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Acoustic Holographic Studies of Solar Active Regions

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Abstract. We present results of a study of the morphology and evolution of active regions using solar acoustic holography. These include acoustic signatures of large far-side active regions and their relationship to near-side activity indices a half rotation before and after the farside image, and the direct comparison of near-side acoustic signatures with the standard activity indicators, not only in their own right but also to calibrate the farside acoustic signature.

1. Introduction

Oscillatory motions observed on the surface of the Sun with periods near five minutes arise from acoustic waves that propagate completely around the Sun. These waves carry information about the conditions along their entire trajectory, including the otherwise invisible farside. We use observations from the Michaelson Doppler Imager Scherrer(1995) on the Solar Heliospheric Observer (*SOHO*) and the groundbased Global Oscillation Network Group (GONG) program to study the acoustic signatures of active regions on the Sun's far surface (see Lindsey & Braun (2000a), Lindsey & Braun (2000b), Braun & Lindsey (2001)).

2. Comparisons between far side and near side acoustic images

Seismic phase correlation maps of far solar surface computed by seismic holography and averaged over several days show a strong correlation with nearside magnetic maps of the same region two weaks before or after, when it can be viewed directly from the near solar surface. An example is shown in Fig 1. Farside synoptic images, properly calibrated, promise the extension of standard activity indices for continuous synoptic coverage of both far- and near-side solar activity on a large scale.

3. Comparisons of nearside acoustic data with observations

Single-skip acoustic holography applied to higher-ℓ modes focuses on waves that skip a shorter distance, arriving into pupils on the same solar hemisphere as the focus itself. Nearside holographic phase-correlation maps show active regions in finer detail, and can be used to calibrate phase correlation signatures with magnetic fields mapped at the same time.

Fig 2 shows a scatter plot acoustic correlation phases and the line-of-sight magnetic field stringth of nearside activity. The correlation is strong but not nearly perfect. One reason is that even the nearside images have a significantly coarser spatial resolution than

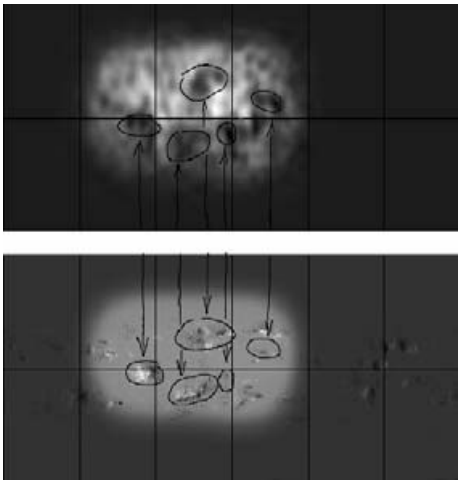

Figure 1

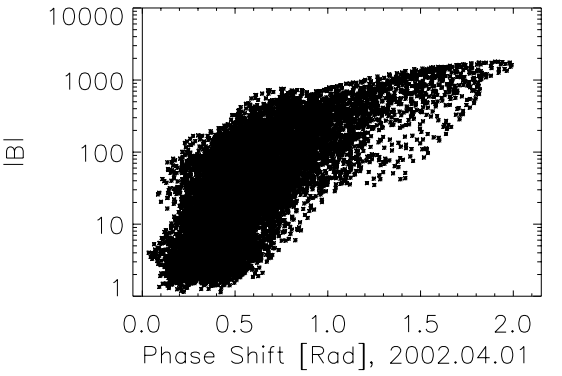

Figure 2

Figure 1. Comparison between phase-correlation maps of the far solar surface covering a 1-wk period (top panel) and synoptic map of the line-of-sight magnetic field on the near side approximately two weeks later.

Figure 2. Scatter plot of holographic correlation phases (x-axis) and magnetic field strength (ordinate).

the near-side magnetograms. Comparisons of nearside acoustic maps various functions of the nearside magnetic field smeared to match the acoustic resolution offer realistic calibrations of farside acoustic images in terms of magnetic properties.

4. Conclusions

Progress towards magnetically calibrated far- and near-side acoustic coverage of large-scale solar activity is very promising.

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