Using CarbonTracker-CH$_4$ to understand the Recent Methane Budget

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CO_2 CH_4

Fluxes We Estimate:

Terrestrial Biosphere
Oceans

Coal Production, Oil/Gas Leaks
Animals, Waste, Rice,Wetlands
Termites, Oceans,Soils, Others

Fluxes We "Know":

Fossil Fuels

None

Photochemistry:

None

Reaction with OH (and Cl)

Measurement Sites

~100

<100

Potentially Helpful:

Oceans are a large term in the budget

Oceans are small term in the Budget (in most places)

Prototype CarbonTracker-CH$_4$: Priors

EDGAR 3; Bergamaschi et al. (2002)

- **Fossil**-Coal, Oil/Gas
- **Agwaste**-Enteric Fermentation, Rice, Waste
- **Biomass Burning** (GFEDv2/v3)
- **Natural**-Wetlands, Soil Uptake, Oceans, Termites

Photochemical Loss
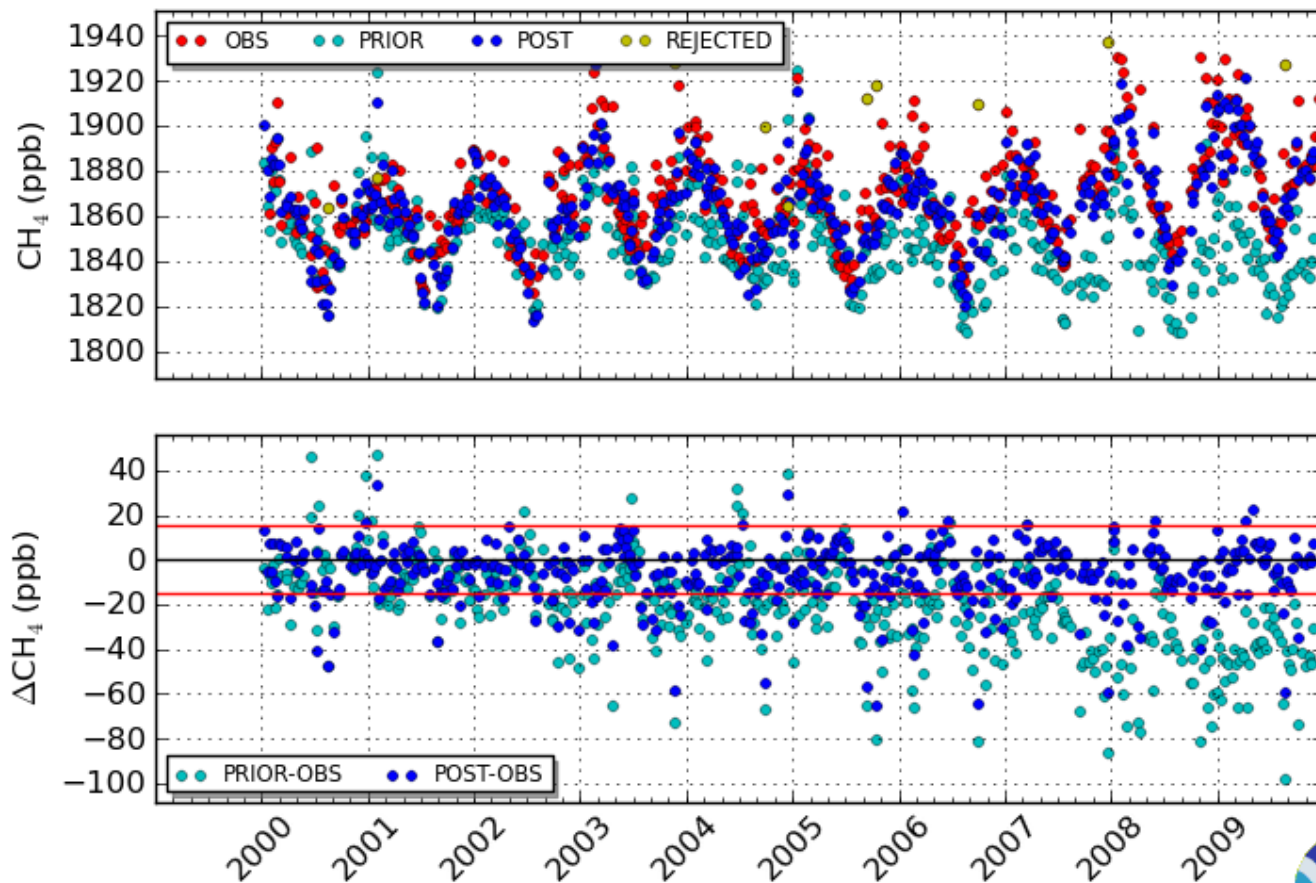
- Repeating Seasonal Cycle, Optimized Using CH$_3$CCl$_3$

121 Estimated Parameters: 12 Land Regions x 10 Source Processes+1 Global Ocean Region
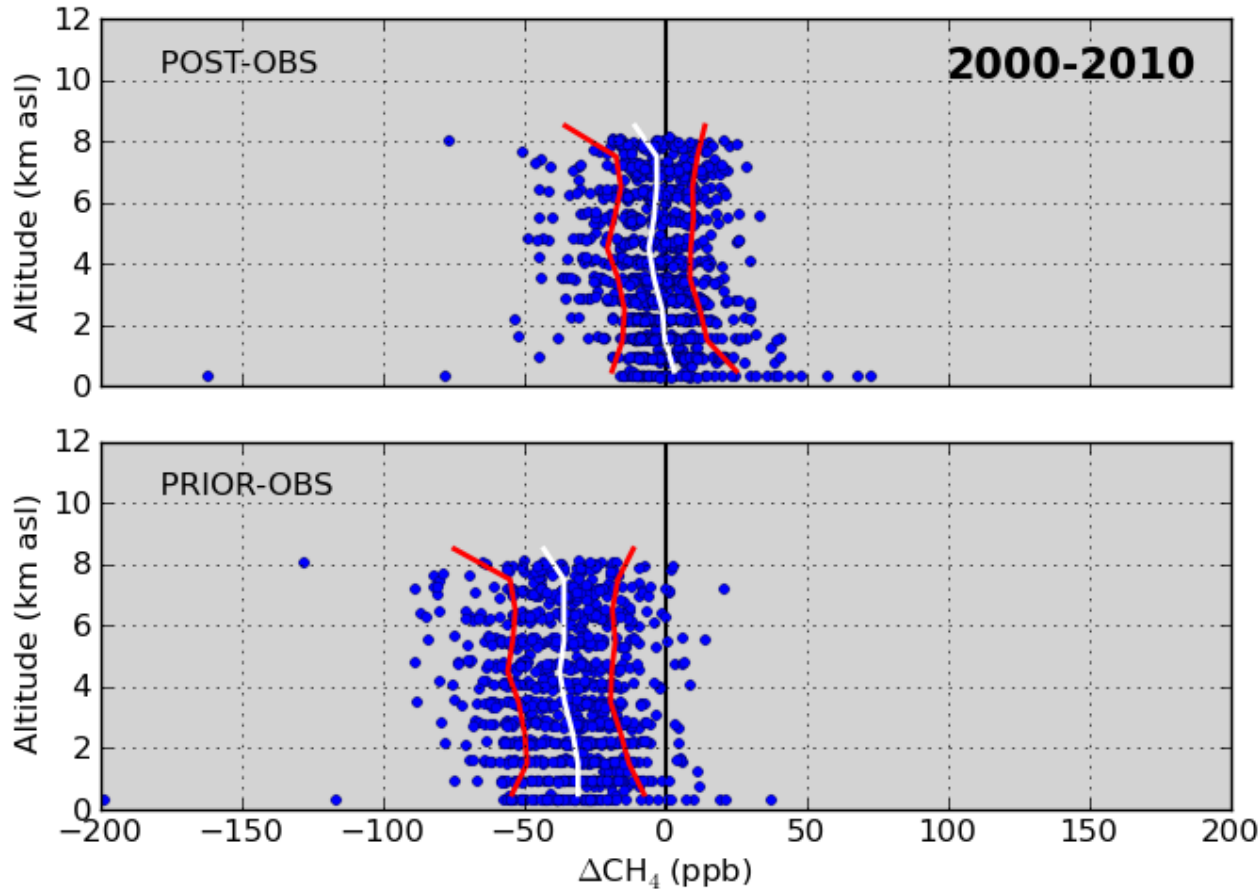
Inversion Quality Control

