Biomass burning emission estimates from IASI CO satellite measurements

With links to the carbon cycle

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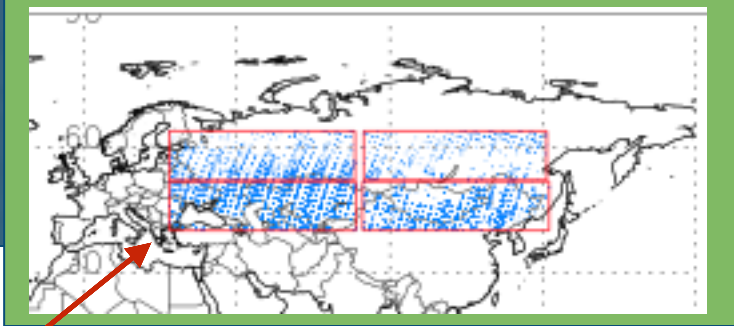
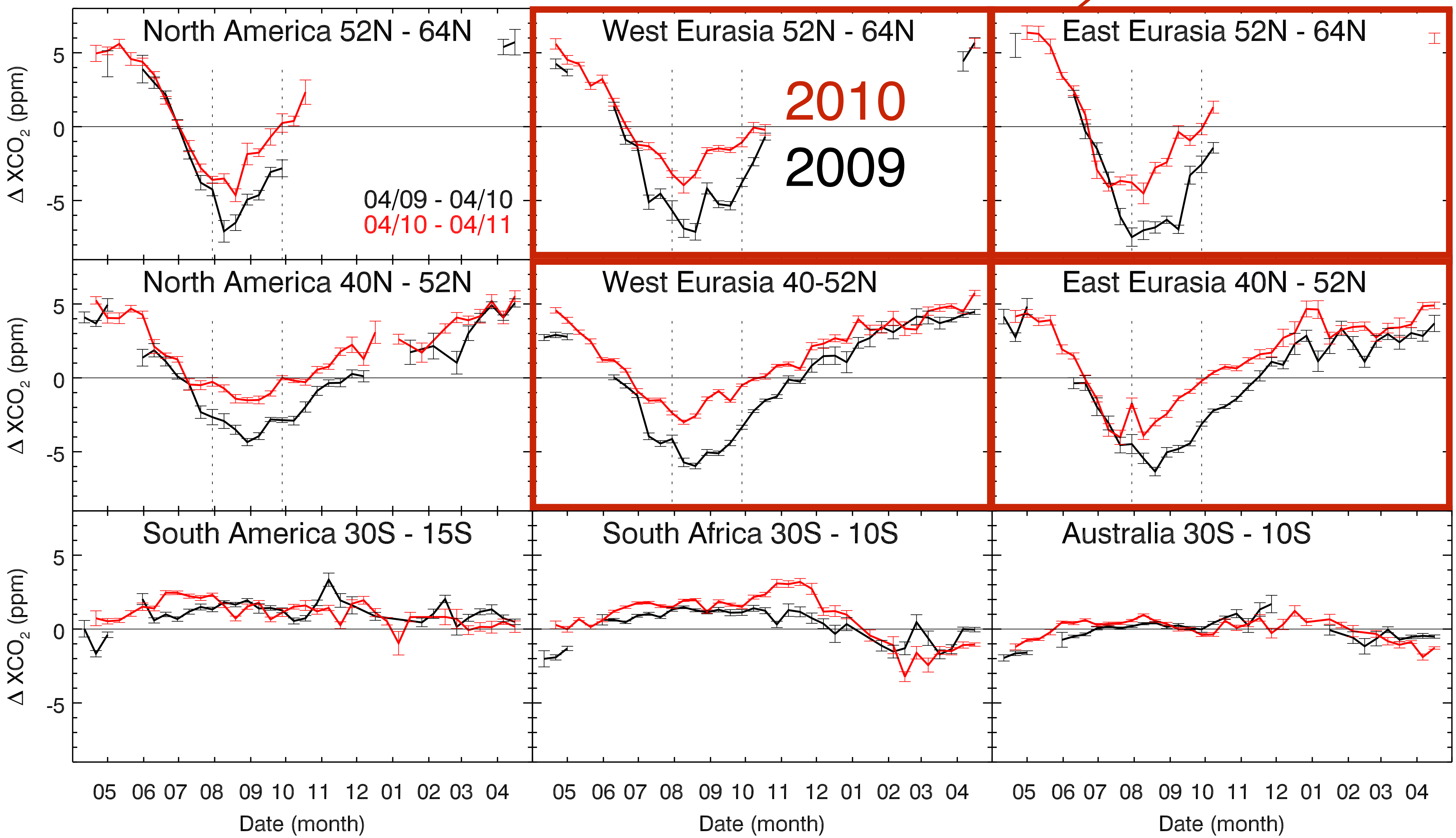
Thanks to: Ingrid van de Laan, Wouter Peters, Cathy Clerbaux, Sourish Basu, Luciana Gatti, John Miller, Ivar van der Velde, Thijs van Leeuwen, Sandrine Guerlet, NOAA

SRON Netherlands Institute for Space Research
IMAU Institute for Marine and Atmospheric research Utrecht
WAGENINGEN UR For quality of life

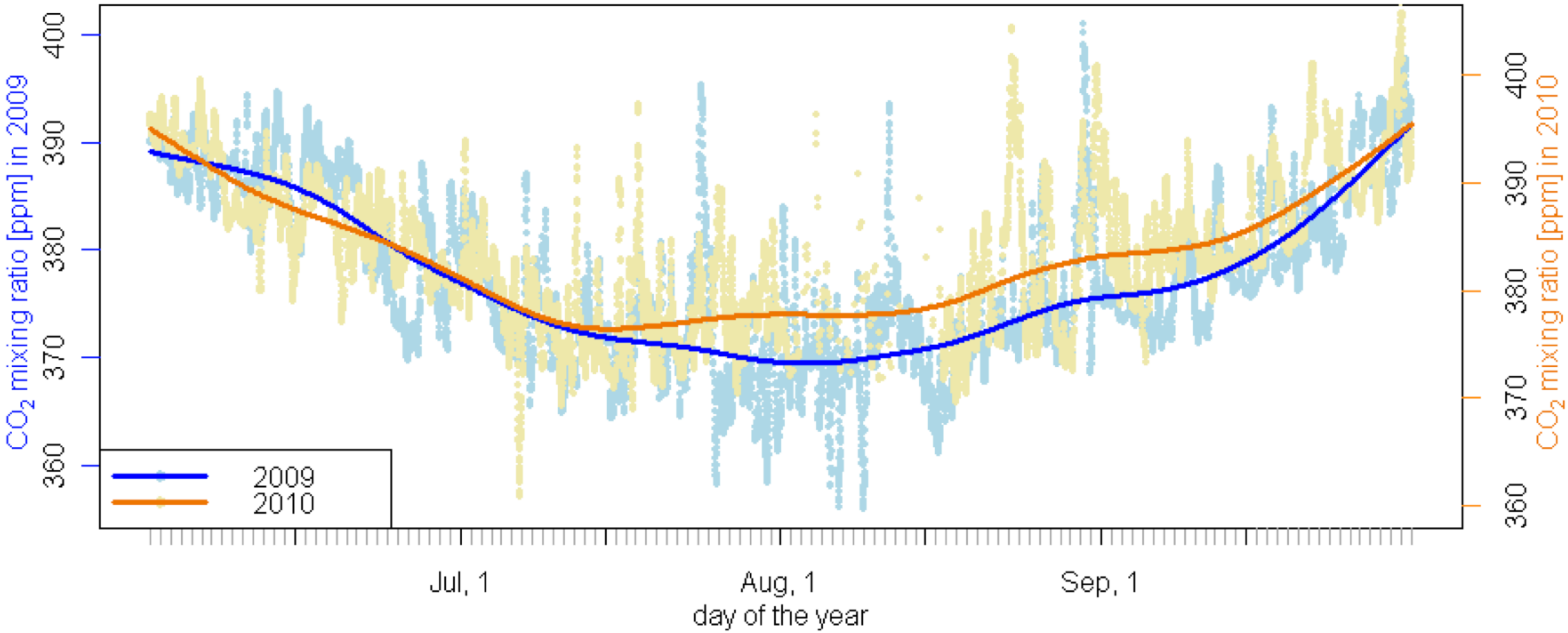
2009 and 2010 XCO_2 from GOSAT

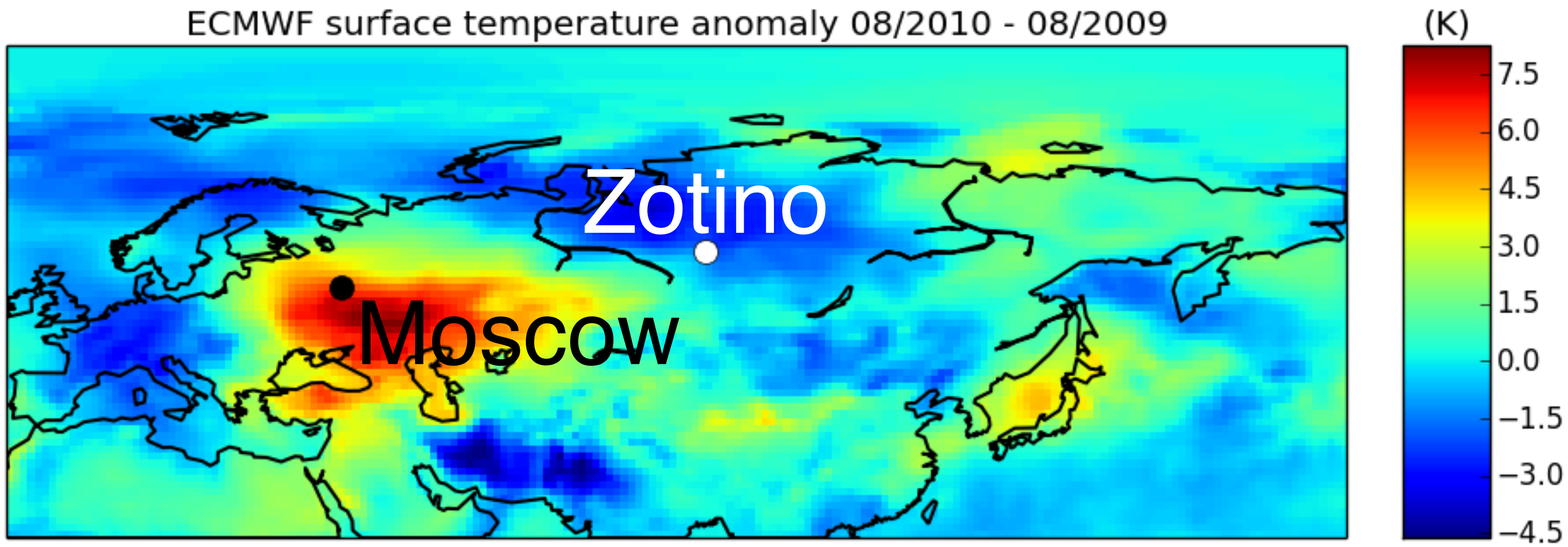




Guerlet et al., GRL, 2013

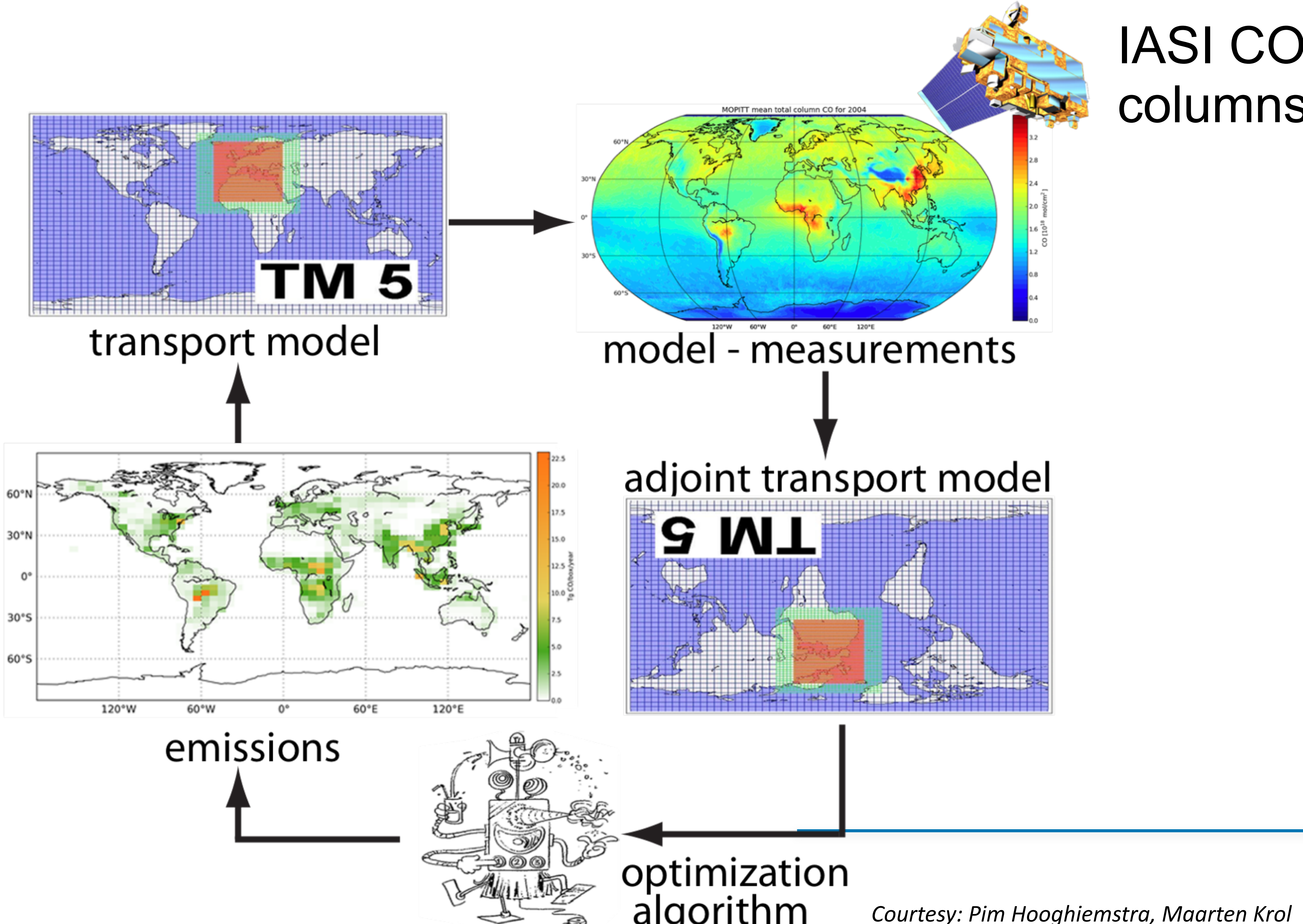
2009 and 2010 CO_2 from Zotino tower (Siberia)





