

# The evolution of the Earth's magnetic moment in the last 400 years. Consequences on the magnetopause standoff distance

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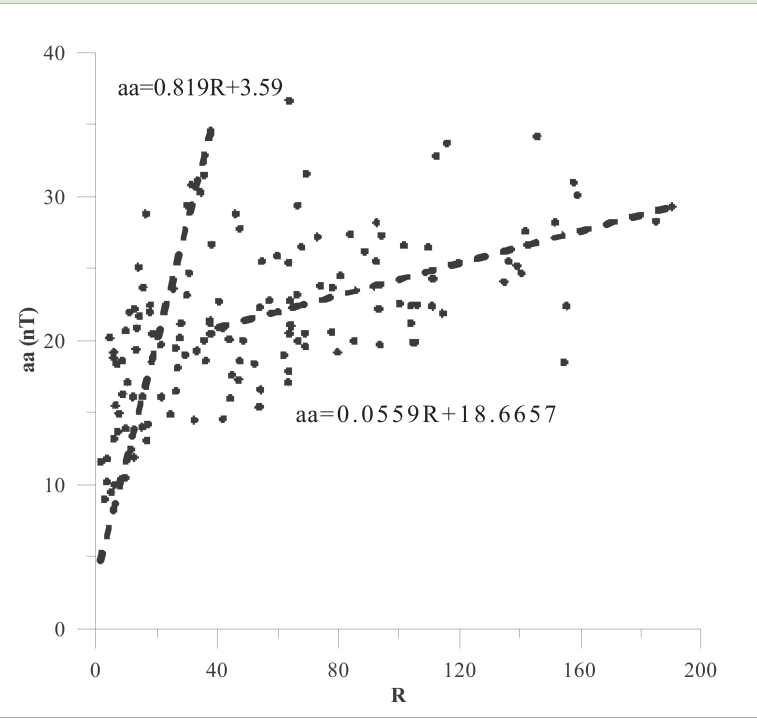
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The dayside standoff distance of the magnetopause is controlled by the balance of the solar wind dynamic pressure on the magnetosphere and the pressure of the Earth's magnetic field.

We analyze the evolution of the Earth's magnetic moment over a time span of 400 years using the gufm1 main geomagnetic field model (Jackson et. al, 2000) and how this influences the standoff distance of the magnetopause and attempt to infer information even further back in time (grand maxima and minima to 850 AD).

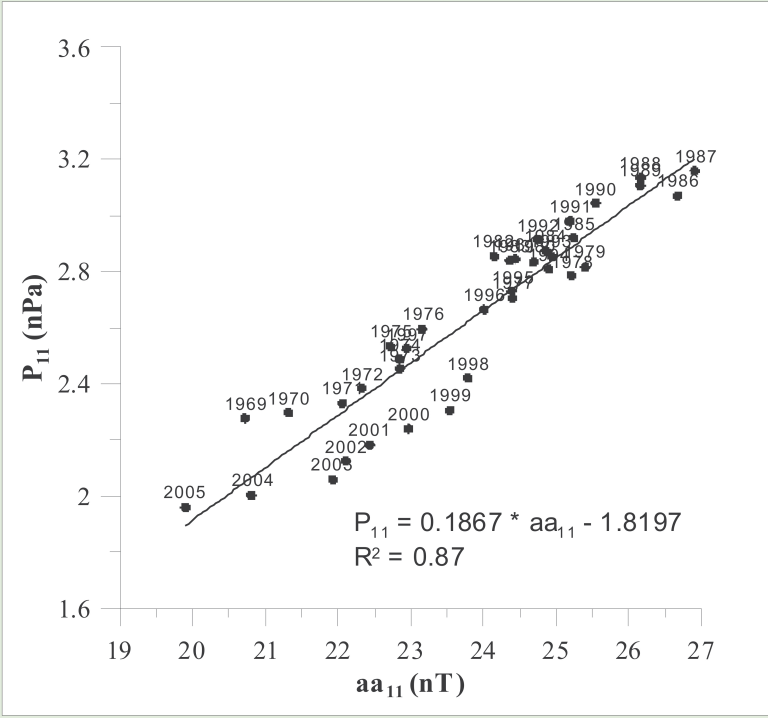
$$P = \frac{B^2}{8\pi} = \frac{1}{8\pi} \left( \frac{fM}{L^3} \right)^2$$

