How much CO was emitted by the 2010 Russian fires?

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TM meeting, 17-10-2012, Crete

ENVIRONMENTAL SCIENCES GROUP
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What is ALANIS?

- Atmosphere Land interaction study, initiated by ESA & ILeaps
- Use of model & Remote sensing data to investigate Land–Atmosphere interactions in Boreal Eurasia
- Three themes:
  - Wetland methane emissions
  - Aerosols
  - Fires

ALANIS Fires

- Combine different RS products with models to better quantify emissions from boreal fires
  - Burning Scars (where do we see imprints of fires?)
  - Smoke Plume Injection Heights (SPIH) (how do we distribute emissions with height?)
  - IASI CO observations (What de we detect in the atmosphere?)
- TM5 was used to integrate the products and to derive CO emissions

IASI observations 05-08-2010

R2

TM5 model 05-08-2010

x10^{18}

4.0

3.6

3.2

2.8

2.4

2.0

1.6

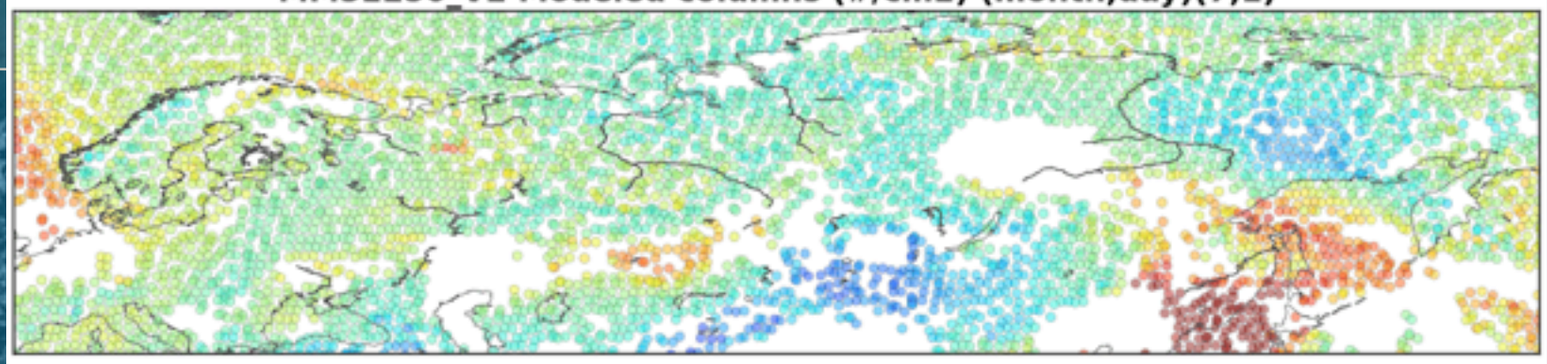
1.2

Molecules CO cm^{-2}

Setup 4D-VAR system

- New PyShell code
  - Emissions can now be optimized on daily timescales
  - PyShell contains the semi-exponential description of the emission PDF
- IASI observations are assimilated (200.000 per month!)
- Prior emissions + SPIH are used
  - Only the emission distribution is optimized!
  - SPIH is kept fixed

MM3E250_V2 Modeled columns (#/cm2) (month,day)(7,1)



