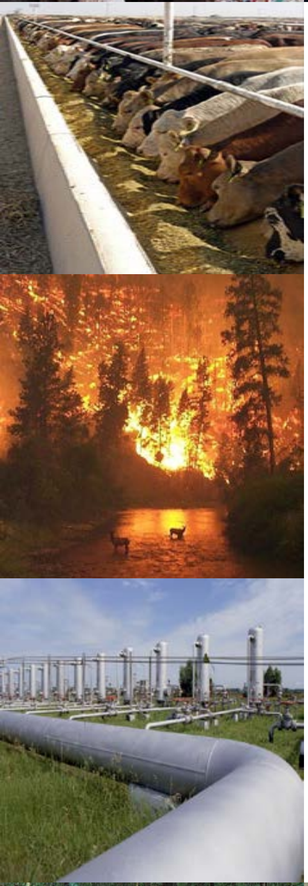

Top-Down Constraints on Wetland Emissions of CH_4

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Ken Masarie

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(Pieter Tans & the NOAA ESRL CCGG Group)

The Wetland and Wetland CH_4 Inter-Comparison of Models Project (WETCHIMP!)

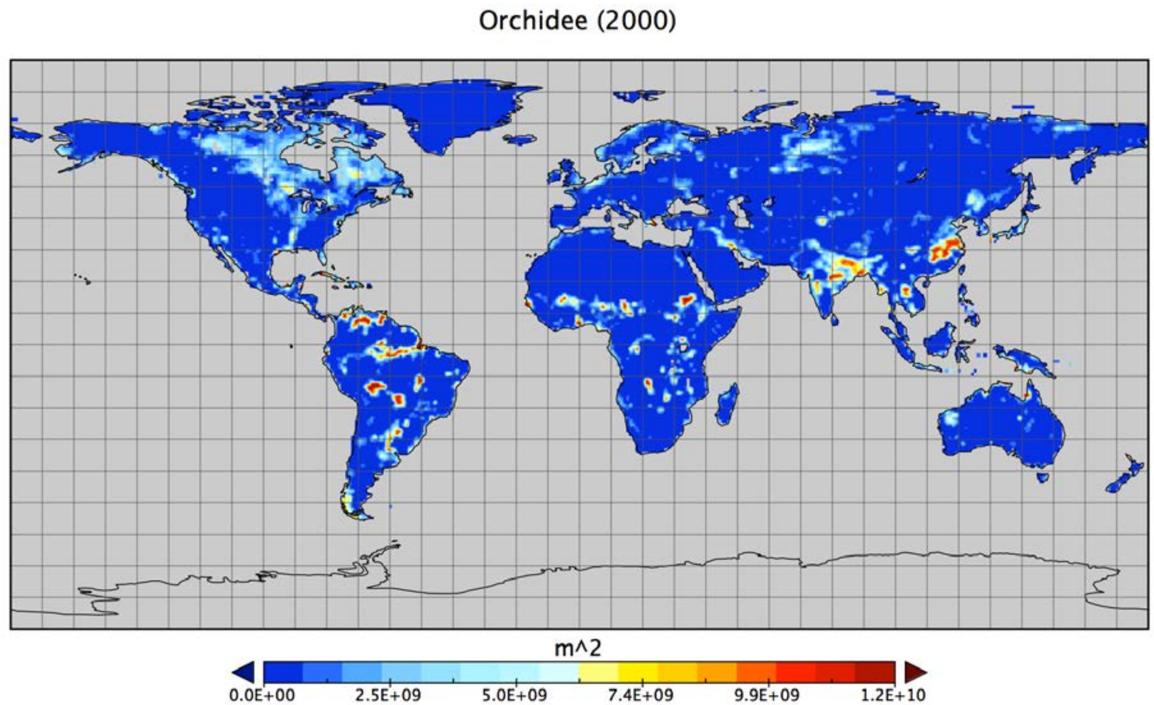
Melton et al.,
Biogeosciences, 2012

Model	Global Emission (Tg/yr)	Wetland Area (10^6 km^2)
LPJ-Bern	228-309	81.7 ± 2.4
CLM4Me	207-229	8.8 ± 1.5
DLEM	168-199	7.1 ± 1.1
LPJ-WHyMe	25-29 (+ CT-CH_4 at lower latitudes ~162)	2.7
Orchidee	261-302	8.6 ± 0.9
SDGVM	192-207	26.9 ± 3.6
LPJ-WSL	157-191	9.0 ± 1.1

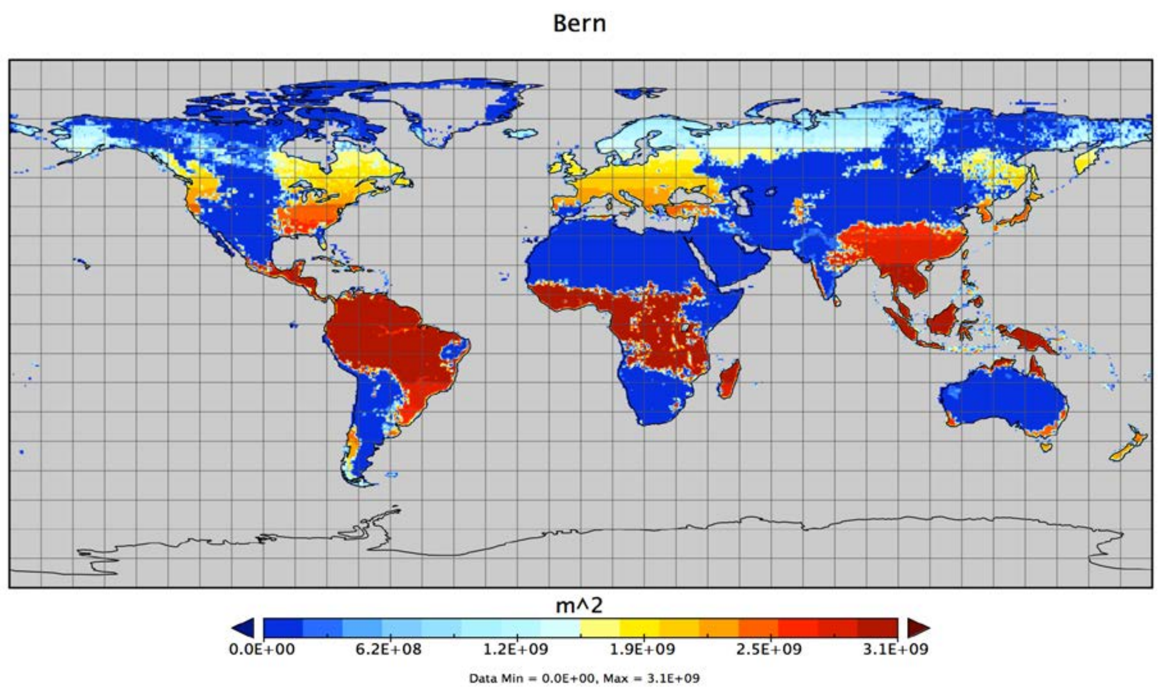
Model	Resolution	Wetland Description	Reference
LPJ-Bern	Global, 0.5° x 0.5°	Prescribed peatlands and monthly inundation, dynamic wet mineral soils	Spahni et al 2011
CLM4Me	Global, 2.5° x 1.9°	Modeled run-off and water table depth	Riley et al 2011
CTEM	Global, 2.8° x 2.8°	Simulated wetlands	V. Arora
DLEM	Global, 0.5° x 0.5°	Maximum wetland area from inundation data set with simulated intra-annual variation	Tian et al. 2011
LPJ-WHyMe	Peatlands > 35N 0.5°x 0.5°	Prescribed peatlands with simulated soil saturation	Wania, 2010
Orchidee	Global, 1° x 1°	Mean inundation with simulated intra and inter annual variability	Ringeval, 2012
SDGVM	Global, 0.5°x 0.5°	Simulated wetlands	Hopcroft, 2011
LPJ-WSL	Global, 0.5°x 0.5°	Prescribed monthly inundation	Hodson et al 2011

