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Interactive comment on "Simulating the atmospheric CO_2 concentration across the heterogeneous landscape of Denmark using a coupled atmosphere-biosphere mesoscale model system" *by* Anne Sofie Lansø et al.

Anne Sofie Lansø et al.

anne-sofie.lanso@lsce.ipsl.fr

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We would like to thank Reviewer 2 for taking his/hers time to complete the review of our paper and provide constructive comments that will lead to an improvement of the quality of our manuscript. We appreciate that the reviewer acknowledges the importance of studying the exchange of CO2 at finer scales to obtain a better understanding of the underlying processes. As pointed out be Reviewer 2, we have documented the coupling between SPA and DEHM well and provided a thorough evaluation of SPA, except for the inclusion of Taylor Diagrams, which we will provide in a revised version of

the manuscript. Reviewer 2 likewise asks for a validation of the meteorological drives used by the developed model framework including a description of the setting in our WRF configuration. DEHM driven by meteorological drivers from WRF has already been used in various well validated studies related to air pollution (see e.g. Im et al., 2018). But we agree that to provide a full analysis of the capability of our model system, we need to include this aspect in our manuscript. We will therefore include two new subsections; one including a description of the specific setting of WRF used in this study, and one where the validation of the meteorological drives used in DEHM is conducted (examples of figures from this analysis are given in Fig. 1 and Fig. 2 at the end of this document). As both Reviewer 1 and Reviewer 2 have asked for additional analysis and figures, we will add a supplement to the manuscript, where some of the new figures will be included.

The specific comments and suggestions made by Reviewer 2 will be addressed below and moreover outlines how the manuscript will be revised. No minor comments (spelling, etc) are individually addressed, as they will all naturally be implemented.

P1 – "Surface heterogeneity can be challenging to fully encompass by modelling studies of CO2 surface exchanges, especially when it comes to land-sea boarders." Strange construction and confusing. Re-phrase. The first sentence should introduce the broader context of your study, and possibly the objectives in a broader context. Why do you need to understand the complexity of the land-sea border?

Reply: As per request from Reviewer 1, the abstract will be re-written and shortened. In doing so, we will make sure the first sentences will introduce the boarder context of the study.

P2: "These difficulties in simulating the local impact from the Roskilde Fjord might arise from" – What is the difference between (i) and (ii)? Isn't (ii) part of (i)? The third solution is not a difficulty but a possible physical reality. You should re-phrase the beginning of the sentence. And a fourth solution could be that the fluxes from the Fjord are small, hence not detectable.

Reply: No, (ii) is not intended to be a part of (i). (i) questions whether the fjord is resolved by the model grids, while (ii) questions whether the representation of surface water pCO2 is realistic and captures the large observed variability. Measurements have found that the surface water pCO2 in Roskilde Fjord can vary with 200 uatm (Mørk et al., 2016). To avoid confusion, we will rephrase this sentence to: "The inability to simulate the local impact from Roskilde Fjord might arise from; (i) the fjord not being adequately resolve by the model grids, (ii) the lack of a realistic representation of surface water pCO2, (iii) the fjord is not in the simulated footprint, and (iv) the fluxes from Roskilde Fjord are insignificant and thus not detectable".

P2 L10 – Eliminate is impossible. Any physical quantity has an associated uncertainty. What are these uncertainties? Cite studies that demonstrated our current uncertainties in the present carbon cycle are too large.

Reply: Agreed, this sentence was over optimistic. Eliminate will be deleted and the paragraph will be re-written including new references: "To have the best chance of accurately predicting the future evolution of the carbon cycle, and its implications for our climate, it is important to minimise the uncertainties that exists presently (Carslaw et al., 2018). Enhanced knowledge and a better process understanding in ecological theory and modelling could potentially reduce the model structural uncertainties (Lovenduski and Bonan, 2017) which together with improvements in the spatial surface representation could minimise our current uncertainties".