Winderlich, PhD Thesis, Hamburg, 2012

4D-VAR in a nutshell

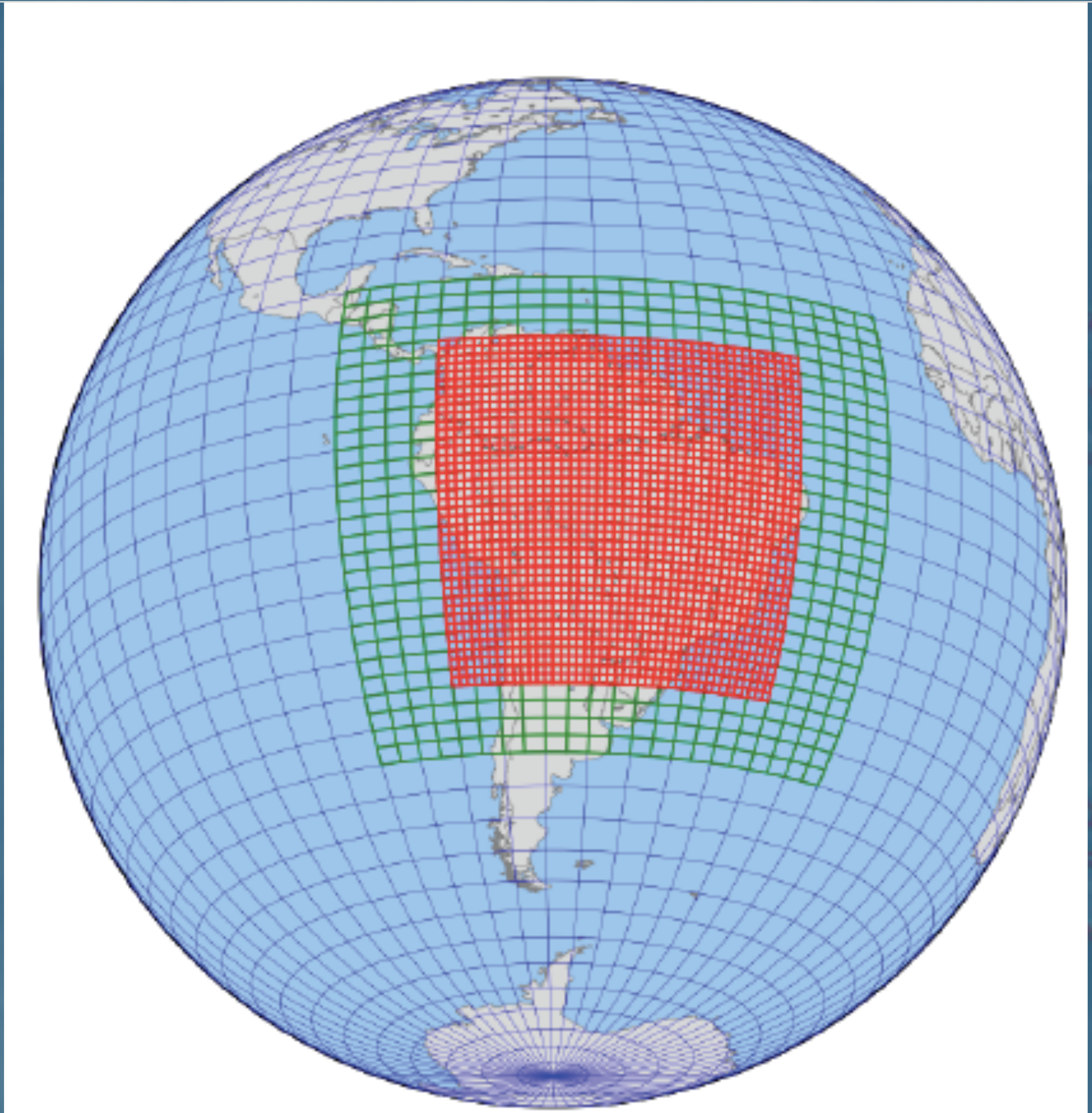


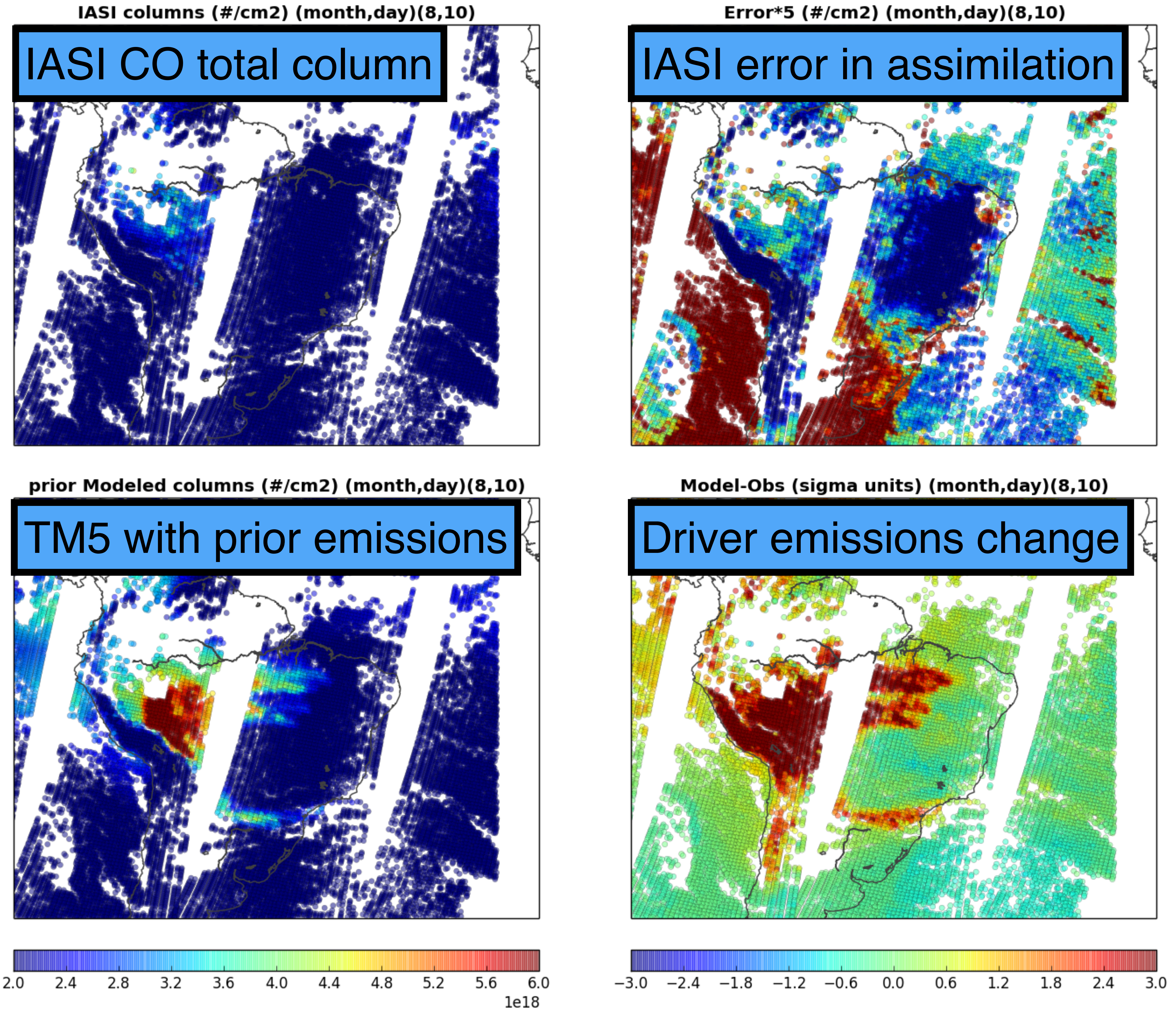
Courtesy: Pim Hooghiemstra, Maarten Krol

TM5-4DVAR system

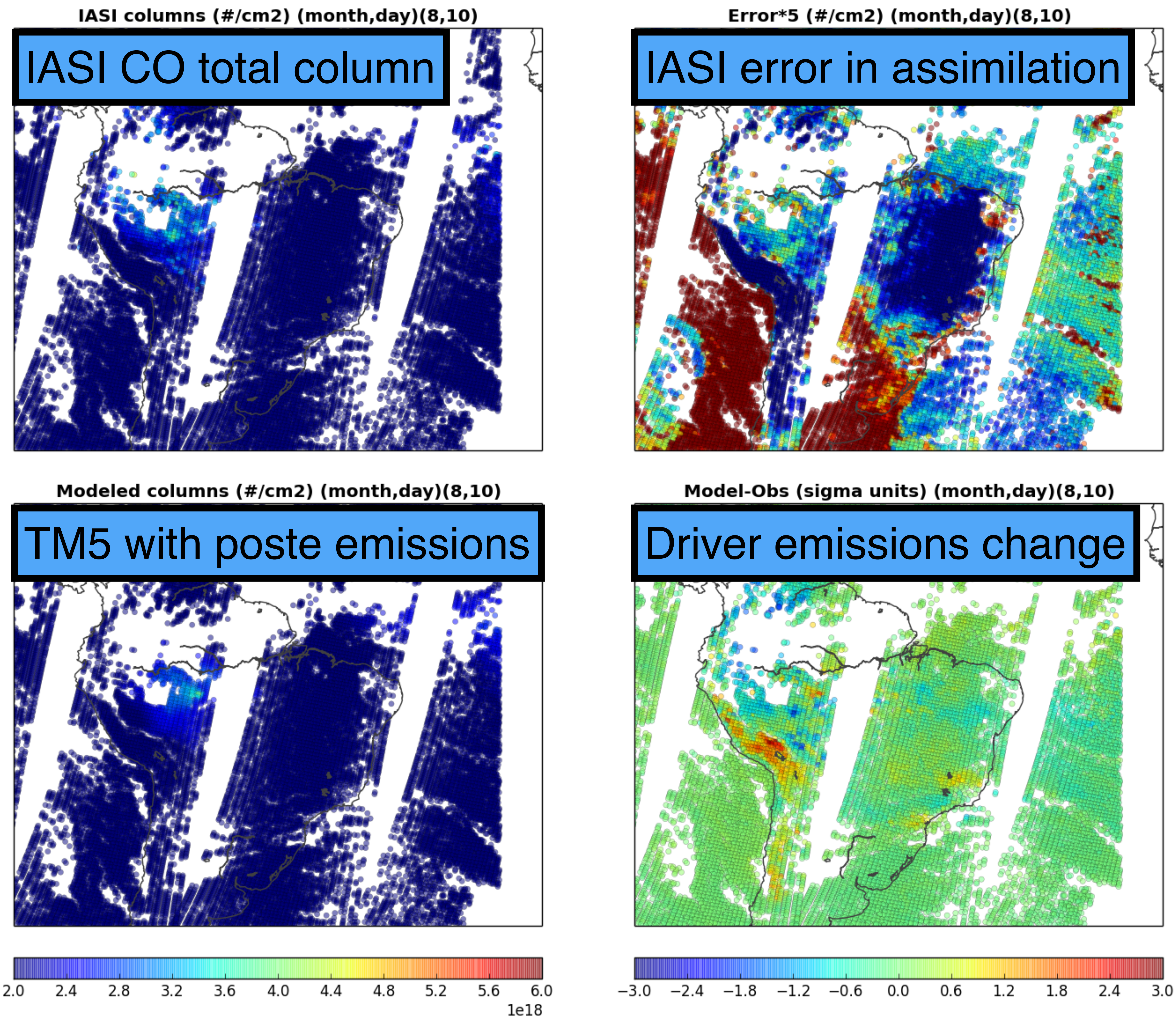
- Zoom (1x1 degree) over region of interest
- Optimize CO emissions
  - Biomass burning: 3-day periods (Prior SibCASA-GFED4)
  - VOC CO source: monthly
- Oxidation sink: fixed OH
- Assimilate observations:
  - IASI CO (individual measurements only over zoom)
  - NOAA CO on background stations (to anchor CO background)

South America: 2010 (dry) & 2011 (wet)





Day: 10 August 2010, Before Assimilation



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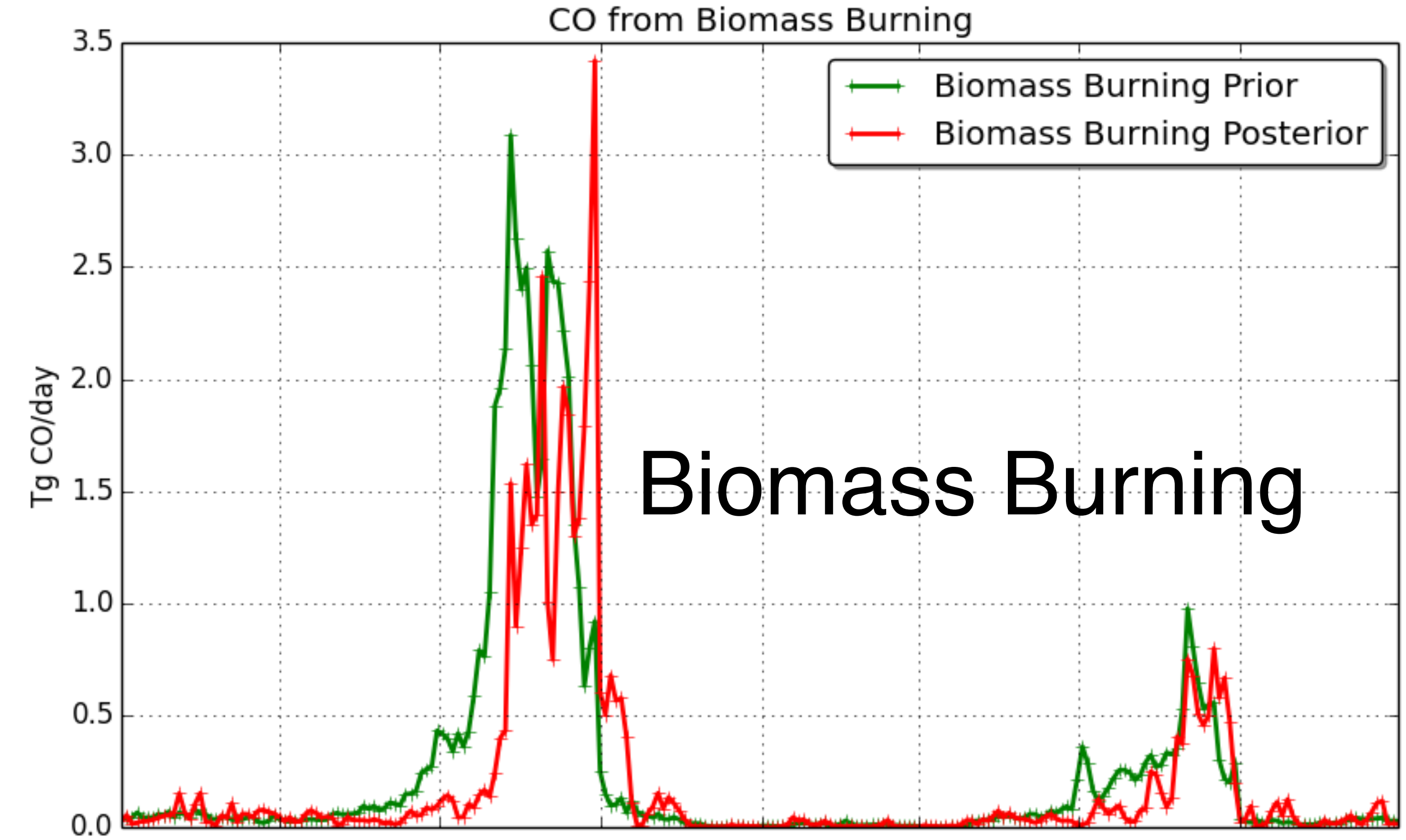
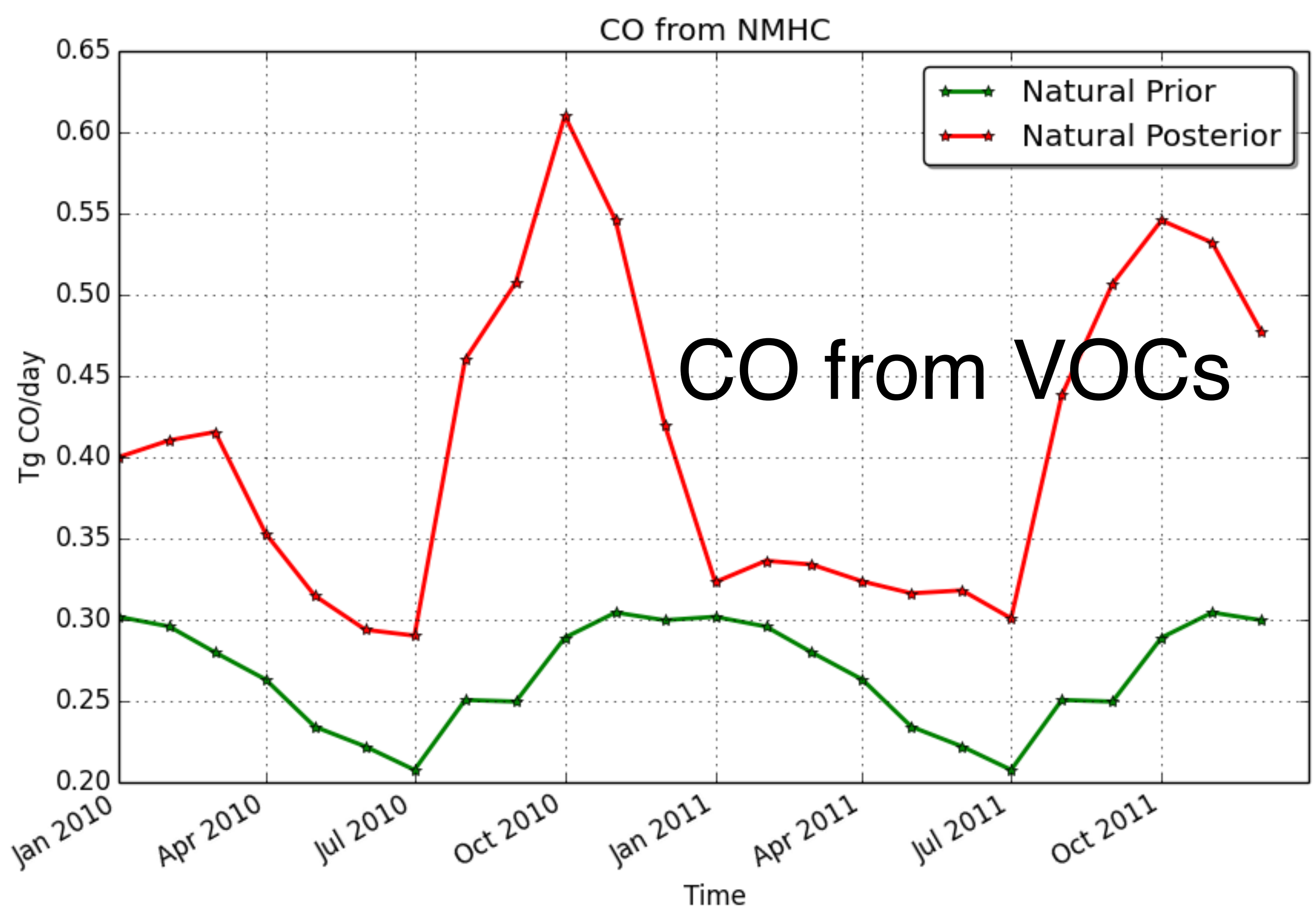


