NO_x emission factors from GOME-2 measurements for the major types of open biomass burning

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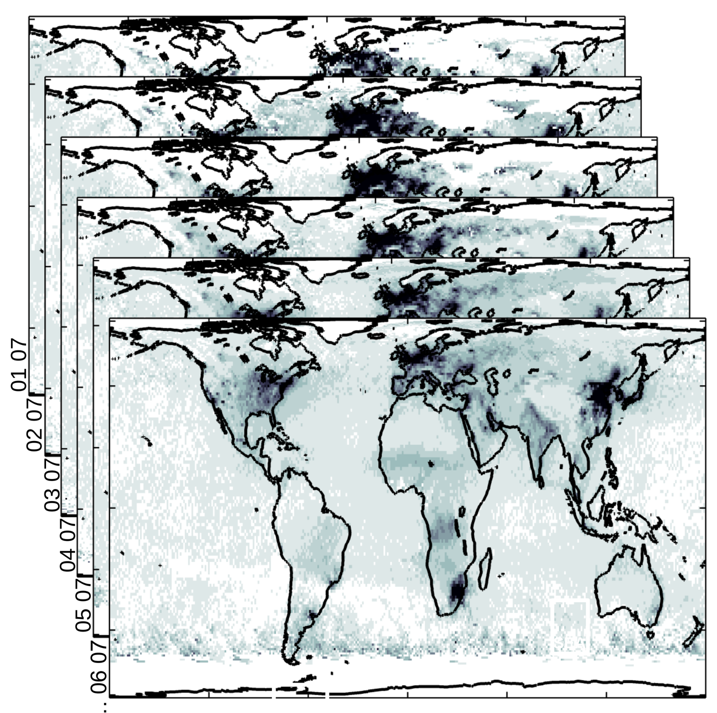
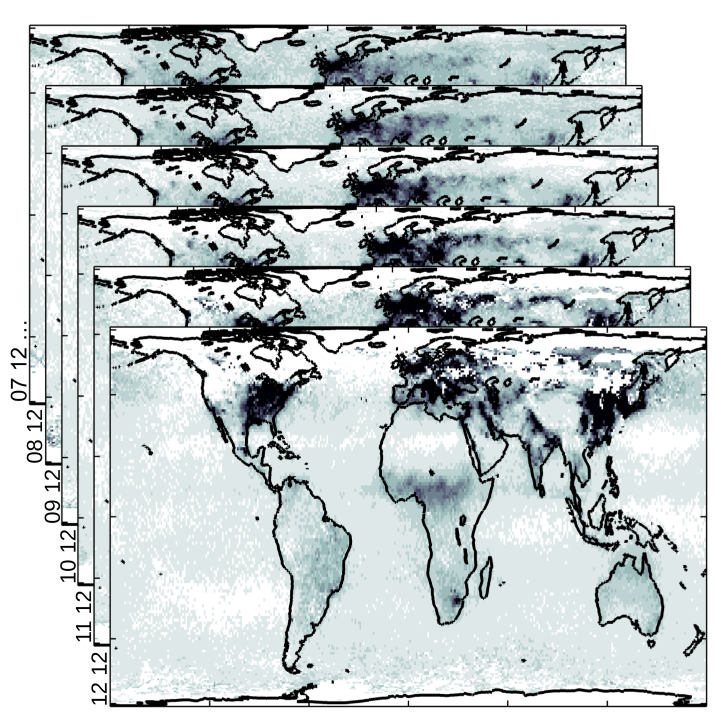
1 Data analysis

Tropospheric NO_2 vertical columns (**TVC NO_2**) in [10^{15} molecules cm^{-2}] from GOME-2 on board MetOp-A
1° x 1° horizontal grid
monthly means (2007-2012)
NO_2 retrieval is based on the DOAS technique