P2 – "These atmospheric inversions are capable of capturing the year to year changes in natural surface fluxes, the magnitude and distribution of regional fluxes, and distinguish between land and ocean fluxes (Le Quéré et al., 2015)." Several inter-comparison studies have shown large differences among inverse estimates. The study cited here is using aggregated inverse fluxes over large latitudinal bands or a land-ocean separation. This statement is very optimistic and very likely over-confident. See Peylin et al.,

(2013) for more details on global inversions.

Reply: We agree that this sentence is optimistic, but the cited study was capable of distinguishing should fluxes, albeit at a very coarse resolution. However, we will delete this paragraph entirely to allow for space in the introduction to improve the storyline in relation to the coastal vs. land fluxes

P2: "atmospheric inversions are limited by the availability of atmospheric measurements" – And erroneous prior fluxes, errors in transport models, and simplified error covariances. Add citations related to limitations in inversions. Increasing the resolution and denser networks do not fix all the problems encountered by global inversions. Reply: We agree that atmospheric inversions indeed are limited by more than atmospheric measurements. As mentioned above this paragraph will be deleted.

P3 L6-14: Most studies have ignored coastal fluxes because flux measurements and model estimates suggest that coastal fluxes are negligible compared to terrestrial fluxes in most areas. A brief comparison of existing studies to provide a range of coastal fluxes would be useful. While very large amount of carbon will be transported from the land to the deep ocean, the net surface fluxes remain small. You should justify better why you expect significant fluxes in your case.

Reply: We plan to improve the storyline of the manuscript by making this clearer in the introduction. The term coastal areas covers both coastal shelf seas and estuaries. In general, the air-sea CO2 exchange is per area numerical larger for estuaries than shelf seas (see Chen et al., 2013, Laruelle 2010 and Laruelle 2014), and can for estuaries be as large as -696 gC/m2/yr to 1,956 gC/m2/yr, while shelf seas have fluxes in the range of -153 gC/m2/yr to 180 gC/m2/yr (Chen et al., 2013). Denmark is bordered by the Baltic Sea and the North Sea, which are connected through the Danish straits and Kattegat. The Baltic Sea is a marginal sea that experiences large seasonal variability in their CO2 fluxes, with outgassing of CO2 in winter, while biologic activity allows for uptake during spring and summer, while the North Sea is a continental shelf sea with uptake throughout the year. Previous studies have estimated annual fluxes in the range of -34 to 20 gC/m2/yr for the Baltic Sea (Kuss et al., 2006, Norman et al., 2013, Wesslander et al., 2010), -40 to 19 gC/m2/yr for Kattegat (Gustafsson et al., 2014, Norman et al., 2013, Wesslander et al., 2010) and -17 gC/m2/yr for the North Sea. Laruelle et al., 2014 estimate the Baltic Sea to have a total annual uptake of 2.245 TgC/yr. Moreover, the few direct EC measurements in the Baltic Sea have found that upwelling events greatly increase the air-sea CO2 exchange (Kuss et al., 2006, Norman et al., 2013). Considering that the coastal sea area surrounding Denmark is almost thrice the size of the Danish land masses, the air-sea CO2 fluxes are thought to be of significance for the study region. We will elaborate in more details on this in the discussion, while also change the paragraph between line 6 and line 14 in the introduction to: "Heterogeneity can also be considerable in coastal oceans, and as with terrestrial surface fluxes, the high spatiotemporal variability leads to large uncertainties in estimates of coastal air-sea CO2 fluxes (Cai 2011, Laruelle et al., 2013). Coastal seas play an important role in the carbon cycle facilitating lateral transport of carbon from land to the open ocean, but almost 20 % of the carbon entering estuaries are released to the atmospheric, while 17 % of the carbon inputs in coastal shelf seas comes from atmospheric exchange (Regnier et al., 2013). In general, the air-sea CO2 exchange is per area numerical larger for estuaries than shelf seas (Chen et al., 2013, Laruelle et al.,2010, Laruelle et al., 2014), and can annually for estuaries be as large as -704 gC/m2/yr and 1,958 gC/m2/yr while continental shelf seas have fluxes in the range of -154 gC/m2/yr to 180 gC/m2/yr (Chen et al., 2013). The large spatial and temporal heterogeneity of coastal ocean contributes with large uncertainty to assessment of the air-sea CO2 exchange (Regnier et al., 2013). The observed high spatial and temporal variability (Kuss et al., 2006, Leinweber et al.,2009, Vandemark et al., 2011, Norman et al., 2013, Mørk et al., 2016) are not always included in marine models (Omstedt et al., 2009, Gypens et al., 2011, Kuznetsov et al., 2013, Gustafsson et al., 2015, Valsala et al., 2015}, let alone taken into account in atmospheric mesoscale systems simulating CO2 (Sarrat et al., 2007, Geels et al., 2007, Law et al. 2008, Tolk et al., 2009, Broquet

