A Calibration of POES Hemispheric Power Index and its Strong Linear Relation to the *IHV* Geomagnetic Activity Index

Leif Svalgaard, ETK
Ed W. Cliver, AFRL

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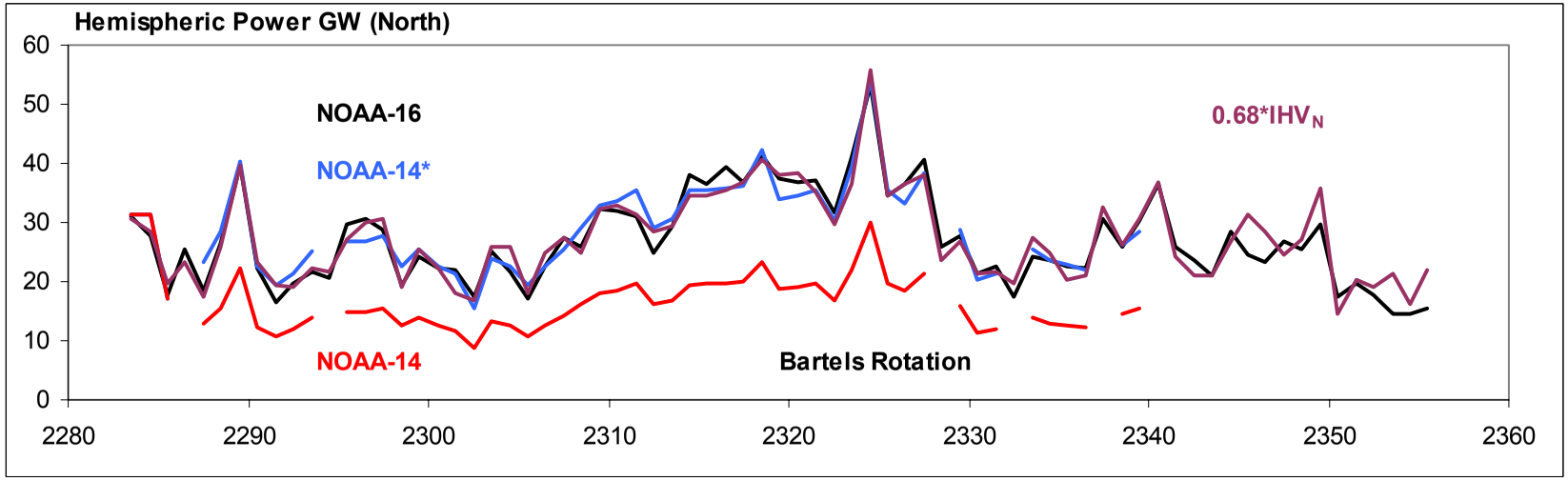
A newly-defined geomagnetic activity index, the Inter-Hourly Variability Index (*IHV*), has been found to have a very high correlation (R=0.93 for monthly means) with the NOAA/POES Hemispheric Power Index (*Hp*) that provides an estimated power in gigawatts deposited in the polar regions by energetic particles during transits over the poles by the NOAA POES satellites. The relationship is strong enough to allow us to intercalibrate the many POES satellites. Each satellite (*n*) has its own scale factor, *F*(*n*), between *Hp* and *IHV* from various instrumental causes. Because *IHV* has a very stable long-term calibration (being derived from dozens of ground-based observatories) we can use *IHV* to provide a stable calibration for *Hp* as well. We calculate for each POES satellite the ratio between *F* for the satellite and *F* for a suitably chosen reference satellite. The ratio between these two *F*-

