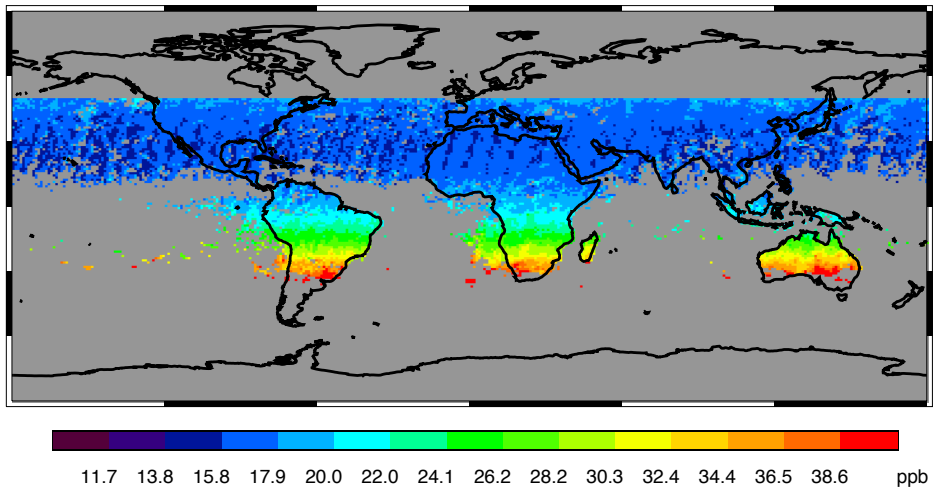
- Peter: $BIAS_{month} = A + B.Lat + C.Lat^2$

Optimized bias correction

Jan. 2005

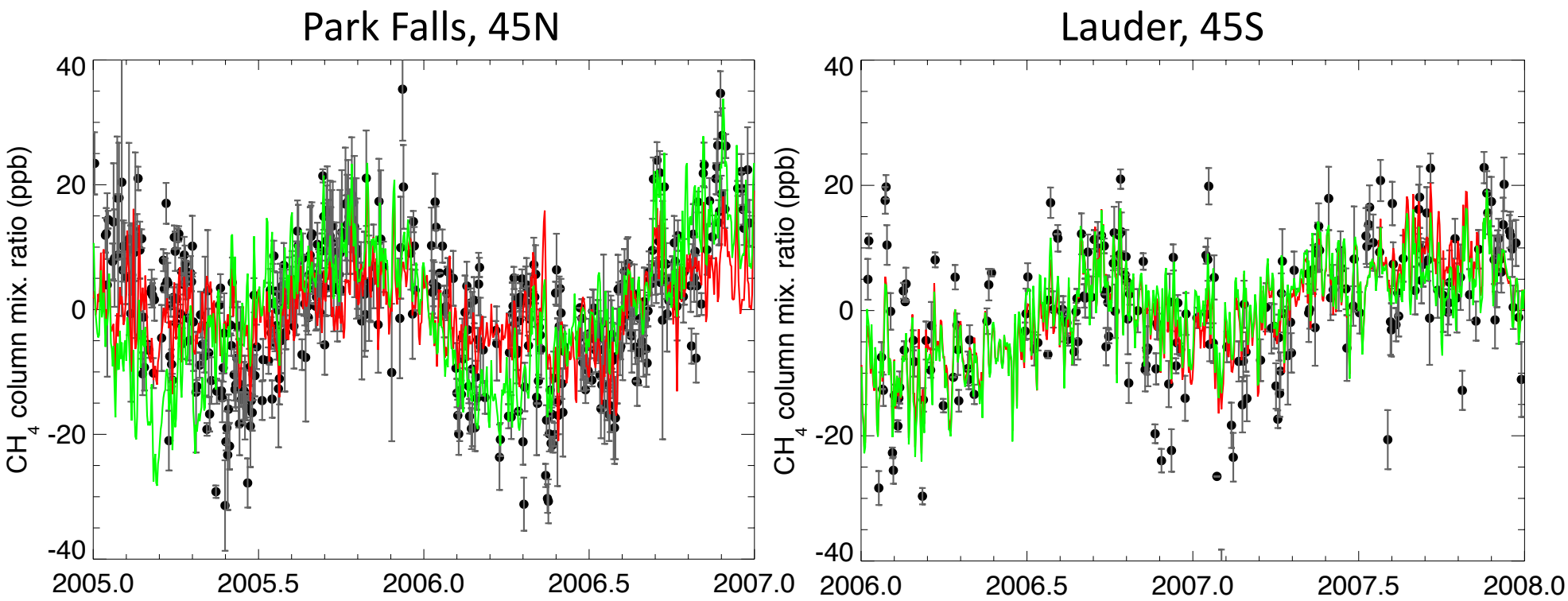


Jul. 2005



- BIAS formulation: seasonal & latitudinal corrections are linked
- Hypothesis: Latitudinal correction is in response to a seasonal problem

