

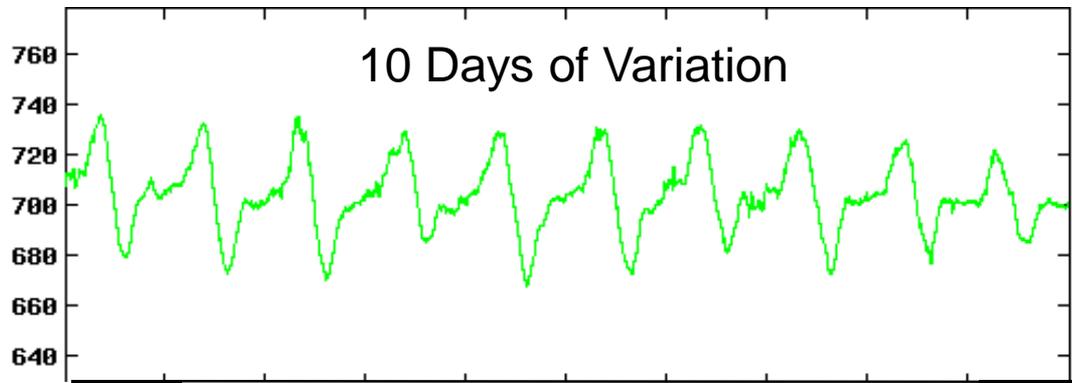
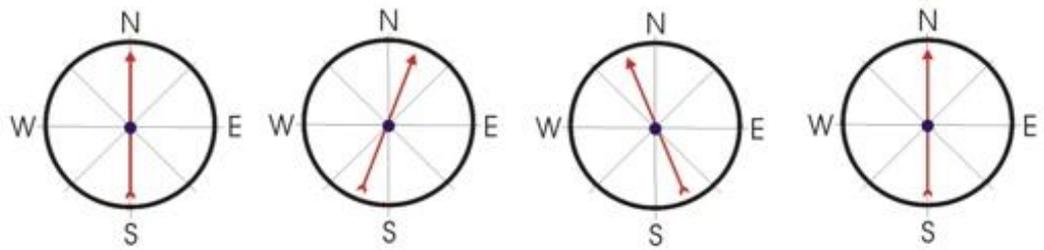
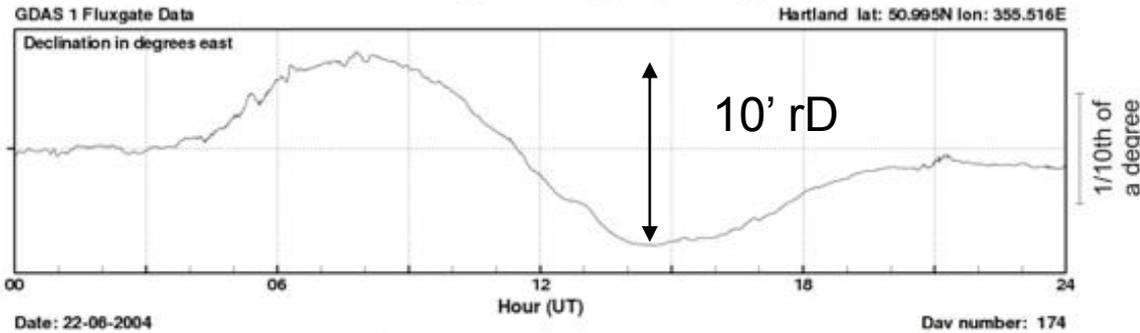
Solar Multi-Messenger

Leif Svalgaard

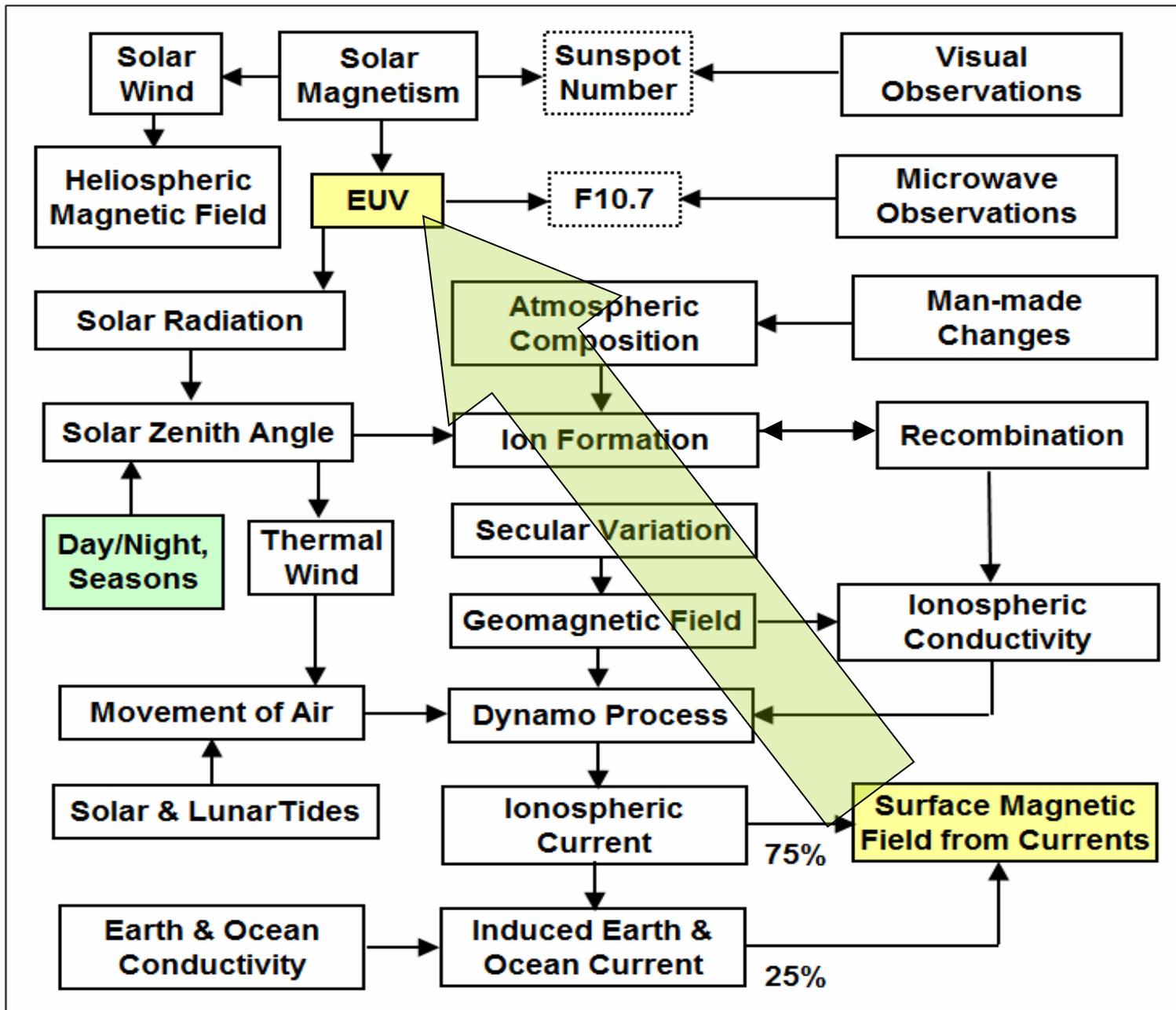
July 27, 2018

The Diurnal Variation of the Direction of the Magnetic Needle

National Geomagnetic Service, BGS, Edinburgh



George Graham [London] discovered [1722] that the geomagnetic field varied during the day in a regular manner.



