Referee #3

1. The submitted manuscript describes a development of ORCHIDEE, in which several branches have been combined to better assess the global carbon cycle. As the authors state it has long been ignored that the carbon transport from land, via rivers to the ocean also plays an important role. I was developing something comparable a few years back and am very certain about the importance and high relevance of such a model enhancement.

The results are promising. But the description of the methods and the presentation of the results can be improved, e.g., there are lengthy quotes in the methods which can be reduced, or some of the table/figures in the SI should be moved to the main text for clarification and a better understanding.

Overall, I think the content of the manuscript is convincing but can be strengthened by removing unnecessary parts and moving some explaining information from the SI to the main text. I believe that the manuscript can be improved, and I recommend it for publication after major revision.

Below I list some unclear sentences, problematic points, and questions. This list is chronological and not based on the importance of the points. I was much more detailed in the methods, but think that the results/discussion section can also profit from the listed points.

Thanks a lot for your positive comments, as well as your specific suggestions and corrections below. Your comments are very helpful to improve our manuscript. We have carefully studied them and revised our manuscript accordingly. Please see our detailed responses to your comments below.

2. l.86. Is the litter also included as a part of OC input? It is mentioned a few times, but not explained or shown in Fig 1?

No, litter is not included as a part of OC input. In our model (also many other erosion models), litter is an important factor (the C-factor in MUSLE, Eq. 1) for protecting soil from being eroded.

3. Please also mention the branch names (e.g.in l. 114)

We have added the branch names. Please see “In previous studies, the leaching and fluvial transfer of DOC and the erosion-induced delivery of sediment and POC from upland soil to river network have been implemented in two different branches of the ORCHIDEE LSM (i.e. ORCHILEAK (Lauerwald et al., 2017) and ORCHIDEE-MUSLE (Zhang et al., 2020)).” (lines: 112-116)

4. An overview map of the catchments would be helpful or at least of how much of the drainage area of Europe is covered.

Our study covers all catchments in Europe. We have provided the detailed information of our study area and map of catchments in the Methods and Results section. Please see section 2.3.

5. l. 135. Is ‘bare soil’ a PFT (plant functional type)?

We have revised the this sentence to give a more accurate description. Please see “In its default configuration, ORCHIDEE represents 13 land cover types, with one for bare soil and 12 for lands covered by vegetation (eight types of forests, two types of grasslands, two types of croplands).” (lines: 134-136)

6. l. 148: Are the two litter pools part of the POC in soil? Please clarify.

The litter pools are also organic carbon pools. However, they did not contribute to the lateral POC transfer. In our model, only soil organic carbon (SOC) contributes to the lateral transfer of POC. To avoid misunderstanding, we have revised this sentence from the original “ORCHIDEE-SOM subdivides the particulate organic carbon stored in soil into two litter pools (metabolic and structural) and three SOC pools (active, slow and passive) that differ in their respective turnover times.”. to “ORCHIDEE-SOM represents two litter pools (metabolic and structural) and three SOC pools (active, slow and passive) that differ in their respective turnover times.” (lines: 148-150)

7. ll. 156-162 is a quote. Please shorten or refer right away to the cited paper.

We have shortened and reorganized the quoted contents. Please see “Adsorption and desorption of DOC follows an equilibrium distribution coefficient calculated from soil clay and pH. Free DOC can be transported with the water flux simulated by the soil hydrological module of ORCHIDEE. However, DOC adsorbed to soil minerals can neither be decomposed nor transported (Camino-Serrano et al., 2018).” (lines: 157-160)

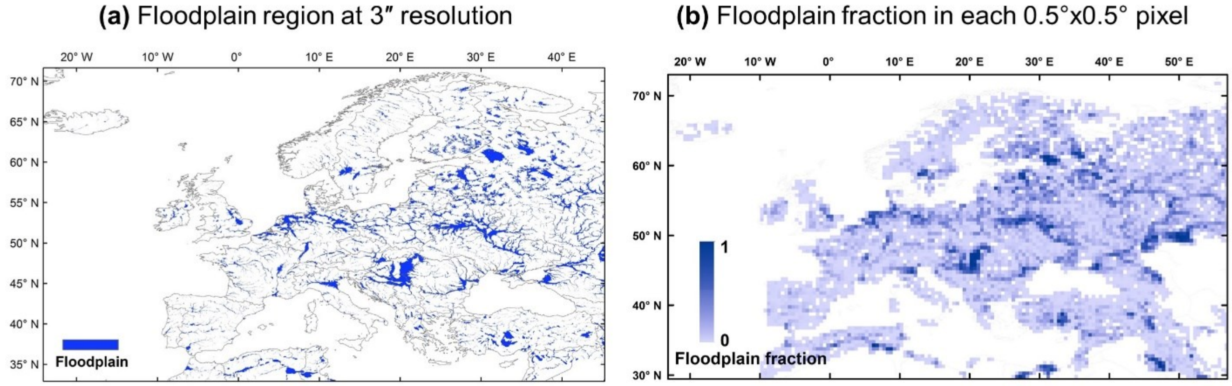
8. l. 183. How does the DOC 'enter' the water? Does it depend on vegetation cover? Please clarify.