Can We Believe the Results?

Posterior Model-Data Agreement

Agreement with Unused Observations

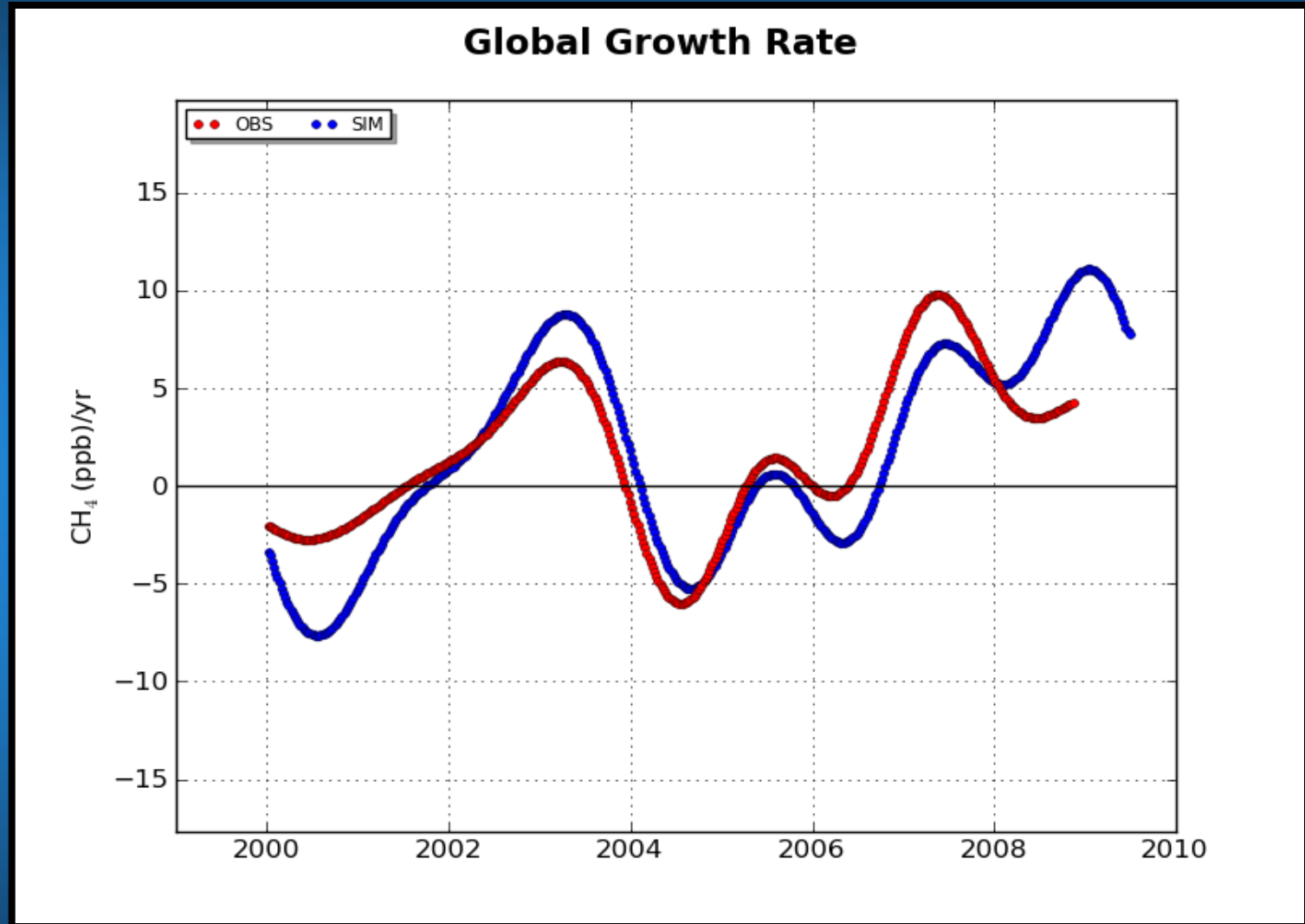(But we probably should use them…..)

