

## Final authors' response (AC) to the referee comments (RC1) on acp-2021-873

*We are very thankful to the reviewer for the constructive comments and for considering the manuscript for publication in ACP after minor revisions, which we have done according to the suggestions of reviewer. In the following, we address the reviewer comments under the respective sections — i.e., General comments, Detailed comments, and Technical corrections.*

*Note: The reviewer comments (RC1) are referred to in "Arial" font type throughout the texts, and the authors' responses are referred to as "Italic Arial" with indented lines.*

### Anonymous Referee #1 (RC1)

Referee comment on "NEE estimates 2006–2019 over Europe from a pre-operational ensemble-inversion system" by Saqr Munassar et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-873-RC1>, 2021

#### 1) General comments

Authors present an analysis of the European terrestrial carbon cycle variability in 2006-2019 made with the pre-operational inverse modelling framework "CarboScope Regional". The CO<sub>2</sub> flux estimates are shown to be largely independent from the prior fluxes in the area of dense observations. The results confirm dominance of the observational constraint on fluxes and the importance of climate controls on the interannual flux variability. Authors find the inverse model predicts statistically significant positive CO<sub>2</sub> flux anomalies in 2018-2019 related to hot and dry climate in those anomalous years. The paper is well written and can be considered for publication after minor revisions.

*Thank you for considering the paper to be published in the ACP journal. We have revised our manuscript accordingly as detailed below.*

#### 2) Detailed comments

L75-80 Although some of the information can be found in references, to improve readability it is useful to give few more details about the CSR such as optimization scheme and temporal resolution of flux corrections.

*We agree that adding more information about the optimization scheme is useful, so a complementary description is added in the methods in the revised manuscript (L85-101).*

L104 Need to give detail – where station types come from.

*The station types are categorized with different classes according to the ability for the regional transport model to reasonably simulate the atmospheric concentration, given the variable complexity to represent the local circulation, over each station as explained in Rödenbeck, (2005). We have added this information in the revised manuscript (L130-132).*

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L248-L300 The correlation of posterior fluxes with climate indices has been reported in detail. To enhance the validation of interannual flux variability, can authors add comparison with interannually varying regional flux estimates by independent process-based models, and possibly, top-down?

*We have added an additional comparison on interannual variability of flux estimates in the supplementary materials (subtitled as “validation test on posterior IAV”, also Fig. S3) using an independent top-down model (LUMIA inversion) which serves as a validation of IAV in our results. The validation showed good agreement in the IAV between both estimates despite different data inputs and inversion setups between both inversion systems.*

L407 Need a reference here on systematic bias in transport models.

*Reference has been added in L488.*

### 3) Technical corrections

L18 Phrase ‘We further investigate the unprecedented increase of temperature ...’ is somewhat incomplete, better write that one investigates the impact of ‘unprecedented increase ..’ on the carbon cycle.

*This has been rephrased accordingly (L18-19).*

L103 ‘South-eastern Europe (light red).’ Line out of place.

*This line is removed (L130).*

L265 ‘fluxes of both’ can be replaced with ‘fluxes estimated with both’

*We changed it in the revised version, L326.*

L405 ‘widespread scale’ can be reduced to ‘wide scale’

*It is changed based on the suggestion, L486.*

L424-425 The phrase ‘spatial correlation length of prior error’ can be reformulated, it would be more accurate to avoid using ‘prior’ as this spatial correlation is applied to posterior flux corrections.

*The spatial correlation actually belongs to the prior error, together with the temporal error correlation it forms the assumed error structure associated with the prior uncertainty (L506-507).*

L460 Paper number in Chevallier 2012b is missing (Global Biogeochem. Cycles, 26, GB1021, doi:10.1029/2010GB003974)

*We corrected the reference information accordingly, L550.*