Comparing Results from the GONG \( l=0 \) and BiSON time series
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ABSTRACT

Approximately 5 years of the \( l=0 \) time series from the GONG project have been analyzed using the algorithm developed for the BiSON 0-dimensional data. The data cover the period 1995-2000. The results are compared with those from a parallel analysis of contemporaneous BISON data, and also with the results of the traditional GONG analysis of the low-degree time series. The spectra analysed were prepared using the multipaper spectral analysis technique used in the recent re-analysis of the GONG data. We consider both solar-cycle trends and temporally averaged values for mode frequencies, linewidths, amplitudes and asymmetry parameters.

INTRODUCTION

The BISON project has collected unresolved helioseismic data for well over two decades, and has operated a full six-station network of automated and semi-automated stations since 1991. The GONG project, on the other hand, has collected resolved helioseismic images since 1995, using a 6-station network of 256x256 pixel cameras. The \( l=0 \) time series of the GONG data is analogous to the unresolved observations, though the visibility of the higher \( l \) modes falls off faster with \( l \) in the GONG data. The GONG PEAKFIND algorithm is not highly optimized for the lowest-degree modes, so it is interesting to see whether we can improve our results by using the BISON algorithms.

In the BISON fitting (2) the peaks are fitted in pairs, \( l=0/2 \) and \( l=1/3 \), using an asymmetric peak profile for each peak. The relative height of the temporal sidebands for each fitting run was fixed at a value determined by the fill. The peak profile is defined as:

\[
\eta(p) = \left[ \frac{1}{1 + \frac{h}{\text{FWHM}}^2} \right] \left( 1 + \frac{\alpha}{\text{FWHM}} \right)
\]

where \( \eta = (\nu - \nu_0) / \Gamma \), \( \Gamma \) is the FWHM, \( h \) is the mode height and \( \alpha \) is a parameter quantifying the mode asymmetry (3).

We plot below the mean values of \( \Gamma \), \( h \), and \( \alpha \) for both projects, for modes that were successfully fitted in all 6 288-day non-overlapping spectra.

Peak Parameters – Mean Values

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Temporal Variations of Peak Parameters

Peak parameter shifts were found by identifying modes that were successfully fitted in all the 144-day time periods, then comparing the values at each epoch with the temporal mean and averaging over the available modes. Frequency shifts (left) are shown for GONG (red) and BISON (green) and show an increasing trend with the rising solar cycle, while the mode height (right) shows a decreasing trend, modulated to some extent by the duty cycle of the data.

Comparison with GONG pipeline values

To compare with the GONG pipeline results, we use overlapping 108-day periods, and compare only \( l=0 \) modes common to all analyses. The GONG pipeline values are shown in blue. Similar trends are seen in all sets for frequency (left), mode height (bottom left) and mode width (bottom right).

Consistent Anomaly in Frequency Variations

Although the frequency shifts seen are highly correlated with the global magnetic flux index, a linear fit to this parameter leaves residuals (right) showing a strong quasi-periodic variation, with the residuals themselves being well correlated between the two projects. Similar effects have not been found in high-degree modes.

Discussion

• The GONG and BISON \( l=0 \) spectra are too different to allow either to be trivially used to improve the fill of the other.
• The GONG and BiSON data show broadly similar temporal trends in frequency, mode width and mode height.
• The difference in the \( l=0 \) asymmetry, if genuine, might reflect a difference in the way the observing spectral lines of the two projects are formed, with different limb-darkening effects preferentially showing up in the radial mode, which is more heavily weighted away from disk center.
• The fluctuations in the mode frequency that do not correlate with the activity index may be related to high-latitude magnetic flux changes that are sensed by the low-degree modes but not well detected in the magnetogram measurements.

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REFERENCES