Global Average CH$_4$
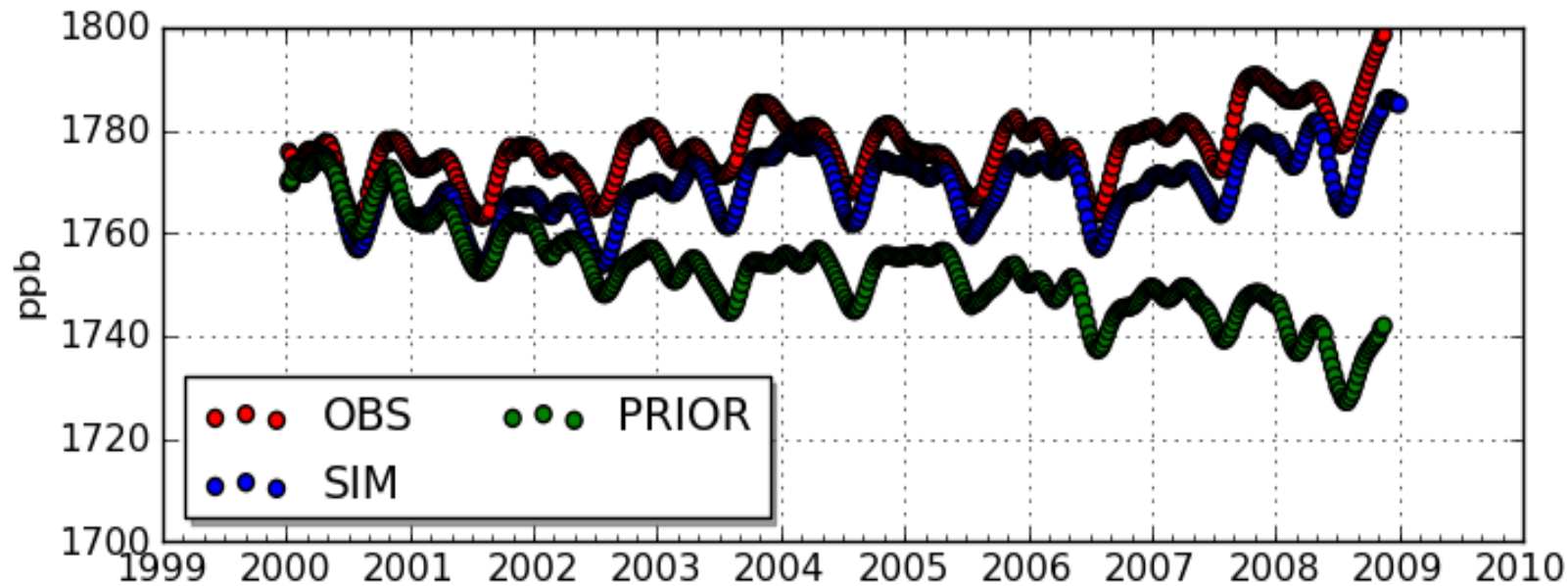
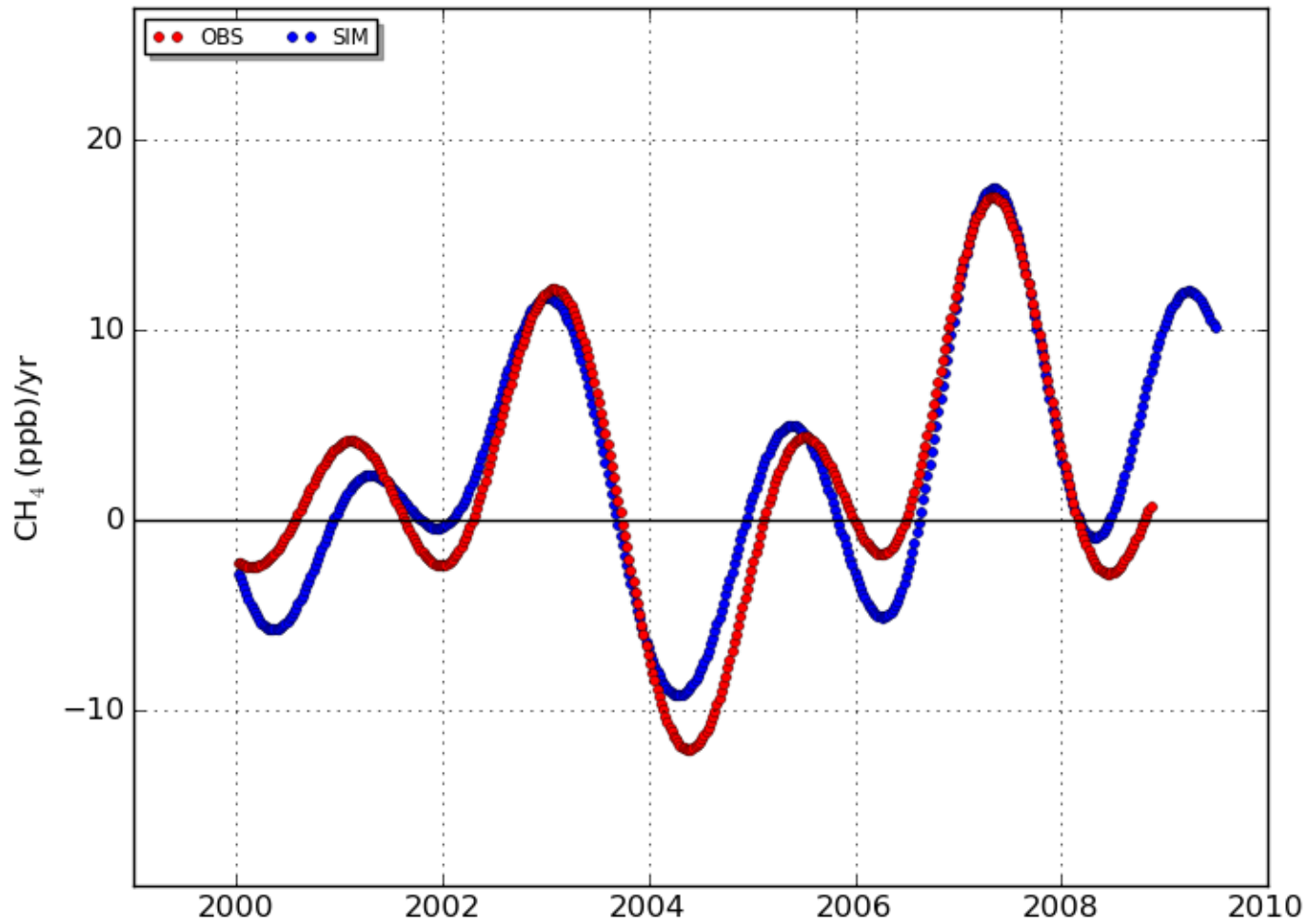The Assimilation compromises between the Observations and the Priors (~2% low bias).

