

Response to Referee #3.

Rautiainen, L., Johansson, M., Lensu, M., Tyynelä, J., Jalkanen, J.-P., Stenbäck, K., Lonka, H., and Laakso, L.: Studying anomalous propagation over marine areas using an experimental AIS receiver set-up, EGU sphere [preprint], <https://doi.org/10.5194/egusphere-2025-1790>, 2025.

We thank Referee #3 for their time and the insightful comments that improved this manuscript. We have provided our responses to each comment below indicated with red font.

RC4 – Anonymous Referee #3 - 19 Sept 2025

An interesting manuscript showing ideas and possibilities to monitor atmospheric ducting conditions (near) real time, using relatively low-cost, off-the-shelf hardware.

The manuscript feels a bit long with a lot of details. The authors should consider leaving out some details in following chapters:

We thank the Referee for the valuable suggestions on how to condense the study. The length of the study was also pointed out by the other Referees. We have done the changes accordingly:

- remove/shortening last paragraph of chapter 2.1,
Done
- shorten chapter 2.2, ex details on sensors later removed are not necessary, L106-110
Done
- Remove chapter 2.5 and introduce eq 4 and 5 in introduction, second paragraph.
We removed the equations from chapter 2.5 and instead cited our previous studies where the same calculations were done. This significantly shortened the chapter.

The authors should be consequent when describing the 7 m and 30 m receivers. In some figures 30 is described first, while sometimes the 7 m receiver is described/plotted first. In figs 3, 7, 9, 12, 13, 15 the 7 m receiver is mentioned first, while in figs. 4, 5, 6, 10, 11, 16, 17, 18 the 30 m receiver is described/plotted first. This might be confusing to the reader. Suggestion is to consequently describe/plot 7 m first and 30 m second.

We thank the Referee for the suggestion; it is indeed quite inconsistent. We have fixed these as instructed.

In Discussion line 390-393 comparing your findings with Rautiainen 2025 and Norin 2023 where AIS is more often affected by ducting than X and C band radars: This difference needs a comment or discussion. Usually, higher frequencies (X and C band) are more affected by ducting and require lower/shallower atmospheric ducts than lower frequencies (VHF) to be captured in the duct.

This point was also raised by Referee #2 and as such we have written the same answer for both comments:

Our study cannot confidently state that the increased horizon (i.e. anomalous propagation) is only due to ducting, especially as our observations are limited to 59 m above the mean sea level. Based on the maximum wavelength (e.g. Kerr, 1951; Turton et al., 1988), X- and C-band generally require shallower (> 10 m) and weaker ducts than the VHF-band (> 100 m). While the X- and C-band are affected by evaporation and surface ducts, the VHF-band is more affected by elevated ducts, and our current set-up does not allow for detection of elevated ducts above 60 m.

We are planning a measurement campaign where soundings will be carried out at the measurement site which hopefully will shed some light on the issue. Meanwhile, there are no comparable studies that would allow us to compare our results. We hope that this study will inspire others to reproduce the study as the set-up is low-cost and simple to implement.

We have added the following:

“The X- and C-band are more affected by the surface ducts (~10s of meters), while the VHF-band is affected by the elevated ducts (~100s of meters). Unfortunately, the set-up at Utö is limited to the height of 59 m, which omits the assessment of elevated ducts. For future analyses, including weather soundings to account for the heights above 60 m is needed.”

Kerr, D. E., 1951: *Propagation of Short Radio Waves*. McGraw-Hill, 728 pp.

Turton, J. D., D. A. Bennetts, and S. F. G. Farmer, 1988: An introduction to radio ducting. *Meteor. Mag.*, **117**, 245–254.

Details, line by line:

53: Consider using Gunashekar et al. 2010, ‘Long-term statistics related to evaporation duct propagation of 2 GHz radio waves in the English Channel’ instead of Gunashekar et al 2006.

We appreciate the very interesting article recommended by the reviewer. We added a line to also acknowledge UHF frequency and included the recommended article. This article will help us in our future studies also, thank you!

75: Clarify that M-profiles are derived from the mast measurements of T, RH.

Fixed.

Fig. 1 a) Arrows pointing at the AIS receivers.

Done.

144: Is the maximum estimated AIS range for the 7 m receiver correct? Text says 65-80 km, while in Fig 3 it seems to be approx. 50-75 km. Or do I interpret Fig 3 wrong? I interpret the maximum AIS range to be where the dashed and dotted green and pink lines cross the black -115 dB line. For 30 m receiver text and Fig 3 are coincidence.

We thank the reviewer for noticing this error, it should say 50-75 km. We have fixed this in the text.

171: Remove the part “the refractivity N”. You have already introduced ‘M’ and said that “For all practical purposes, M is used ...” in line 168. The sentence could then be ‘In order to study if ducting influences the AIS range observed in Utö, the modified refractivity M (Eq. 4 and 5) were calculated’

Fixed.