The University of Birmingham
Registry - Academic Services

DOCTORAL REPORT FORM
PART ONE: INDEPENDENT REPORT ON THESIS
(A JOINT REPORT IS NOT ACCEPTABLE)

Independent Report normally 500 words which should address the following.

a) Was the nature and purpose of the research made clear and was this substantially achieved?
b) To what extent does the thesis demonstrate that the candidate has an adequate understanding of the subject and knowledge of the literature? Is there coverage of recent and relevant literature in the field of study which shows critical appraisal and an original synthesis?
c) Has the candidate chosen the appropriate methodology for the study? Is the methodology then used effectively? Are the findings interpreted in a valid way?
d) What evidence is there of independent critical and analytical skills, and the ability to evaluate evidence?
e) Is there an understanding of the theoretical field associated with the study? Is the linkage and balance between practical investigation and theory satisfactory?
f) Are the arguments put forward in an appropriate and coherent form?
g) To what extent does the thesis show evidence of originality and make a contribution to knowledge? Does it contain matter suitable for publication in whole or in part in a learned journal or the equivalent?
h) What is your view of the overall quality of the research described in the thesis?
i) Is the synopsis an adequate summary of the work presented?
j) Is the thesis clearly written and presented? Is the style and structure of the thesis satisfactory?

Overall the research was clearly presented, and the purpose of the work was well described. The thesis demonstrates that the targeted goals were achieved. Recent and relevant literature in the field is well covered. The thesis shows an excellent understanding of the subject. The only additional literature that should be covered would be some discussion on the actual impacts of GLEs / GCRs – especially since Space Weather (as in the thesis title) is focused on impacts and applications as opposed to Space Science. The methodology is appropriate, rigorously implemented and well interpreted. A wide range of evidence is presented demonstrating critical analysis and the appropriate evaluation of evidence. The thesis does an excellent job combining practical investigation with underlying theory. It flows nicely from chapter to chapter, arguing the key points appropriately and well. The thesis demonstrates much originality, in theory and practicality. This is further demonstrated with the fact that two journal papers have been published from the research. Overall the research described is of excellent quality. The synopsis is a good summary of the work which has been undertaken and the thesis is well presented, clearly and concisely. Each chapter starts with a good introduction and an excellent concluding summary of the key results. The style and structure of the thesis is good with only a few minor grammatical and structural changes required.

Continue on a separate sheet if necessary.

Please return this part BEFORE the Oral, (keeping a copy for yourself) to Research Student Administration via e-mail to pgrstudentrecords@contacts.bham.ac.uk.

Date Of Oral (please insert) **An oral examination is compulsory for a doctoral thesis**	**14/05/2021**

Examiner	**Name (Block Capitals)**	**Signature (if sending by e-mail insert "by e-mail"**	**Date**
Internal	SEAN ELVIDGE	By e-mail	13/05/2021

DOCTORAL REPORT FORM
PART TWO: JOINT REPORT ON THE ORAL EXAMINATION

A joint report (approximately 200 words), should be completed immediately after the oral examination and returned, with Parts 3 and 4, to Research Student Administration via e-mail to pgrstudentrecords@contacts.bham.ac.uk.

Date of Oral (please insert) **An oral examination is compulsory for a doctoral thesis**	14/05/2021

Overall Eddie's oral examination was excellent and confirmed the initial impressions of the thesis formed by both examiners. Following a thorough, but concise, introduction to his research area, with particular focus on the novel elements of the work, a detailed, chapter-by-chapter, work through of the thesis was undertaken.

Throughout the examination Eddie showed maturity of thought, answered questions well and, when presented with something he was unsure about, made logical deductions from what he did know to try answer the questions. Both examiners agree that it was a very enjoyable discussion and perfectly complemented a good thesis. We are happy to recommend that the degree be awarded subject to minor corrections.