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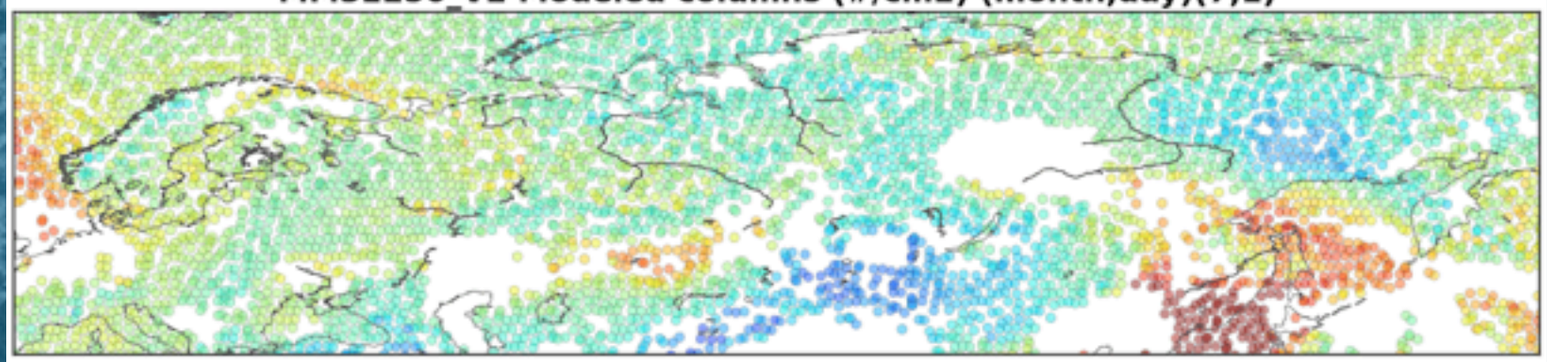

