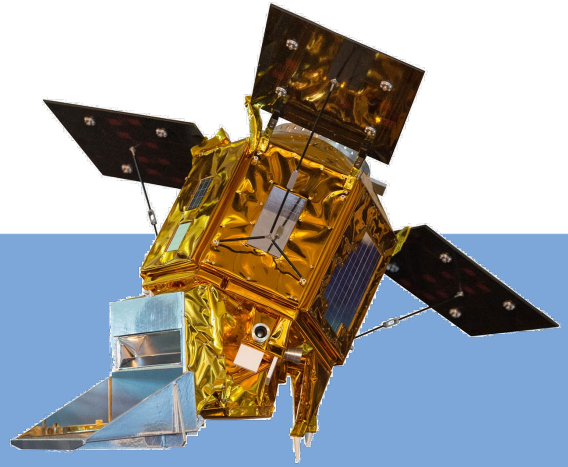
Vertical information about carbon monoxide by assimilating TROPOMI column measurements

Tobias Borsdorff, Rainer Volkamer, Kyle Zarzana, Natalie Kille, and Jochen Landgraf

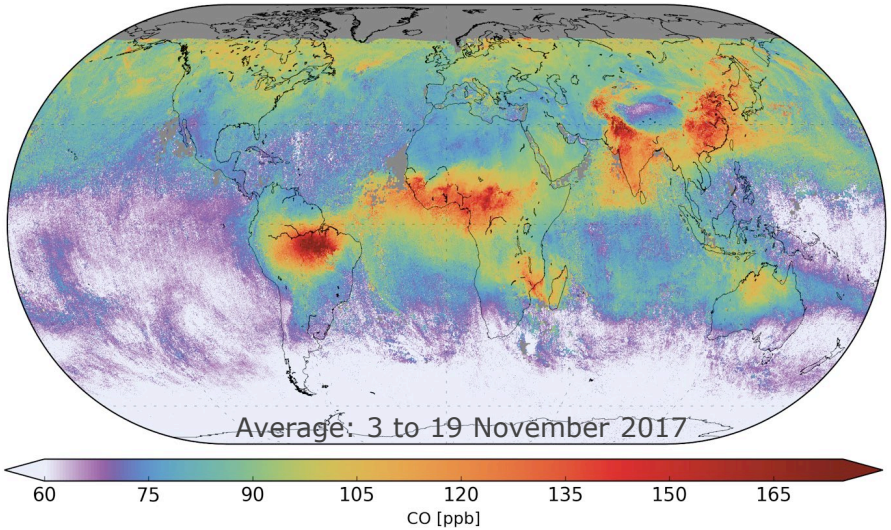
SRON

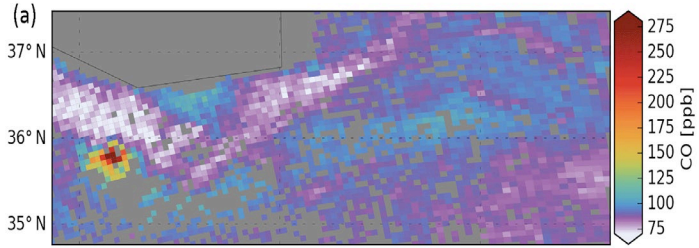


Netherlands Institute for Space Research

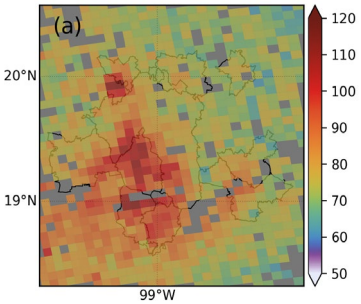
Netherlands Organisation for Scientific Research (NWO)

TROPOMI CO dataset

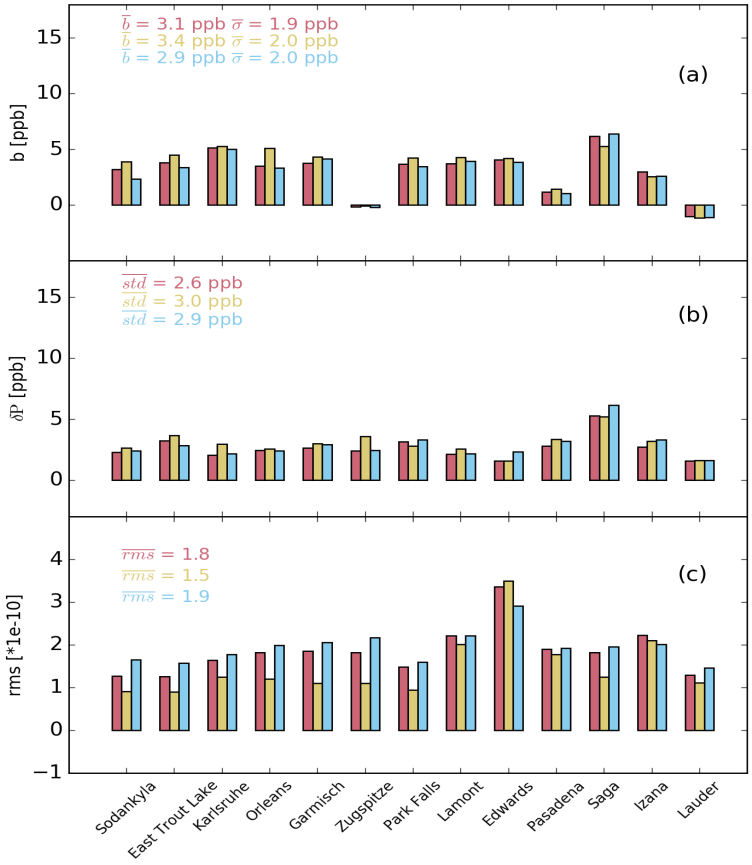




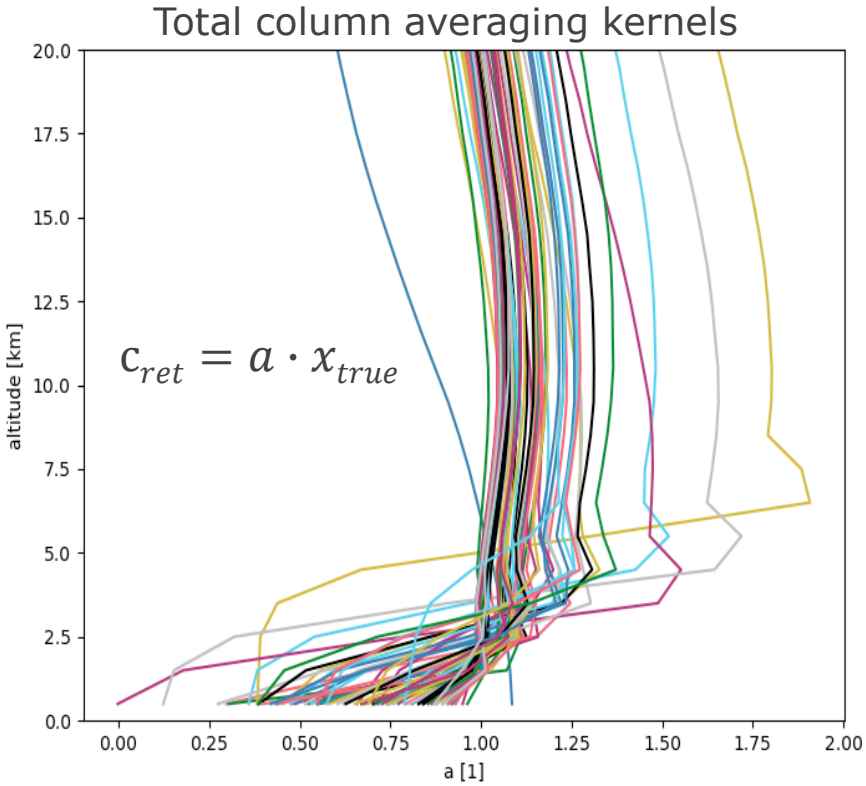
Borsdorff et al. (2018b)



