Solar and Astrophysical Dynamos and Magnetic Activity
Proceedings IAU Symposium No. 294, 2012
A.G. Kosovichev, E.M. de Gouveia Dal Pino, & Y. Yan, eds.

doi:10.1017/S1743921313002299

Interplanetary scintillation signatures in the inner heliosphere of the deepest solar minimum in the past 100 years

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Abstract. We have used interplanetary scintillation (IPS) observations at 327 MHz spanning years 1983-2009 to study microturbulence levels in the inner heliosphere. We find that the microturbulence levels show a steady and significant drop in the entire inner heliosphere starting from around 1995. The fact that the solar polar fields have also shown a similar declining trend provides a consistent result showing the buildup to the solar minimum between the solar cycles 23 and 24, the deepest in the past 100 years, actually began more than a decade earlier.

Keywords. Sun: magnetic fields, Micorturbulence, Interplanetray scintillation.

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1. Introduction

The solar minimum experienced at the end of solar cycle 23 has been the deepest minimum in the past 100 years. Using theortical modelling, Nandy *et. al*, 2011 tried to explain this unusual solar minimum through changes in the the meridional flow rates. However, this did not provide any insights into when this deep minimum would have been actually initiated. It has been observed that solar polar fields in the latitude range, 45°-78°, computed from the ground-based magnetograms have shown a steady decline since ∼1995 (Janardhan *et. al*, 2010). Since photospheric fields are continuously swept out into the inner heliosphere by the solar wind, one would expect to see these changes reflected globally in the interplanetary medium as a reduced level of micro-turbulence.

2. Result and Implications

IPS is defined as the random fluctuations in the intensity of the extra-galactic radio sources due to the turbulent and refracting solar wind. The measureable quantity in an IPS observation is the scintillation index (m), where m = $\Delta S/\langle S\rangle$ is the ratio of the scintillating flux ΔS to the mean source flux $\langle S\rangle$. In general, m is function of both source size and distance $'r'$ of the line-of-sight (LOS) from the Sun. The distance dependance of m can be removed by normalizing all observations by values of m obtained for a point source like 1148-001 which has an angular diameter of ∼10 milli arc seconds.

We have used the IPS measurements of ∼200 extra-galactic radio sources from the Solar Terrestrial Enviornment Laboratory (STEL), Japan in the years 1983-2009. But with the selection criteria of minimum 400 observations and covering the period from 1983-2009, we could retrieve only IPS measurements for 27 sources. Each of these observations (in the distance range 0.3 to 0.8 AU) were then made distance independent by normalizing them with the values of m for the point source 1148-001. Figure 1 shows the normalized values of m for 9 of the 27 sources. The open circles and stars represent yearly averages for high and low helio-latitude sources respectively. A steady decline in m is evident from

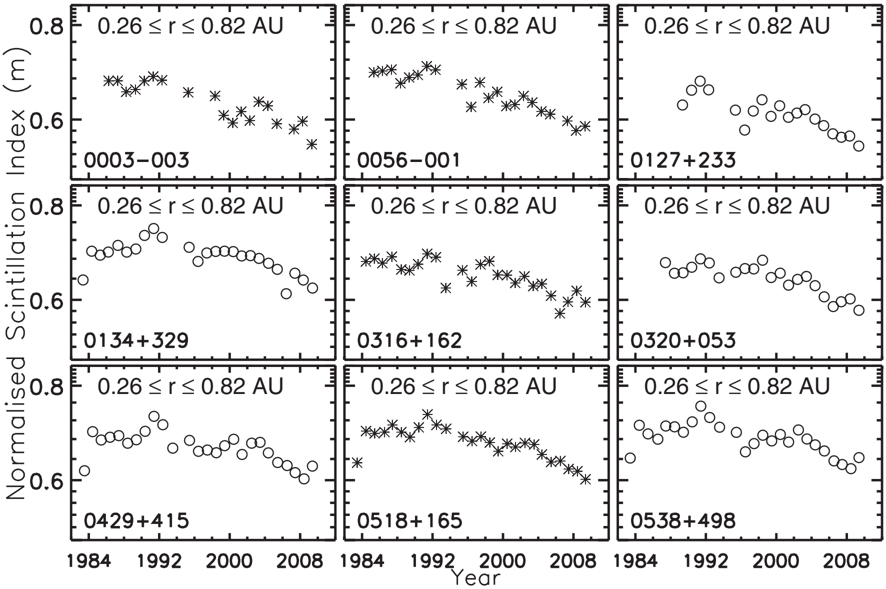

Figure 1. Shows the normalized scintillation index (m) for 9 sources out of the selected 27 sources as function of years in the distance range 0.26 to 0.82 AU. The open circles and the stars are annual means of observations for high and low helio-latitude sources respectively. The IAU names of each source are indicated at the bottom left of each panel.

Figure 1 for all 9 sources since ∼1995. We believe that this large-scale IPS signature, in the inner heliosphere, coupled with the fact that solar polar fields have also been declining since ∼1995, provide a consistent result showing the buildup to the deepest solar minimum in 100 years actually began more than a decade earlier (Janardhan *et al.*, 2011).

References

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https://doi.org/10.1017/S1743921313002299 Published online by Cambridge University Press