Universität Bremen

Inversions of Californian wildfire CO using TROPOMI

Killing off humanity with TM5-4DVAR

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Outline

Objective and Motivation

Californian wild fires

- Warmer and dryer than usual $\rightarrow$ wildfires more likely
- November and December 2018: major burning events
- Focus on Camp and Woolsey fires, raging in the weeks after November 8th
  - Devastated area about $1000\,\mathrm{km}^2$
  - Direct damage: 88 dead, burned land and structures, forced evacuation of multiple towns
  - Indirect damage due to pollution

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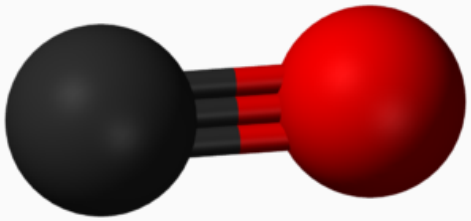
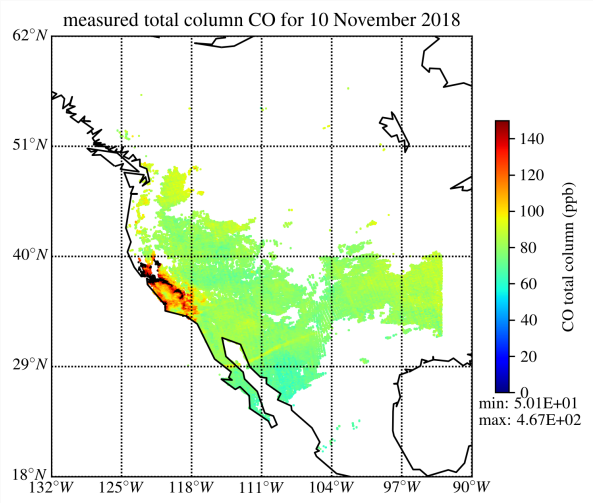
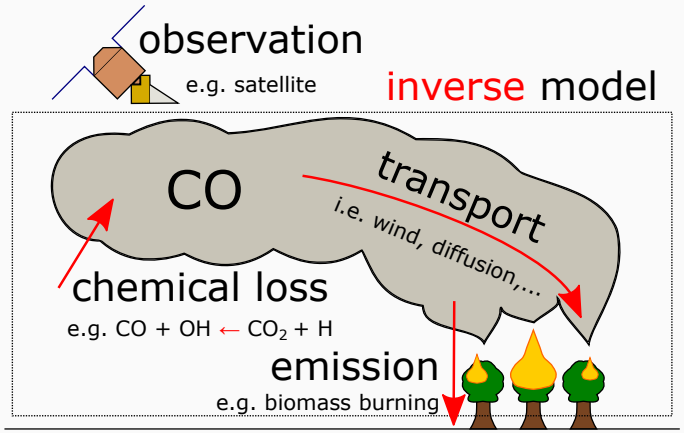


Retrieve CO emissions from biomass burning events in California using TROPOMI observation in the TM5 4DVAR model.





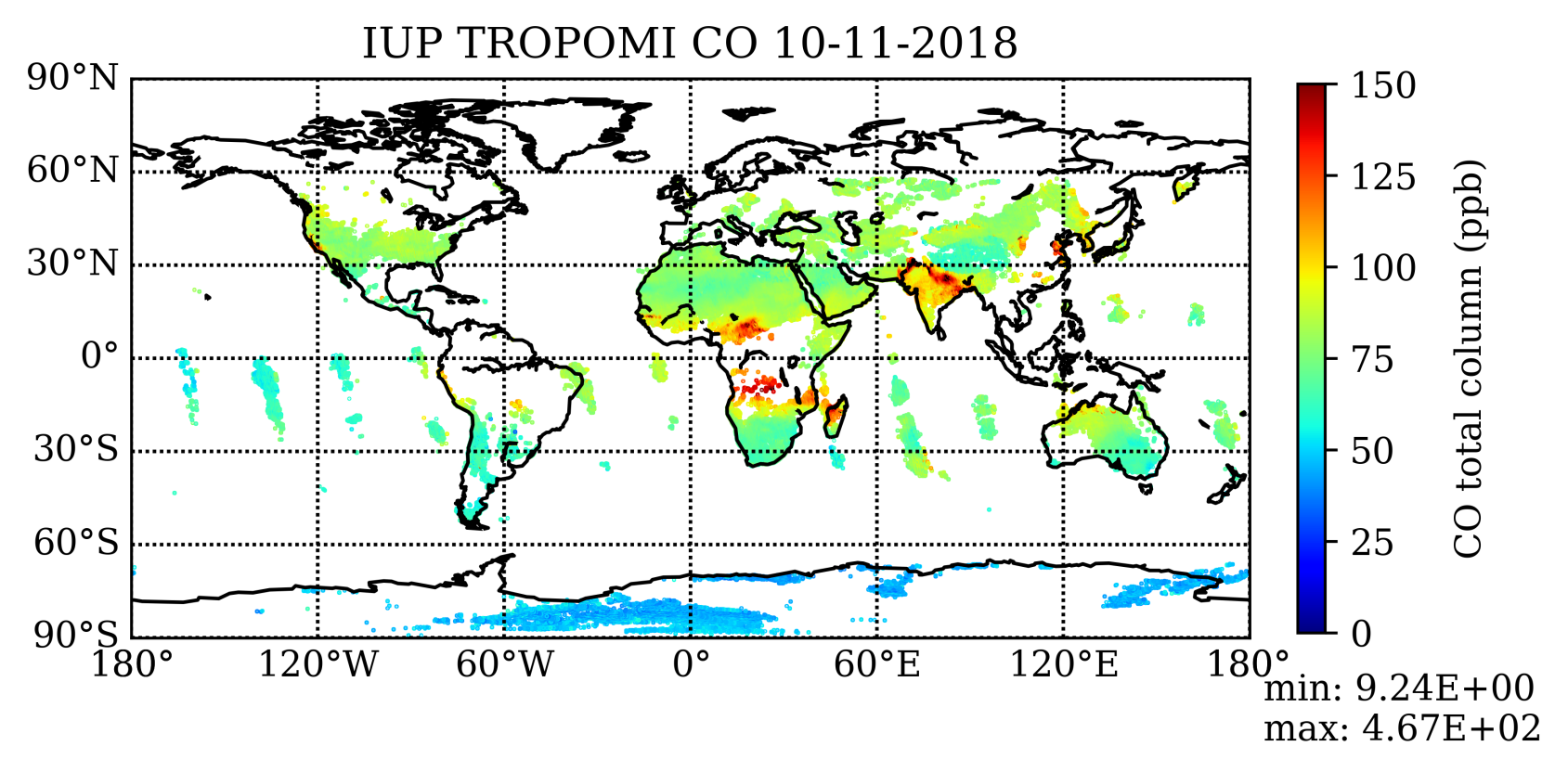
Images: Fire: Mark McKenna / Zuma Press, LA-Times; S5P: ESA

