Response to the revised manuscript by Urbanek and Doerr – CO2 efflux from soils with seasonal water repellency.

With the responses to the referees, the authors have greatly improved the manuscript. The only issue that has, in my opinion, not been sufficiently addressed is the display of Fig. 4. I still find it very hard to see which dots belong to bare soil and which ones belong to vegetated soils. This makes it a bit hard to believe the statistics presented in table 2. Additionally, the grammar of the manuscript needs improvement (please see comments below).

Title: now to me is a bit meaningless as it does not state what to expect, although it is correct.

P1L8: "causes reduced" -> reduces
P1L10: add commas: dynamics, and specifically on CO2 efflux, have
P1L14: Soil CO2 efflux. We conducted in situ field based measurements which were carried out… (though, in situ could be deleted as field measurements are already in situ)
P1L19: suggest to replace diminished -> reduced
P1L21/22: … with different characteristics related to CO2 production and transport.

P2L18: 2016), but also (insert comma)
P2L21: Why not say "Most soils are very …"

P3L3: "offered" seems the wrong word. What about "created by"?
P3L4/5: sentence grammar needs correcting: "Irregular water infiltration in water-repellent soil often creates distinct zones with water filled pores, concentrated dissolved organic C and …" (remove comma, remove "a", use C instead of carbon"

P3L8: hydrophobic particle-surfaces; or is it possible just to say hydrophobic surfaces?
P3L9: simplify sentence: "has been reported to reduce soil microbial…"
P3L11: food and water sources (plural)
P3L13: soil organic matter (SOM)
P3L14: add comma: "water-repellent state, and…"
P3L18: soil respiration (i.e. CO2 efflux) – I think you should either introduce this before (e.g. when you first use the term soil respiration, or delete "(i.e. CO2 efflux)"
P3L19: remove however
P3L20/21: simplify to: "The aim of the current study is to investigate soil CO2 efflux responses…". To the reader it is already clear that the novelty of the study is that you explore something that has not yet been done. You emphasise this with the paragraph before. No reason to overdo it (In my opinion).
Also, as mentioned before, in-situ is field. In line P1L14 you write in-situ without hyphen -> decide which one to use if you feel the word is necessary.
P3L22: consider changing "real world" to "natural"

P4L4: six study plots
P4L6: When is the growing season? Could you add this information in brackets? -> e.g. growing seasons (Apr-Aug)
P4L7: Suggest splitting the sentence: "… years (2013-2015). SWC, temperature, CO2 efflux and SWR was measured in approximately monthly intervals."
P4L9: change vegetation plot -> study plot (to be the same as in the figure caption. Additionally, it is clearer because you have two vegetation types.
P4L9-11: for clarity consider the following:

Both study sites consisted of six plots with two PVC collars for CO2 efflux measurements (n=12) arranged along a 20-m transect (Fig. 1). Grass and bracken vegetation was covered equally. At each study plot, soil respiration was measured on vegetated soil and on bare soil respectively. Bare soil measurements were conducted on soil collars from which the vegetation and litter layer inside the collar was temporarily removed for the duration of the CO_2 efflux measurement to assess the contribution of different layers to total soil respiration, and put back after the measurement. The sites were monitored during the growing seasons in three consecutive years (2013-2015), involving continuous measurement of SWC and soil temperature, and recording of CO_2 efflux and persistence of SWR during site visits at approximately monthly intervals.

Also, you repeat part of this information on P8. Chose one place and remove in the other.

P4L15: "C and N" – you have not yet specified that N = nitrogen

P5L2: sites (plural)
P5L3: 20-m (insert hyphen as in text)
P5L5: from your explanation to the referee comments, it is clear what you did. I suggest to change "bare soil with vegetation temporarily removed" to "vegetation temporarily removed for soil CO2 efflux measurements = bare soil"

P6L2/3: it is not obvious to me why the abbreviation of the sites need a "T" – why not call it Grass and Forest instead? Which would make distinguishing the sites when reading the paper much clearer.
P6L6: since 1995 -> I assume the network was established in 1995 and is running since 1995. Choses either or.
P6L9: "site was converted"
P6L10: for simplification consider: "The dominant vegetation cover and soil level was similar for both sites with large areas…"
P6L12: "was also present"

P7: Add to the Table header that T-f is forest and T-g is grassland. I'd suggest to move the information "(mean (st.dev))" that is currently in the table to the Figure header. Although you say see main text for more information, it seems useful to know that the SD for each was calculated for n=6

P8L2: information in brackets could be removed i.e. (twelve per study site)
P8L2: For simplification consider: … were inserted into the soil for CO2 efflux measurements.
P8L6-8: this is a nice description, but repeated (P4L8-12) – I personally find this description better.
P8L9: CO2 efflux was…
P812/13: "… exponential function to the accumulation of CO2 over time..."
P8L14: was below 0.95"
P8L16 "5 cm deep"
P8L16/17: … at 5 and 10 cm depth was conducted at both study sites/all plots…" – something seems wrong with the sentence, please check. Please specify if measurements were conducted at each plot (n=6 per site) or at each site (n=2 in total)

P9L2: "at constant temperature (xx oC) for 24 hr"
P9L4: add what WDPT means
P9L7: should <5 be <6?
P9L10: remove "essentially"
P9L12: "diverse soil water distributions." (plural)
P9L15: N – should be defined earlier
P9L18: "using gas chromatography" – remove the

P9L18: I assume that C:N ratios were not calculated based on peak areas but based on elemental composition?

