Supplement to:

The CO_2 release and Oxygen uptake from Fossil Fuel Emission Estimate (COFFEE) dataset: Effects from varying oxidative ratios

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This supplement contains:

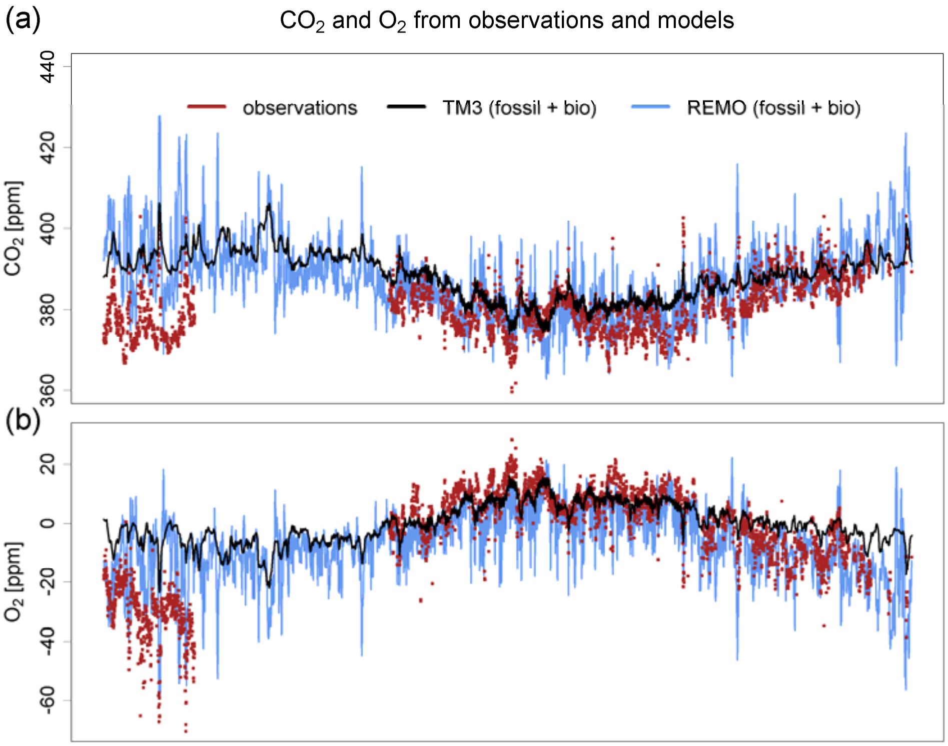
- Table 1, referring to the creation of the COFFEE dataset as described in Section 2 of the paper. The table contains an overview of EDGAR usage types and corresponding UN categories, with some information how the usage types of the two datasets were merged.

- Figure S1, referring to the model simulations in Section 4.1. The figure compares simulations from the global model TM3 and the regional model REMO to observations at the station Ochsenkopf in Germany.

EDGAR 3.2 usage type		**Corresponding UN usage type(s)**	
code	*description*	*code*	*description*
F10/ B10	Fossil fuel use/ Biofuel combustion: Industry (excluding coke ovens, refineries, etc.)	0911 0914 0924 121 084	Consumption by mining industry Consumption by biogas plants Consumption by blast furnaces Consumption by industry & construction Conversion in blast furnaces
F20/ B20	Fossil fuel use/ Biofuel combustion: Power generation (public and auto; including cogeneration)	0927 0928 088	Consumption by thermal power plants & auxiliaries Consumption by other energy producers Conversion in thermal power plants
F30	Fossil fuel use: Other transformation sector (refineries, coke ovens, gas works etc.)	0913 0921 0922 0923 0925 089	Consumption by natural gas fields & plants Consumption by coke ovens Consumption by gasworks Consumption by briquetting plants Consumption by petroleum refineries Conversion by other energy-producing plants
F40/ B40	Fossil fuel use/ Biofuel combustion: Residentials, Commercials and Other sector (RCO)	123	Consumption by households and other consumers
F51 F54 F57	Fossil fuel use: Transport (Road,Rail, Inland water, Pipeline, Non-specified, Air)	122	Consumption by transportation industry (road, rail, inland water ways, air, other)
F58	Fossil fuel use: International shipping	05	Bunkers/international shipping
F61 F62	Fossil fuel use:non energy use CO_2 / feedstocks	11	Consumption for non-energy uses
F80	Fossil fuel use: Oil production, transmission and handling, gas flaring	0912 104	Consumption by crude petroleum fields Natural gas - Flared and vented

Table 1: Overview of EDGAR 3.2 categories and their corresponding UN usage types. The "F" in the code of the EDGAR usage types indicates "Fossil fuel use". In addition, for three usage types also emissions from biomass combustion are given, these are labeled with a "B" in the usage type code (B10, B20 and B40).

