CO emissions over South America

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TM meeting May 2014

I. van der Laan Luijkx, S. Basu, C. Clerbaux, I. van der Velde, W. Peters, L. Gatti, E. Gloor, J. Miller, L. Giglio, T. van Leeuwen, G. van der Werf

ENVIRONMENTAL SCIENCES GROUP WAGENINGEN UR

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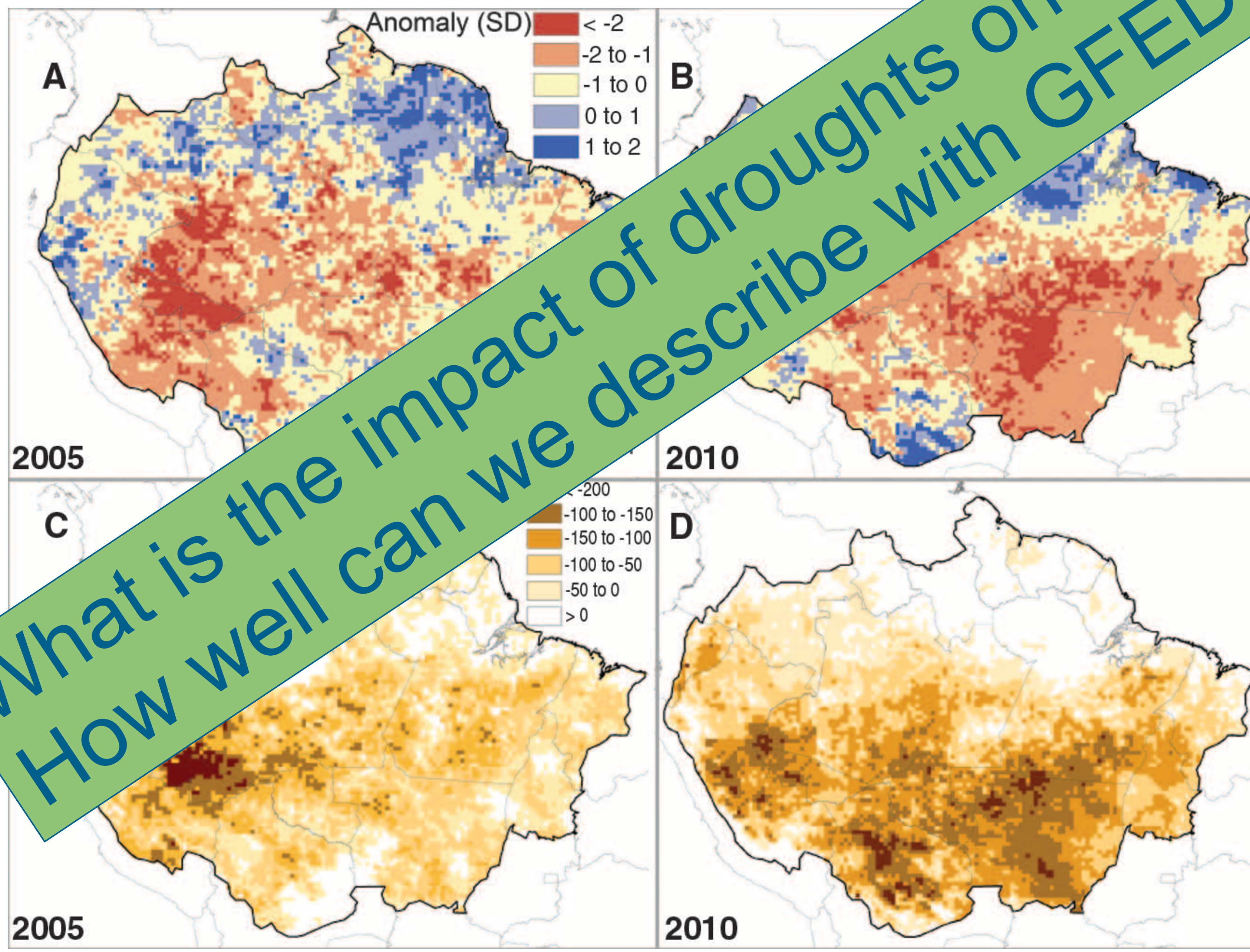
The 2010 Amazon Drought

Simon L. Lewis,[1]*† Paulo M. Brand… …r L. Phillips,[1]
Geertje M. F. van der Heijden,[4] …[2]

What is the impact of droughts on fire?
How well can we describe with GFED?

Rainfall

Water deficit



Abrupt increases in Amazonian tree mortality due to drought–fire interactions

PNAS, April 2014

Paulo Monteiro Brando[a,b,c,1,2], Jennifer K. Balch[d,1], Daniel C. Nepstad[e,1], Douglas C. Morton[f], Francis E. Putz[g],

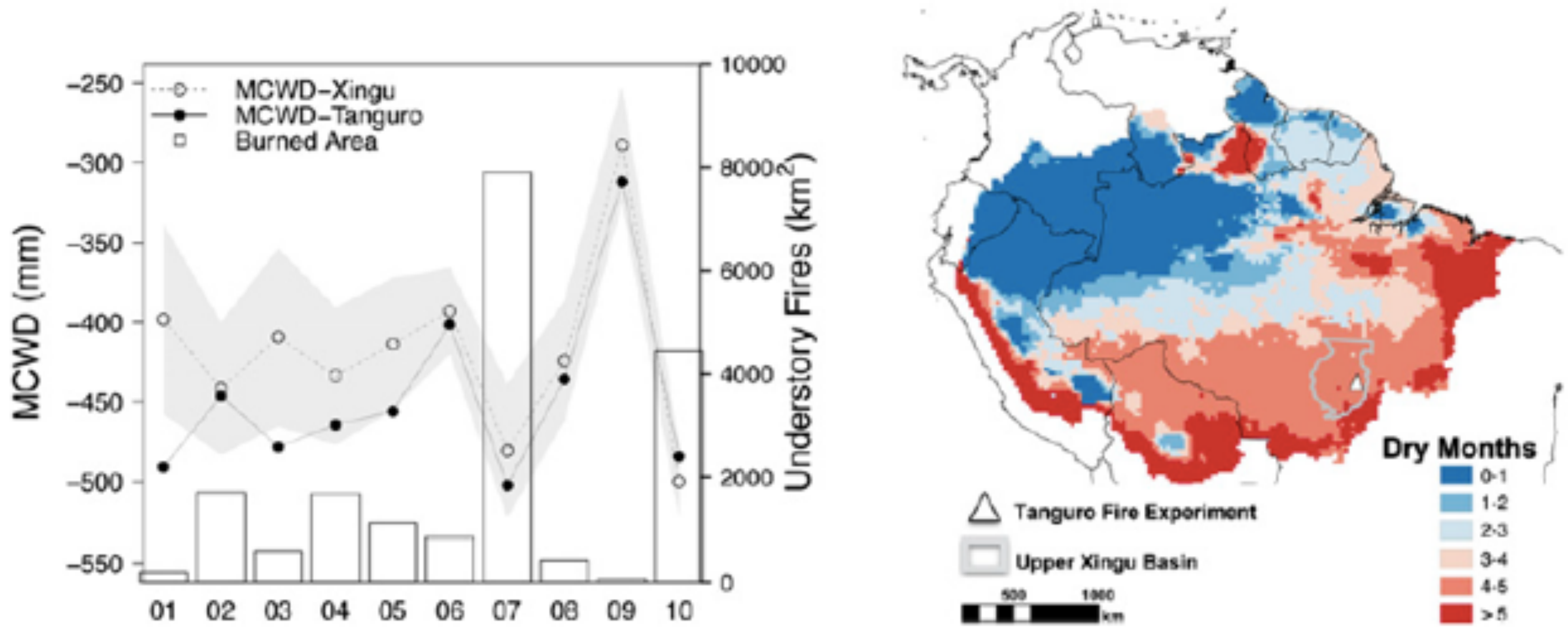


Fig. 2. (*Left*) Annual MCWD between 2000 and 2010 for the Upper Xingu Basin (solid circles) and the experimental field site (Fazenda Tanguro, solid triangles). The shaded area represents the SD of the mean and accounts for the spatial variability in MCWD across the Upper Xingu Basin. (*Right*) Average dry-season length (i.e., number of months with precipitation ≤100 mm) and the locations of both the Upper Xingu Basin (in gray) and the fire experiment (triangle). MCWD and monthly precipitation were derived from the TRMM.

One of the last great wildernesses on earth – known as the lungs of the world – is balancing dangerously close to a "tipping point" where forest fires will become so commonplace and extensive that they will change much of the landscape forever, scientists said.

Although fires have always occurred in Amazonia, they have been largely controlled by the natural humidity of the region. Now, however, the drying out of the rainforest threatens to ignite the tree-filled habitat – with its rich biodiversity – and convert it almost overnight into barren desert, they warned.