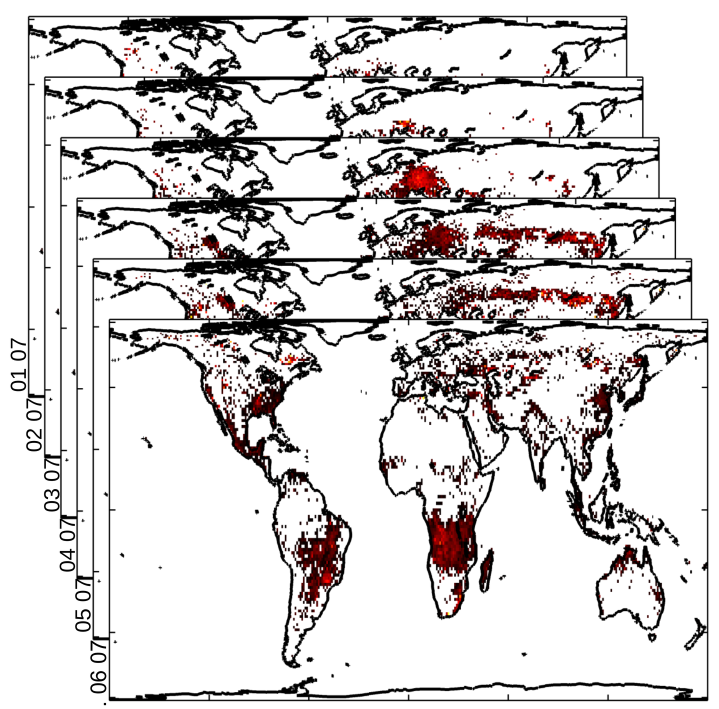
Fire radiative power (**FRP**) in [mW m^{-2}] from MODIS on board Terra
1° x 1° horizontal grid
monthly means (2007-2012)
FRP retrieval is based on Stefan-Boltzmann law



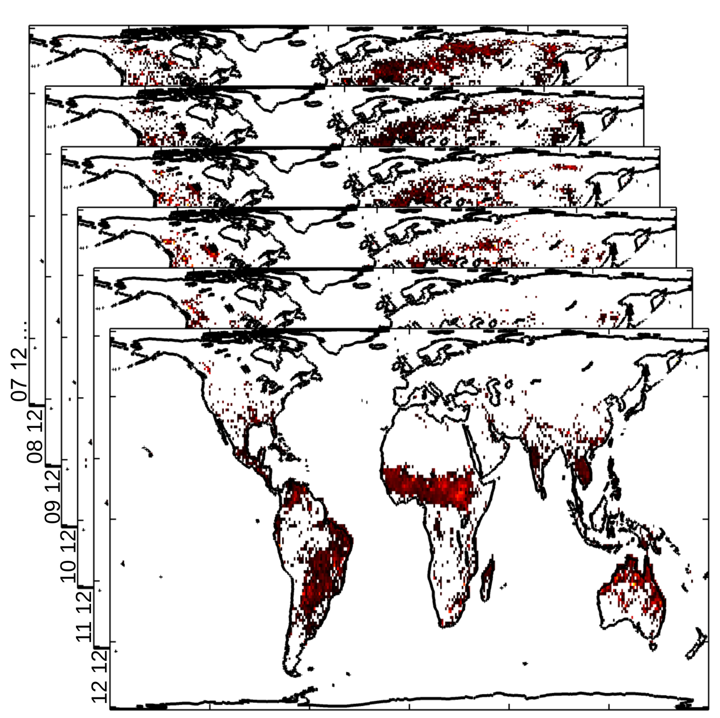
gridded GOME-2 TVC NO_2 data (1° x 1°)
01/2007 – 12/2012



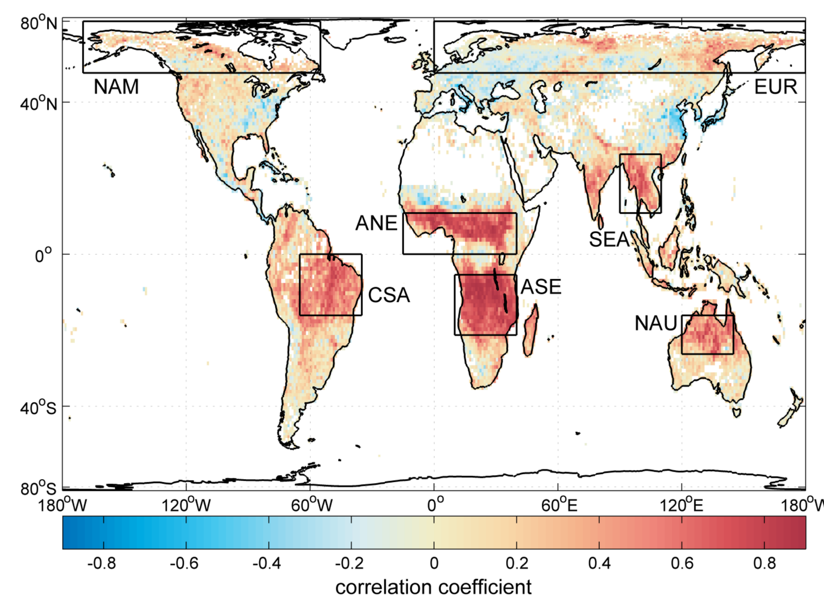
Linear relationship between TVC NO_2 (from GOME-2) and FRP (from MODIS)