TROPOMI observations

- **TROPO**spheric **M**onitoring **I**nstrument onboard of **S**entinel-**5** **P**recursor
- Daily global coverage
- Local overpass time 13:30
- High resolution (up to $7 \times 7\,\mathrm{km}^2$)
  - $\rightarrow$ Still useful for $1^\circ \times 1^\circ$ model pixels: lower error, chance to have at least some cloud free pixels
- Especially sensitive to troposphere/boundary layer

Image: ESA

Satellite observations



- Given: TROPOMI CO total column observation

Satellite data courtesy of Oliver Schneising and Michael Buchwitz of IUP Carbon and Greenhouse Gas Group

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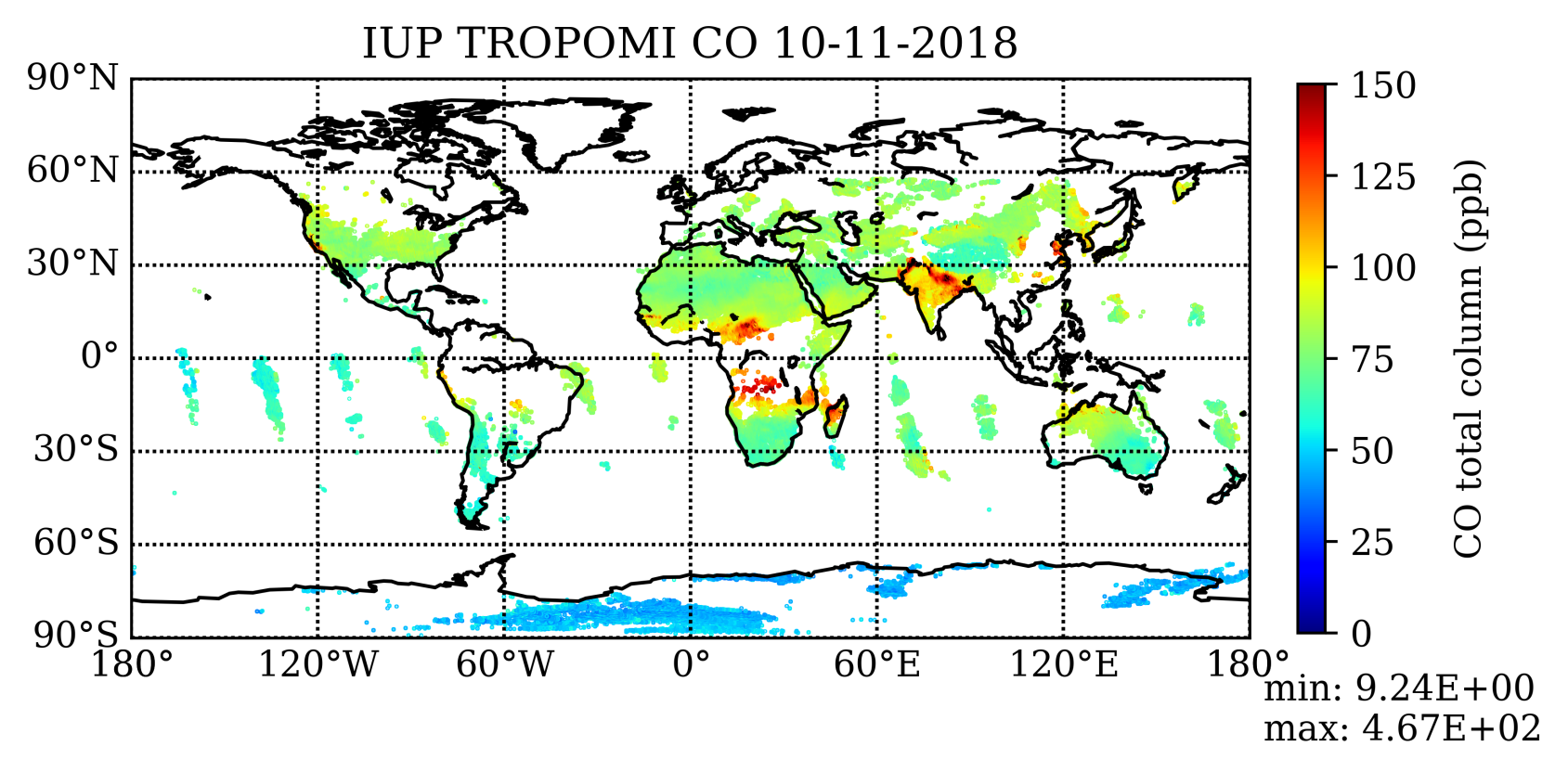

