Review for the EGU Peer Review Training

"On the estimation of stratospheric age of air from correlation of multiple trace gases"

F Voet., et al

Note: I compiled this review in the framework of the Copernicus ECS peer-review training 2024.

Overall Impression

This research introduces a novel method to estimate the Age of Air (AoA) by analyzing atmospheric measurements of various long-lasting trace gases. The method is based on examining the relationships between specific trace gas species (such as CFC-11, CFC-12, HCFC-22, CH4, N2O, and SF6) and AoA. The effectiveness of this method was tested using simulations with the CLaMS model and resulted in a calculated weighted mean AoA from satellite observations of the six trace gases. The study found that the difference between this calculated AoA and the actual AoA in the model remained below half a year in the lower stratosphere. Additionally, the method was applied to measurements using GLORIA-B, leading to more reliable results and significantly reduced uncertainty compared to traditional methods. Overall, this study demonstrates the potential accuracy of determining AoA from satellite observations of multiple trace gases and their correlations with AoA.

The authors have successfully highlighted the need and relevance of the study. They have very well explained the setup of the model, the calculations done for AoA estimation and data analysis from GLORIA-B instrument in the methods section making their study reproducible. Results are clear and appear in a logical manner with all the figures being explained in detail with comprehensive captions. The authors have also suggested future improvements for their new method.

Based on my review of the manuscript and considering the comments below, I suggest minor revisions. The manuscript is overall very well written and structured. I would like to inform the editors that the study topic is new to me, as my expertise lies in atmospheric chemistry in the troposphere. Specifically, I work with the molecular-level chemical composition of sea spray aerosol and the associated aging processes through laboratory experiments and field campaigns. I have extensive experience using a chemical ionization mass spectrometer and can provide better reviews for papers in the field of atmospheric chemistry.

However, I have still made my best efforts to review the given manuscript but there could be some potential errors that I could not recognize.

Minor Comments

Abstract – The method for mean age calculation should be described more clearly. I am not able to understand exactly the meaning of compact correlations. Do they mean strong positive correlations between the trace gases and AoA? Also, the authors should consider giving a standard name to their method.

Figure 2: expand vmr (volume mixing ratio) in the figure caption to improve readability

Tables 1 and 2 could be combined for conciseness.

Line 48: Spelling error - CO2 **possess** a strong seasonal cycle in tropospheric mixing ratios……

Line 78: Spelling error - if **they** can be retrieved with sufficiently low uncertainty (Schoeberl et al., 2005).

Lines 107-110: I suggest to modify these sentences for consistency. I have highlighted the part of the sentence that could be changed. For example,

From - "The lowest model layer (lower boundary layer of the model) extends from the surface to approximately 1.5 km (more precisely0 K < ζ < 70 K). The uppermost model layer (upper boundary layer) covers the potential temperature range 2350 − 2650 K (altitude of about 55 km), hence the model domain extends from the surface to about the stratopause."

To - "The lowest model layer (lower boundary layer) extends from the surface to approximately 1.5 km (more precisely 0 K < ζ < 70 K). The uppermost model layer (upper boundary layer) **extends up to an altitude of about 55 km (potential temperature range 2350 − 2650 K)**, hence the model domain extends from the surface to about the stratopause."

Line 158: Stylistic error with the use of inverted commas - "exact" should be "exact". This error is observed at several instances throughout the manuscript, such as, lines 186, 195, 401, 415, 421, and Fig 10 caption.

Line 263: The authors could briefly describe the convolution method since the reference is still under review. This would help the readers to understand your method better.

Figure 10: It is a very intriguing plot which has been well explained in the text. I understand that the new correlation method has improved the Gloria standard method. I also understand that the CLaMS new method is comparable with the CLaMS clock tracer method, making the correlation method reliable. However, I am wondering why the use of the new method is increasing the distance between the Gloria measurements (magenta line) and CLaMS model results (dashed magenta) compared to the standard Gloria method (blue line). What could be a potential explanation of observations and model results becoming more distant between 18-21 km when using the new method?