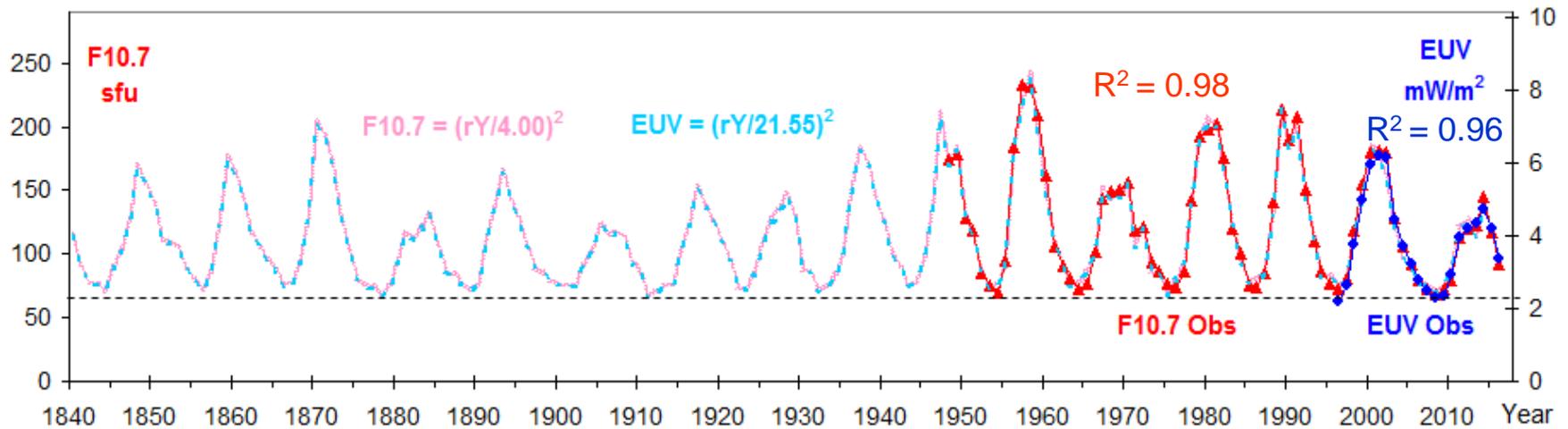
Determining EUV Flux from the magnetic effect of dynamo currents in the E-region of the ionosphere

The physics of the boxes is generally well-known

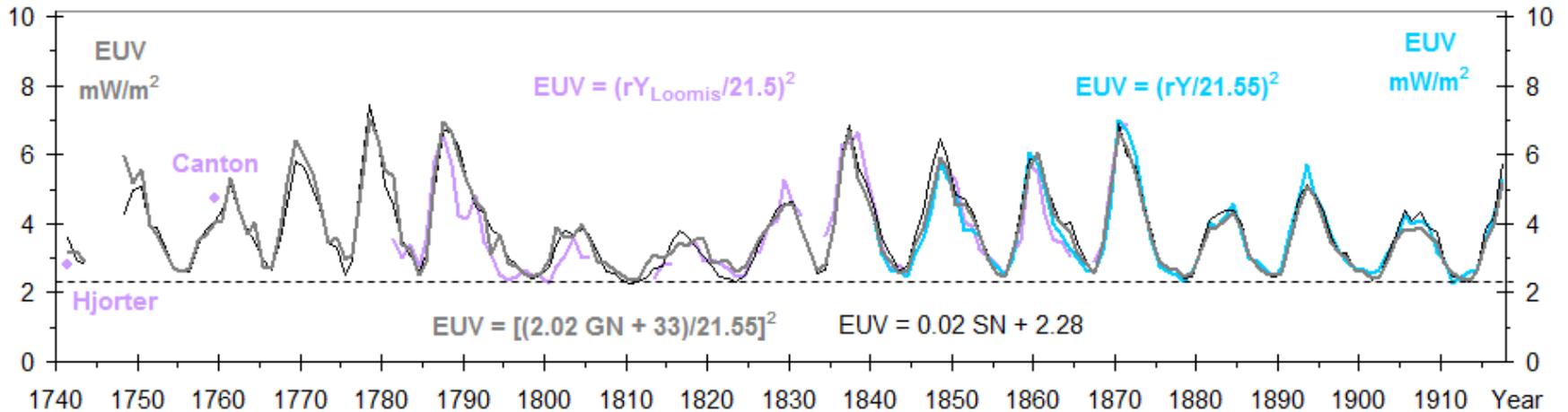
We shall determine the EUV from the magnetic effects

Reconstructions of EUV and F10.7

Reconstruction of F10.7 Flux and EUV < 103 nm Flux



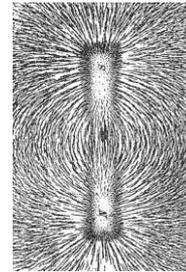
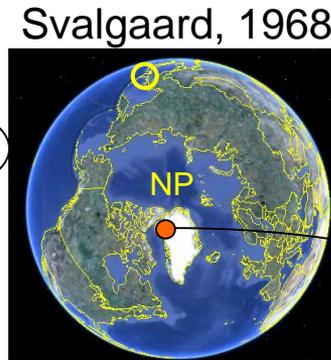
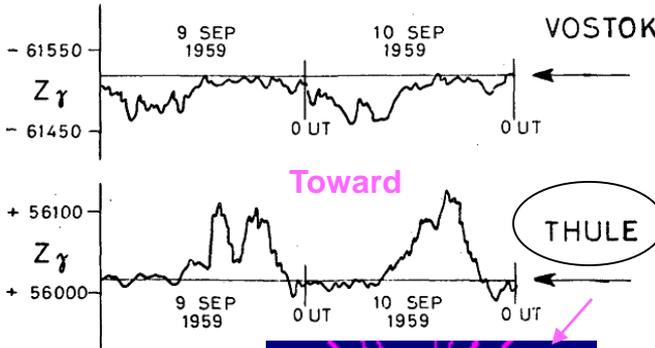
Reconstruction of EUV < 103 nm Flux