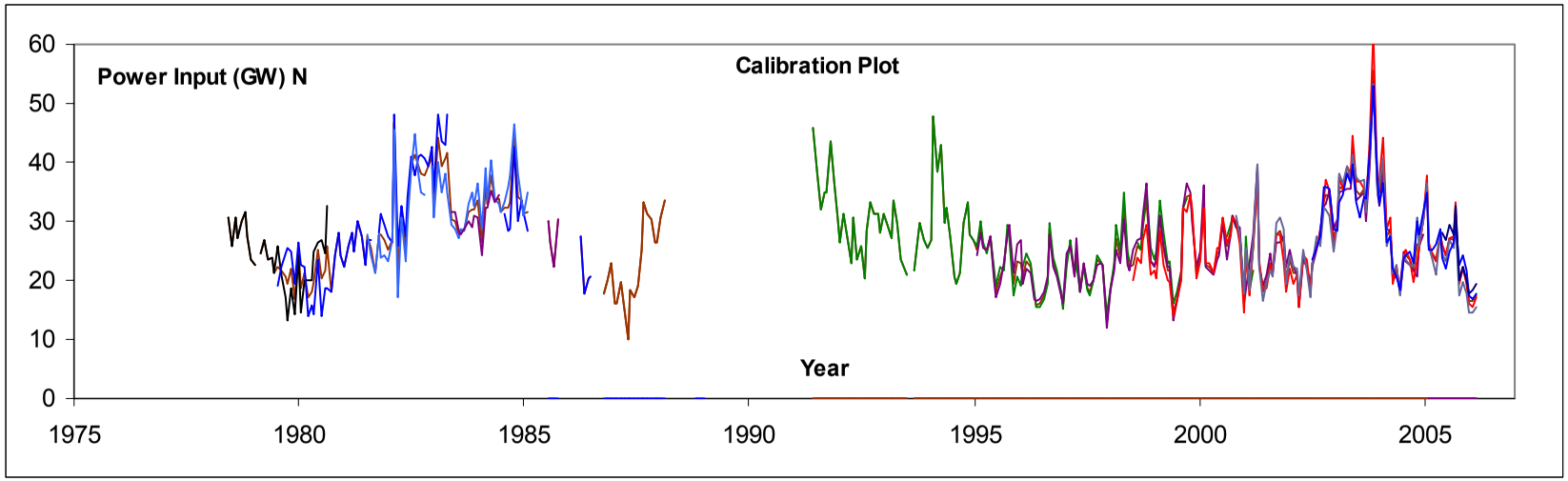
values is the calibration factor to reduce satellite *n* to the reference. If we use NOAA-16 as reference satellite, we find *Hp* (GW) = 0.68 *IHV* with correlation coefficient 0.93. This is for the Northern Hemisphere. A similar result holds for the Southern Hemisphere. This relationship holds back to the beginning of the *Hp*-series in 1978. We do not see any reason why it should not hold prior to that. Since *IHV* is available back to 1883, we have inferred *Hp* back to 1883 as well. *IHV* can be calculated in near real-time. The *IHV* index is also a good proxy (R = 0.96) for interplanetary parameters (magnetic field *B* nT and solar wind speed $V_o = V$ / (100 km/s)): $B\ V_o^2 = 4.34$ (*IHV* - 6.2) for monthly means and $B\ V_o^2 = 4.60$ (*IHV* - 8.7) for yearly means. It follows that *Hp* is similarly controlled by $B\ V_o^2$ as confirmed by direct comparison.

We analyze the POES *Hp* data as given at the website **http://www.sec.noaa.gov/pmap**.

We show below the 27-day (Bartels) rotation averages of Hp measured by NOAA-16 and compared to IHV (scaled by 0.68). They match closely. For other satellites a similar good match is obtained (e.g. as shown for NOAA-14), but each satellite has a different scale factor to IHV. The ratios between these scale factors are the calibration factor to bring a satellite on the NOAA-16 scale.



Here we show with different colors the result of normalizing all the satellites to NOAA-16:

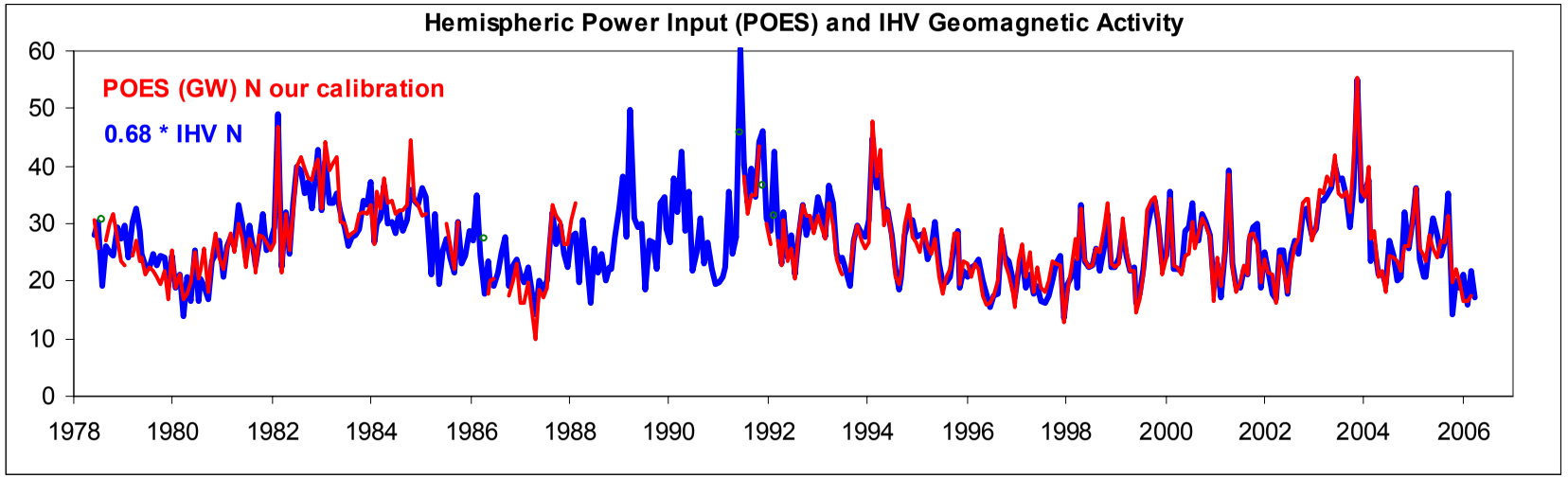


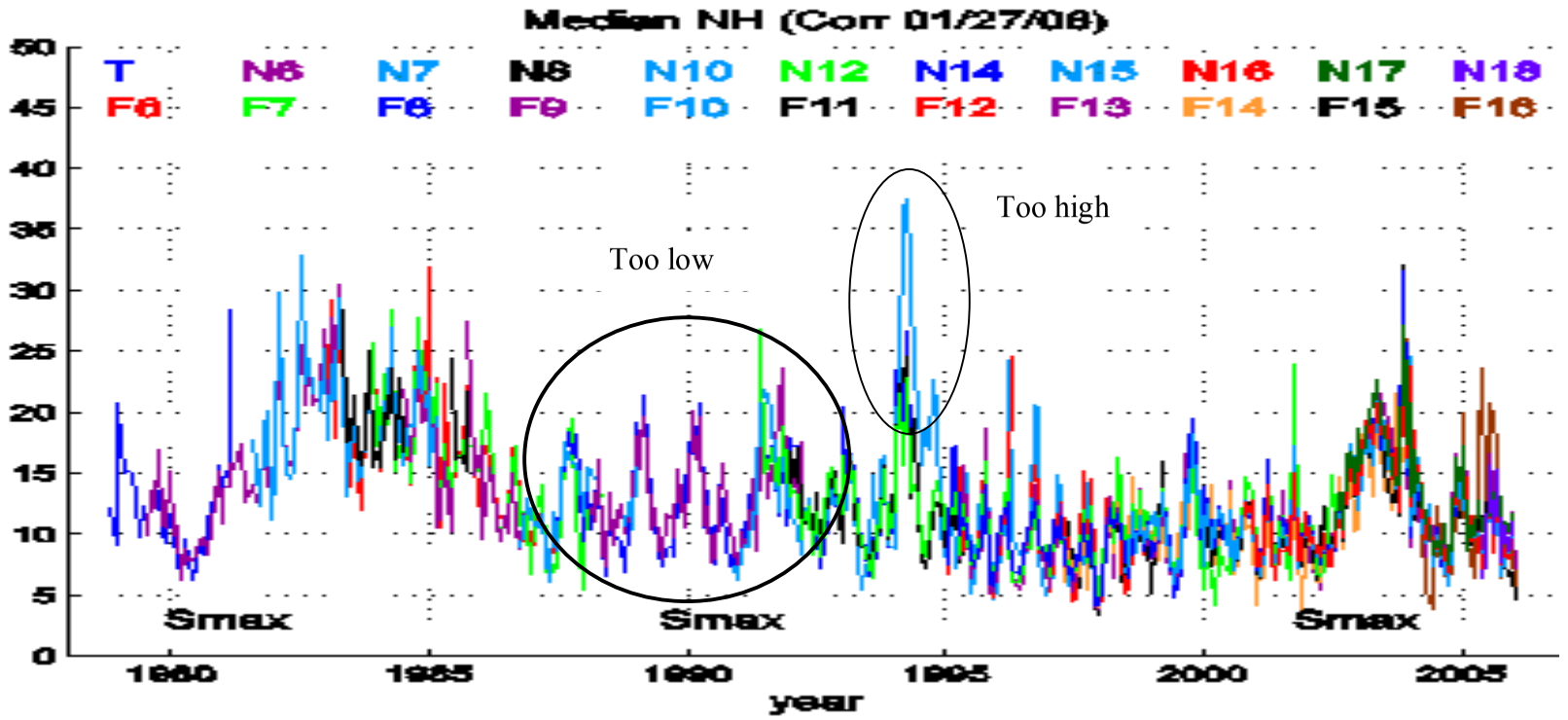
Northern Hemisphere

SAT	Scale Factor	
TIROS-6	1.456	
NOAA-6	1.408	
NOAA-7	1.292	
NOAA-8	1.307	
NOAA-10	1.706	
NOAA-12	0.966	
NOAA-14	1.336	< 1996.0
NOAA-14	0.766	1996.0-1998.5
NOAA-14	0.931	1998.5-2001.0
NOAA-14	1.786	> 2001.0
NOAA-15	0.853	
NOAA-16	**1.000**	
NOAA-17	0.955	
NOAA-18	1.118	