- Given: TROPOMI CO total column observation
- Wanted: Location and temporal development of emissions

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Intermediate Results

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  - $\rightarrow$ Extended to handle TROPOMI data

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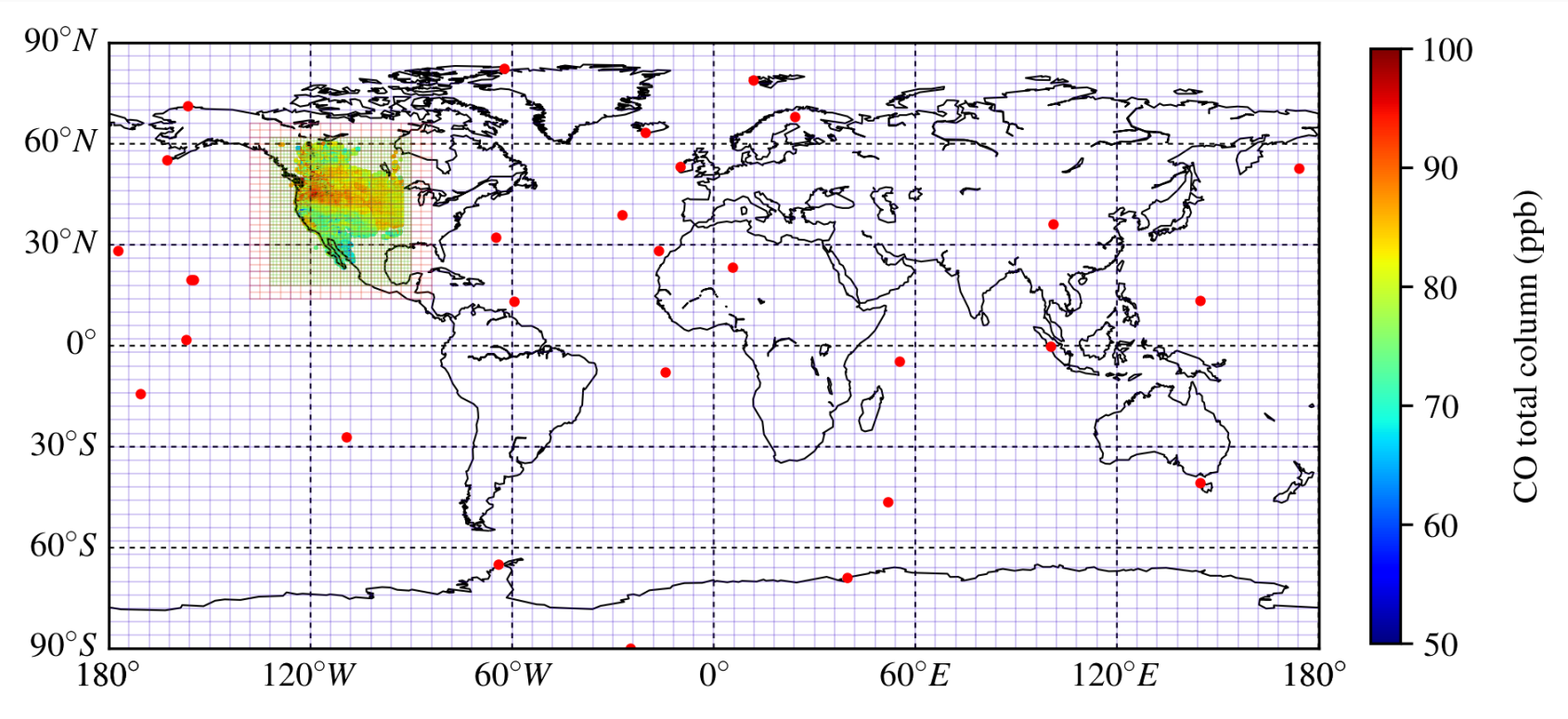
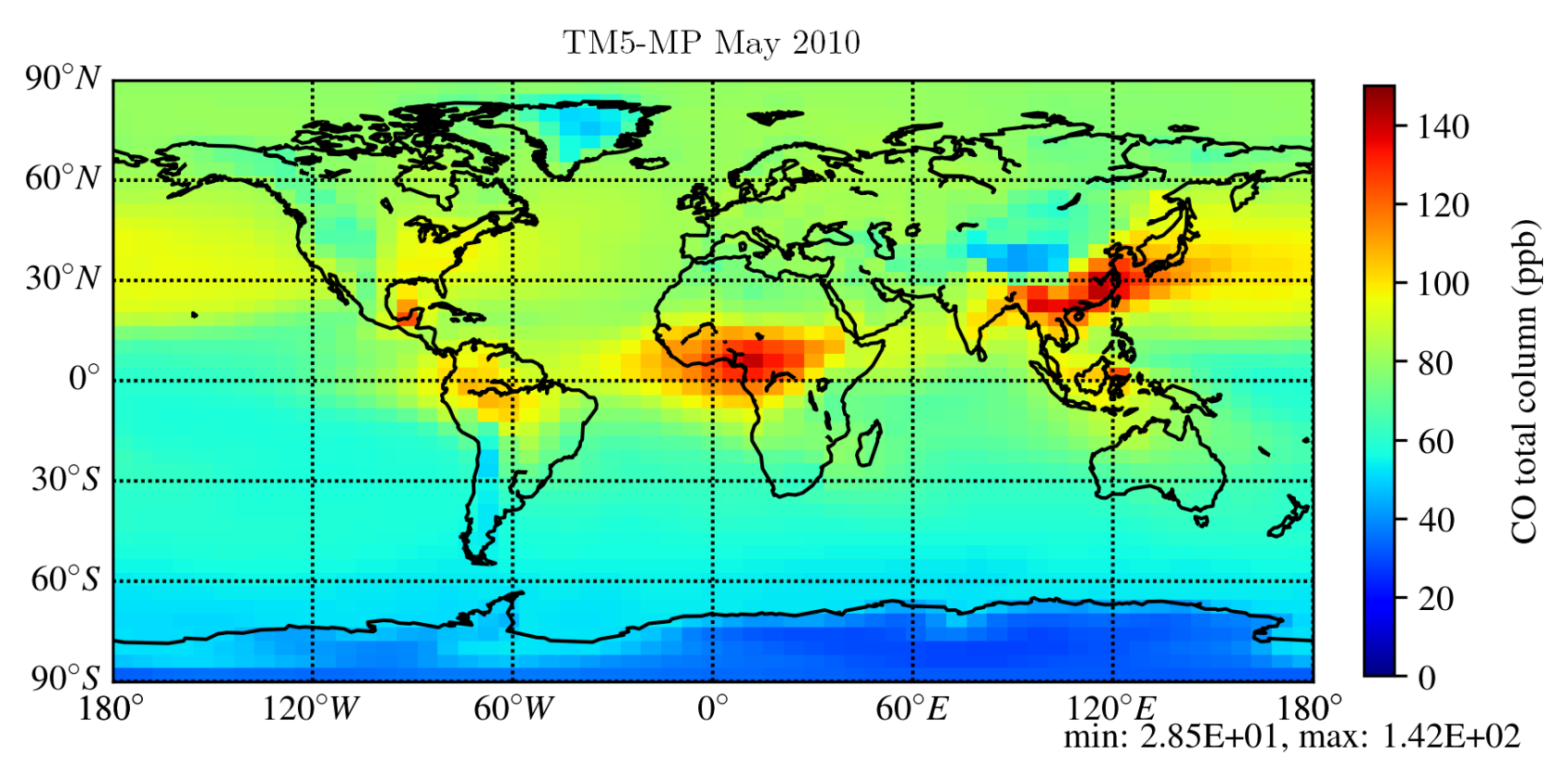
- M1qN3 optimizer
- Zoom over California