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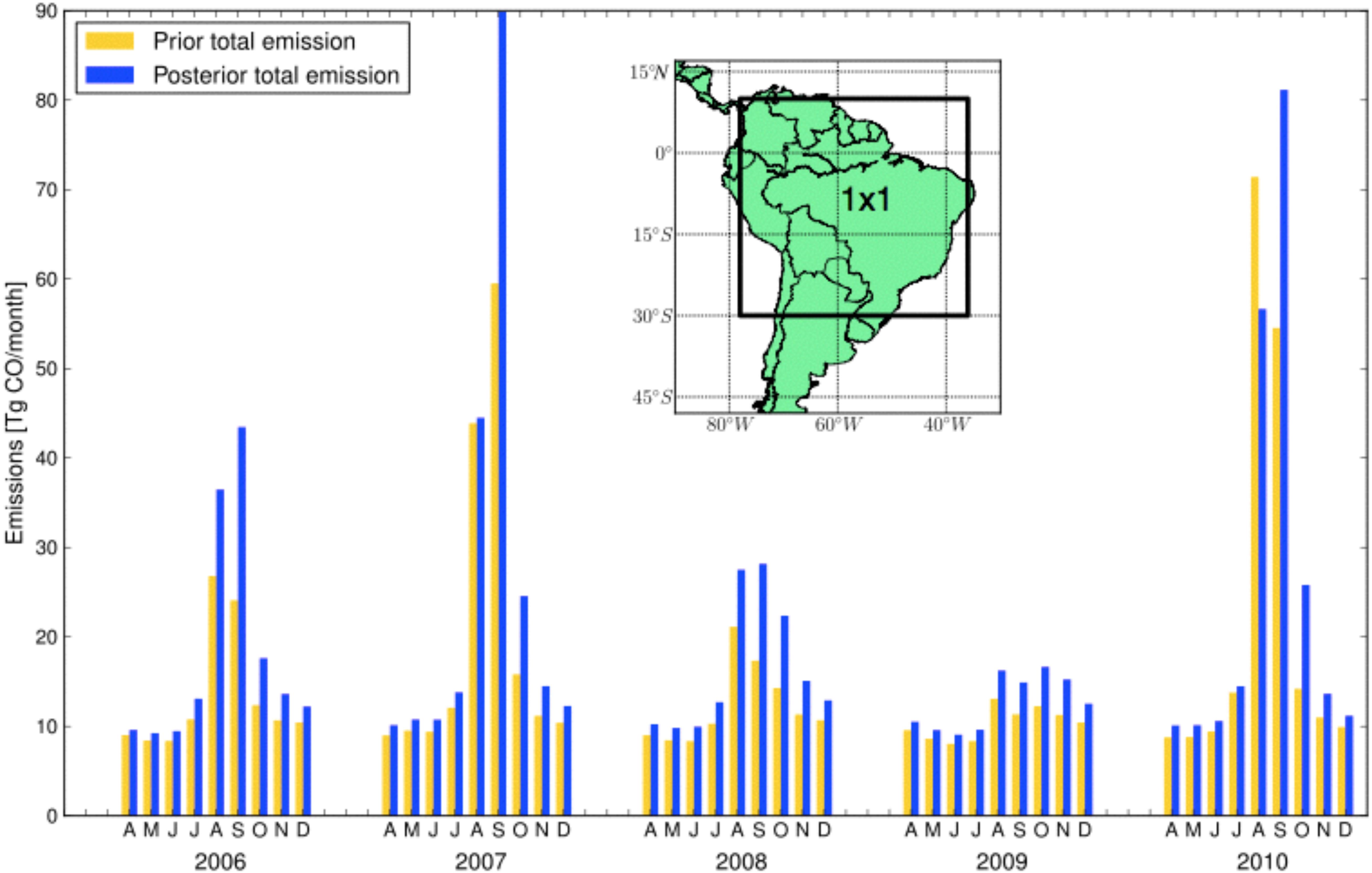
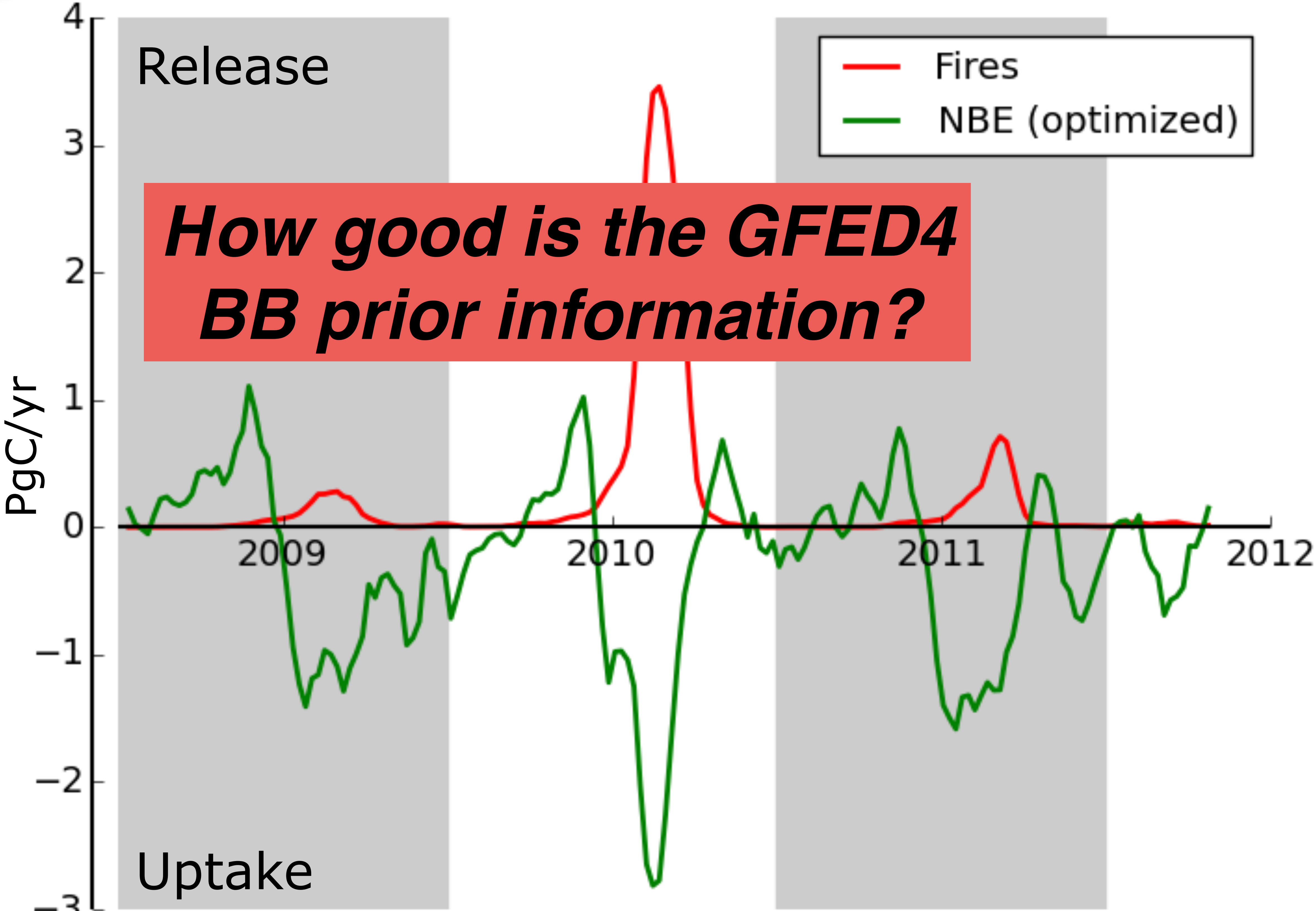
MOPITT 4 derived CO emissions



Seasonal CO_2 fluxes



How good is the GFED4 BB prior information?

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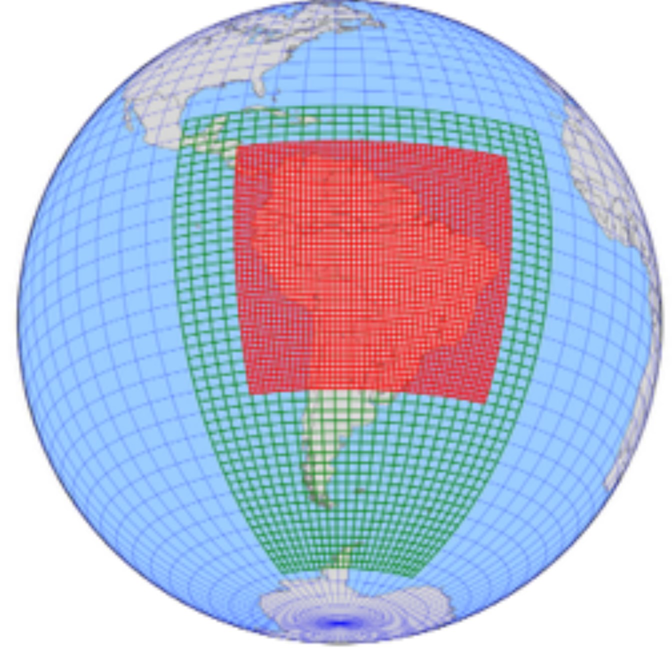
What will I discuss today?