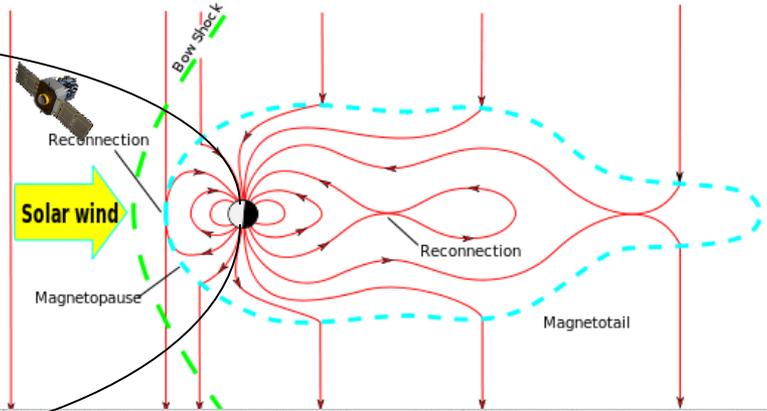
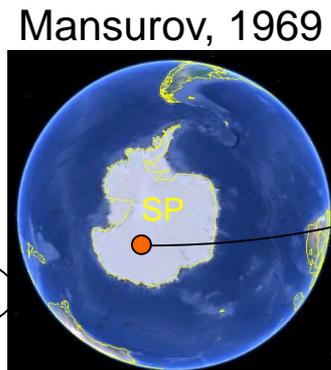
Note the constant basal level at every solar minimum

Magnetic Fields on Earth and in Space

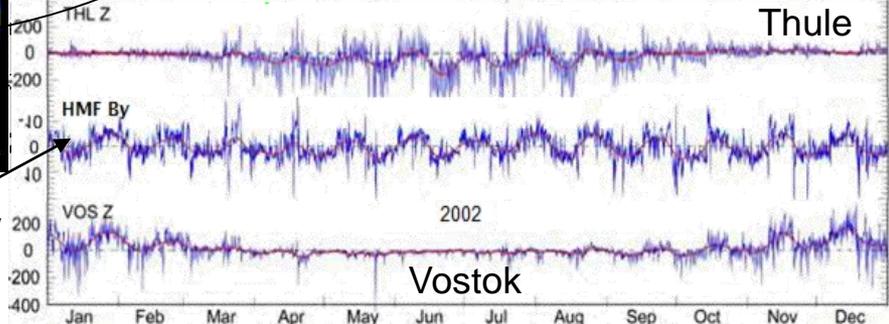
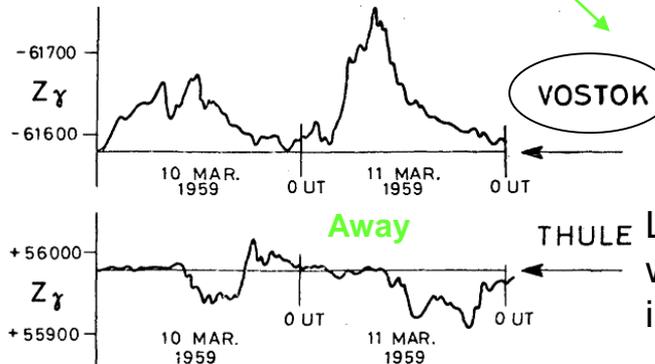
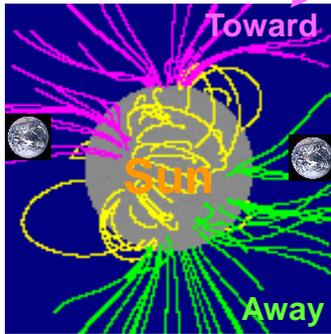
The solar system is permeated by magnetic fields coming from the Sun with the **Solar Wind** and connecting with the field of the Earth [and other planets]



Magnetic field lines show the direction of the magnetic field



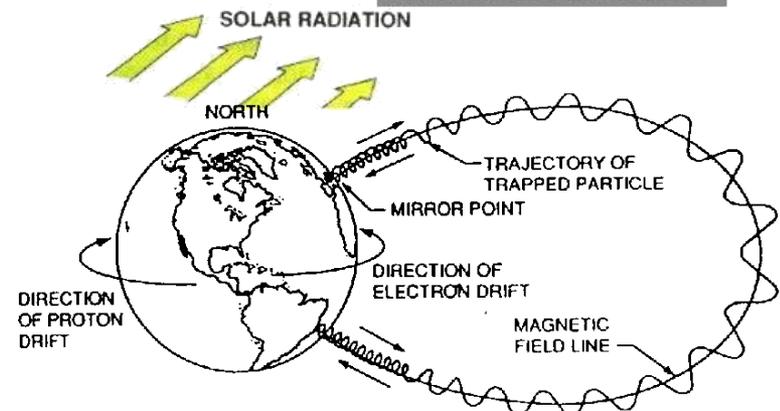
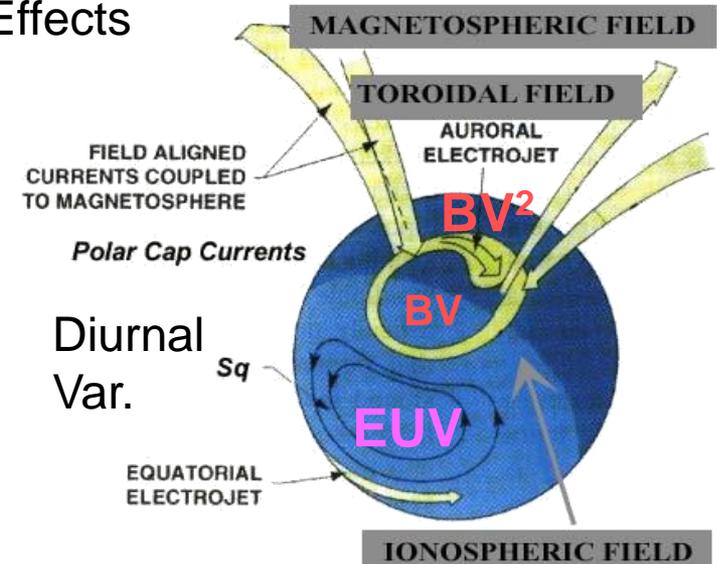
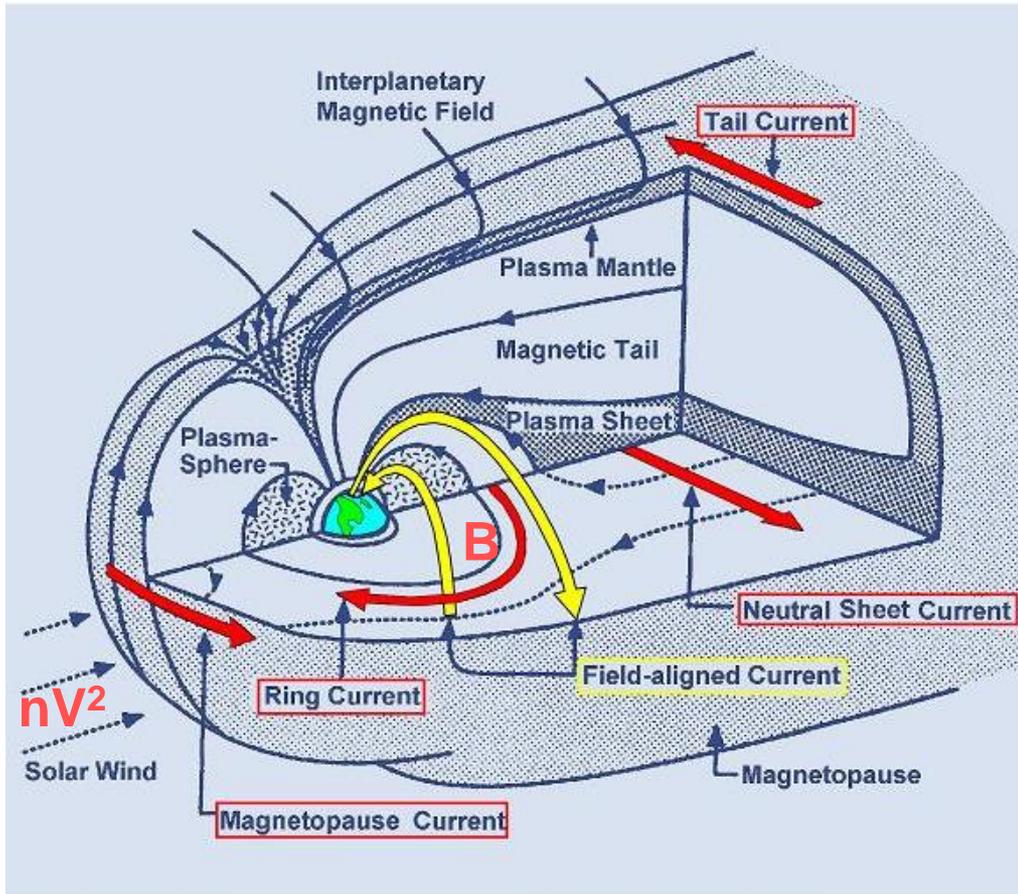
The records from Earth's polar regions show the Sun's fields



