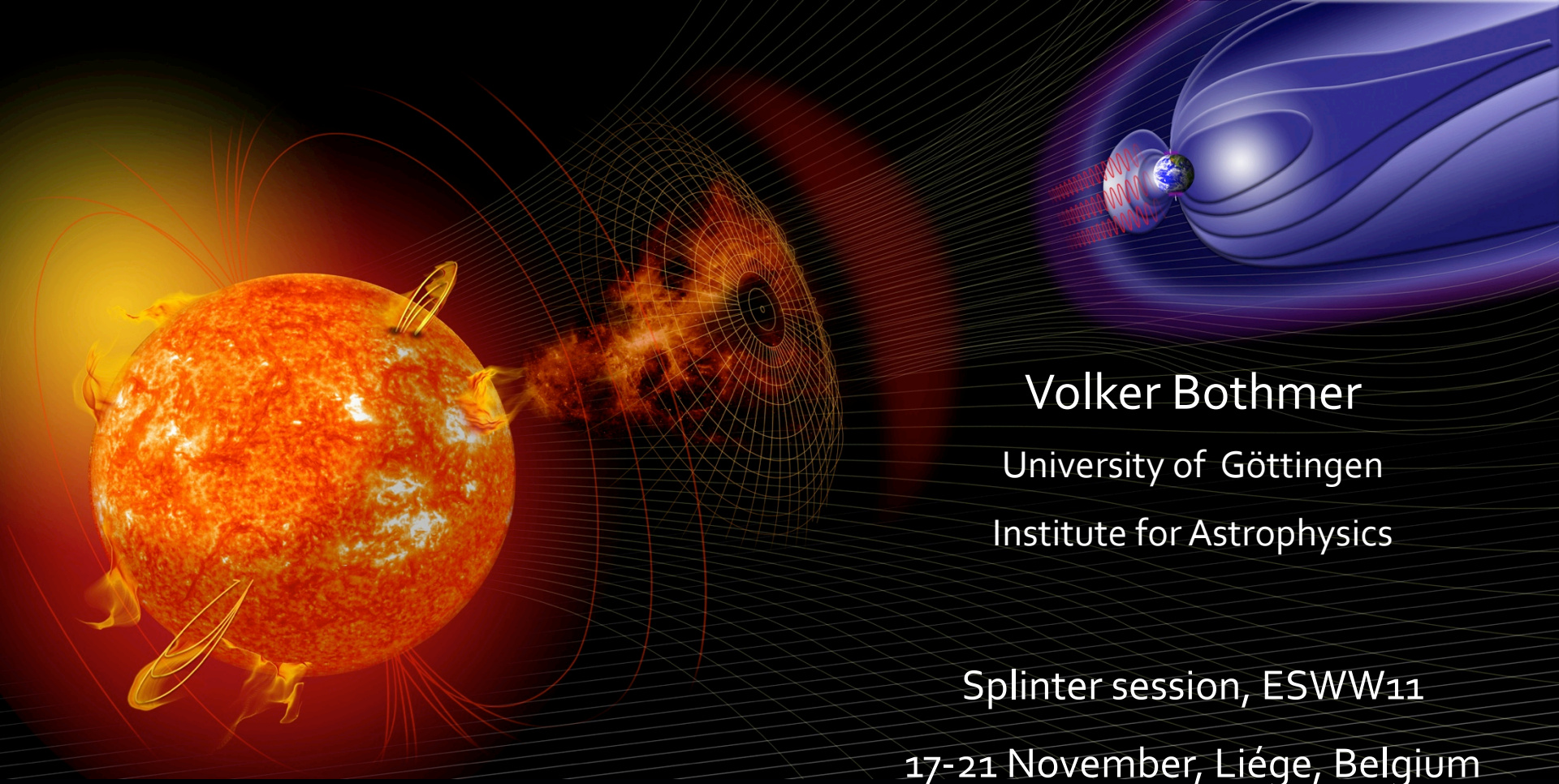

Volker Bothmer

University of Göttingen

