Comparing the heliospheric magnetic fields over several solar cycles

Jennimari Koskela, Ilpo Virtanen, Kalevi Mursula
Introduction

❖ We make a point-by-point comparison between HMF measured at Earth (hourly OMNI2 data), and coronal field produced by the PFSS model (and CSSS model)

❖ Photospheric maps: WSO, HMI, MDI, SOLIS

❖ WSO dataset gives us a continuous time series, starting 1976
Assumption of no electric currents between the photosphere and source surface leads to the Laplacian equation $\nabla^2 \Psi = 0$, which can be solved with a spherical harmonic expansion.

For this, we need to calculate coefficients $g_{nm}$ and $h_{nm}$ from the Br component in photospheric synoptic maps.

We use radial assumption and the LOS measurement.
Zhao & Hoeksema 1995

Field becomes open on cusp surface (~ 2-3 R_s), radial on source surface (~ 10-15 R_s)

\( g_{nm} \) and \( h_{nm} \) are calculated both on the photosphere and cusp surface
Methods

- We try to determine the effect of source surface distance and number of multipoles of the spherical harmonic expansion.

- We compare **polarity** and the **power of radial decay**.

- Polarity comparison is unaffected by the scale of photospheric field! It depicts how well the photospheric observations + model can predict the large scale structure of the HMF.
Polarity match

\[
polarity\ match = \frac{\text{number of matched hours}}{\text{number of all hours}}
\]
Power of radial decay:

- If we don’t take into account superradial expansion and other such effects, \( p \) should be 2 (according to Maxwell’s equations).

- However...
Results - $p$
Results - polarity match
Results - PFSS vs CSSS

- PFSS and CSSS polarity match
- PFSS and CSSS n-value
- PFSS radial field at source surface ($r_{ss}=3.5$, CR1998)
- CSSS radial field at source surface ($r_{ss}=15$, $r_{cp}=3.5$, $a=0.2$, CR1998)
PFSS and CSSS models can both predict the large scale structure of the HMF fairly well.

During the time there is overlap between different magnetograms, they agree very well.