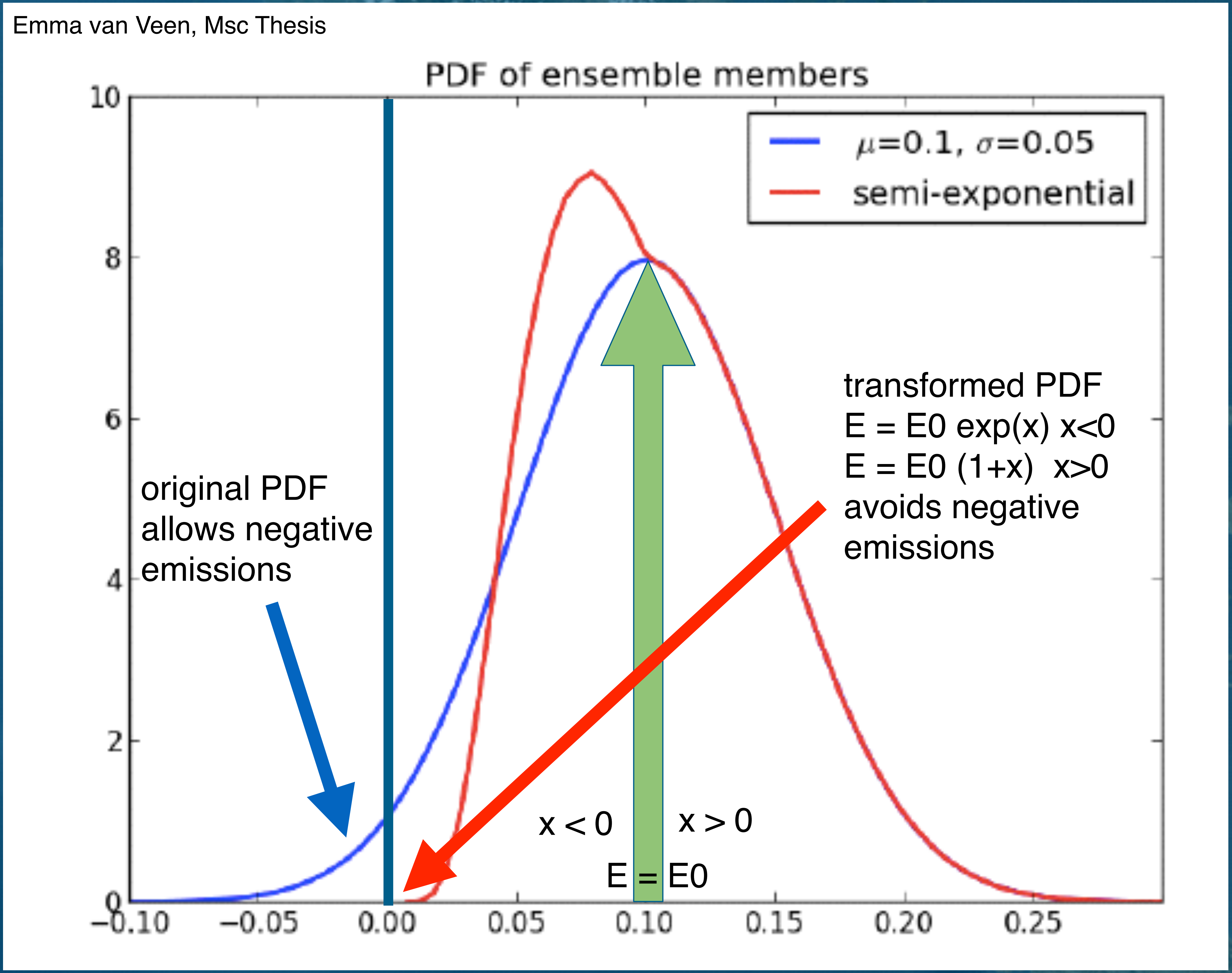
- » Set-up IASI inversions to infer CO emissions
  - How to optimise emissions?
  - Avoid negative emissions
- » Detailed inspection of 2010 result
- » Spin-off: What about other CO sources (NMHC)

Set-up inversions



- nam300x200, nam100x100
  - optimise “biomass burning”, “rest”
  - bb: 250%, L=200 km, T=0.1 month, 3 days (land)
  - rest: 50%, L=1000 km, T = 9.5 month, monthly
- glb600x400
  - optimise “total”
  - 250%, L = 1000 km, T=0.5 month, 7 day
- Prior PDF (avoid negative emissions)
  - $E = E0 \exp(x)$, for $x < 0$
  - $E = E (1+x)$, $x > 0$
- One year inversion (2010, 2011)