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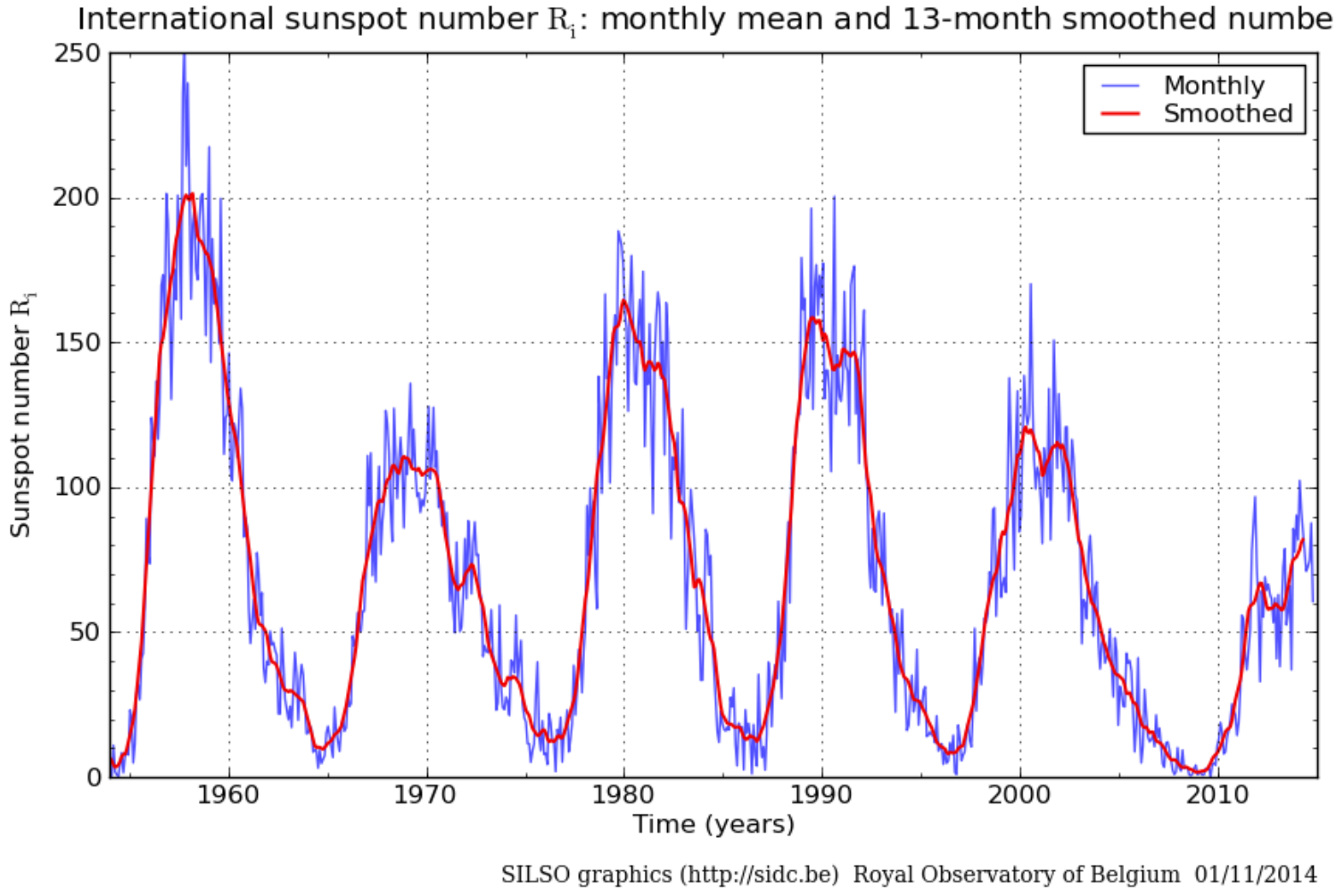
Splinter session, ESWW11