When flooding water is infiltrated into soil, the DOC and CO_2 in flooding water will naturally enter into soil along with the infiltrating water. The infiltration rate of flooding water depends on soil properties and soil water content, but does not depend on vegetation cover. As this process is originally developed in the ORCHILEAK model and has been introduced in detail in Lauwerwald et al. (2017), we only gave a brief overview about this part of the model.

Lauerwald, R., Regnier, P., Camino-Serrano, M., Guenet, B., Guimberteau, M., Ducharne, A., Polcher, J., and Ciais, P.: ORCHILEAK (revision 3875): a new model branch to simulate carbon transfers along the terrestrial–aquatic continuum of the Amazon basin. Geosci. Model Dev., 10, 3821-3859, 2017.

9. Table 1: Is a spatial resolution of 0.5° (55km*55km max) sufficient to inform the model about the 'Area fraction of river surface'? Later it is mentioned that for the delta of the Danube the high resolution was problematic (because of gauging station data available). But is there also a problem of scale for other data? E.g. 'maximum water storage in river channel' is also only on 0.5°.

The area fractions of river surface or floodplain in each grid cell at 0.5° are derived from high-resolution (e.g. 3″ or 90 m) topographic or satellite data (see the references in the Methods) (e.g. Fig. R1 below). Thus, these area fraction data should be reliable. Indeed, there can be many different river channels in each 0.5°×0.5° pixel in reality. However, it is almost impossible for a global land surface model to explicitly simulate the riverine processes for each individual river channel. Thus we assume that there is one virtual river channel in each 0.5°×0.5° pixel (line 343). The surface area of this virtual river is the sum of all real rivers and the flow direction of this virtual is assumed to be same to the largest real river.


(a) Floodplain region at 3″ resolution

(b) Floodplain fraction in each 0.5°x0.5° pixel

Figure R1. (a) Floodplain region derived from high-resolution (3″) DEM data and (b) the floodplain fraction (0-1) in each 0.5°×0.5° pixel. Map (b) is derived from map (a).

10. l. 207. The temporal resolution of 6’’ for CO2 evasion is totally reasonable, but for the DOC decomposition it seems to be too much (as for the litter added, l. 212), also given the fact that the temperature (on which the decomposition is also depending) only changes every 3h.

- Why is there a water temperature of 28° assumed? Is this realistic?

Sorry for the mistake. Only CO_2 evasion is simulated at a time step of 6 minutes. DOC decomposition is simulated at daily time step. We have revised our manuscript accordingly. Please see “Decomposition of DOC in stream and flooding waters is calculated at daily time step based on the prescribed turnover times of labile (2 days) and refractory (80 days) DOC in waters (when temperature is 28 °C) and a temperature factor obtained from Hanson et al. (2011). CO_2 evasion in inland waters is simulated using a much finer integration time step of 6 minutes.” (lines: 205-208)

The temperature of 28° is not assumed in tour study. It is only a reference temperature at which the turnover rate of DOC was originally observed . Using a temperature-dependent function (Hanson et al., 2011), we can then calculate the turnover rate of DOC at any other temperature. For example, the DOC turnover rate ($dDOC_{Ti}$) at temperature T_i is calculated as:

$$dDOC_{Ti} = dDOC_{T28}\; 1.073^{(T_i - 28.0)}$$

where $dDOC_{T28}$ is the DOC turnover rate at 28 °C.

11. ll. 212-218. Again, a quote. Can be shortened. Is wind speed considered for the CO2 evasion?

We have shortened and reorganized the quoted contents. Please see "The CO_2 partial pressures (pCO_2) in water column is first calculated based on the temperature-dependent solubility of CO_2 and the concentration of dissolved CO_2 (Telmer and Veizer, 1999). Then the CO_2 evasion is calculated based on the gas exchange velocity, the water–air gradient in pCO_2, and the surface water area available for gas exchange (Lauerwald et al., 2017)." (lines: 208-210)

In current version of our model, the effect of wind speed on CO_2 evasion is not represented.

12. ll. 227-238. Again, a pretty long quote.

With these lines, we describe the MUSLE model used to simulate sediment delivery from uplands to river networks. As it is better to keep the equations and variable definitions identical to that used in our previous publication (Zhang et al., 2020, JAMES), we thus directly quoted the contents used in our previous paper. Actually, we have discussed this with the editor of our manuscript before. In fact, he recommended us to quote these contents.

13. l. 243 mentions a 'management factor', which is only explained in l.264.

In the original line l.243, we only give a general explanation on the definition of C_{ref} in MUSLE model (i.e. the cover management factor) (see lines 241-242 in the revised ms). In original line 264, we provided the specific method for calculating the cover and management factor (C_j) (see 262-265 in the revised ms).

14. ll. 250. It is not clear on which resolution the model runs. Some of the input is fine scale (e.g. 250m for floodplains), but then the results are aggregated to 0.5°. Please clarify.

ll. 254-258. The sentence is not understandable.

l. 268. Why only headwater?