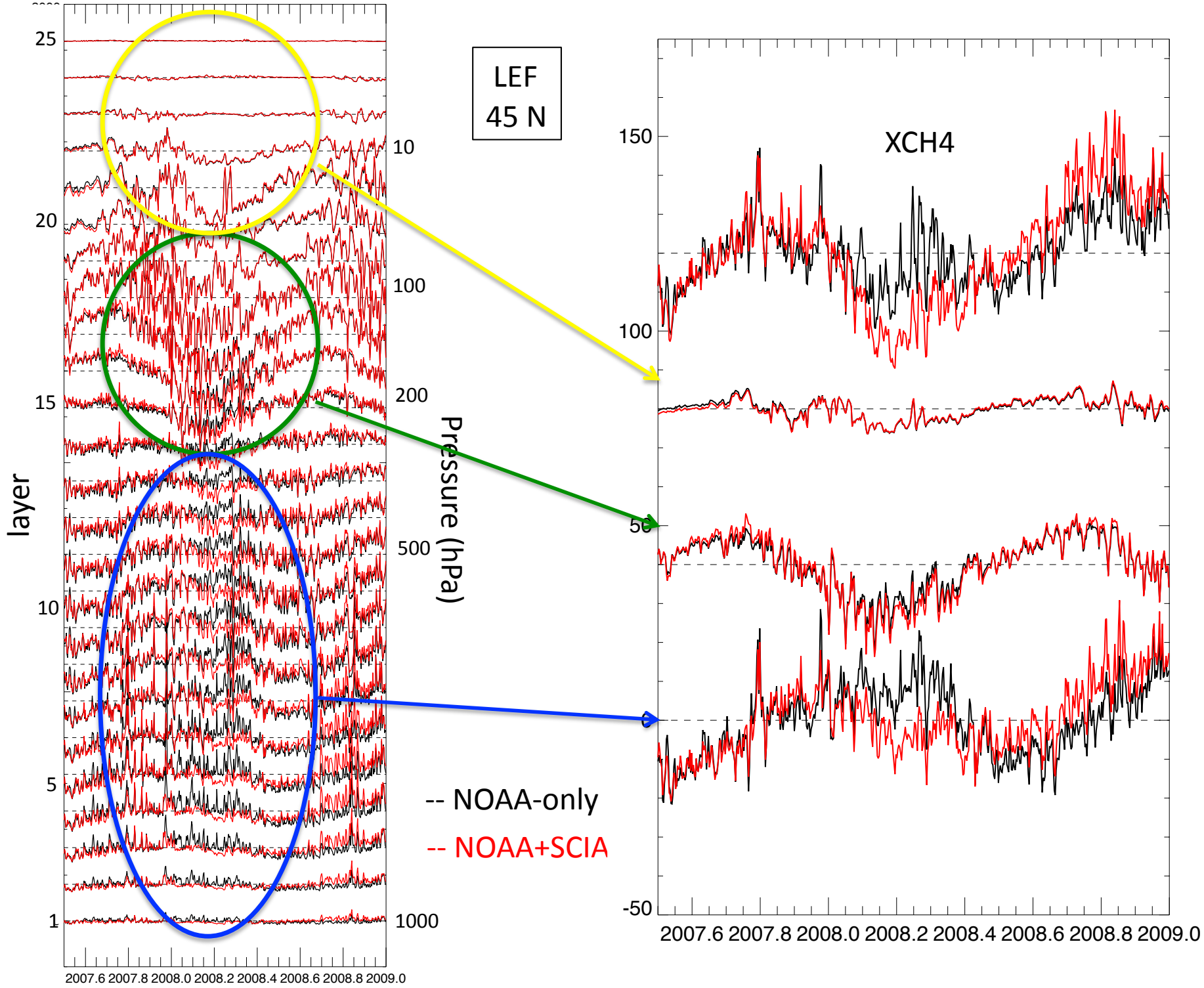
Comparison to FTS



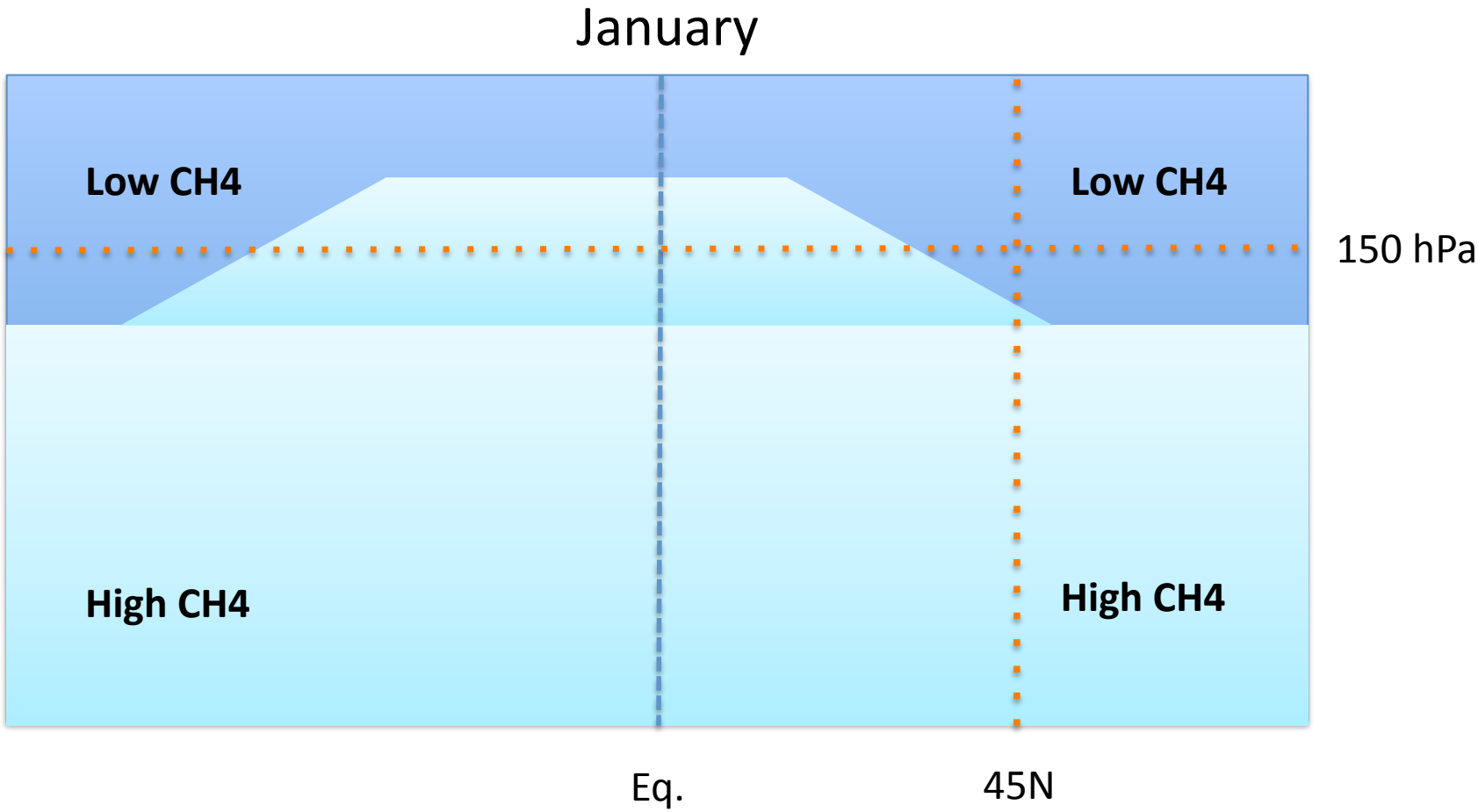
Obs. **NOAA-only** **NOAA + Sciamachy**

- NH: RMS measurements point to a larger seasonal amplitude of XCH4
- What explains the difference between NH & SH?

What determines the XCH4 seasonality?


LEF
45 N
XCH4
layer
Pressure (hPa)
25
20
15
10
5
1
10
100
200
500
1000
150
100
50
-50
2007.6 2007.8 2008.0 2008.2 2008.4 2008.6 2008.8 2009.0
-- NOAA-only
-- NOAA+SCIA

What explains the seasonal cycle in the lower stratosphere?