Borsdorff et al. (2020)



Posteriori profile retrieval



Forward model: $y = K \cdot x_{true} + e$

$$y = (c_1, c_2, \ldots, cm)$$

$$e = (e_1, e_2, \ldots, em)$$

$$K = \begin{pmatrix} a_1 \\ \ldots \\ a_m \end{pmatrix}$$

Inverse problem:

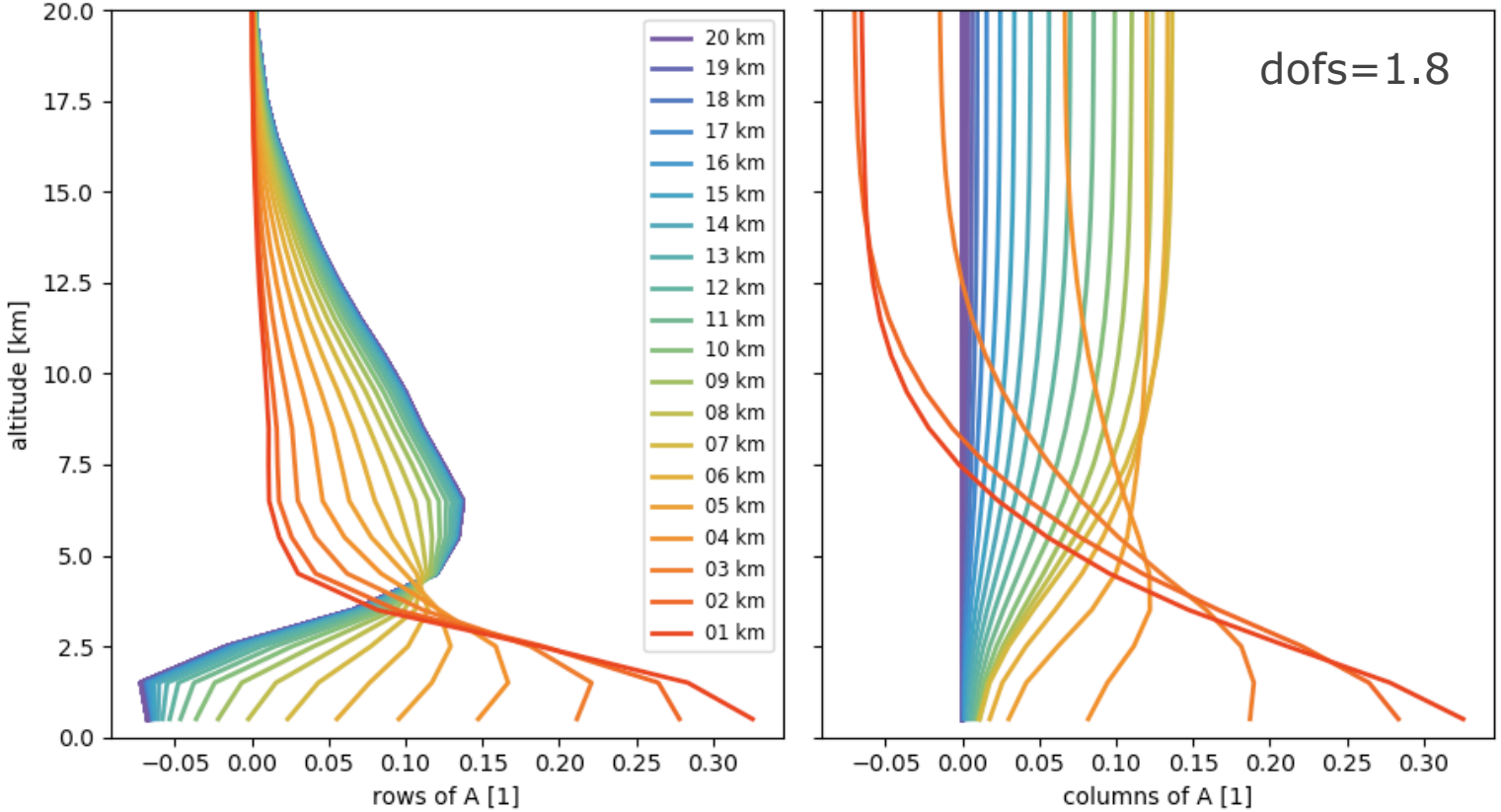
$$x_{ret} = \min_x \{ \; |y - Kx|_{S_e}^2 \; + |x - x|_R^2 \; \}$$

Regularization:

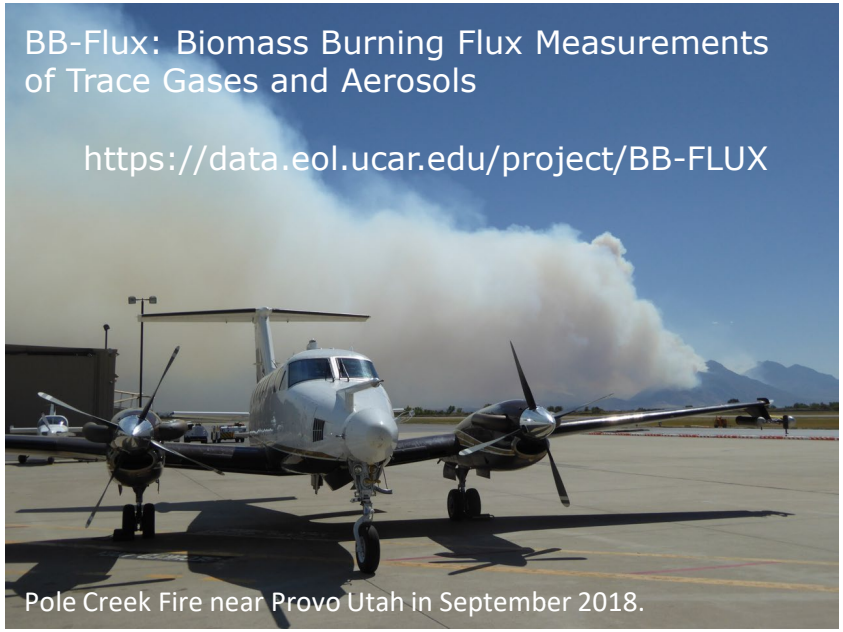
$$R = L_1^T * L_1$$

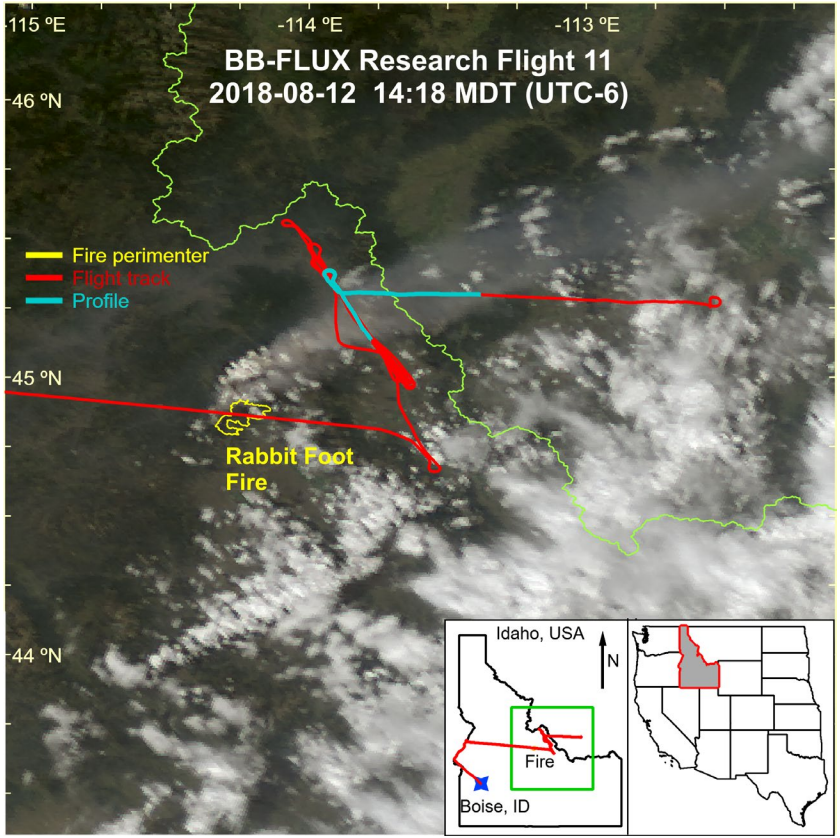
simulating profile scaling via a profile retrieval Borsdorff et al. (2014).