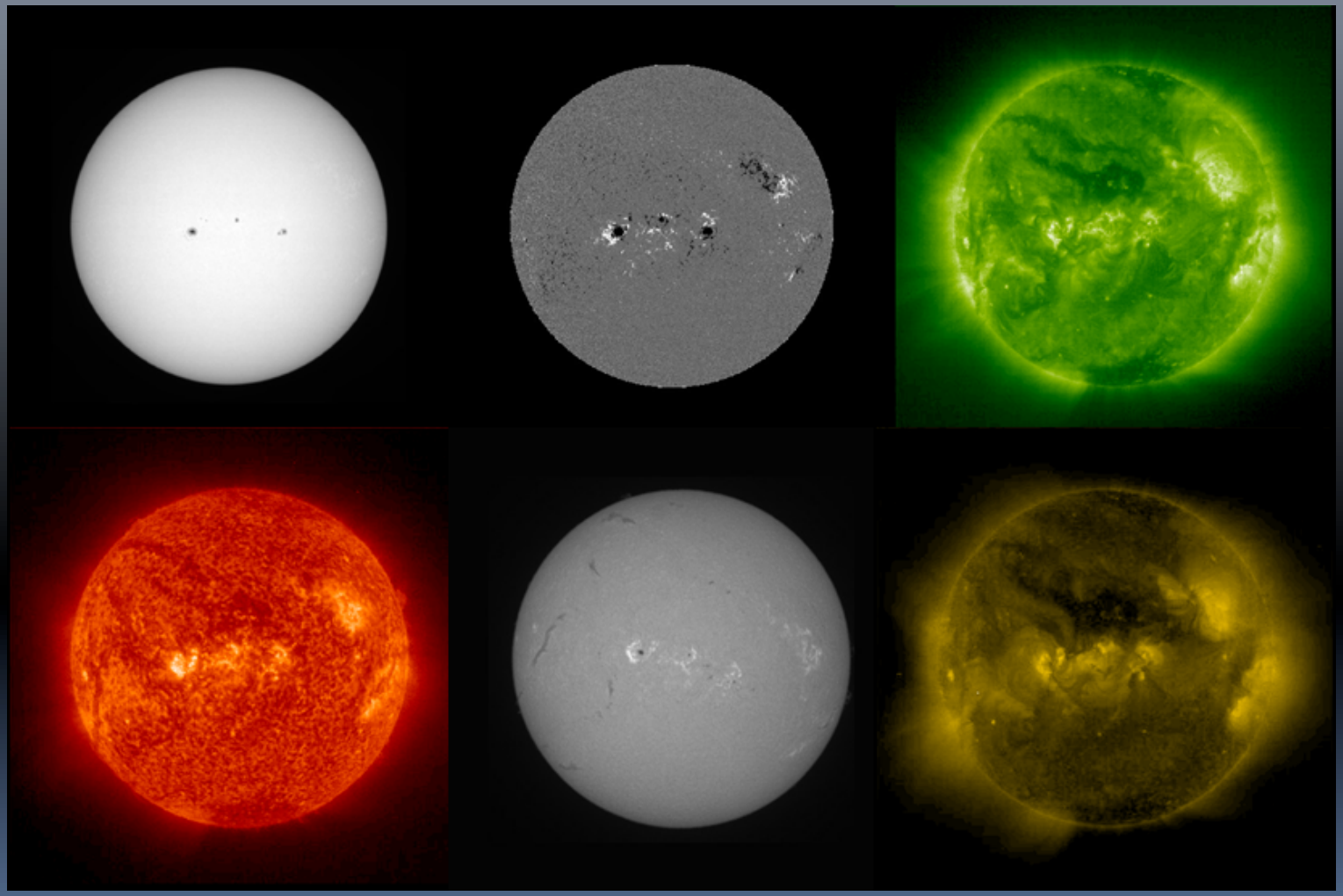
17-21 November, Liége, Belgium

Origins and frequencies of geoeffective solar superstorms

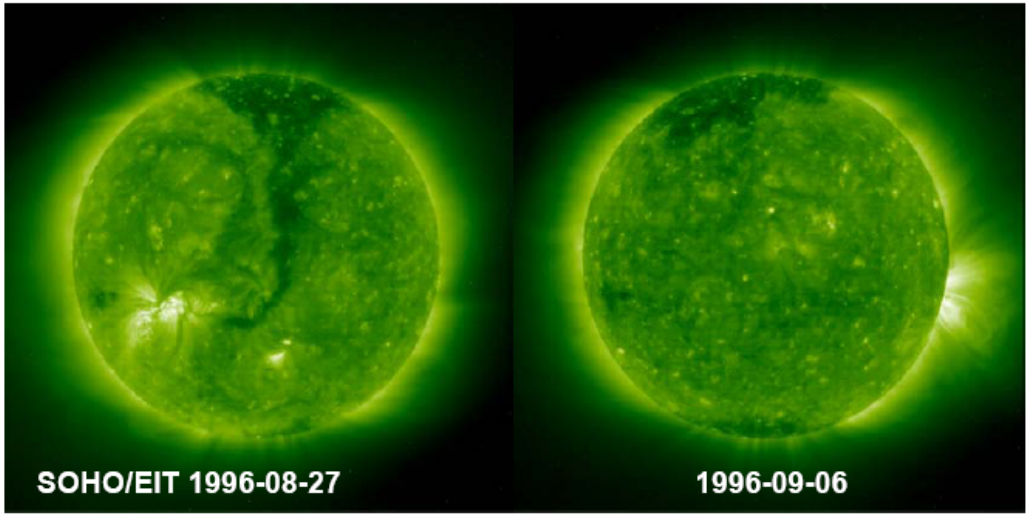
The Sunspot Cycle