Sorry for having not provided a detailed description on the upscaling scheme for simulating sediment and POC delivery from headwater basins to river networks, as this scheme has already been explained in detail in our previous paper by Zhang et al. (2020). The headwater basins are extracted from high-resolution (3″ (~ 90 m) in this study) DEM, and there can be many headwater basins in each 0.5° grid cell of ORCHIDEE-Clateral (Fig. S2, see below). To simulate the sediment and POC deliveries from land soils to river networks, we first extracted the headwater basins and river networks from high-resolution DEM data (Fig. S2a,d). Then the MUSLE model (Eq. 1) was applied at each headwater basin to calculate the reference net soil loss rate (Fig. S2e) under a given set of reference runoff and vegetation cover conditions. By summing up the net soil loss from all headwater basins in each grid-cell (Fig. S2e), we can calculate the total soil loss rate from land to river network under reference runoff and vegetation conditions (Eq. 3, Fig. S2f). Finally, the aggregated data of soil loss rate at 0.5° is used as a forcing file of ORCHIDEE-Clateral to calculate the actual daily soil loss rate from land to river (Eq. 4, Fig. 2g). The upscaling scheme and the method for extracting headwater basins and river networks has be introduced in detail in Zhang et al. (2020) , that is why we only give a brief overview in this manuscript.

Nonetheless, we have revised the method section of this manuscript and added a supplementary figure (i.e. Fig. S2) to give a better explanation on the method for simulating sediment delivery from uplands to the river channels. Please see "To give an accurate simulation of sediment delivery from uplands to river network and maintain computational efficiency, an upscaling scheme which integrates information from high-resolution (3″) topographic and soil erodibility data into a LSM forcing file at 0.5° spatial resolution, has been introduced (see details in Zhang et al., 2020, Fig.S2). With this upscaling scheme, the erosion-induced sediment and POC delivery from upland soils to the river network, as well as the changes in SOC profiles due to soil erosion had already been implemented in ORCHIDEE-MUSLE (Zhang et al., 2020). The sediment delivery from small headwater basins (which are basins without perennial stream and are extracted from high-resolution (e.g. 3″) digital elevation model (DEM) data, Figs. S2a&d) to the river network (i.e. gross upland soil erosion – sediment deposition within headwater basins) is simulated using the Modified Universal Soil Loss Equation model (MUSLE, Williams, 1975). As introduced in Zhang et al. (2020), "the daily sediment delivery rate from each headwater basin (S_{i_ref}, Mg day^{-1} basin^{-1}) is first calculated for a given set of reference runoff and vegetation cover conditions (Fig. S2e)" (lines: 216-227)

From Fig. S2, you can find the model is finally run at a spatial resolution of 0.5°. The headwater basins cover all upland areas, including not only the upland regions where the main streams originate, but also all upland regions where the tributary streams originate.

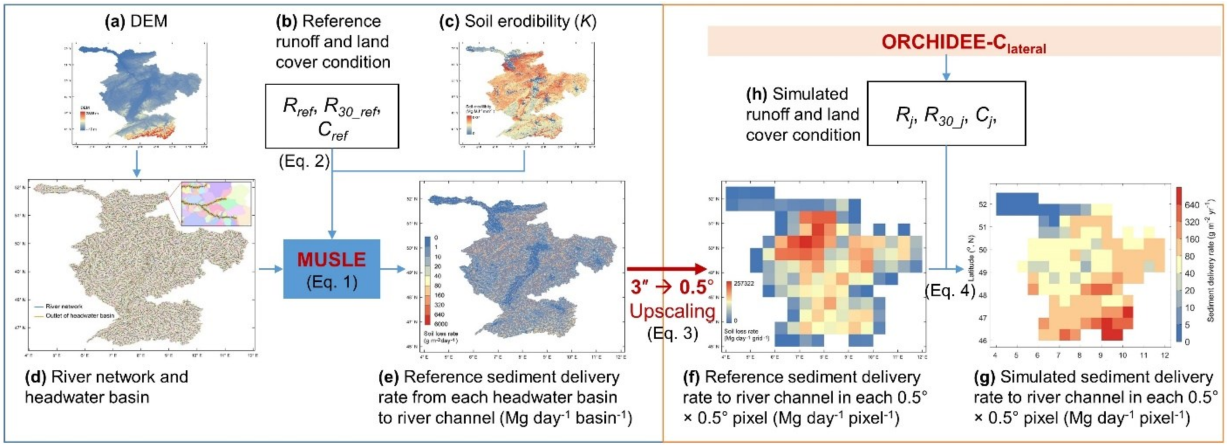


Figure S2 Upscaling scheme used in ORCHIDEE-MUSLE (Zhang et al., 2020) for calculating the sediment delivery rate from headwater basins to river networks. MUSLE is the Modified Universal Soil Loss Equation; DEM is the digital elevation model (m); *K* is the soil erodibility factor (Mg MJ-1 mm-1); R_{ref} is the assumed reference daily runoff depth (= 10 mm day^{-1}); R_{30_ref} is the assumed reference maximum 30-minutes runoff depth (= 1 mm 30-minutes^{-1}); C_{ref} (= 0.1, dimensionless) is the assumed reference cover management factor; R_j, R_{30_j} and C_j are the simulated daily total runoff depth, daily maximum 30-minutes runoff depth and daily cover management factor, respectively.