Profile averaging kernels



”Rabbit Foot Fire" in Idaho, 12th of August 2018



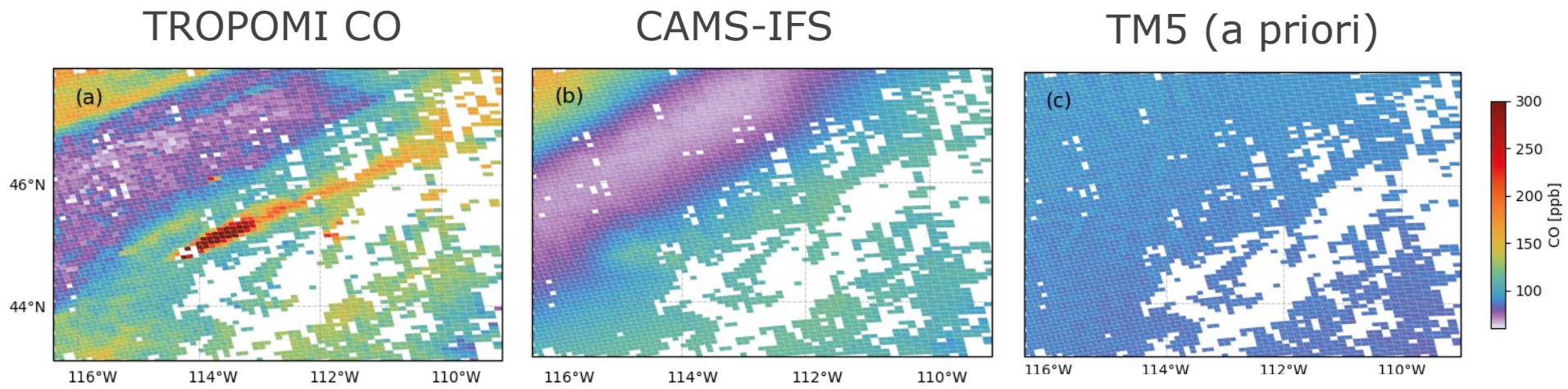


Carbon Monoxide in Optically Thick Wildfire Smoke: Evaluating TROPOMI Using CU Airborne SOF Column Observations

Jake P. Rowe et al., submitted to ACS Earth and Space Chemistry (2022).