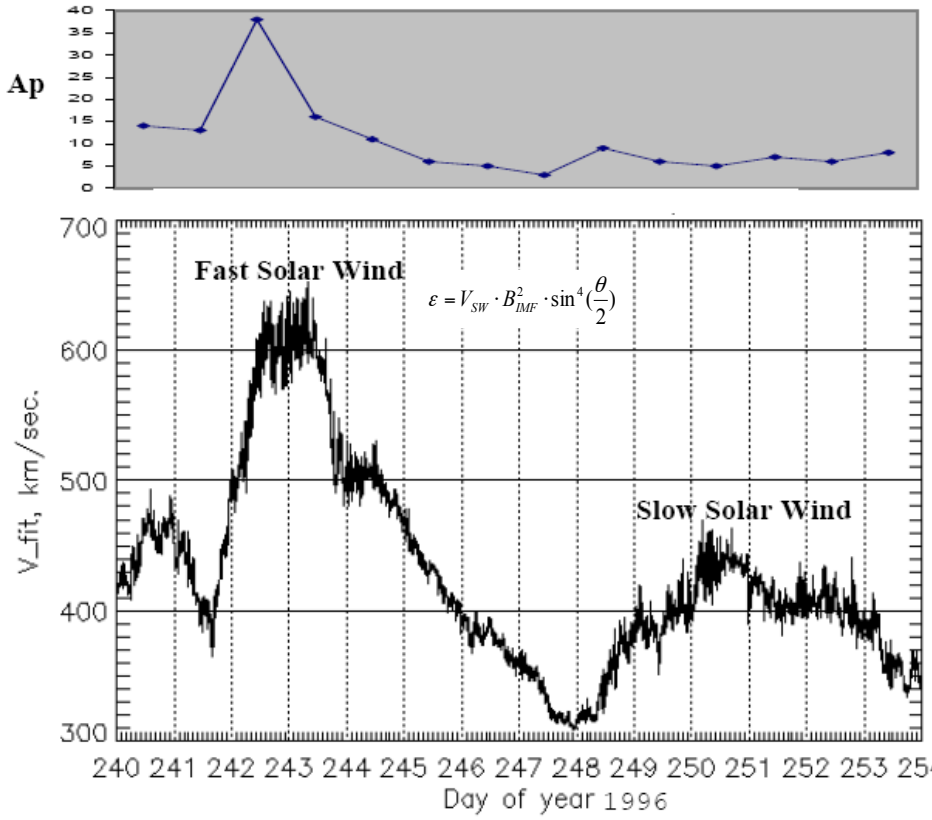


Sunspots do not provide direct information on the Sun‘s corona



The Sun imaged at different wavelengths on 9th November 2005 (Bothmer & Zhukov 2006).