P9L23: "narrow range (e.g. …)" – remove values

P10L2: removed analysed

P10L3: ANOVA and post hoc test were used (plural)

P10L10: summers (plural)

P10L13: temperatures (plural)

P10L14 suggest to remove "environment"

P10L15: suggest: … at 5 cm depth at the T-g and T-f site, respectively

P10L18: water content in the top soil… than lower down in the soil profile, while…

P11L4 (Figure heading) you mention soil temperature before moisture although it is located on the second axis. It would be more intuitive to change it around

P11L5: this is the first time that you call it "Thetford-forest" (and grassland) – consider introducing it in the method section.

P12L2: Suggestion to change the structure slightly and split the sentence into two: "At least some degree of SWR occurred during the summer months… followed by increased soil wettability in the colder… at both sites (Fig. 3). However, SWR patterns varied from…"

P12L4: 2015, when (insert comma)

P12L5: WDPT > 6 : would this be above 5? When looking at Fig. 3, the green colour has a range of 6-10.

P12L6: while the other seasons

P12L11: exhibiting the full range

P12L12: the WDPTs corresponded (it is times, right?, there are no time values) (also in P12L16); similar in P12L13 – suggest to call it SWCs

P12L16: Thus, soil at the T-f site… (spelling it out makes it easier to follow)

P12L17: occurrences (plural)

P12L17: samples remaining water-repellent: do you mean "being water repellent? The word "remaining" seems wrong. Please check that the sentence says what you want to say.

P13 Figure caption: please spell out SWR and WDPT. Is it really SWR persistence or is it SWR? Suggestion: SWR measured by water drop penetration time (WDPT) for the topsoil 0-9 cm. Frequency distribution of WDPT ranges for 120 measurements per sampling date."; in Figure: blue range should be <6?

P14L3: lowest CO_2 effluxes were … (plural); same in P14L4

P14L4: suggest: variability in CO_2 efflux rates between samples.

P14L5/6: Bare soil plots showed signi. lower CO_2 efflux… - I cannot see this in the plot but the statistic is clear. However, I think I would rephrase that sentence to saying that vegetation plots in T-f showed significantly higher CO_2 efflux than bare soil. My line of thinking is that vegetation will add to CO_2 efflux by its presence and bare soil is the baseline.

P14L8: Why is it 10 or 12 oC? Is it for each of the sites?

P14L10: "…grassland site (T=g), a reduction in CO2…" - add "site" and remove "however"; Also, define what is "former".

P14L12: total variation in (singular)

P14L12: why not just saying: "by considering soil temperature and moisture together…"

P14L14: and can lead to

P14L15: reduced again at high SWCs. (not SWC values)

P14L15: what is a very limited effect? Remove "very"

P14L18: improved the explanation

P15 Figure legend: vegetated (filled circles, grass and bracken plots combined, n=6); The explanation at the end "with both bracken and grass plots" added at the end is rather confusing. In general, to me, the visibility of information shown in the figure has not improved from the last version. Figure 5a shows the point you want to make (summer-higher temperatures-higher CO_2, winter-lower temperatures-less CO_2 efflux) much better in my opinion.

P16: say that SWC is soil water content and SWR is soil water repellency. Though, is SWR not the frequency distribution of WDPT ranges? (You explain what you did in P19L4/5 – it might be worth adding this to the Figure or add to the methods section) P15L5: SWC – move up to L2; L5 and L7: change fluxes to effluxes.

P18 Table header: CO_2 effluxes

P19L1: section 3.2 uses SWR – be consistent
P19L2/3: "and at the site it was observed at higher soil temperatures and lower SWC" – I don't understand what you want to say. Please clarify.
P19L6: represents soil (use present past), same for denoted -> denotes; also next line
P19L12: around -> between
P19L15: consider: events -> dates/time points

P20L6: grassland revealed (remove comma)
P20L11: considered to be a state most susceptible…
P20L17: consider: pinpointed -> determined
P20L17: "in this study within each year" - remove "within each year" as it is not relevant as it was not determined in any of the years.
P20L20: entire warmer periods – suggest to remove "entire"
P20L21: soil at the site – do you mean sites (plural) or one of the sites (if so, specify which one)?
P20L25: throughout what? Suggest to remove "throughout"
P20L26: soil areas – what are the areas? Do you mean between plots? Or depths?

