Reviewer #1 (Formal Review for Authors (shown to authors)):  
  
I found this paper to be well written, important and quite topical. I liked the embedded movies - they are very well done. I recommend publishing pretty much as is.  
  
It is the coming of age of electronically steerable array ISRs that makes this paper truly valuable. Even before we had the capability of nearly instantaneous pointing (or steering) of the ISR beam, the space-time ambiguity was an issue and needed to be resolved in various ways. Basically, of course, to get good statistics one needed to assume the medium was not changing. To even make sensible measurements at all on parameters like the vector velocity, one had to make some serious assumptions about the medium. All of this was done and the results were quite good.  
  
But with the advent of electronically (read quasi-instantaneous) steering a whole range of new capabilities has been opened up and a more sophisticated way of estimating the errors of the different parameters is required. And that is just what this paper does with the introduction of SimISR.   
  
To be honest, I did not check the simulation methodology math - but I could follow it and it 1) seems reasonable 2) references all the right people and 3) builds on other solid peer-reviewed papers.  
  
I particularly like the examples of possible uses of SimISR because they are not esoteric at all, but examples of real physical interest (like resolving a dense but thin fast moving electron density layer - like an auroral arc --in a broader but less dense ionosphere).   
  
I think there are two important take away messages from this paper: 1) the ESA ISRs can do a lot and make some important discoveries - even esoteric things that may happen on time scales of an inter-pulse period, but many of those capabilities can only be fully exploited and the results believed if we have a formal process for determining the errors; and 2) given the myriad of possible observing modes or arrangements it is not possible to determine what is the optimal way to make the measurement of interest without a tool like SimISR.  
  
So kudos to the authors!  
  
But I did say I "publish pretty much as is". What could be changed or added? Well the authors do point out SimISR is open to all and even provided a website with instructions on how to use it. That's exceptional. But I feel the all the ISRs and the ESA ISRs in particular are very underutilized and this tool could be a big step forward in improving that. So I would like to see something more active and less passive - perhaps, as a start, mentioning it as something to be taught at the annual ISR summer school and, of course, making the proper arrangements to do so. A trivial addition to an important and well done paper.  
  
The authors want to thank the reviewer for their input and are proud to have such a forceful endorsement. We are working on adding some more education focused examples. Currently we have one ipython notebook example which will allow students or new users to interact with the simulator in a more direct way. We have plans to expand this interactive capability and possibly point out this tool at the ISR Summer school as well.  
  
Reviewer #2 Evaluations:  
Significant (Required): The paper has some unclear or incomplete reasoning but will likely be a significant contribution with revision and clarification.  
Supported (Required): Yes  
Referencing (Required): Mostly yes, but some additions are necessary.  
Quality (Required): Yes, it is well-written, logically organized, and the figures and tables are appropriate.  
Data (Required): Yes  
Accurate Key Points (Required): Yes  
  
Reviewer #2 (Formal Review for Authors (shown to authors)):  
  
Review of Observability of Ionospheric Space-Time Structure with ISR: A Simulation Study  
  
Summary: This study presents a newly developed Incoherent Scatter Radar (ISR) simulator and attempts to use this simulator to examine some common questions about the errors inherent in ISR measurements. This simulator will have several uses outside of the scope of this original manuscript (like the future potential to directly assimilate ISR raw measurements into ionospheric models), which easily warrants acceptance by the publication.   
  
My overall recommendation for this manuscript is that "Minor Revisions" are necessary in order for this manuscript to be accepted for publication.   
  
This work is well presented and follows a logical progression. It fits well within the scope of the journal. The figures are clear and largely necessary.  
  
Minor Revisions:  
- Please provide a few more details with regard to your treatment of the beamwidth in your simulator.

An extra paragraph to section 3.1 has been added that describes the beam patterns. References to specific patterns are given.  
- Consider revising your statement on lines166-169. The statement can be a bit confusing, as the use of several widely separated points raises other questions about errors as a result of spatial smoothing, which depend on the larger-scale correlations in the plasma and its motion (discussed to some extent later on in the paper). Your statement about the Debye length goes largely without saying, as I doubt anyone is concerned about correlations at those scales here (we're talking several orders of magnitude smaller grid scales before one would begin to be concerned about the Debye length here).

The statement is necessary to argue that only the time-correlations of the fluctuations are needed to model the process, thus allowing the use of the filter structure that is proposed. The Debye length gives the physical reasoning behind why the spatial correlations can be neglected in the modelling.   
- Lines 321-322 - Please elaborate.

Changed too “Another observation is that as the number of pulses increases the bias and skew in the measurement is reduced. This is likely due to closer convergence to a Gaussian like distribution as more pulses are added. The electron density measurement is proportional to the 0$^th$ lag of the ACF, along with a multiplication by $1+T\_r$. This would cause the distribution to become more Gaussian like as more pulses are added through the Central Limit Theorem \citep{papoulis2002}. Also of note these histograms are 1-D projections from a 4-D distribution that likely has a very elaborate correlation structure, due to the relationship between the ACF and plasma parameters being very complicated.”  
- Provide a reference for the PFISR system specifications (lines 311-312) or provide the specifications in the text.  
Reference added.  
Grammar Adjustments:  
1) The author tends to use "which" excessively. When a set-off clause is not necessary, one should use the word "that". If a set-off clause is necessary, then please use "which" with appropriate comma ahead of it and after the clause. (i.e. Line 165 should read: "a nearest neighbor rule is used that selects the closest point in...". The unlabeled lines between lines 120 and 121 demonstrate an example of proper use of the word "which"). I only mention this because, in a few instances, the use of "which" somewhat confuses the meaning of the statement.