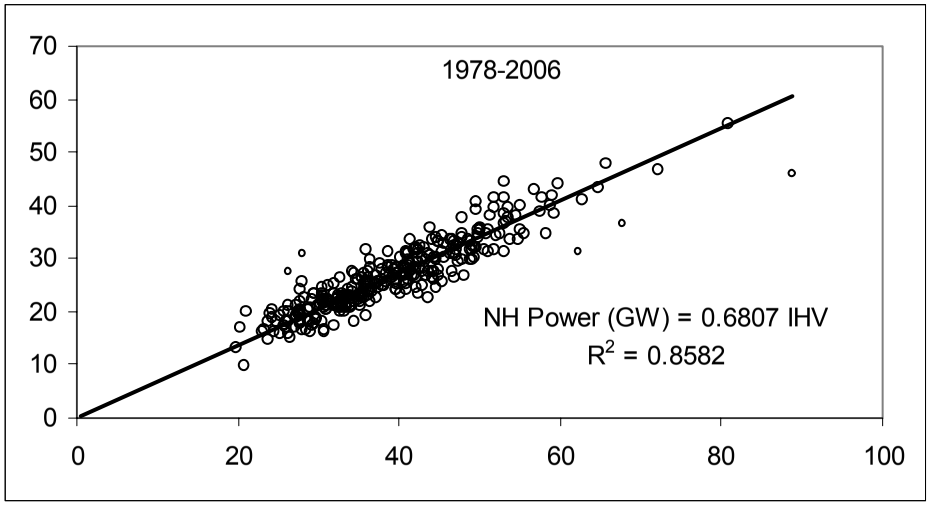
Scale factors to reduce a satellite to NOAA-16. For NOAA-14 the calibration changes over time as shown.

Using the intercalibrated satellite measurements we construct a composite time series of *Hp* POES and compare it with *IHV*:





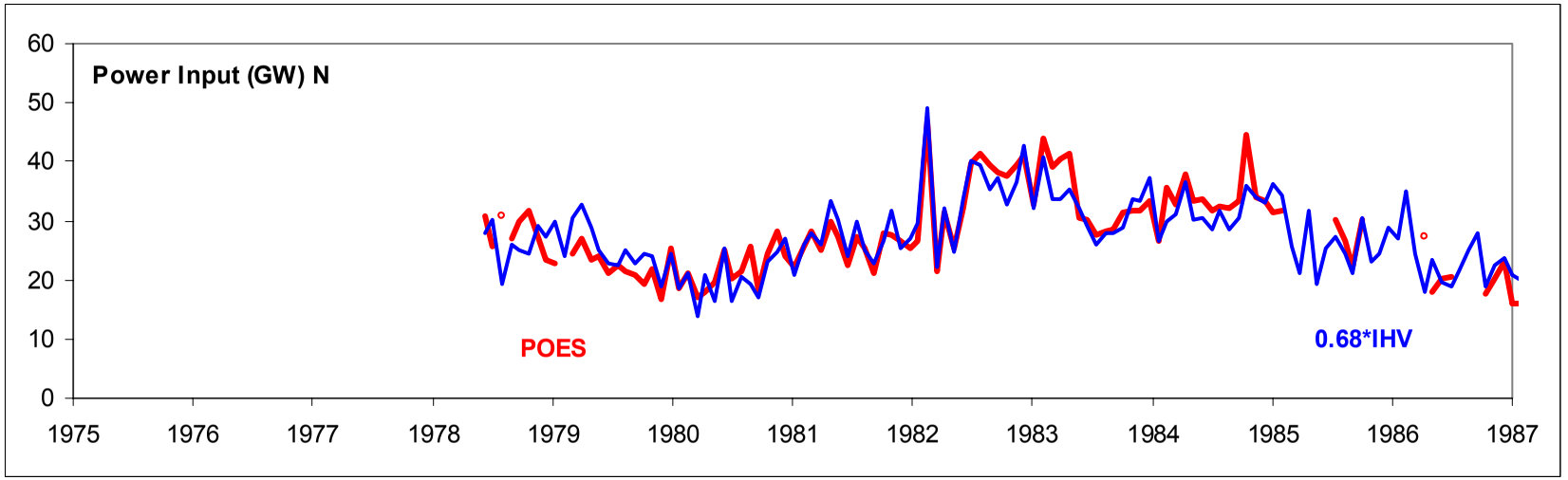
Shamelessly taken from Barbara Emery's upcoming paper on the POES calibration. There are significant differences apart from the general level being different by about a factor of two.