Correlation between the geomagnetic index  $aa$  and the sunspot number  $R$

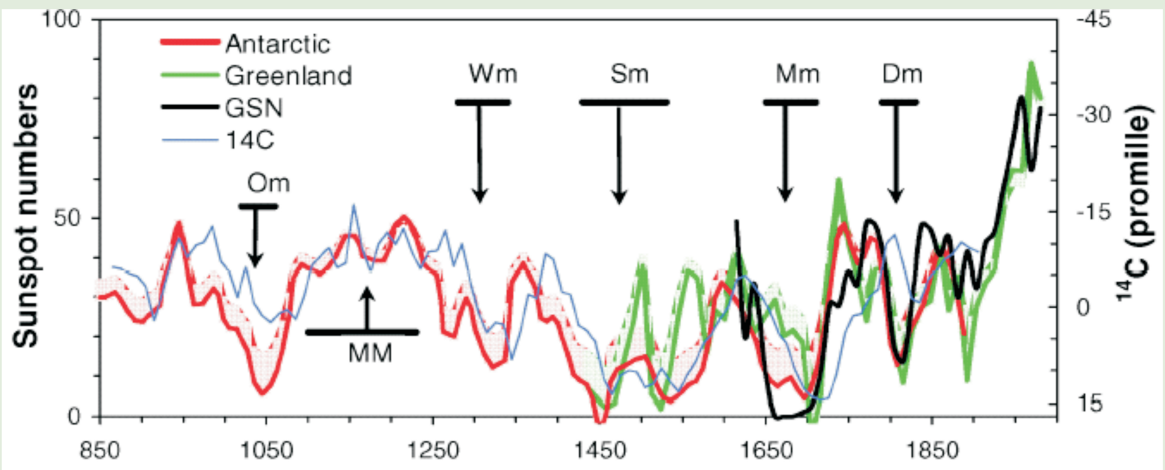


Scatter plot  $aa$ - $R$  (1868-2010)

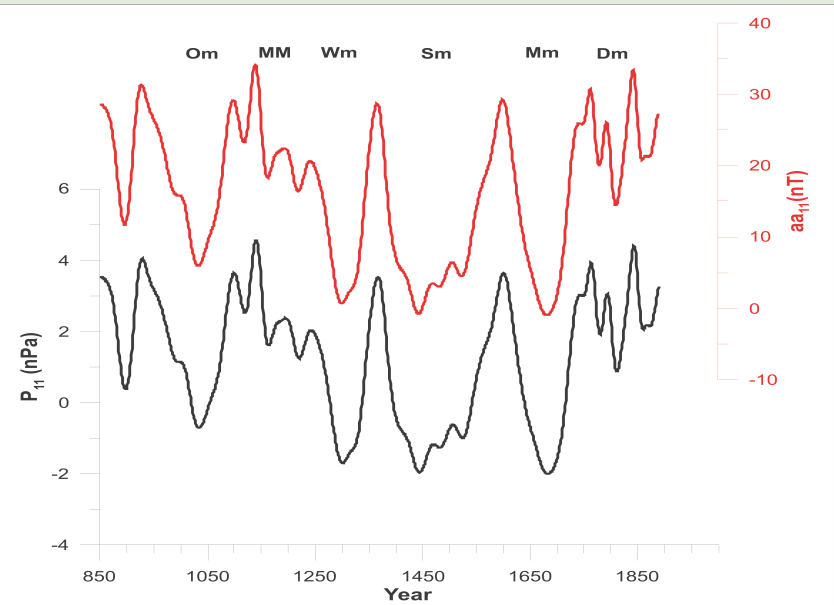
Correlation between 11-year smoothed solar wind dynamic pressure  $P$  and geomagnetic index  $aa$



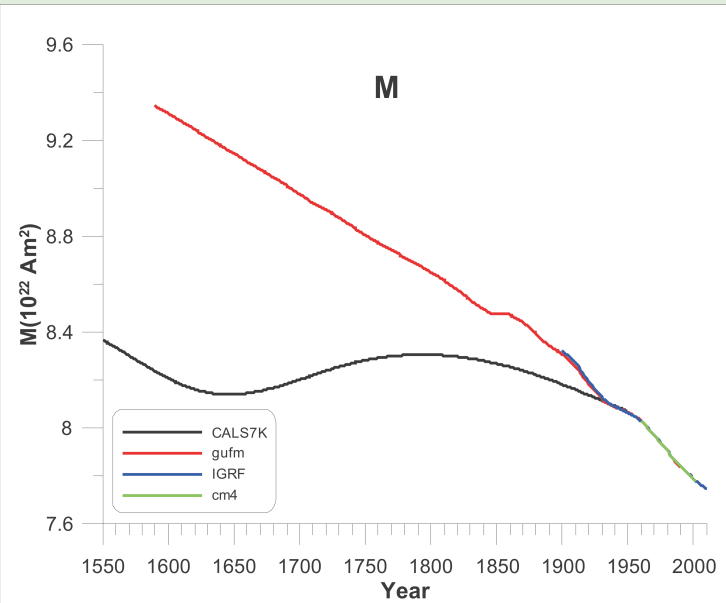
Scatter plot  $P_{11}$ - $aa_{11}$  (1969-2005)



Reconstruction of the sunspot number  $R$  (Usoskin et al., 2003)



Reconstruction of  $aa$  (upper panel) and  $P$  (lower panel) between 850 AD-1895