Two Very Different Wetland Distribution Approaches:

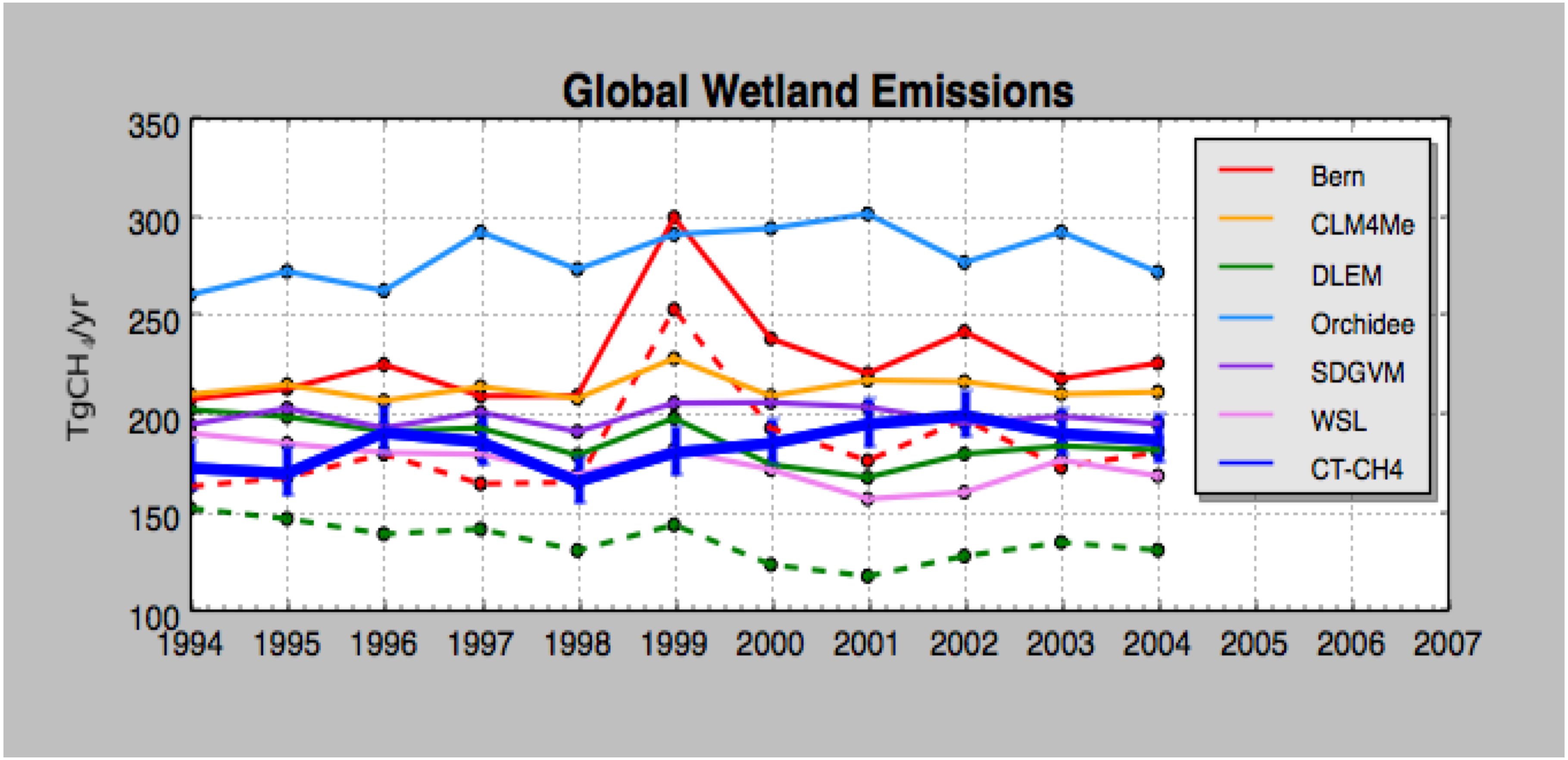
Mean Remotely Sensed Inundation + Intra/Inter Annual Variability