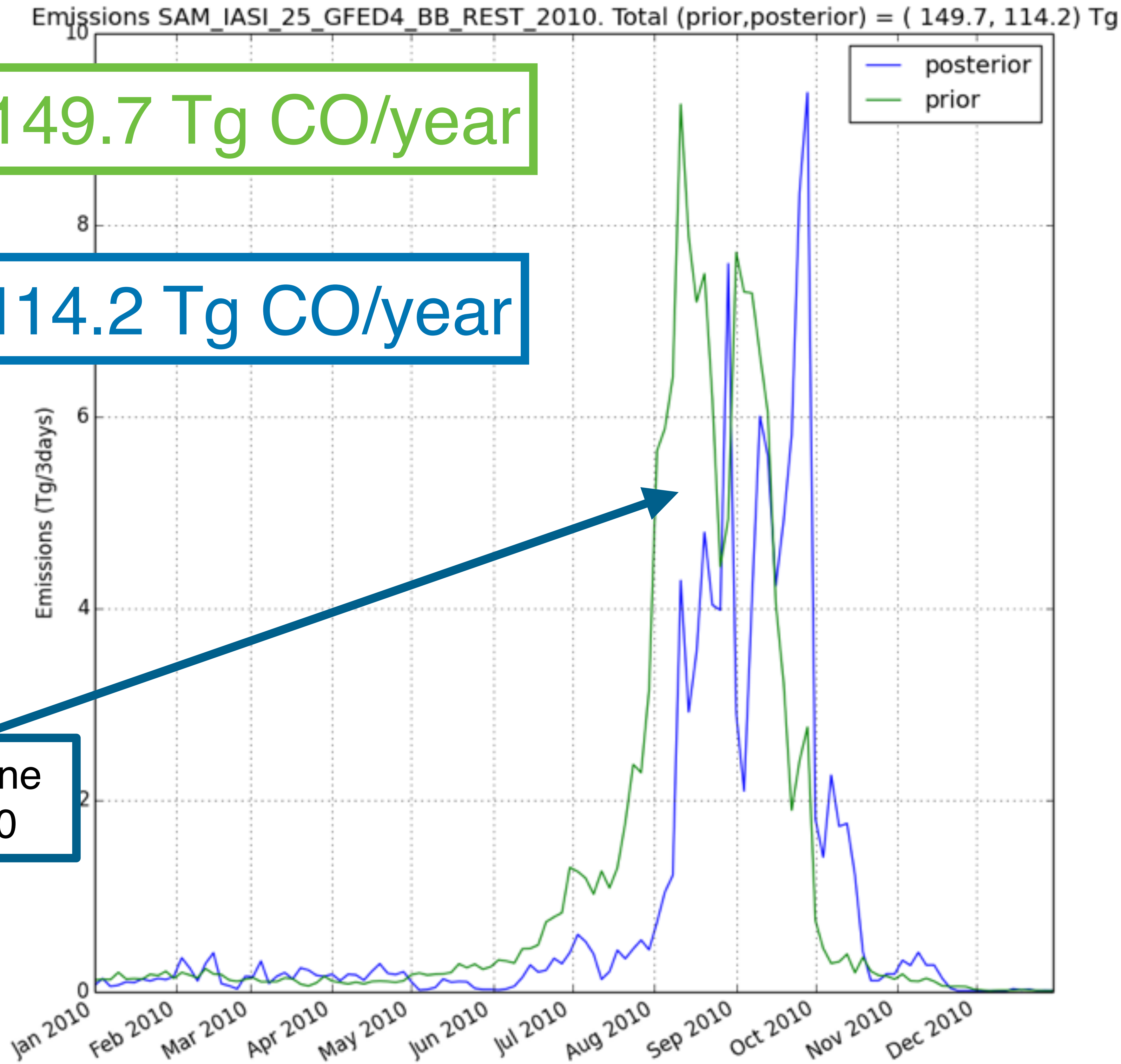
semi-exponential PDF: forces use M1QN3



CO emissions increment per 3 day period

Prior GFED: 149.7 Tg CO/year

Posterior : 114.2 Tg CO/year



Large CO emission decline calculated in August 2010

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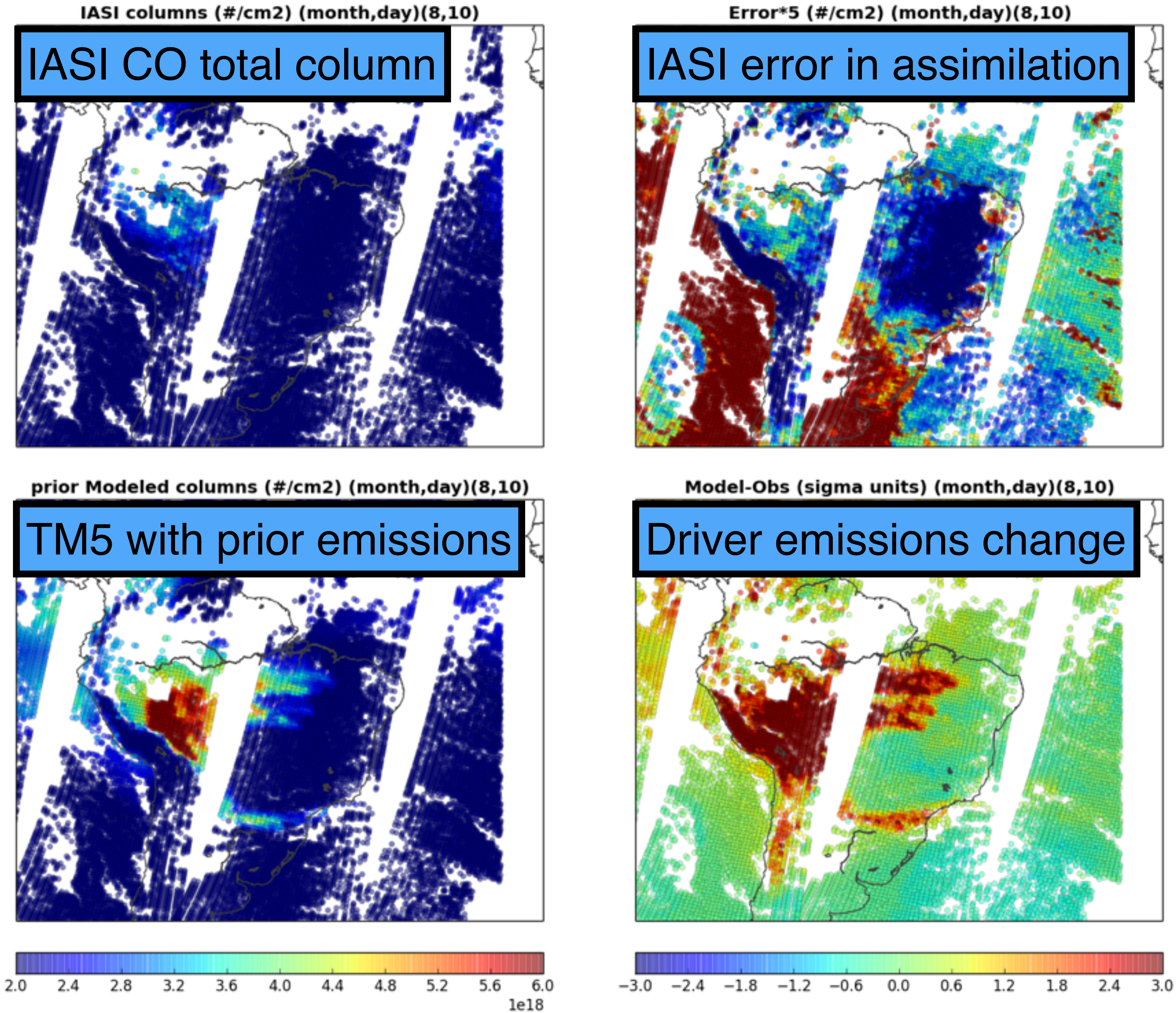
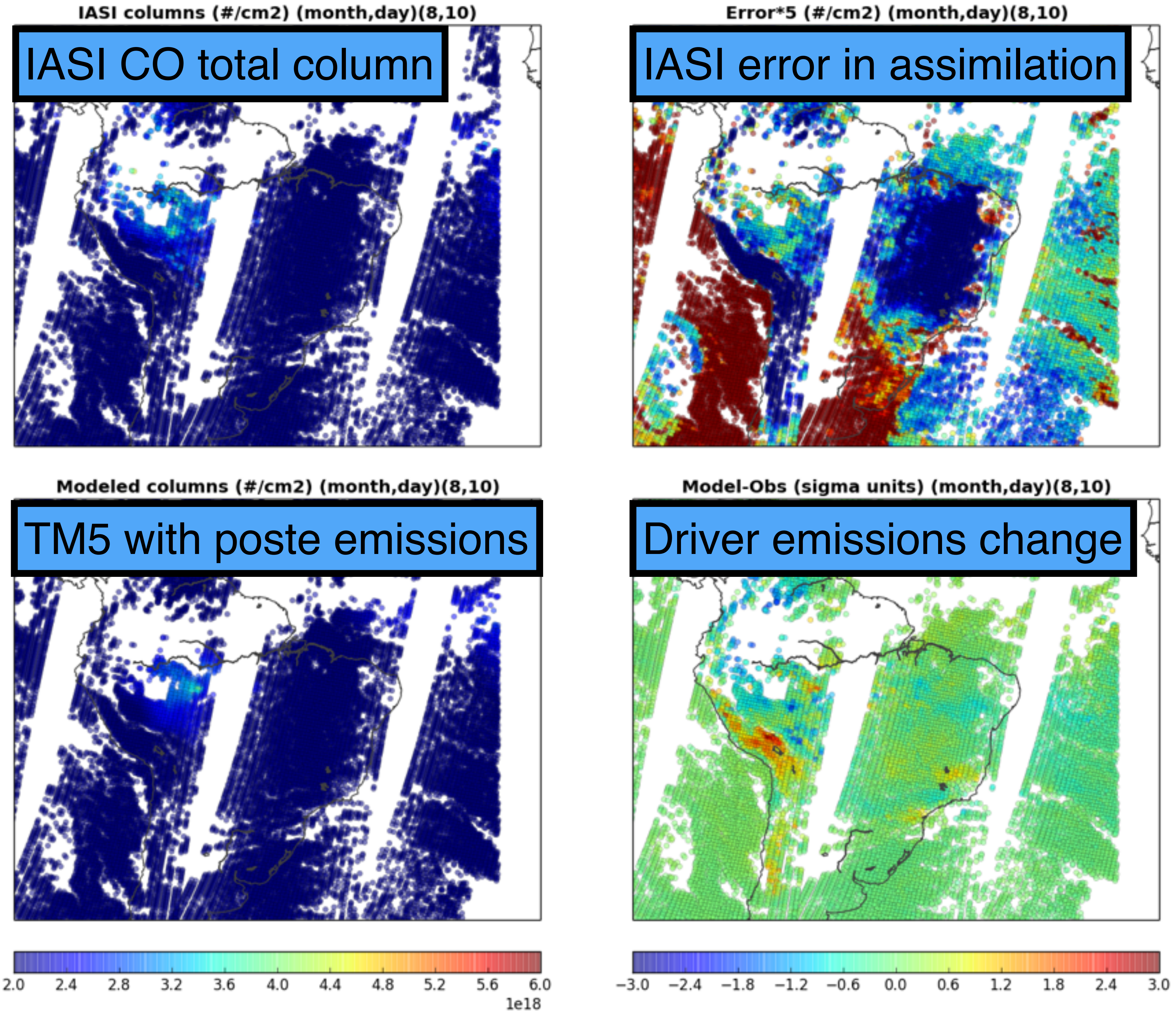
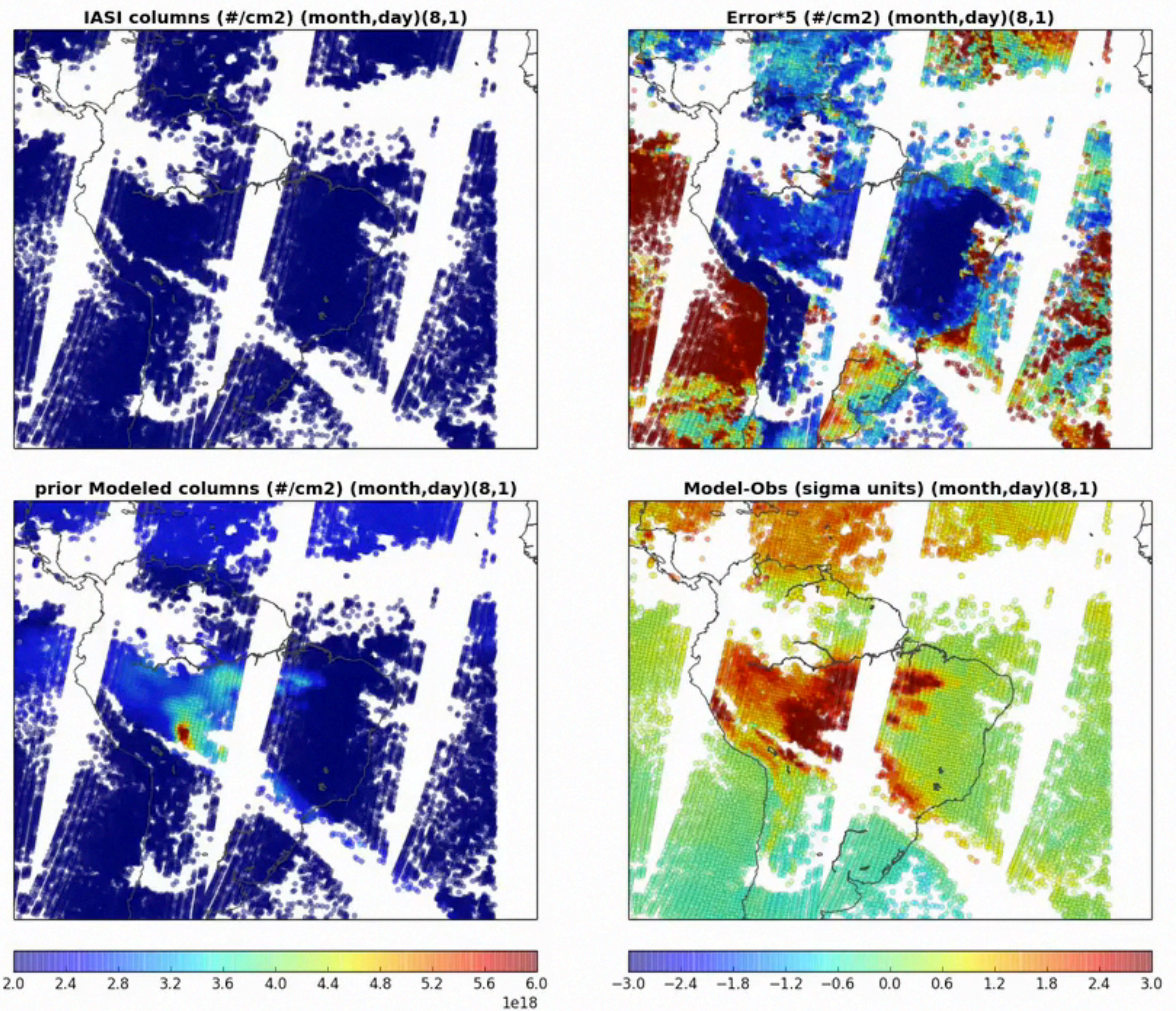