Zooming, flask measurements and satellite observations



- Satellite data only in zoom region
- Only background stations (Hooghiemstra et al 2012)

Initial conditions and spin up



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  - Simple forward run to capture current major events
  - 8 year old distribution still more proper than "80 ppb everywhere"

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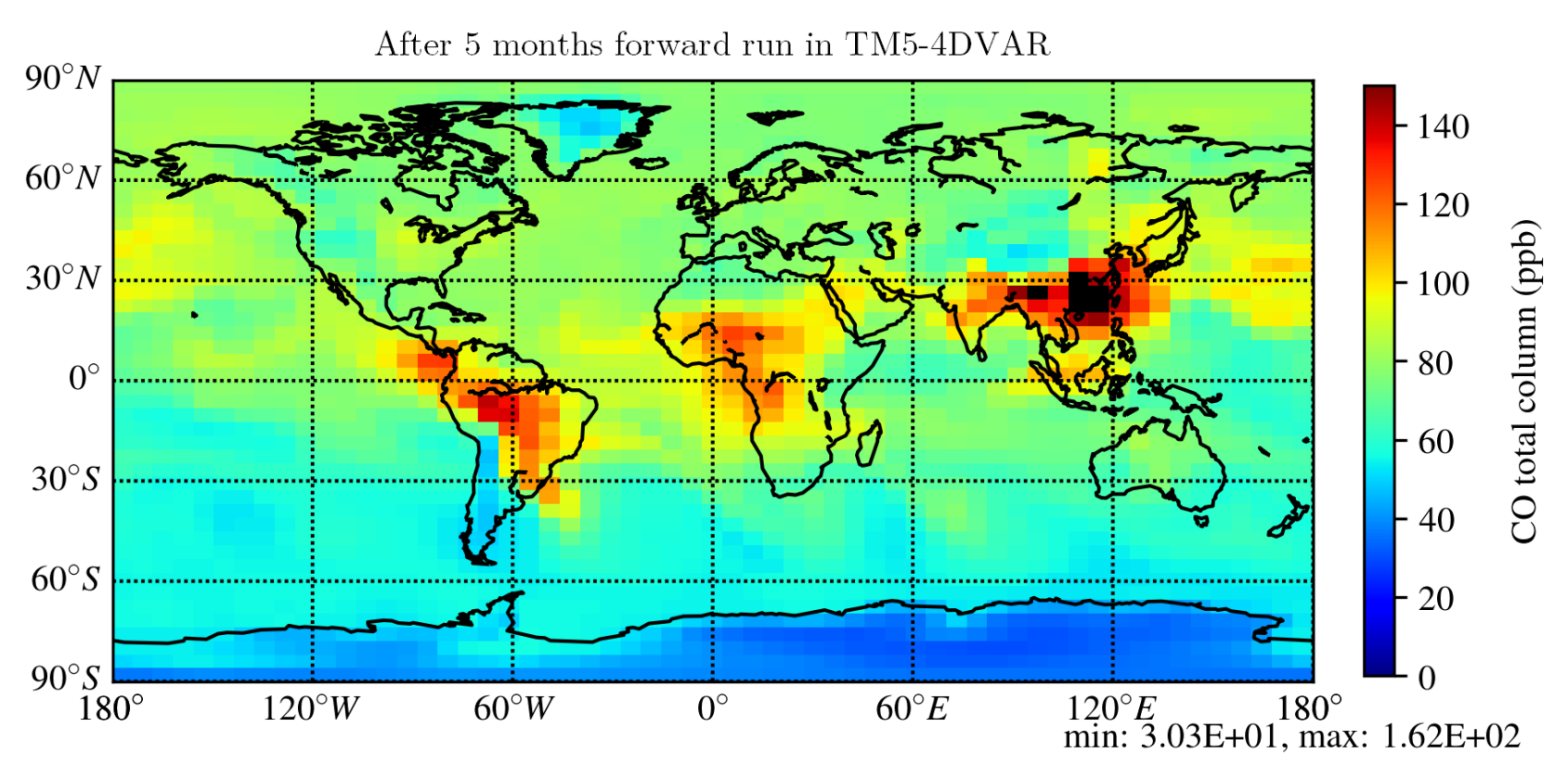