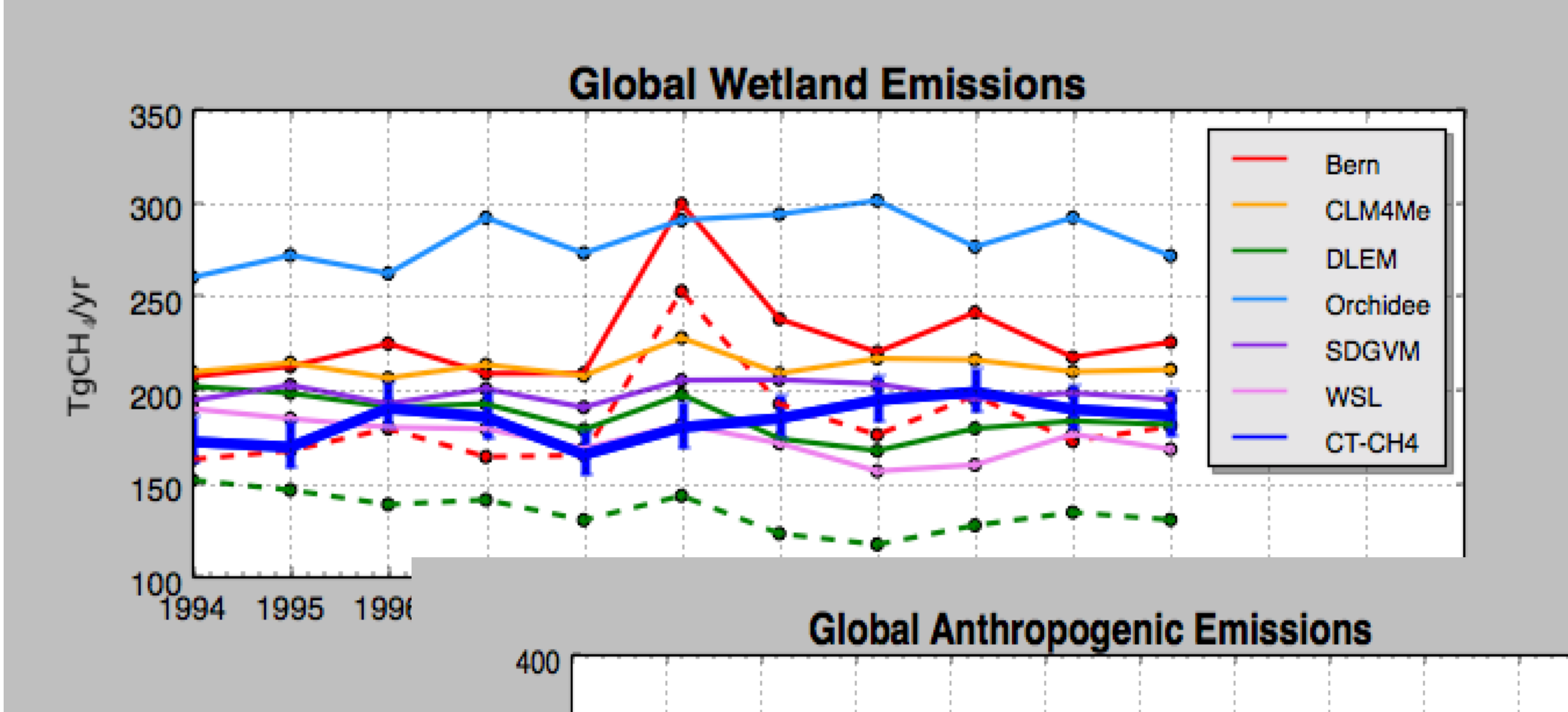
Remotely Sensed Monthly Inundation + Wet Mineral Soils + Prescribed Peatlands

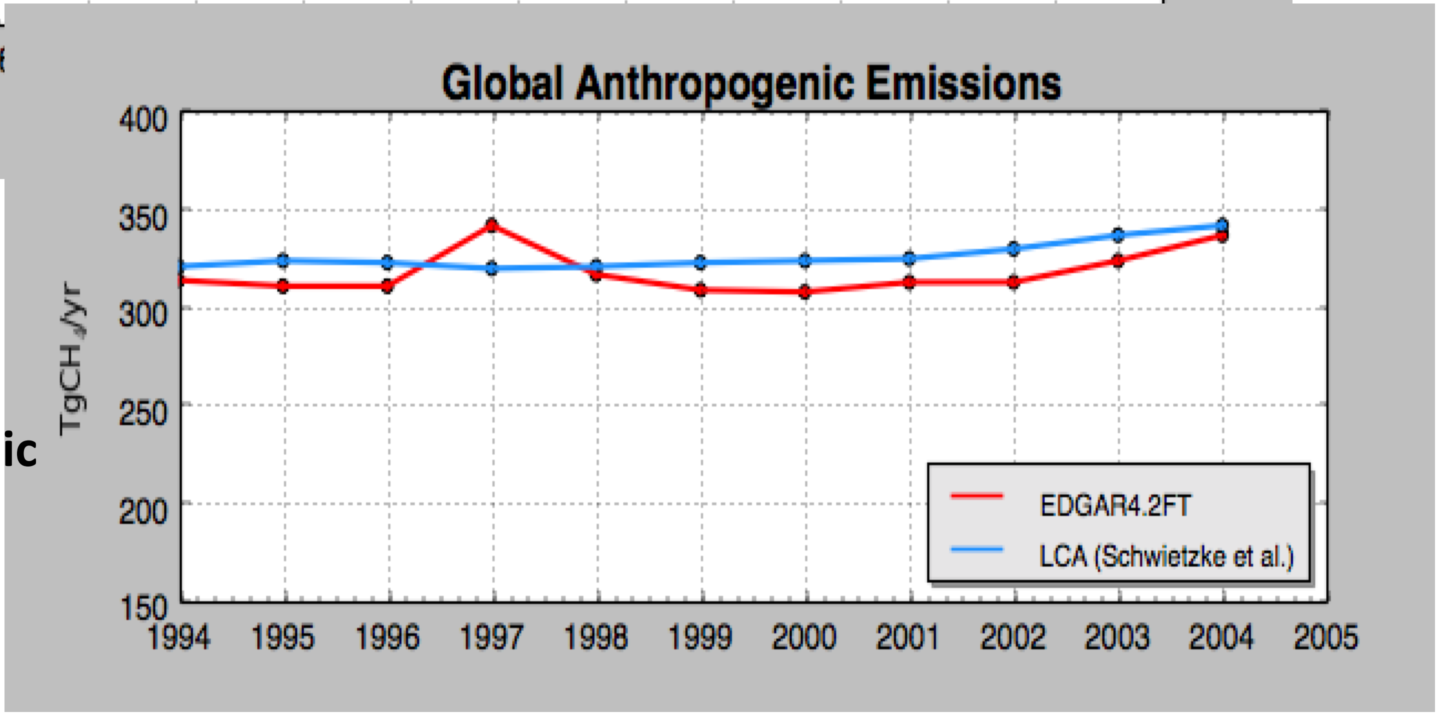


Large Variation in Global Emissions Among the Models!



Can Global Network Observations Help Identify the Better Models?





What are the likely uncertainties in global anthropogenic emissions?

- **Can we evaluate the performance of these models using multi-decadal atmospheric CH_4 observations?**

- **Do they reproduce the observed seasonal and inter-annual variability?**

- **Do they capture the observed spatial gradients?**

- **Can we trust their predictions of future emissions?**

- ***Would they make good prior estimates for CarbonTracker-CH_4?***

Model Responses to Climate Parameters: (In order of importance)

- Models are very sensitive to increases in Atmospheric CO_2 (73% more emissions with a step increase up to 857ppm!)

- Global wetland emissions decrease (~5%) with increasing T (3.4°C) due to tropical drying of wetlands.

- Small emission increases (~5%) with increased precipitation (3.9%).