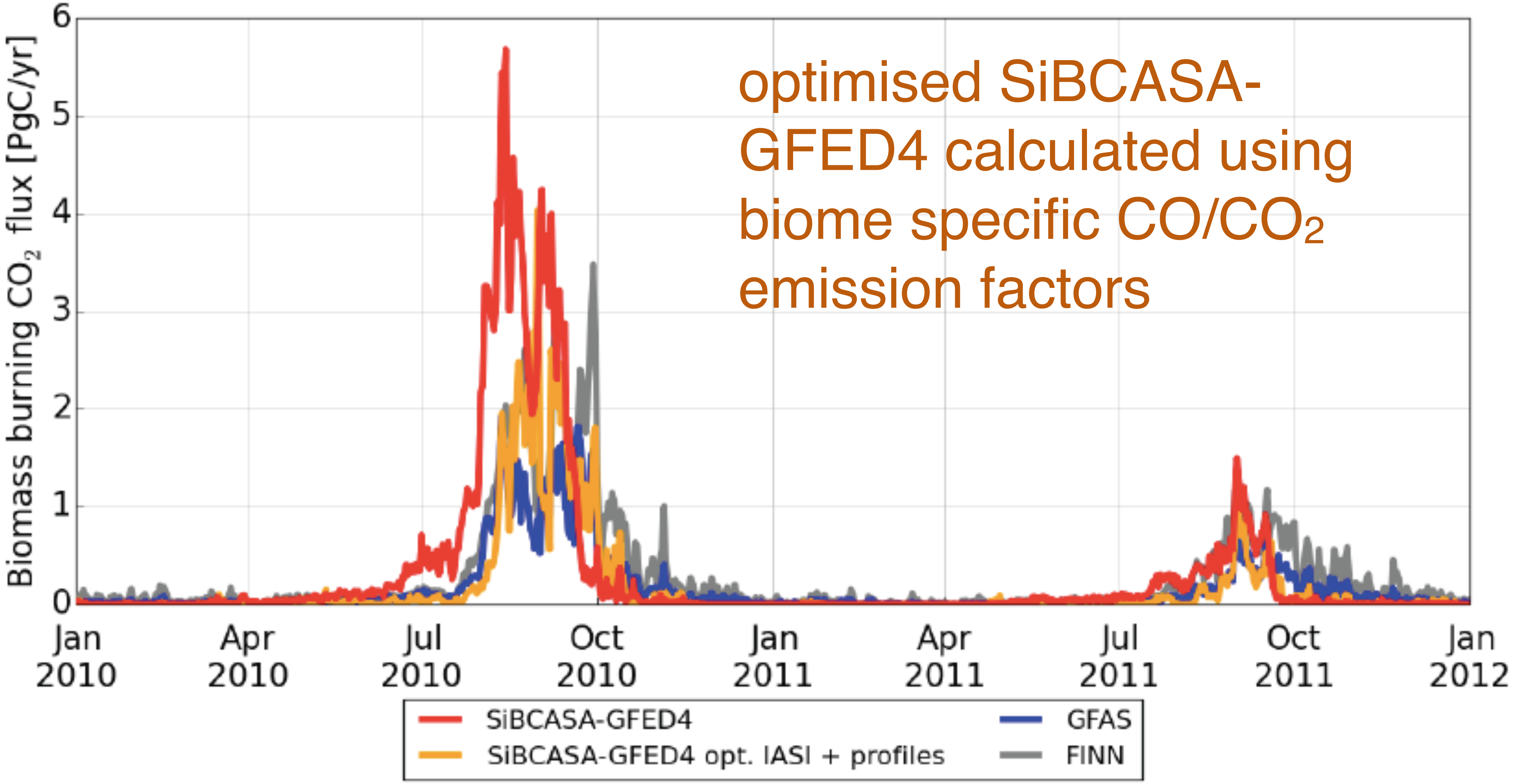
2010: 150 Tg—> 113 Tg
2011: 39 Tg—> 32 Tg



2010: 97 Tg—> 153 Tg
2011: 97 Tg—> 145 Tg

Seasonal cycle optimised CO from VOCs better fit satellite CH_2O observations

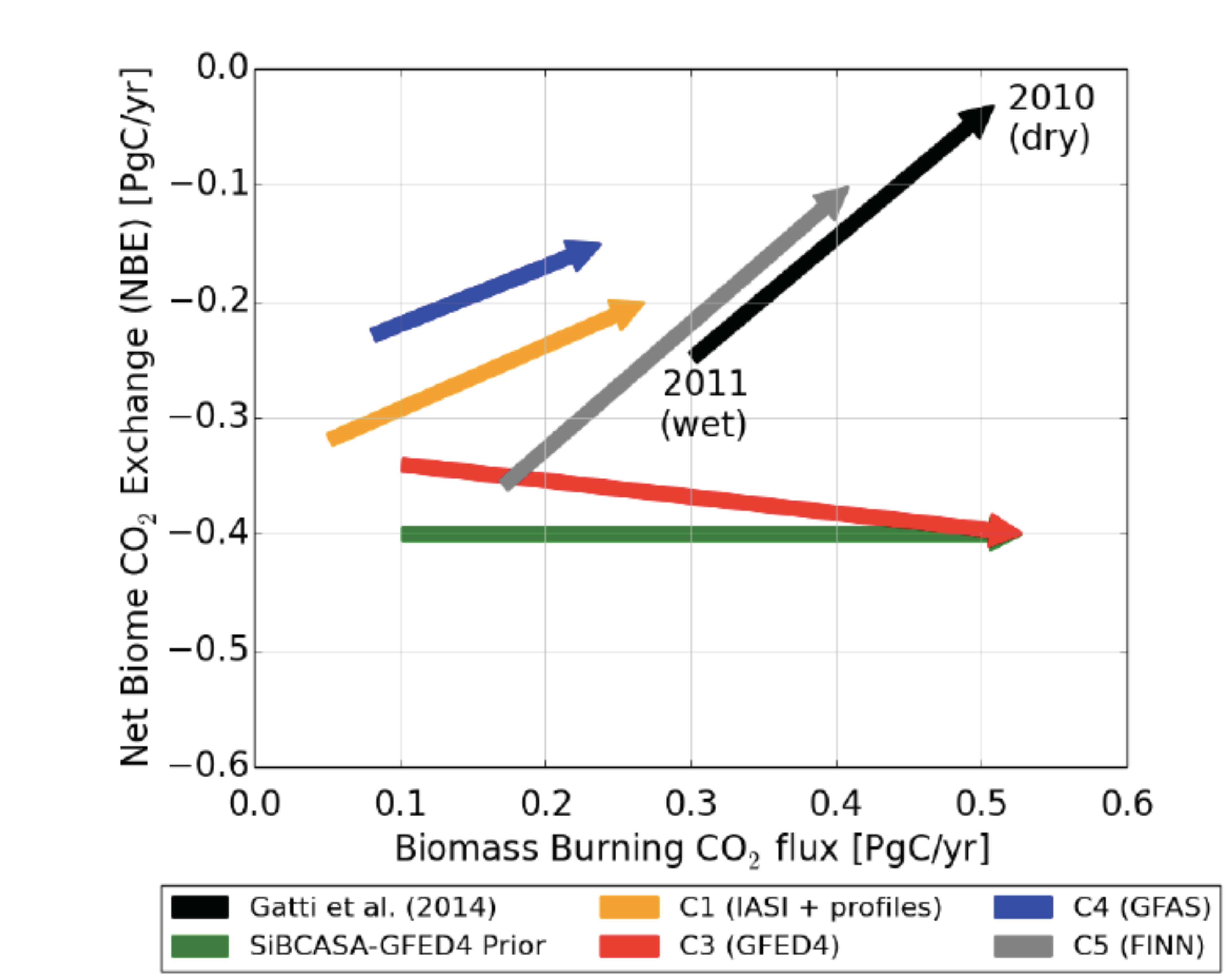
CO_2 - Biomass burning emissions over South America



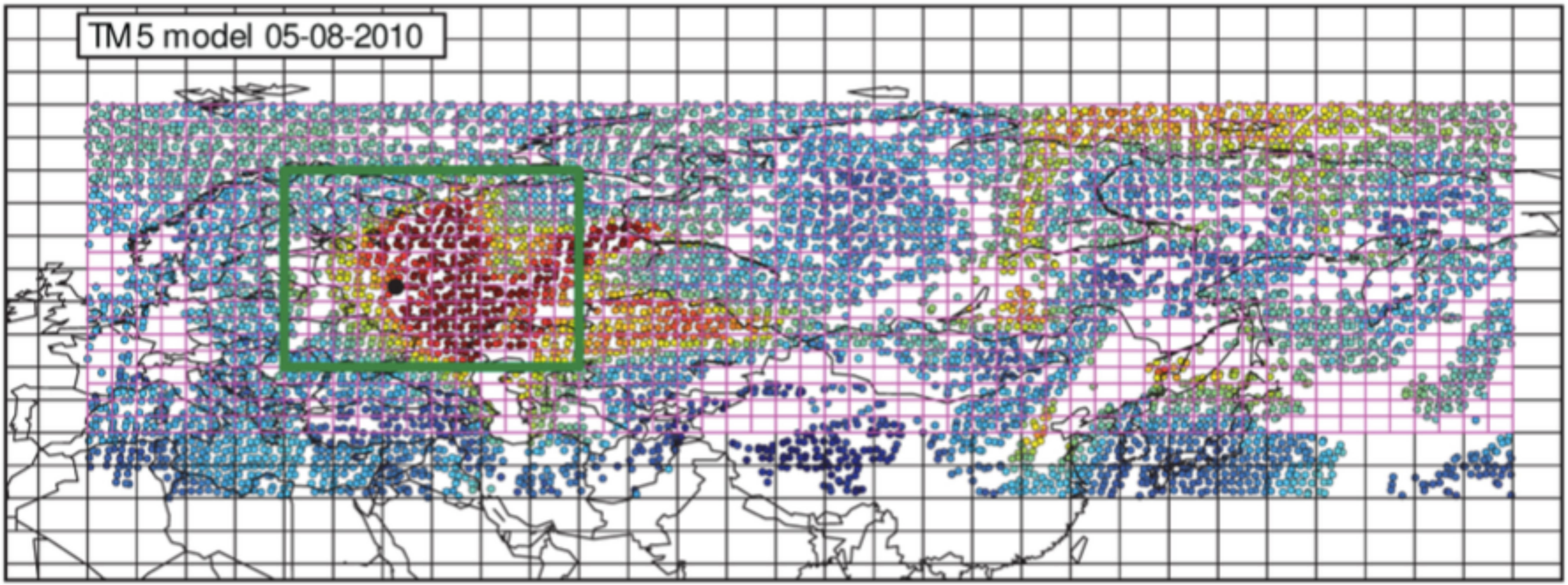
optimised SiBCASA-GFED4 calculated using biome specific CO/CO_2 emission factors