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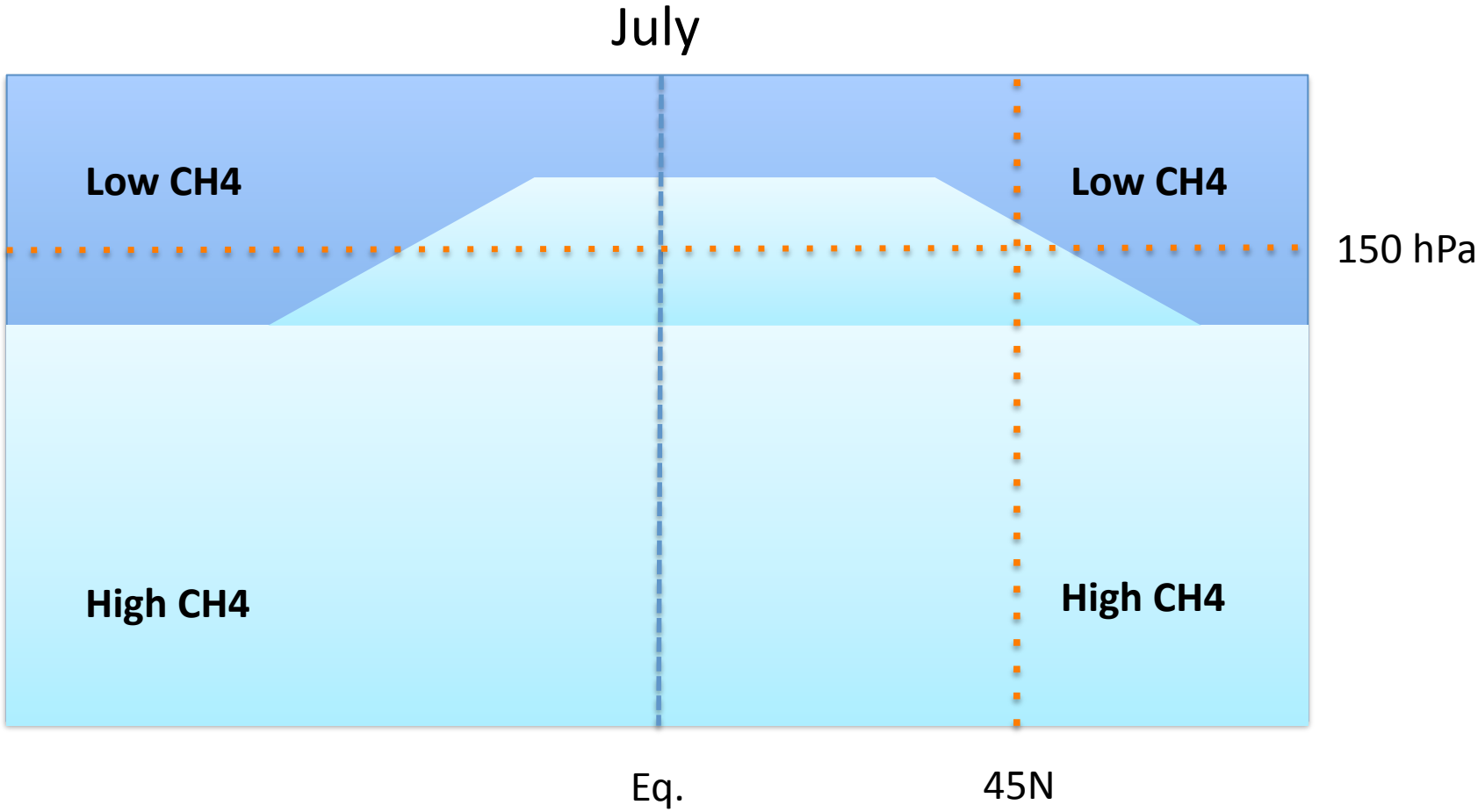