Look how accurately we can see the field in **space** from Earth

Electric Current Systems in Geospace

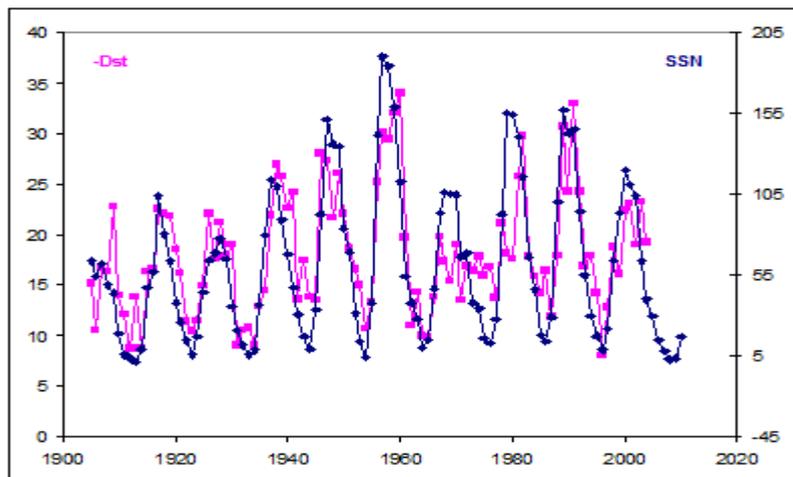
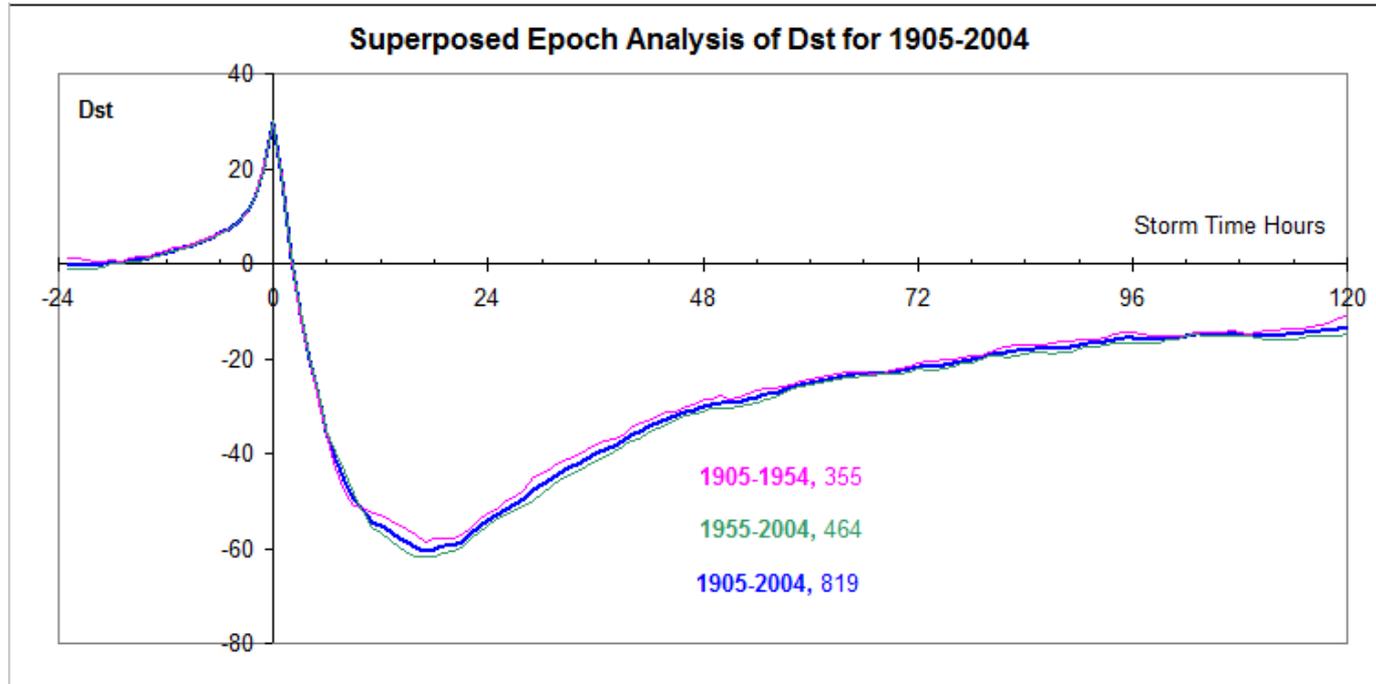
Different Current Systems \longleftrightarrow Different Magnetic Effects



We can now invert the Solar Wind – Magnetosphere relationships...

Oppositely charged particles trapped in the Van Allen Belts drift in opposite directions giving rise to a net westward 'Ring Current'.⁶