Changed a number of cases of “which” to “that” including the specific cases highlighted.  
2) A bit of a nit-pick: If you are considering using "As such," or "However," to start a sentence, please instead consider using a semi-colon (i.e. "; however," and "; as such,"), as these are subservient clauses.

Adjusted in a few cases.  
3) Insert "the" after the "and" on Line 325.

Done  
4) Line 529: "antenna based" should be "antenna-based".

Done  
  
Things to Consider:  
1) While this paper is branded as an evaluation of the errors due to our assumptions and the limitations of ISR measurements (time integration, etc...), it serves somewhat better as a presentation of a new ISR simulation model with a few examples of its use (i.e. focused more on the simulator). If we are to consider errors in ISR measurements as a whole, other error sources come to mind, such as those from solid targets (satellites/meteors) or from the process of calibrating electron density from these ISRs (RISR, for example) with local ionosonde measurements, which are single point measurements that are not fully collocated with one of the ISR beams.

It is true that the scope of the error analysis is limited to impacts from the ambiguity and measurement variance. This was done to highlight the tradeoffs researchers have to face with respect to these two sources of error and how SimISR can help inform choices with experiment design. In the case of solid targets order statistics can be used to reduce the impact and often this takes place during the noise estimation period, see lines 267-269. Returns from solid and coherent targets can be incorporated into SimISR with some adjustment to the software.   
  
  
  
Reviewer #3 Evaluations:  
Significant (Required): The paper has some unclear or incomplete reasoning but will likely be a significant contribution with revision and clarification.  
Supported (Required): Yes  
Referencing (Required): Yes  
Quality (Required): Yes, it is well-written, logically organized, and the figures and tables are appropriate.  
Data (Required): Yes  
Accurate Key Points (Required): Yes

This is the review of the manuscript titled: ̈Observability of Ionospheric Space-Time Structure

with ISR: A Simulation Study ̈ by J. Swoboda et al.

The article is written as a development of a simulation tool, SimISR, based on Incoherent

Scatter Radar theory, which is used to put under test three ionospheric scenarios. The article

is well written, follows a logical order, has a good set of references, proposes a relevant

contribution to the ISR community and points out interesting results about experiment set ups.

The images and videos are good and make the point. I recommend the paper for publication

although I consider that the article could be strengthened in a specific area:

1) There is not much justification about the noise statistical selection representing the electron

random behavior. I am unsure what is the ground (physically) for the treatment and I would

like to see, if possible, a more detailed explanation of why the noise is considered white and

multiplicative in frequency.

The argument that the returns can be modelled by Gaussian random variables comes from the Central Limit Theorem. There can be 1011 free electrons in a cubic meter at the peak of the F-region the measurement often covers numerous cubic km, thus there are a large number of Hertzian dipoles (the electrons) radiating EM randomly. The frequency spectra is informed by the electrical interactions of the ions and electrons, which give the time correlation that leads to the double humped spectral shape. This correlation structure is covered in much of the literature, such as in Kudeki and Milla’s 2011 IEEE paper and similar treatments. This leads to the model that we are using for the returns from the IS process, which is a shaped Gaussian noise process.

The filtering technique to create the shaped Gaussian noise is commonly seen in the statistical signal processing literature (Papoulis 2002). As stated in the paper it has been used in vocoders to represent the spectral shape of the sounds that are created from the human vocal tract (Rabiner 2010).

It is true that one could create returns using techniques that more closely resemble the processes that are taking place in the plasma. Though in order to produce the amount of data that is required for a 3-D simulation techniques, like PiC simulations, would be far too computationally expensive.

Although the article is in good shape I recommend to give a last view in search of typos and

mistakes. Some of the issues I found are:

1) Notation excess. In equation 9, if I understood well, ̈k ̈ represents discrete times.

However, in equation 10 ̈k ̈ represents wave number.

Changed to “I” in this case due to k also representing wave number.

2) In equation 14, the bracket is not described or defined. Is it mean average of the

assembles?

Changed to improve the clarity of the statement.

3) Line 269 I think the ̈P ̈ should not be capital.

Changed to lower case.

4) Line 270 ̈..from a models ̈ should change to ̈...from a model ̈

Fixed

5) Line 315, erase ̈To calculate ̈ or review the sentence.

Fixed

6) Line 361, erase extra ̈of ̈

Fixed

7) Line 369, erase extra ̈instead ̈

Fixed

8) Line 433, ̈...free parameters can... ̈ might change to ̈...free parameters that can... ̈

or review the sentence

Fixed

9) Line 503, either erase result or yield or review the sentence

Fixed

10) Caption Figure 1, should it say ̈form ̈ instead of ̈from ̈? Or you should erase the first

̈a ̈

Fixed

11) Caption Figure 15, please change ̈...an polar cap... ̈ to ̈...a polar cap... ̈

Fixed

12) Please review references. There are some mistakes in them. Examples are: Line

566, change ̈n/a-n/a ̈ (same issue in line 597), Line 569 ̈Fregion ̈ should say ̈F-

region ̈, Line 700 ̈..... ̈and ̈n/a-n/a ̈.

Fixed