The Plan:

- Use results of WETCHIMP Experiment 2:

Transient simulation from 1901-2009

Observed climate/CO_2

Comparison period is 1993-2004 (GIEMS dataset coverage)

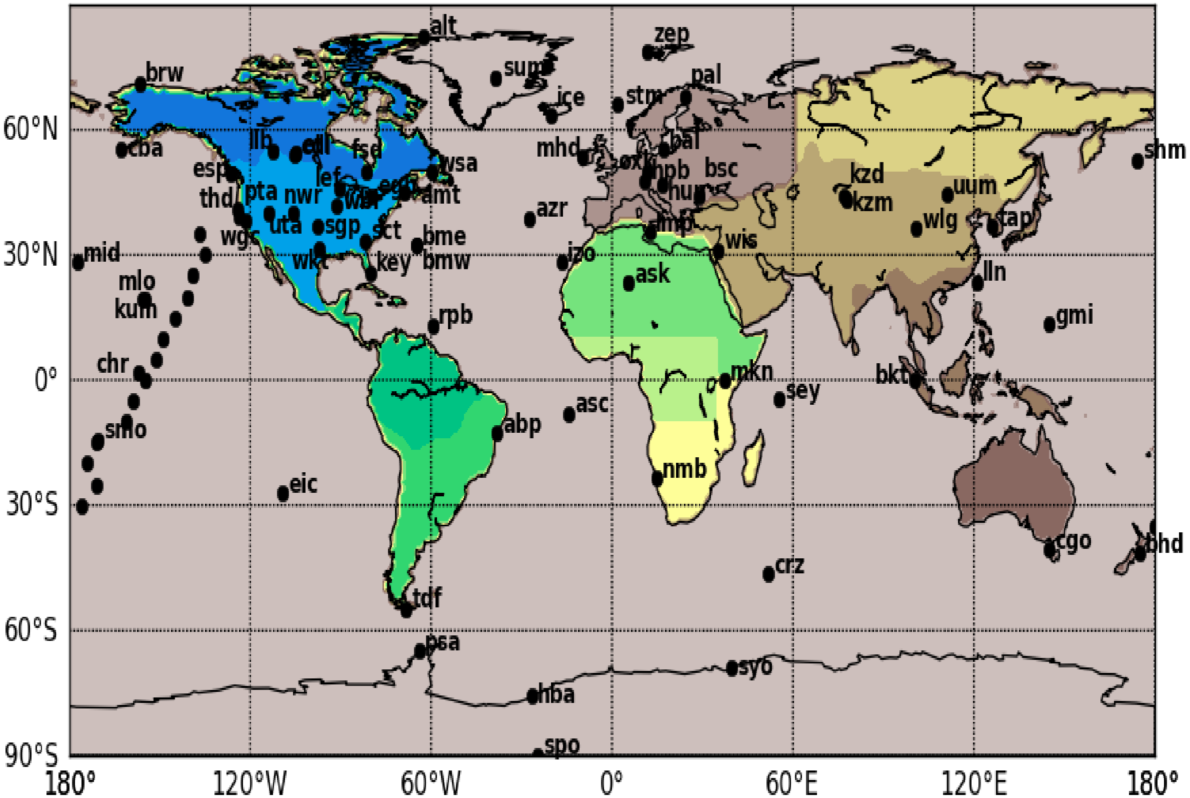
- Simulate observations using:

TM5 Transport Model

Constant Anthropogenic and non-wetland emissions

Repeating annual cycle of chemical loss.

The atmosphere integrates over large scales, flux observations Have small footprints



Use results of WETCHIMP Experiment 2:

- Transient simulation from 1901-2009
- Observed climate/CO_2
- Comparison period is 1993-2004 (GIEMS dataset coverage)

Simulate observations using:

- TM5 Transport Model
- Constant anthropogenic and non-wetland emissions
- Repeating annual cycle of chemical loss.

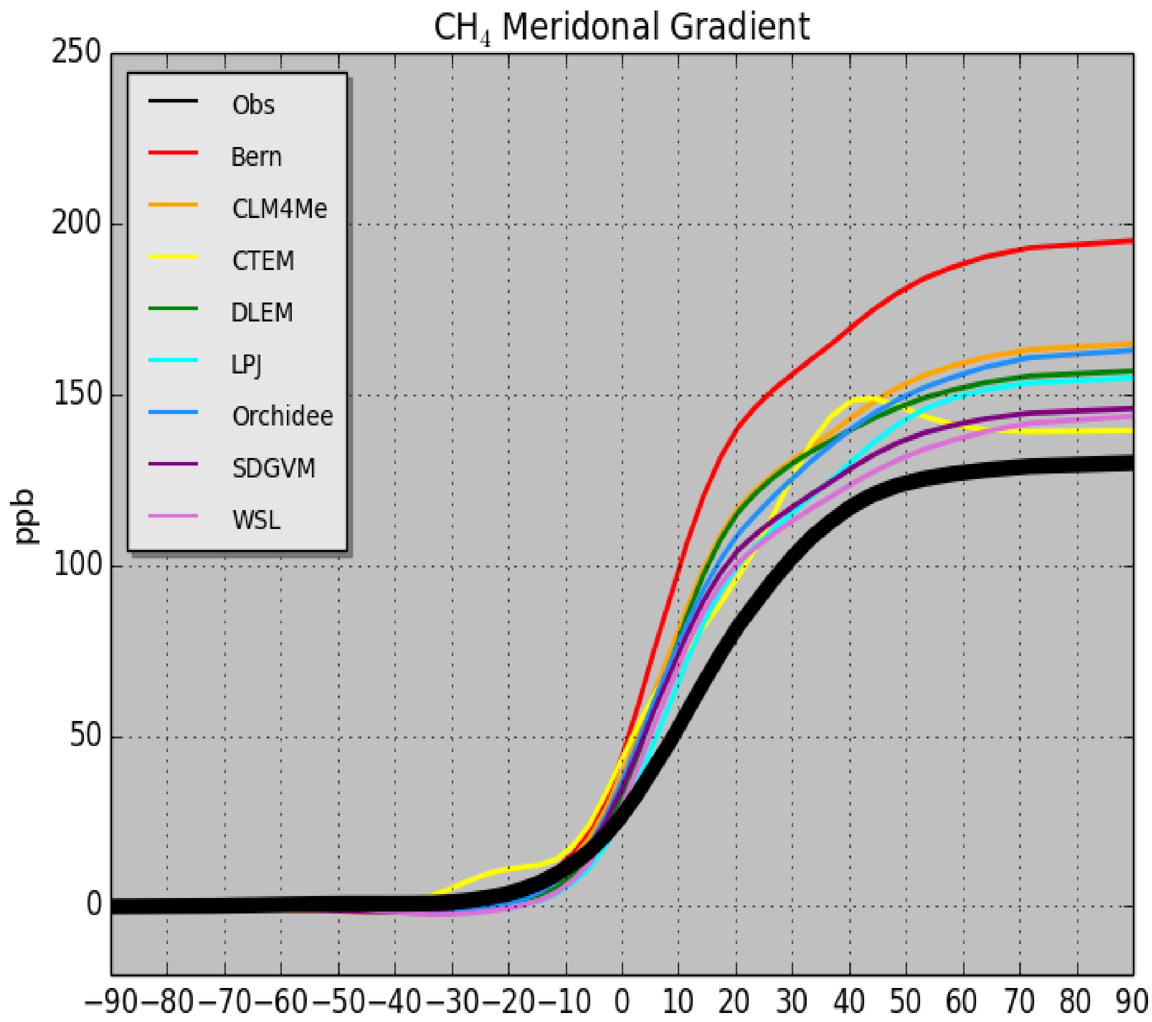
The North-South Gradient

Some emissions are too low south of the Equator

Some models may emit too much at high northern latitudes

Transport of emissions from populated mid-latitudes is important

There could be transport biases.