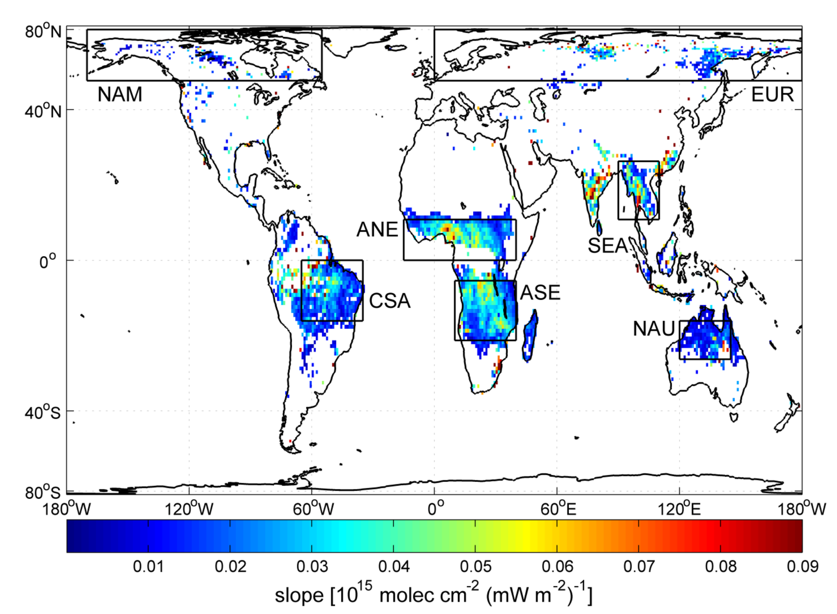


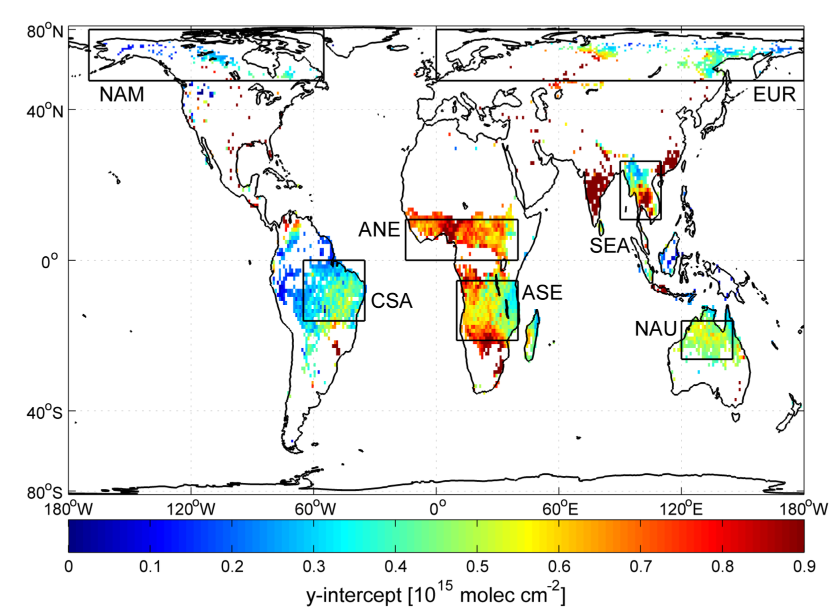
gridded MODIS FRP data (1° x 1°)
01/2007 – 12/2012
(ftp://neespi.gsfc.nasa.gov/data/s4pa/Fire/)



2 Regression coefficients







Very strong linear relationship between the two time series (TVC NO_2 vs. FRP) is found for the major biomass burning regions (*upper left*).

The empirical relationship forms the basis of the approach to estimate EFs of NO_x as it is a reasonable tool to separate between different NO_x sources.

To assess NO_x from vegetation fires only, the y-intercepts (*lower right*) of the linear regression model have been subtracted from TVC NO_2.

Higher (lower) gradients indicate that lower (higher) values of FRP are necessary for reaching a specific NO_2 level (*lower left*).