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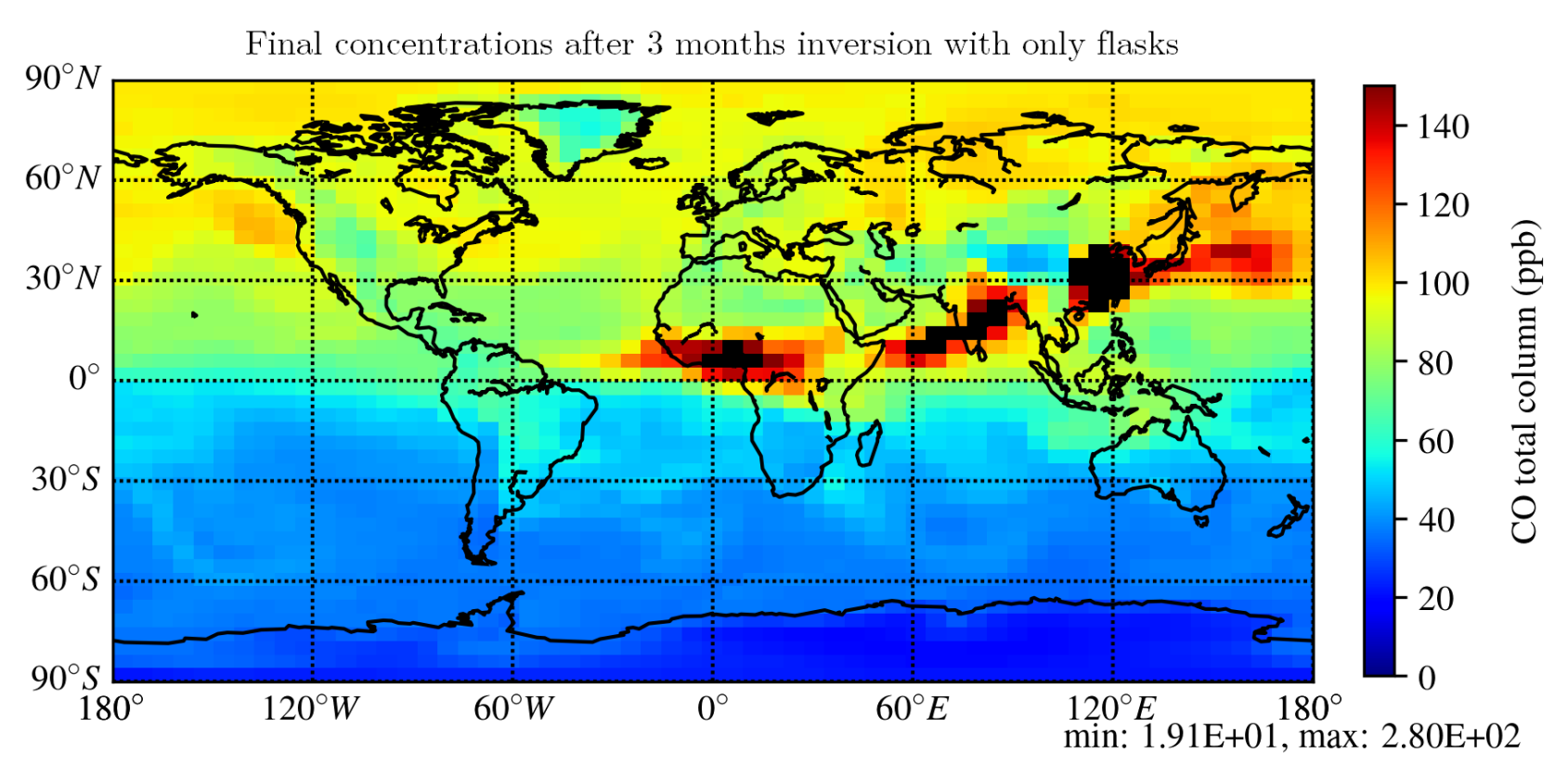
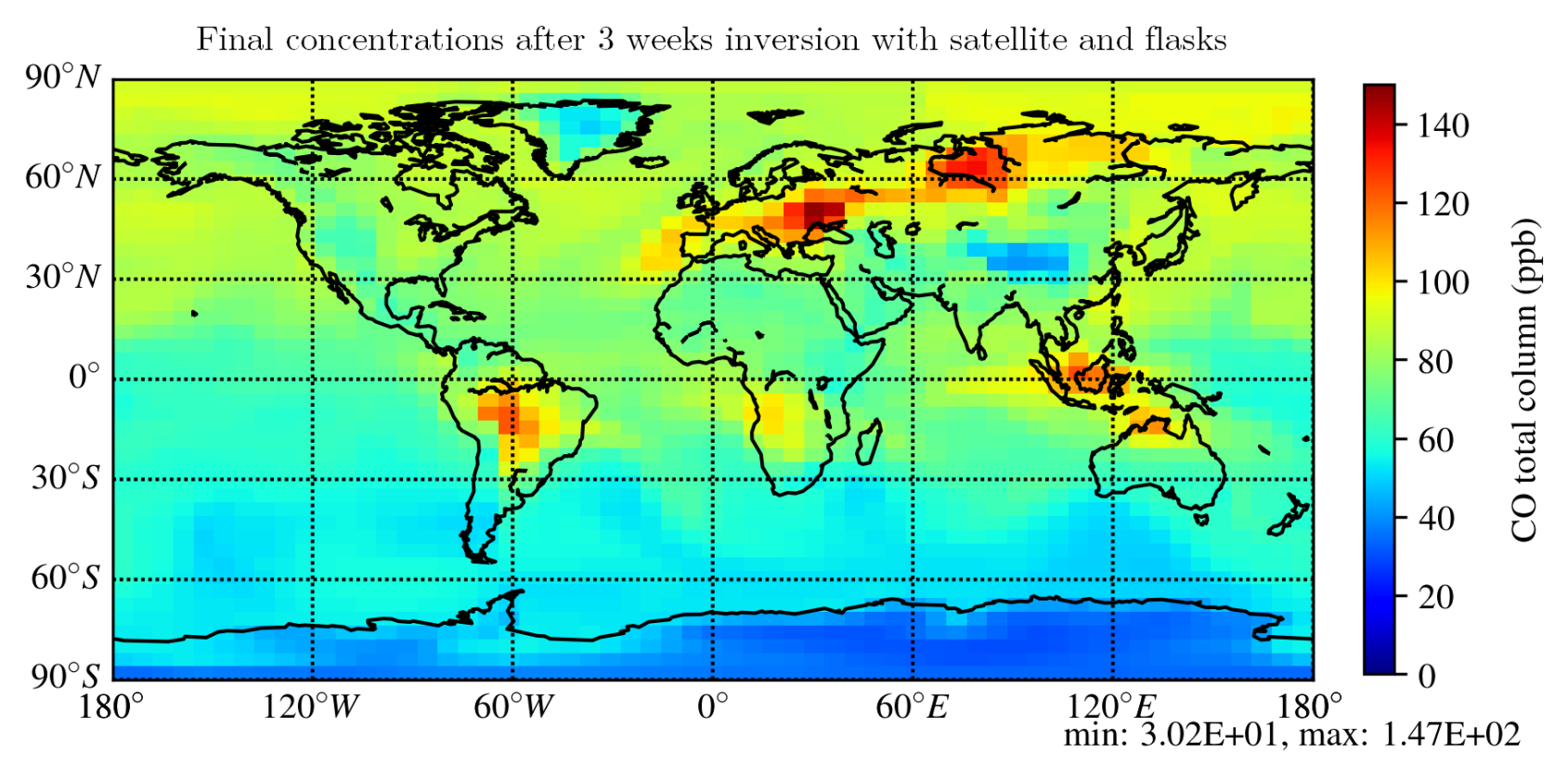
Inversion period



