# Thesis Corrections

1. Iii – Added HiSPARC and Met Office to the acknowledgments
2. I – changed to: Sunspot Number (SSN)
3. Xxvi – changed to: International Sunspot Number (ISSN)
4. Xxviii – changed to: Sunspot Number (SSN)
5. 1 – changed from “solar cycle” to “sunspot cycle”
6. 3 – changed to: Sunspot Numbers (SSNs) and International Sunspot Number (ISSN)
7. 4 – changed to match the legend in the figure
8. 5 – changed as suggested in annotated thesis
9. 7 – changed to bring “recently” to front of sentence and removed “of”
10. 8 – changed “exists” to “exist”
11. 10 – changed to Sunspot Numbers (SSNs) and International Sunspot Number (ISSN) and added “The F10.7 value and SSN are strongly correlated. Therefore,”
12. 11 – added “so called” and changed to Sunspot Number (SSN)
13. 13 – changed to (Cannon, 2013)
14. 14 – changed to Cannon (2013), added extra detail tightening up the Carrington event, and provided detail on use of cosmonuclides
15. 15 – changed timeframe for another Carrignton-like event from 250 years to approx. 100 years and updated references to include Elvidge (2018) and Love (2020, 2021). Also incorporate Hapgood (2021) into the discussion around the lesson learned from COVID-19 that are relevant to the risks of severe space weather
16. 17 – removed “effects induced”, changed “communications” to “signals”, and changed to (Cannon, 2013)
17. 18 – reviewed Eastwood et al. (2018) and updated this paragraph to state issues with the Homeier & Wei (2013) study. Hoever, no clear UK economic values were presented, but re-reviews of the U.S. economic effects were provided, so summarized here and used the Eastwood et al. (2018) reference in the text too.
18. 19 – added “and that there is a good communications strategy” and changed 1 keV to 103 eV, and changed "can even forbid lower energy GCRs from the inner" to "can prohibit lower energy GCRs from entering the inner"
19. 20 – changed ~ to consistently remove space, changed “–” to “to”, removed “of”,
20. 22 – swapped first comma to and “and” and left second comma in.
21. 27 – made suggested changes in annotated PDF: changed “–” to “to” and added “for up to”
22. 34 – this is already covered in Section 1.2.2: Impacts of Space Weather, but I have changed some of the wording on pages 17/18 to introduce ‘avionics’ and the reference to Hubert & Aubry (2021).
23. 35 – changed “–” to “and”, and removed “to demonstrate”
24. 37 – removed brackets, added comma, and changed 2/4 to two/four
25. 39 – changed “400MHz and each PMTs” to “400MHz and each PMT”
26. 45 – changed Sun Spot to Sunspot
27. 47 – changed “largest recorded event” to “largest GCR flux recorded”
28. 51 – added a paragraph explaining the context of the events in Table 2.1, i.e. linking them to specific notable events and ARs.
29. 55 – added “due to inconsistencies and data quality” and changed numbers from symbols to words
30. 57 – added MM/YYYY labels to x-axis of Fig. 2.4
31. 67 – added “from thermally induced noise due to diurnal temperature variation”
32. 69 – added more text in Sec. 2.5.1 and 2.5.2 to clarify that the long-term excursions and short-term (diurnal) variations are due to atmospheric variations
33. 73 – changed as suggested in annotated PDF
34. 74 – added correlation value, fixed caption spacing for Fig. 2.18, changed spelling of correlation, and removed “however”
35. 75 – Added dates of GLEs
36. 76 – added the size of the increase measured for GLE 42 at Oulu, Finland, compared to GLE 70, 71, and 72, also measured at Oulu.
37. 77 – changed wording to firm up comparison between Fig. 2.22 and 2.23
38. 78 – same as above
39. 79 – changed “–” to “to”
40. 82 – changed dashes for commas
41. 84 – changed /s to s^-1 as recommended
42. 91 – changed as suggested: “resulted … as” to “makes”
43. 92 – added extra detail to justify rationale
44. 93 – same as above
45. 98 – added “seen”
46. 103 – changed “some time” to “several months”
47. 107 – comments reflected that it is not necessary to include this discussion in the thesis, but we appreciate the link to the other data source
48. 108 – removed beginning of sentence, to being as “For …”
49. 112 – “assumption” changed to “fact”
50. 113 – changed “causation” to “causaility”
51. 115 – answered in viva and comments reflect no change now necessary
52. 116 – inset caption in Fig. 3.10 changed to correct “coincidences” to “singles”, and added text “from the nearby MIDAS station”
53. 117 – fixed caption separation in Fig. 3.12
54. 119 – changed /s to s^-1 as recommended
55. 120 – changed /s to s^-1 as recommended and removed “by the Python script”
56. 121 – changed /s to s^-1 as recommended
57. 124 – changed “no space weather events” to “no GLEs” and removed italics on “is”
58. 128 – changed notation
59. 130
60. 134 – changed wording/added in more detail to explain meaning
61. 140 – added (expected)
62. 150 – fixed layout so sentence is no longer sandwiched between figures and tables
63. 155 – changed 0.34 to 0.36
64. 157 – answered in viva, no change necessary
65. 158 – answered in viva, no change necessary
66. 160 – changed “in around 2019-2020” to “in December 2019”
67. 161 – changed RHS y-axis labels to same blue as the HS 501 line for clarity
68. 165 – added Bose & Nagaraju (2018) plot
69. 166 – changed “there regions” to “these regions”
70. 168 – changed “pertains” to “pertains to”
71. 190 – changed “asymmetric” to “symmetric”
72. 204 – added “Chapter 5”, and changed "both of the observation" to "both of the observations"
73. 206 – added space in 31.7 nHz
74. 217 – changed "and is in agreement" to "and it is in agreement"
75. 226 – changed /s to s^-1 as recommended, and changed "spurious counts is of about" to "spurious counts is about"
76. 237 – changed dot to cdot
77. ~~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.~~ 
    1. – changed from “solar cycle” to “sunspot cycle”
78. ~~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)~~ 
    1. – changed to “The F10.7 value and SSN are strongly correlated. Therefore,”
79. ~~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~~
80. ~~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.~~
81. ~~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.~~
82. ~~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.~~
83. ~~Pg 19. "can even forbid lower energy GCRs from the inner" -> "can prohibit lower energy GCRs from entering the inner"~~
84. ~~Pg 20. Be consistent with a space after (or not) when using "~"~~
85. ~~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.~~
86. ~~Pg 39. "400MHz and each PMTs" -> "400MHz and each PMT"~~ 
    1. – changed “400MHz and each PMTs” to “400MHz and each PMT”
87. ~~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.~~
88. ~~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.~~
89. ~~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).~~
90. ~~Pg 84. Be consistent with the use of s-1 (on this page and later on)~~
91. ~~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)~~
92. ~~Pg 113. causation -> causality~~
93. ~~Pg 116. Fig 3.10 legend and caption inconsistent~~
94. ~~Pg 117. Fig 3.12 caption - split of pressure for a) and b) a bit clumsy~~
95. ~~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.~~
96. 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.
97. ~~Pg 134. I'm not sure exactly what you mean by "an exasperation of statistical fluctuations" - some additional text needed here.~~
98. ~~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.~~
99. ~~Pg 166. there -> these (regions)~~
100. ~~Pg 168. pertains -> pertains to~~
101. ~~Pg 204. "both of the observation" -> "both of the observations"~~
102. ~~Pg 217. "and is in agreement" -> "and it is in agreement"~~
103. ~~Pg 226. "spurious counts is of about" -> "spurious counts is about"~~