et al., 2011, Kretschmer et al.,2014), but a recent study has found that short-term variability in the partial pressure of surface water CO2 (pCO2) can be influential of the annual flux for some coastal areas (Lansø et al., 2017). Moreover, Direct Eddy Covariance (EC) measurements in the Baltic Sea have found that upwelling events greatly increase the air-sea CO2 exchange (Kuss et al., 2006, Norman et al., 2013)."

P4: You need to describe briefly the nesting. And DEHM is a chemical transport model using existing meteorological fields. These input fields come from a simulation or an existing product. In your case, if you used WRF simulations, you need to describe these as well, including WRF configuration and the domain setup.

Reply: As already mentioned, a subsection including the WRF configuration will be added. The two-way nesting will be included in section 2.1 and added to line 7 on page 4: "The two-way nesting replaces the concentrations in the coarser grids by the values from the finer grids."

P4: "towards the Southern Hemisphere"- Very confusing. What do you mean here? You have not coupled the full boundaries of your simulation domain? How are CO2 mole fractions coupled to your simulations?

Reply: DEHM only covers the Northern Hemisphere. Therefore, as boundary conditions, the model reads atmospheric mole fractions of CO2 vertically at the outer boundaries of the main domain of DEHM. All the outer boundaries of DEHM are facing the Southern Hemisphere. To avoid this confusion, we will change "Similarly, CT2015 three-hourly mole fractions of CO2 were used boundary conditions towards the Southern Hemisphere." To "Similarly, CT2015 three-hourly mole fractions of CO2 were read in as boundary conditions at the lateral boundaries of the main domain of DEHM."

P4 L19-21: This description is too succinct. You need to develop that part significantly. Describe the physical schemes used in WRF, the domain, and simulation period (reinitalizations or continuous run?).

Reply: A subsection, named "Meteorological drivers", containing this information, will be added to the manuscript:" The necessary meteorological parameters for DEHM were simulated by the Weather Research and Forecast Model (WRF) (Skamarock et al., 2008), nudged by six hourly ERA-Interim meteorology (Dee et al., 2011) continuously ran between 2008 and 2014, and was also used as initial and boundary conditions. In WRF the Noah Land Surface Model, Eta similarity surface layer and the Mellor-Yamada-Janjic boundary layer scheme were chosen to simulate surface and boundary layer dynamics. The CAM scheme was used for long and short-wave radiation, the WRF Single-Moment 5-class Microphysics scheme was applied for microphysical processes, and the Kain Fritsch scheme for cumulus parametrisation (Skamarock et al., 2008). In WRF the same nests as in DEHM were chosen, and the meteorological outputs were saved every hour. To get the sub-hourly values that match the time step in DEHM, a temporal interpolation is conducted between the hourly time steps when DEHM is reading the hourly meteorological data. Furthermore, a correction of the horizontal wind speed is conducted in DEHM to ensure mass conservation and compliance with surface pressure (Bregman et al., 2003)."

