Drones and global navigation satellite systems: current evidence from polar scientists

Iain Sheridan

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Final acceptance: 26 February 2020

Note: Reports are unedited and appear as submitted by the referee. The review history appears in chronological order.

Review History
RSOS-191494.R0 (Original submission)

Review form: Reviewer 1 (Katarina Gårdfeldt)

Is the manuscript scientifically sound in its present form?
Yes

Are the interpretations and conclusions justified by the results?
Yes

Is the language acceptable?
Yes

Do you have any ethical concerns with this paper?
No

Have you any concerns about statistical analyses in this paper?
No

Recommendation?
Accept as is
The authors make a significant contribution to the field of using drones for earth observations, especially at high latitudes, by addressing the possible uncertainty when applying various positioning systems and drones.

The survey made in the study shows that among the responders GPS navigation system or GPS combined with other systems (e.g. GLONASS and GALILEO) were most common. One important contribution the authors make is to showcase the need of studying the effect of phase scintillation on various navigation systems over polar regions not only when using GPS but also e.g. BEIDOU, GALILEO and GLONASS systems for drone navigations.

Review form: Reviewer 2 (Joseph N. Pelton)

Is the manuscript scientifically sound in its present form? Yes

Are the interpretations and conclusions justified by the results? Yes

Is the language acceptable? Yes

Do you have any ethical concerns with this paper? No

Have you any concerns about statistical analyses in this paper? Yes

Recommendation? Accept with minor revision (please list in comments)

Comments to the Author(s)
This is a very interesting survey. The changing conditions in terms of the GNSS satellite systems, new capabilities such as the Aeron system on Iridium, and especially the changes in multi-system receivers and their declining costs should be noted.

Decision letter (RSOS-191494.R0)

24-Jan-2020

Dear Mr Sheridan,

On behalf of the Editors, I am pleased to inform you that your Manuscript RSOS-191494 entitled "Drones and Global Navigation Satellite Systems – current evidence from polar scientists" has been accepted for publication in Royal Society Open Science subject to minor revision in accordance with the referee suggestions. Please find the referees' comments at the end of this email.

The reviewers and handling editors have recommended publication, but also suggest some minor
revisions to your manuscript. Therefore, I invite you to respond to the comments and revise your manuscript.

• Ethics statement
If your study uses humans or animals please include details of the ethical approval received, including the name of the committee that granted approval. For human studies please also detail whether informed consent was obtained. For field studies on animals please include details of all permissions, licences and/or approvals granted to carry out the fieldwork.

• Data accessibility
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If you wish to submit your supporting data or code to Dryad (http://datadryad.org/), or modify your current submission to dryad, please use the following link: http://datadryad.org/submit?journalID=RSOS&manu=RSOS-191494

• Competing interests
Please declare any financial or non-financial competing interests, or state that you have no competing interests.

• Authors’ contributions
All submissions, other than those with a single author, must include an Authors’ Contributions section which individually lists the specific contribution of each author. The list of Authors should meet all of the following criteria; 1) substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; and 3) final approval of the version to be published.

All contributors who do not meet all of these criteria should be included in the acknowledgements.

We suggest the following format:
AB carried out the molecular lab work, participated in data analysis, carried out sequence alignments, participated in the design of the study and drafted the manuscript; CD carried out the statistical analyses; EF collected field data; GH conceived of the study, designed the study, coordinated the study and helped draft the manuscript. All authors gave final approval for publication.

• Acknowledgements
Please acknowledge anyone who contributed to the study but did not meet the authorship criteria.

• Funding statement
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Once again, thank you for submitting your manuscript to Royal Society Open Science and I look forward to receiving your revision. If you have any questions at all, please do not hesitate to get in touch.

Kind regards,
Royal Society Open Science Editorial Office
Royal Society Open Science
openscience@royalsociety.org

on behalf of Dr Bethan Davies (Associate Editor) and R. Kerry Rowe (Subject Editor)
openscience@royalsociety.org

Reviewer comments to Author:

Reviewer: 1
Comments to the Author(s)

The authors make a significant contribution to the field of using drones for earth observations, especially at high latitudes, by addressing the possible uncertainty when applying various positioning systems and drones.

The survey made in the study shows that among the responders GPS navigation system or GPS combined with other systems (e.g. GLONASS and GALILEO) were most common. One important contribution the authors make is to showcase the need of studying the effect of phase scintillation on various navigation systems over polar regions not only when using GPS but also e.g. BEIDOU, GALILEO and GLONASS systems for drone navigations.

Reviewer: 2
Comments to the Author(s)

This is a very interesting survey. The changing conditions in terms of the GNSS satellite systems, new capabilities such as the Aerion system on Iridium, and especially the changes in multi-system receivers and their declining costs should be noted.

Author's Response to Decision Letter for (RSOS-191494.R0)

See Appendix A.
Decision letter (RSOS-191494.R1)

26-Feb-2020

Dear Mr Sheridan,

It is a pleasure to accept your manuscript entitled "Drones and Global Navigation Satellite Systems – current evidence from polar scientists" in its current form for publication in Royal Society Open Science.

Please ensure that you send to the editorial office an editable version of your accepted manuscript, and individual files for each figure and table included in your manuscript. You can send these in a zip folder if more convenient. Failure to provide these files may delay the processing of your proof. You may disregard this request if you have already provided these files to the editorial office.

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Thank you for your fine contribution. On behalf of the Editors of Royal Society Open Science, we look forward to your continued contributions to the Journal.

Kind regards,
Anita Kristiansen
Editorial Coordinator

Royal Society Open Science
openscience@royalsociety.org

on behalf of Dr Bethan Davies (Associate Editor) and R. Kerry Rowe (Subject Editor)
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**Appendix A**

**Reviewer 2 Comment 1 to the Author**

The author should note the changing conditions in terms of GNSS satellite systems, such as the *Aerion* system on *Iridium*.

**Author response added to article**

Subject to research funding constraints, some polar scientists may benefit from assessing cutting-edge, privately-owned satellite systems for drone PVT. As just one example, in 2019 Iridium completed the launching of its 66 low Earth orbiting (LEO) satellite system. This Iridium constellation carries Aireon aviation flight tracking technology that allows commercial aircraft to transmit their GPS positions once every half second at any point around the planet. The Iridium satellites, as a network, transmit aircraft positions to a ground-level receiver. This Iridium constellation provides real-time, 100 per cent coverage of Earth.

One consequence of the Aireon technology is an increased likelihood of locating a crashed aircraft. The permanent loss of aircraft, in the way that Malaysia Airlines Flight 370 disappeared in 2014, can be minimised. For high value drones making beyond line of sight flights, this Aireon technology provides a higher probability of recovering crashed drones.

**Reviewer 2 Comment 2 to the Author**

The author should note the changing conditions in terms of GNSS satellite systems, especially the changes in multi-system receivers and their declining costs.

**Author response added to article**

Polar scientists are aware of the inexorable trend of new GNSS technology providing more than GPS. This trend is driven partly by the decreasing cost of positioning, velocity and timing (PVT) semiconductor components in both drones and ground station receivers that provide multi-GNSS options. Typically, such PVT components contain BEIDOU, GALILEO, GLONASS and GPS options, with the ability to concurrently always provide for at least two of these GNSS.