The EDGAR and UN usage types were first matched according to the category/usage type description. It can be seen that in most cases the UN dataset has a more detailed separation of usage types than EDGAR, so mostly several UN usage types were aggregated to match those from EDGAR. Based on a comparison of the resulting CO_2 emissions per usage type, some adjustments in the matching were made. The table shows the matching that gave the best agreement of the two datasets on global and country level.



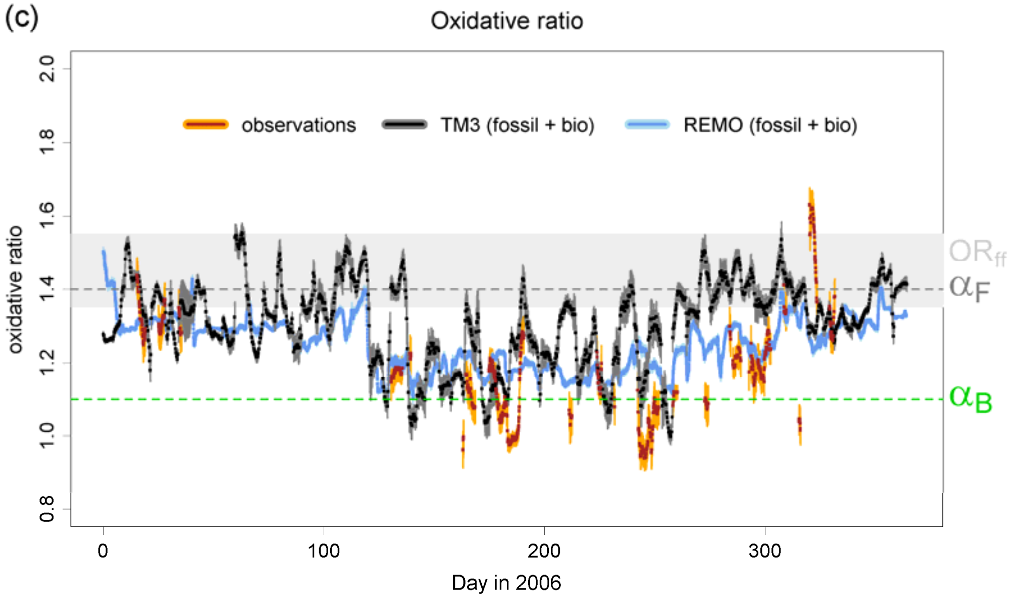


Figure S1: Comparison of observed and simulated CO_2 (a) and O_2 (b) mixing ratios and oxidative ratios (c) at the station Ochsenkopf in Germany.

This plot is an addition to Figure 5 in the paper. Figure 5 has shown the simulated fossil fuel signals and the fossil fuel related oxidative ratio OR_{ffp} at the Ochsenkopf (OXK) station, indicating the different sensitivities of the global model TM3 and the regional model REMO. As the atmospheric signal at OXK is strongly influenced by biospheric processes, model simulations also need to include the biospheric component in order to be compared to observations. Here the upper two plots show

CO_2 (a) and O_2 (b) simulations from TM3 (black) and REMO (blue), including the fossil-fuel-related and the biospheric component (the ocean component is negligible here). Observational data (courtesy of R. Thompson and the MPI-BGC tall tower group, see also (Thompson et al., 2009)) is added to the plots in brown. Plot (c) shows the oxidative ratios, derived from simulations and observations using the same 5-day running regression as used in Figure 5c. A clear seasonal cycle is seen in the CO_2 and O_2 signals as well as in the oxidative ratio. In the summer, the oxidative ratio is closer to the biospheric value (α_B =1.1*, indicated by the green line), while the fossil fuel influence dominates in the winter (the grey line shows the global average value α_F=1.4, the shaded area indicates the range of OR_{ffp} at OXK, derived from the model simulations). This seasonal variation is captured equally well by both models. However, comparing the overall signal to the fossil fuel simulations in Figure 5, it can be seen that the synoptic variability – in the CO_2 and O_2 signals themselves as well as in the oxidative ratio – is mostly dominated by biospheric signals and atmospheric dynamics rather than by fossil fuel events. The fact that the total oxidative ratio is smaller than OR_{ffp}/α_F most of the time also indicates that some biospheric influence is present all of the time, even in the winter months.

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*Note that this value is also a global average: Depending on local plant types and dominating processes, OR_{bio} can also exhibit variations that are not accounted for in the models. For discussions on this issue and the range of observed OR_{bio} see for example: Seibt et al., 2004; Sturm et al., 2006; Stephens, 2007; Popa, 2008.

References:

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