Figure 1: Add the vegetation type next to the name of the site. How did you calculate the standard deviation? Is it the STD using 30-min fluxes? or from the parameter calibration? Provide more details on your shaded areas (STD's) for both model and data.

Reply: For both model and observations the STD are calculated for hourly values. The information will be added to the figure caption.

P6 For the Skjern Enge site, the uptake seems over-estimated by the model, as you pointed out in the text. How much excess in uptake would that correspond to? You noted in the results, later in the paper, and in the abstract, how grassland plays a critical role in the annual uptake. Is it over-estimated by the SPA model?

Reply: This is an excellent point, which we will elaborate more on in the discussion,

where we also will examine the observed and modelled annual accumulated flux at Skjern Enge to establish the overestimation at the site. We already mention that it is impossible to take management practises from individual grasslands into account, as they both varies from year to year and from grassland to grassland site. Interestingly, when compared to other estimates of annual fluxes for grasslands site in Denmark, we find that our model system has the smallest annual uptake for grasslands in Denmark.

Section 2.3: This section is too succinct and provides very little details on the measurements. Which Picarro instrument was used? How often was it calibrated? Which standards did you use? Any publications looking at the data? Without a careful calibration, CRDS instruments from Picarro are not accurate enough to be used for CO2 studies. You need to document your measurements here.

Reply: The measurements from the Risø Tower have not previously been published. The required information will be added to section 2.3: "Tall tower continuous measurements of atmospheric CO2 concentrations at Risø were made by a Picarro G1301 placed in a heated building. The inlet was 118 m above the surface and the tube flow rate was 5 slpm. At the onset of the measurements the Picarro was new and calibrated by the factory. The calibration was checked by a standard gas of 1000 ppm CO2 in atmospheric air (Air Liquide). During the measurement period from the middle of 2013 to the end of 2015, the instrument showed no other drift than the general increase in the global atmospheric concentration."

P7: "In winter, GPP is highest for evergreen, grassland and agricultural other." – Respiration is higher during that time of year. Why do you focus on GPP in winter? What about the net positive flux?

Reply: In the revised manuscript, a large focus will be put on the net flux (see Fig. 3 at the end of this document).

P7: "Respiration is less concentrated for individual land-use classes and the individual monthly contributions vary much less for respiration than GPP throughout the year" –

How different are your parameter values for respiration across land use classes? Could you explain why? Is it a reasonable result?

Reply: In SPA a fraction of GPP is moved to a pool for autotrophic respiration. For all the landcover classes the turnover rate of this pool is 0.07. The fraction of GPP to autotrophic respiration varies between 0.32 to 0.55 amongst the landcover classification. The deciduous trees and the spring crops are more conservative with their carbon, and a smaller fraction of GPP is used for the autotrophic respiration than the evergreen and winter crops. Heterotrophic respiration is in SPA determined by the mineralisation rate, size of litter or soil organic matter pool, temperature and a temperature coefficient. Of parameters, only the mineralisation rate varies between the landcover classifications. In general, the crops have the highest mineralisation rates of litter and soil organic matter, reflecting that the residues from crops are easier degradable than residues from trees. Respiration occurs throughout the year. Heterotrophic respiration is controlled by temperature, thus if temperature increases, heterotrophic respiration will increase for all landcover classifications accordingly, and the mutual ratios might not be changed. Autotrophic respiration is directly dependent on the plant productivity: the more GPP, the more carbon can be put into the autotrophic respiration pool and the larger amount of carbon can be respired. Since only a part of the total respiration is directly related to the GPP, less variation is seen for the monthly contributions in Table 3. The following will be added to page 7 line 25:" This is because, only part of the total respiration is directly related to the plant productivity (autotrophic respiration) in SPA, while the heterotrophic respiration is temperature dependent, and thus if the temperature increases the heterotrophic respiration will increase proportionally for all landcover classification."