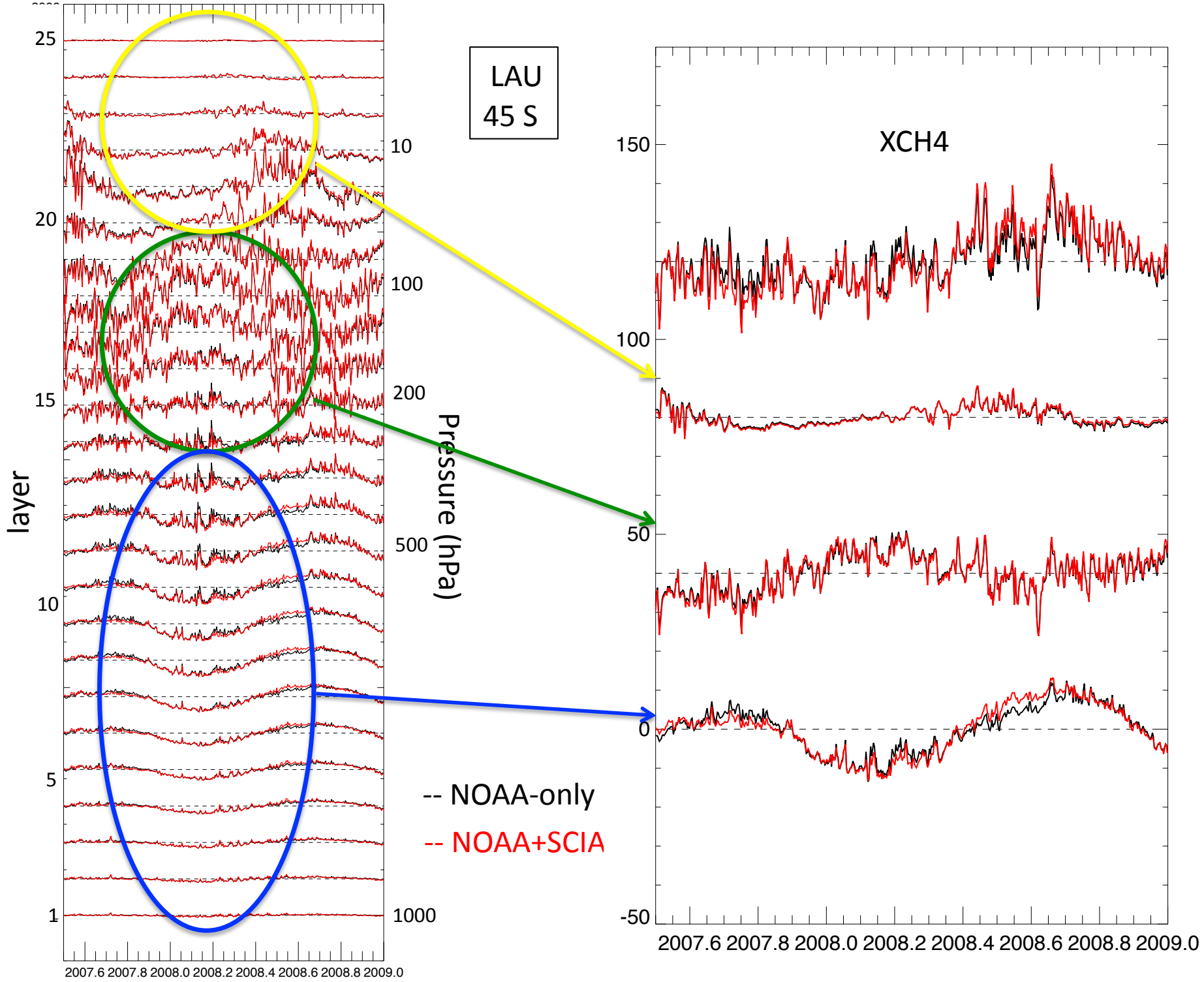
LAU
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Pressure (hPa)
25
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-- NOAA-only
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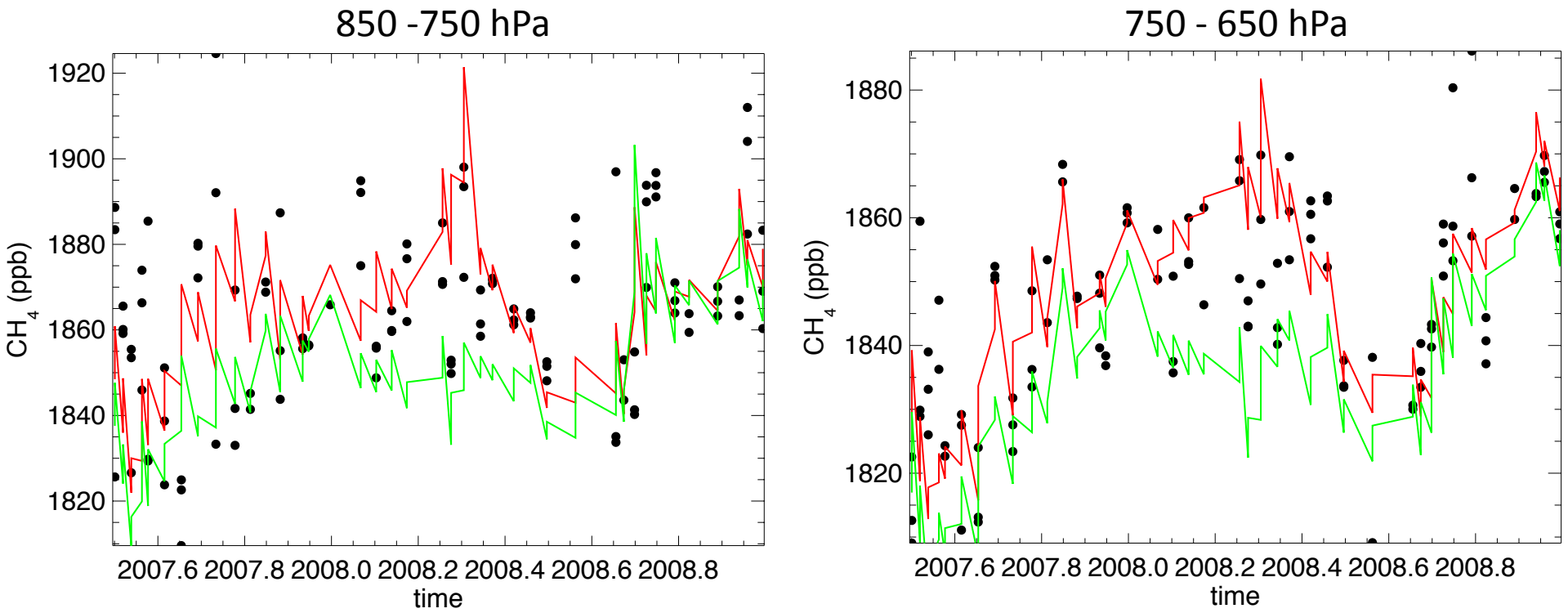
LEF: Aircraft measurements