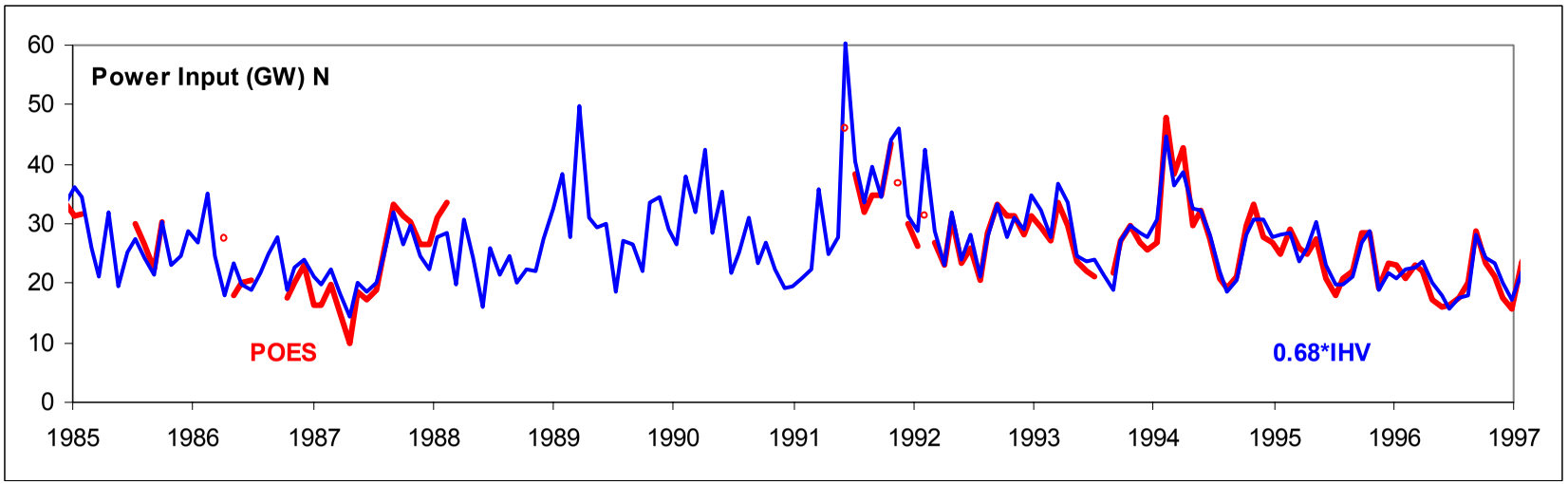


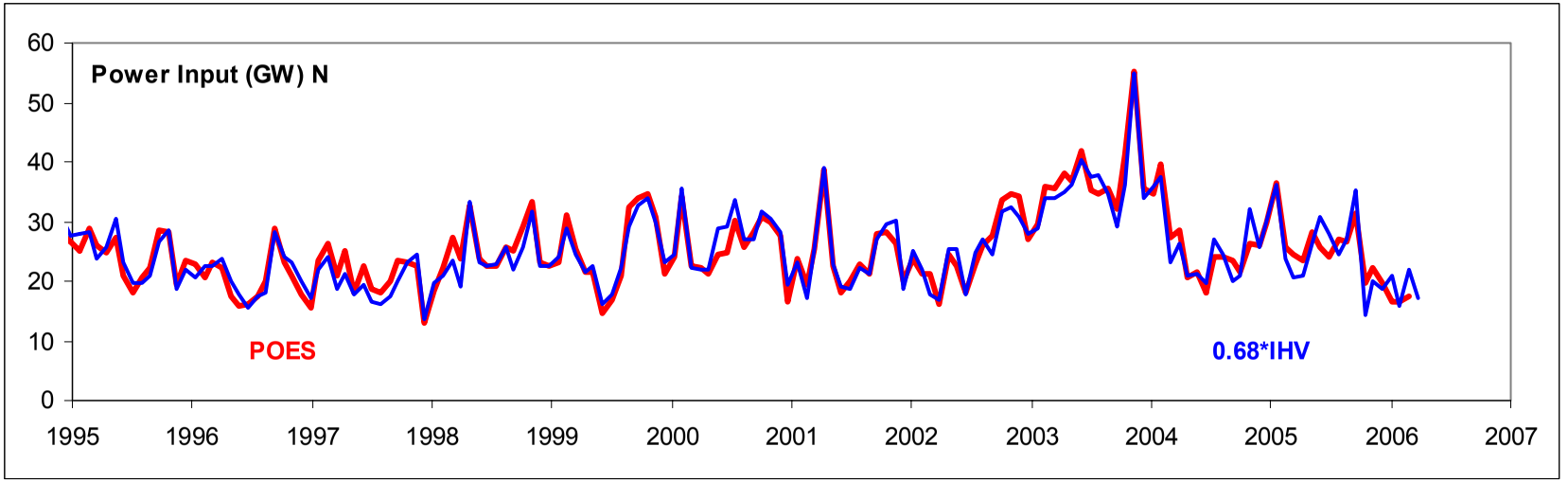
Correlation between rotation averages of POES *Hp* (N) and *IHV* for the Northern Hemisphere.

