Archival Investigations for the Past Sunspot Observations in the Last 4 Centuries

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Telescopic sunspot observations have offered unique references for the sunspot group number and sunspot positions to quantify solar activity. These datasets consist of multiple individual telescopic observations since the early 17th century. These records have been used to reconstruct, quantify, and visualize solar cycles over the last four centuries. However, their reconstructions have considerable variations before the mid 19th century and accommodated considerable data gaps and uncertainty. A recent status report [1] has emphasised two fault lines for the sunspot number recalibration: the Dalton Minimum and the neighborhood of the Maunder Minimum, owing to the lack of the sunspot data and discrepancy of the reconstructed sunspot group number [2].

However, recent archival investigations have been contributing to overcome such difficulties, adding previously forgotten records and revising the existing datasets. This presentation aims at reviewing recent developments of archival investigations on the sunspot records, focusing on the Dalton Minimum [3], the neighborhood of the Maunder Minimum [4][5], and the beginning of the 17th century [6]. The recent archival investigations fill their data gaps, cross validate some anomalous features in the Maunder Minimum, and extend our datasets even back to 1607. These datasets offer not only the source data for further recalibrations for sunspot group number but also source data to reconstruct almost continuous butterfly diagrams since 1607.

Our result independently confirms the considerable concentration of the reported sunspot groups in the southern solar hemispheric in the late Maunder Minimum [5] and reasonable distributions of reported sunspot groups in both solar hemispheres in the immediate aftermath of the Maunder Minimum [4] and in the overall period of the Dalton Minimum [3]. These results quantify the past solar cycles and contrast solar cycles in the Maunder Minimum with solar cycles in the other periods.

This conclusion seems consistent with what historical eclipse records show. According to these records, significant coronal streamers were missing in the Maunder Minimum, whereas regular coronal streamers were evidently visible in other periods such as the immediate aftermath of the Maunder Minimum and the overall period of the Dalton Minimum [7][8]. These features emphasized anomaly of the Maunder Minimum even in contrast with the Dalton Minimum.

References
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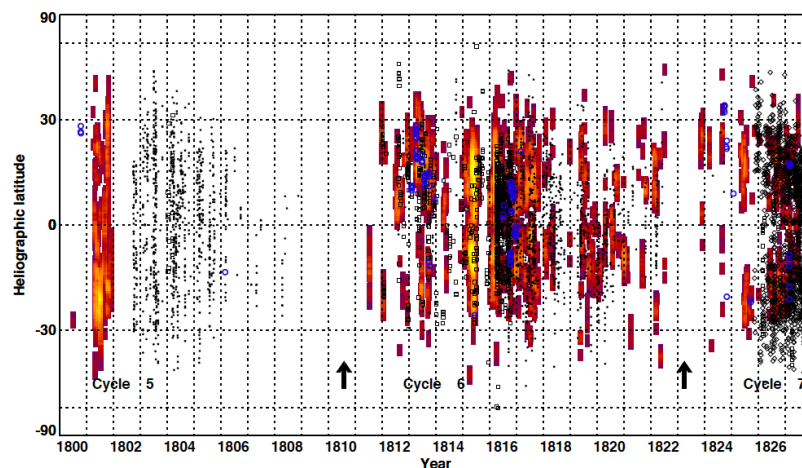
Figure 1: Reconstructed sunspot positions in the Dalton Minimum, as reproduced from [3]