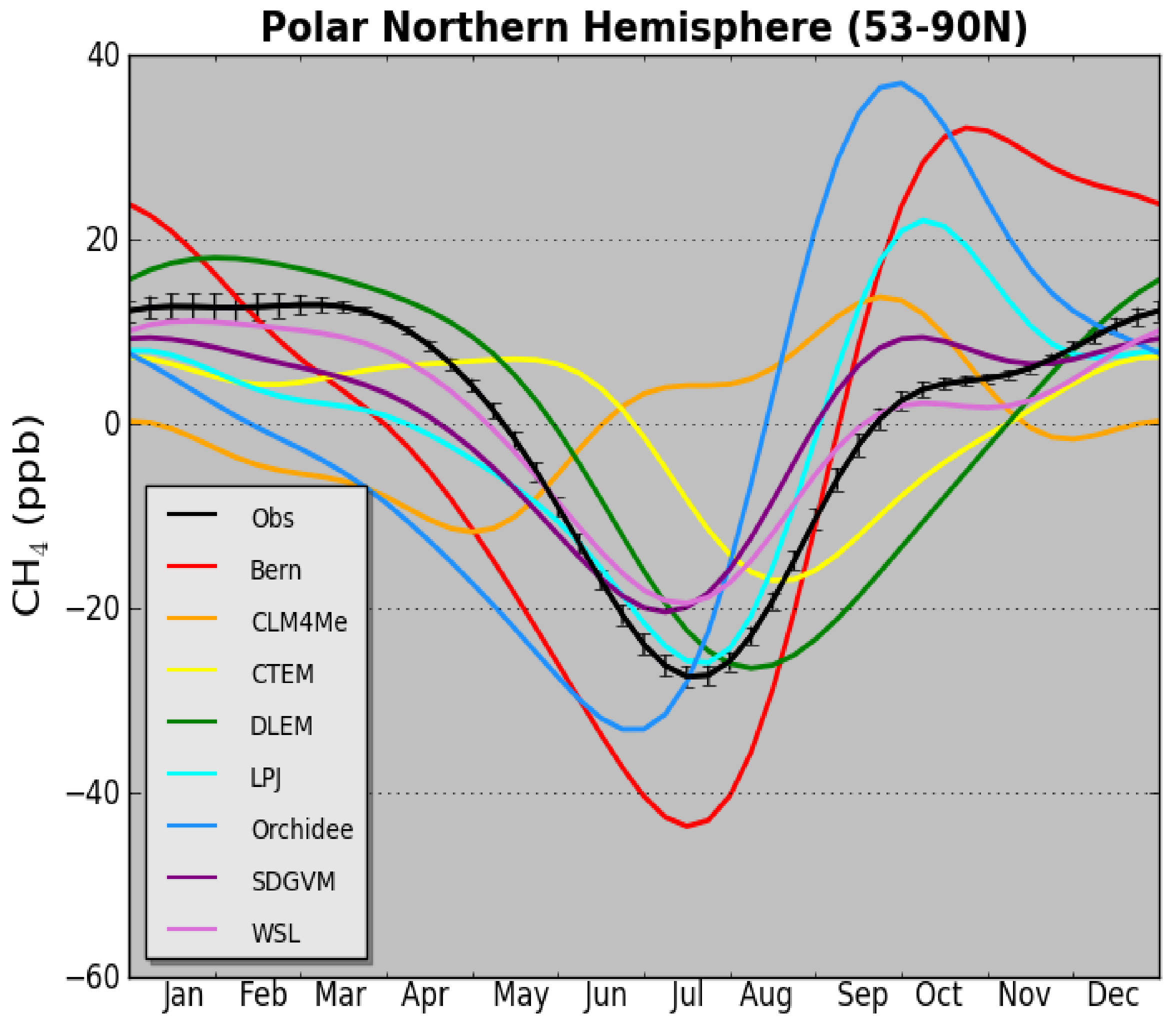
High Northern Latitude Seasonal Cycle

Important information about timing of emissions

-some models emit too early

-some emit too much in late summer/early Autumn

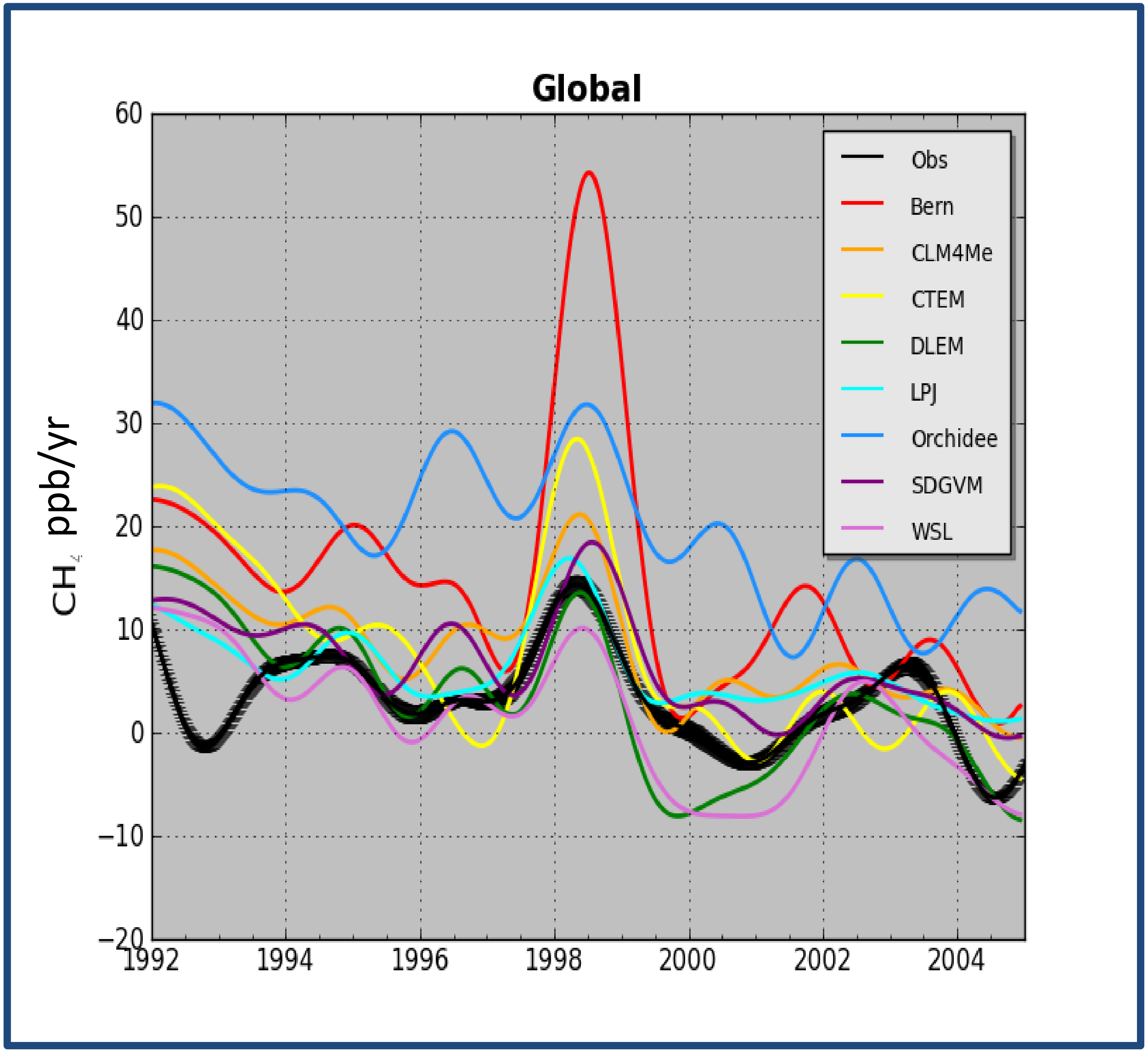
The annual amplitude is well simulated by some models, but overestimated by others