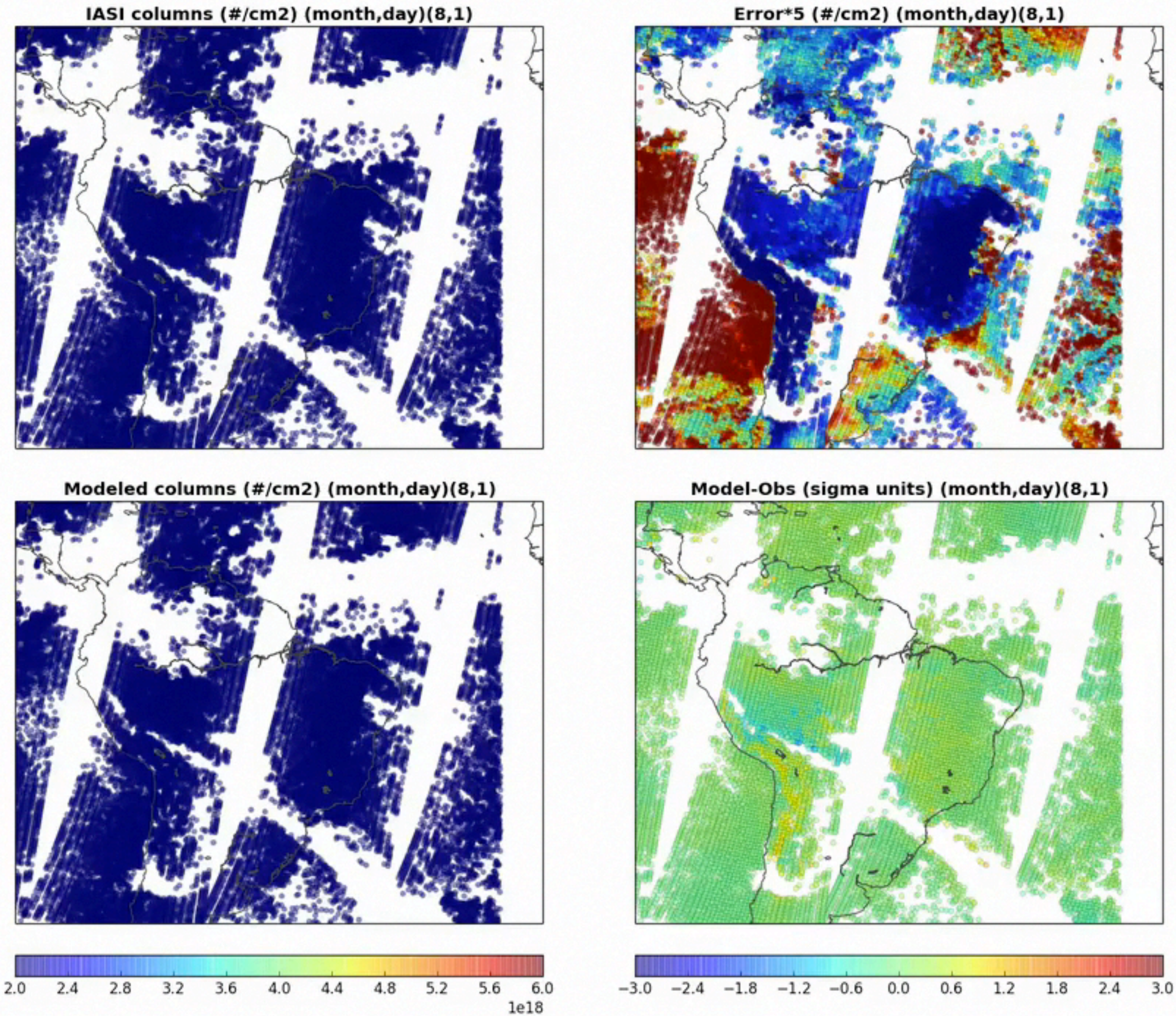
Day: 10 August 2010, Before Assimilation