3 Production rates of NO_x

Computation of TVC NO_2 from fires:

$$TVC_f[NO_2] = TVC[NO_2] - TVC_b[NO_2]$$

Computation of production rates (P_f) of NO_x

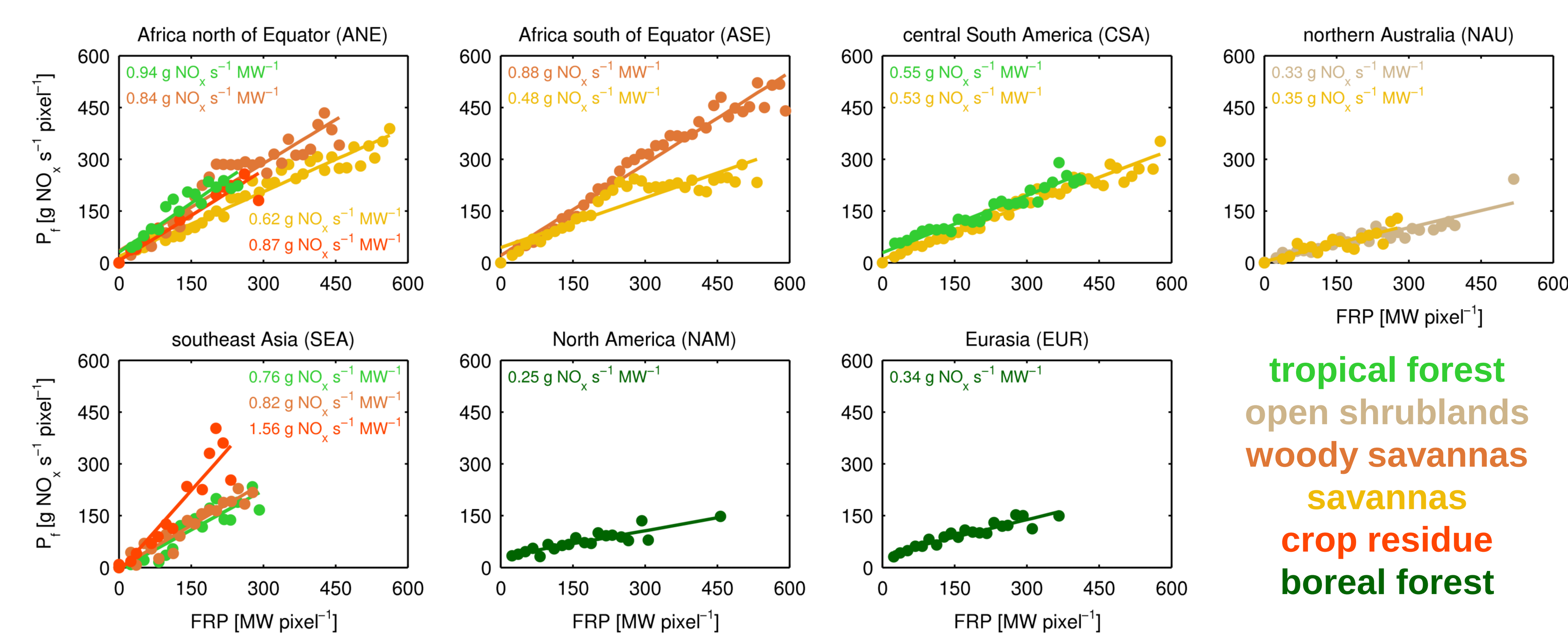
$$P_f = \frac{TVC_f[NO_2] * M \left(1 + \frac{NO}{NO_2}\right) A_p}{N_A * \tau}$$

In order to obtain the satellite-derived NO_2 amounts produced by fire (TVC_f NO_2), the background levels of tropospheric NO_2 (TVC_b NO_2) are subtracted from TVC NO_2.

As chemical models typically require values for the amount of NO_x being released as a function of time, we estimate the monthly mean top-down production rate of NO_x from fire (P_f) for six years of GOME-2 measurements.