Are the Prior Fluxes too small? Is the chemical Loss too fast?
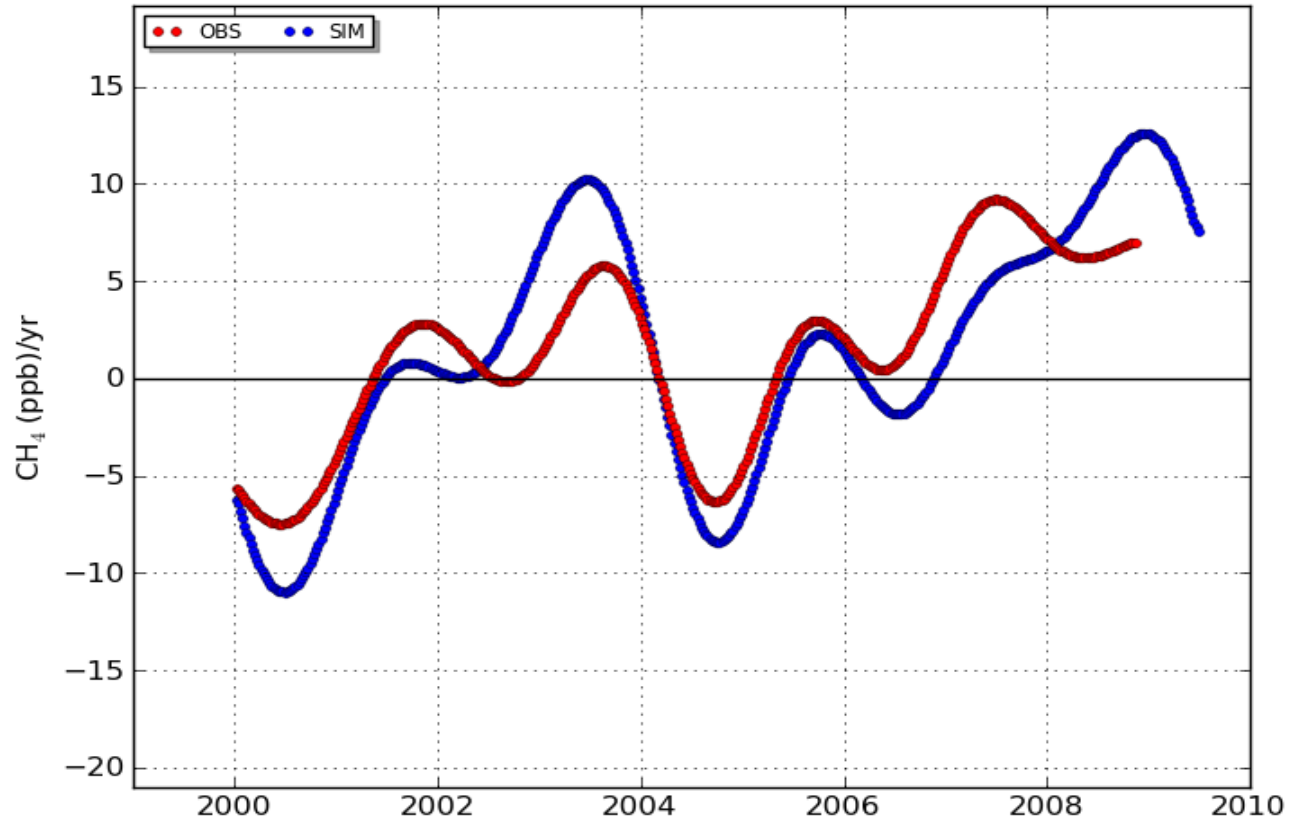
Growth Rates

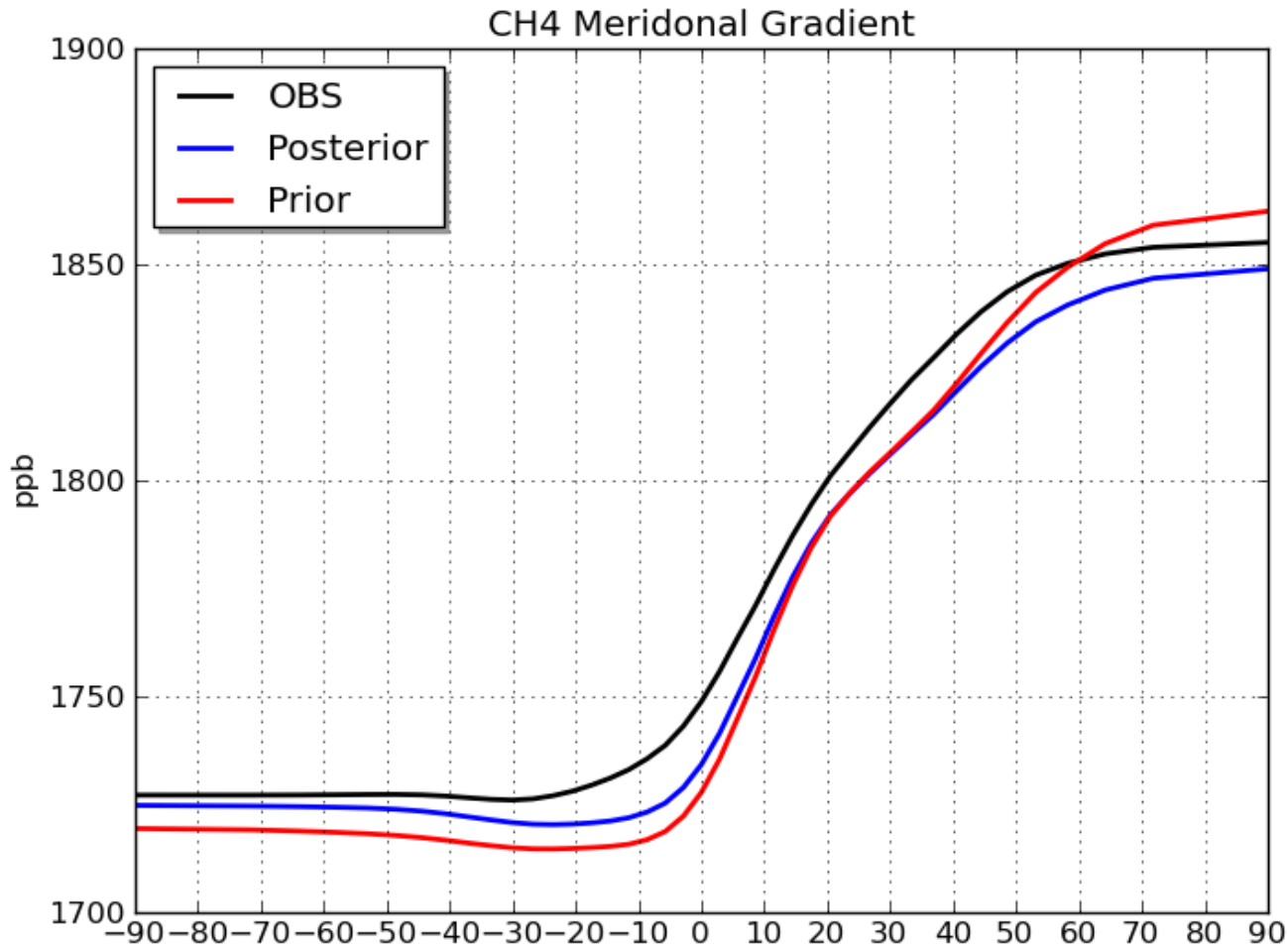(Directly Related to Emissions)