Obs. **NOAA-only** **NOAA + Sciamachy**

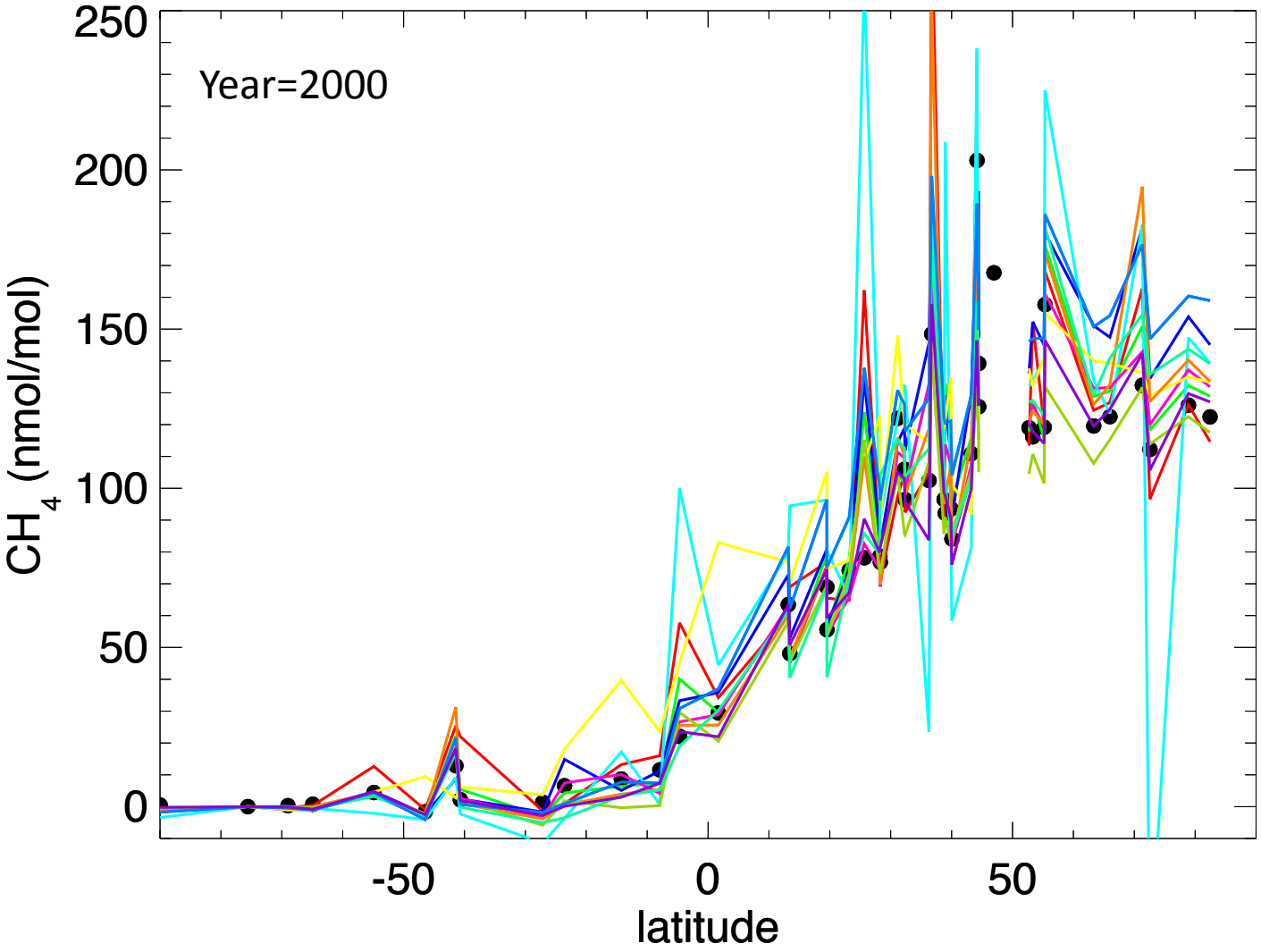
- These comparisons suggest that the inversion fixes the total column by adjusting the wrong parameters