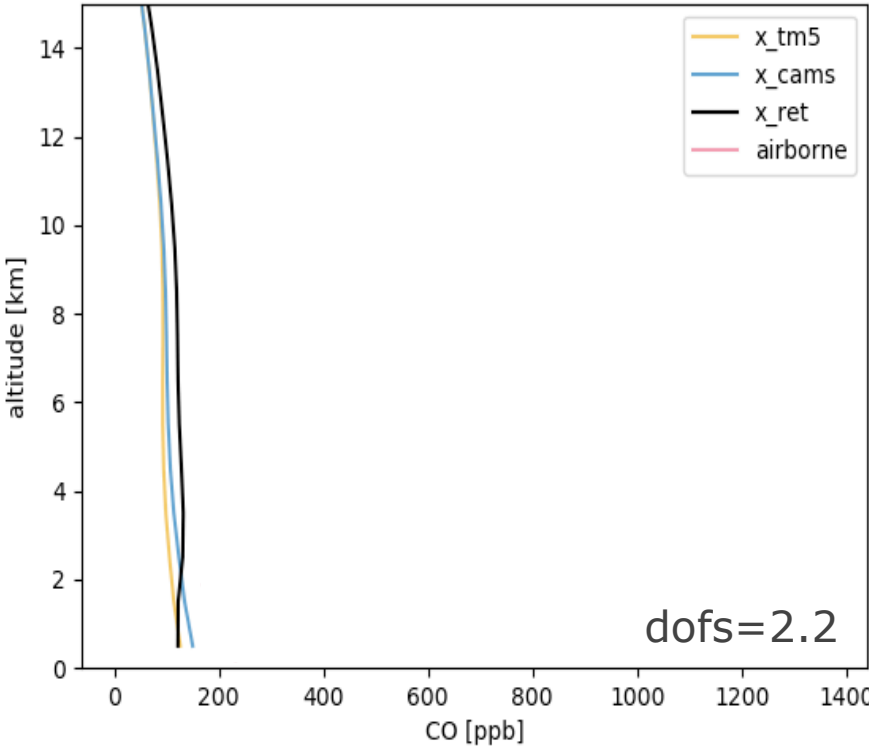
SRON

”Rabbit Foot Fire" in Idaho, 12th of August 2018

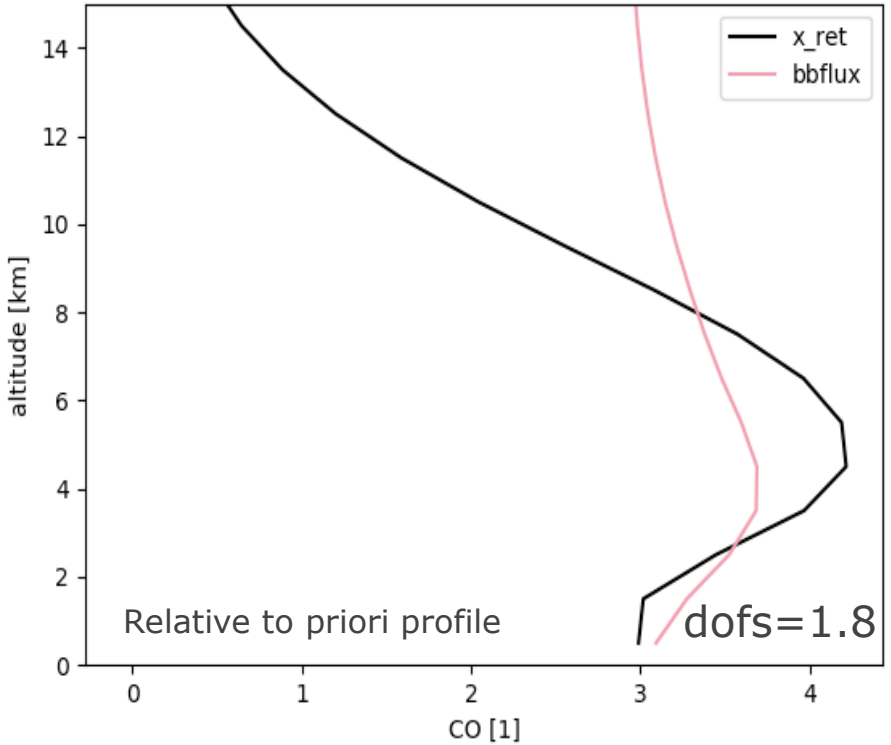


”Rabbit Foot Fire" in Idaho, 12th of August 2018

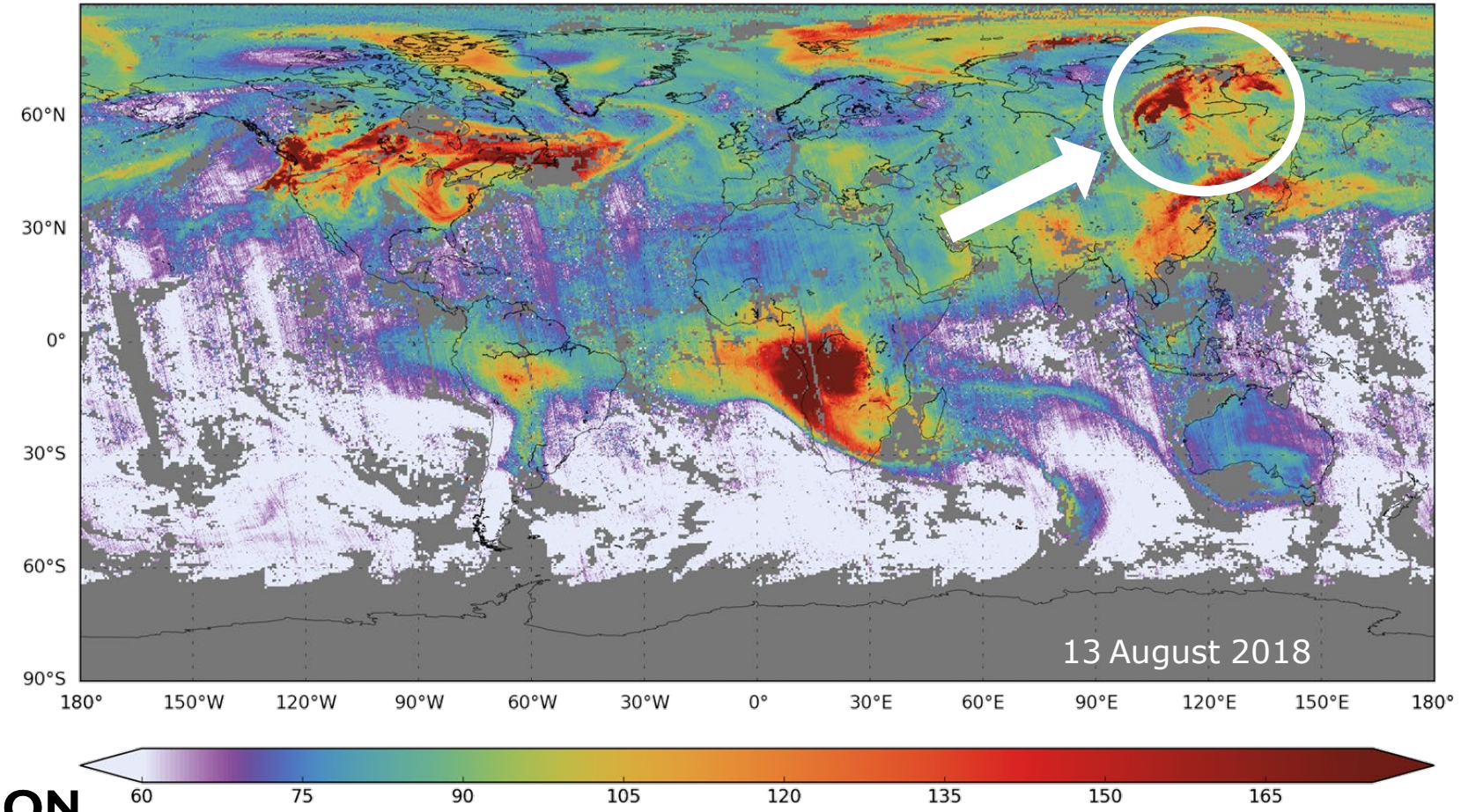
background (CO<=2.8e18)



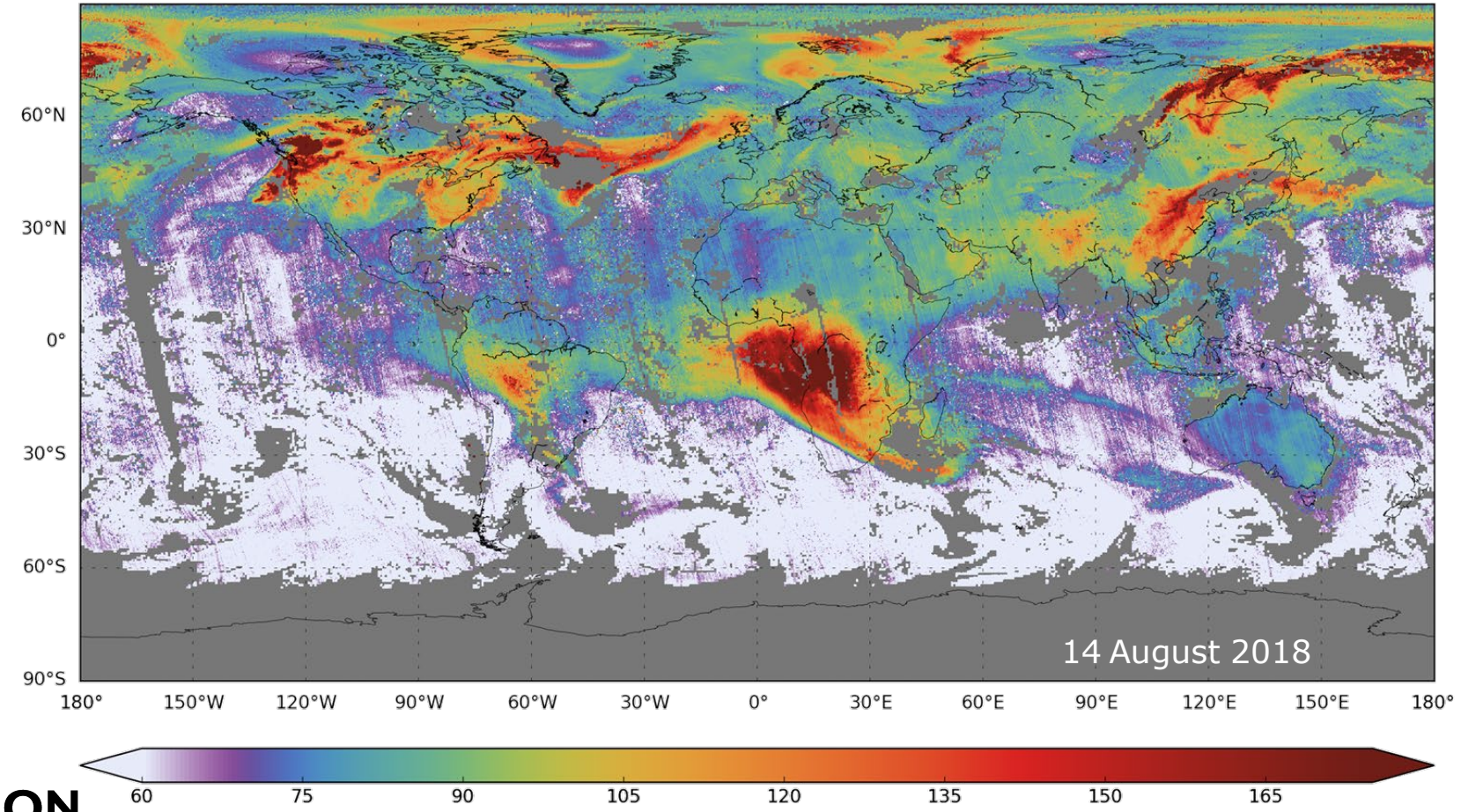
plume (CO>2.8e18)



