A SPATIAL ANALYSIS OF LOCAL SOURCES OF OSCILLATION

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1. Introduction

Recent observational studies of the spatial and temporal relations between impulsive and periodic perturbations (Deubner and Kleineisel, 1997; Espagnet et al., 1996; see also Goode et al., these proceedings) suggest that oscillations in the solar atmosphere are excited locally and stochastically by turbulent convection. Proper characterization of the dynamical processes involved requires careful analysis of the observations in the spatial as well as in the temporal domain. Wavelet transforms (Combes et al., 1984) allow the characterization of waveforms together with the temporal delays that occur between the observed fluctuations. We have employed Morlet wavelets (Daubechies, 1992) in the present analysis. In addition to the phase relation between convective eddies and the atmospheric waves we study in particular the 2-D spatial evolution of the perturbations, to better distinguish different modes of oscillation. The observational material used is the same as in Deubner and Kleineisel (1997).

2. Methods of analysis

Spatio-temporal filters have been utilized to separate the "convective" and "oscillatory" components of the observed brightness fluctuations, corresponding to gravity waves, and to the evanescent and propagating p-mode regime in the solar atmosphere, respectively.

In contrast to Deubner and Kleineisel (1997), the present study is not limited to preselected "events". For 4 subcubes (Deubner and Kleineisel, 1997) as well as for the whole data cube, we have calculated the spatio-temporal cross-correlation functions between the subsonic and oscillatory components of the white light and CaK_2 data. Furthermore, the Morlet wavelet centered at a wave period of 200 seconds was used to obtain the amplitudes of the oscillatory wave packets. Then spatio-temporal cross-correlation functions between the subsonic components and wavelet transformed oscillations were calculated again. At the photospheric level, we find that the onset of a granule is followed by a decrease of oscillatory amplitude, whereas the opposite happens at the borders of the intergranular lanes, confirming the findings in Deubner

F.-L. Deubner et al. (eds.), New Eyes to See Inside the Sun and Stars, 461–462.

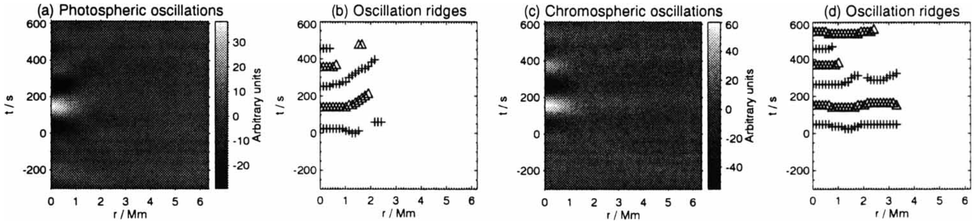

Figure 1. Oscillatory intensity at positions of intergranular lanes in the photosphere (a) and in the chromosphere (c). Corresponding ridges of minimal and maximal intensity (b) and (d)

and Kleineisel (1997).

Using our data we have defined a new criterion for the granular and intergranular "events" by searching automatically for the onset of a strong granule followed by a significant decrease of oscillatory power after a lapse of time as determined by the cross-correlation above, or respectively, for rapid darkening in intergranular lanes followed by an increase of oscillatory power. We also sharpen the criterion by specifying that no adjacent "event" center is within a subcube with 2" radius and 40 min duration of each "event" center. In this way, we have selected 1897 granular and 1762 intergranular events that are not located on the supergranular network.

3. Results and discussions

Centered around the positions defined above, we have averaged the evolution of the brightness distribution both azimuthally and over all 1897 granule, respectively 1762 intergranule events, covering a radial range of 7.6 Mm, and a time interval of 300 s before and 600 s after the event center. Figure 1 shows the temporal-spatial evolution of the oscillatory data at the intergranular event positions at both heights.

4. Conclusion

Our results corroborate strongly previous suggestions that the solar oscillations may indeed be excited by convective downflows.

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