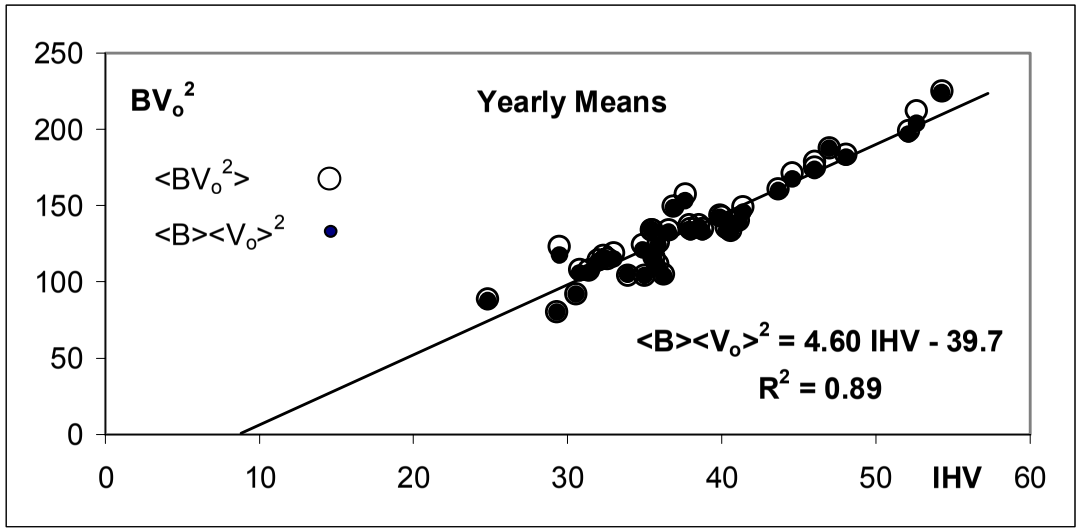
Very similar result for the Southern Hemisphere (no surprise as POES *Hp* is calibrated originally so that the South has the same mean as the North.

Detailed comparison between 27-day (Bartels) rotation averages of POES and *IHV* (both N):

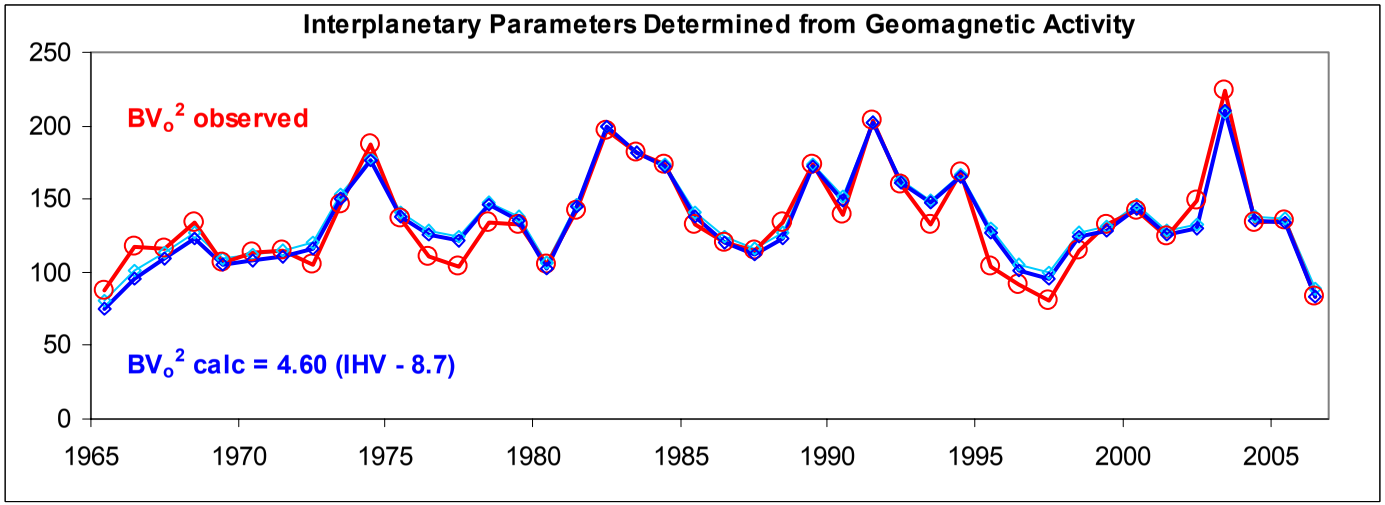



Power Input (GW) N
60
50
40
30
20
10
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
POES
0.68*IHV