CO over Canada from Siberian wildfires

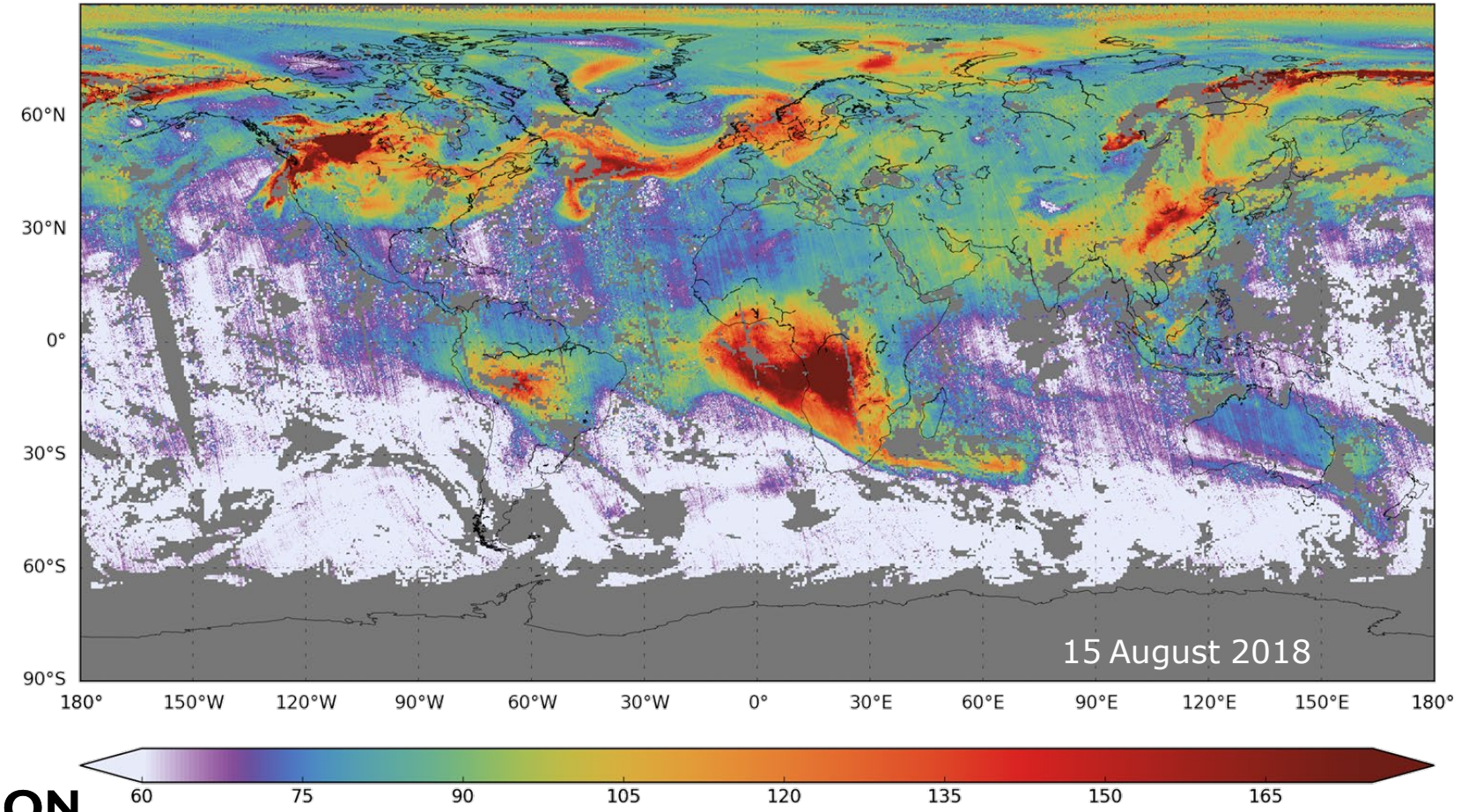


CO over Canada from Siberian wildfires

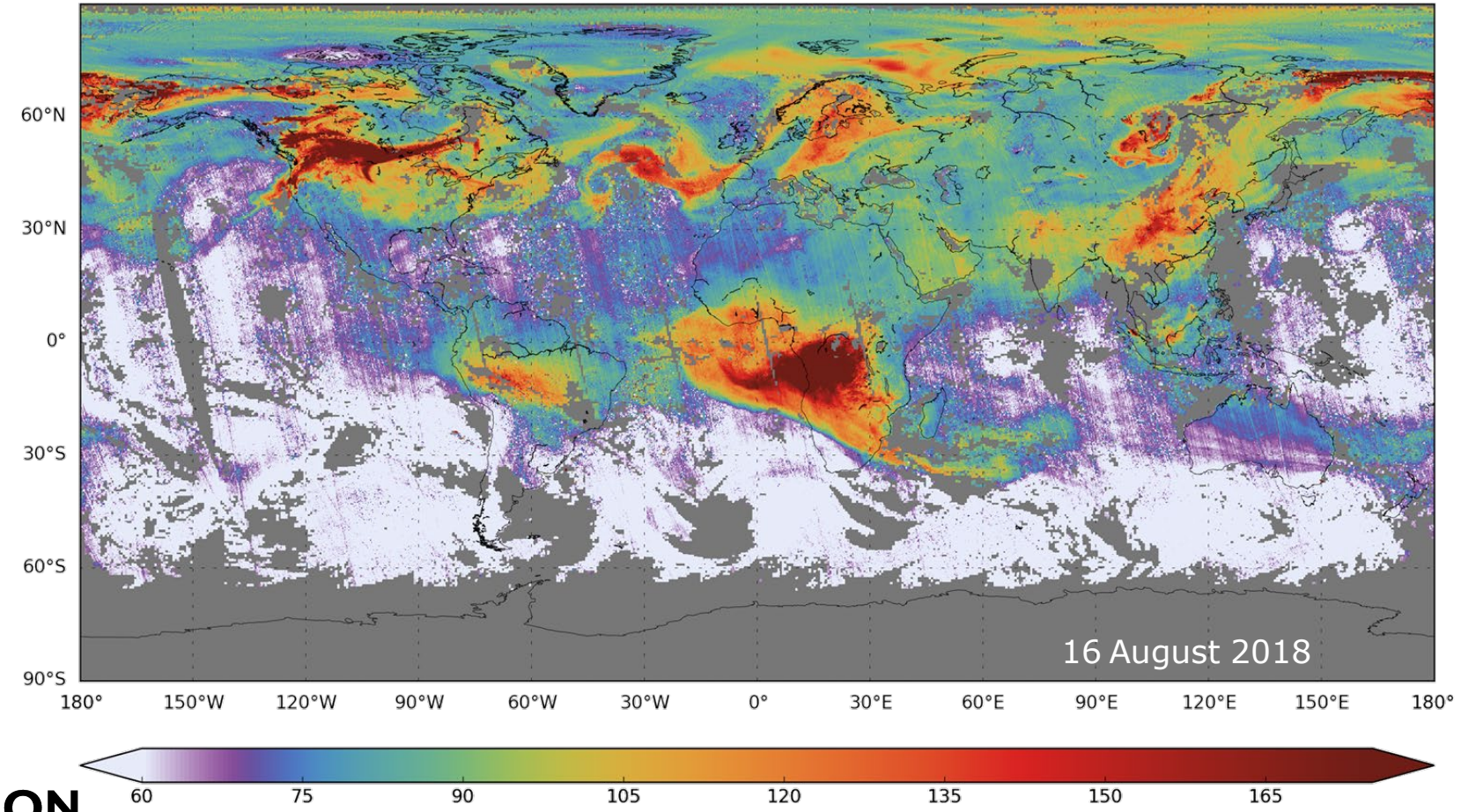


SRON

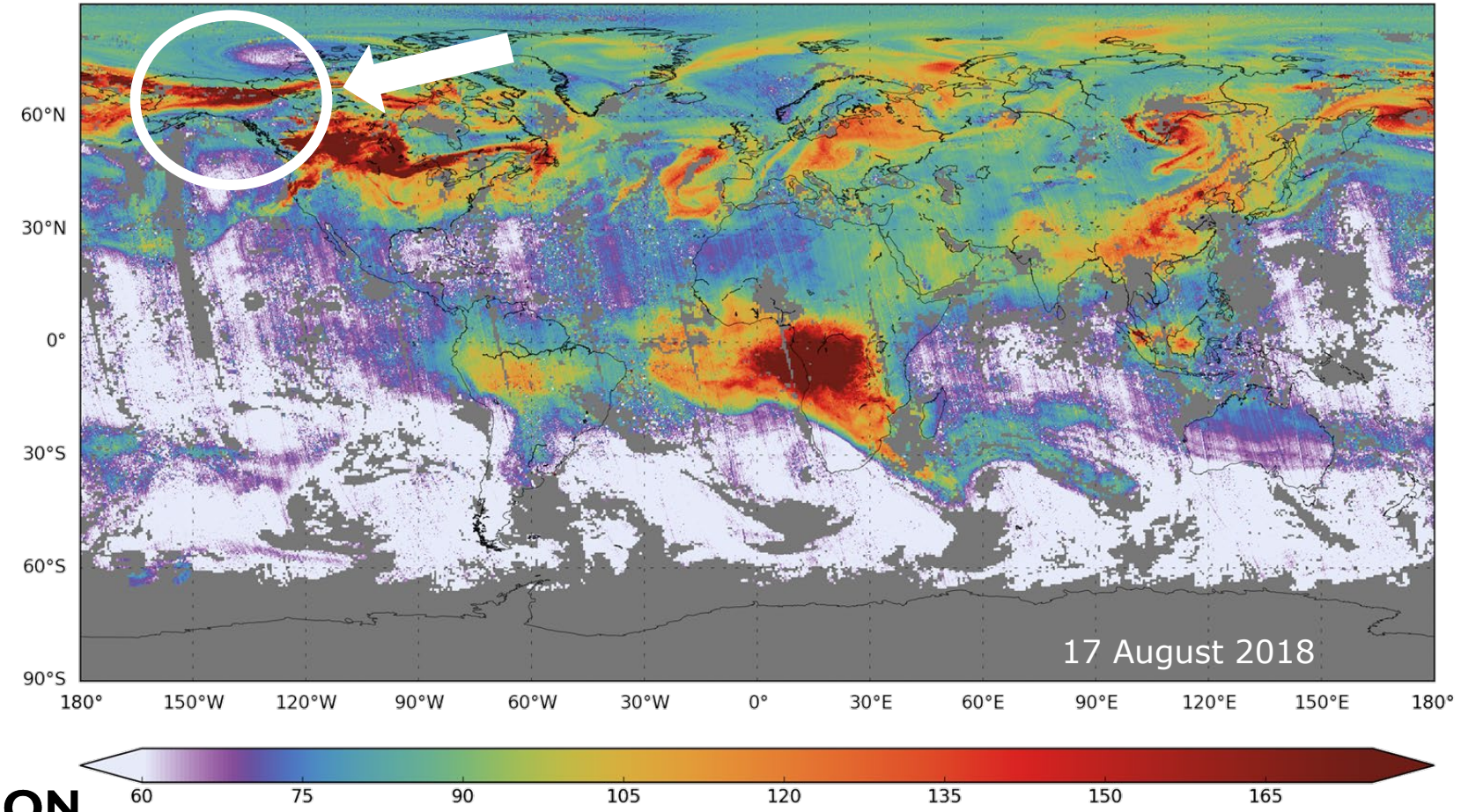
CO over Canada from Siberian wildfires