Examiner	**Name (Block Capitals)**	**Signature (if sending by e-mail insert "by e-mail"**	**Date**
Internal	SEAN ELVIDGE	By e-mail	14/05/2021

DOCTORAL REPORT FORM
PART THREE: FINAL RECOMMENDATION

- For definitions of minor and major corrections and revise and resubmit and their time limits, please refer to the Examiners Guidance Notes.
- Where a recommendation is minor or major corrections or revisions to the thesis, examiners must complete Part Four of the report.
- Where examiners agree, a joint Part Three report should be completed.
- Where examiners are unable to agree on a final recommendation, please refer to the Examiners Guidance notes. In this situation each examiner should complete a separate final recommendation form**.**

The whole examination process should be completed by 27 May 2021.

I/We recommend:		Tick One Option
1.	**Degree to be awarded**	☐
2.	**Degree to be Awarded Subject to Minor Corrections** (Complete a list of corrections on Part 4). The normal timeframe for completion of minor corrections is one month. Please state here if the examiners wish to give the candidate a longer period. Click here to enter text. An electronic copy of the corrected thesis will be emailed to the internal examiner for checking. If you prefer to check a paper bound copy please tick here ☐	X
3.	**Degree to be Awarded Subject to Major Corrections** (Complete a list of corrections on Part 4) The normal timeframe for completion of major corrections is six months. Please state here if the examiners wish to give the candidate a longer period. Click here to enter text. An electronic copy of the corrected thesis will be emailed to both examiners. If you prefer to check a paper bound copy please tick here ☐	☐
4.	**Degree to be Revised and Resubmitted for the same degree** (Complete a list of corrections on Part 4). A further oral will be held following resubmission. The normal timeframe for revision and resubmission is one year. Please state here if the examiners wish to give the candidate a longer period. Click here to enter text.	☐
5.	**That the degree should not be awarded**, but: (Please tick **<u>one</u>** of the following options)	
	a) **Award an appropriate Masters degree.** (The candidate shall have the right of appeal.) Enter programme title of Masters degree here: Click here to enter text.	☐

	b) **Award an appropriate Masters degree, subject to Minor/Major* Corrections** (*please delete as appropriate). (Complete a list of corrections on Part 4 of the report form). (The candidate shall have the right of appeal.) Enter programme title of Master's degree here: Click here to enter text. The normal timeframe for completion of minor corrections is one month and for major corrections six months. Please state here if the examiners wish to give the candidate a longer period. Click here to enter text. An electronic copy of the corrected thesis will be emailed to the Internal for minor and both examiners for major corrections. If you prefer to check a paper bound copy please confirm here ☐	☐
	c) **Revised and Resubmitted for an appropriate Master's degree.** (The candidate shall have the right of appeal.) (Complete list of corrections on Part 4.) Enter programme title of Masters degree here: Click here to enter text. The normal timeframe for revision and resubmission is one year. Please state here if the examiners wish to give the candidate a longer period. Click here to enter text.	☐
6.	**Rejected,** without opportunity for resubmission. The degree will not be awarded. (The candidate shall have the right of appeal.)	☐

Examiner	**Name (Block Capitals)**	**Signature**	**Date**
Internal	SEAN ELVIDGE	By e-mail	14/05/21
External	SARAH MATTHEWS	By e-mail	21/05/21

DOCTORAL REPORT FORM
PART FOUR: LIST OF CORRECTIONS/REVISIONS

This part must be completed in all cases where the recommendation is minor or major corrections or revise and resubmit the thesis.

To remove any ambiguity examiners should be explicit in the guidance given with regard to corrections.

Corrections have been noted on the body of the thesis	YES	~~NO~~
If yes, has the thesis been returned to candidate	YES	~~NO~~

Corrections have been noted in the thesis, below are the page numbers where changes are needed. Longer comments (if not obvious from the noted corrections in the thesis) appear after the page number list:

i, xxvi, xxviii, 1, 3, 4, 5, 7, 8, 10, 11, 13, 14, 15, 17, 18, 19, 20, 22, 27, 34, 35, 37, 39, 45, 47, 51, 55, 57, 67, 69, 73, 74 75, 76, 77, 78, 79, 82, 84, 91, 92, 93, 98, 103, 107, 108, 112, 113, 115, 116, 117, 119, 120, 121, 124, 128, 130, 134, 140, 150, 155, 157, 158, 160, 161, 165, 166, 168, 204, 206, 217, 226, 237.