van der Laan-Luijkx et al., GBC, in review

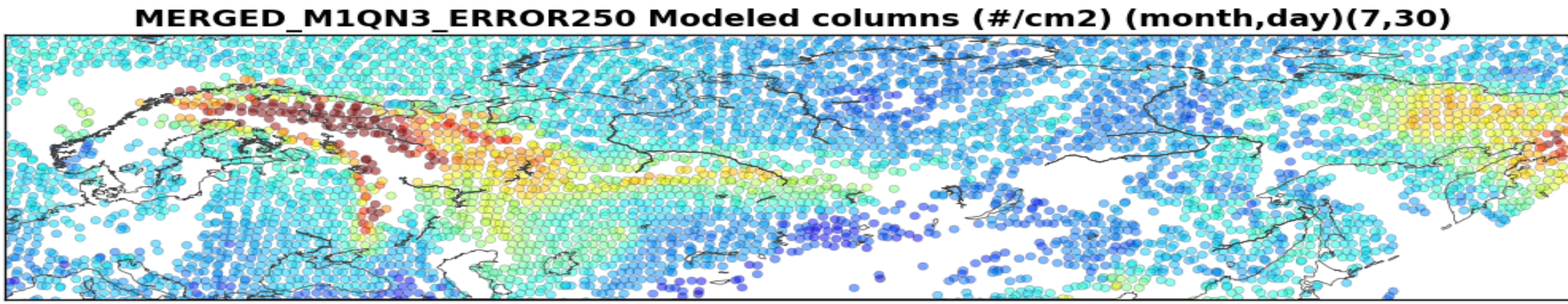
Impact on CarbonTracker CO_2 exchange



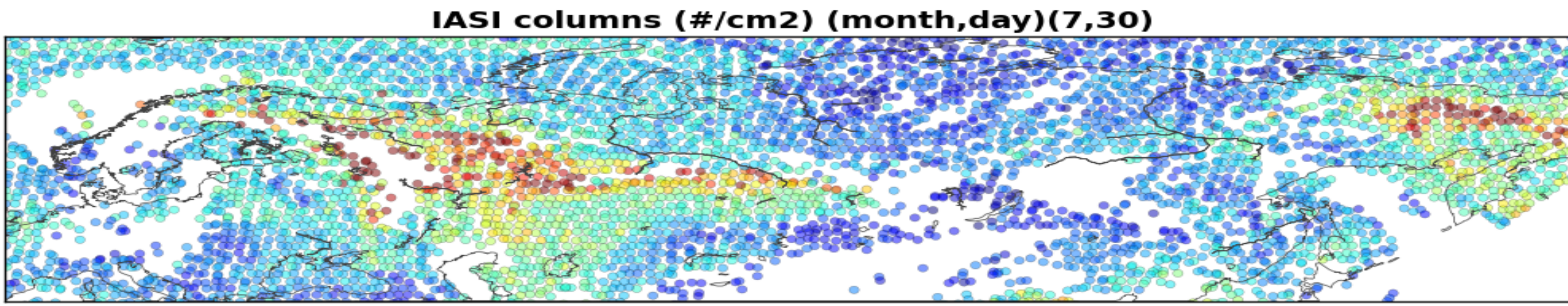
Moscow Fires 2010 (sampled IASI CO)

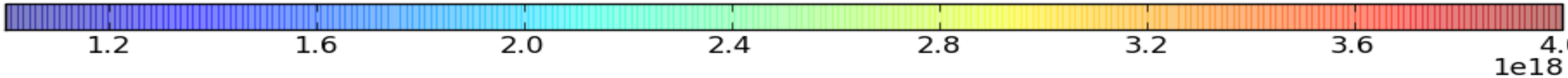


TM5 Model



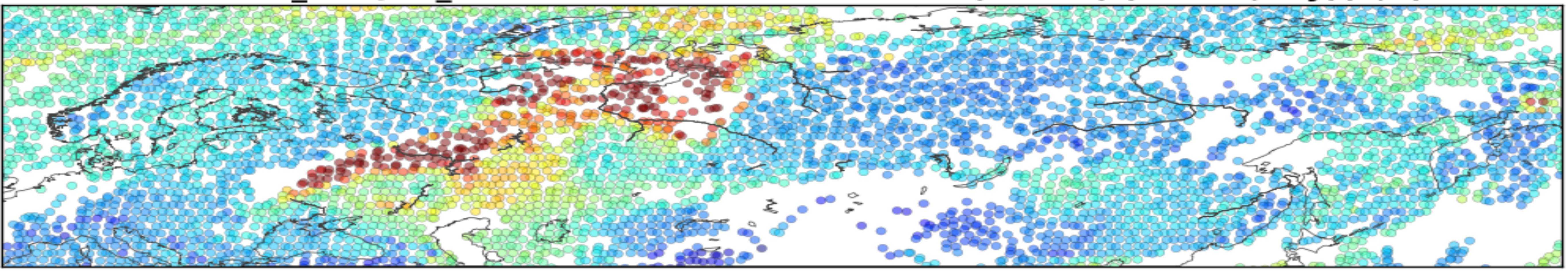
IASI satellite observations





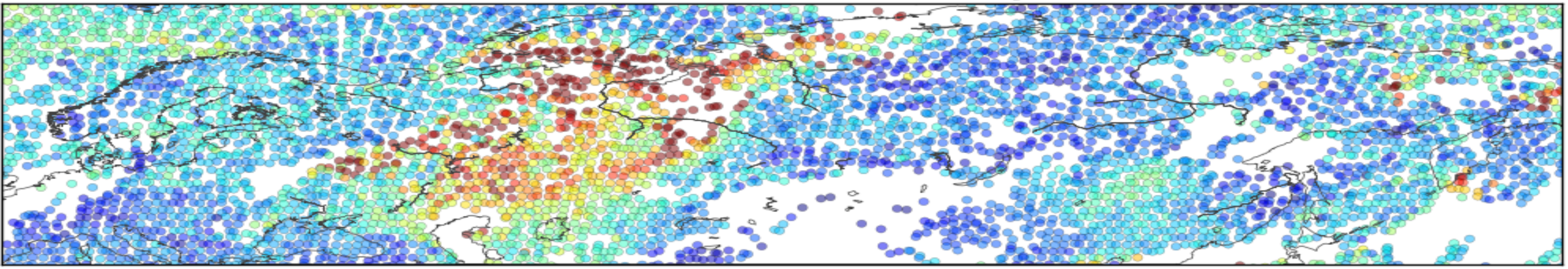
TM5 Model

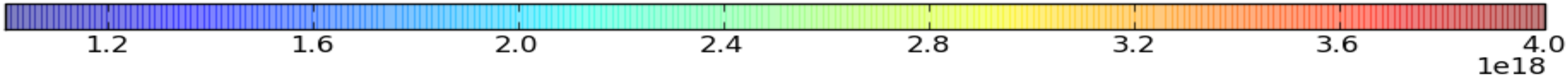
MERGED_M1QN3_ERROR250 Modeled columns (#/cm2) (month,day)(8,1)



IASI satellite observations

IASI columns (#/cm2) (month,day)(8,1)





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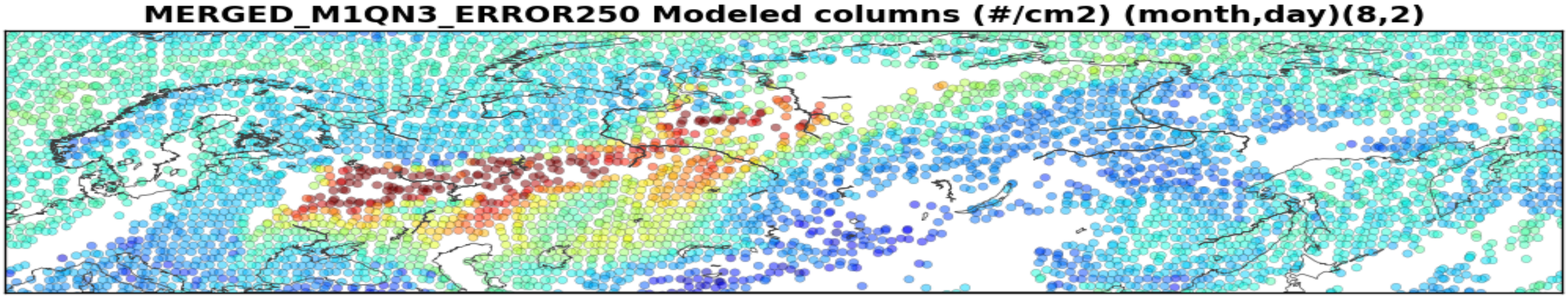

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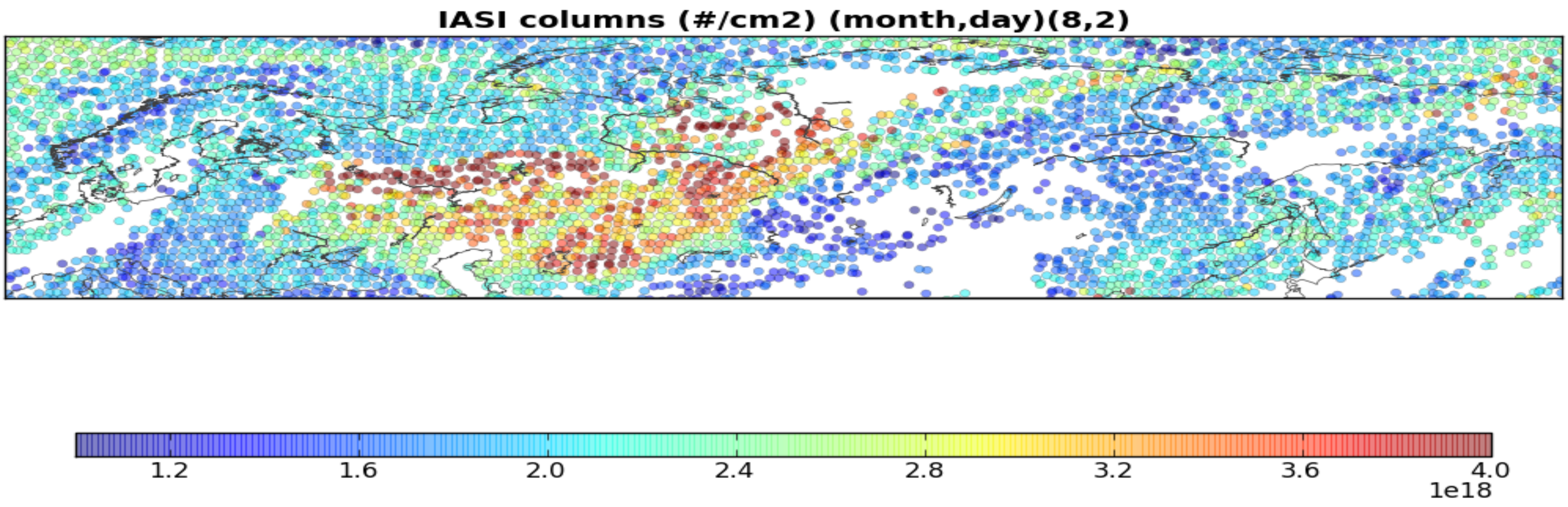

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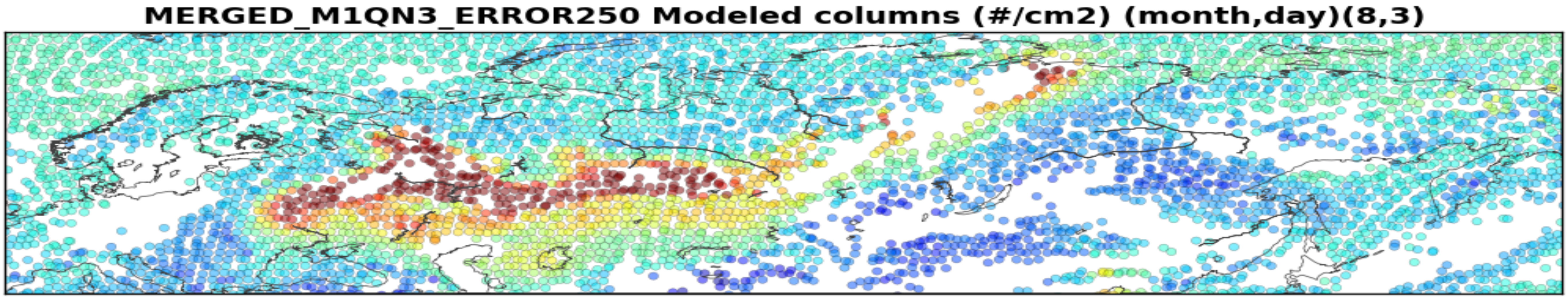

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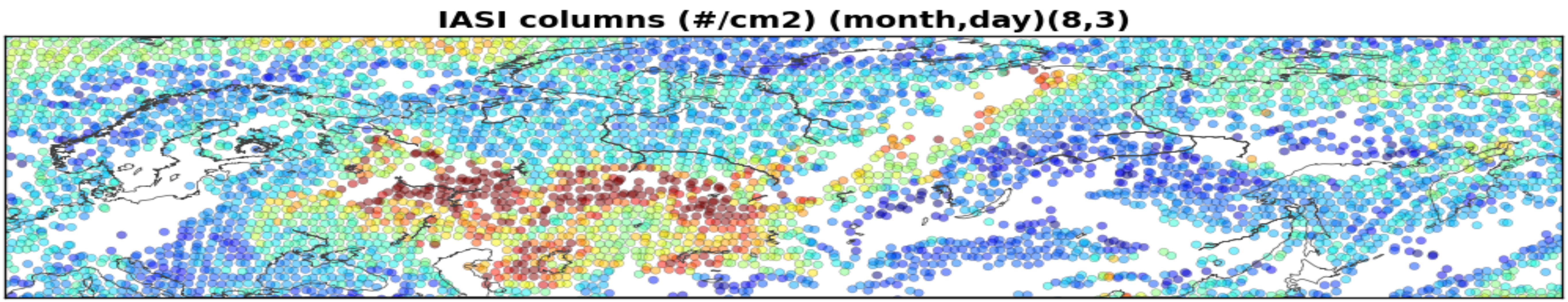
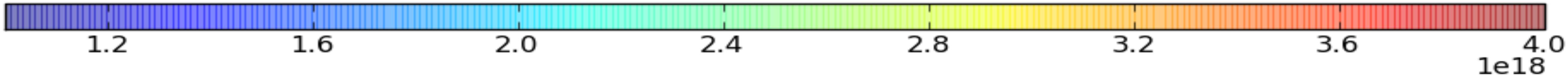
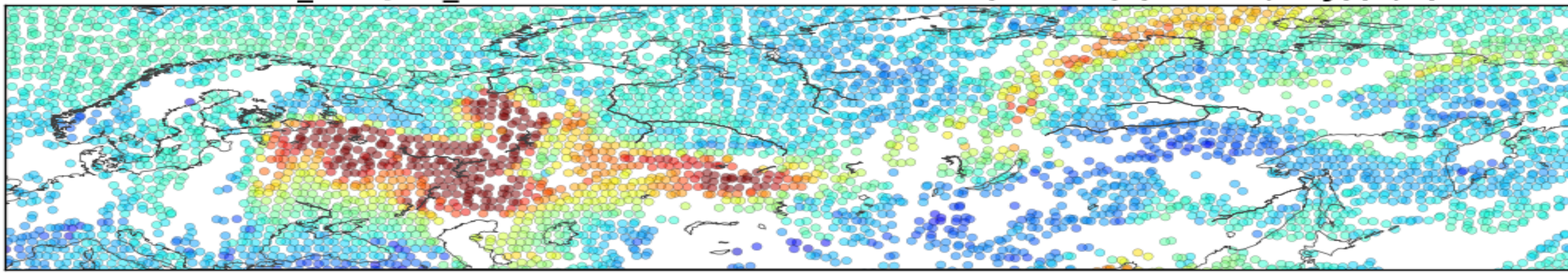




