General comments:

The authors investigate CO_2 emissions from dry sediments at one site in a large German river. High frequency automatic flux measurements provide an excellent view into the temporal dynamics of CO_2 emissions. Additionally, measurements across transects provide information on spatial variability and the contribution of groundwater is assessed using Rn as a tracer. The CO_2 emissions are primarily driven by microbial respiration. Furthermore, there interesting descriptions of hysteresis and dark CO_2 uptake. The study appear thorough, methods appropriate, and results are well presented and discussed. Unfortunately, I was not able to access the supplementary material.

Thanks Kenneth for the helpful review.

Specific comments:

- I miss some explicit hypothesis. The aims (1.4) are presented in a broad sense, and test of the groundwater hypothesis is mentioned but so much more data is presented in the manuscript which is why a think specific hypothesis should be included.
  We agree. In a revised manuscript we will add a hypothesis addressing the drivers of CO_2 emissions like "if CO_2 originates from groundwater we hypothesize a low temperature dependence of CO_2 emissions.".
- How are the flux chamber data quality checked (L 103)? I think this should be described.
  When waves reached the chambers sand was washed away and in some occasions the chambers were not tight any more. This immediately led to concentration data fluctuating around atmospheric concentration which results in zero flux with low R^2 of the linear fit. Such data was discarded. We will change to: "Automatic flux chamber data were discarded when the collar was flooded or the sand was washed away by waves removed, which resulted in CO_2 concentrations fluctuating around ambient concentration".
- L 216, following the ANOVA test I would have expected something like a Tukey post hoc test adjusted for multiple comparisons and not repeated pairwise t-tests.
  Right – the Tukey test is the right choice here. We will change that in the revision.
- Regarding LME, how was model selection performed? In general, I miss some more details on the modeling procedure.
  We first tried a complete model including temperature, moisture, and thickness of the unsaturated zone as predictors. We then removed single predictors and compared R^2 values. We specify in the method section: "Linear mixed-effects models (lme) were applied to predict the influence of the environmental variables on the CO_2 flux at the study site for variables for which a linear relationship with the CO_2 flux was presumed. Model selection was done by removing predictors and comparing conditional R^2 values of different models."
- Also regarding LME, I miss a more detailed description of LME results. Currently, only the R^2 values are presented but a table (supplementary perhaps) with model coefficients etc. would be welcome.
  We will add model results incl. the AIC as a table to the supplement
- Figure 5, I had a difficult time understanding this figure. Could this alternatively be shown using lines in a CO_2 flux (y) vs distance (x) type plot. Something is also wrong

in the legend, i.e. "NA" values.

We agree that the figure is difficult to read. We will try to improve it by adding a "plant line" to the figure.

- I think the hysteresis results (L 430-43$_2$) should be presented the Results section. The hysteresis is interesting and could potentially be further elaborated in the discussion, where there any differences between sites?

The hysteresis part was indeed developing during writing of the manuscript. As the reviewer states it is now an important result. We will move the presentation of the data to the results. We had scanned the hysteresis figures for several dates. Four additional dates are already shown in the supplement (which for some reason the reviewer could not access) indicating that the general appearance of these curves was quite similar between days. We will check whether there are systematic differences between sites.

- An admittedly minor thing perhaps, but please be consistent with capitalization of axis and legend labels in all figures. Also for figure references, e.g. Figure 5 (L 304), figure S1 (L 91) and Fig. S1 b in (L 135). Please correct throughout the manuscript.

We will correct this and unify labels.

- Date formatting in tables and figures differ, e.g. month-day in figure 5 and day.month.year in table 1, at least month-day or day-month order should be consistent. Please correct throughout the manuscript.

We will unify this to mm-dd.

Technical comments:

L28 Replace "largely" with "greatly" or other.
Will be replaced.

L55-57 Awkward sentence, please rephrase.
We will reformulate to: "Investigating temporal variability of CO_2 fluxes should provide information about the potential sources of emitted CO_2. Knowing sources of emitted CO_2 from dry sediments is crucial to be able to model or scale up GHG emissions from these systems."

L64 Is something missing e.g. "In contrast to respiration"? Please rephrase.
We rephrase to: "In contrast to respiration, abiotic processes are rarely taken into account as sources of CO_2 (Rey 2015)".

L71 Replace over-saturated with super-saturated
Will be replaced.

L131 Replace "manual" with "Manual"
Will be replaced.

L186-188 and $_2$3$_2$-$_2$34 Same paragraph occurring twice
Sorry. L232-234 will be deleted.

L230 regard log-transformation, there are also negative fluxes how were they treated.
We shifted all fluxes to positive values by adding 121 mmol m^{-2} d^{-1},(120 was is the value of the largest negative flux).

L242 +/- what – standard error? Please write.
Standard Deviation. We will specify that in the method section.

L243 Replace "Mai" with "May"
Will be replaced.

L260 Just write LOESS smoother with span 0.1. The gray confidence region around the smoothers are confidence intervals or standard errors? And not SD?
Will be changed. The gray area is the confidence interval – will be specified in the legend.

L262 What is "HF" in title?
Its "High Frequency". Will be removed.

L266 Details regarding modelling, e.g. chamber as a random effect should be in methods.
We think if we do not list the predictors here it will be difficult for the reader to figure out about what model we are talking. We would prefer keeping it as it is.

L267 What are the R^2 values for the mixed models? Often they are conditional/marginal depending on whether they include random effects or not.
We used the conditional R^2 which includes random effects. This information will be added to the methods section.

L291 Replace "spatial" with "Spatial"
Will be replaced.

L306 Awkward sentence, please rephrase.
Will be rephrased to: "In sum, our field based measurements provide strong evidence that respiration in the sediment was the major driver of the observed CO_2 flux.".

L318 Description of texture method should be in Methods.
Will be moved to Methods.

L550 "Short term temporal dynamics" Maybe replace "dynamics" with "variation"?
We agree. Will be replaced.