How to further investigate this?

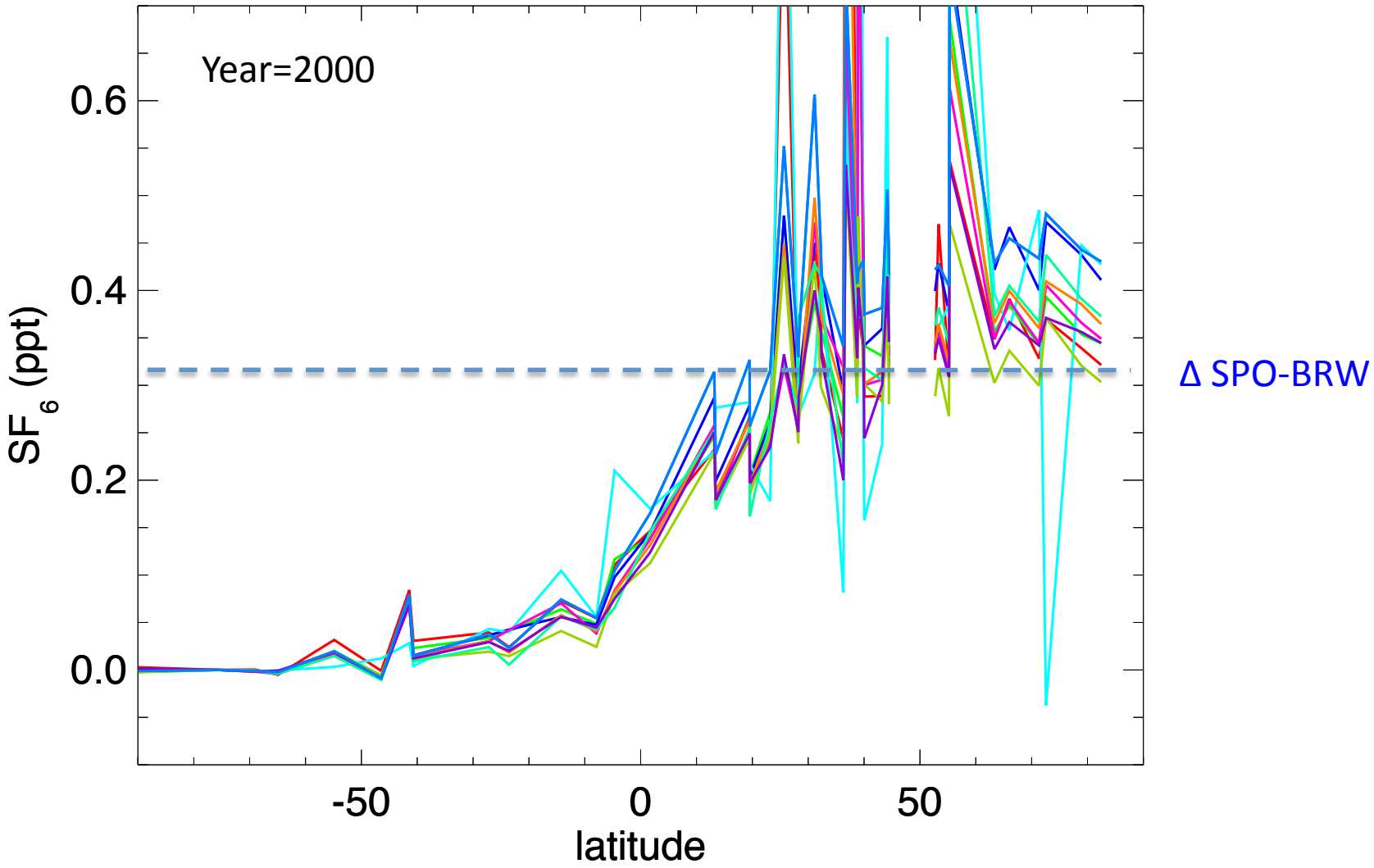
- FTS observed HF (separate stratosphere from troposphere)