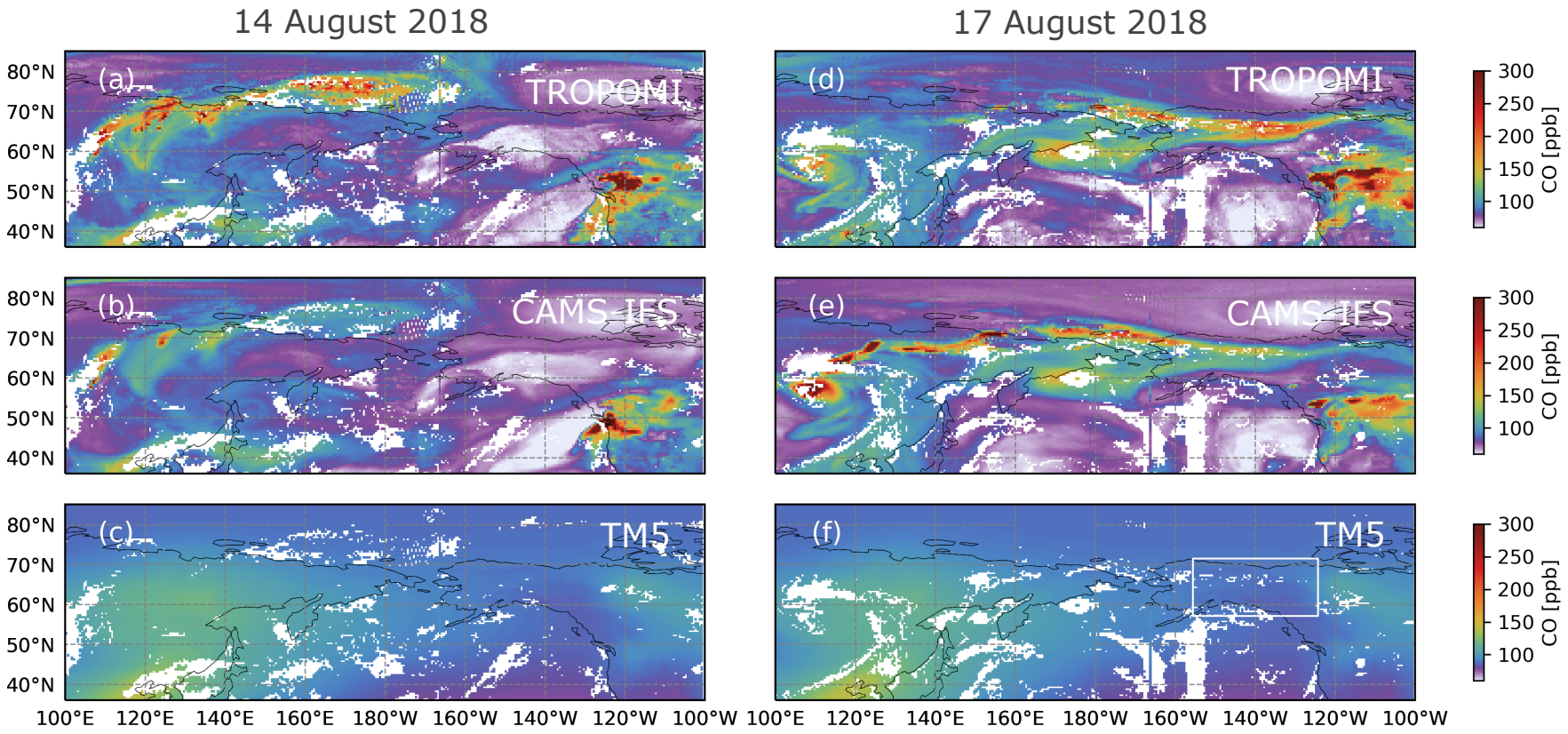
CO over Canada from Siberian wildfires



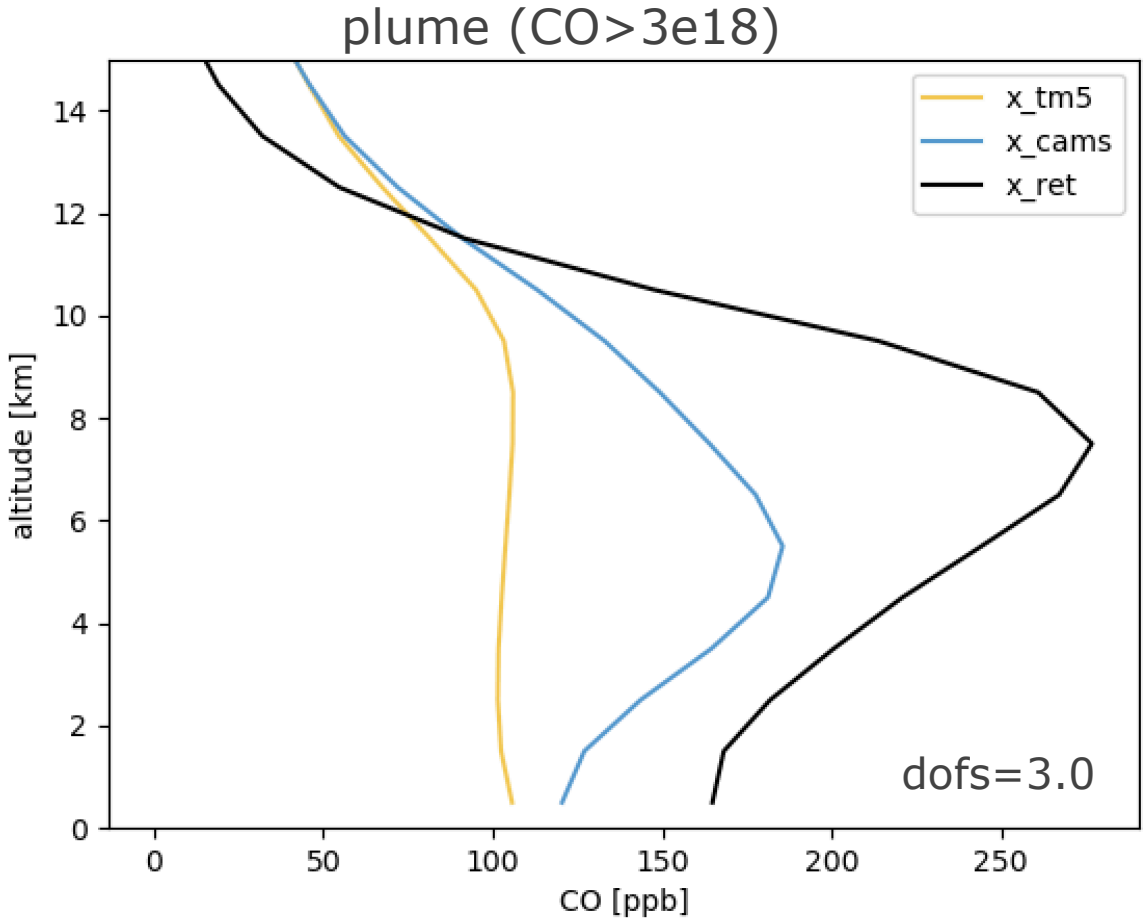
CO over Canada from Siberian wildfires



CO over Canada from Siberian wildfires