P8: The Danish CO2 budget needs to be completed. When considering the total CO2 budget of a country, one needs to include the lateral fluxes (export/import) of agricultural production and include all the sources of CO2 including animal livestock. Otherwise you simply remove carbon from the country or from the food chain which

creates artificially a local sink in agricultural land not compensated by the emissions. If you want to discuss the national Danish CO2 budget, you need to consider all the components of the problem. I would suggest you simply remove this part, unless you want to develop it with the other exchanges of CO2.

Reply: As it is currently not possible to include the remaining components for the national CO2 budget in the model framework, we will follow the recommendation of Reviewer 2 and delete this subsection in the manuscript.

P8: "Overall the model simulates the atmospheric CO2 quite well, indicating that the simulated surface exchange of CO2 is acceptable." Acceptable for what goal? How did you define the statistical success of your model? You need to discuss here what you want to accomplish with your system, and how you defined success.

Reply: With the constructed model framework we wish to accomplish a model system that is capable of simulating surface fluxes and atmospheric CO2 concentrations over Denmark at a high spatiotemporal resolution. One success criterion is to reproduce the temporal pattern at both diurnal and seasonal time scale when compared to measurements. We will rephrase the sentences on page 8 line 29 to: "The comparison between observations and the model results show that the model can capture the overall variability of the atmospheric CO2 concentrations and fluxes."

P10: "However, improvements to the evergreen plant functional type in SPA are needed" – Confusing. The model is fine (following the previous lines) but it needs improvement. Clarify why the model has to be improved.

Reply: Indeed, these sentences create some confusion. To clarify: "Even though SPA experiences a lag in the seasonal onset for the evergreen forest, the annual estimated uptake of -386 gC m-2 yr-1 compares well with previous estimates of temperate evergreen forests with -402 gC m-2 yr-1 (Luyssaert et al., 2007) and Danish evergreen plantations of -503 gC m-2 yr-1 (Herbst et al., 2011). However, improvements to the evergreen plant functional type in SPA are needed, and an addition of a labile pool to the evergreen carbon assimilation would omit the seasonal lag (Williams et al., 2005). Such adjustments have already been made to the DALEC carbon assimilation system utilised by SPA (Smallman et al., 2017), but not yet incorporated into SPA." Will become "Improvements to the evergreen plant functional type in SPA are needed, and an addition of a labile pool to the evergreen carbon assimilation would omit the seasonal lag (Williams et al., 2005). Such adjustments have already been made to the DALEC carbon assimilation system utilised by SPA (Smallman et al., 2017), but not yet incorporated into SPA. The annual estimated uptake of -386 gC m-2 yr-1 is in the low range of previous estimates of temperate evergreen forests with -402 gC m-2 yr-1 (Luysseart et al., 2007) and Danish evergreen plantations of -503 gC m-2 yr-1 (Herbst et al., 2011). This could be caused by the slow leaf onset in spring, inhibiting the productivity at the beginning of the growing season."

P11: The discussion on the national CO2 budget is weak. As noted above, this part needs to be extended to the entire nation including all the components, as you noted in the discussion.

Reply: As mentioned above, we will delete the section related to the national CO2 budget and consequently also the discussion section related to it.

P11: The "land-sea signals" discussion seems to argue that fjord fluxes are still important despite the limited impact on the modelled concentrations. If the tower location is a problem, you can sample your model in an optimal location to compute the maximum influence of the fjord on the CO2 mole fractions. You can look at the potential impact on the potential measurement locations. In any case, the fluxes are small. Is it really important at the annual scale? You need to provide numbers to demonstrate this statement. The section argues that fjords are important for the CO2 budget but without a clear demonstration.