- Pg 1. Technically the 11 year cycle is known as the sunspot cycle, not the solar cycle, which you note later in the paragraph anyway. Re-word to make the distinction clear.
- Pg 10. Somewhere in the 10.7 cm flux section at the least can you add that the F10.7 value and SSN are strongly correlated. (you could add a plot of this, but it isn't necessary)
- Pg 14. "largest documented space weather event" – this isn't quite true. It depends specifically on the specific 'type' of space weather event you are thinking about. The Carrington event is commonly referred to as the "largest" but this should be tightened up. See the Cliver & Svalgaard 2004 paper about biggest events by type
- Pg 15. Quite a lot of work has been done recently on improving the estimates of return time of a Carrington-like Event (even I have a paper on it!). Certainly we have improved the estimates from the RAEng Space Weather report (and have tightened the uncertainties). Please reference at least one of the more newer papers.
- Pg 15. Likewise a recent paper by Hapgood et al. 2021 reviews the space weather preparedness of the UK specifically mentioning COVID-19 and highlighting our need to learn from it.
- Pg 18. The early $2 Tn estimates of the impact of SpWx are now thought to be exaggerated values. Eastwood et al. 2017 provides newer values (with a UK focus). These should be used here instead.
- Pg 19. "can even forbid lower energy GCRs from the inner" -> "can prohibit lower energy GCRs from entering the inner"
- Pg 20. Be consistent with a space after (or not) when using "~"
- Pg 34. Please include some discussion on the impacts of GLEs (not 'physics' impacts, but 'real world' impacts). For example there was a paper by Hubert et al. in 2020 which discussed GLE impacts on avionics. This doesn't have to be on page 34, could be somewhere you think is more appropriate.
- Pg 39. "400MHz and each PMTs" -> "400MHz and each PMT"
- Pg 51. A number of the events (GLEs or FDs) you list here are very well known SpWx events. I think a brief section describing the cause of the event would be helpful for wider context.
- Pg 69. I don't think in Section 2.5 that you demonstrate that the "excursions in the data" are from atmospheric variations – at least not explicitly. I think a little additional text is needed (in Sec 2.5) to make this clear.
- Pg 76. Here (and a few times in other locations) you highlight the GLE from Sept 1989 as being one that could be observed since it was a bigger event. Could you provide some comparison on the size of that event *compared* to the events you are looking at (e.g. GLE 71, 72).
- Pg 84. Be consistent with the use of s^{-1} (on this page and later on)
- Pg 107. I actually don't think it is now worth including this discussion in the thesis – but it is useful to know for anyone who does follow on work. There is a weather station on the roof of Gisbert Kapp which also measures pressure. Would it be more useful to use this observation since it is closer than the MIDAS site you used (link at eee-weather.bham.ac.uk/wx)

- Pg 113. causation -> causality
- Pg 116. Fig 3.10 legend and caption inconsistent
- Pg 117. Fig 3.12 caption – split of pressure for a) and b) a bit clumsy
- Pg 128. I think the notation used here is not very clear. Might be easier (and then much clearer) just to use a few words to describe exactly what you mean.
- Pg 130. You make reference to (a) that you did study the 7.5% and 10% cases and then mention your "complete analysis" I would like to see (at least one) result(s) from the 7.5% or 10% case. This could be added to Fig 3.20, or even just in a Table.
- Pg 134. I'm not sure exactly what you mean by "an exasperation of statistical fluctuations" – some additional text needed here.
- Pg 165. Figure 2 from the Bose & Nagaraju (2018) paper should be included here and then it would be much easier to follow what you are describing.
- Pg 166. there -> these (regions)
- Pg 168. pertains -> pertains to
- Pg 204. "both of the observation" -> "both of the observations"
- Pg 217. "and is in agreement" -> "and it is in agreement"
- Pg 226. "spurious counts is of about" -> "spurious counts is about"

Examiner	**Name (Block Capitals)**	**Signature**	**Date**
Internal	SEAN ELVIDGE	By e-mail	14/05/21
External	SARAH MATTHEWS	By e-mail	21/05/21

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