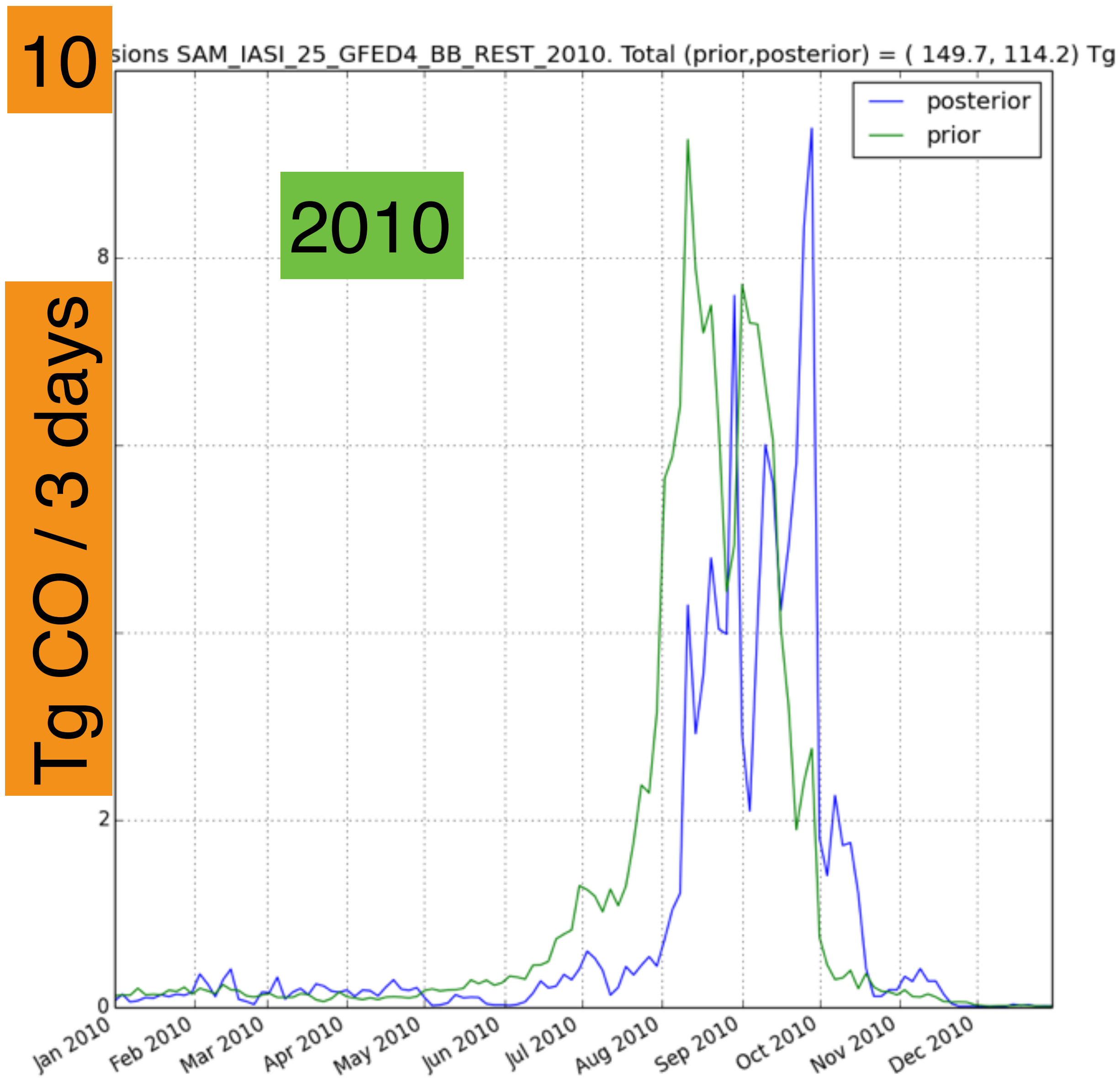
Day: 10 August 2010, After Assimilation

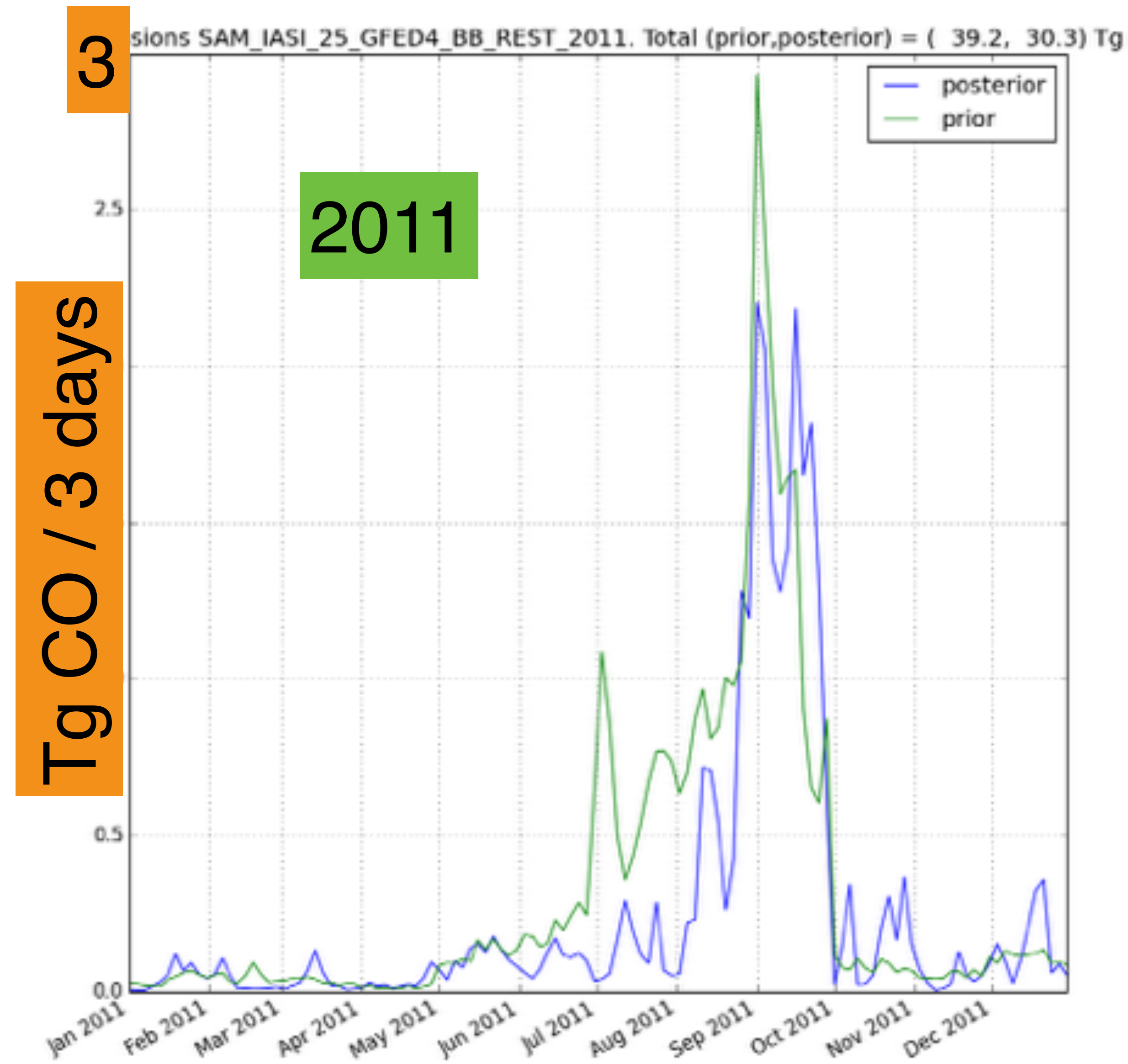


Before assimilation



After assimilation





2010: 150 Tg —> 114 Tg

2011: 39 Tg —> 30 Tg

CO produced by Biomass burning

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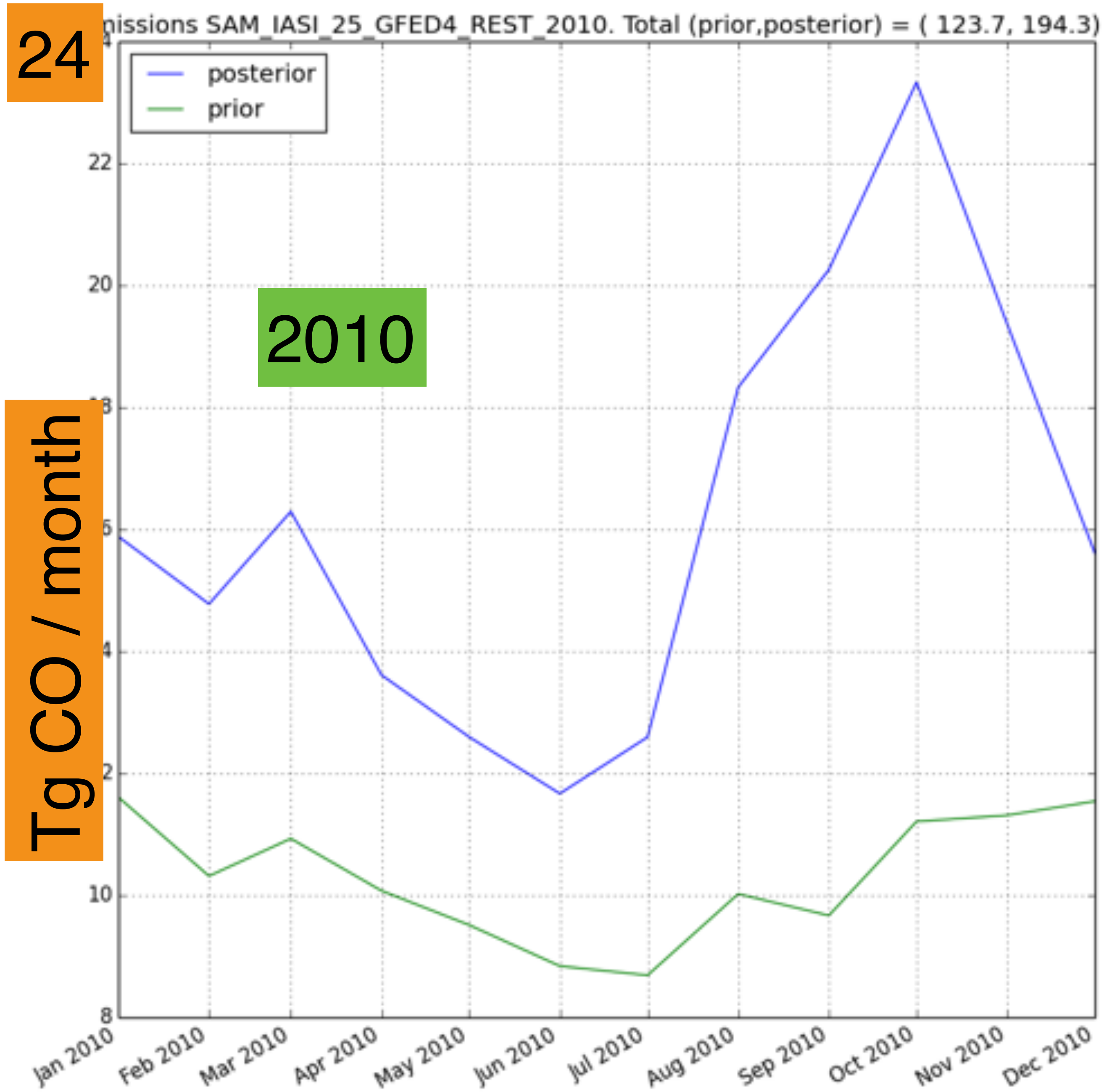