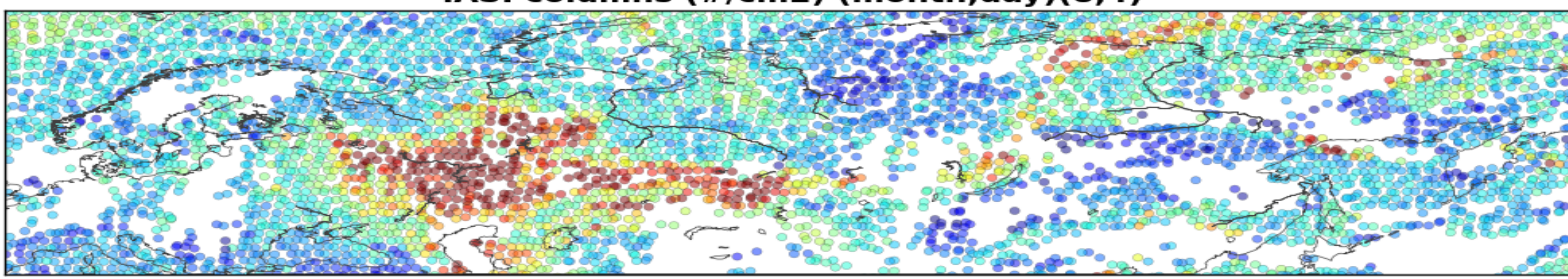
TM5 Model

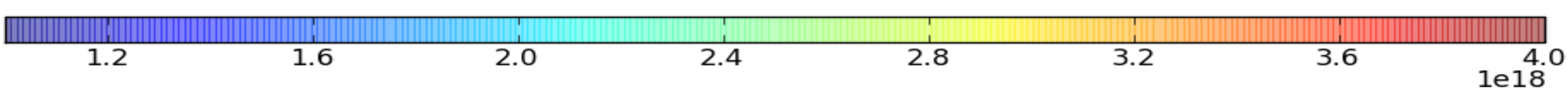
MERGED_M1QN3_ERROR250 Modeled columns (#/cm2) (month,day)(8,4)



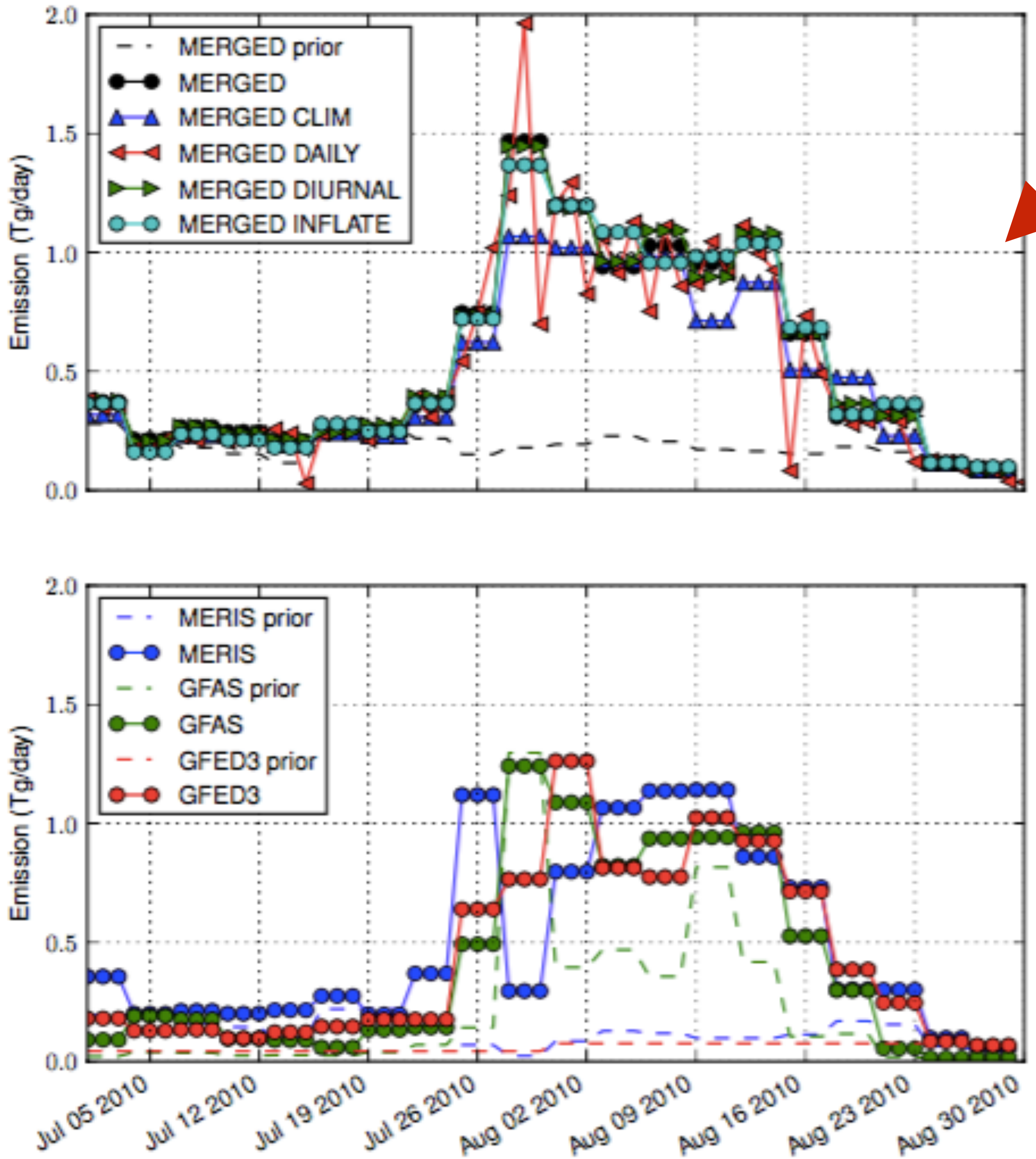
IASI satellite observations

IASI columns (#/cm2) (month,day)(8,4)

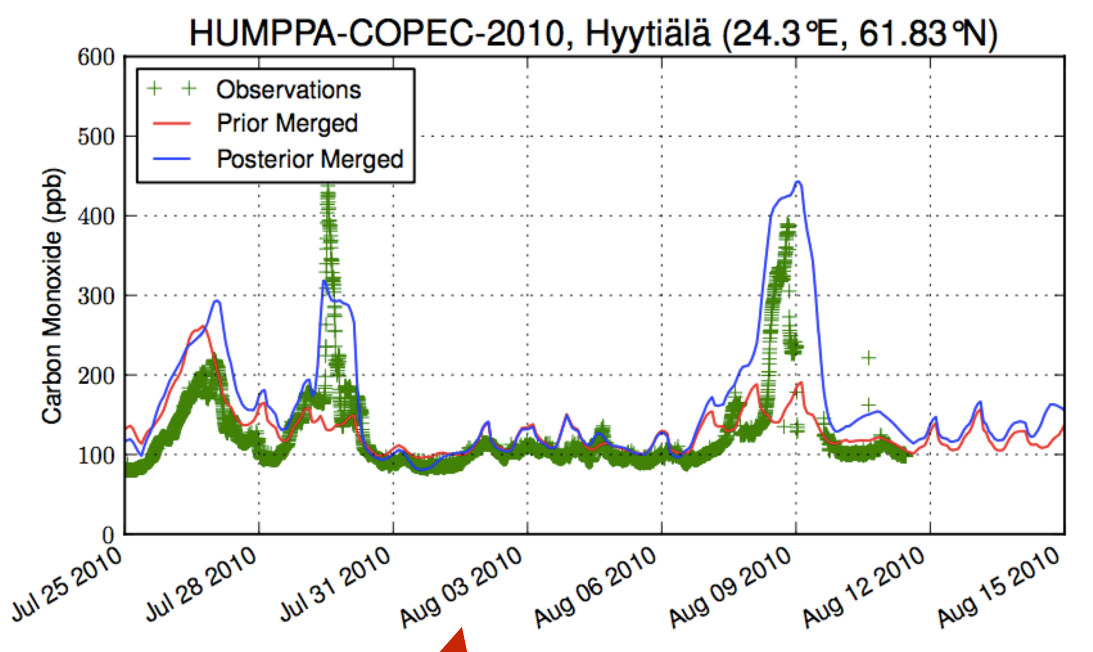




CO emissions Moscow Fires:



Assimilation IASI CO requires large increments emissions GFED (peat burning)

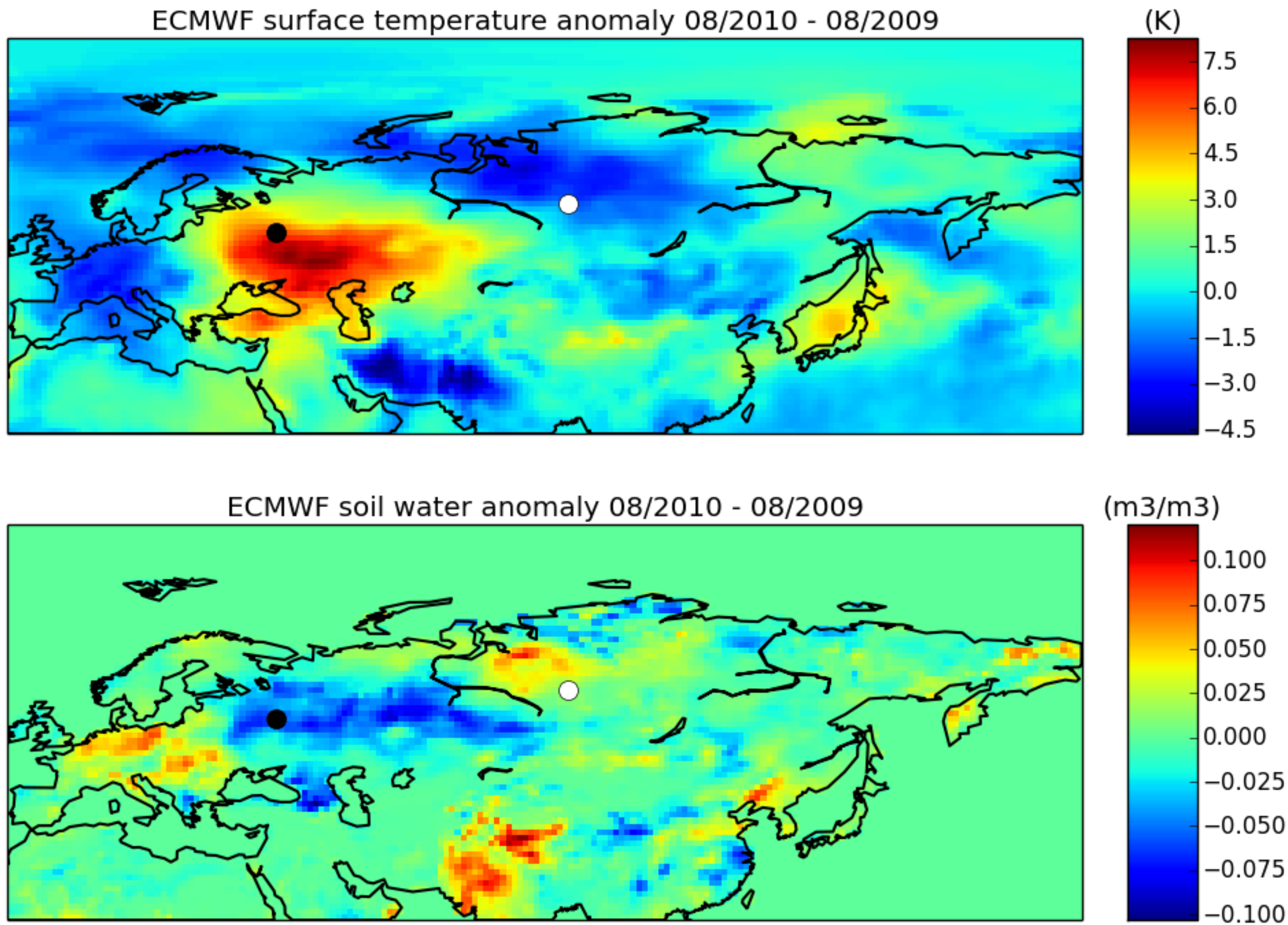


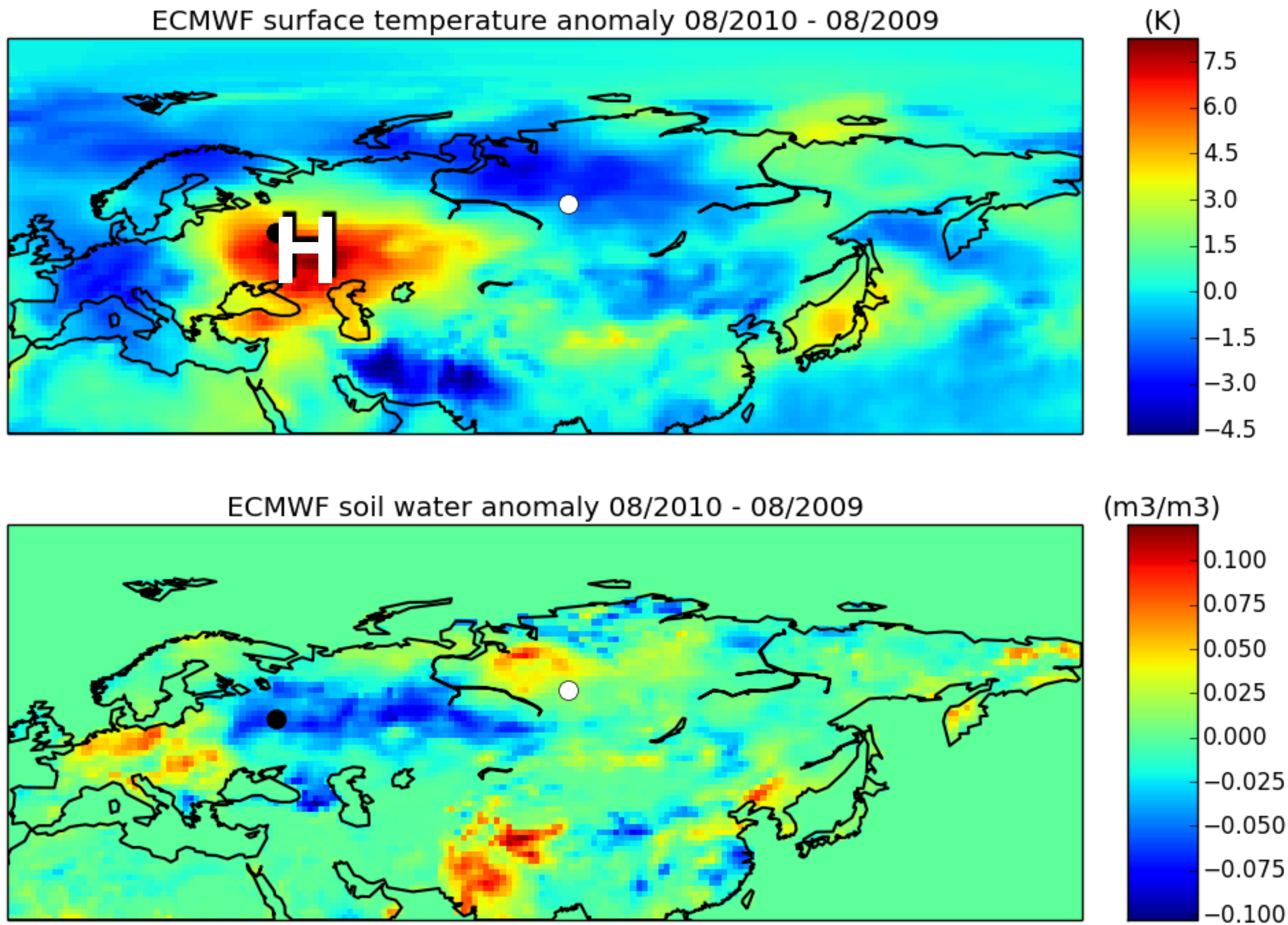
Optimised emissions lead to better fit to independent observations in Finland

Krol et al., ACP 2013

Moscow Fires CO_2 emissions

- Peat fires: large CO/CO_2 emission ratios
- Upper limit CO_2 emissions not sufficient to explain observed XCO_2 and CO_2 in 2010
- So, what caused the additional CO_2 in 2010?