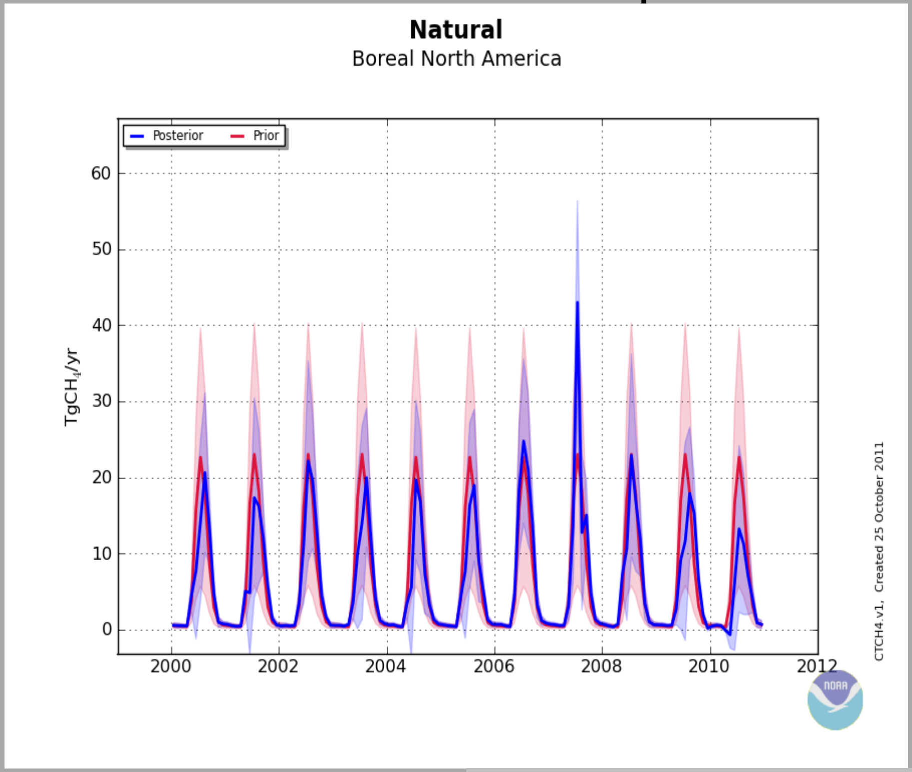
Inter-annual Variability is due primarily to wetland emissions

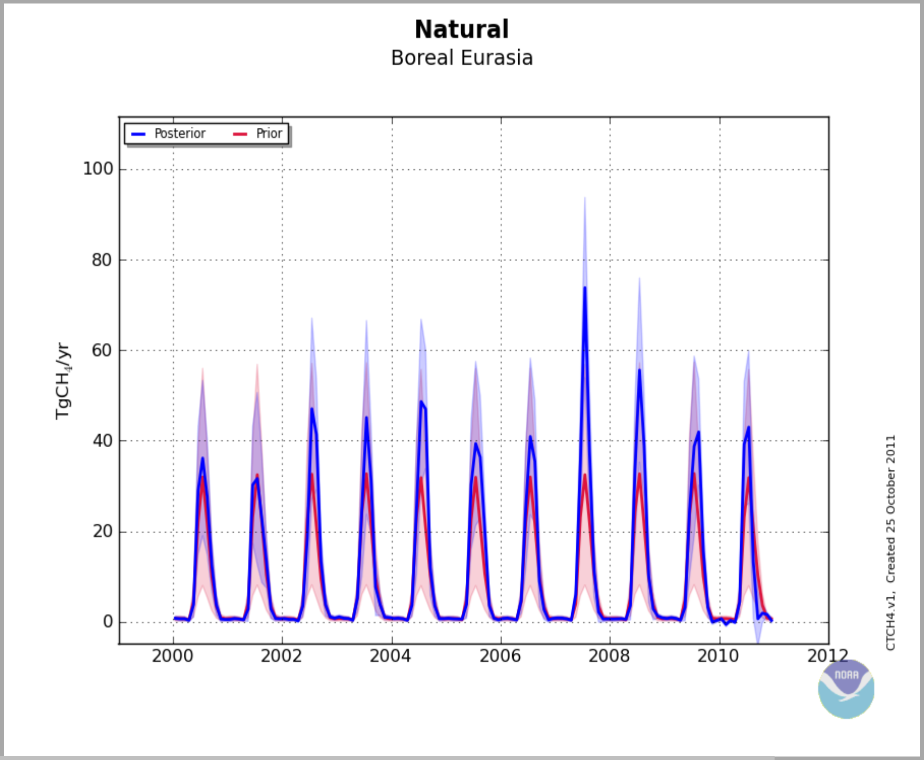
Models agree that changes
In wetland emissions related
To the 1997/1998 ENSO event
Caused an increase in CH_4
Growth.

Some models reproduce
The 2002/2003 event
As well.