Reply: A special focus has been put on Roskilde Fjord in the analysis because it is near the Risø tall tower site. Therefore, it is investigated whether a direct impact

from the air-sea fluxes from Roskilde Fjord can be detected on the atmospheric CO2 concentration at the Risø site in the model system, which turns out to be difficult. We do not mean to state that the Danish fjords are of high importance. However, the air-sea CO2 exchange from all Danish marine areas (including all fjord, inner straits and Kattegat) has during winter an impact. Between November and February, the air-sea fluxes from the total Danish marine area corresponds to 20 – 47 % of the monthly NEE. As mentioned in the response to Reviewer 1, we plan to include the monthly air-sea CO2 fluxes from the Danish marine areas in the Table of NEE that moreover will be converted to a figure (see Fig. 3 at the end of this document). This will aid in clarifying the section on the land-sea signal. Moreover, part of this section will be re-written to make sure this message gets across.

P12: "to repeatedly simulate atmospheric transport to robustly quantify the impact of flux uncertainties on atmospheric CO2 concentrations due to their computational requirements." – Clarify. Why is SPA involved in atmospheric transport? What computational requirements?

Reply: What was meant was that repeating the simulation to determine the impact on atmospheric concentrations due to changes in surface CO2 exchange alone is out of scope for the current study The existing sentence: "While SPA also uses DALEC to simulate carbon allocation and turnover, it is currently impractical to conduct a similar data assimilation analysis or repeatedly simulate atmospheric transport to robustly quantify the impact of flux uncertainties on atmospheric CO 2 concentrations due to their computational requirements." Will become "While SPA also uses DALEC to simulate carbon allocation and turnover, it is currently impractical to conduct a similar data assimilation analysis to optimise DALEC (or SPA) parameters based on comparison with observations of atmospheric CO2 concentrations as this would require repetition of computationally intense simulations of atmospheric transport."

P12: "The usage of satellite retrievals by data assimilations systems and their accompanying improvements moreover highlights the future enhancement to the current modelling framework, where satellite products could be utilized for upscaling reducing the related error." – Very confusing sentence. Re-phrase. Which satellite data? What are the accompanying improvements? Future enhancements of what?

Reply: We agree that this sentence is poorly placed and out of scope for the paper. Thus, it will be removed it, and instead a sentence from earlier in the same paragraph will be revisited: "Increasing the amount of observational data used in data assimilation system have been found to reduce uncertainty in retrieved parameters and thus simulated carbon stocks and fluxes of CO 2 (Smallman et al., 2017); including all observations counting both in situ and satellite, Smallman et al. (2017) halved the uncertainty of the net biome productivity" TO "Increasing the quantity and type of observations available for data assimilation systems can have a significant impact on reducing uncertainty of model process parameters and simulated fluxes (Smallman et al., 2017). In particular, availability of repeated above ground biomass estimates was able to half the uncertainty of net biome productivity estimates for temperate forests (Smallman et al., 2017). Above ground biomass estimate are currently available from remote sensed sources (e.g. Thurner et al., 2014; Avitabilie et al., 2016) with future missions planned such as the ESA Biomass mission (LeToan et al., 2011) and NASA GEDI (https://gedi.umd.edu/)."

P12: "could be utilized for upscaling reducing the related error" – Which error? Reply: See previous reply.

P12: "while the choice of surface map could change the study region from an annual sink to source of atmospheric" – You need to clarify two things here. First, if you remove land from your map, you will make the fjord or the coast more important. What do you mean by "change the study region"? And second, even if you double your coastal flux, what would be the conclusions compared to the biosphere and the fossil fuel emissions? Globally, it matters, but regionally, aren't the conclusions unchanged? Conclusions: Are there any measurements available to evaluate your coastal fluxes?