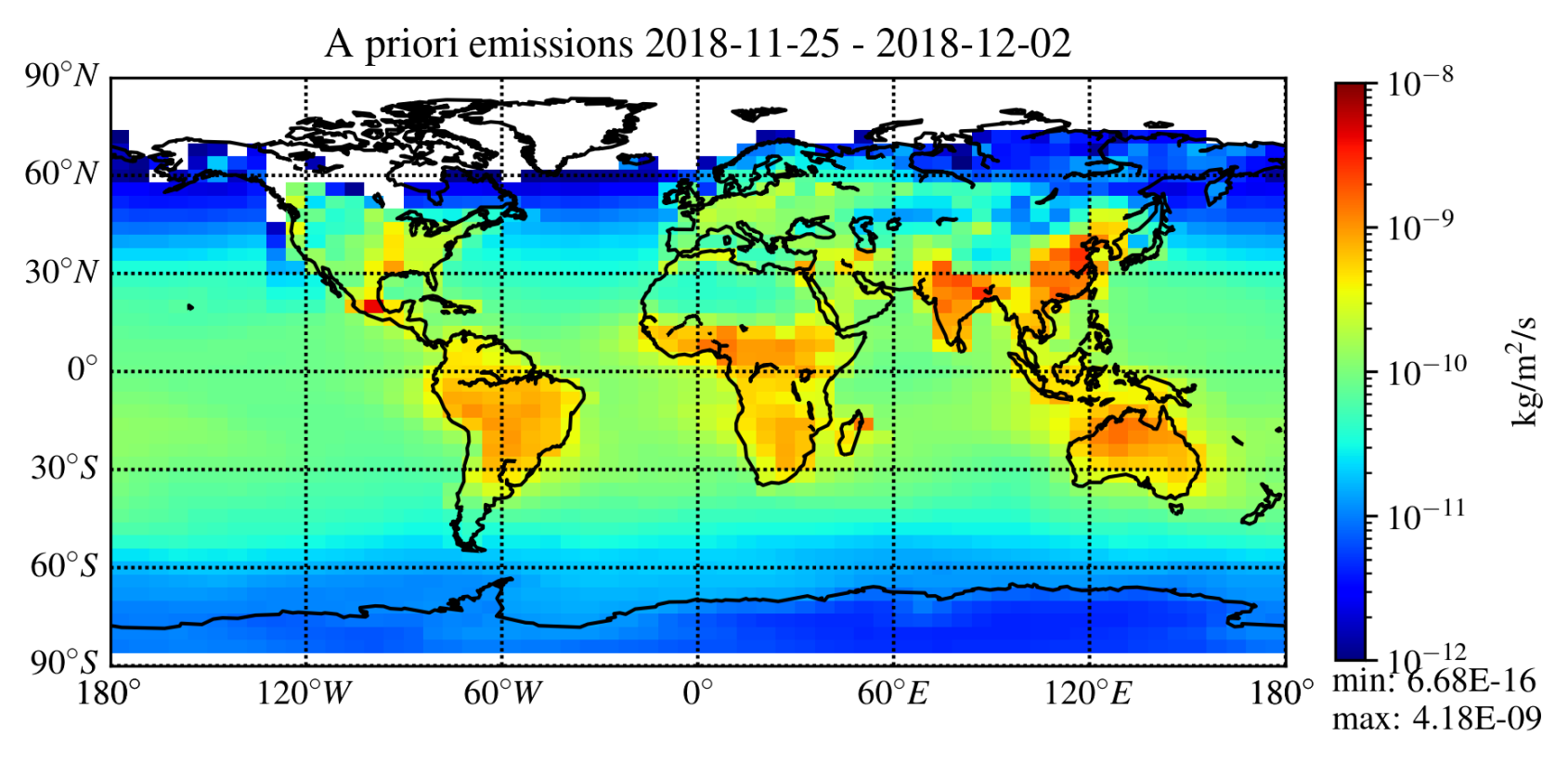
- 3 month (Oct-Dec) inversion period, event starts 8.11
- Only converges properly without satellite observations. Concentrations still messed up.