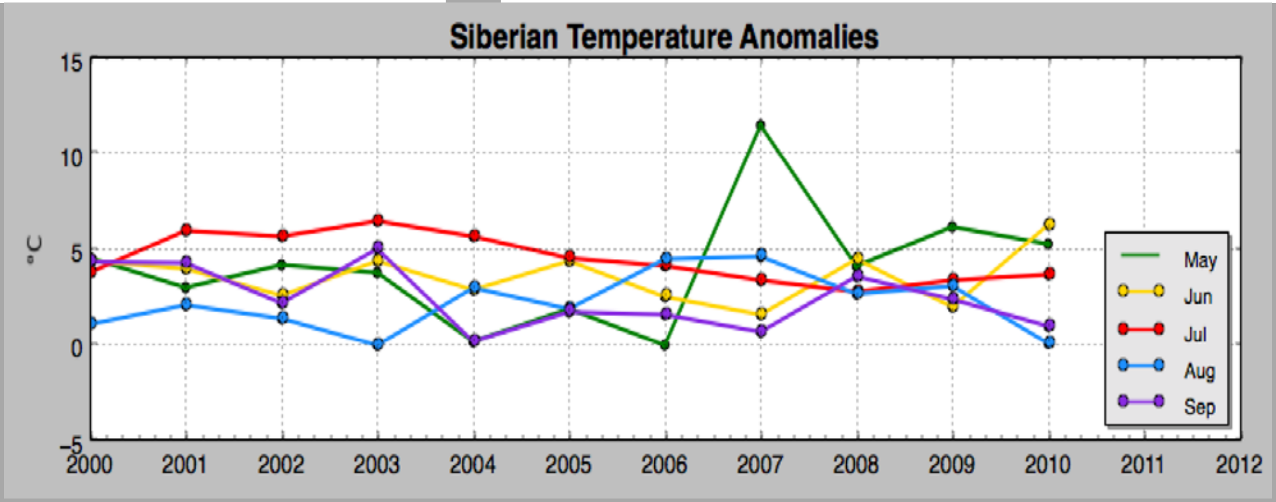


CarbonTracker-CH_4: Inter-Annual Variability, No Trend





May 2007 was very different!



Conclusions

Atmospheric Observations can be useful for evaluating model performance:

Is intra and inter-annual variability captured?

Are N-S gradients similar?

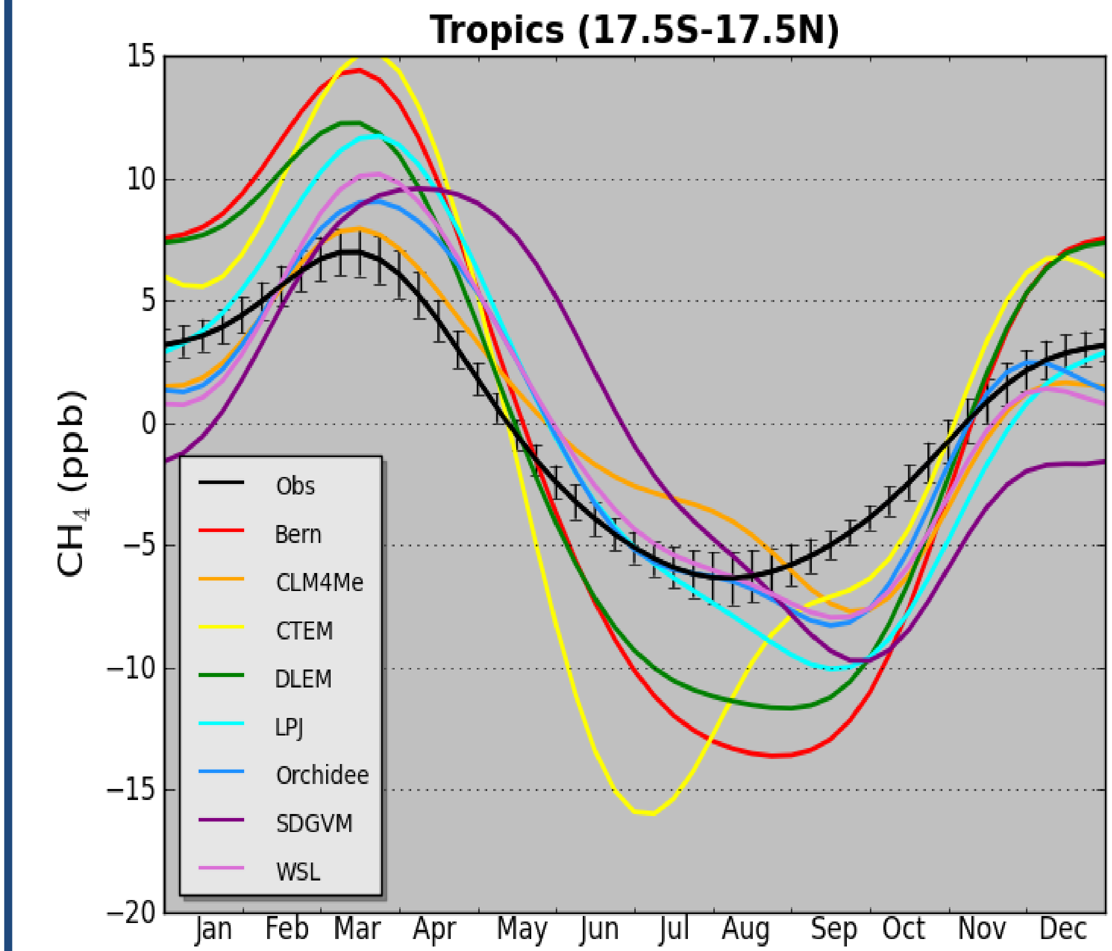
How do trends compare with observed trends?

This can lead to improved representation of Arctic-Climate feedbacks and better predictions of future climate.