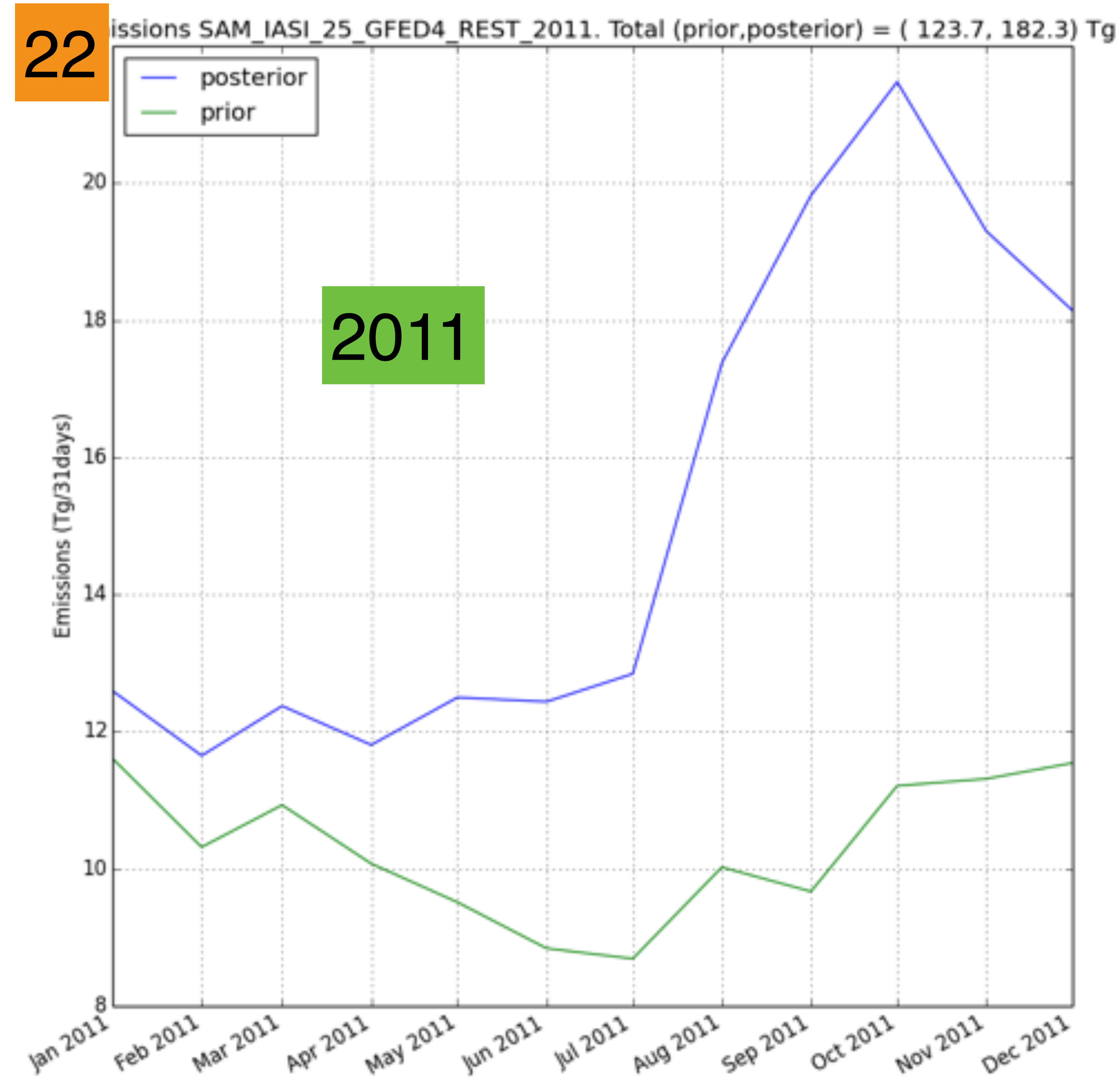

2010: 124 Tg—> 194 Tg

2011: 124 Tg—> 192 Tg

CO produced from NMHC & anthropogenic

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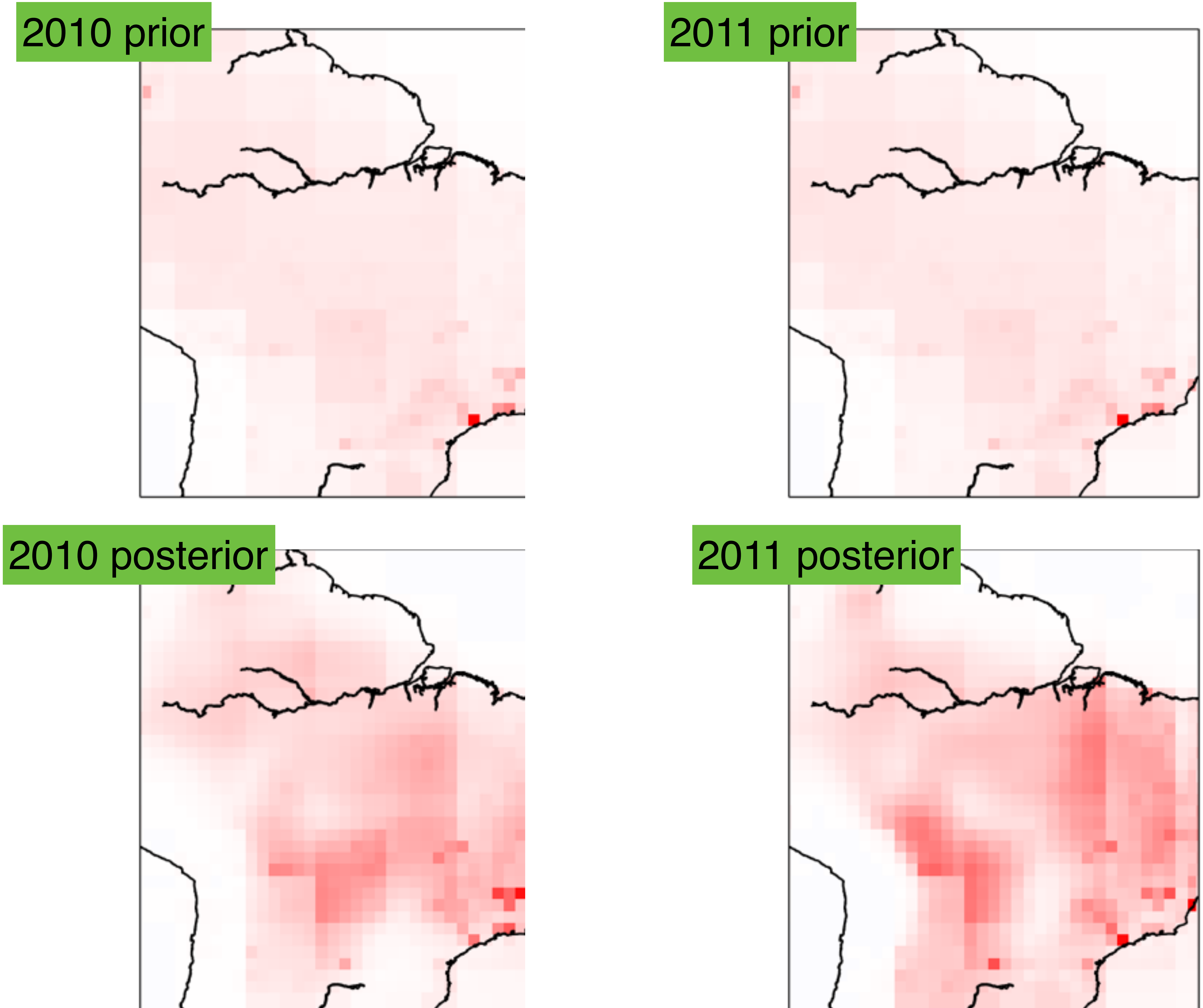

2010 prior
2011 prior
2010 posterior
2011 posterior

Improved retrieval of global tropospheric formaldehyde columns from GOME-2/MetOp-A addressing noise reduction and instrumental degradation issues

AMT, 2012

I. De Smedt[1], M. Van Roozendael[1], T. Stavrakou[1], J.-F. Müller[1], C. Lerot[1], N. Theys[1], P. Valks[2], N. Hao[2], and R. van der A[3]

