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Comment on egusphere-2022-39

David Holdsworth (Referee)

Referee comment on "On the use of high-frequency surface wave oceanographic research radars as bistatic single-frequency oblique ionospheric sounders" by Stephen R. Kaeppler et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-39-RC2, 2022

This is a very interesting paper that is of value to the ionospheric sensing community. It demonstrates that a low-cost software defined receiving system can be used to receive transmissions from other HF users, and contribute meaningful propagation path and travelling ionospheric disturbances (TIDs) information to the community. The paper is well written and structured.

Unfortunately I have only had the opportunity to read the paper once (my bad), but would like to read it at a later date, and may make further comments later.

I have four reservations that I'd like the authors to address:

- There is a no information provided about how the signal transmitted by the CODAR propagates into the ionosphere. CODARs are designed to transmit signals at low elevation towards the sea so the transmitted waveform "adheres" to the sea surface, rather than into the ionosphere which can potentially introduce "clutter" signals that impact the interpretation of the sea scatter the radar seeks to exploit. One presumes the majority of the signal received is transmitted through the sidelobes (or backlobes) of the CODAR transmit array? Figures 2 and 3 (particularly the latter after 2200 UTC) reveals range spreading indicative of multi-path, likely from horizontally transmitted signal that is then backscattered off sea-waves into the ionosphere. It would be worth doing a simplified signal analysis that includes a) the transmit antenna pattern and b) backscatter coefficients to give a clearer picture of the transmission path.
- I would like to see more effort expended in interpreting the ionospheric processes responsible for some of the features observed in Figures 2 and 3. I realize the intent of the paper is to demonstrate the sensor capability, but having made reasonable efforts to describe some of the ionospheric processes it is a shame that this has not been taken to a logical conclusion. For instance, there is no reference to the multi-hops observed. The "hoops" are a well known phenomenon where the "nose" of the F2 low

"breathes" in and out such that the maximum usable frequency "oscillates" about the transmission frequency. Unfortunately I'm unable to locate a reference for this at present, but I'm sure there must be one available if the authors are prepared to put in the effort. I also note that the aforementioned range spreading on the F2-low mode around 2200 UTC looks like mid-latitude spread-F. Having said that, spread-F occurs typically after midnight local time. As discussed above, this spreading may be indicative of multipath, which may indicate a weakness of the proposed receiving system in that it may be unable to unambiguously verify existence of spread-F, a phenomena often thought to be associated with TID's.

- Instead of operating the receivers as fixed frequency sounders, the authors could operate them as swept frequency sounders which may potentially yield improved ionospheric information. Have the authors considered this? What are the pros and cons for such operation?
- I find the authors reference to "open" and "closed" propagation channels misleading. They appear to use "open" to mean there is no propagation path available. This contradicts the terminology used in the HF communications were "open" means "available for use". I suggest the authors use less ambiguous terms to clarify whether a propagation channel is available.

Some minor issues and grammatical comments:

- the comment about GPS TEC on line 32 slightly misses the mark. GPS TEC is a path-integrated quantity that is strongly *influenced* by the peak electron density, rather than *biased* by it. The use of the word *bias* suggests that the estimated value is incorrect.
- Line 119 states "We use the E-region or surface wave as a means by which to calibrate for an absolute group range". Only the DUCK CODAR in Figure 2 shows any sign of (weak) surface wave signal (at 1600 km between 10 and 15 UTC) so I have doubts as to how useful the surface wave is for range calibration. The surface wave signal may be more useful at higher frequencies where there is less groundwave attenuation
- Line 258: "qualitative" should be "qualitatively".
- Line 259: suggest replace "which is a" with "which illustrates the results from a".
- Line 260: suggest replace "produce similar virtual height as the virtual height extracted" with "produce similar virtual height as that extracted"
- Line 318: replace "go down" with decrease.
- Line 319: replace "optimal" by "optimally".
- Figure 4: please fix the caption, which the caption runs of the edge of the page.