Polar NH Growth Rate

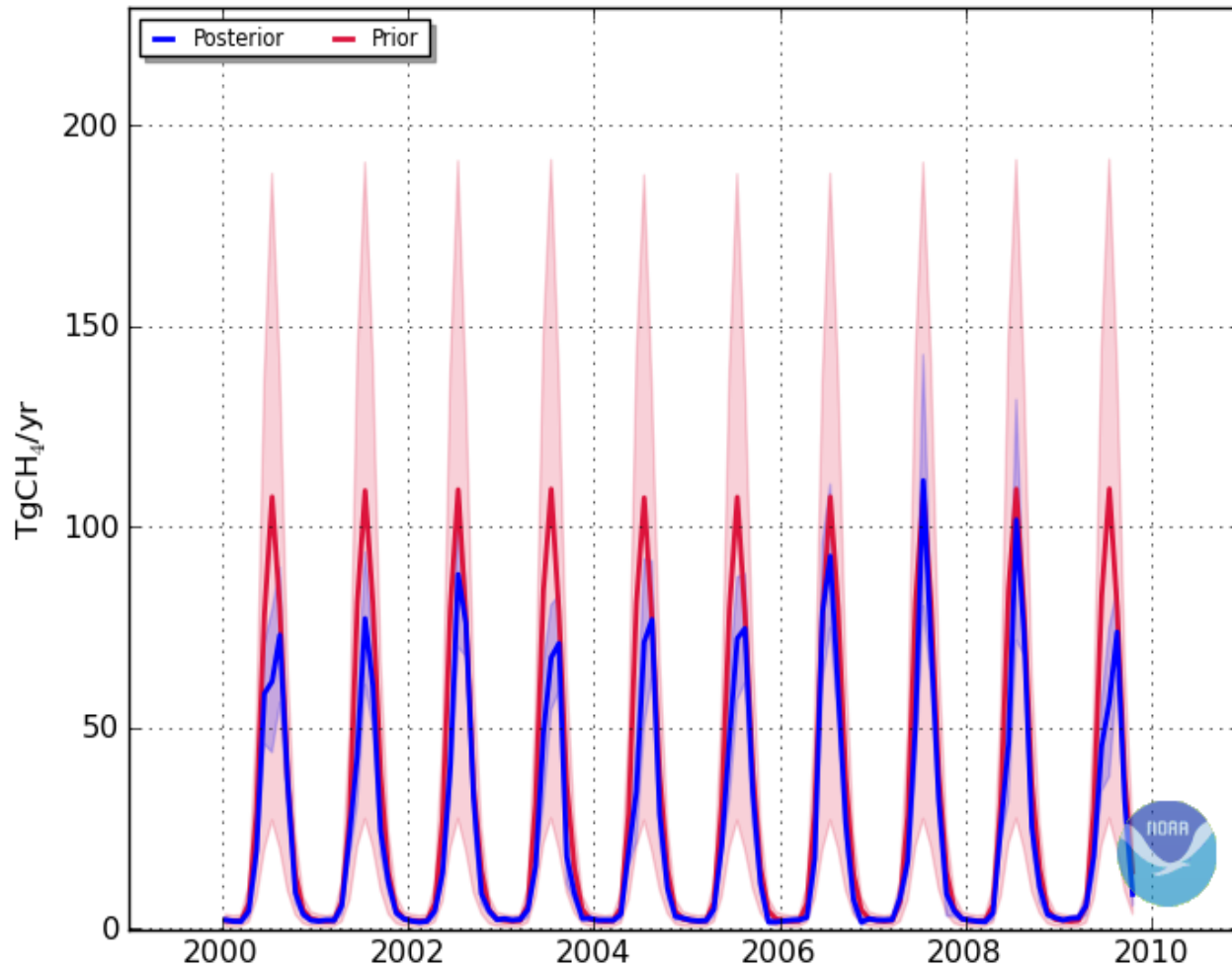Tropical Growth Rate

Not much surface data available in the tropics

Wetland prior is probably too small

Transport model may not represent tropical transport accurately

CH4 Meridonal Gradient

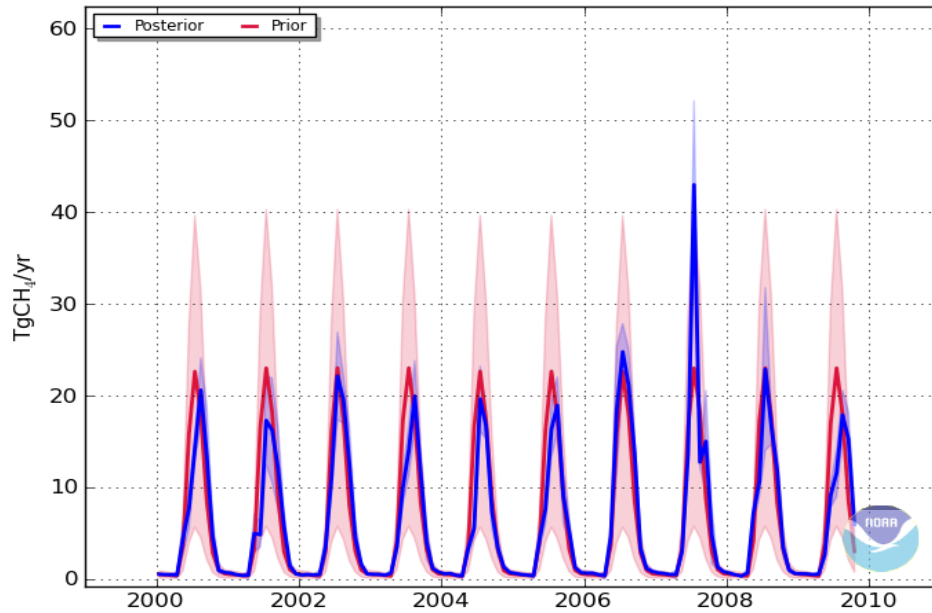Emissions Reduced at High Latitudes
Solution Stays near Priors in N.
Subtropics/Tropics

Variability is mostly due to natural sources
Generally, sources are reduced

Regional Source Information

Natural — Boreal North America

Natural — Boreal Eurasia

GISS Surface Temperature Analysis

Sources and parameters: GHCN_GISS_HR2SST_1200km_Anom0603_2007_2007_1951_1980
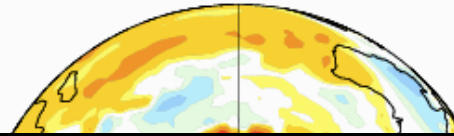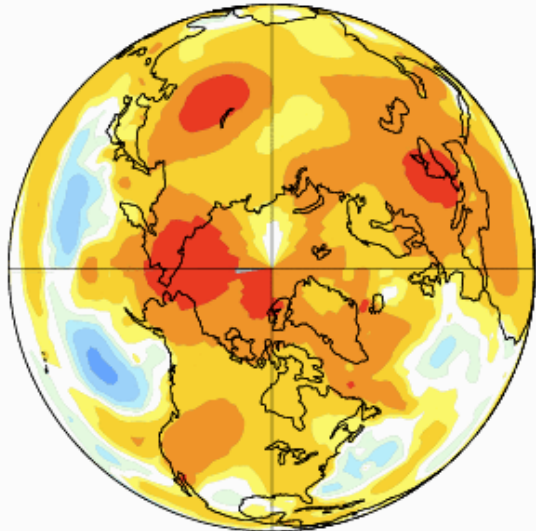
Note: Gray areas signify missing data.
Graphics bug: Occasionally the color for the .5-1C range is replaced by gray.
Note: Ocean data are not used over land nor within 100km of a reporting land station.