Zhang, H., Lauerwald, R., Regnier, P., Ciais, P., Yuan, W., Naipal, V., Guenet, B., Van Oost, K., and Camino-Serrano, M.: Simulating Erosion-Induced Soil and Carbon Delivery From Uplands to Rivers in a Global Land Surface Model. J. Adv. Model. Earth Syst., 12, e2020MS002121, 2020.

15. Figure 1. (I like it.) It would be helpful if the naming in part a and b would be consistent. Having the time steps mentioned in a separate box is helpful and keeps the figure clean, but it is not clear which processes belong to which group. E.g. 'deposition' - mentioned several times in the figure is not part of the 'time step' box; 'decomposition' in the time-step box consists of 'litter and SOC' but the litter can't be found in the figure. It could also be helpful to add the abbreviations from part b to part a, to make the link clearer and easier to understand. (b) is missing in the caption.

ediment transport

Thanks to your careful checking and helpful suggestion. In the time step box, we have changed the ‘erosion & fluvial transfer’ to ‘Lateral sediment & C transfers’. The erosion, leaching, transport and deposition processes are all belong to the ‘Lateral sediment & C transfers’, thus are all simulated at daily time step. We changed the original ‘Litter & SOC decomposition’ to ‘Organic C decomposition’, as we only presented the decomposition of POC and DOC in panel (a). In panel (a), we originally intend to show the main processes of lateral sediment and C transfers represented in our model. As we hope the make the readers can understand panel (a) without referring figure caption, we did not include the abbreviations in the original panel (a). In addition, panel (a) is mainly used to show the processes in real world, and panel (b) is mainly used to explain the framework used in our model (including the conceptualized C pools and C fluxes) to simulated the lateral transfers. Processes in panel (a) and (b) are not strictly same. Nonetheless, we have added some abbreviations in panel (b) to panel (a) following your suggestion. The revised Fig. 1 is shown below.

