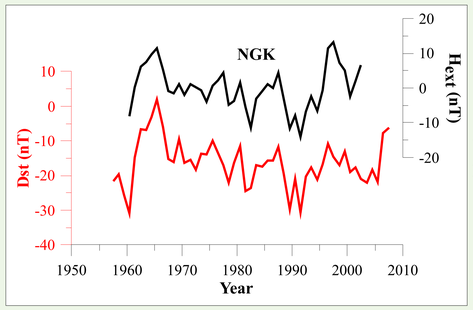
Long-term external effects in annual means from observatory data and main field models

C. Stefan, C. Demetrescu, V. Dobrica

Institute of Geodynamics, Romanian Academy, Bucharest, Romania, cristiana_stefan@geodin.ro

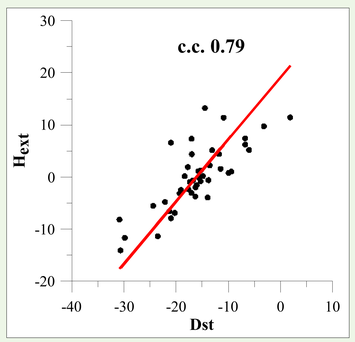
Abstract. We analyze long-term European observatory data in terms of external effects present in the annual averages of recorded values and model the corresponding time series by means of a combination of geomagnetic indices as proxy for various current systems in ionosphere and magnetosphere that add external effects to the internal field. We show that the external contribution leaks into main field models based (mainly) on observatory data (*gufm 1*, IGRF) and discuss its evolution since 1600. Annual means at: http://www.geomag.bgs.ac.uk/data_service/data/annual_means

External contribution in annual means for the time-span 1960-2002 at Niemegk (H_{obs}-H_{CM4}=H_{ext}+Crust)



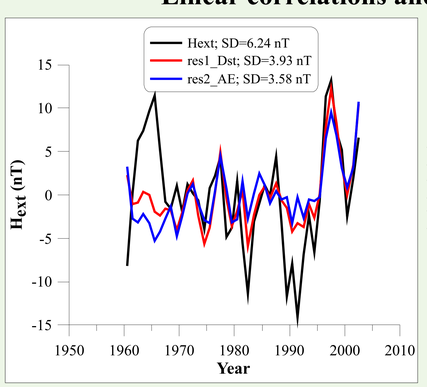
- **CM4** - the only external-effects-free main field model (*Sabaka et. al.,2004*)
- Crust= $\overline{H_{obs}-H_{CM4}}$

Correlation between H_{ext} and Dst



- External effect - a result of incomplete averaging out of geomagnetic disturbances in annual means
- Contributing candidates: geomagnetic storms (Dst, AE) and Sq

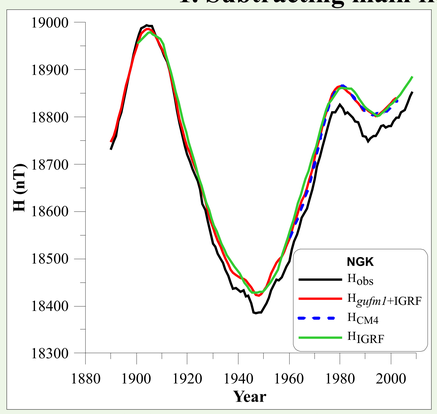
Linear correlations and residuals



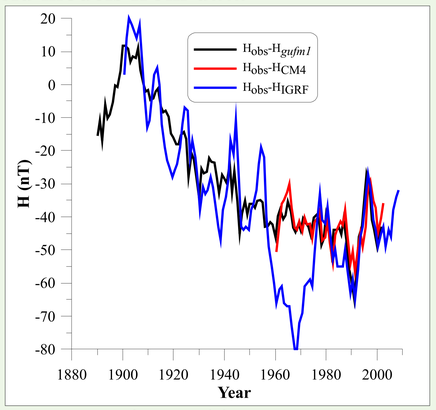
H_{ext}= a+bDst
Res1_Dst = c+dAE
Res2_AE