Jun−Jul−Aug 2007   L−OTI(°C) Anomaly vs 1951−1980   .52

−4.1   −2 −1 −.5   .2 .5 1 2 4 4.4

GISS Surface Temperature Analysis

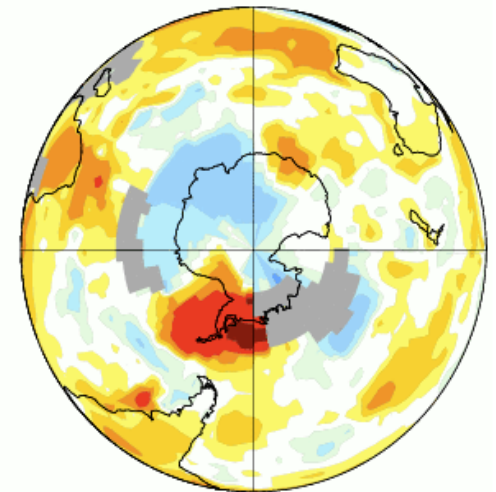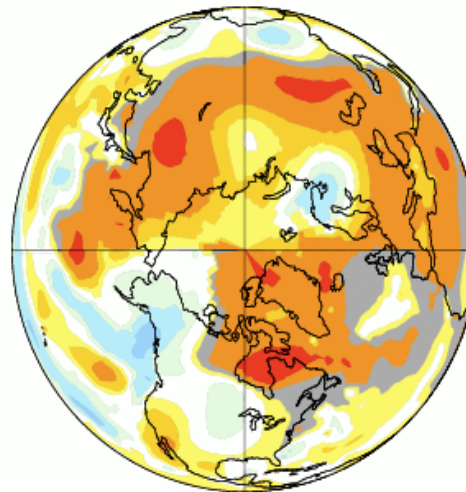Sources and parameters: GHCN_GISS_HR2SST_1200km_Anom0603_2008_2008_1951_1980

Note: Gray areas signify missing data.
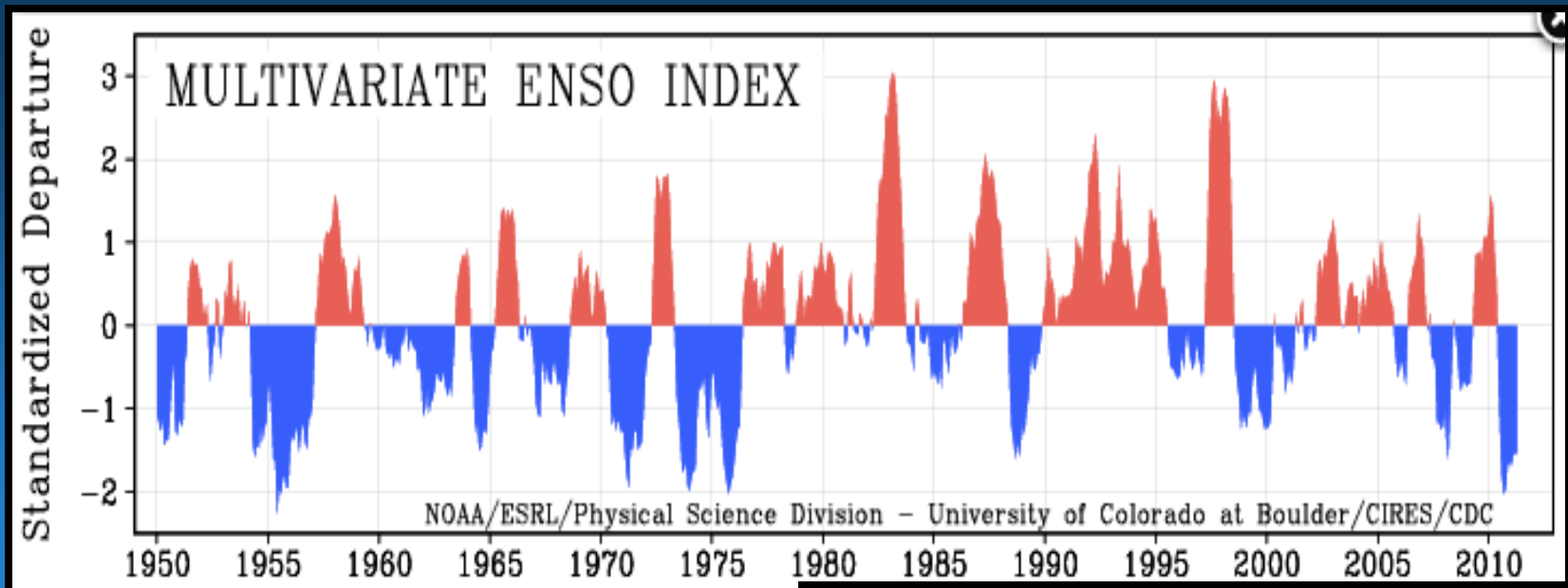Graphics bug: Occasionally the color for the .5-1C range is replaced by gray.
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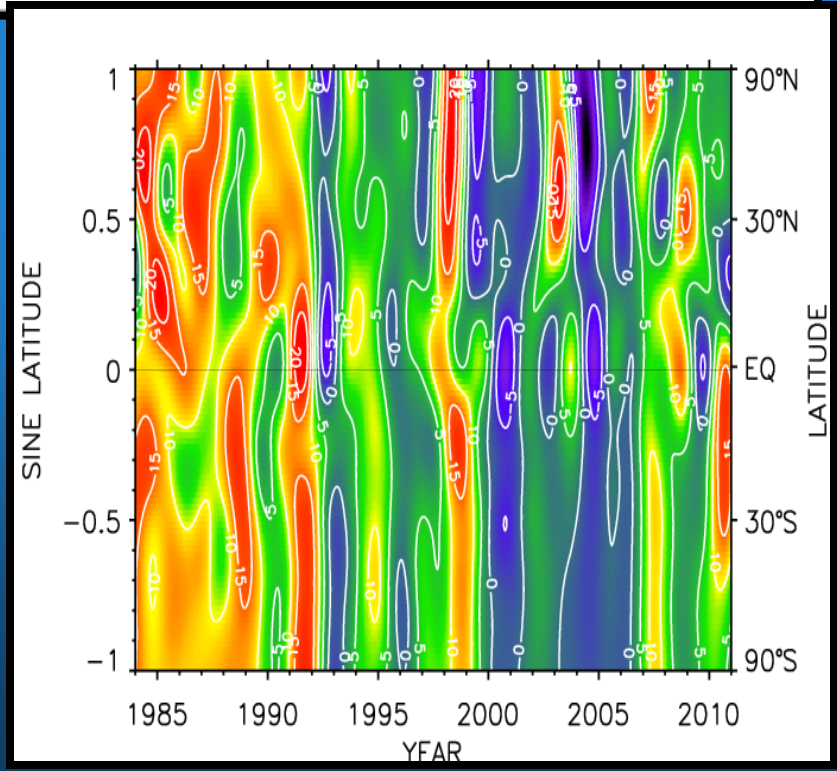
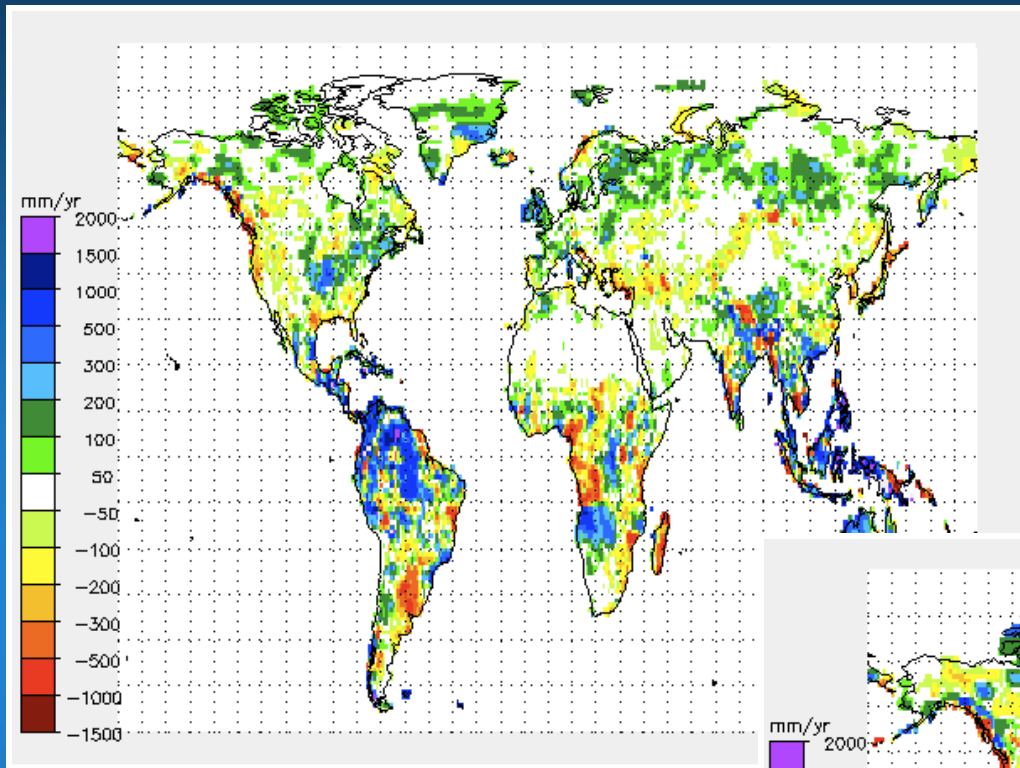Jun−Jul−Aug 2008   L−OTI(°C) Anomaly vs 1951−1980   .40