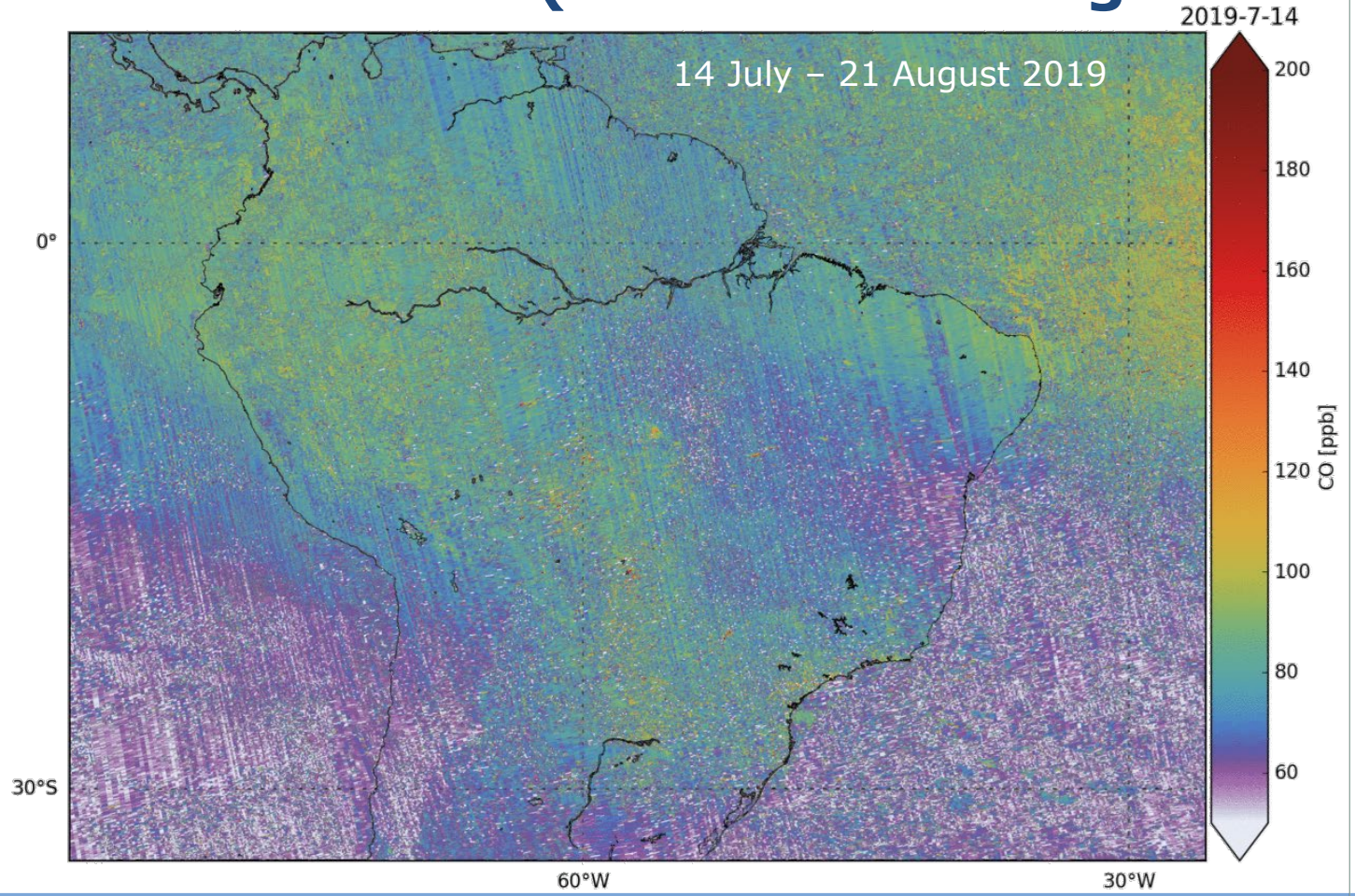


CO over Canada from Siberian wildfires



Mean CO Profile
17 August 2018

CO over the Amazon (biomass burning season)

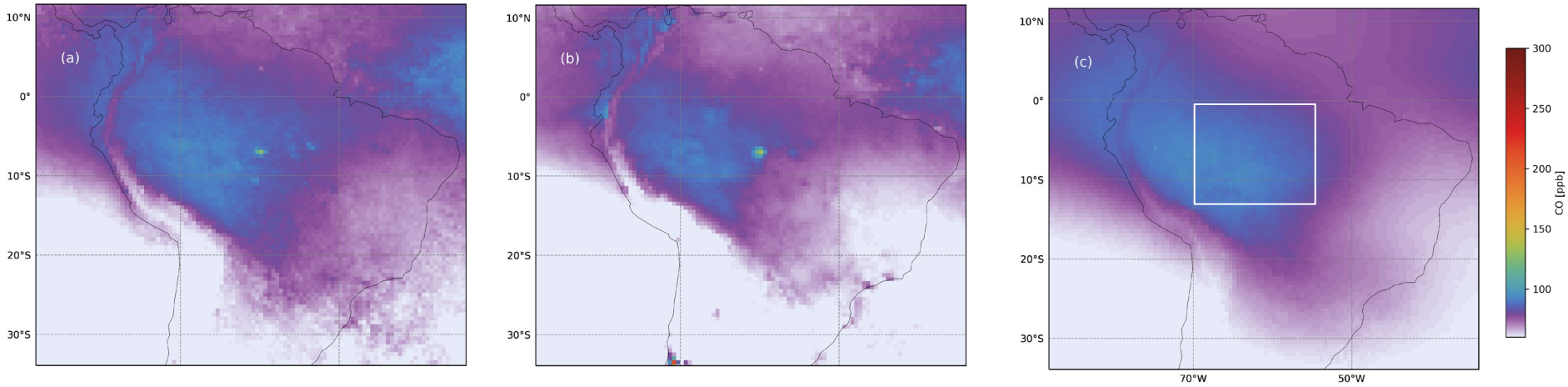


CO over the Amazon (before the burning season)