Nudge initial conditions to satellite observations

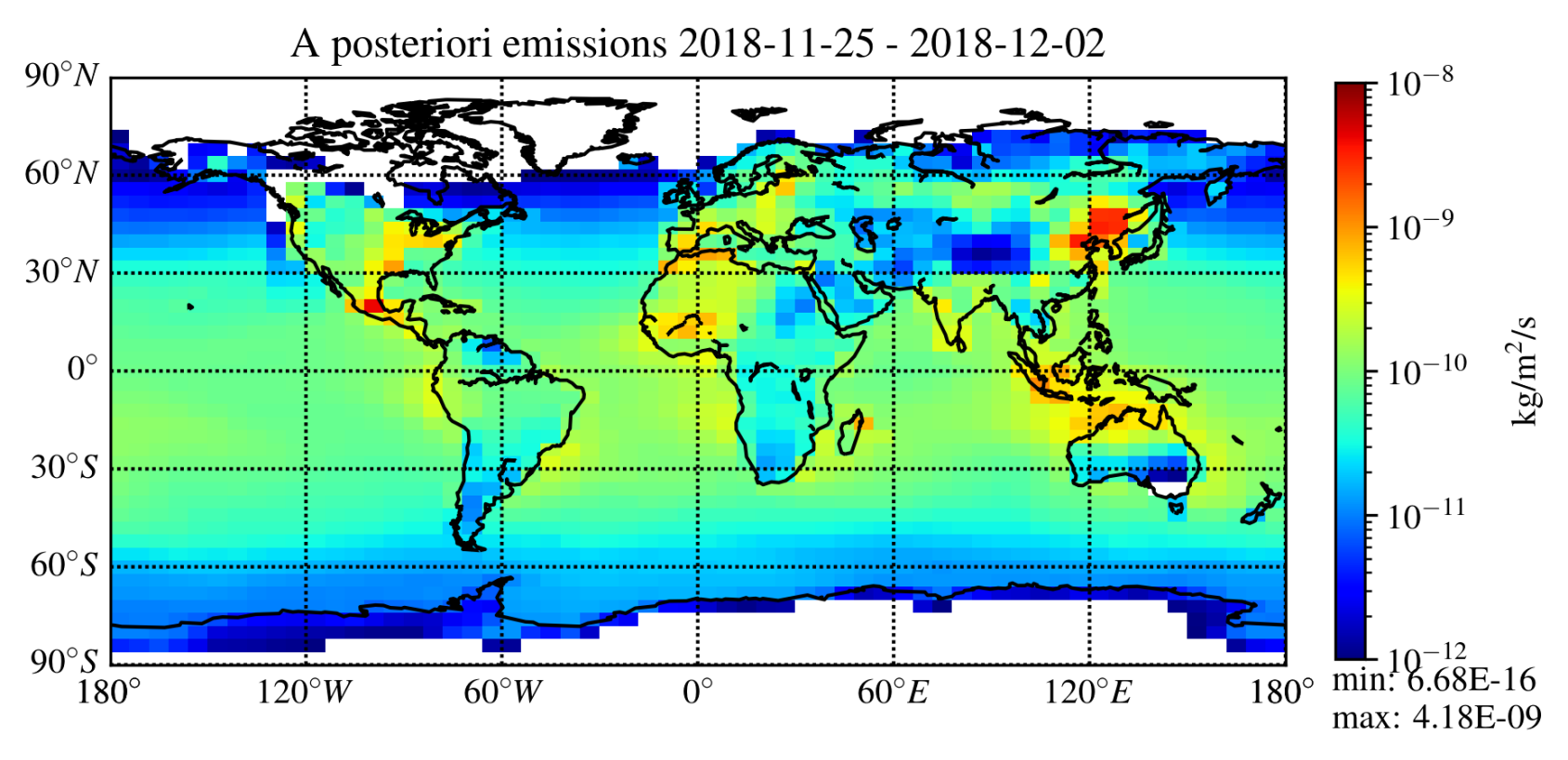


Tried splitting off first 3 weeks to get concentrations closer to satellite as in Krol et al 2013 $\rightarrow$ converges somewhat, but global distribution unreasonable (clean China and India etc.)