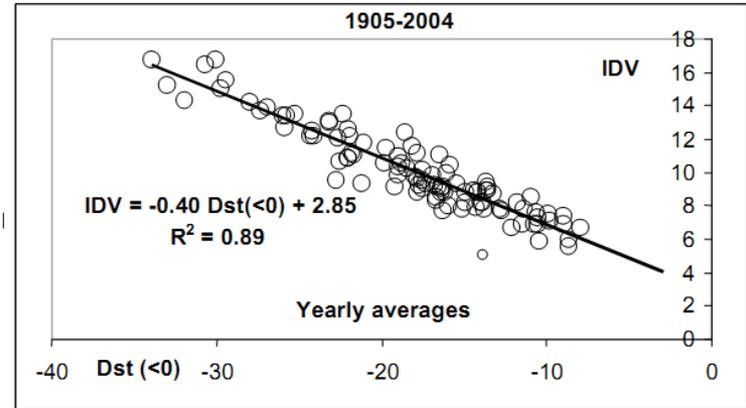
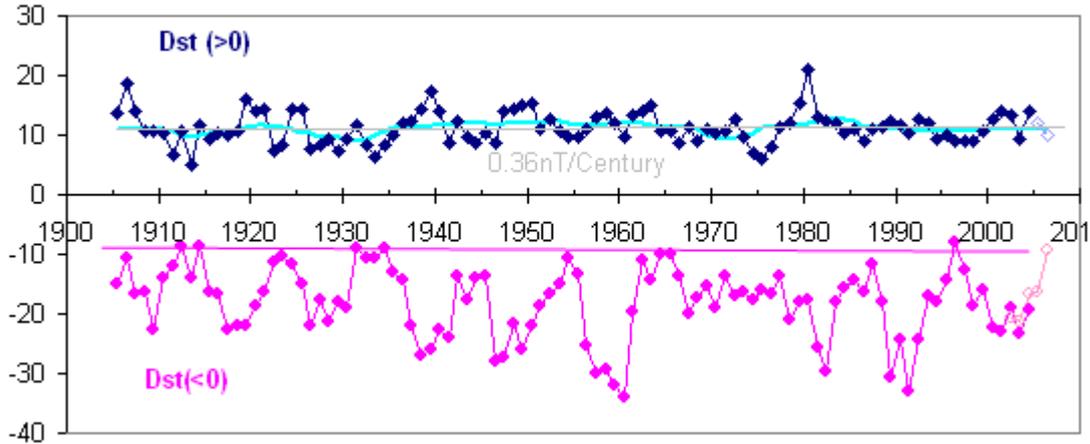
Dst Index and the Nachstörung



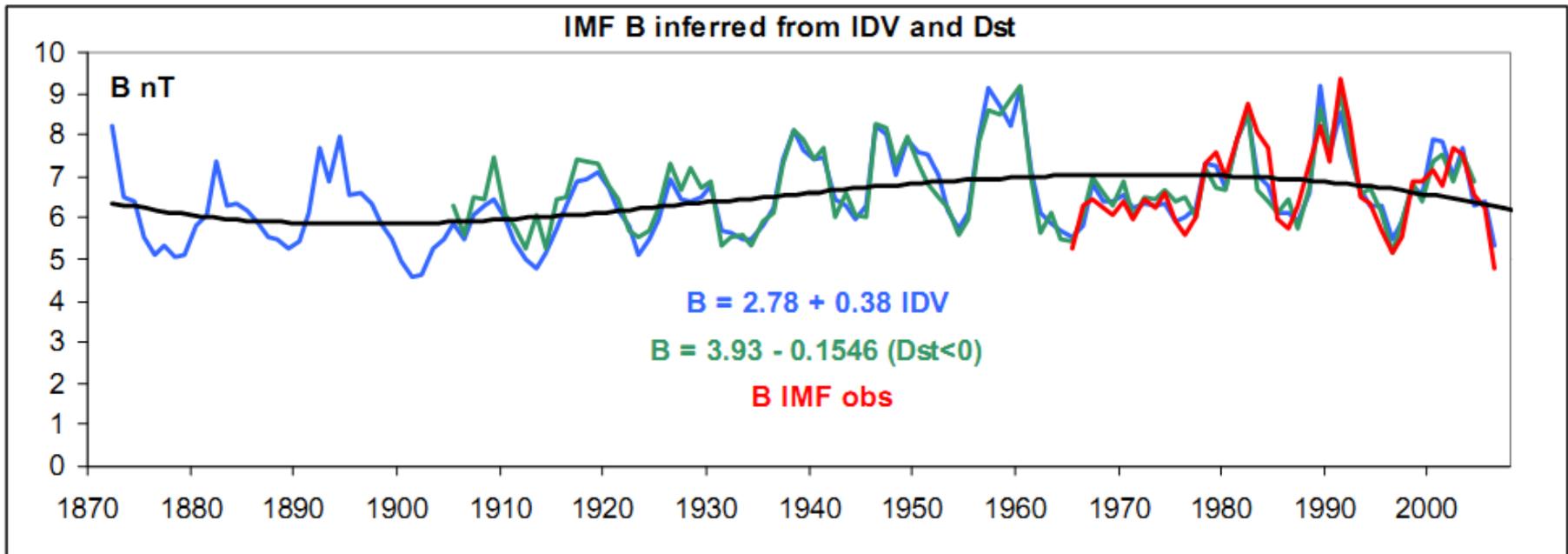
The IDV-Index is the difference from one day to the next without regard of the sign between the midnight values of the horizontal component H . The importance of this quantity was first recognized by the Scotsman Broun in 1861