Power Input (GW) N
60
50
40
30
20
10
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
POES
0.68*IHV

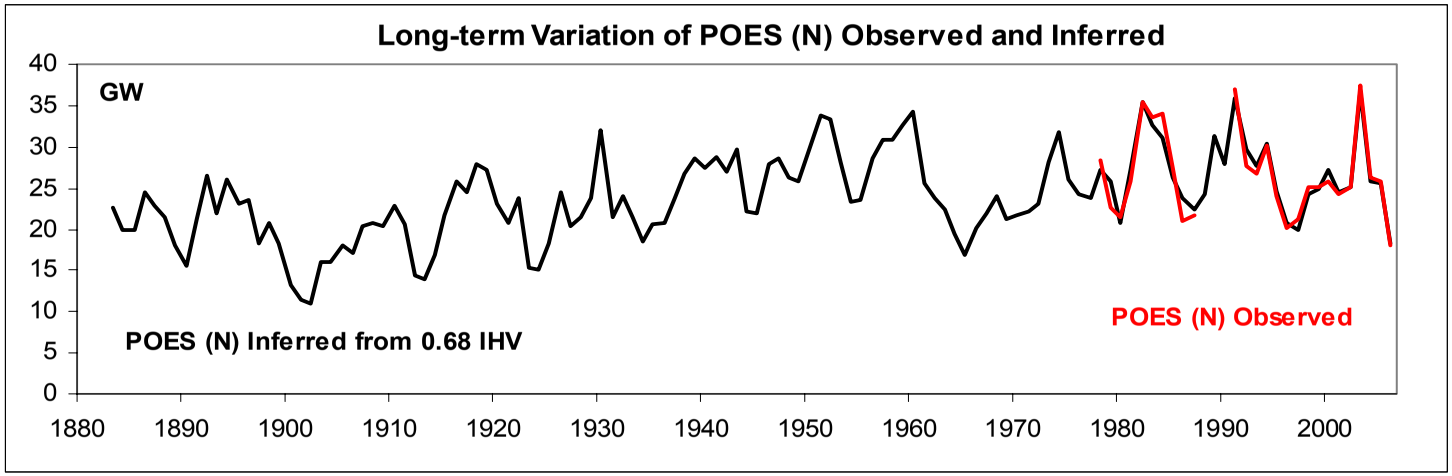


The correlation between yearly means of *IHV* and the product of IMF strength *B* (nT) and square of solar wind speed *V* (actually $V_o = V/100$ km/sec). It makes very little difference if BV_o^2 is calculated before averaging or from averages of *B* and V_o.