ECMWF surface temperature anomaly 08/2010 - 08/2009
(K)
7.5
6.0
4.5
3.0
1.5
0.0
−1.5
−3.0
−4.5
ECMWF soil water anomaly 08/2010 - 08/2009
(m3/m3)
0.100
0.075
0.050
0.025
0.000
−0.025
−0.050
−0.075
−0.100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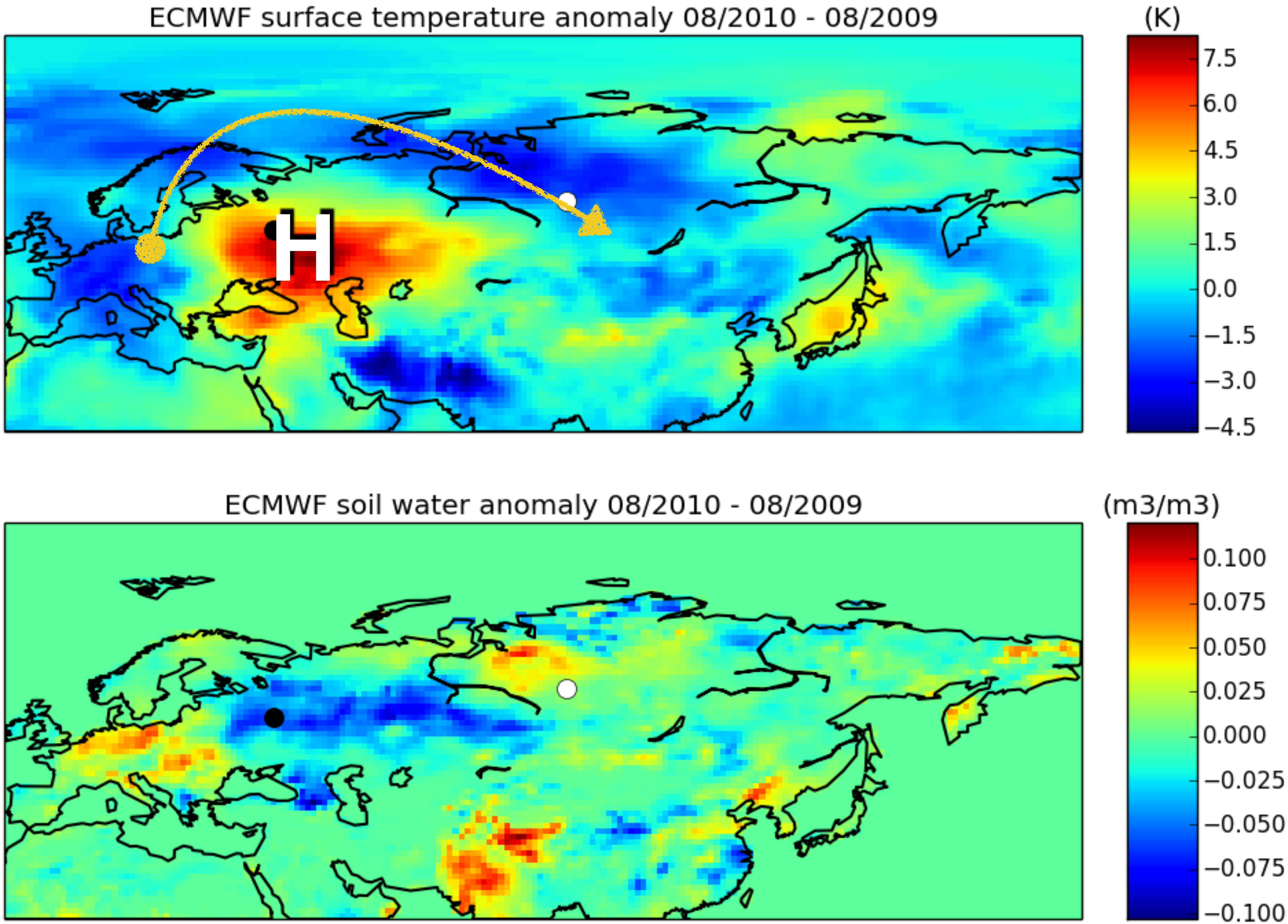
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−0.050
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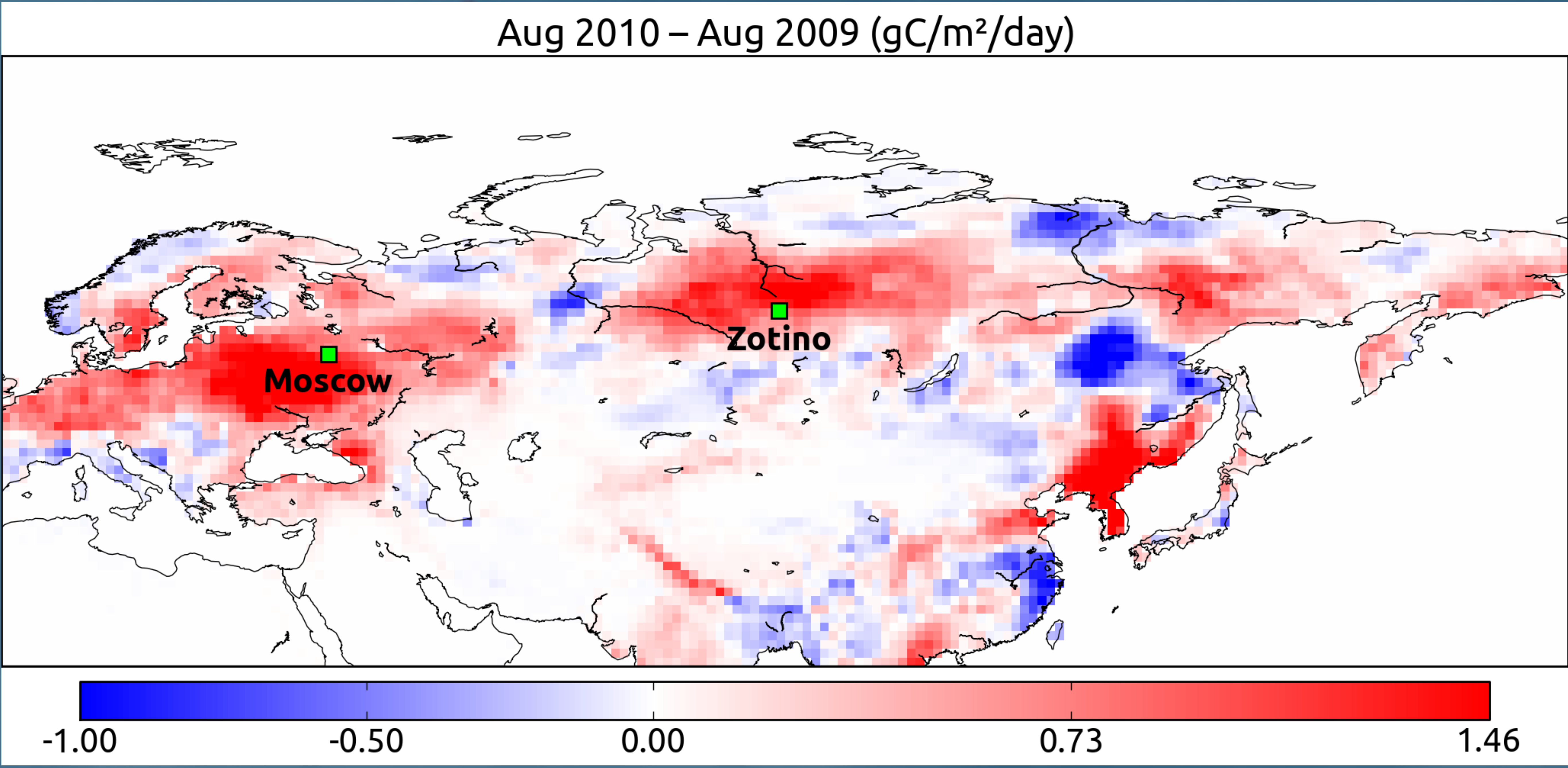
−0.100

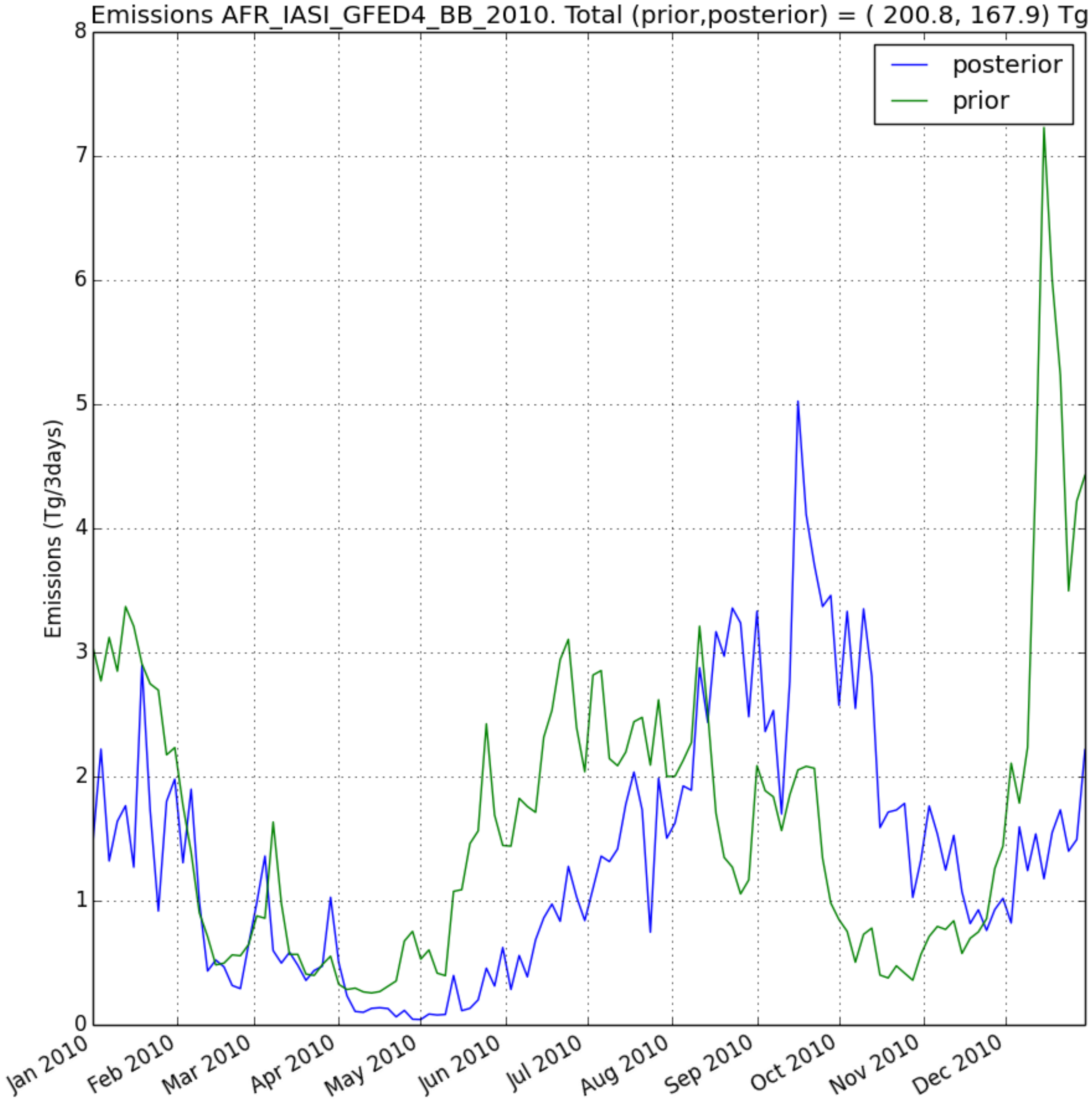
C-uptake difference calculated by CASA-GFED2