TROPOMI CO

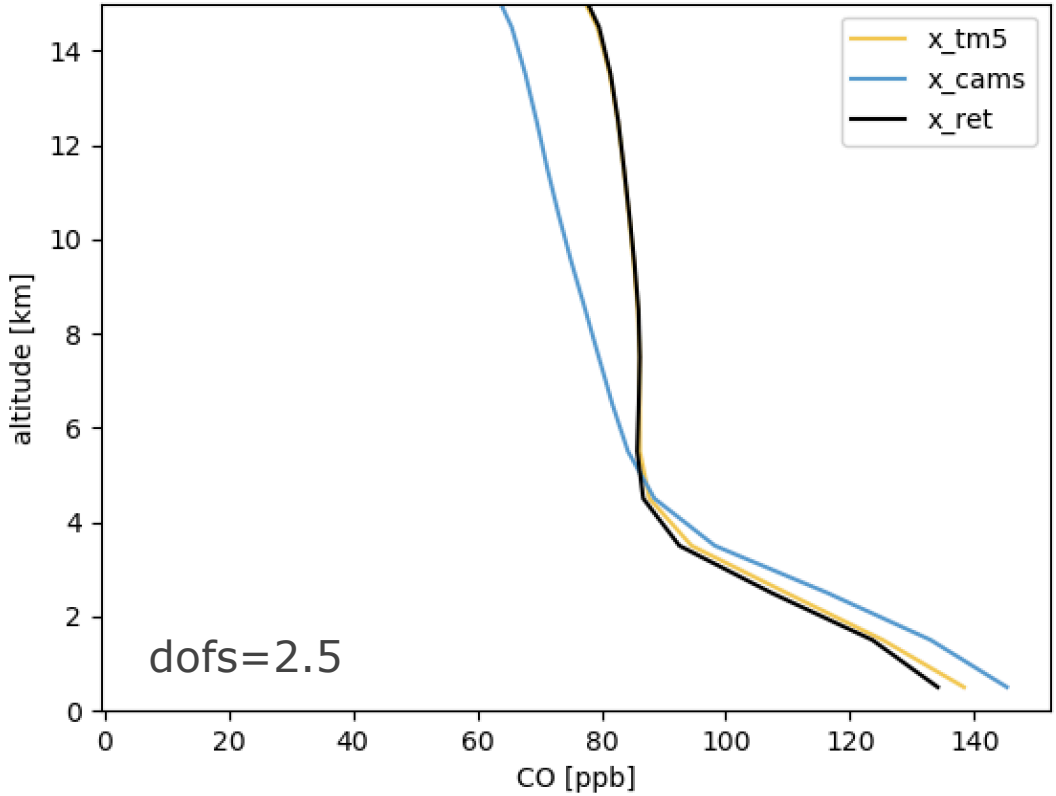
CAMS-IFS

TM5 (a priori)



Average CO: 16 July – 1 August 2019

CO over the Amazon (before the burning season)



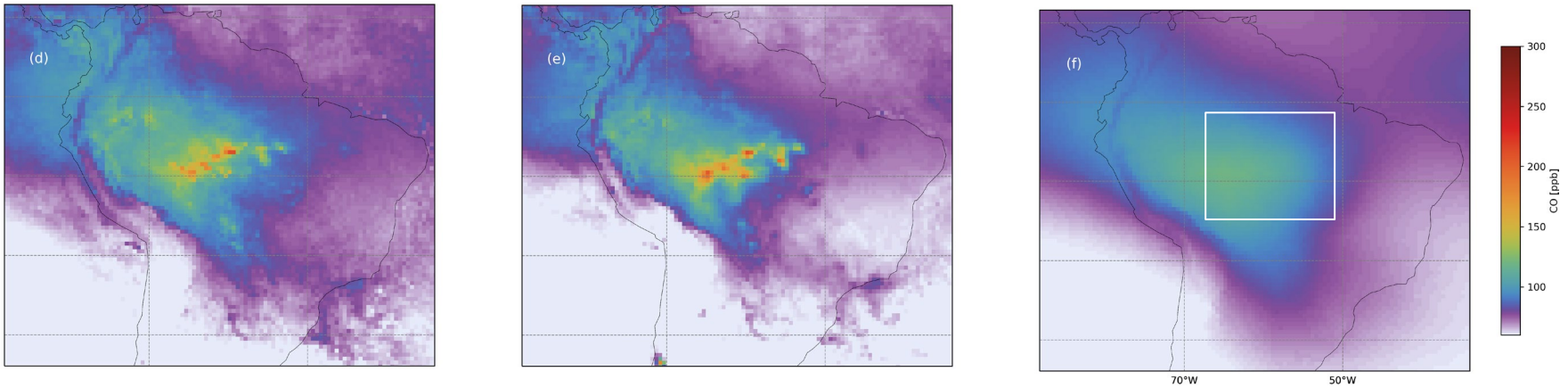
Mean CO profile:
16 July – 1 August 2019

CO over the Amazon (during the burning season)

TROPOMI CO

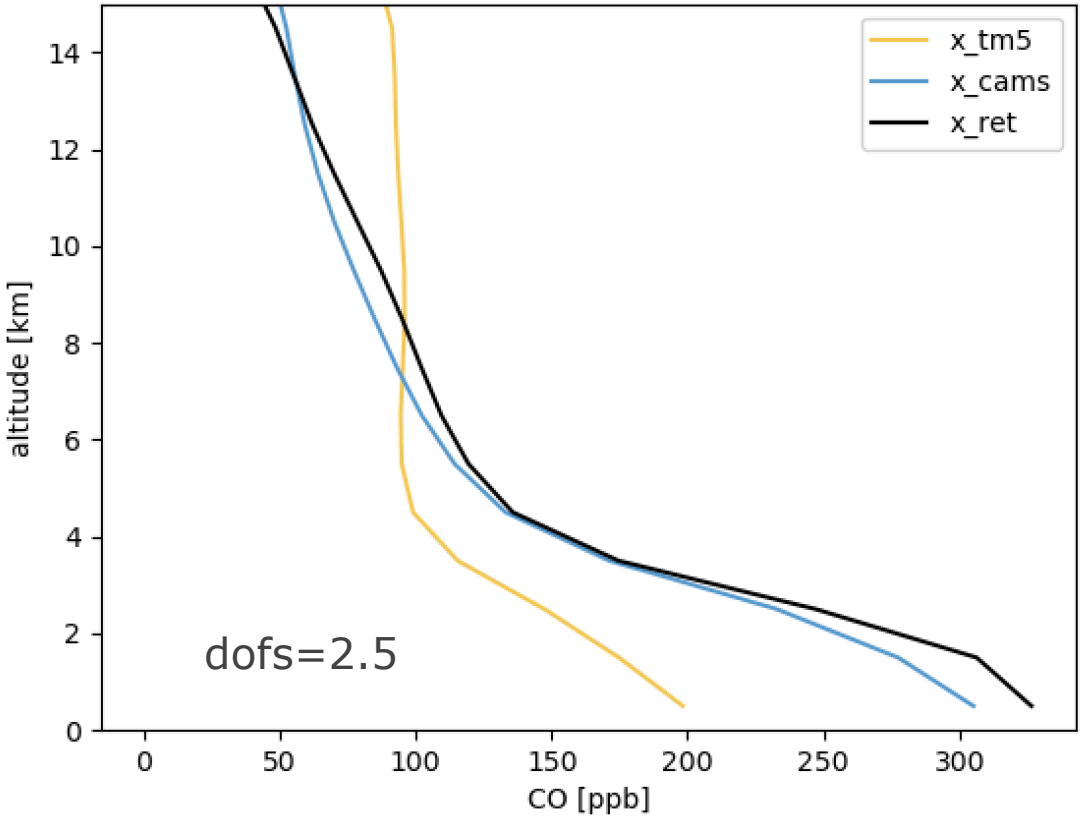
CAMS-IFS

TM5 (a priori)



Average CO: 1 August – 15 August 2019

CO over the Amazon (during the burning season)



Mean CO profile:
1 – 15 August 2019

Summary and Conclusions

- TROPOMI CO resolves individual pollution plumes not reflected by CAMS-IFS (e.g “Rabbit Foot Fire”, Idaho 2018).

- TROPOMI CO can help to improve quantification of CO emissions (e.g. wildfires in Siberia 2018).

- Assimilating TROPOMI CO together with the Averaging Kernels will provide vertical information about CO.