Reply: The choice of surface map here refers to the choice of pCO2 map applied to the coastal region, while the study region refers to the Danish waters. The air-sea CO2 exchange is evidently sensitive to the surface water concentrations of CO2. If the product providing surface water CO2 is changed, the annual air-sea flux of CO2 will be altered and can even change sign. To avoid further confusion this will be clarified in the last paragraph in section 4.4. Moreover, the total Danish coastal fluxes have been added to the figures showing monthly NEE for the different landcover classifications to show that on a monthly basis these coastal fluxes can be comparable to monthly fluxes of individual landcover classifications (see Fig. 3 at the end of this document). During the cause of the year the coastal fluxes for the study region, however, almost averages out to zero. Thus, if we double the monthly air-sea CO2 fluxes for the study region we would reach the same conclusion for the annual flux, because we have a coastal system that seasonally can shift between a source and a sink of CO2 Only few direct measurements of the air-sea CO2 exchange are available for the Baltic Sea and only for limited time periods (Roskilde Fjord (2012-2013), Arkona Sea 2002-2003, and short periods at Östergarnsholm). Only Roskilde Fjord is positioned with the study area of the current study. The applied monthly pCO2 maps has previously been compared to pCO2 measurements in Danish waters and were found to capture the seasonal cycle (Lansø 2016).

Fig 3: Your caption should include more information. Which driver data? at what resolution? and which formulation did you use?

Reply: The air-sea CO2 fluxes are calculated within the model framework at each time step, thus meteorological drives from WRF are used for these calculations. The spatial resolution follows those from the DEHM nest, and thus over Denmark the resolution is 5.6 km x 5.6 km. As already mentioned in the text (section 2.1.2) the formulation by Ho et al., 2006 is used to calculate the air-sea CO2 fluxes, as this has been found to match the EC measurements made at Roskilde Fjord.

Fig 4: "annual mean values" – Did you compute a running mean for each day of the year? or a trend? Reply: It will be added to the caption of Fig. 4 in the manuscript that a trend was removed.

Fig 6: Are these concentrations at the exact hour or hourly averages? Reply: These are hourly averages, which will be specified in the caption of Fig. 6 in the manuscript.

Fig A1: Fonts are too small. Caption needs additional information. Which model was used? At what resolution? Reply: The fonts size will be increase and the additional information will be added to better explain these model inputs. The resolution is the same as the smallest nest in DEHM which is 5.6 km x 5.6 km.

New References in the revised text and in the reply: Avitabilie et al., (2016) An integrated pan-tropical biomass map using multiple reference datasets. Global Change Biology, doi: https://doi.org/10.1111/gcb.13139

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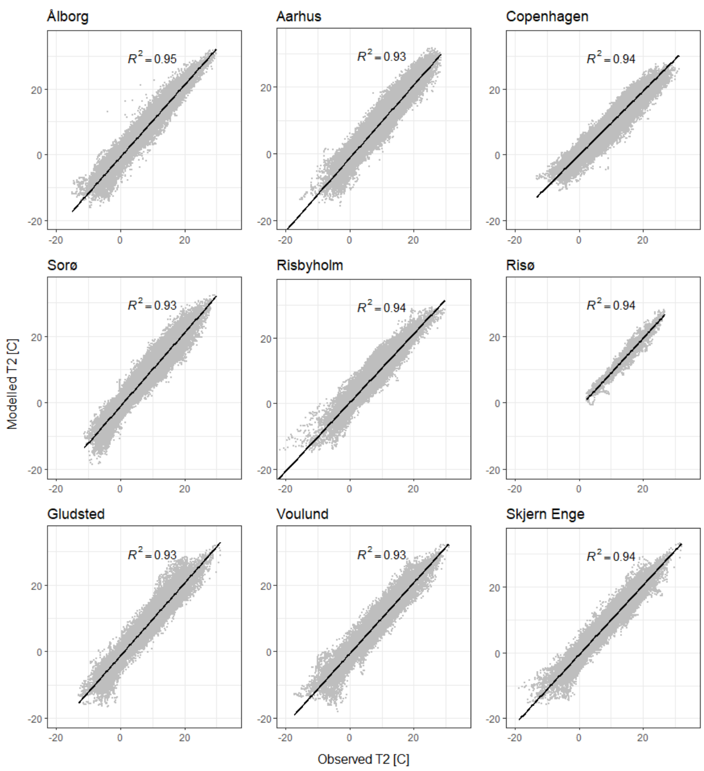

Fig. 1. Scatter plots of measured and modelled 2 m temperature for the five EC sites used in the study, the Risø tall tower site and three additional air pollution monitoring sites.