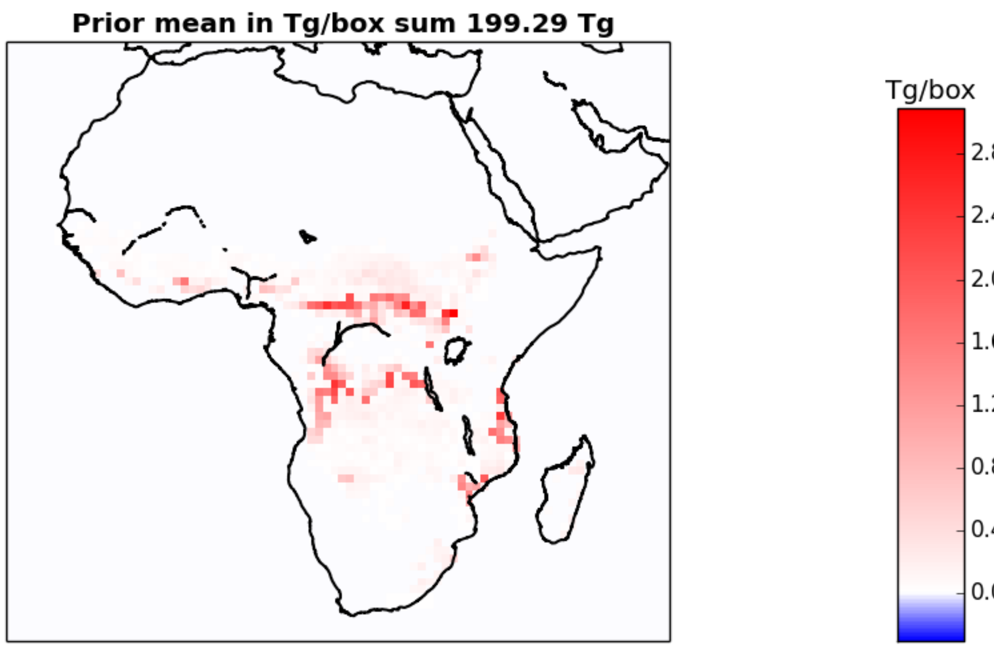


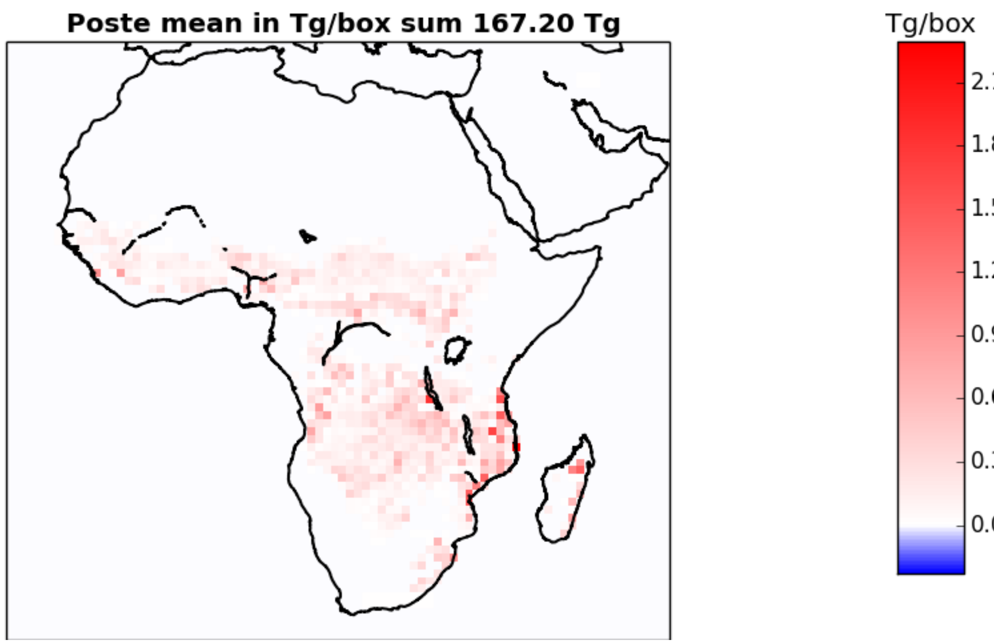
Conclusions

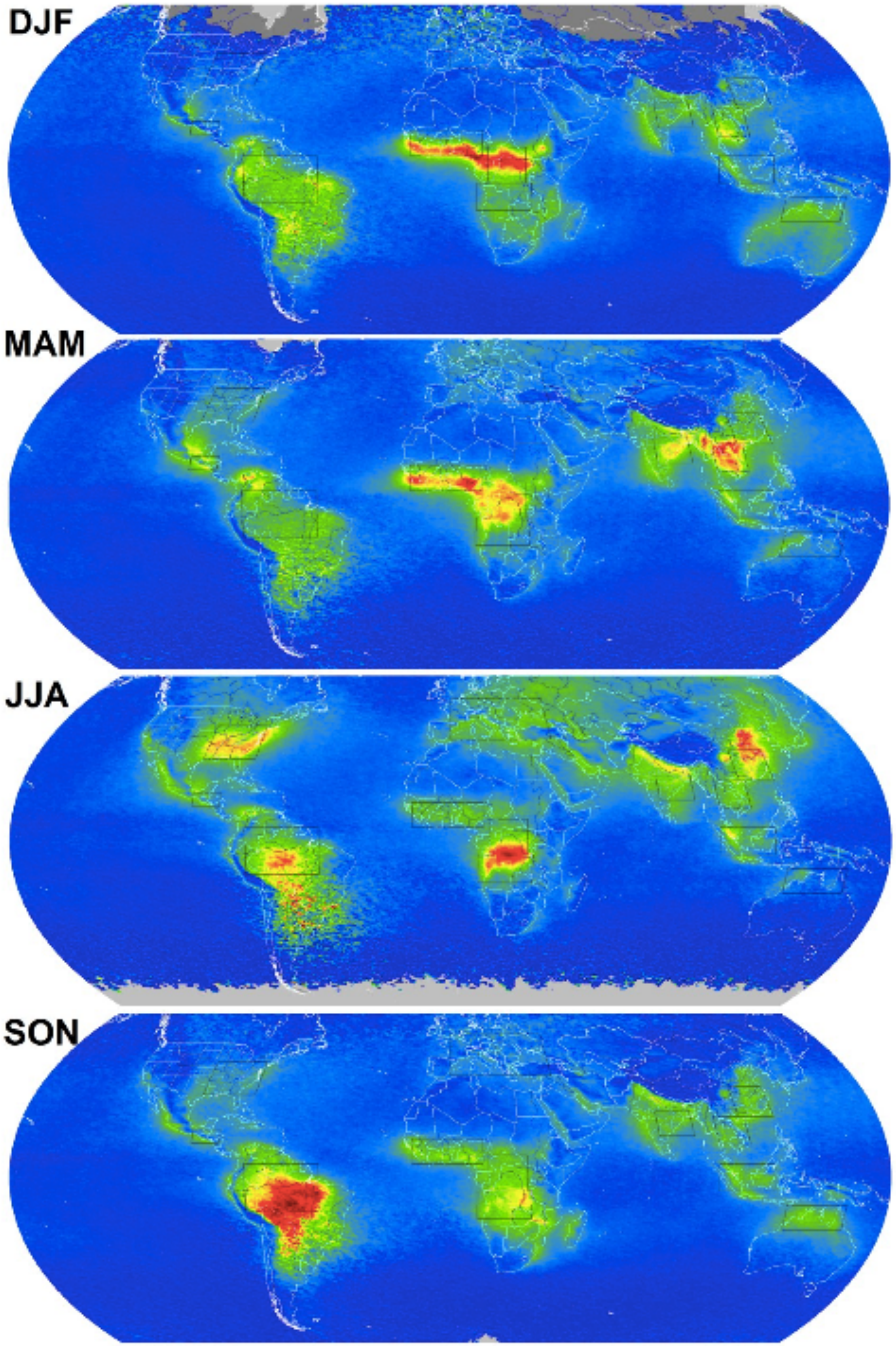
- Biomass burning CO emissions from GFED seem too high
- Optimised emissions come closer to GFAS (and FINN)
- Knowing Biomass burning emissions of CO_2 is important to assess drought sensitivity Amazon
- Other factors, like reduced boreal C-uptake, played a role in the reduced drawdown of CO_2 in 2010
- Africa 2010 Biomass burning: same GFED bias!