$TVC_f[NO_2]$	… TVC NO_2 produced from fires	$1 + NO/NO_2$	… assumed ratio (1.34)
$TVC_b[NO_2]$	… y-intercept (background NO_2)	A_p	… area of 1° x 1° pixel
P_f	… production rates of NO_x from fire	N_A	… Avogadro's number
M	… molar mass of NO	τ	… assumed NO_x lifetime (6 h)

4 Fire emission rates of NO_x

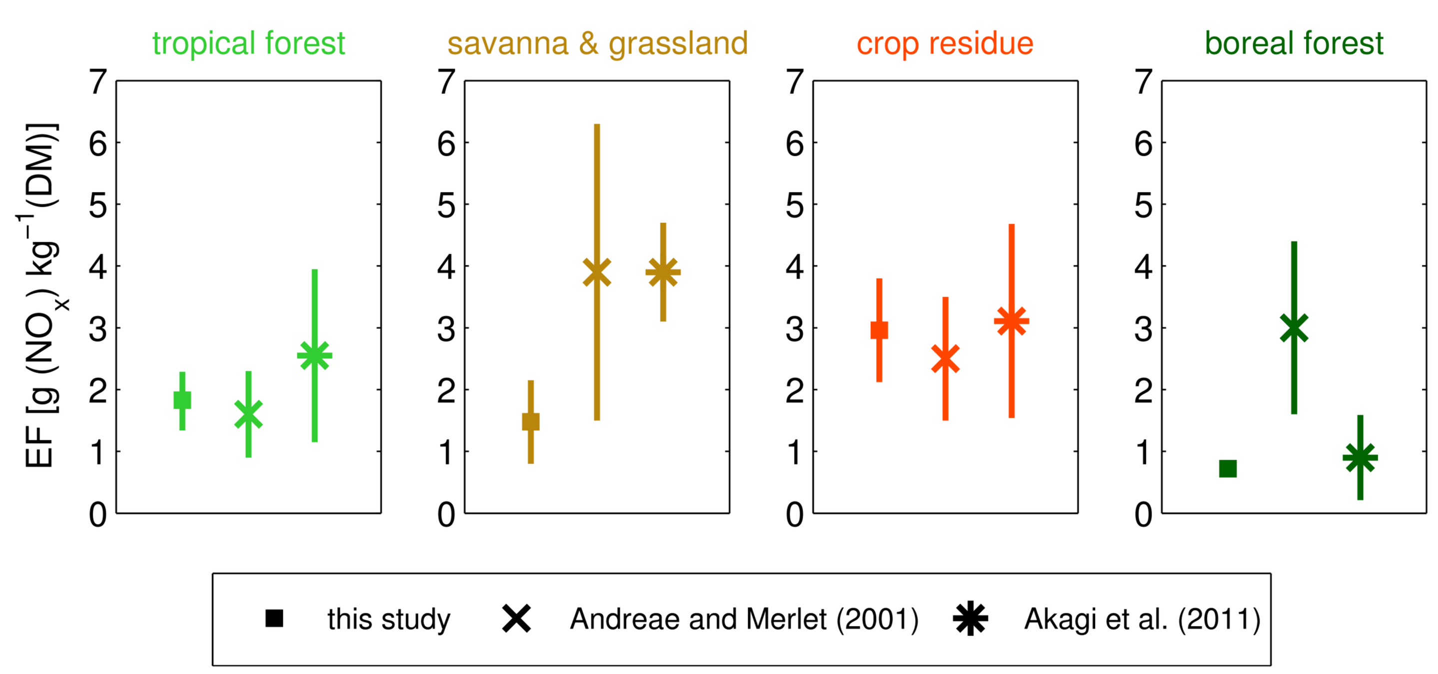


The best fitting least-squares regression lines between P_f and FRP, here referred to as fire emission rates (FERs) of NO_x, are computed for the dominating land cover types within the selected regions. Here, the UMD classification scheme has been selected.

Lower values of FERs are observed for boreal forest, open shrublands, and savannas and higher values are found for tropical forest, woody savannas, and crop residue.

For the computation and comparison of EFs, open shrublands, woody savannas, and savannas are aggregated to savanna and grassland.

5 Emission factors of NO_x



The figure provides the arithmetic means of EFs as obtained from satellite data as well as arithmetic means of EFs reported in the literature.

The error bars denote one standard deviation of the arithmetic mean in the literature and indicate the minimum and maximum values for the different regions in this study.

The conversion of FERs into EFs is based on a constant conversion factor of 0.41 kg MJ^{-1}.

6 Summary and Conclusion

The emission factors (EFs) of NO_x are estimated at 1.83, 1.48, 2.96, and 0.72 g kg^{-1} for tropical forest, savanna and grassland, crop residue, and boreal forest, respectively.

We found overall agreement with the values reported in the literature.

However, the EFs for savanna and grassland obtained in this study are lower by a factor of 2.5 when compared to the literature values.

Acknowledgements

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Selected References

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