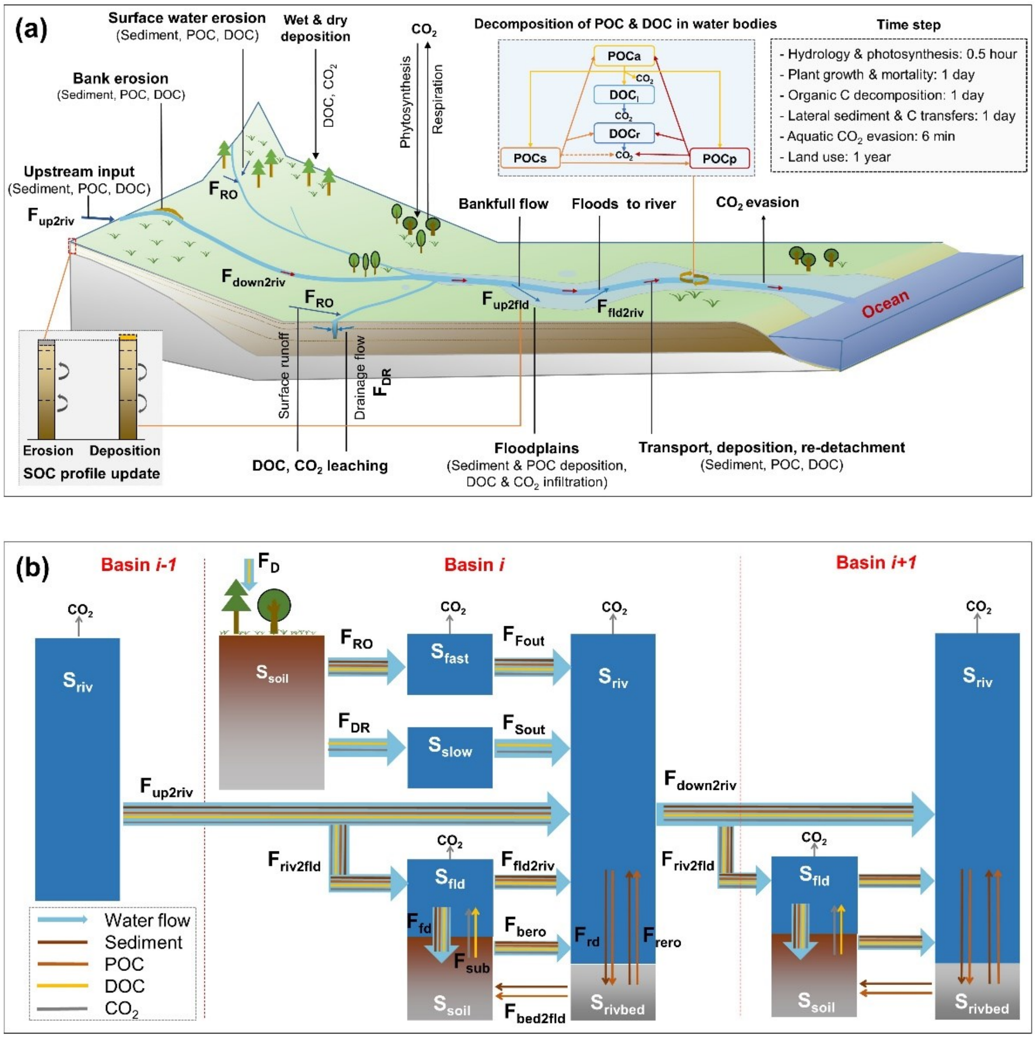


Figure 1 Simulated lateral transfer processes of water, sediment and carbon (POC, DOC and CO_2) in ORCHIDEE-$C_{lateral}$ (a) and a schematic plot for the reservoirs and flows of water, sediment and carbon represented in the routing module of ORCHIDEE-$C_{lateral}$ (b). S_{soil} is the soil pool. S_{rivbed} is the sediment (also POC) deposited on the river bed. S_{fast}, S_{slow}, S_{riv} and S_{fld} are the 'fast', 'slow', stream and flooding water reservoir, respectively. F_{RO} and F_{DR} are the surface runoff and belowground drainage, respectively. F_{Fout} and F_{Sout} are the flows from fast and slow reservoir to the stream reservoir, respectively. F_{up2riv} and $F_{down2riv}$ are the upstream inputs and downstream outputs, respectively. $F_{riv2fld}$ is the outputs from river stream to the flooding reservoir. $F_{fld2riv}$ is the return flow from flooding reservoir to stream reservoir. $F_{bed2fld}$ is the transform from deposited sediment in river bed to floodplain soil. F_{bero} is bank erosion. F_{rd} and F_{rero} are the deposition and re-detachment of sediment and POC in river channel, respectively. F_{sub} is the flux of DOC and CO2 from floodplain soil (originated from the decomposition of

submerged litter and soil carbon) to the overlying flooding water. F_{fd} is the deposition of sediment and POC and the infiltration of water and DOC. F_D is the wet and dry deposition of DOC from atmosphere and plant canopy. DOC_l and DOC_r are the labile and refractory DOC pool, respectively. POC_a, POC_s and POC_p are the active, slow and passive POC pool, respectively.

16. ll. 329-343 and ll. 344-353. This is much more discussion than methods. Can be shortened and should be moved.

We have moved these contents to the discussion section. Please see lines: 803-840

17. ll. 384. What is the effect of scale here if you move the OC from one catchment to the next? How does is differ between large and small catchments?

As we have explained in our manuscript ("Along with surface runoff (F_{RO_h2o}, m^3 day^{-1}), the sediment delivery (F_{RO_sed}, g day^{-1}) from uplands in each basin (i.e. each 0.5° grid cell in the case of this study) initially feeds an aboveground water reservoir (S_{fast_h2o}, m^3) with a so-called fast water residence time" (lines 299-302), the so-called basin here is actually an 0.5°×0.5° grid cell. In other words, each 0.5°×0.5° grid cell is regarded as an individual basin. Therefore, in the original line 384 ('the bankfull flow of a specific basin is assumed to enter the floodplain in the neighboring downstream basin instead of the basin where it originates.'), we intend to explain that the bankfull flow of a specific 0.5°×0.5° grid cell is assumed to enter the floodplain the in neighboring downstream grid cell. So there is no effect of scale here.

18. Section 2.2.2. What is the exact difference between sediment flow and the described POC flow, if it's closely linked to sediments? Is the POC calculations the same as clay?

As we have described, 'In ORCHIDEE-$C_{lateral}$, the physical movements of POC in inland water systems are simply assumed to follow the flows of finest clay-sediment (Fig. 1b).' (lines: 392-393). The simulation of transport, deposition and re-detachment processes of POC in the river network and floodplains is similar to that of clay-sediments. Of course, POC is also impacted by decomposition, although this process is relatively minor in quantitative terms.

19. l. 438. You use the water temperature to calculate the processes, but as input you use air temperature. How do you accommodate for the difference and the time-lag (e.g. over the course of a day)?

The water temperature (T_{water}, °C) is calculated from local soil temperature (T_{soil}, °C) using an empirical equation (i.e. $T_{water} = 6.13 + 0.8*T_{soil}$) developed in Lauerwald et al. (2017). We have added an explanation on this. Please see "where T_{water} (°C) is the temperature of water reservoirs and is calculated from local soil temperature using an empirical function (Lauerwald et al., 2017)." (lines: 416-417). Actually, Lauerwald et al. (2017) has tried to include a time-lag effect between air and water temperature, but it did not improve the prediction equation nor altered the simulated total CO_2 emission significantly.

20. ll. 442. Why do you refer and explain so much about SOC here? The section title is 'POC transport and decomposition'. Maybe some reference to the SOC section would help to clarify.

The scheme for simulating POC decomposition in waters follows that for SOC. With the explanation on SOC decomposition here, we intend to explain how the decomposition of POC is simulated and how we represented the accelerated POC decomposition during the transport process due to the breakdown of sediment aggregates.

21. L. 468. You refer to Figure S1 in the SI, but this figure shows the return period over two years.

Sorry for the mistake. It should be Fig. S4 in the revised manuscript. We have corrected this error.

