Geophysical Research Abstracts
Vol. 21, EGU2019-12887, 2019
EGU General Assembly 2019

Spatial power spectrum of the photospheric magnetic field during solar minimum

Kalevi Mursula (1), Bertalan Zieger (1,2), and Ilpo Virtanen (1)

(1) University of Oulu, ReSoLVE Centre of Excellence, Space Climate Research Unit, Oulu, Finland (kalevi.mursula@oulu.fi), (2) Center for Space Physics, Boston University, Boston, MA, USA

During solar minima the spatial power spectrum of the photospheric magnetic field is dominated by the low-degree zonal (axisymmetric; m=0) harmonic components, reflecting the large polar coronal holes of unipolar magnetic field. However, measuring polar fields is difficult because of the unequal visibility of the two poles during most of the year and the small line-of-sight component of the roughly radial field at high solar latitudes. Here we derive the spatial power spectrum of the photospheric magnetic field in terms of the harmonic coefficients of the radial component (Br) as well as in terms of the harmonic coefficients of the internal potential (known as Gauss coefficients). We calculate the zonal spatial power spectrum using Mount Wilson Observatory (MWO) synoptic maps in 1995-1996, during the solar minimum between solar cycles 22 and 23, and investigate how filling or not filling the polar data gaps affects the zonal harmonic coefficients. We show that the vantage point effect can be eliminated by removing the highest 5 degrees of the measured magnetic field and by calculating the latitudinal profile of the zonal median field over the two years, which ensures equal latitudinal data coverage of both solar hemispheres. We then derive the zonal harmonic coefficients using this latitudinal profile of Br.

We find that, leaving the polar data gaps unfilled produces strong artificial power above harmonic degree of l=8. Only the first 5 degrees can be considered reliable in this case. Therefore, polar filling is essential to obtain a realistic spatial power spectrum. Filling the polar gap with a constant (non-zero) value yields zonal harmonics that are reliable up to l=9. We find that the zonal octupole component has the largest contribution to the total spatial power, stronger than the zonal dipole, even during the solar minimum conditions. This difference is seen more clearly in the case of polar filling. We also verify that the asymmetry of the polar fields during the solar minimum is statistically significant.

Our results emphasize the importance of filling the polar data gaps in order to obtain a correct estimate of the spatial power spectrum of the photospheric field. This helps in estimating the reliability of polar fields and the large-scale structure in synoptic maps of different origin. Our results also verify the asymmetric nature of the polar fields, which is important for the heliospheric magnetic field and for solar dynamo modeling.