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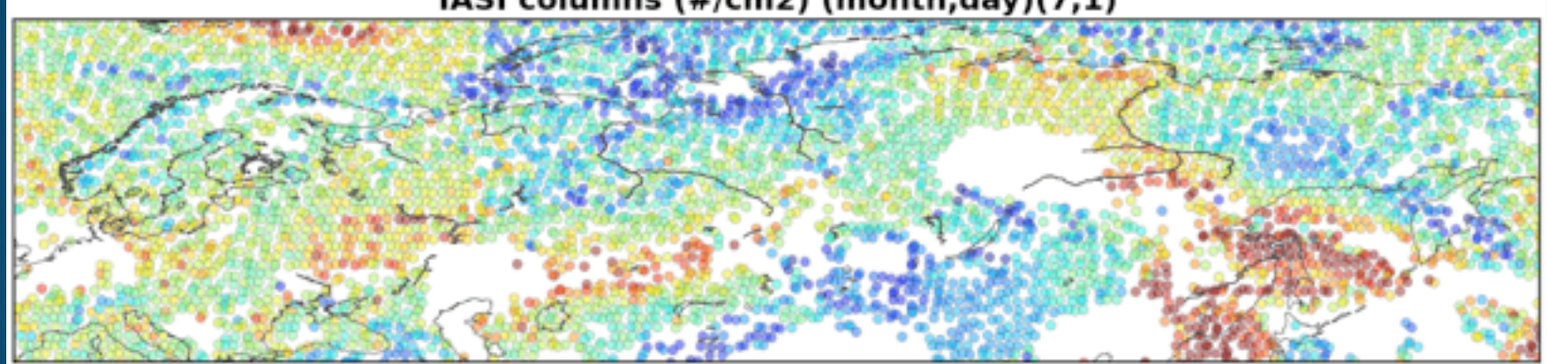