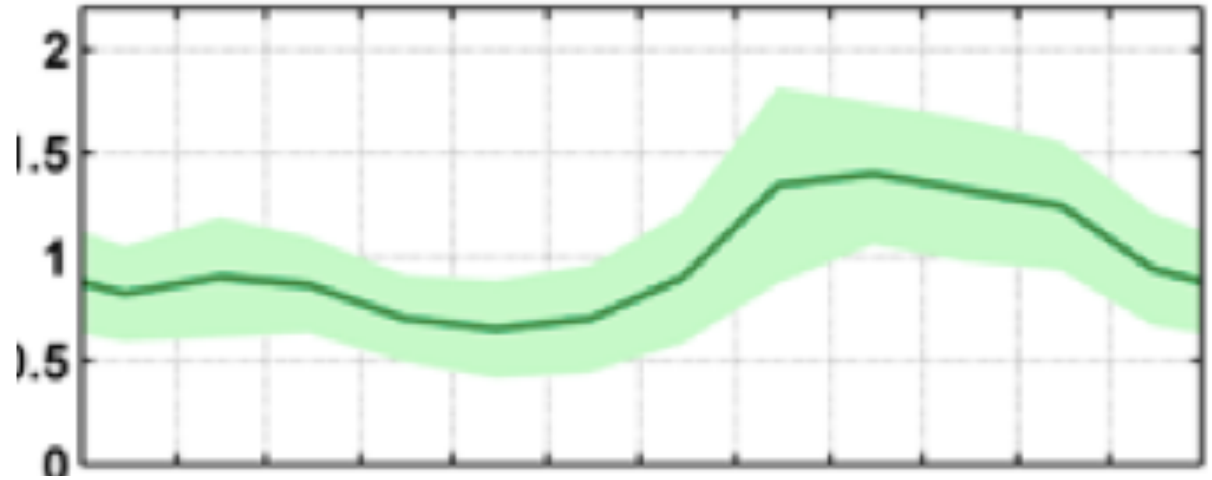
BB emissions 2010

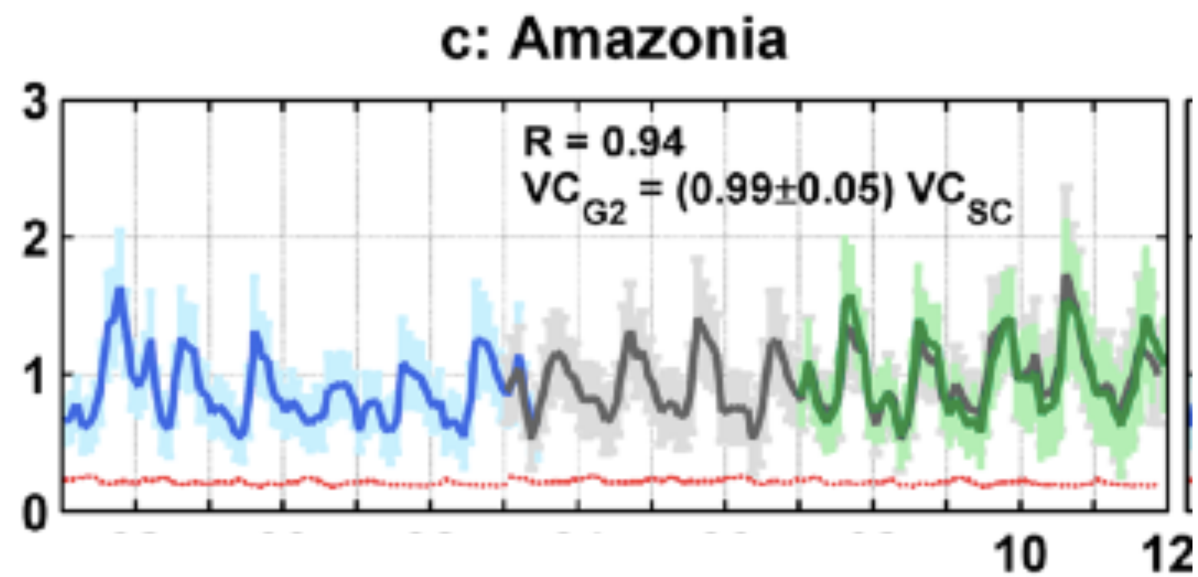


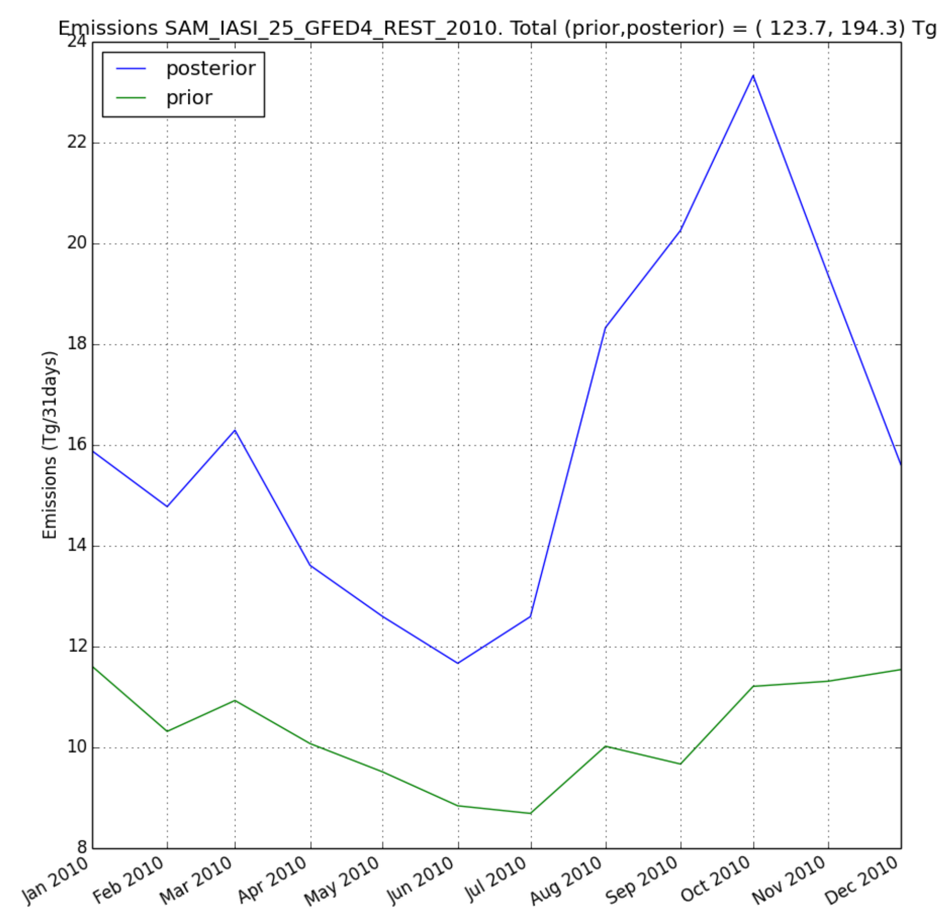


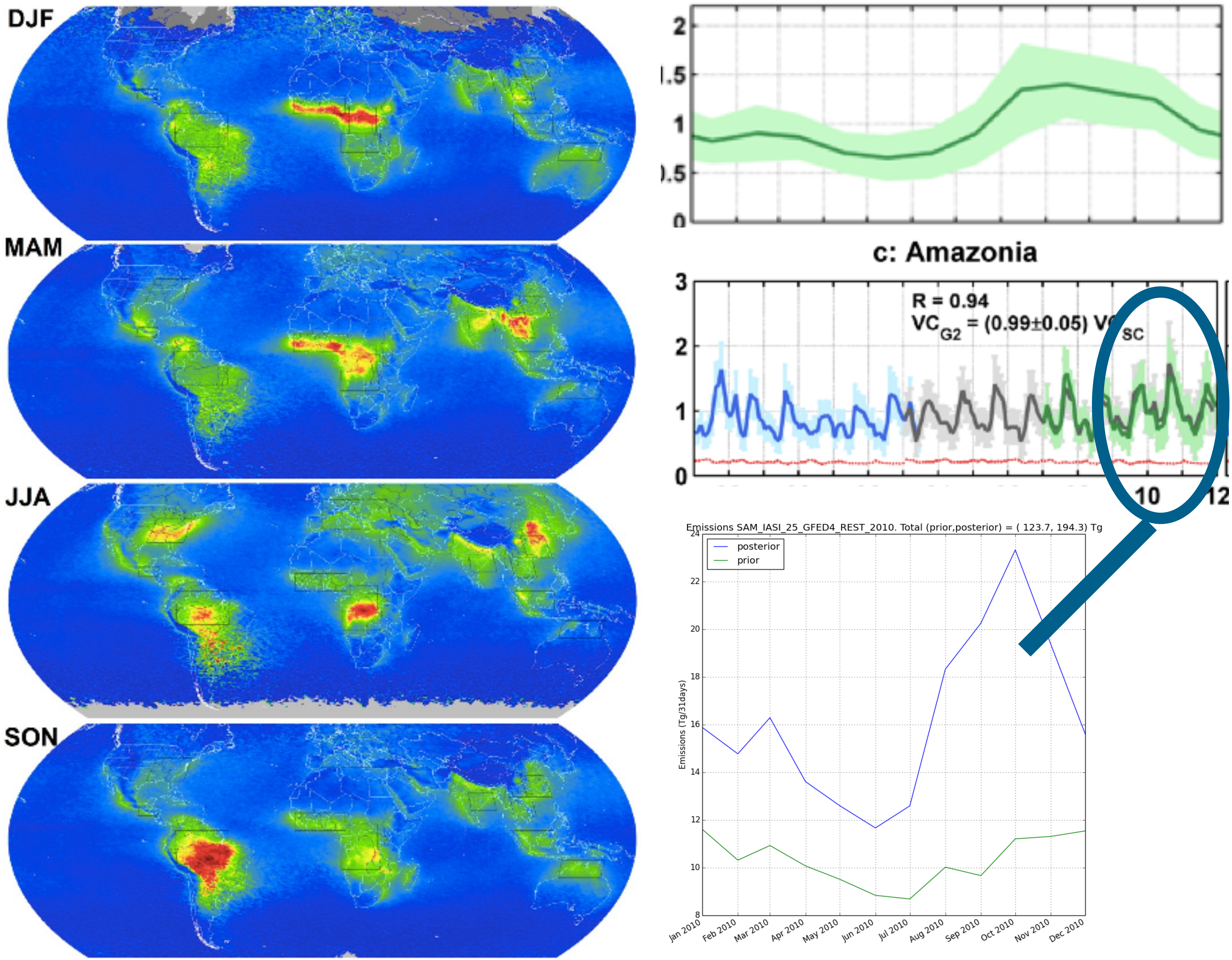



DJF
MAM
JJA
SON


2
1
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



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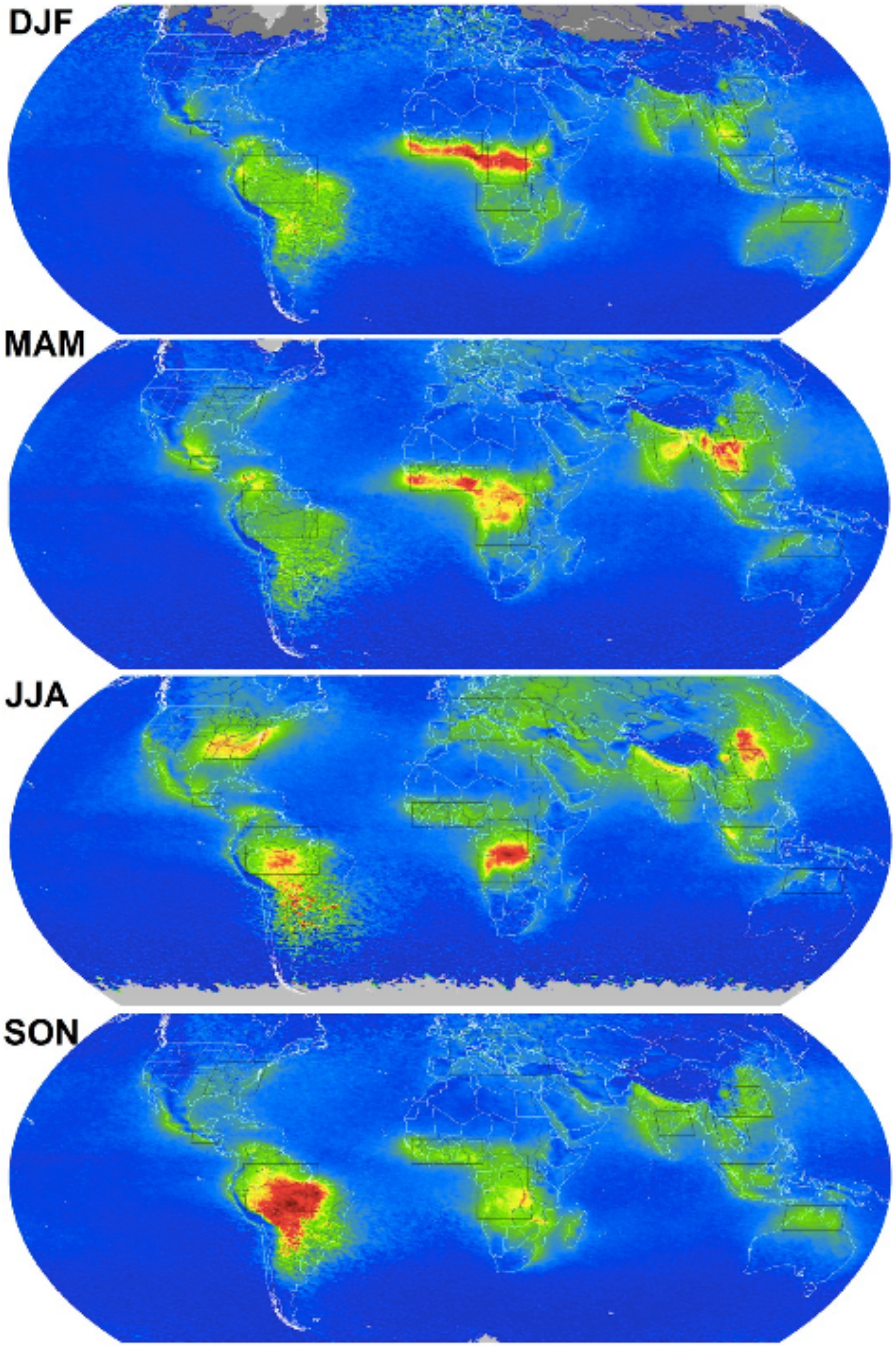
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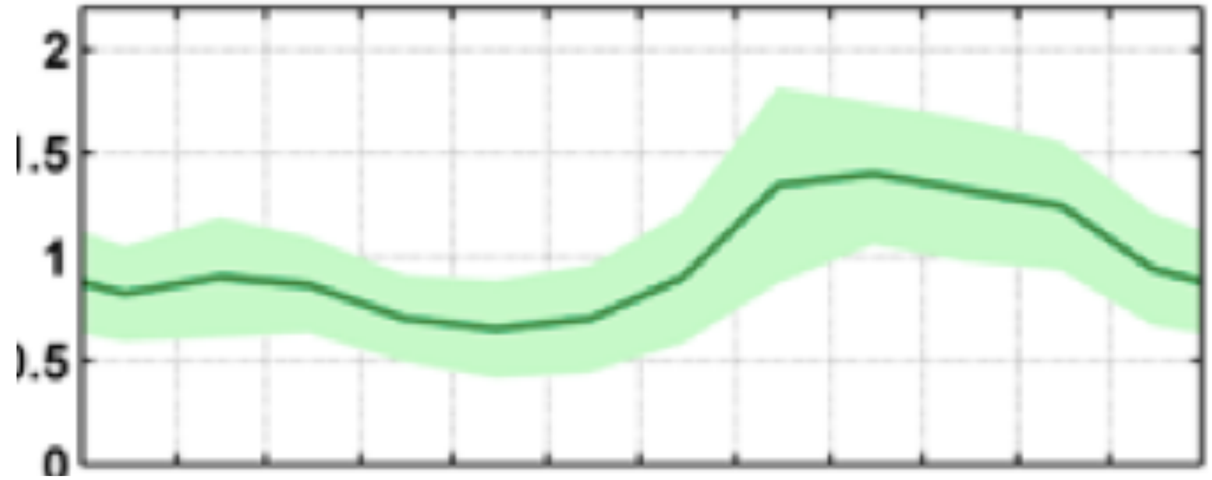
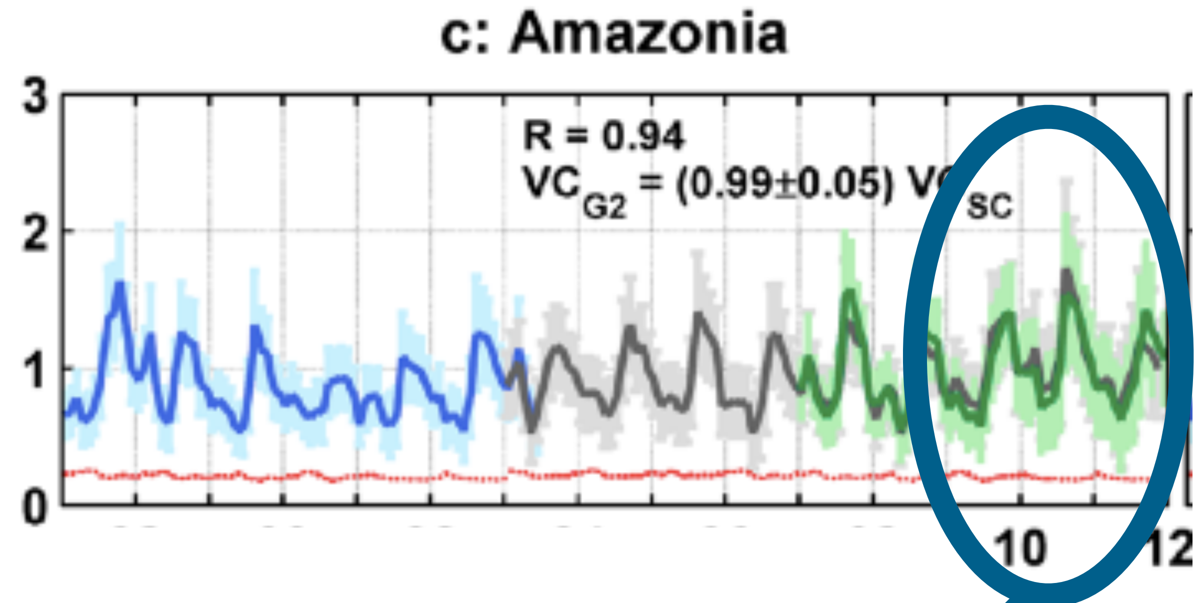

2
.5
1
.5
0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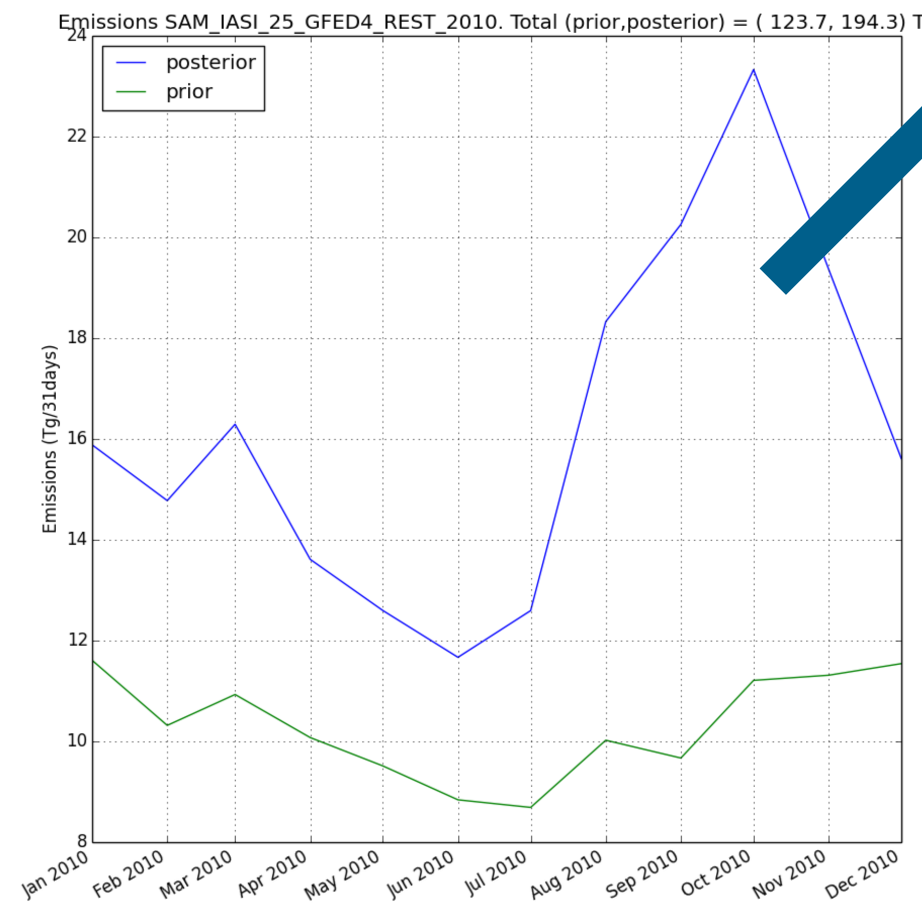
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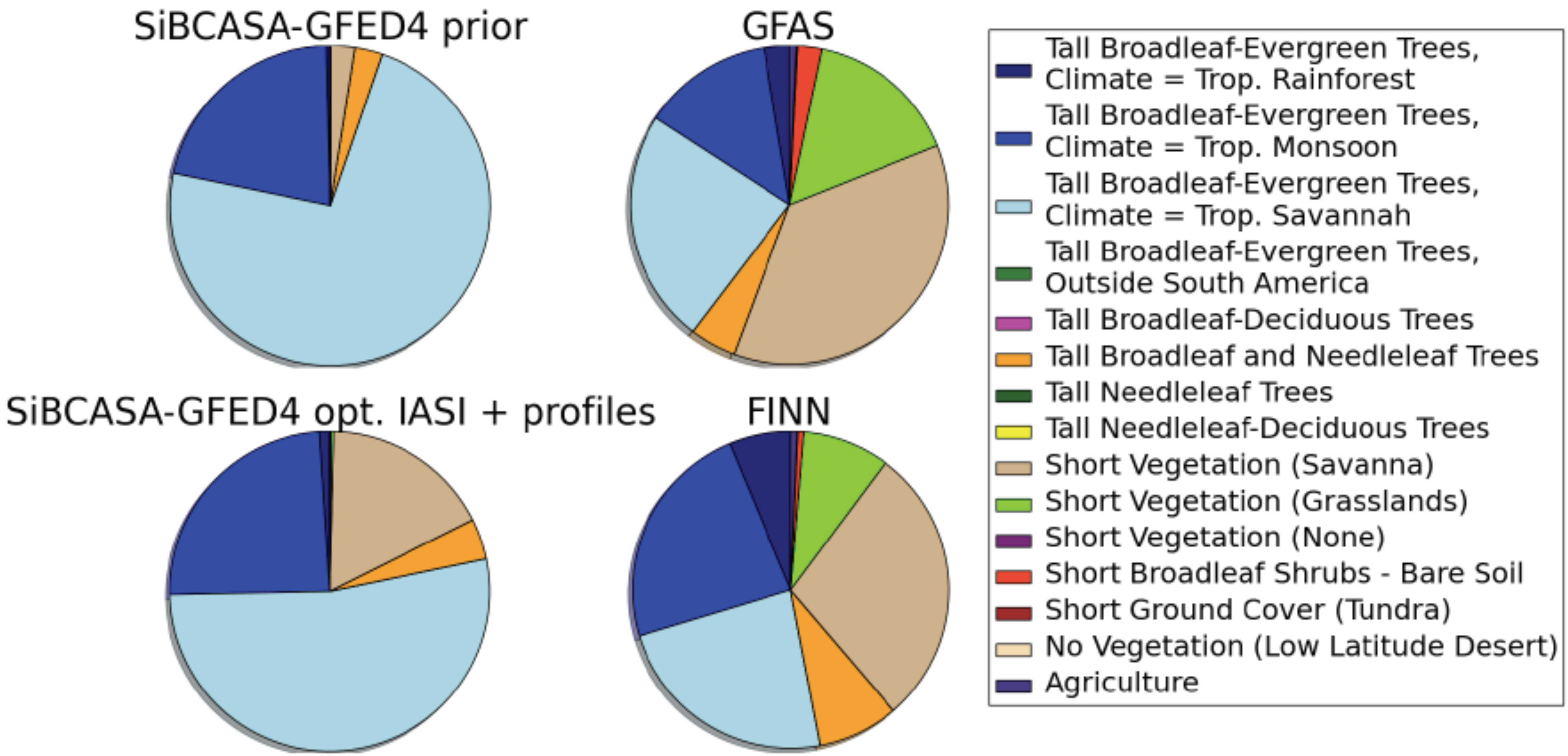
Biomass burning over South America: biome specific



van der Laan-Luijkx et al., GBC, in review