22. l. 484. A map or a list of the catchments would be helpful (as in SI Figure S2(d)).

In this sentence, we intended to report that the sediment delivery data simulated by the WaTEM/SEDEM model have been calibrated and validated using observed sediment fluxes from 24 European catchments (Borrelli et al., 2018). These 24 catchments have been listed in Borrelli et al. (2018). We did not used these data to calibrate and evaluate our model. Thus we did not provide a table or figure to introduce these catchments.

Borrelli, P., Van Oost, K., Meusburger, K., Alewell, C., Lugato, E., and Panagos, P.: A step towards a holistic assessment of soil degradation in Europe: Coupling on-site erosion with sediment transfer and carbon fluxes. Environ. Res., 161, 291-298, 2018.

23. l. 549. Why is that set to 0.1? It is not clear at this point.

The return period of flooding (=0.1 year) is calibrated against observed bankfull flows obtained from Schneider *et al.* (2011). We have explained this in the Methods (section 2.3). Please see "Existing observational data on $P_{flooding}$ are still very limited to our knowledge. Therefore, following Schneider *et al.* (2011), we also a constant $P_{flooding}$ to simulate the bankfull flows from European rivers and the observed long-term (1961–2000) average bank full flow rate (m^3 s^{-1}) at 66 sites obtained from Schneider *et al.* (2011) was used to calibrate $P_{flooding}$ (the optimized value is 0.1 year, Table 2).".

To avoid misunderstanding, we have revised the original texts from "By setting the return period of the daily flooding rate to 0.1 year," to "With the calibrated return period (= 0.1 year) of the daily flooding rate (see section 2.3)," (line: 533)

Schneider, C., Flörke, M., Eisner, E., and Voss, F.: Large scale modelling of bankfull flow: An example for Europe. J. Hydrol., 408, 235-245, 2011.

24. Fig 3-5 are convincing.

Thank you very much for your positive comment.

25. Section 3.1.3. Your model simulates a too low SOC stock while the TOC and DOC concentrations look better. I would also discuss more here that the temporal pattern of observation and simulation does not match (Fig. S 8), although the mean looks promising.

The simulated SOC actually is overall comparable to the SOC obtained from the HWSD database, which has been regarded as one of the most reliable soil database to present (Fig. S8). But in southern Europe, we indeed underestimated the SOC contents. We have indicated this in our manuscript (lines: 575-582).

We have added a discussion on the bias of the simulated temporal pattern (i.e. the overestimated seasonal variation). Please see "The simulation of the soil DOC dynamics and leaching in our model need to be further improved to better simulate the seasonal variation of riverine DOC and

TOC concentrations. The concentration of soil DOC and the DOC decomposition rate during the lateral transport process in the river network are the two key factors controlling DOC concentration in river flow. As only a small fraction (< 20%) of the riverine DOC is decomposed during lateral transport (Fig. 7), the overestimated (Fig. 5) seasonal amplitude in riverine DOC (and TOC) concentrations is likely caused by the uncertainties in the simulated seasonal dynamics of the leached soil DOC. The current scheme used in our model for simulating soil DOC dynamics has been calibrated against observed DOC concentrations at several sites in Europe (Camino-Serrano et al., 2018). Although the calibrated model can overall capture the average concentrations of soil DOC, it is not able to fully capture the temporal dynamics of DOC concentrations (Camino-Serrano et al., 2018). Given this, it is necessary to collect additional observation data on the seasonal dynamics of soil DOC concentration to further calibrate the soil DOC model. In addition, averaged over the various DOC and SOC pools we distinguish in the soils, DOC represents a much more reactive fraction of soil carbon (with a turnover time of several days to a few months) than SOC (with a turnover time of decades to thousands of years). Therefore, soil DOC concentrations experience large seasonal variations, while SOC concentrations generally are much more stable and show very limited seasonal dynamics. Overall, seasonal variations in riverine POC concentrations are mainly controlled by the seasonal dynamics of soil erosion rates, rather than by the seasonal SOC dynamics, which explains a partial decoupling in the behavior of POC compared to that of DOC.” (lines: 841-861)

26. Fig 5. I would add the names of the rivers as a side panel instead of having the letters.

We have added the name of the stations and rivers to Fig. 5. Please see:

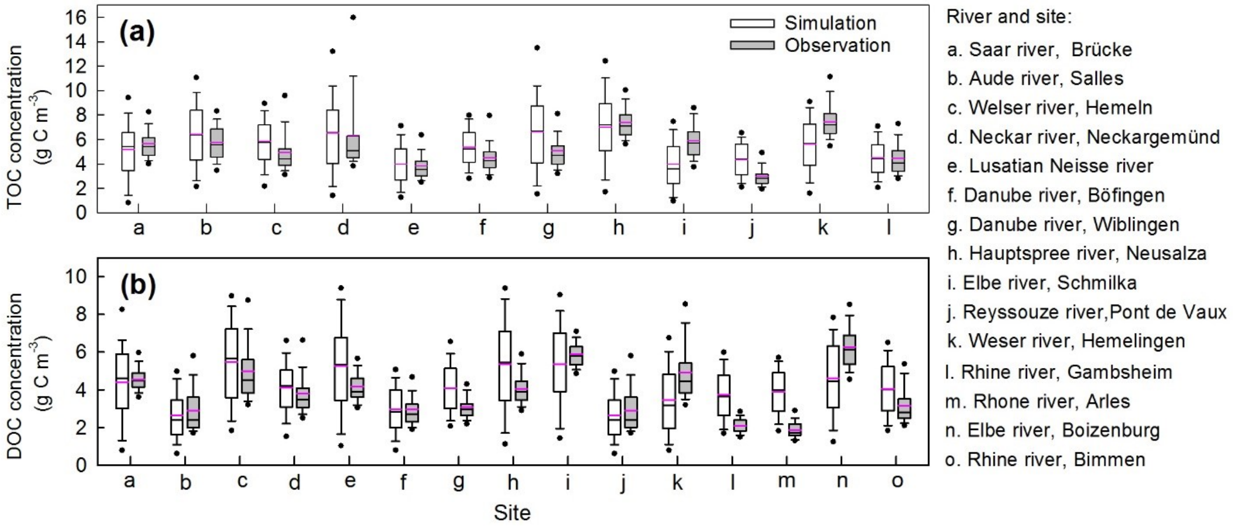


Figure 5 Comparison between the observed and simulated concentrations of total organic carbon (TOC, a) and dissolved organic carbon (DOC, b) in river flows. The black and pink lines in each box denote the median and mean value, respectively. Box boundaries show the 25th and 75th percentiles, whiskers denote the 10th and 90th percentiles, the dots below and above each box denote the 5th and 95th percentiles, respectively.

27. Fig. 6. I suggest to add a panel for discharge (observed vs. simulated).

We have added a panel to show the observed vs. simulated POC discharge. Please see Figs. 6b, d, e:

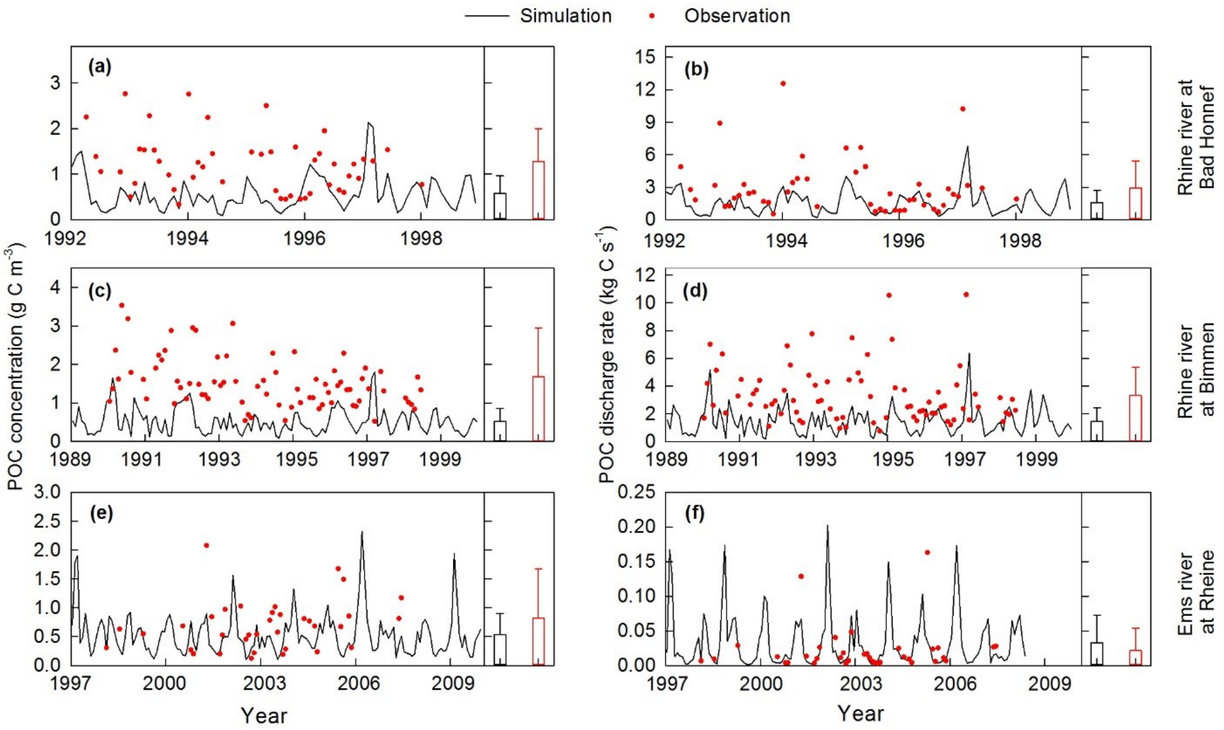


Figure 6 Comparison between the observed (instantaneous measurement) and simulated (monthly average value) riverine POC concentrations and POC discharge rates at three gauging sites. The histograms and error bars denote the means and standard deviations of POC concentrations, respectively. Long-term average water discharge rates at Bad Honnef, Bimmen and Rheine during the observation periods are 2023, 2100 and 80 m^3 s^{-1}, respectively.