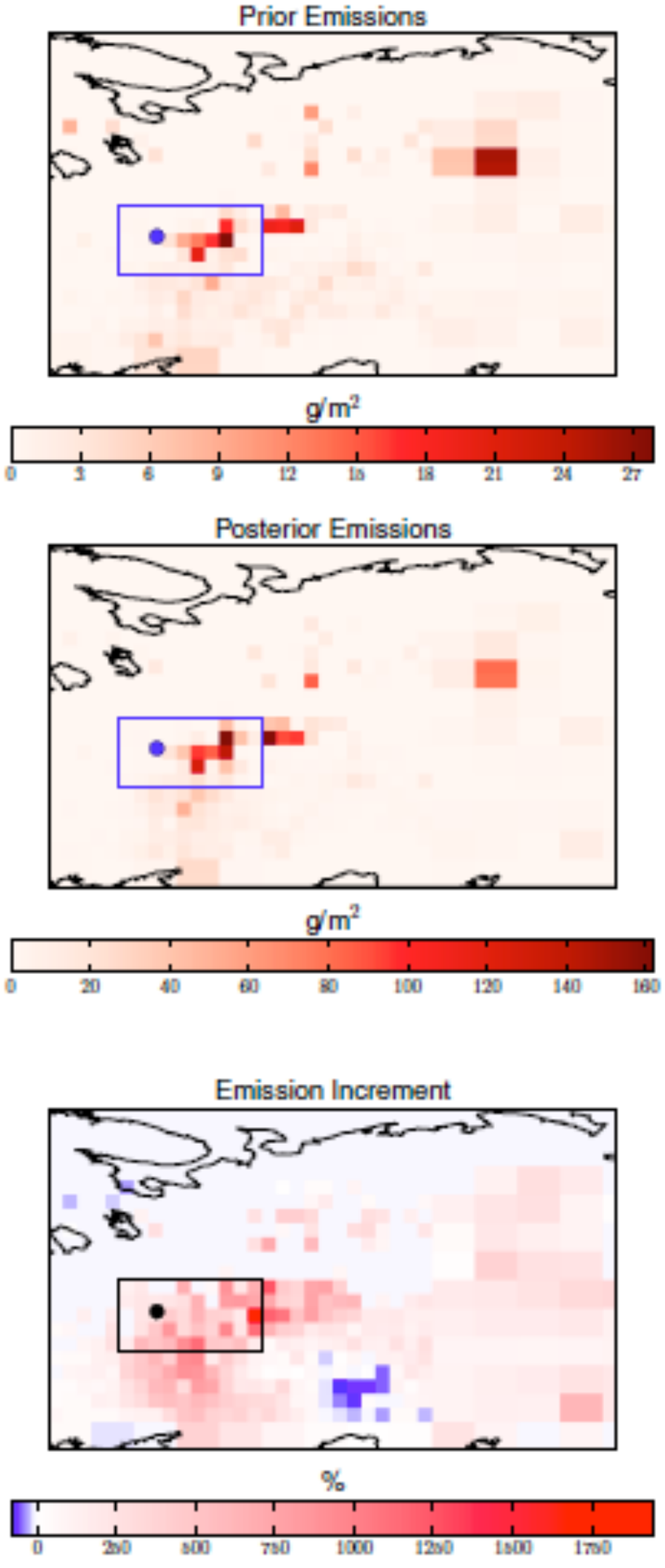
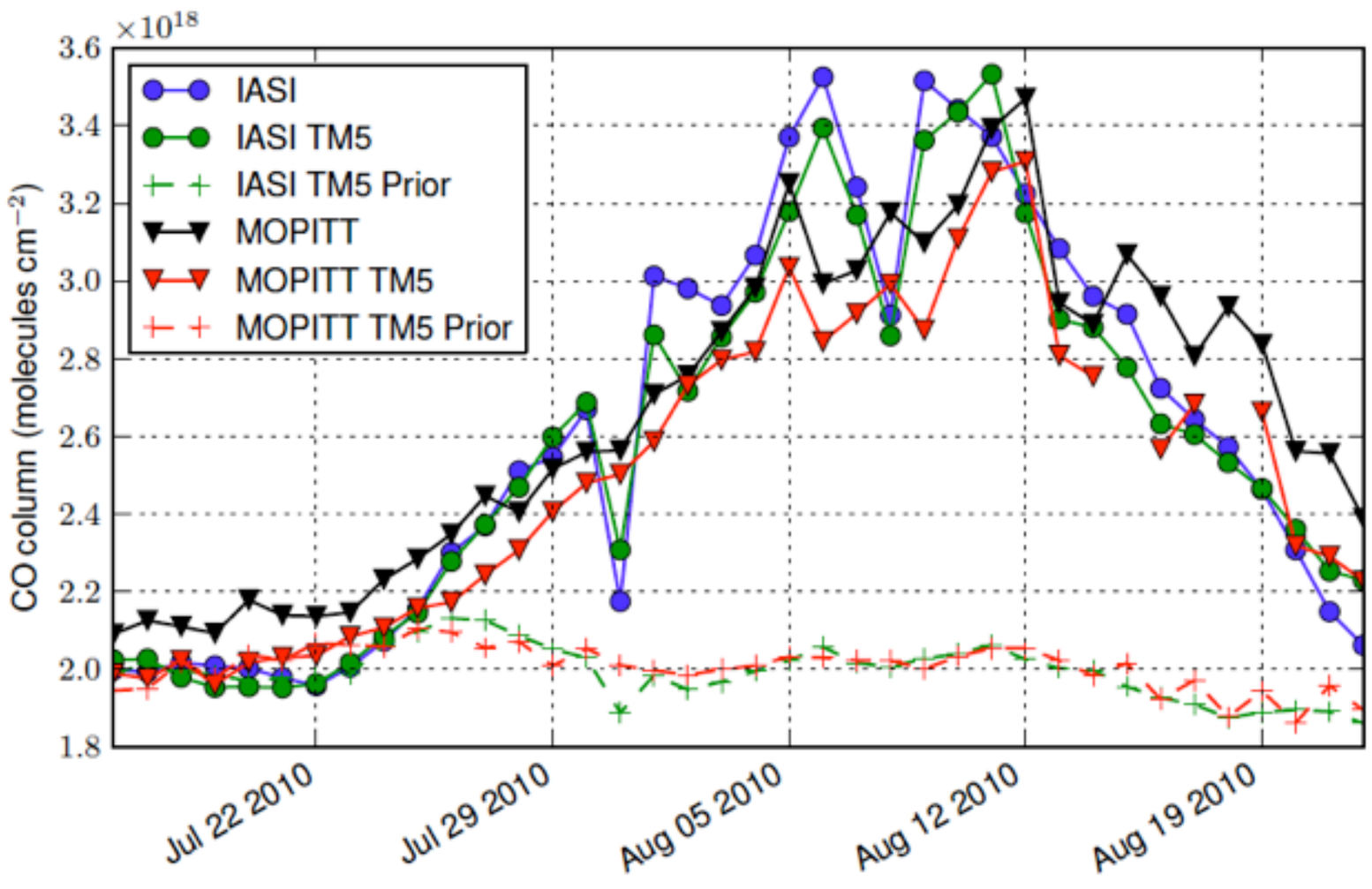