HMF B and the Dst Index

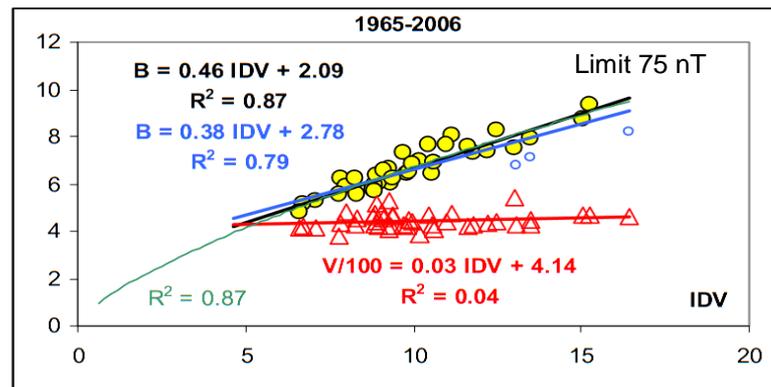
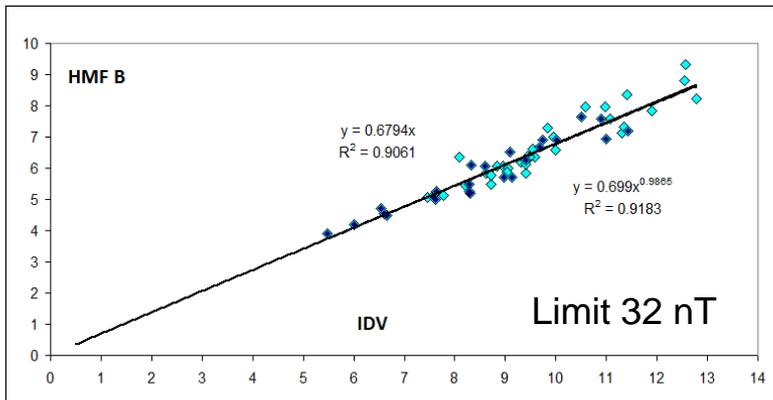
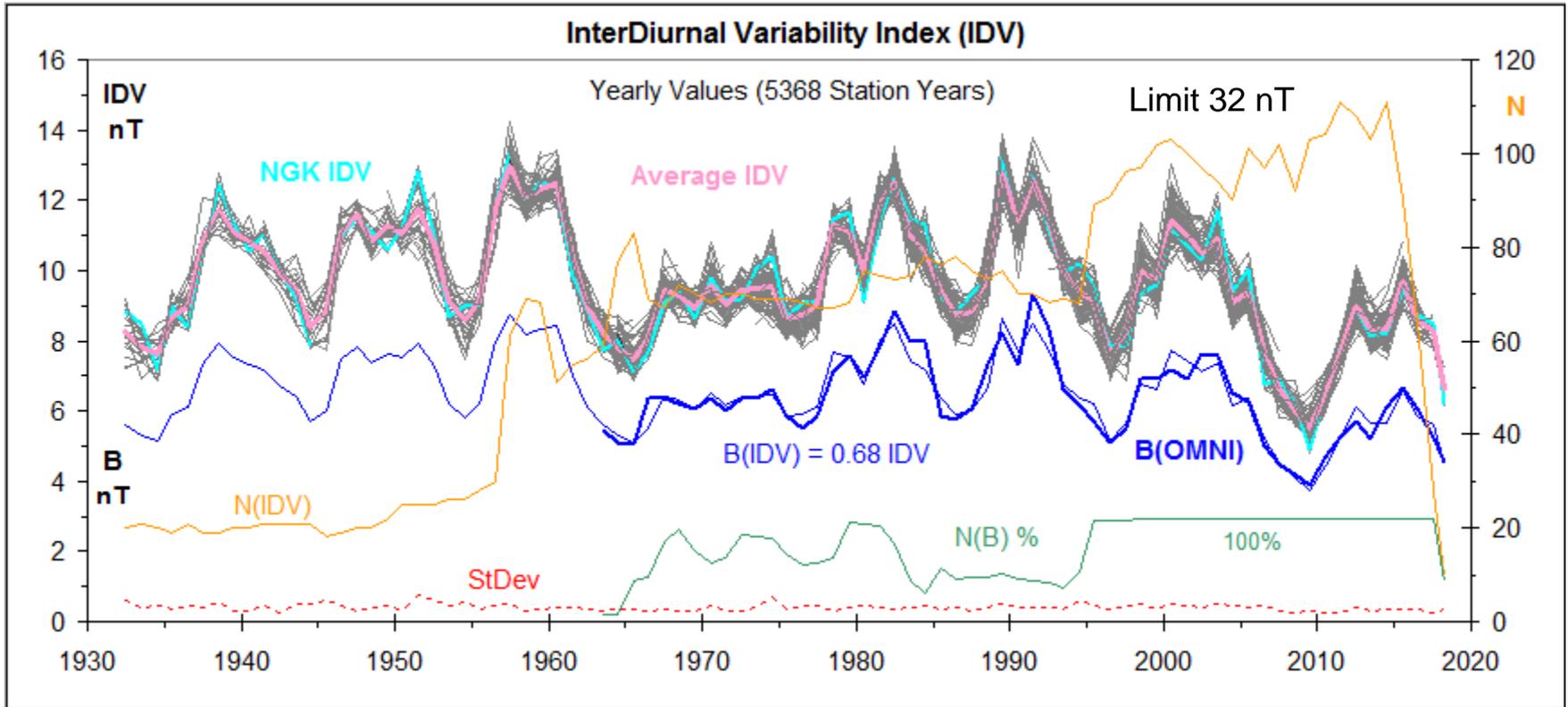
Dst (Love) Separately for Negative and Positive Values



IMF B inferred from IDV and Dst



IDV and HMF B

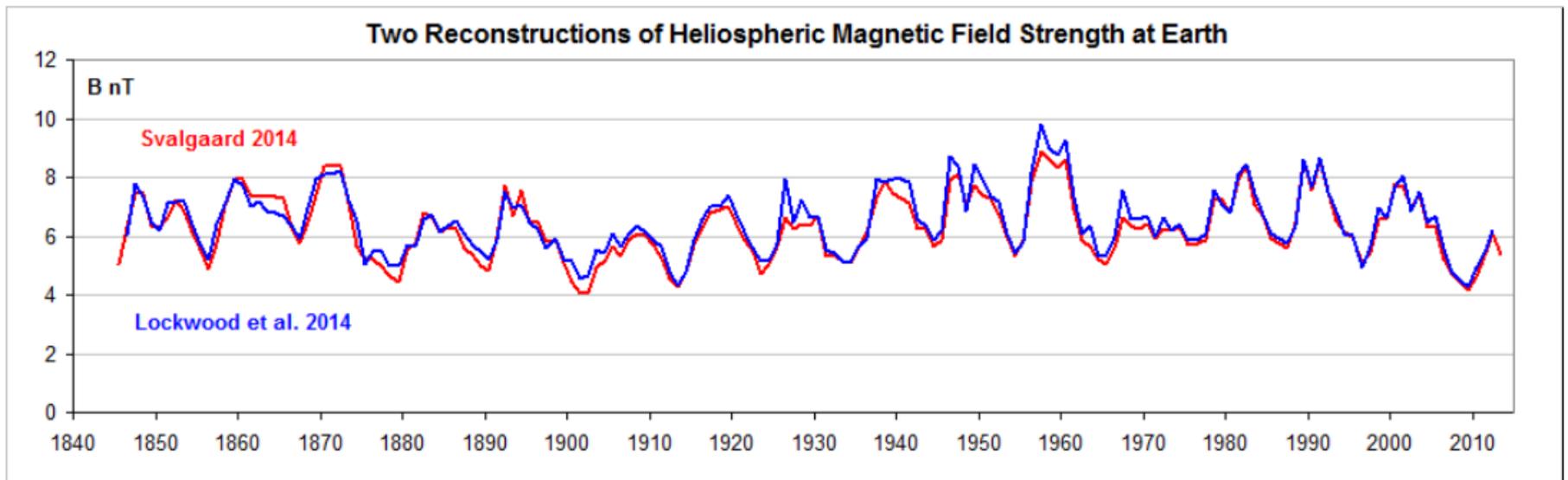
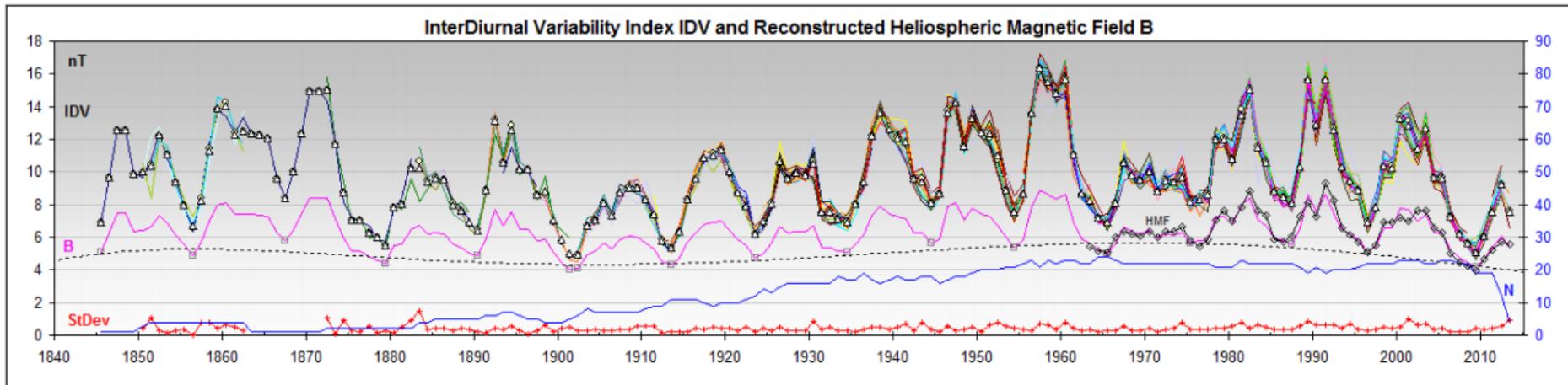