28. ll. 645. I am glad to read about the effect of the vegetation type more explicitly here. It could be mentioned earlier.

Thanks to your positive comment. In section 3.1, we showed the evaluation results of our model. Then we presented the effect of vegetation type on lateral sediment and C transfers in the section 3.2. Actually, we only intend to introduce the scheme and algorithms of our model and presented the primary evaluation results of our model. To estimate the effects of vegetation cover and climate change on the spatiotemporal variation of lateral C transfer, we now have conducted a model application study. These results are actually part of a follow-up ms.

29. l. 662. Is the difference between 3.0 Pg and 2.3 Pg significant? In the corresponding figure S11a there is a lot of fluctuations over the years.

Yes, based on the independent sample t-test, the decline from 3.0 to 2.3 Pg yr^{-1} is significant, although there is a large inter-annual variation. We have added this information in the revised manuscript. Please see "From 1901 to 1960s, the annual total sediment delivery from uplands to the whole river network of Europe declined significantly ($p<0.01$, independent sample t-test) from about 3.0 Pg yr^{-1} to about 2.3 Pg yr^{-1} (Fig. S13a)." (lines: 646-648)

30. Fig 7a. The percentage for the fluxes does not sum up to 100. Why?

Sorry for the mistake. The fraction of deposited sediment should be 63.2%. We have revised this error. Please see:

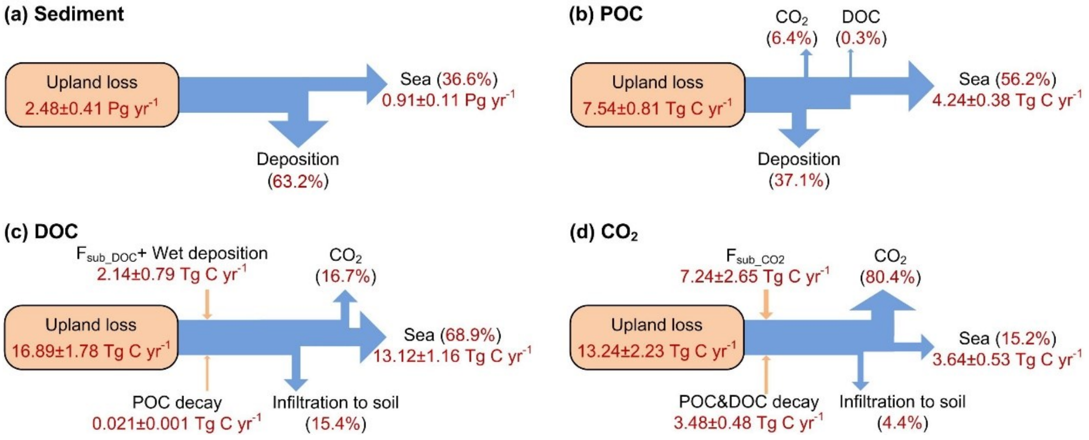


Figure 7 Averaged annual lateral redistribution rate of sediment (a), POC (b), DOC (c) and CO_2 (d) in Europe for the period 1901-2014. F_{sub_DOC} and F_{sub_CO2} are the DOC and CO_2 inputs from floodplain soil (originated from the decomposition of submerged litter and soil carbon) to the overlying flooding water, respectively.

31. l. 682. You mention several times 'small rivers'. Did you conduct a classification for the rivers or is it more a vague grouping?

In the original line 682-684: "But although the sediment discharge rates in some ~~small~~ rivers in the Middle East can be as high as that in the Danube or Volga river (Fig. 8c), the POC delivery rates in these ~~small~~ rivers is much smaller than in the larger ones (Fig. 9c)." , the 'small river' is only a vague description, and it means the rivers that are smaller than Danube and Volga river. We find it is not necessary to repeatedly use 'small' in this sentence. Thus we have deleted the 'small' in the revised manuscript.

32. Section 3.3. There are several strangely set parentheses.

Sorry for the mistakes. We have double-checked the section 3.3 and the other sections of our manuscript to make sure all parentheses are used in the right way.

33. ll. 738. I like this clear listing and explanation (first, second, third). It makes it easier to follow the argumentation.

Thank you very much for your positive comment.

34. ll. 752. What is the effect of anaerobic conditions in the sediment? Wouldn't the decomposition be lower then?

Sorry for the mistake. The turnover time of litter and SOC under flooding waters is set to be one third, not three times, of the litter and SOC turnover times in upland soil. We have corrected this error in the revised manuscript. Please see "Moreover, in ORCHIDEE-$C_{lateral}$, the turnover times of litter and SOC under flooding waters (assumed to experience anaerobic condition) are set to be <u>one third</u> of the litter and SOC turnover times in upland soil (Reddy & Patrick Jr, 1975; Neckles & Neill, 1994; Lauerwald et al., 2017). Accounting for flooding thus decreases the decomposition rate of litter and SOC stored in floodplain soils." (lines: 732-736)

35. Section 3.4. I think that is a necessary part of papers like that. Thank you.

Thank you very much for your positive comment.