−4.1   −2 −1 −.5   .2 .5 1 2 4 5   −4.1   −2 −1 −.5   .2 .5 1 2 4 5
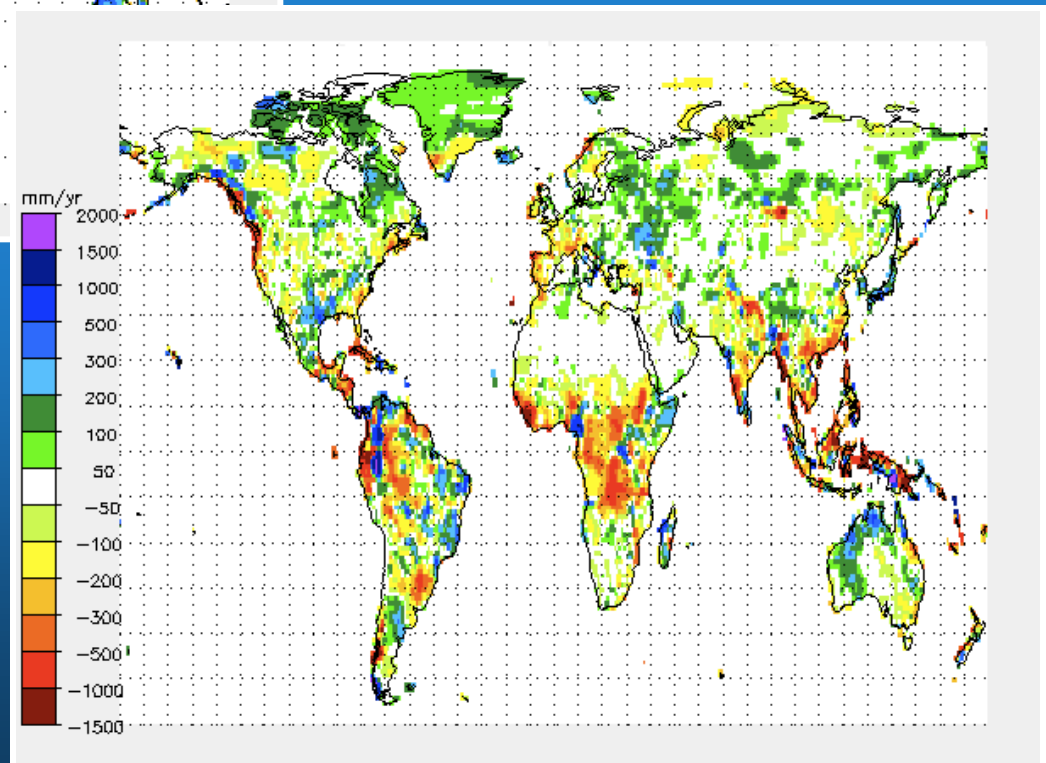
2008 was also warm in Boreal Eurasia

Correlation Between ENSO and Tropical CH_4 Sources?
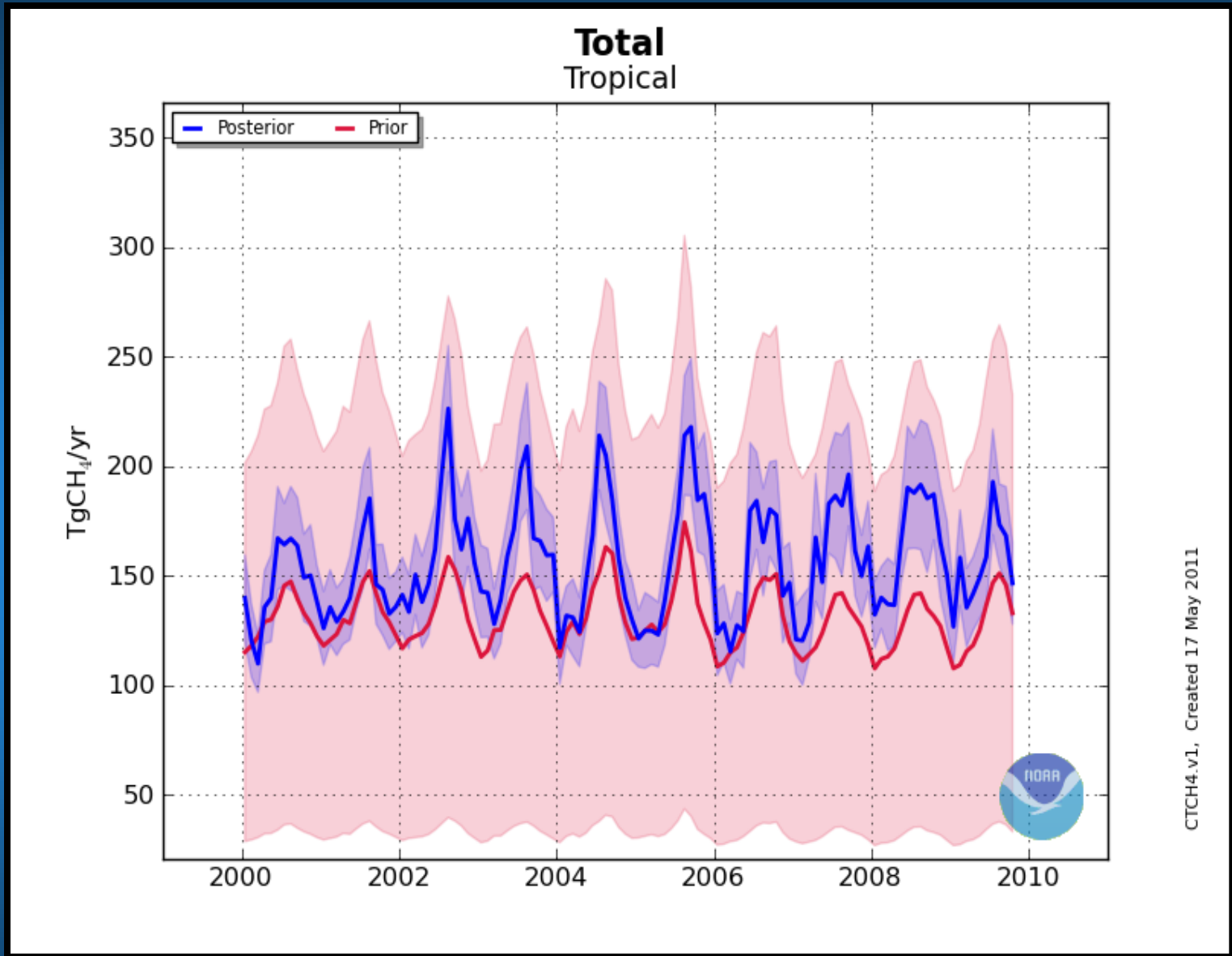
Composite Precipitation - La Niña