External variation in observatory data

1. Subtracting main field models from data

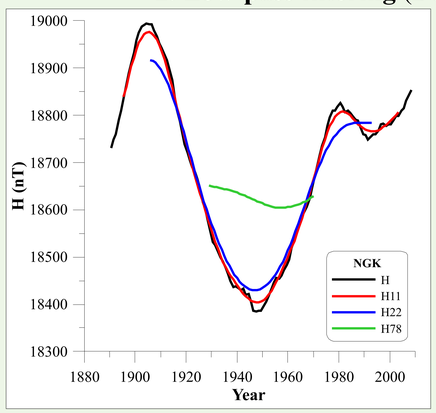


Recorded H at NGK and several long-term main field models

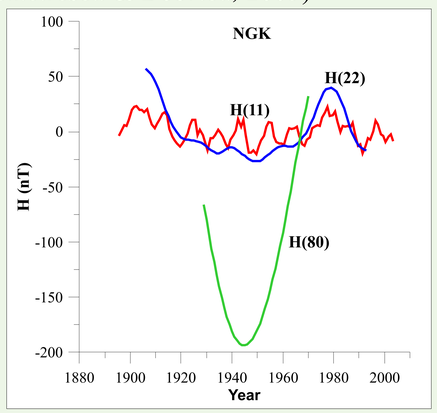


Distorted long-term solar-cycle-related variation

2. Low-pass filtering (*Demetrescu & Dobrica, 2005*)



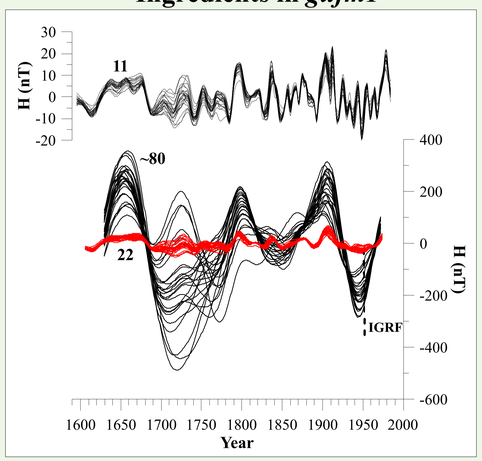
Successive running averages, windows as indicated



Corresponding ingredients of the recorded field

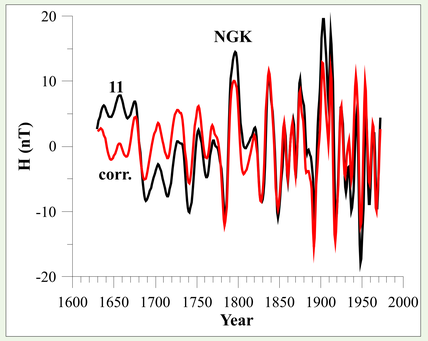
External variation prior to observatory data

Ingredients in *gufm1*

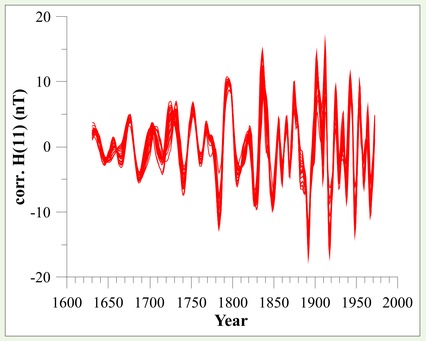


Effect of the ~80-year variation in the 11-year variation

Correction: H(11) = a+bH(80)

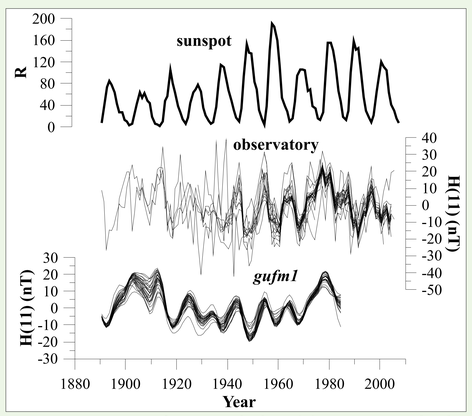


Results

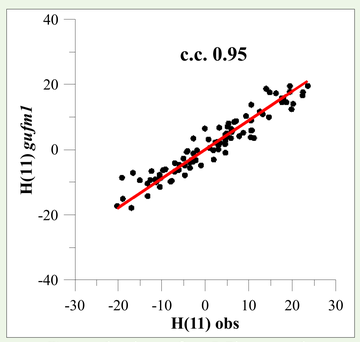


The 11-year variation (raw and corrected)

The 11-year variation in Europe



The sunspot number and the 11-year variation at European observatories and in *gufm1* of *Jackson et. al.*(2000)



Correlation for Niemegk

Conclusions

- External effects in annual means were singled out (1) by subtracting the CM4 main field model from observatory data (time-span 1960-2002) and (2) by low-pass (11 year) filtering recorded data;

- When applied to long time-span main field models *gufm1*(1590-1990) and IGRF-11(1900-2010), method (2) shows the presence of external effects;

- Information back to 1630 regarding the geomagnetic activity and geoeffectivity of solar/heliospheric precesses interacting with Earth's environment can be retrieved .

References

Demetrescu C., Dobrica V., 2005. Recent secular variation of the geomagnetic field. New insights from long series of observatory data, Rev. Roum. Geophysique, 49, 63-72.

Jackson A., Jonkers A., Walker M., 2000. Four centuries of geomagnetic secular variation from historical records, Phil. Trans. Roy. Soc., 358, 957-990.

Sabaka T.J., Olsen N., Puruker M.E., 2004. Extending comprehensive models of the Earth's magnetic field with Oersted and CHAMP data, Geophys.J.Int.,159,521-547.

Acknowledgements

Funding by the Ministry of Education and Research, UEFISCDI, Project IDEI 93/2011.