**Journal:** Atmospheric Measurement Techniques
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**Title:** Accounting for spatiotemporally correlated errors in wind speed for remote surveys of methane emissions
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# Point-by-point Responses to Reviewer Comments

## *Reviewer 2*

*In this manuscript, Conrad and Johnson discuss the importance of wind speed uncertainties when estimating methane emissions using remote sensing observations. The study is strongly focused on theory and technical elements of model development. They demonstrate the applicability of a combined model for wind uncertainties for a testcase in Canada. They also suggest a new experimental design to reduce temporal autocorrelation effects. The topic is of great importance as this source of uncertainty is usually neglected in remote sensing studies. The text is well written und the manuscript has a clear and easy to follow structure. However, given the focus of the manuscript on model design it might be better suited for another EGU journal, namely, Geoscientific Model Development. Nevertheless, the study also overlaps with the scope of AMT.*

We thank the reviewer for their positive comments.

***There are only some minor comments that should be addressed before publication.***

*Page 1, line 27: Would you consider the level of uncertainty similar for aircraft and satellite studies or should they be considered differently? Especially the fact that airborne surveys often have on-board wind data and are not restricted to clear-sky day bias could suggest that they might not experience the same limitations.*

Uncertainty in the quantification of methane emissions is highly dependent on the measurement technique. For aircraft- and satellite-mounted imagery- and LiDAR-based techniques, uncertainties are driven by spatial resolution of the imagery, the precision of inferred methane concentrations/enhancements, and, as we focus on in this work, the estimation of a representative wind speed that propagates the emission. Although comparing uncertainties between these various techniques is beyond the scope of this work, the contribution of wind speed error is expected to be similar.

Indeed, direct measurement of wind speed could be highly advantageous in reducing uncertainties in estimated emissions. Direct measurement could be performed with ground-based on-site anemometer(s) or advanced remote techniques from the aircraft, such as Thorpe et al.'s (2021) airborne doppler wind LiDAR.

*Page 2, line 17 [Page 4, line 16]: Why is the analysis limited to May to October? Satellites are observing and reporting observations in all seasons. Are you confident there is no seasonal bias in the NWP performance?*

In our case study's region of interest (northeastern British Columbia, Canada), snow-cover generally precludes accurate measurement or, at a minimum renders measurement challenging, during approximately November to April, inclusive. As such, for the case study, we have constrained our analysis period from May to October.

Seasonal bias is certainly a possibility if not a likelihood and we do not suggest that it is absent. To make this clear, we have made two revisions. In Section 3.1, we identify that this time period is chosen the "typically non-snowy months in this region". We also now note in our revised limitations and future work section that:

> *Our case study analysis was performed during the typical non-snowy period in Northeastern British Columbia, May to October, since the presence of snow may preclude remote measurements from air and space. The presented methodology is agnostic to the time period of interest and can be applied to data from any time period as long as there are sufficient data available. Indeed, as indicated in Table A1, we have applied our method to evaluate the ERA5-Land reanalysis product over the entire calendar year in the primary oil and gas-producing region of Colombia.*

Please also note that this methodology is agnostic to the period of interest (Table A1 shows that we execute this analysis for the whole calendar year in Colombia) and can indeed be employed to objectively assess seasonality of wind speed error.

*Page 7, line 14-15: The two references cited here: Sklar 1959 and Nelsen 2006 are not easily accessible or behind a paywall. So, please provide more details on Copulas here or provide additional references that discuss Copulas in more detail.*

These citations refer to books. The work by Sklar (1959), which first presented Copulas, is available through the HAL open archive. The work by Nelsen (2006) is the seminal textbook on the topic with over 20,000 citations but it does not seem to be freely available online.

*Page 9, line 12: More details on DECLUS would be helpful here.*

We have revised the text to read (additions in bold):

> *Data were weighted … using the "DECLUS" cell declustering algorithm (Deutsch and Journel, 1997)**, which weights station data by the inverse of station count on a regular but randomly perturbed two-dimensional grid**.*

*Page 9 line 19: If there is a myriad of literature, why do you only provide a single reference, which is, again, behind a paywall.*

Cressie (1993) is a seminal textbook on the topic of spatial statistics, which we present as an example of the literature in the field. We have revised the text to note this (additions in bold):

> *… autocorrelated geostatistical data**, including the seminal work of** (Cressie, 1993).*

*Page 12: Section 2.3. highlights that this study is really about the model itself and maybe better suited for Geoscientific Model Development. Nevertheless, it is a good example for more detailed analysis of correlated uncertainties affecting many applications.*

We appreciate the reviewer's feedback.

*Page 19, line 24: The point about sun-synchronous satellites is crucial and it might be good to highlight that nearly all current satellites used for methane emission monitoring are sun-synchronous.*

This is a great point, which we have adopted in the text (additions in bold):

> *Of course, this is not possible for observation by sun-synchronous satellites**, which includes most methane-detecting satellite instruments (Jacob et al., 2022),** but could be accommodated by careful planning of aerial surveys.*

### *References*


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