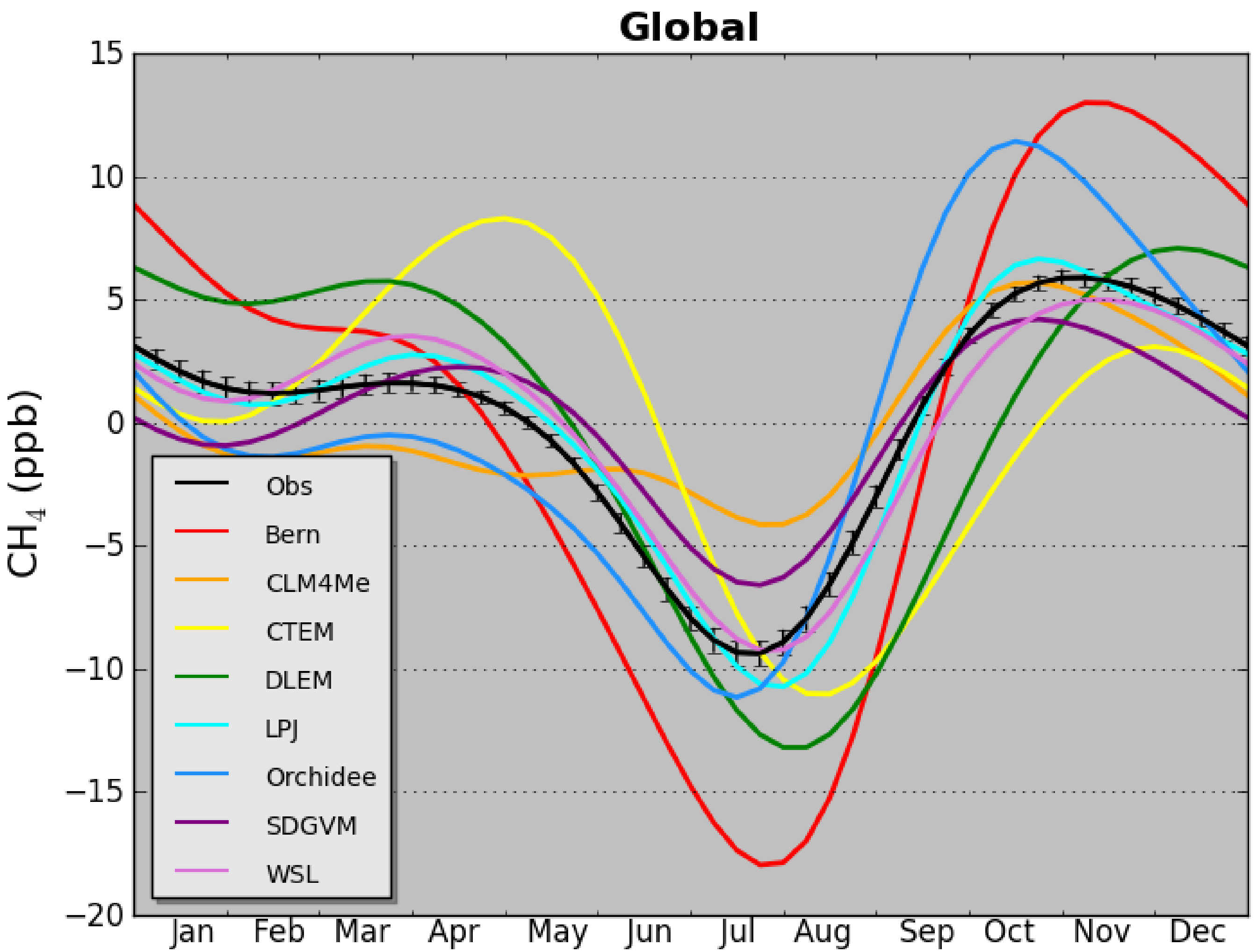
Tropical Annual Cycle

Reflects dry/wet seasons in tropics.

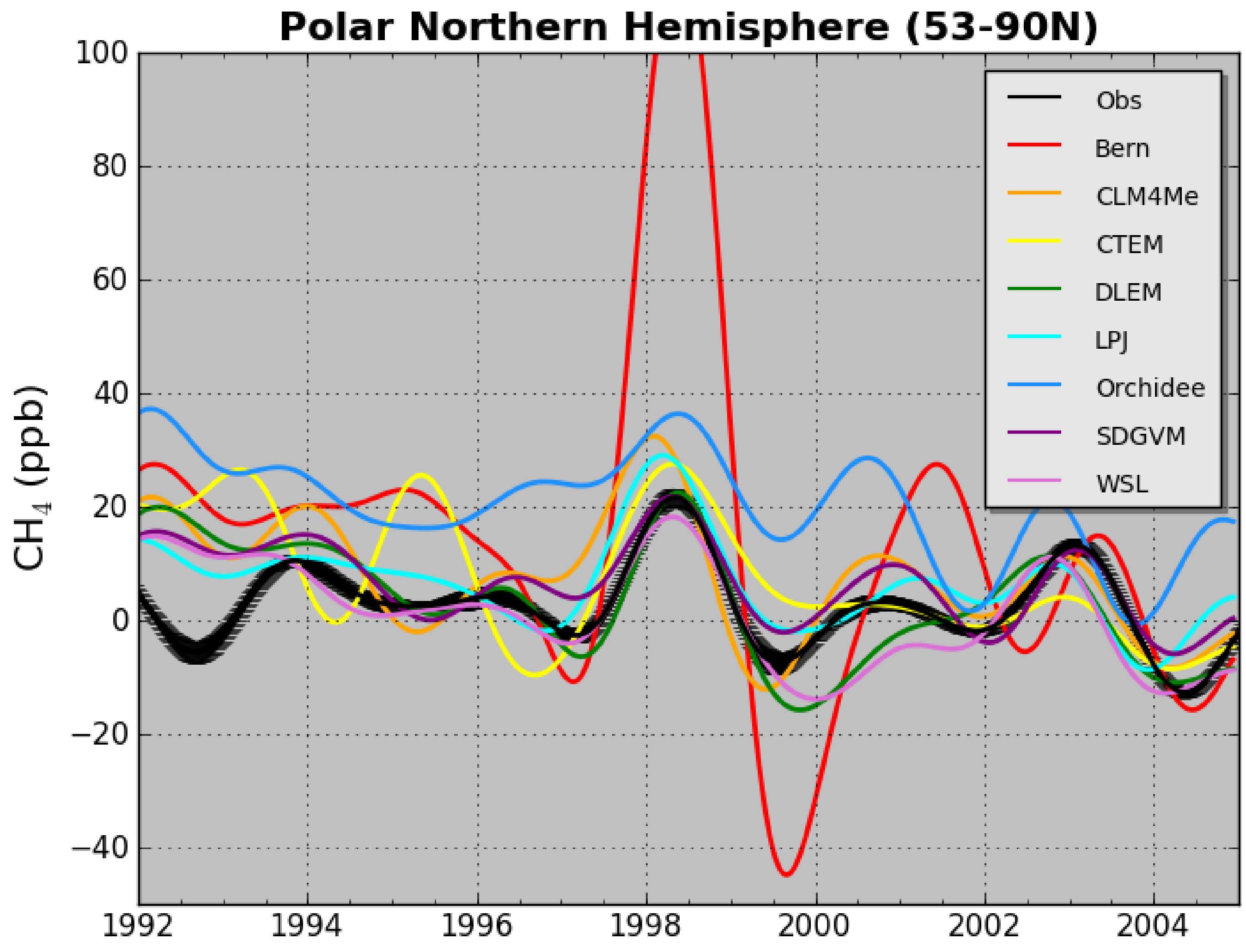
Could Northern Tropical wetlands be underestimated?



The Global Average Annual Cycle



Inter-annual Variability in Wetland Emissions



Inter-annual Variability in Wetland Emissions