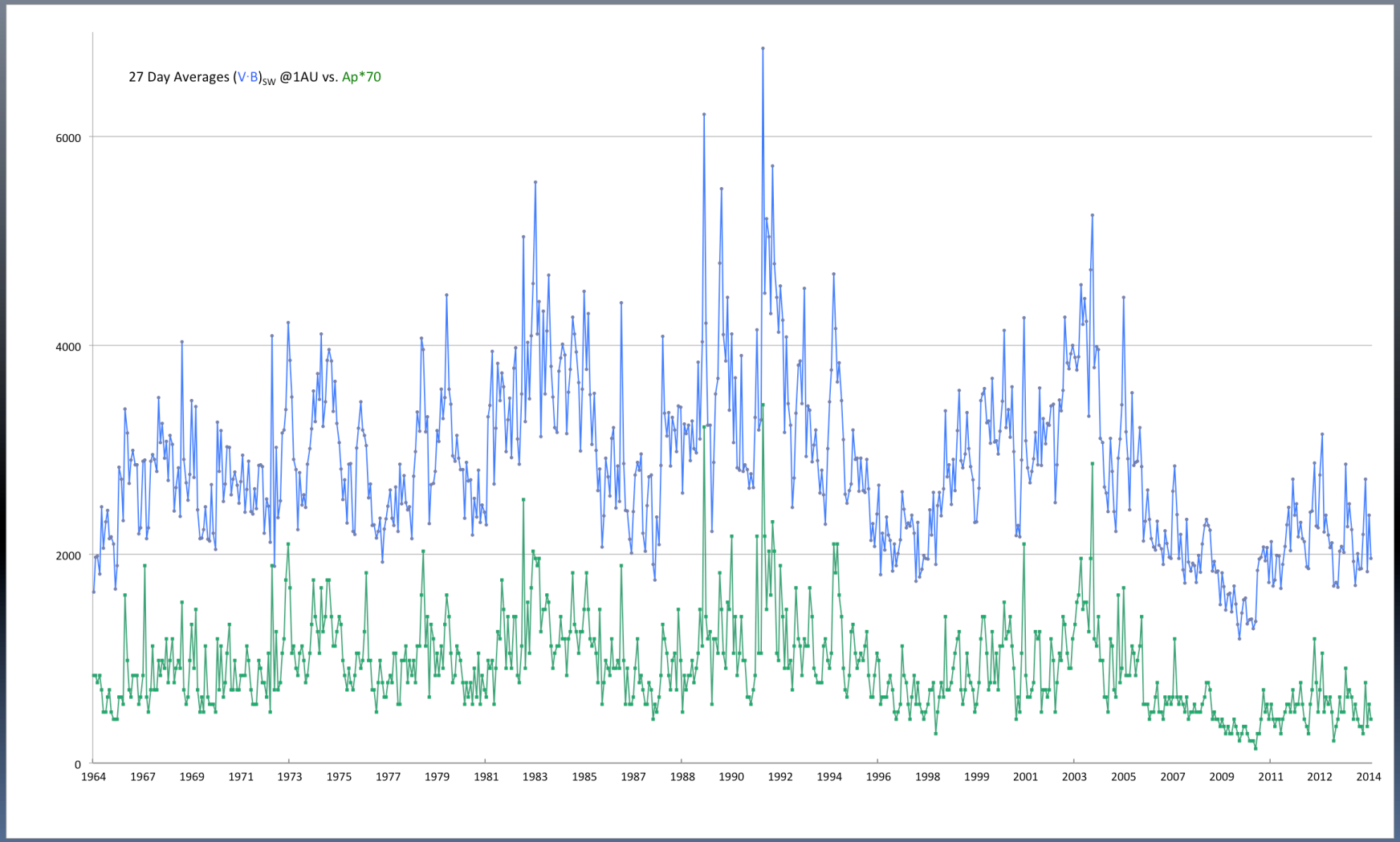




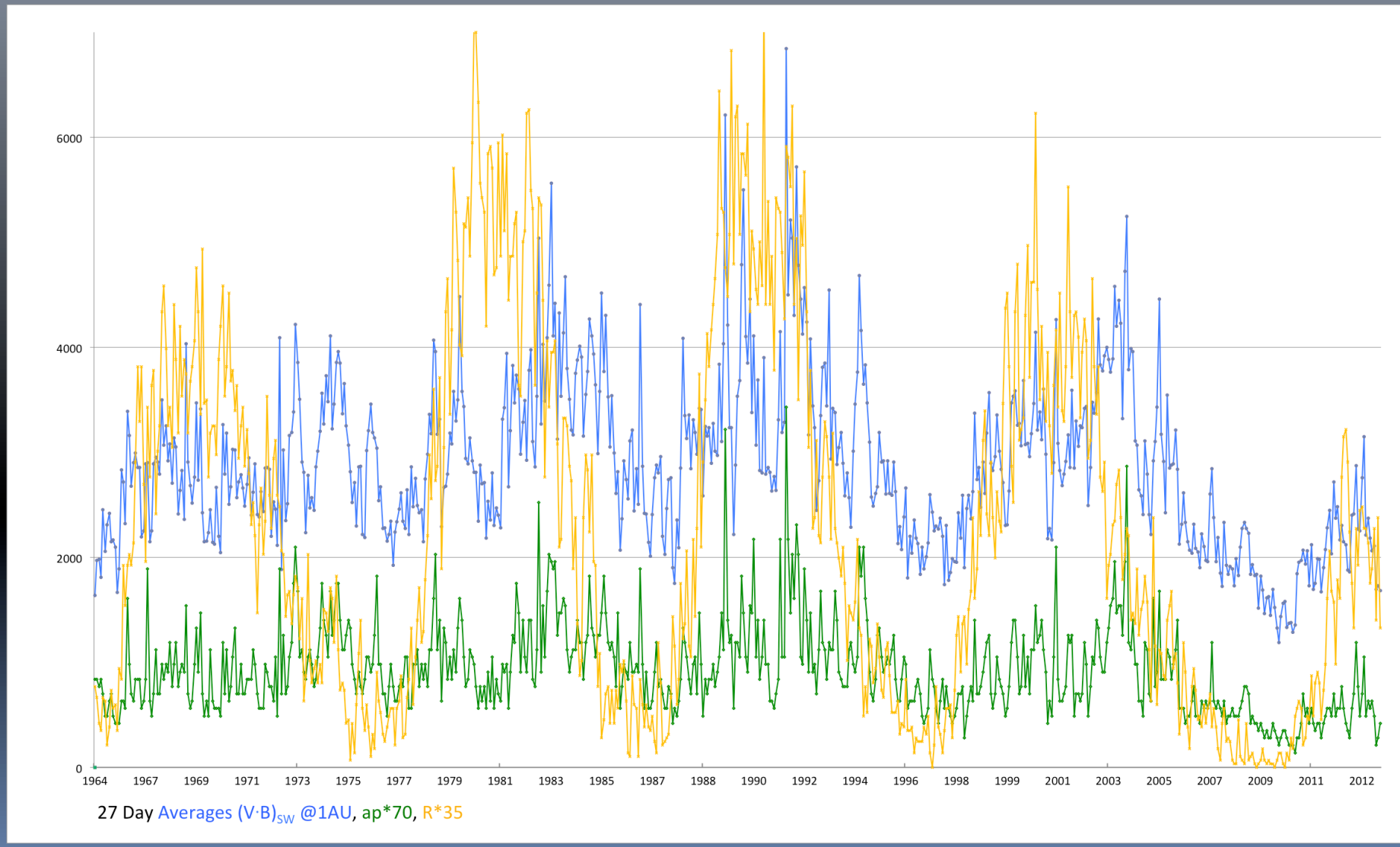
Fast solar wind from coronal holes as causes of increased geomagnetic activity

Bothmer & Zhukov (2006)