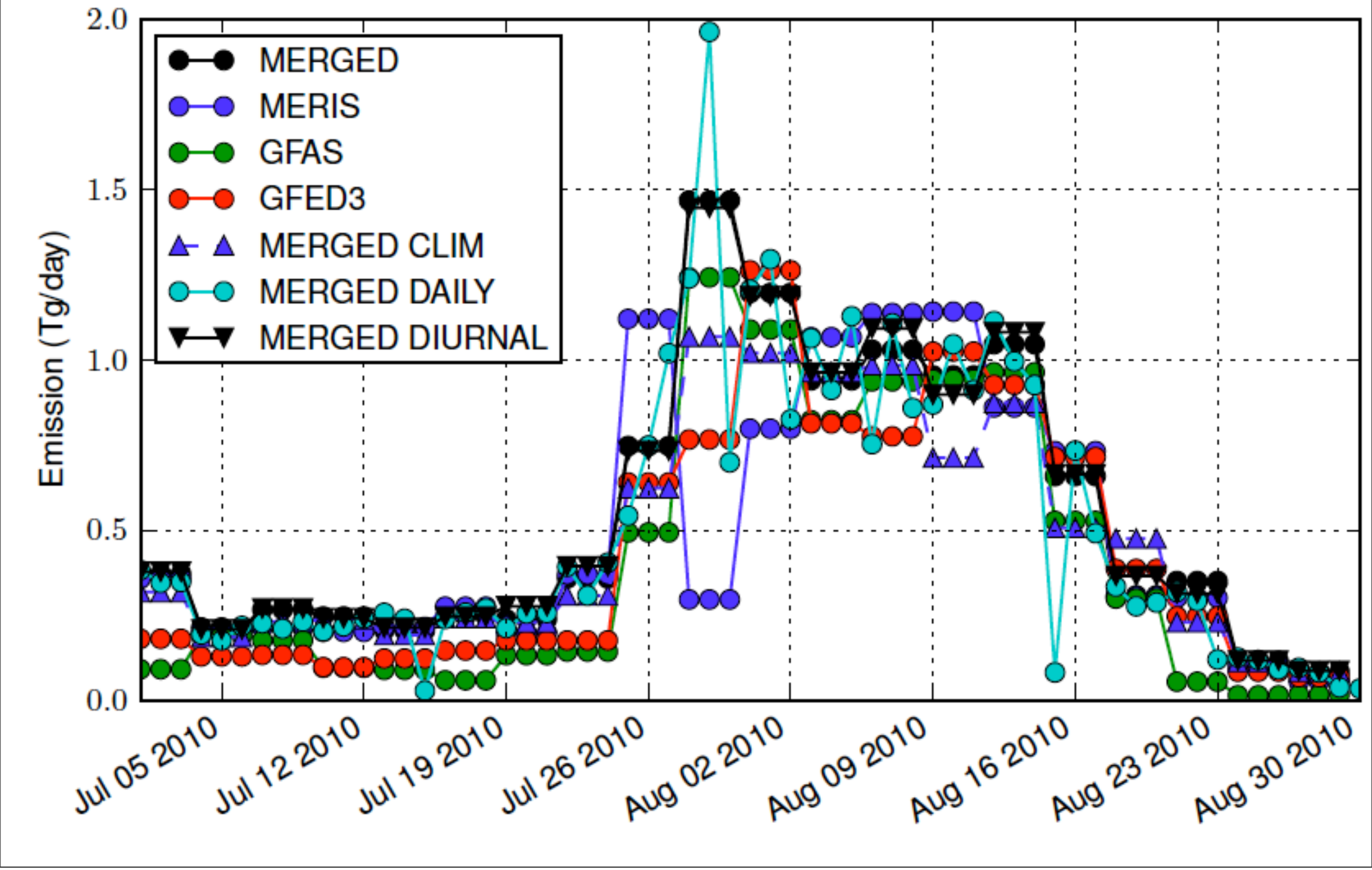
IASI = Used for Optimization
MOPITT = Used for Validation