IDV depends on HMF B but is blind to speed V

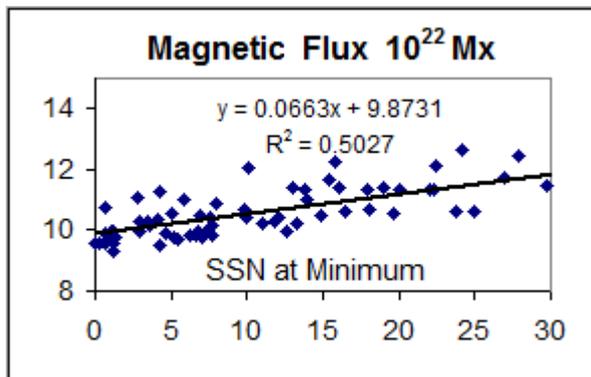
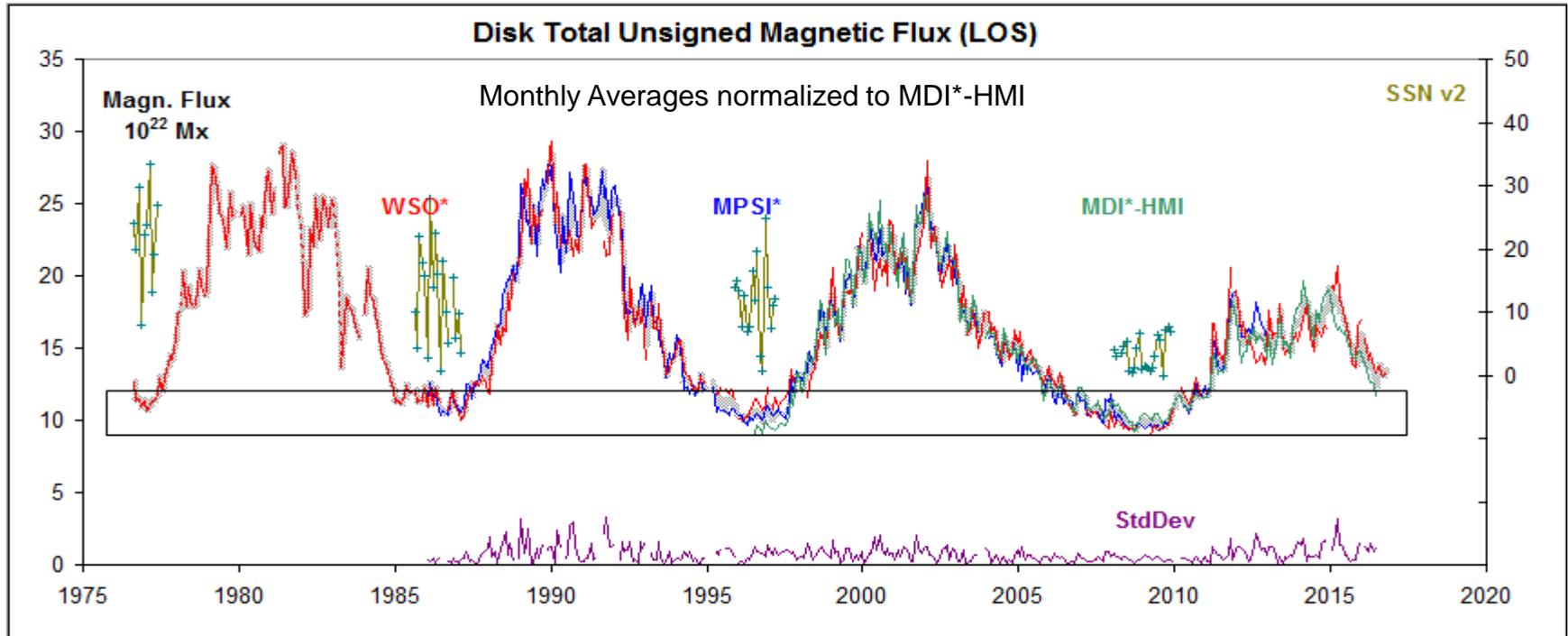
Map of IDV Stations 1932-2018



Applying the relationship we can reconstruct HMF magnetic field B with Confidence:

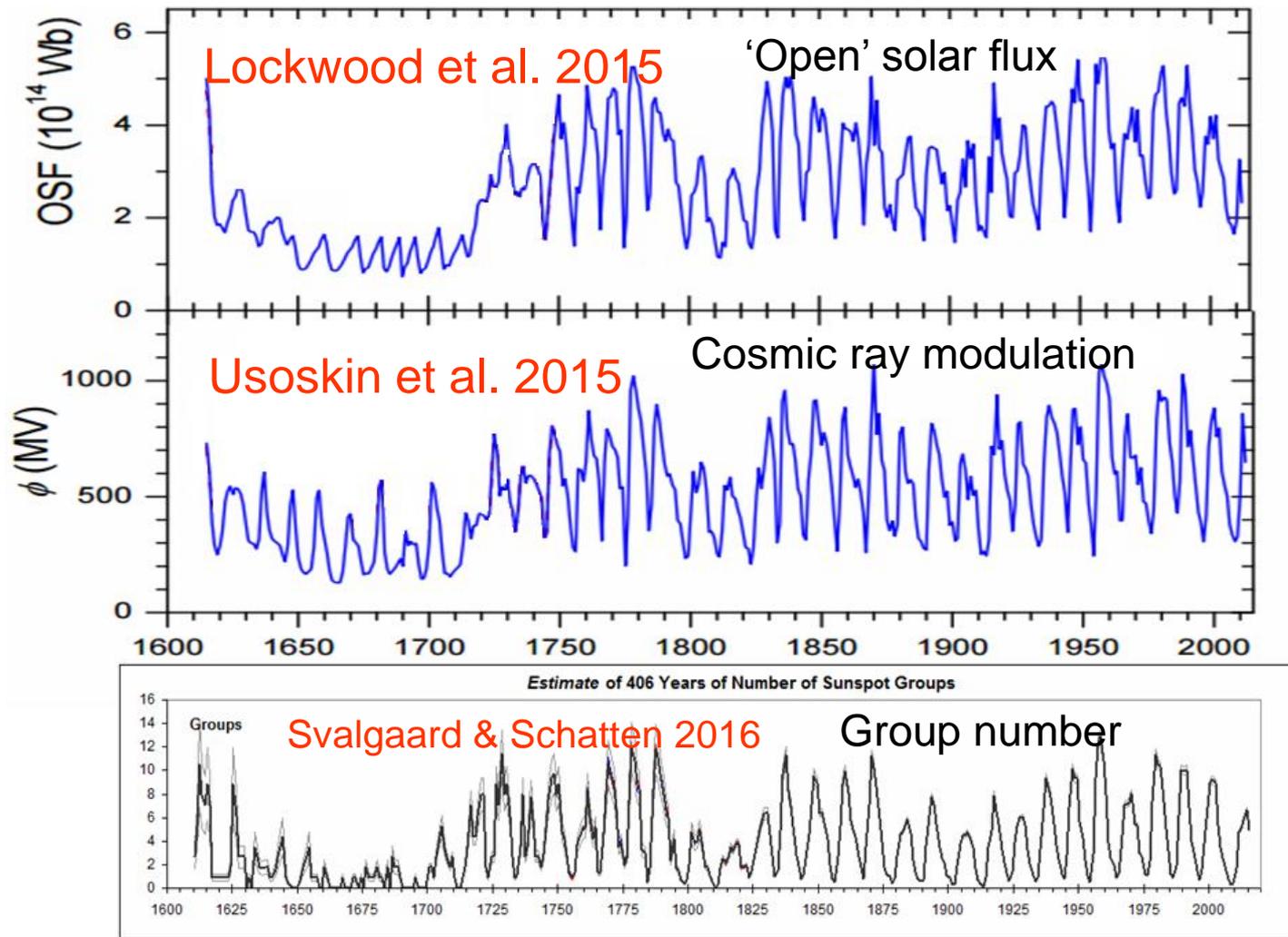


Magnetic Flux back to 1976



The **Wilcox Solar Observatory** and the **Mount Wilson Observatory** give us a longer baseline. A very slight decrease with time of the flux at solar minimum is probably due to the effect of decreasing residual sunspot number [if not instrumental]

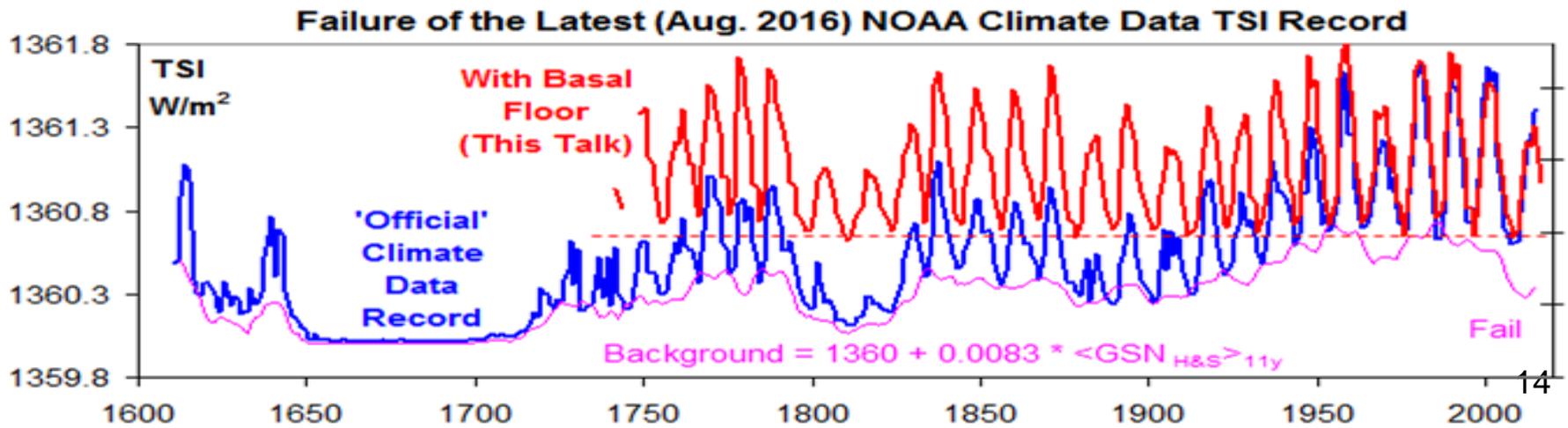
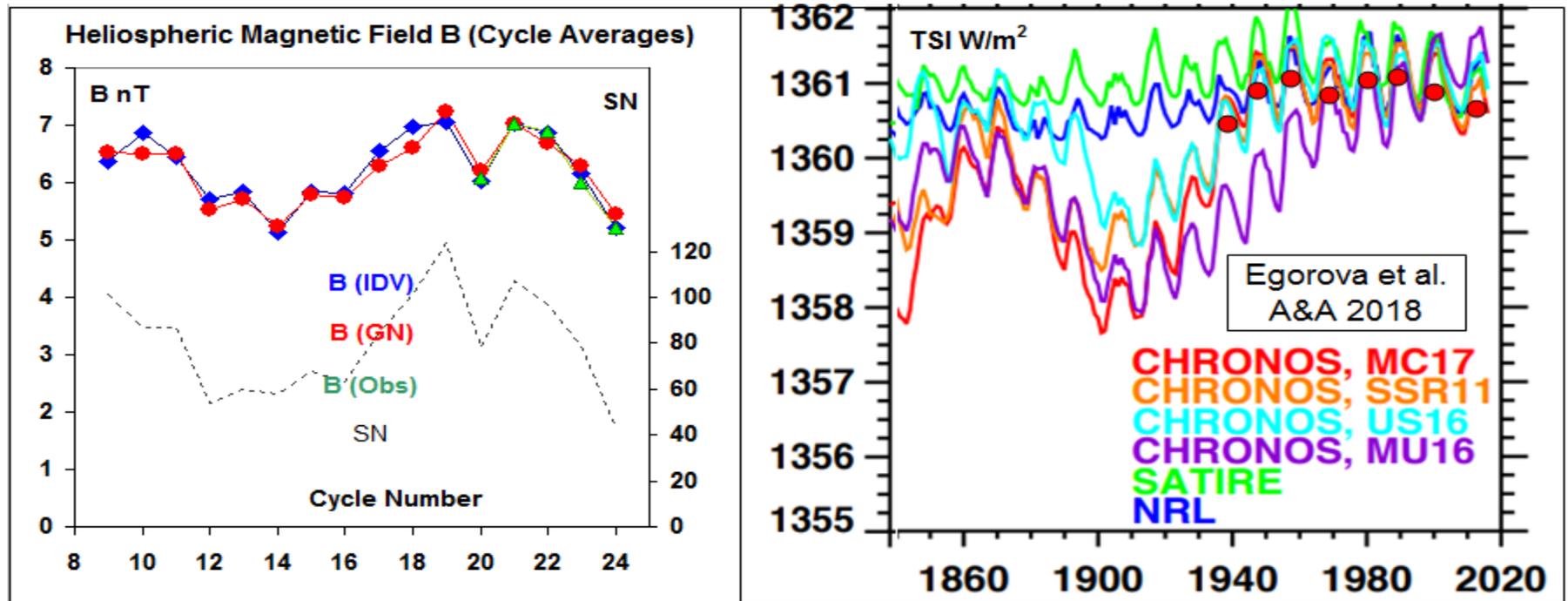
Putting it All Together (Real Progress!)



Very good agreement between different reconstructions.

Full Disclosure: There is still a rear-guard debate about the early record¹³

Tension Between B and TSI



TSI Reconstruction and Climate Data Record

