Review ESSD-2022-303, radar detection ionosphere

Assurance: This particular data product and data description might make nice publication in ESSD. Initial flaws coupled with absence of key pieces of information, but once authors fix those and make a few other improvements, I could recommend for publication.

Authors should check ESSD guidelines, at https://www.earth-syst-sci-data.net/10/2275/2018/. Please note importance of uncertainties and validation.

I agree with substance and tone of earlier review. I repeat and amplify some of those points below.

Data easy to access and read.

Note: this reviewer prefers term 'diel' to include diurnal (daylight) and nocturnal (night-time) measurements. One advantage of diel: it does not specify mid-day or midnight maximum or minimum.

The word 'uncertainty' appears nowhere in this manuscript. Have these authors, unique in vast world of geophysics, finally achieved perfect data? Doubtful. Authors show raw and filtered data (e.g. Figs 6, 8, 9) or high (temporal) resolution data (Fig 11), with, often, actual frequency response extents of digital filters, but never an error bar. To trust and use these data, e.g. with Doppler shifts of 1 Hz, readers will need to know: variations in transmit frequency and power (authors mention at lines 104, 105 but never quantify); attenuation as it might affect frequency and power of transmitted and refracted pulses; actual refraction terms e.g. dependencies on TEC, on EC gradients, other factors; antenna gain; accuracy and uncertainty of reception; certainty of GPS reference time / oscillators (high, one hopes); etc., all for a stable medium. Then add in horizontal and vertical velocity changes on time scales from minutes to seasons, from which the authors propose detection of e.g. diel or transients patterns. A complicated chain of multiplicative uncertainties exists, from source to receiver, but authors give no hint. If authors don't quantify, how can users have confidence in their data? If, even cumulatively, uncertainties remain very small (signal to noise remains very high), or - as seems likely - uncertainty varies as a function of receiving equipment, tell us so. Prove that you know and have addressed uncertainties.

Likewise for validation. Give readers/users evidence that these measurements replicate real features. Diel patterns well known from e.g. ground-based radar, balloon-based spectrometers, satellite-based column TEC measurements? Fig 11 hints at validation (e.g. because it includes satellite data and shows both power and frequency), but authors need to provide users with validation examples. These data improve on other types? Great, show/prove it. Authors say (line 166) "discussion on validation may be found in … Gibbons". No! That paper reports hardware (receiver, frequency) performance but says nothing about seasonal patterns, vertical refraction profiles, etc. Here you want to show real data derived from these hardware systems? Prove that your data reproduce, or perhaps improve on, prior or other measurements. Validate your work!

Fig 4 shows midpoints but authors never mention, much less explain? These represent supposed refraction points/regions? Given beam dispersion and gradients of refraction index, with what horizontal or vertical uncertainties? If authors consider midpoints irrelevant, leave them out. If relevant, explain them, with uncertainties.

Fig 1 comes verbatim from Gibbon et al. 2022b. And, perhaps from other previous work from this group? Settle on definitive source, use that to establish copyright, then all subsequent uses must cite original. E.g. 'reproduced from', 'adopted from', 'modified from', your choice as

appropriate. The reader doubts clean symmetrical transmission / refraction patterns as implied in Fig 1.

Data address only Grape 1 and only source signals from WWW (Ft Collins). If authors want to mention other potential sources (necessitating different receiver frequencies), they should do so in Discussion. Including, as they do now, mention of WWVH (Hawaii) and of CHU (Canada, Ottawa), in Abstract and again in Introduction, when data only come from continental USA stations, seems misleading at best.

What do authors actually see for future of this technology? Global coverage? With what spacing? Stations outside of narrow mid-latitude regions? Again, reader gains a glimpse of network (longitudinal) spacing goals (e.g at line 103) but without follow-up or confirmation. To resolve what features? How do you improve on, validate, out-compete, etc., SuperDARN, rockets, ionosondes, satellites, etc. Any forecast possibility? Explain how systematic coverage could provide better understanding of solar impacts? How a less-expensive network compliments or replaces current capabilities. In present system, roughly half of stations inoperable at any one time (e.g Fig 5); with what impact? How does down-time impact or interact with network goals? Anchor these systems in science that you want to do. Get readers / users excited about new possibilities. Who else (outside of ionosphere / space weather communities) might use these data? If you think you have potentially a good product / good solution, give some hints about who might benefit!

Finally, we need some description other than ‘citizen science’. Citizen science as ESSD promotes involves passive engagement (allow installation of weather station in garden), or active non-technical observation (standing near runway counting flights and noting tail numbers). Even CoCoRaHS, the USA NWS rain hail and snow network, which involves specific training and establishes measurement guidelines, does not require soldering, flashing of microcomputers, obtaining (at some cost in some countries) call signs (e.g line 71), transferring and uploading from SD cards, switching over (expensive) radio equipment for those using said systems, etc., as necessary for these participants. I work extensively with sensors, small networks, Arduino, etc., but I probably would not take on efforts as required here. Unless I could see real social benefit (see prior paragraph). Radio enthusiasts? Advanced community space weather trackers (ACSWT)? Not really citizen science as we understand.

A few typos exist. Authors should please give careful read as they prepare revisions. Better you and now than later at proof-reading stage.