Sensitivities

MERGED	Based on MODIS & MERIS burned scars
MERIS	Only based on MERIS burned scars
GFAS	Burned on daily GFAS priors from the MACC project
GFED3	Monthly GFED prior
MERGED-CLIM	Using the SPIH from the Val-Martin Climatology
MERGED-DAILY	Optimizing on daily time-scales
MERGED-DIURNAL	Applied a strong diurnal pattern to the emissions

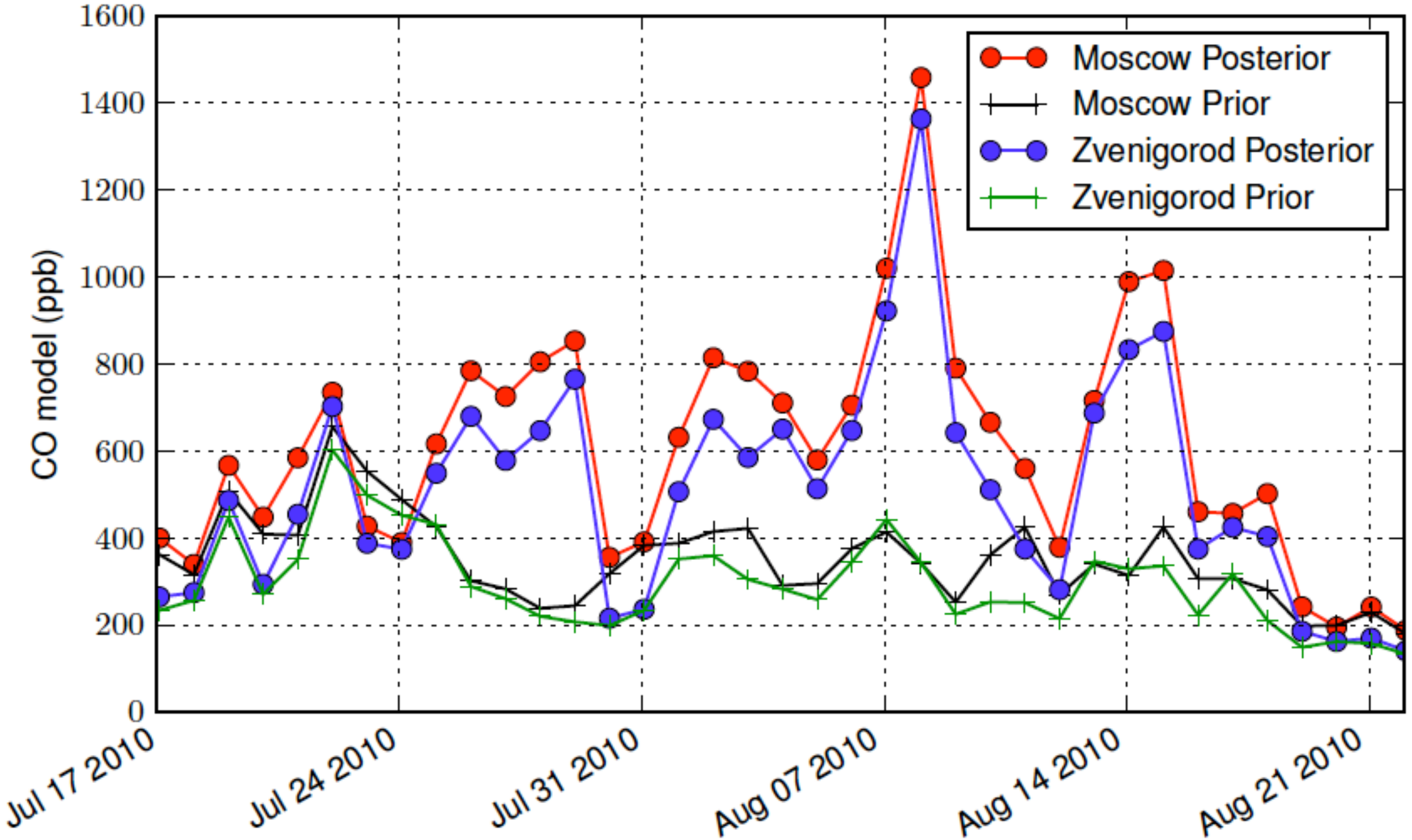
Optimized Emissions



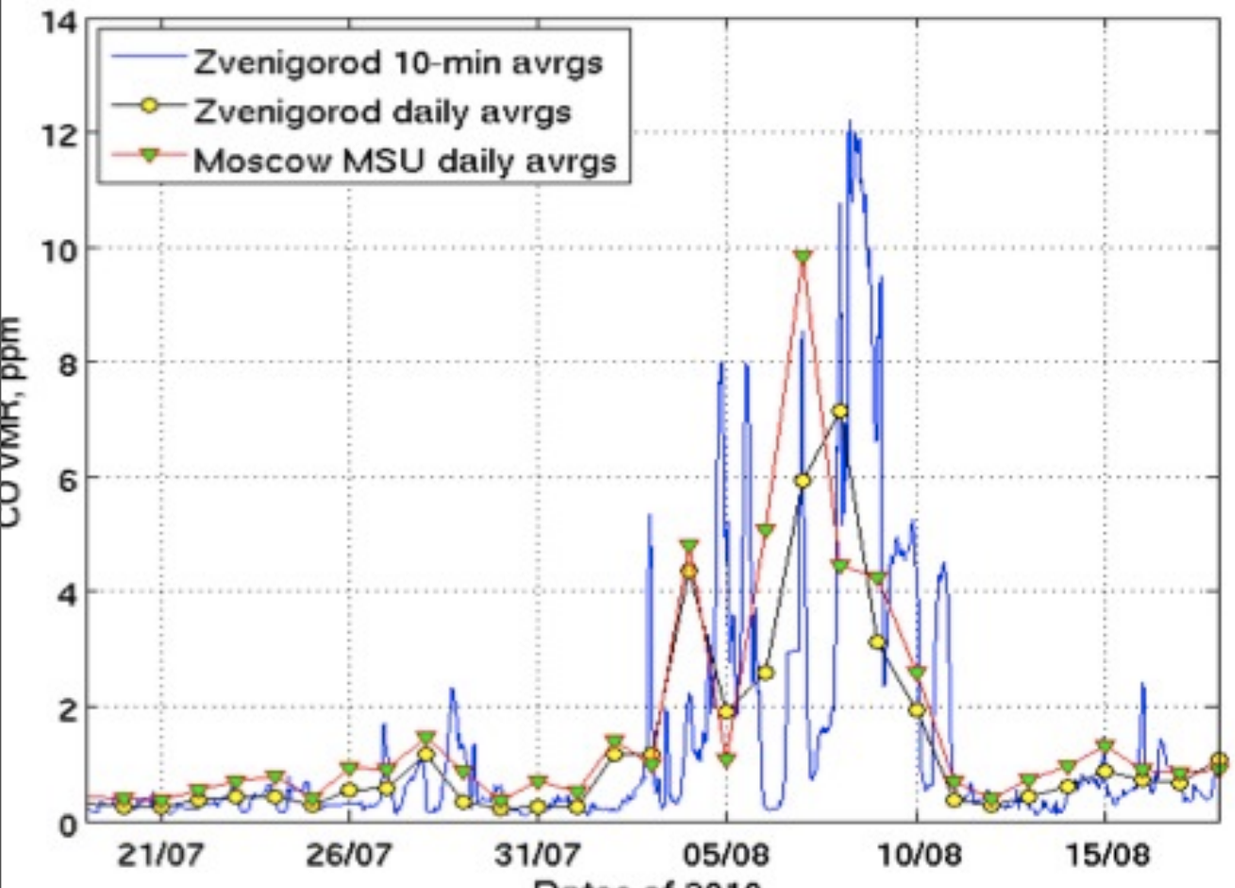
Optimized Emissions (Tg/33 days)