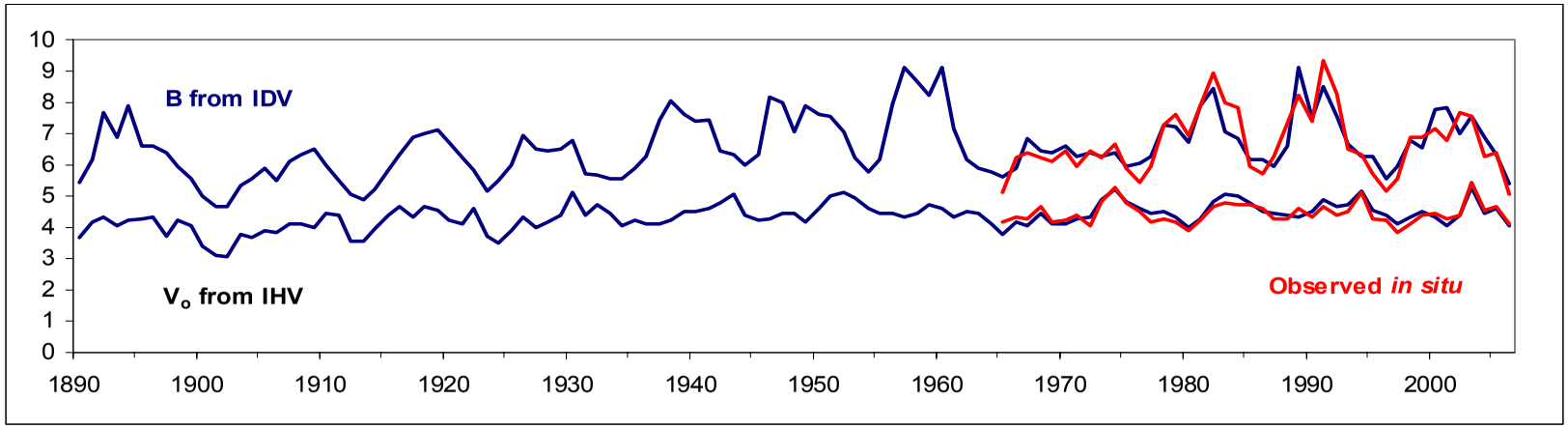


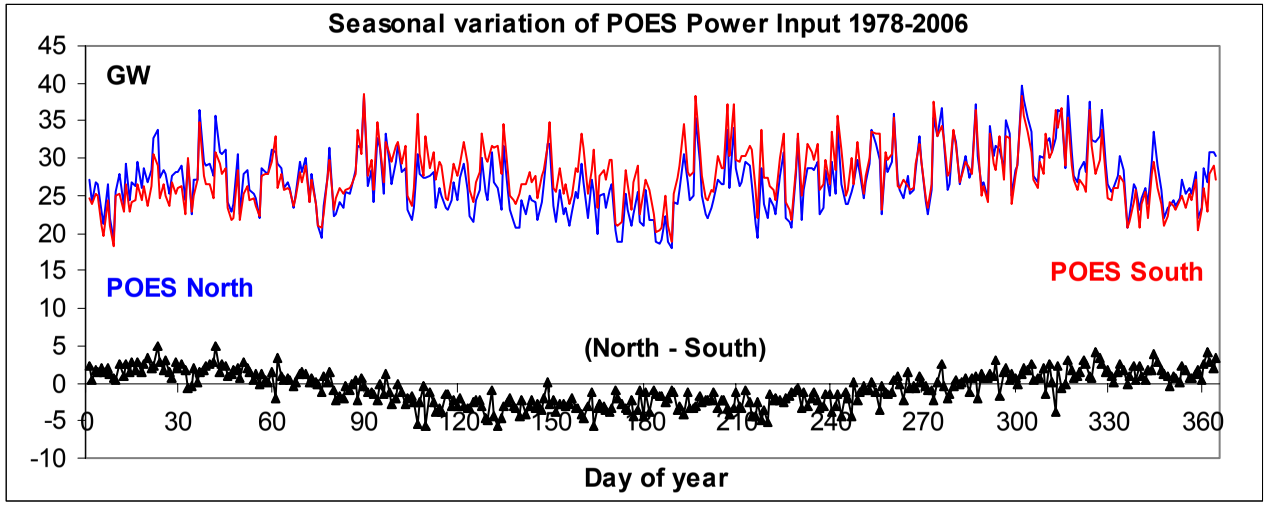
Time series graph of the above correlation.

The *IHV* 22-year cycle is evident



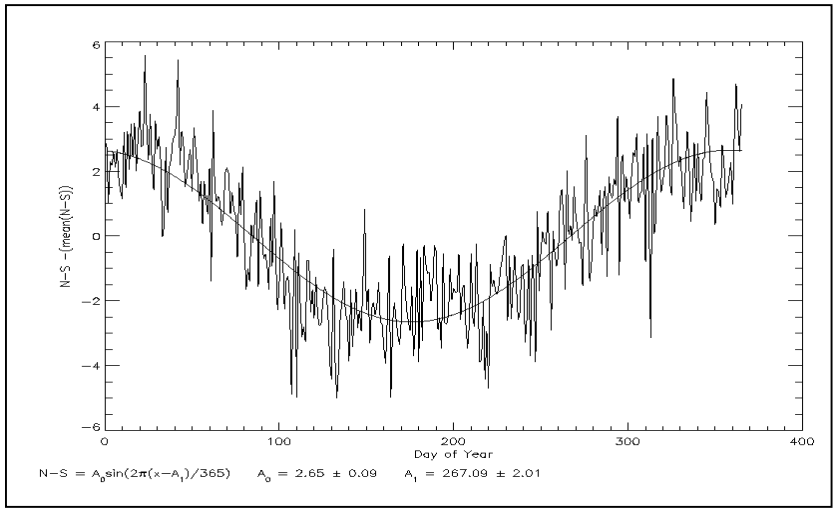
Since *IHV* is known back to 1883 we can reconstruct POES *Hp* back to then as well. *IHV* gives BV_o^2, but, actually, B and V_o are both known separately:





We confirm that there is a yearly variation of *Hp*, being larger in local ***winter***.

IHV also shows this curious fact.



The difference (North - South) of *Hp* POES (and of *IHV*) can be fitted to a sine wave that goes through zero within two days of the equinoxes.

The cause of this (±10%) variation is unknown.