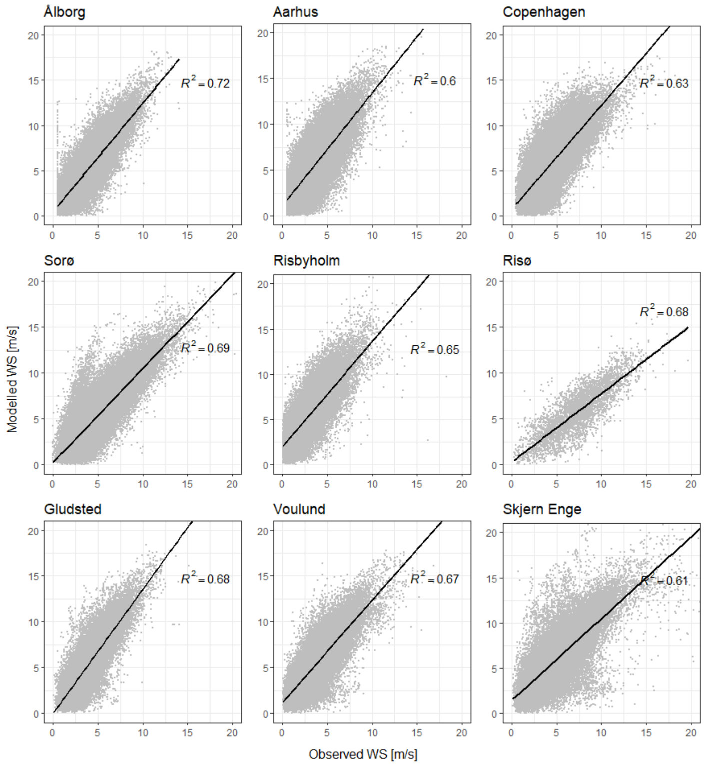

Fig. 2. Scatter plots of measured and modelled wind speeds for the five EC sites used in the study, the Risø tall tower site and three additional air pollution monitoring sites.

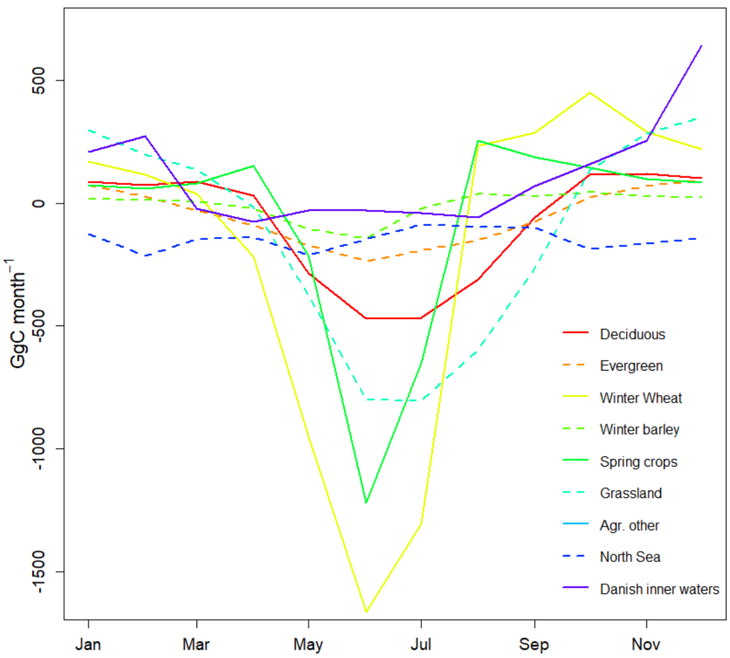

Fig. 3. The total monthly fluxes from the 7 landcover classifications and the fluxes from the marine areas surrounding Denmark. The marine area has been divided into the North Sea and the Danish inner waters