TIME VARIATION OF VELOCITY FLOWS FROM RING DIAGRAMS: A FIRST APPROACH

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1. Introduction

The Ring Diagram analysis is a technique designed to infer the presence of horizontal velocity flows under the solar surface by the analysis of the power spectra of solar oscillations in three dimensions: the two components of the horizontal wave number and temporal frequency (Hill, 1988 and Patrón *et al.*, 1995). This procedure is applied as a local analysis technique, performed for a region of the Sun of several heliographic degrees (typically around 15x15 degrees square). As the Sun is rotating, we must track a chosen region as long as it is present at the visible part of the solar disk, and we can continue the tracking after several solar rotations. The comparison of the estimated flow fields obtained at different times can give some ideas about the temporal variations of the flows.

2. Data acquisition and reduction

The TON images (Chou *et al.*, 1995) consist of intensity Ca K II line images with a resolution of about 2 arcsec per pixel. The spatial resolution at the center of the solar disk is of about 1379 Km per pixel. A region of about 15x15 degrees square has been tracked on the whole solar disk image at the rotation rate of the solar equator. This region is centered at the solar equator and Carrington longitude 29.1738 degrees.

The regions have been remapped onto a great-circle space centered at the center of the region. Temporal series of 512 minutes have been constructed for seven dates: 4/5/97, 5/1/97, 5/28/97, 6/27/97, 8/20/97, 8/21/97 and 9/18/97. The time delay between series is about one solar rotation, except between day 5 and 6, which is 24 hours for testing purposes. Finally a tri-dimensional FFT has been performed in the two spatial coordinates and time, with the resulting tri-dimensional power spectra. A horizontal flow field have been fitted to this spectra and finally inverted to get the two components of the flow (East-West and North-South directions, U_x and U_y) as a

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function of depth (Patrón *et al.*, 1995), as shown in Figure 1. Positive velocities are from South to North and from East to West in the solar disk.

3. Results and conclusions

The temporal resolution of the results, one solar rotation, does not seem to be enough to estimate the temporal evolution of the flows, since the variations do not continue a clear evolution from one rotation to another. In the case of data taken 24 hours apart (8/20/97 and 8/21/97), the flows are more stable, but still big changes occur very close to the surface.

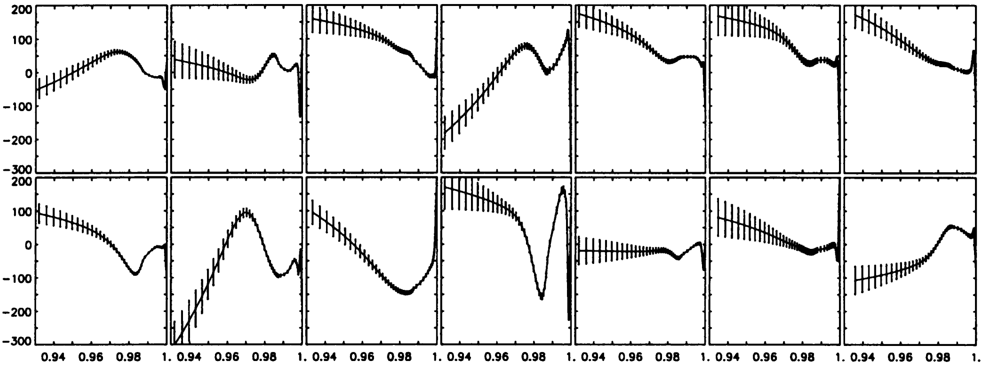

Figure 1. U_x (upper) and U_y (lower) for the 7 time spans (m/s against r/R).

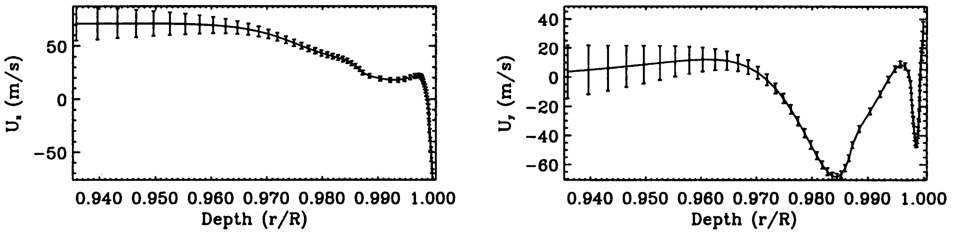

Figure 2. Temporal average of the horizontal flow components.

An average of the seven set of flows have been performed. It is difficult the interpretation of the average in the North-South direction, since we don't have any expectations about steady North-South flows. But in the East-West direction, we have differential rotation with depth. We need to remember that the tracking procedure removes from the data only a constant value corresponding to the estimation of the surface rotation rate, so that, differential rotation still remains in the data. A plot of the average of the components of the flows is shown in Figure 2.

A great part of the computation required for this work was carried out on the Jet Propulsion Laboratory Cray J90 supercomputer.

References

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