El Niño

Source: GPCP

Tropical
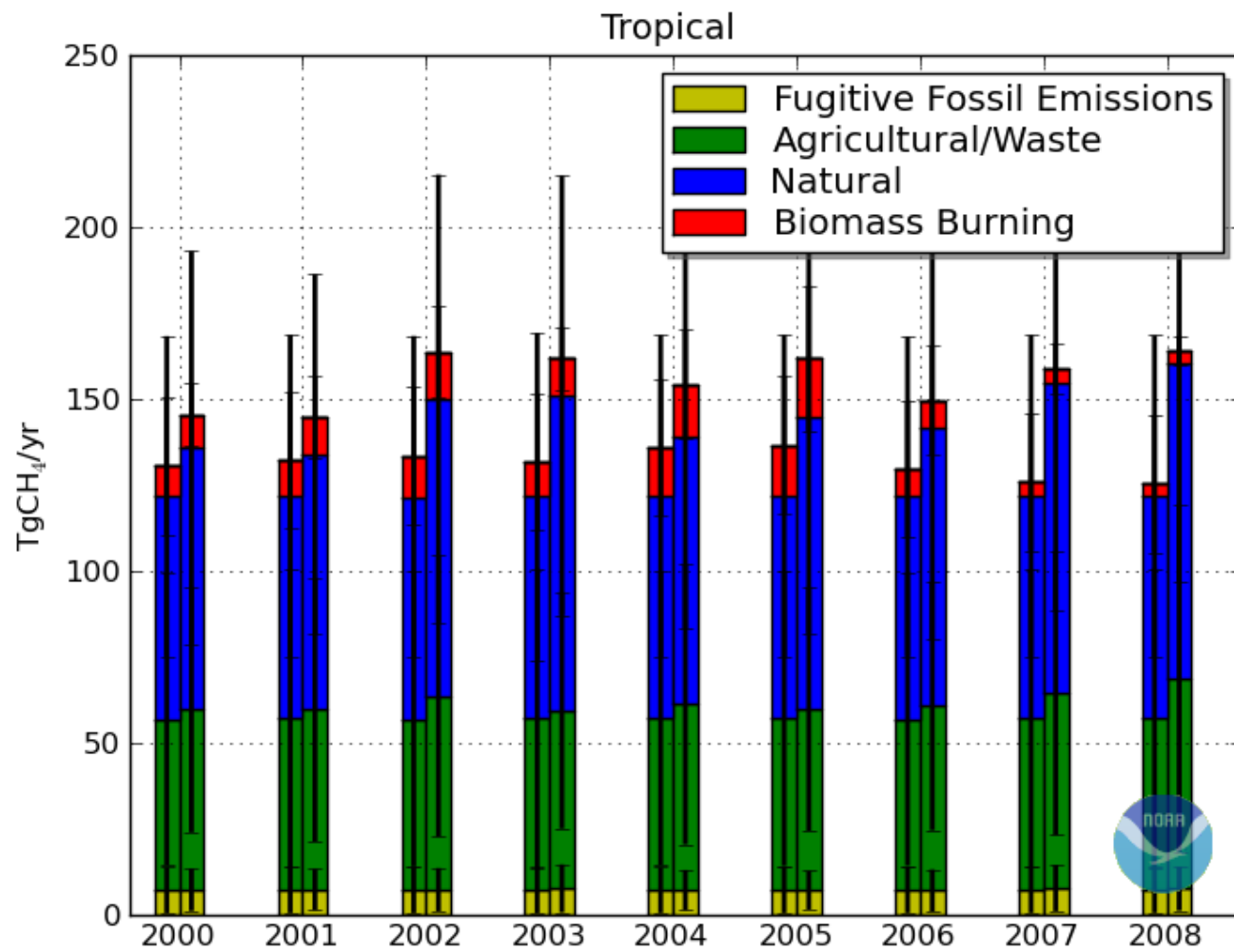
CTCH4.v1, Created 17 May 2011

Total
Tropical

Could the seasonal cycle be changing?

Anthropogenic Sources

Source: EDGAR 4.0 (JRC/PBL, 2009)

Figure 1: Global methane emissions by world region (1970-2005) in Tg C...

Can we see these Increases in CT-CH$_4$?

10Tg/yr since 2000

Source: EDGAR 4.0,
   J. Van Aardenne

Source: E. Matthews

No trend!
Time series is noisy and remains close to prior
(similar figure for Asia)

But what about this one?

Φιναλ Ρεμαρκσ

- Inversion results must be interpreted with care, some useful diagnostics were shown.

- Information about high-latitude sources and variability is possible to retrieve with the current network/assimilation system. Tropics are still under-observed and not-well resolved by assimilation scheme.

- Boreal Eurasia appears to be the main origin of elevated growth in 2007 with a smaller contribution from Boreal N. America.

- Coming soon: CarbonTracker-CH$_4$ web site.

2001 Emissions: 526Tg/yr (Current Inversion Priors)

Coal	30 (TgCH4/yr)
Oil/Gas	50
Enteric Fermentation/Manure	100
Rice	59
Biomass Burning	**32**
Waste	74
Wetlands	**174**
Wild Animals	5
Termites	19
Soil	-38
Oceans	17

Photochemical Loss (mostly reaction w/ OH) τ~10 yrs   ~500 Tg/yr