(Form02-2)

Reconstruction of Solar Surface Magnetic Fields from Archival Data

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Purpose:

Large-scale solar magnetic fields play a significant role in the dynamics of the solar atmosphere. Magnetic fields are the basis for all solar surface and atmospheric features, such as sunspots, prominences, streamers, and loops. Solar magnetic fields often spontaneously restructure, triggering violent solar storms. A better understanding of the solar magnetic field and its behavior will enable us to better predict space weather and take steps to mitigate its consequences. It is well known that chromospheric lines, such as Ca K and H-alpha, are good indicators of solar magnetic activity.

It is possible to reconstruct solar surface magnetic fields over the past century from archival data.

The purpose of this research project is to reconstruct solar surface magnetic fields over the past century from archival databases. The other aims are to study the relationship between solar surface magnetic fields and solar storms and the impact of solar storms on human civilization. We also want to examine the temporal and spatial variations of Ca K intensity and supergranular length scales. The results provide a predictive tool for solar cycle amplitude and sunspot number, with implications for space weather.

Methods:

We used the following datasets to reconstruct the magnetic field: i) The Ca K images from the Kodaikanal Solar Observatory, which cover a period of about 100 years from 1907, ii) The archival data from the National Astronomical Observatory of Japan (NAOJ), which covers nearly 60 years from 1917, and iii) SDO/HMI magnetograms during 2010-2025. An empirical relation can be obtained by comparing present-day Ca K images with magnetograms, and this can be used to derive magnetic field information from archival data. The correlation between surface magnetic fields and past solar storms can give insights into the impact of solar storms on human civilization. The data analysis was done using Solar Software in the IDL environment.

Results:

We obtained magnetic field strengths and network length scales from SDO/HMI magnetograms during 2010-2025. A polynomial fit shows a good correlation between the two quantities. The length scales of the chromospheric network are obtained from the Ca K images of Kodaikanal and NAOJ. The above relationship can now be used to derive magnetic field strengths from the 100-year data. The reconstructed solar surface magnetic fields will help us study the relationship between these fields and solar storms. Variations in chromospheric length scales will provide a predictive tool for solar cycle amplitude and sunspot number.

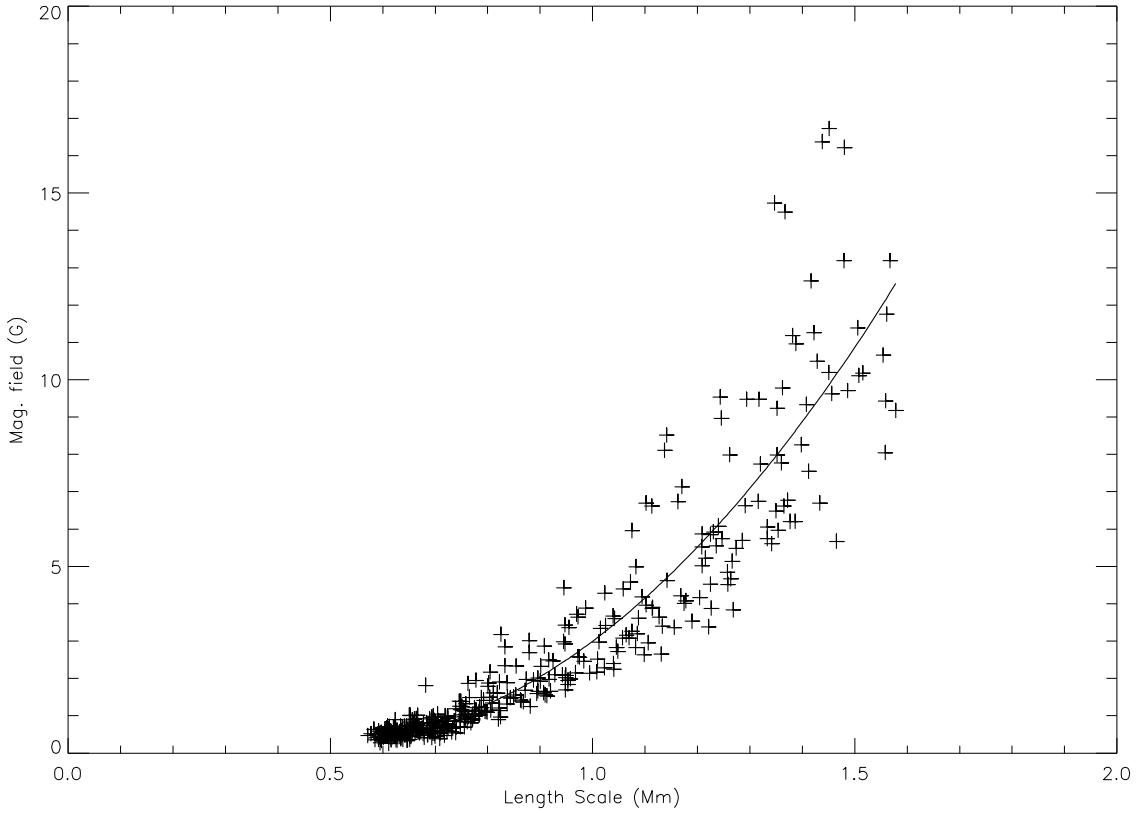

Figure 1. Magnetic field strengths are plotted against network length scales derived from SDO/HMI magnetograms. The continuous line represents a polynomial fit.

I visited Kyoto University on Oct 3, 2025, and NAOJ on Oct 8, 2025, and gave seminars entitled ‘Characteristics of Supergranulation Network from Kodaikanal Archival Data’.

Period of stay in ISEE: August 21—November 15, 2025

List of publications: None yet; we hope to publish 2 papers in peer-reviewed journals.