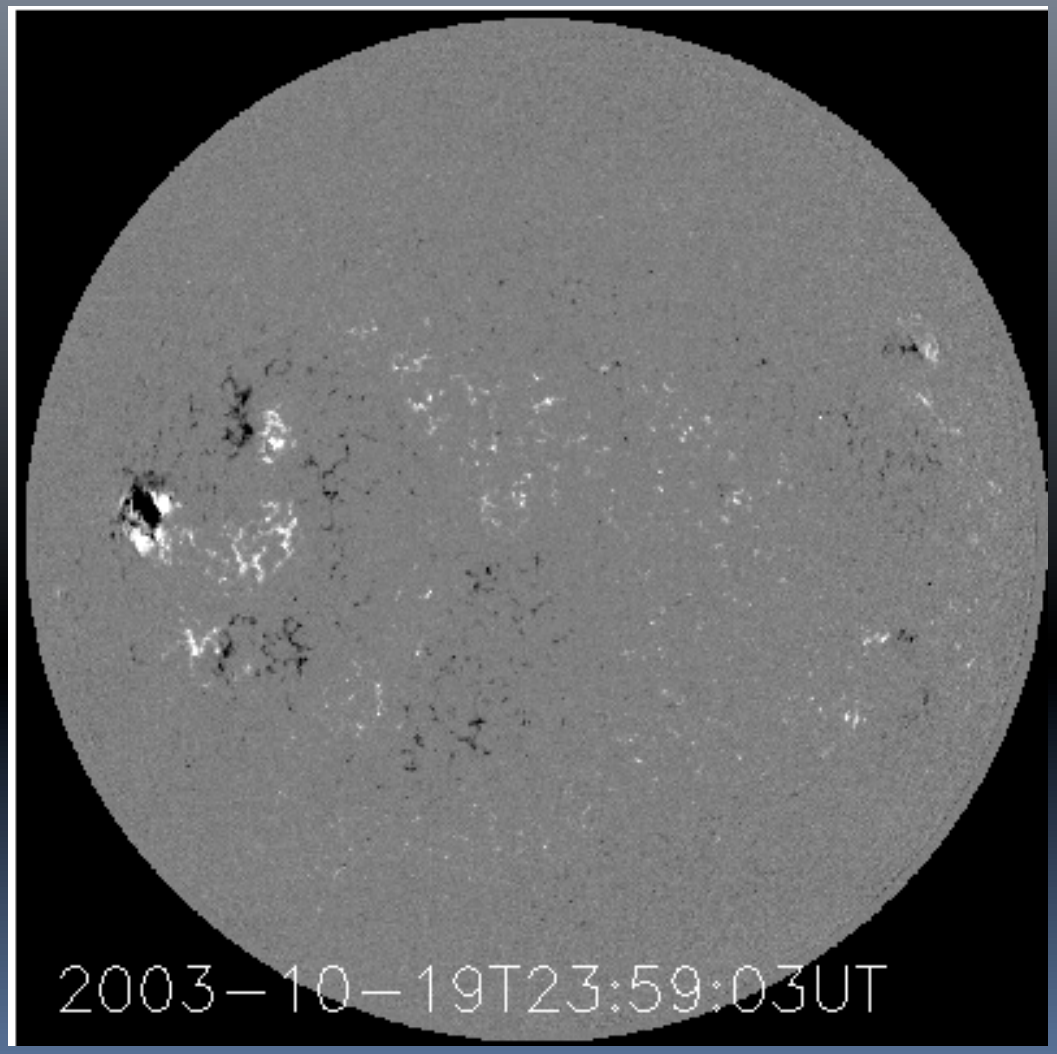
Solar Wind Parameters (v·B) and Geomagnetic Activity (Ap)

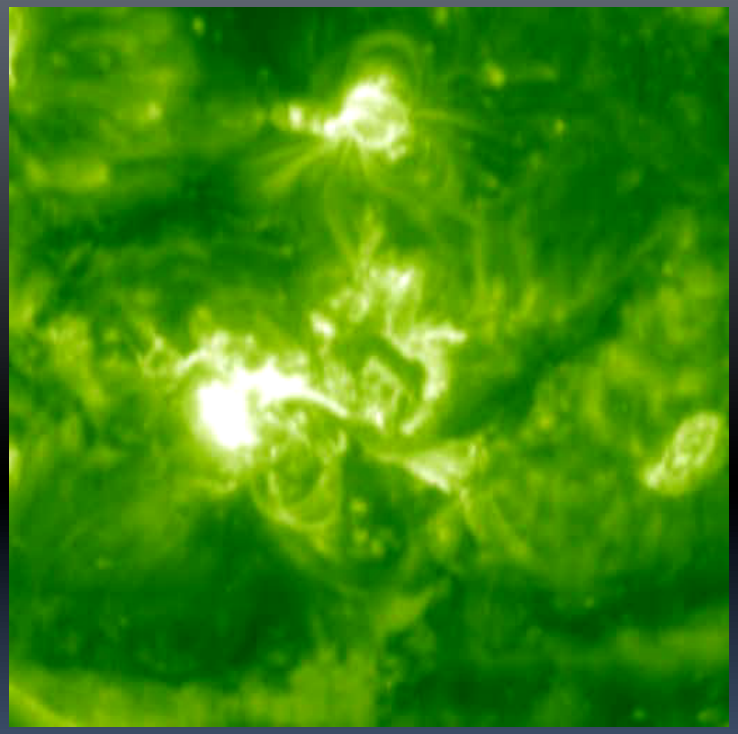


Solar Wind Parameters (v·B), Geomagnetic Activity (Ap) and Sunspot Number (R)