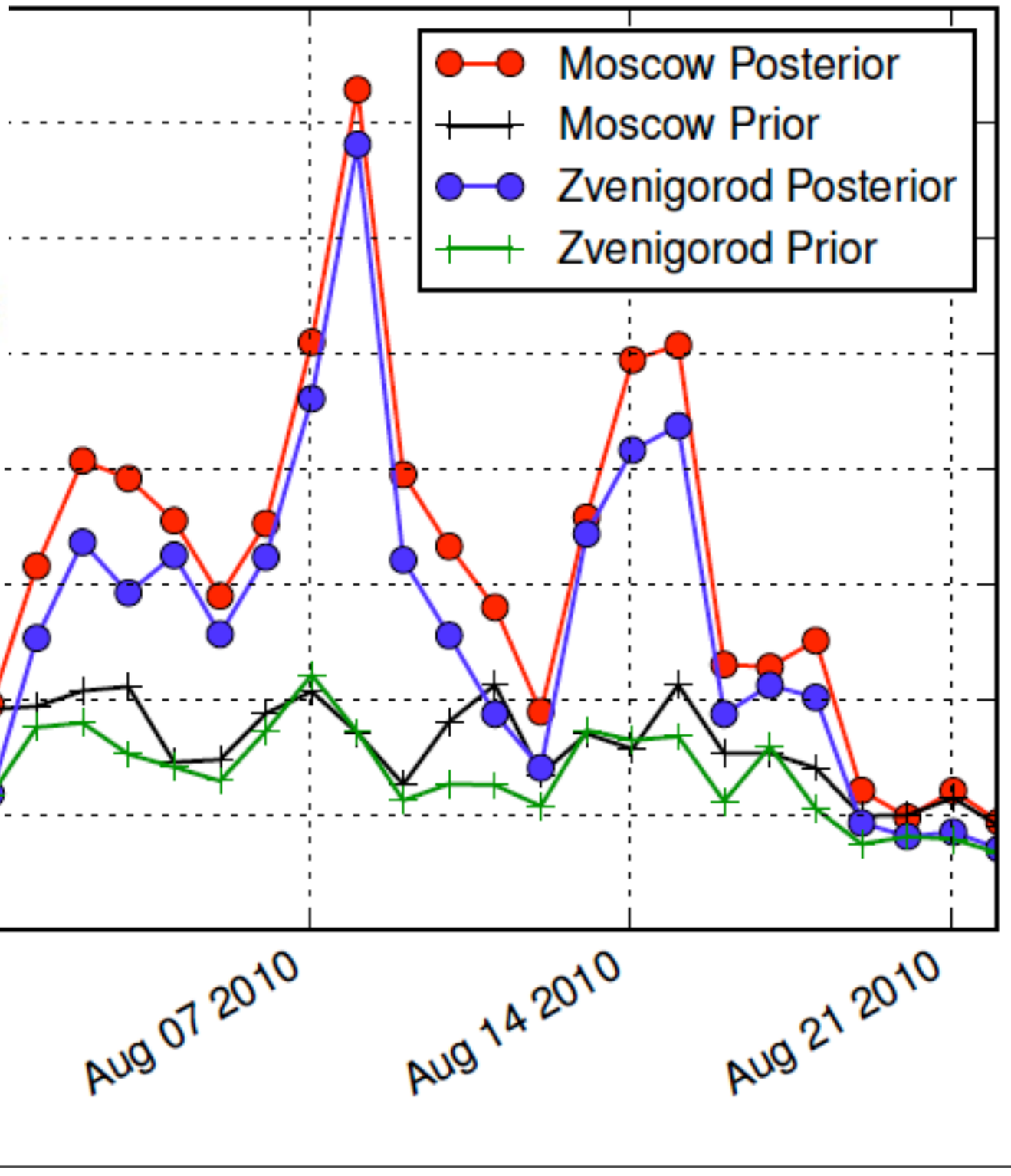
Simulation	Prior R1	Poste R1	Prior R2	Poste R2
MERGED	1.06	6.82	6.5	26.6
MERIS	0.86	7.29	3.9	24.0
GFAS	10.52	9.93	12.4	22.0
GFED3	0.63	10.06	2.0	22.3
MERGED-CLIM	1.06	5.26	6.5	22.6
MERGED-DAILY	1.06	5.98	6.5	25.1
MERGED-DIURNAL	1.06	6.62	6.5	26.9

Validation on stations: observed 10 ppm!!



s: observed 10 ppm!!





Wrap up

- New PyShell-4DVAR system allows for:
  - sub-monhtly optimization
  - IASI CO column observations (200000/month)
  - non-lineair systems (avoiding negative emissions)
- 2010 Russian fires emitted 22-27 Tg CO from mid-July to mid-August 2010
- Peat burning emission estimates too low in 2010
- Surface measurements Moscow still underestimated.