Global emissions - a priori

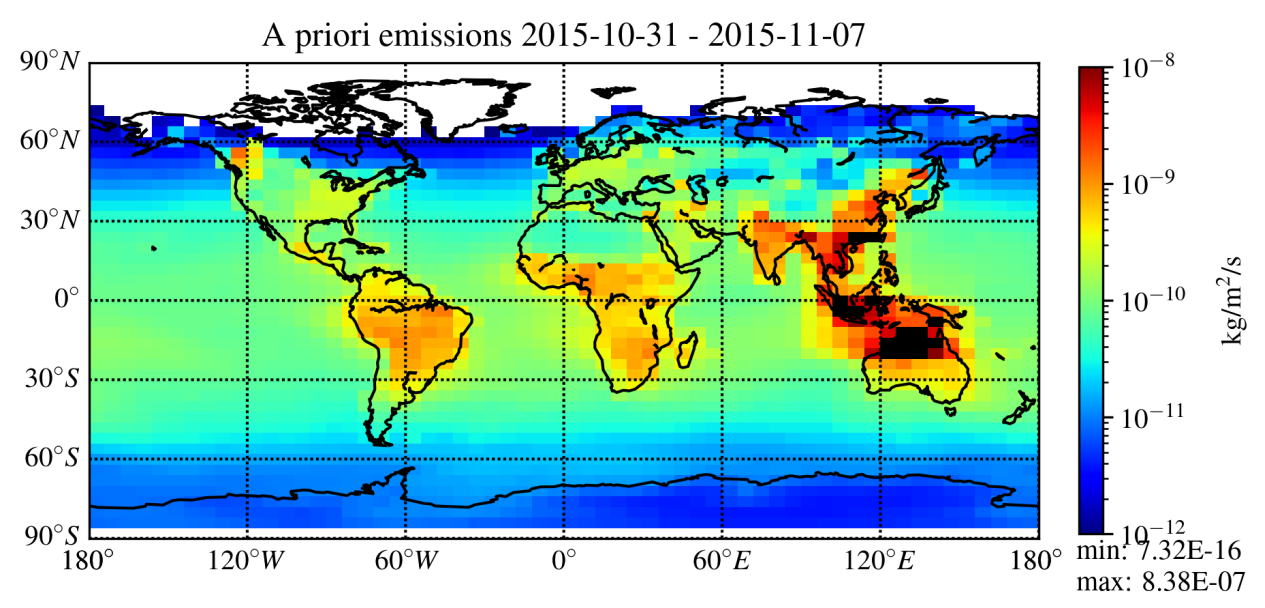


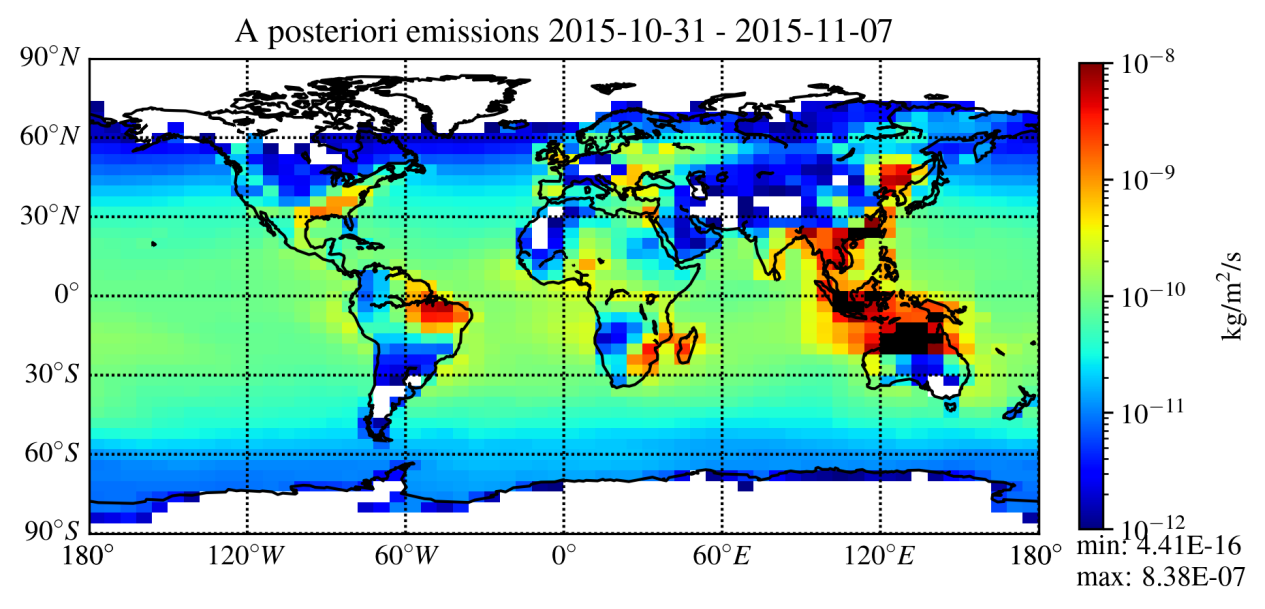
Global emissions - a posteriori



- Human influence and reduced to mostly zero all over
- Strange behavior expected in spin up/down period, i.e. first/last 2-4 weeks, but occurs over whole period
- Satellite may be biased low (or model high), but strange behavior persist even if using station data only

Global emissions





Tried to reproduce results from Nechita-Banda et al. 2018 for Indonesia (using her rc files, but new code)

$\rightarrow$ still messed up global emissions

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- Compare to IASI based inversions
- Consider more complex chemistry, like HCHO

Acknowledgments

- The computations were performed on the HPC cluster Aether at the University of Bremen, financed by DFG in the scope of the Excellence Initiative.
- The PhD position is paid for by the University Bremen.
- Special thanks to the TM5 community, especially Maarten Krol and Sourish Basu for provision of and help with the TM5-4DVAR model.

- ... and of course thank You for your attention