P21L3: and the partial
P21L3/4: was likely a consequence of
P21L3-5: sentence starting with "The high spatial variability…" The sentence does not makes sense to me. Please check and it says what you want to say.
P21L7: anticipate: I think it's the wrong word. Consider believe/assume/suppose or similar
P21L10: had a lower soil (insert a)
P21L11: lower water-repellent soil was moist
P21L13: have been not only deficient (remove one been)
P21L15: and dissolved organic C is expected in wetter zones.
P21L19: be also responsible -> remove also
P21L19: soil respiration and C fluxes – which other C flux then soil respiration have you measured? Remove one of the terms.
P21L20: Thus, no (add comma) – but better use: Therefore, no…
P21L22: than measurements during the warmer (add measurements)
P21L24: seasonal fluctuation of CO_2 efflux - ? if so, please add, if not, then please add
P21L25: "it is clear that the latter constitute the main factor affecting soil respiration" – firstly, it should say "constitutes", secondly, it is not "clear" but it is likely that temperature drives soil respiration to a certain level. Please rephrase.

P22L5/6: specify if a maximum level of CO2 efflux or temperature was reached;
P22L6: when soil CO2 efflux was (singular) or CO2 effluxes were (plural)
P22L8: was the restricting factor for soil CO2 efflux.
P22L9: measurements of low,…
P22L11: (Or et al. 2007), and (insert comma)
P22L12: cause of a decrease in CO2 efflux, primarily
P22L14: soil CO2 efflux (singular) – until now, you always used the singular
P22L15: efflux was (singular)
P22L15: changing SWC, particularly at high soil temperatures (Fig. 5b), and the …
P22L16: high, especially at intermediate SWCs.
P22L18: variable, most
P22L18/19: in a heterogeneous soil moisture distribution. – what is "very heterogeneous, there is a maximum; also, it should be a heterogeneous distributions or heterogeneous distributions)
P22L19: to the development
P22L20: by the presence
P22L25: wide range of scenarios – scenarios of what? I assume ranges of SWR? But its not really clear

P23L1: WDPts … not allow the identification of
P23L3: and the proportion
P23L5: your (a), (b) and (c) would be better used if they were the same as in Fig. 6.
P23L5/6: suggestion: when soil is neither dominated by wettable nor water repellent soil patches…
P23L10: when, due to frequent rainfall, SWR disappeared
P23L10: occasions, low
P23L13: SWR distributions
P23L14: and soil moisture was low.
P23L14: suggest to delete "In the latter case" – the sentence is easier to understand without it
P23L16: similar highly water-repellent soil
P23L17: Owing to -> Due to
P23L18: it ceases -> activity ceases
P23L21: and, this thickness

P24L2: suggest: in the UK in the future
P24L3: during the rewetting
P24L4: Muhr et al who observed a slower – deleted "observed" later in the sentence; that could have been caused by SWR
P24L5: distributions (plural)
P24L5/6: when SWR, and … distribution, was (add commas)
P24L7: which creates
P24L8: "have" – suggest to exchange for provide/contain
P24L8: paths, are
P24L11/12: and the atmosphere
P24L13: this is likely (add is) – but, what's the name of the most common soil condition – replace this by… I guess variably water-repellent soils" (?)
P24L16: suggest to remove "therefore"
P24L17: suggest to replace real world -> natural, field conditions
P24L18: suggest to remove "and its effects are clearly more complex as discussed below" – below is not a great deal of discussion that would (in my opinion) justify this part of the sentence. You more related to points you have already discussed above.
P24L21: should it be particles (plural)?
P24L24: Fig. 6

P24L24: "sufficiently simple to be fundamentally applicable" – it is correct but really hard to read. Consider something simpler. (I would remove the word "fundamentally").

P25L2: this scenario: replace with "SWR"

P27L2: soil respiration, and
P27L3: lead to (singular)
P27L4: exhibit -> suggest to use showed (past tense in any case)
P27L4: which are also (plural)
P27L8: water-repellent soils.
P27L10: remove throughout, or make clear what it relates to

P27L10: soil CO2 effluxes (plural)
P27L11: SWR distribution resulted (remove comma and use past tense)
P27L14: low, or when there was; there was a high; in general, reconsider sentence starting "A wettable soil state…" something is not quite right.
P27L16: suggest to use "natural conditions instead of real world field conditions
P27L16: suggest to remove "examined for the first time here" – you already say that at the beginning of the conclusions
P27L19: soil zones, it can actually
P27L20: SWR, measurements should therefore not…
P27L20: this sentence misses a but – basically it misses your suggestion – please clarify – you probably want to combine it with the following sentence
P27L22: allow the prediction of responses of
P27L24: predictions, and (add comma)
P27L24: sentence starting with "In view of…" – it's your last sentence but it is so long that it is difficult to extract the core message of it. Suggest to split it up to make your last message easily accessible to the reader.

P28L2: foundation for the prediction of C dynamics under