Reply to Review 2 (RC3):

The paper by Luckerath et al. addresses an important topic of aerosol dynamics in the boundary layer where large uncertainties exist in estimating particle fluxes either directly by flying platforms or by indirect/ground measurements. Although scientifically the study does not deliver substantial results, method comparison using specific experimental platform is very important in understanding advantages and limitations of different methods and their uncertainties. The paper is written and developed very well and should be suitable for publication after providing a better context and clarifying few details.

The study was performed over the Northeast Atlantic and the authors should be aware of the number papers over the same region which are relevant both methodologically as well as for their comparative value(Flanagan, Geever et al. 2005, Geever, O'Dowd et al. 2005, Ceburnis, O'Dowd et al. 2008, Ceburnis, Rinaldi et al. 2016)

We thank the reviewer for the positive feedback and agreed that more marine studies could be mentioned here. They used different approaches and measured usually closer to the sea surface and are therefore focused on the lower marine boundary layer, but should be mentioned in the introduction.

RC1 requested results on sea spray emissions in Mace Head and we added the following sentence and refences: 'Results from sea spray emission studies are published in e.g., Geever et al. (2005); de Leeuw et al. (2011) and Ovadnevaite et al. (2014).'

Additionally, we added right after the last sentence: 'Particle number fluxes during nucleation events at the Irish coast were studied by Flanagan et al. (2005) while Ceburnis et al. (2016) investigated sources and sinks of aerosol particles at the same location.'

Comments

Line 36 Very much disputed aspect that sea spray contributes little to aerosol number <300nm. Please refer to (Ovadnevaite, Manders et al. 2014, Xu, Ovadnevaite et al. 2021)

The discussion the papers mentioned above is partly also focused on the chemical composition of sea spray, the role of organic mterial as well as its hygroscopicity. Since our study is focused on the number concentration, we modified the sentence regarding the sea spray aerosol production in the following way: 'While the larger accumulation mode (diameter > 300 nm) is dominated by sea spray aerosol, the contribution of sea spray to the particle diameter range smaller than 300 nm is evaluated differently in the literature (Zheng et al., 2018; Ovadnevaite et al., 2014; deLeeuwet al., 2011} and is therefore subject of further research.'

Line 59. Azores are indeed a good location for flight-borne measurements, but is it perfect given dominant high-pressure systems, contributing to mixing? Methods confirm this by 2/3 of the campaign characterized by dry weather with low cloud fraction. Mid-latitude oceans on the other hand are dominated by low pressure systems.

Agreed. We modified the statement in the revised version to: 'In previous studies it turned out that the islands of Azores provide a good location for studying the MBL with low anthropogenic influence.'

Line 101. I wonder how much of the disturbance helicopter created during the ascent? Wouldn't the descent profile make more sense considering that external cargo was hanging below a helicopter?

During ascent and descent, the helicopter has always a true airspeed of about 20 m/s. The downwash is therefore deflected backwards and the measurements are not influenced by the helicopter. See also the introductory paper by Siebert et al. 2006 where a sketch and more detailed arguments describe this issue.

We added the sentence:'During ascent and descent, the helicopter has always a true airspeed of about 20 m s- and the measurements are not influenced by the helicopter (Siebert et al. 2006).'

Equation 3. Doesn't this formula produce unrealistic K values? E.g. K=0.3*0.3*20*48=86.4m2/s

Thanks for this hint. We checked the values and realized that there was a mistake in the calculation of \tau, which was a factor of 10 to high. The time resolution of our data was 0.1 s, but obviously, they were used in the algorhythm like 1s-data, which create these unrealistic values.

Accordingly, we now use the correct value of \tau = 4.8 s. This modification leads to values for F_K, which are by a factor of 10 smaller. However, they are basically still within uncertainties of the other methods and the main conclusion does not change.

We modified accordingly: F_K in all figures and in table 3 as well as the corresponding passages in the text.

Line 164. Should vTAS be vair?

Thanks for the hint! v_TAS is the true air speed and is also the parameter used in Eq. 4. Therefore, we changed v_air to v_TAS in Eq. 4.

Line 185. derivative instead of specification

Thank you for this comment. We modified the sentence: "The Mixed Layer Gradient (MLG) method is also based on flux-gradient similarity, and derived from K-theory."

Table 2. Comparison to environmental variables is lacking, like horizontal wind speed, etc.

It is challenging to put more environmental variables for profiles into this table. The vertical distribution of e.g. wind direction and speed as well as temperature are described for the whole campaign in the overview paper by Siebert et al., 2021. Therefore, we refer to this paper for more details.

We added the sentence to the figure caption: 'An overview over the synoptic situation, meteorological parameters and their vertical profiles can be found in Siebert et al., 2021.'

Ceburnis, D., C. D. O'Dowd, G. S. Jennings, M. C. Facchini, L. Emblico, S. Decesari, S. Fuzzi and J. Sakalys (2008). "Marine aerosol chemistry gradients: Elucidating primary and secondary processes and fluxes." Geophysical Research Letters **35**(7): L07804.

Ceburnis, D., M. Rinaldi, J. Ovadnevaite, G. Martucci, L. Giulianelli and C. D. O'Dowd (2016). "Marine submicron aerosol gradients, sources and sinks." Atmospheric Chemistry and Physics **16**(19): 12425-12439.

Flanagan, R. J., M. Geever and C. D. O'Dowd (2005). "Direct measurements of new-particle fluxes in the coastal environment." Environmental Chemistry **2**(4): 256-259.

Geever, M., C. D. O'Dowd, S. van Ekeren, R. Flanagan, E. D. Nilsson, G. de Leeuw and U. Rannik (2005). "Submicron sea spray fluxes." Geophysical Research Letters **32**(15): Artn L15810.

Ovadnevaite, J., A. Manders, G. de Leeuw, D. Ceburnis, C. Monahan, A. I. Partanen, H. Korhonen and C. D. O'Dowd (2014). "A sea spray aerosol flux parameterization encapsulating wave state." Atmospheric Chemistry and Physics **14**(4): 1837-1852.

Xu, W., J. Ovadnevaite, K. N. Fossum, C. S. Lin, R. J. Huang, C. O'Dowd and D. Ceburnis (2021). "Seasonal Trends of Aerosol Hygroscopicity and Mixing State in Clean Marine and Polluted Continental Air Masses Over the Northeast Atlantic." Journal of Geophysical Research-Atmospheres **126**(11).