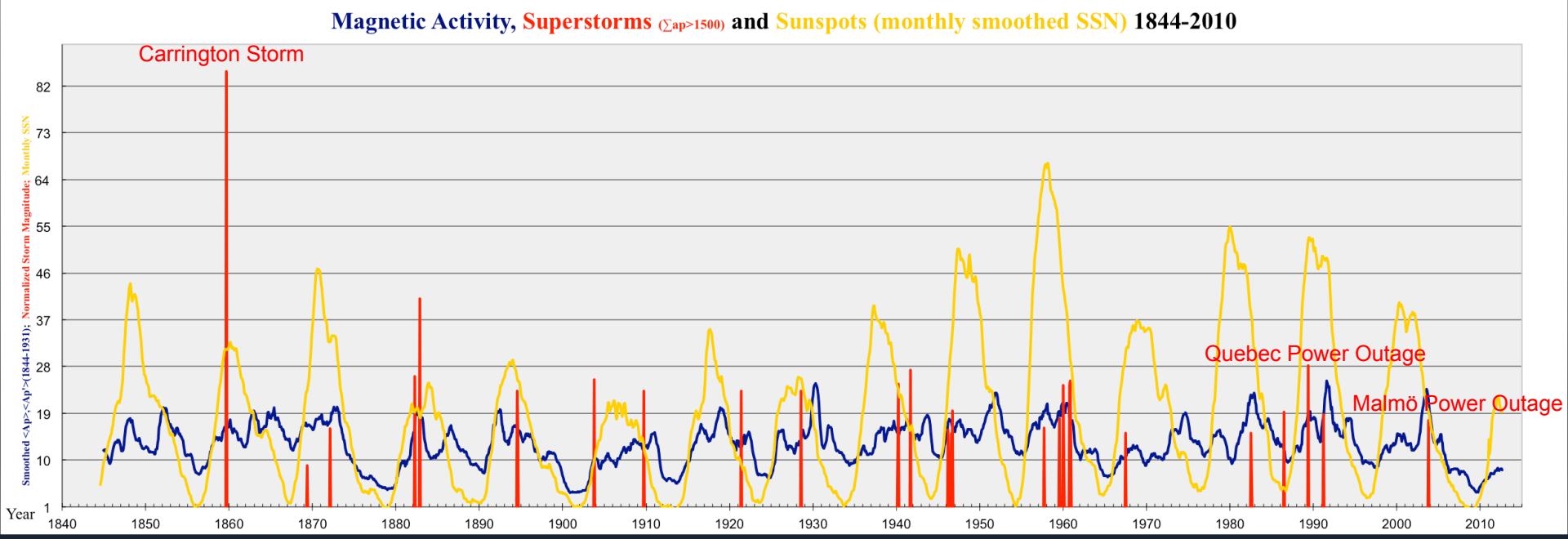
Photospheric variability as driver of coronal instabilities and solar wind hurricanes (coronal mass ejections, CMEs)





Magnetic activity, Superstorms (Kp=9,Σap>1500) and Sunspots 1844-2010 – UGOE tradition

; Monthly Smoothed <Ap>, <Ap'>(1844-1931); Normalized Storm Magnitude;, 1/3 SSN



(Ap' reconstructed by Svalgaard)

Year

Some Statistics (1932-2014):

- 284 storms with Kp≥8-
- 44 storms with Kp≥9-
- About 1-4 severe storms per cycle

Damaged South African Transformers

Summary

- Superstorms are caused by individual solar active regions, mostly at near equatorial solar latitudes, causing series of CMEs
- Superstorms are not related closely to the overall sunspot number but rather to short periods of emerging magnetic flux
- Worst case studies can be undertaken based on upscaling of historic measurements, taking frequency dependences into account