- Transcom-CH4 model comparison

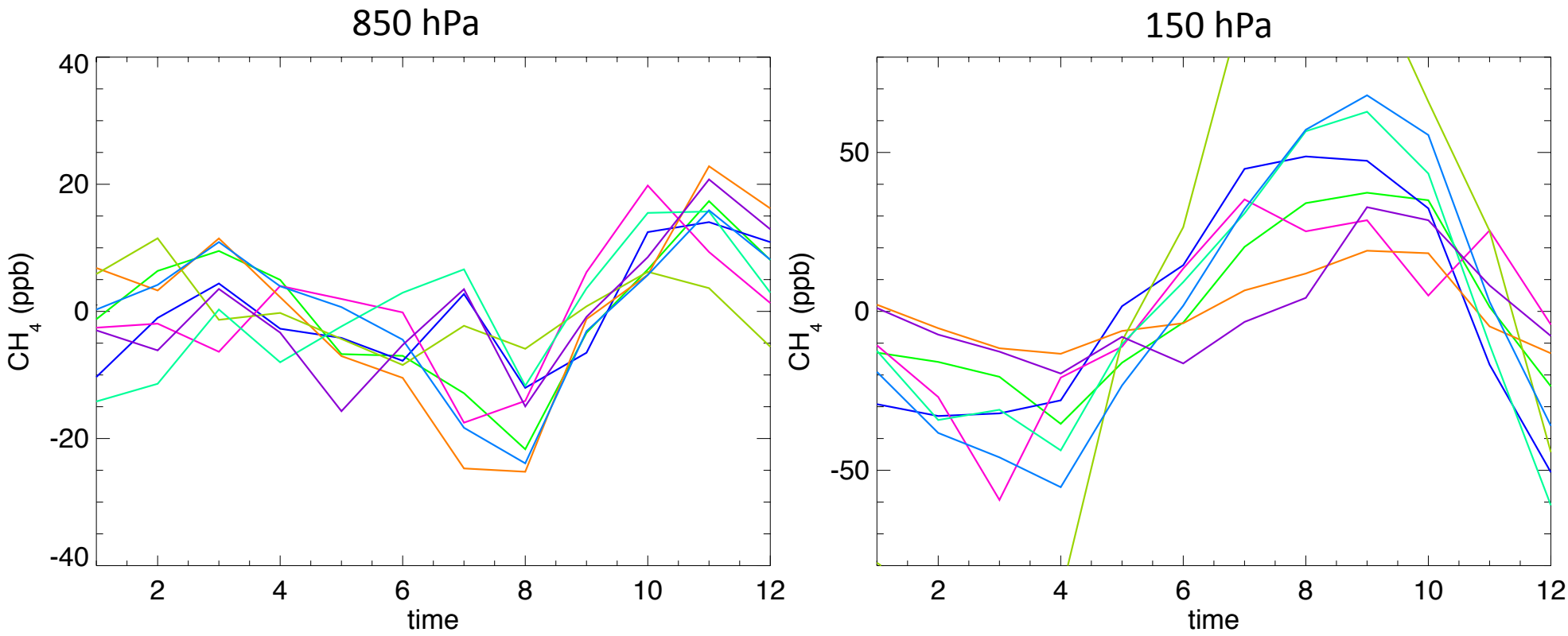
Transcom CH4: N-S gradient



N-S gradient: SF6



Seasonal cycle at LEF



• The variation in seasonality is quite dramatic! Which puts the discussion about a Potential transport problem in TM5 in a different perspective …

Summary

- Mismatch seasonal amplitude: RMS - in-situ
  +> closer look at the lower stratosphere

- N-S gradient: Overestimated in TM5, pointing to a transport problem