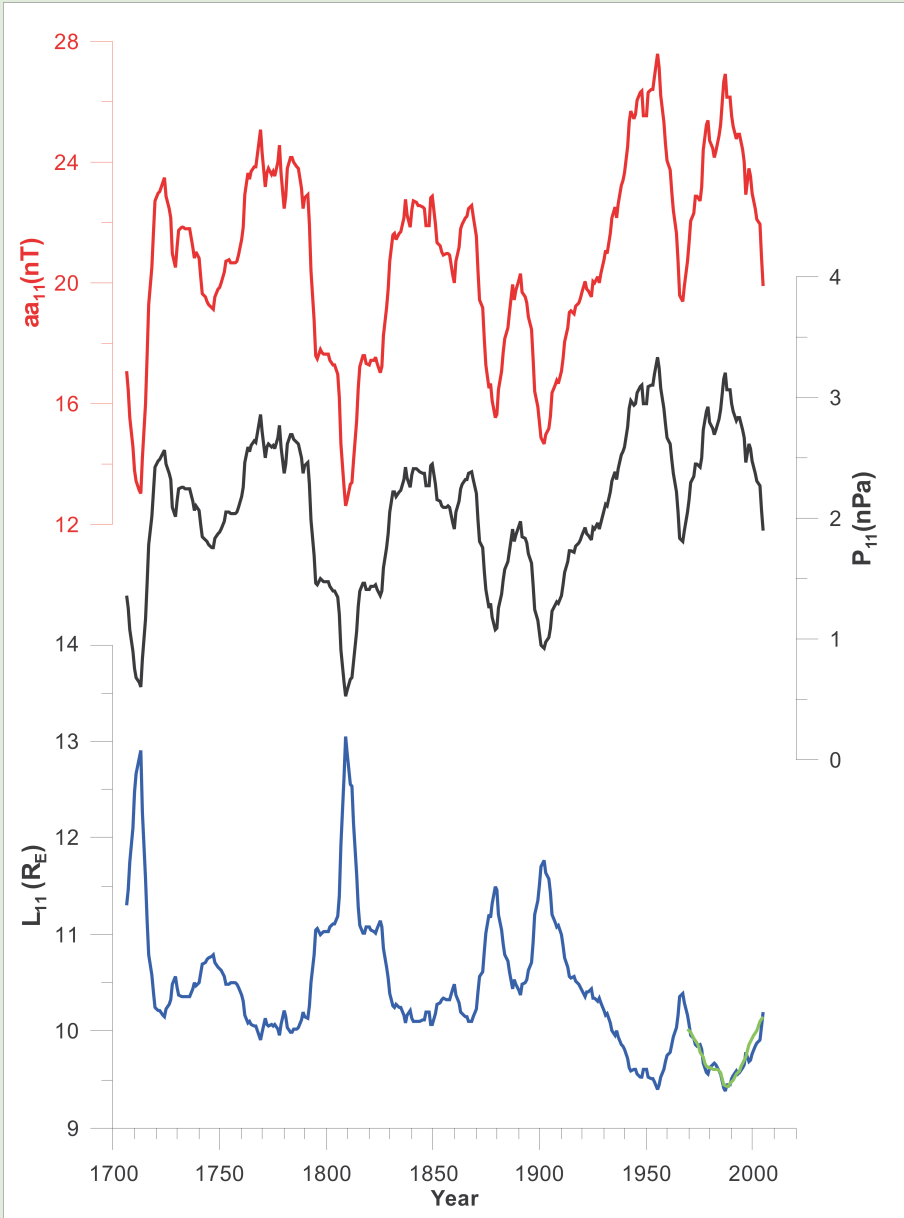
The evolution of the Earth's magnetic moment given by four main geomagnetic field models, namely CALS7K, gufm1, IGRF and cm4

-Earth's magnetic moment from the *gufm1* model was extended until the year 2010 using the IGRF model

-Annual means of the *aa* geomagnetic index, for the period 1868-2010, were used to reconstruct the solar wind dynamic pressure ( $P$ ) based on the correlation between the two of them

-For the period before 1868, the *aa* index was reconstructed using the sunspot number ( $R$ )

-The *aa* and  $P$  series were smoothed out by means of 11-year running average resulting the  $aa_{11}$  and  $P_{11}$  series



Reconstruction between 1700-2005: geomagnetic index  $aa$  (top panel); solar wind dynamic pressure  $P$  (middle panel) and standoff magnetopause distance (lower panel)

## CONCLUSIONS

- The solar wind dynamic pressure on magnetosphere and the corresponding dayside standoff distance of magnetopause were reconstructed back to 850 AD, using sunspot number reconstructions and geomagnetic field models (CALS7K, gufm1, IGRF and cm4);
- $P$  and  $L$  show the same long term variation as other parameters of the heliospheric and magnetospheric environment;
- Results of this work are a contribution to space climate characterization at magnetic and secular solar cycles time scales.

## References

- V. Dobrica, C. Demetrescu, G. Maris (2012). Solar Wind Dynamic Pressure and Magnetopause Stand-Off Distance before the Instrumental Era, Sun and Geosphere
- I. Usoskin, S. Solanki, M. Schussler, K. Mursula, K. Alanko (2003). Millennium-Scale Sunspot Number Reconstruction: Evidence for an Unusually Active Sun since the 1940s, Physical Review Letters