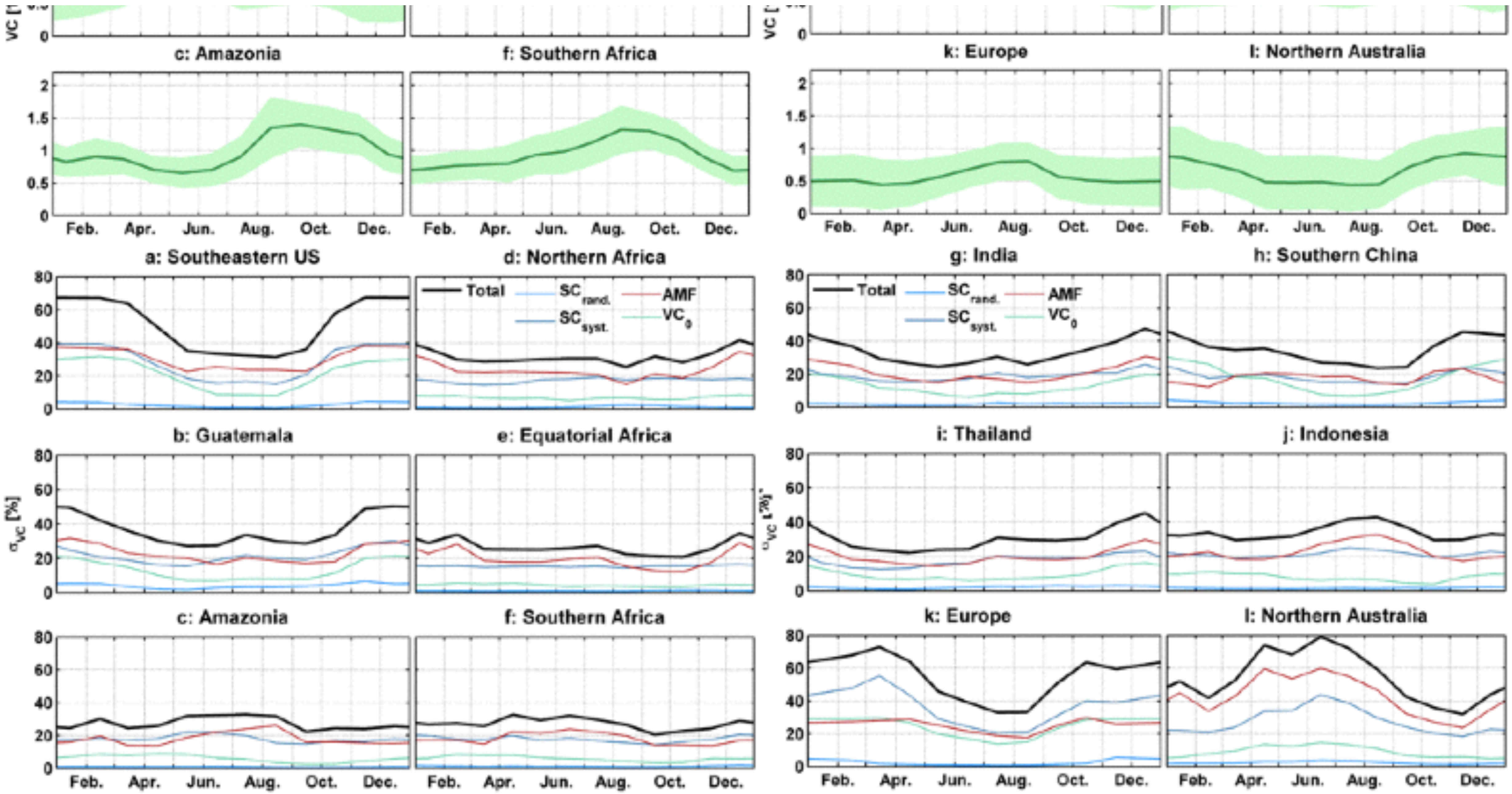
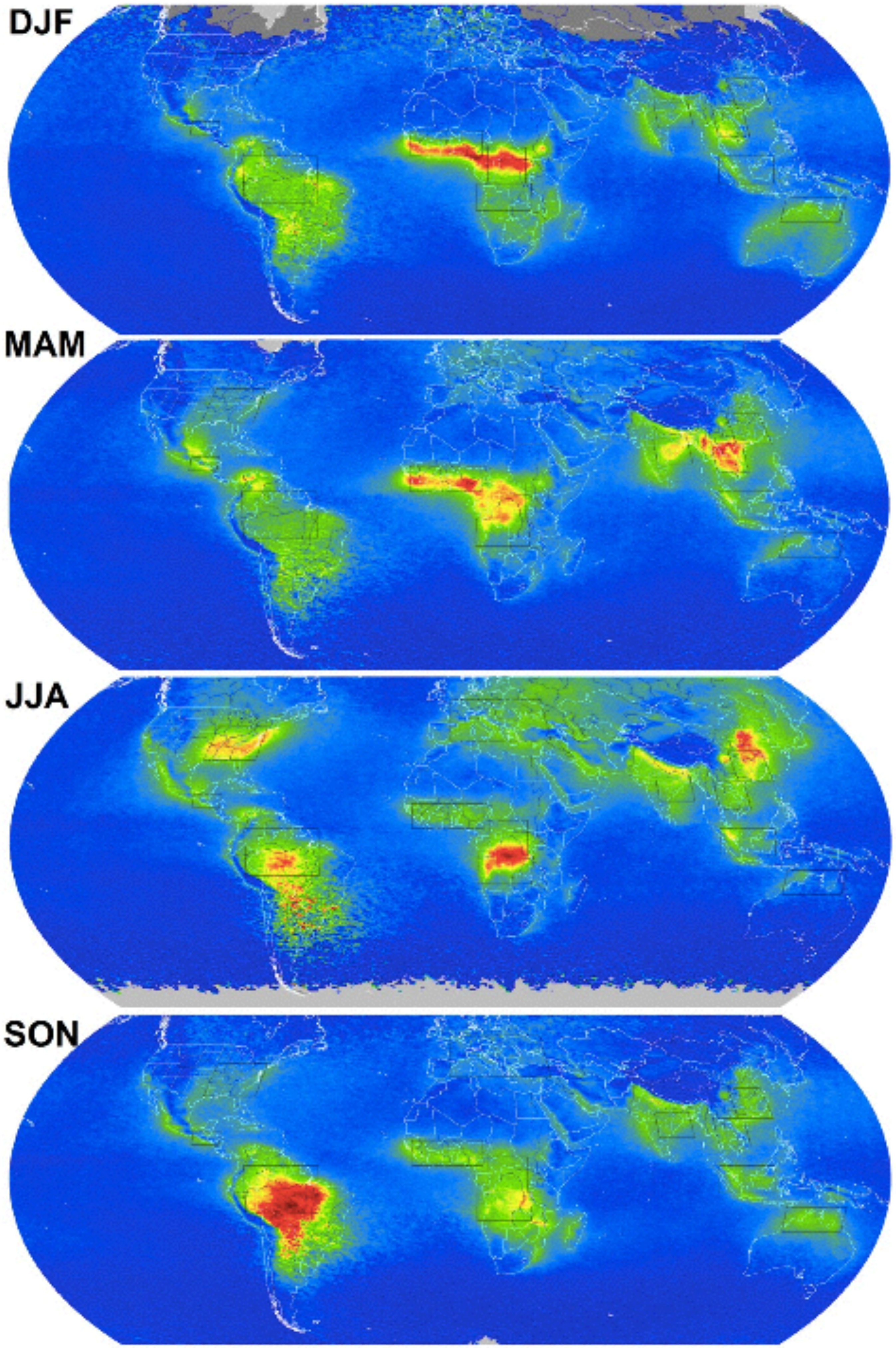
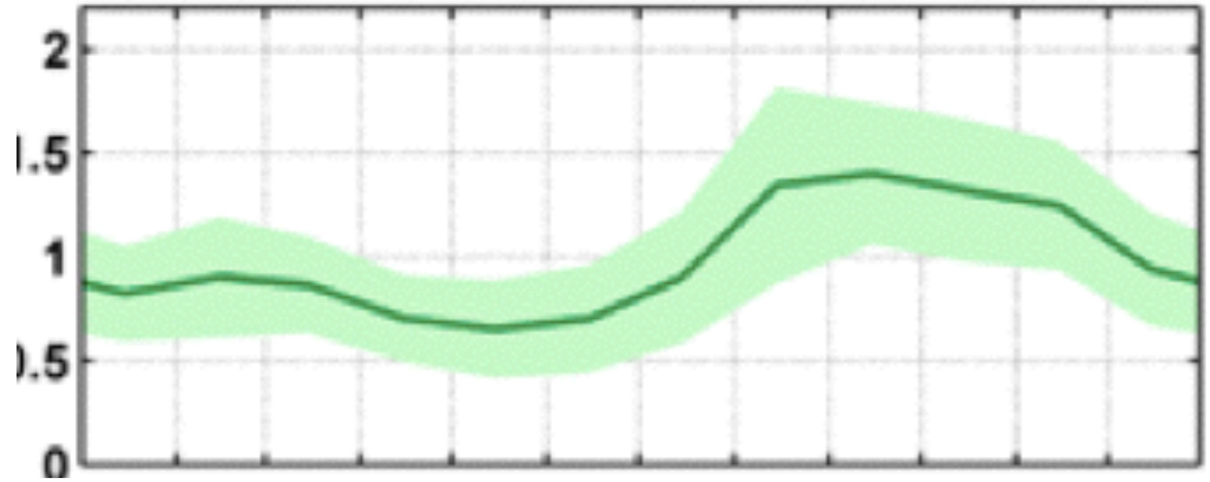
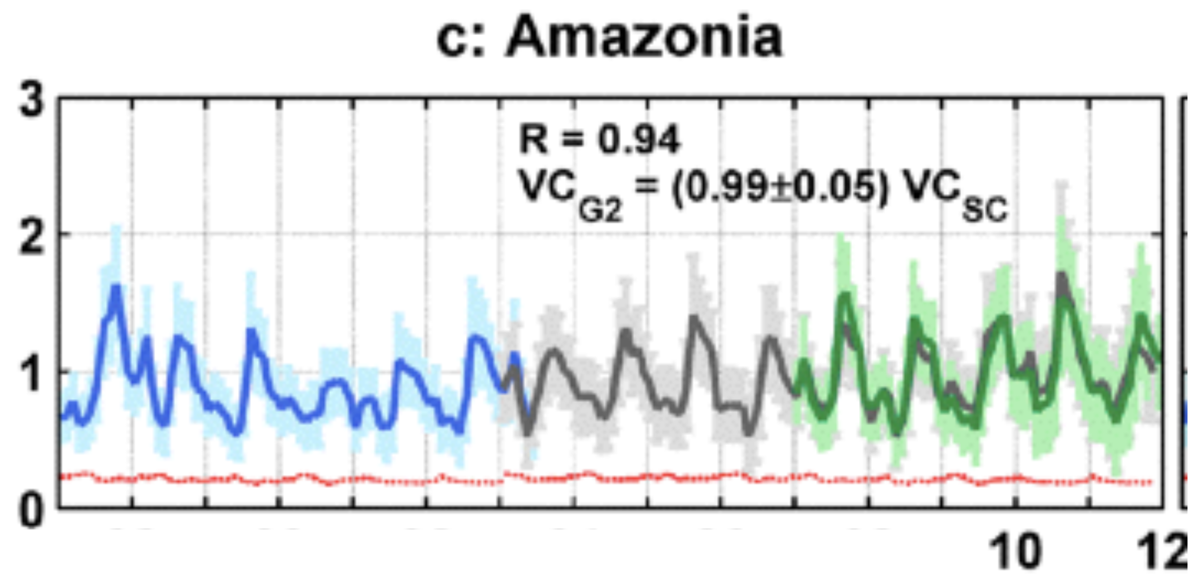
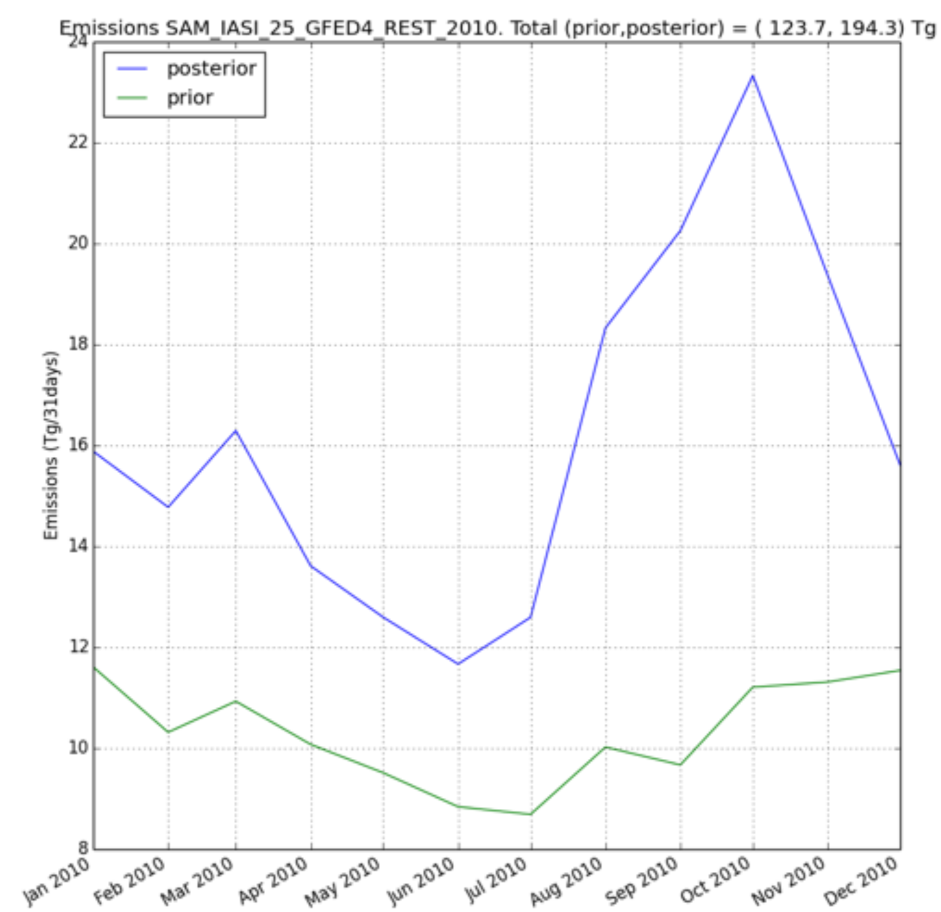


Fig. 10. GOME-2 H_2CO vertical columns averaged regionally between 2007 and 2011 (upper panels), and their estimated relative errors (lower panels) with the contributions of each error source. The limits of the regions are shown in Fig. 9.


DJF
MAM
JJA
SON


2
1.5
1
0.5
0


c: Amazonia
R = 0.94
VC$_{G2}$ = (0.99±0.05) VC$_{SC}$
3
2
1
0
10
12


Emissions SAM_IASI_25_GFED4_REST_2010. Total (prior,posterior) = (123.7, 194.3) Tg
posterior
prior
Emissions (Tg/31days)
24
22
20
18
16
14
12
10
8
Jan 2010
Feb 2010
Mar 2010
Apr 2010
May 2010
Jun 2010
Jul 2010
Aug 2010
Sep 2010
Oct 2010
Nov 2010
Dec 2010

Take home messages

- Drought & Fire in Amazon: large uncertainties
- 4DVAR-CO & IASI data: large constraint on BB timing & magnitude
- But: what about other CO sources? What is biomass burning & what comes from CH_2O?

- Progress:
  - Use CH_2O satellite data?
  - Better prior for NMHC —> CO
  - Ingrid: use CO to constrain CO_2 from burning
  - Sourish: CO-CO_2 inversions