

Atmos. Chem. Phys. Discuss., referee comment RC2  
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## Comment on acp-2022-84

Anonymous Referee #2

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Referee comment on "Particle phase-state variability in the North Atlantic free troposphere during summertime is determined by atmospheric transport patterns and sources" by Zezhen Cheng et al., Atmos. Chem. Phys. Discuss.,  
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The authors described the phase states of aerosol particles collected in the North Atlantic FT and tried to explore the transport patterns of the aerosol particles. Such research topic is interesting for the atmospheric communities, and also the scope of the research is suitable in ACP journal. However, after carefully reviewing this manuscript, the evidence are rather weak to support the results, and conclusion is too generalized. In addition, many errors in the text, figures, Tables, and SI can be founded.

Major comments:

- During the laboratory experiments for the phase determination, at which relative humidity and temperature the ESEM did the authors perform? This should be clearly stated in the manuscript. The main issue is that how the authors can conclude the phase states of the aerosol particles if the relative humidity and temperature during the experiments were different compared to the field measurement periods? The phase states of aerosols are temperature- and relative humidity-dependent, and thus it didn't convince me whether the conclusion is still valid or not. This should be clearly mentioned through the manuscript. The authors should also show the ambient RH and temperature at the monitoring site in a figure and table.
- Regarding the technique of the tiled aspect ratios to determine the phase state of aerosols, I am confusing this technique is reliable for aerosols consisting of mixtures of organic materials and inorganic compounds. The authors should validate and carefully described the evaluation of the results with comparison to previous phase studies using well-known mixtures or commercial standards comprising organic and inorganics. I cannot find such validation from Cheng et al. 2021.
- Figures and SI should be revised (see also below). Moreover, all figures in SI should be mentioned in the main text.

## Minor comments:

- Page 5 line 136: The author should provide more details about stored conditions by mentioning temperature. Furthermore, the authors have to mention the stored period before the experiment due to evaporation issue.
- The authors should provide details about the particle regeneration in the experimental section if it regenerated from the collected samples.
- There are too many academic terms in the manuscript and it is suggested to add a table to summarize all acronyms and full names. The authors repeatedly used a similar abbreviation for the OC component with different names such as Organic (OC) (Page 7 line 192), and organic carbonaceous (OC) (Page 6 line 170). Abbreviation similarity should be consistent without repetition.
- Page 4 line 119: The author mentioned "This study focuses on detailed individual particle analysis on Pico 2017". In addition, on page 6 line 172, the authors mentioned "CCSEM-EDX based particle classification for Pico 2014 can be found in Lata et al., 2021, and that for Pico 2015 will be discussed in our future work". However, some data relevant to the phase state for the 2014 and 2015 shown in Fig. 5. Also, total carbon absorption (TCA) data showed in fig 6 for Pico 2014, and Pico 2015. It makes confusion to the readers regarding which data Pico 2014, Pico 2015, or Pico 2017 is exactly discussed in this manuscript. To avoid more confusion author has to focus more on Pico 2017 data or the data relevant to Pico 2014 and Pico 2015 should move to SI.
- Page 8: In the result and discussion section, the description of Fig. 1 looks confusing and keeps the reader browsing to keep up with the text. The text is littered with redundant statements in parentheses that re-state what has just been explained. Please specify them clearly.
- Page 10 lines 290-294: More careful and detailed description are needed for Fig. 2 by comparing it with the reported study because size distribution is a very important factor when defining the physicochemical properties of an ambient particle. Also, please add how you measured in Experimental.
- To make this manuscript understandable to the readers, I would like to suggest the authors move data relevant Pico 2014, Pico 2015 to the supporting information. It has been already published.
- The authors didn't describe clearly which samples were used for Fig. 4 which is relevant to STXM/NEXAFS spectra, Is that data relevant to Pico 2017? Even though there is no clear evidence in the description part (Page 11 line 323 to 329).
- Please clarify the captions of the SI.
- The title should be revised based on the main findings.