Interplanetary Magnetic Field Strength 1902-1913

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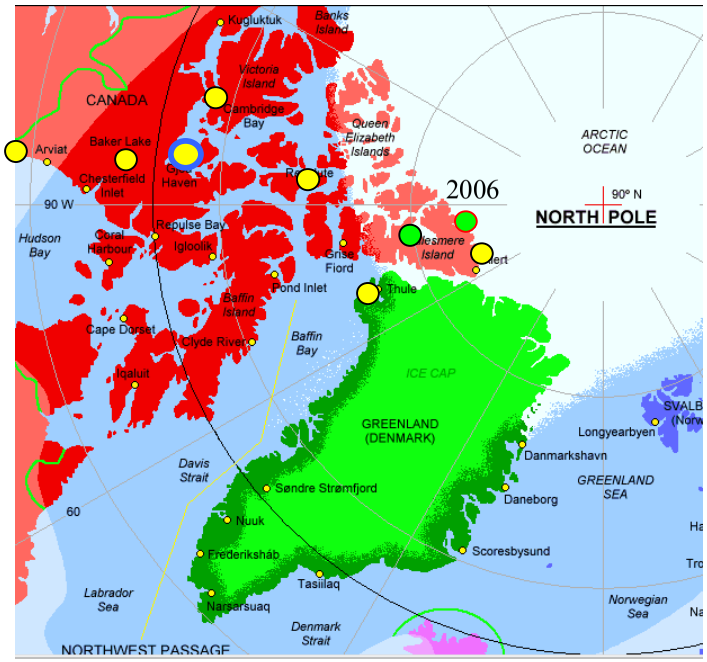
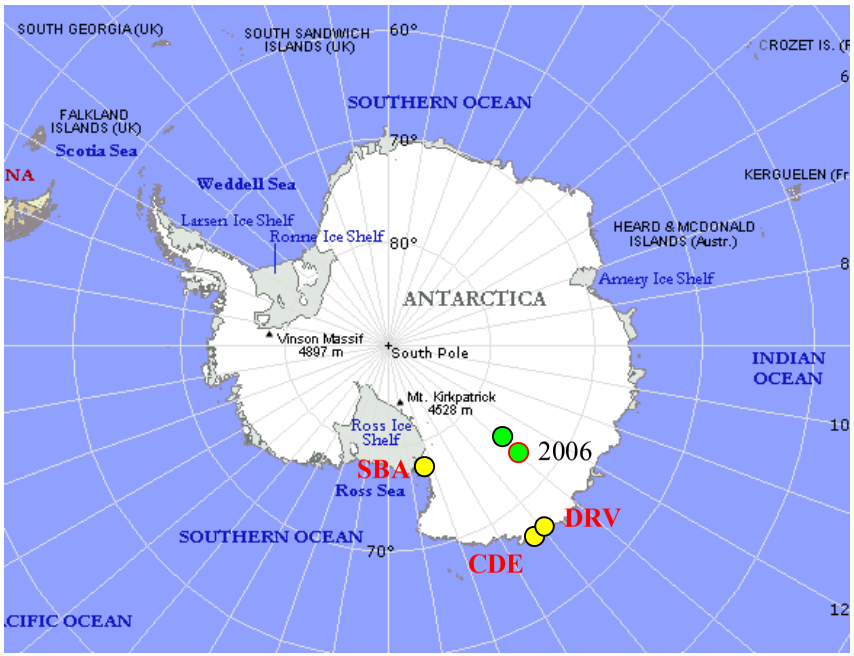
Take-Away Result: IMF ***B*** magnitude 1902-1913 is 5 to 6 nT,
Comparable to modern values, 100 years later.

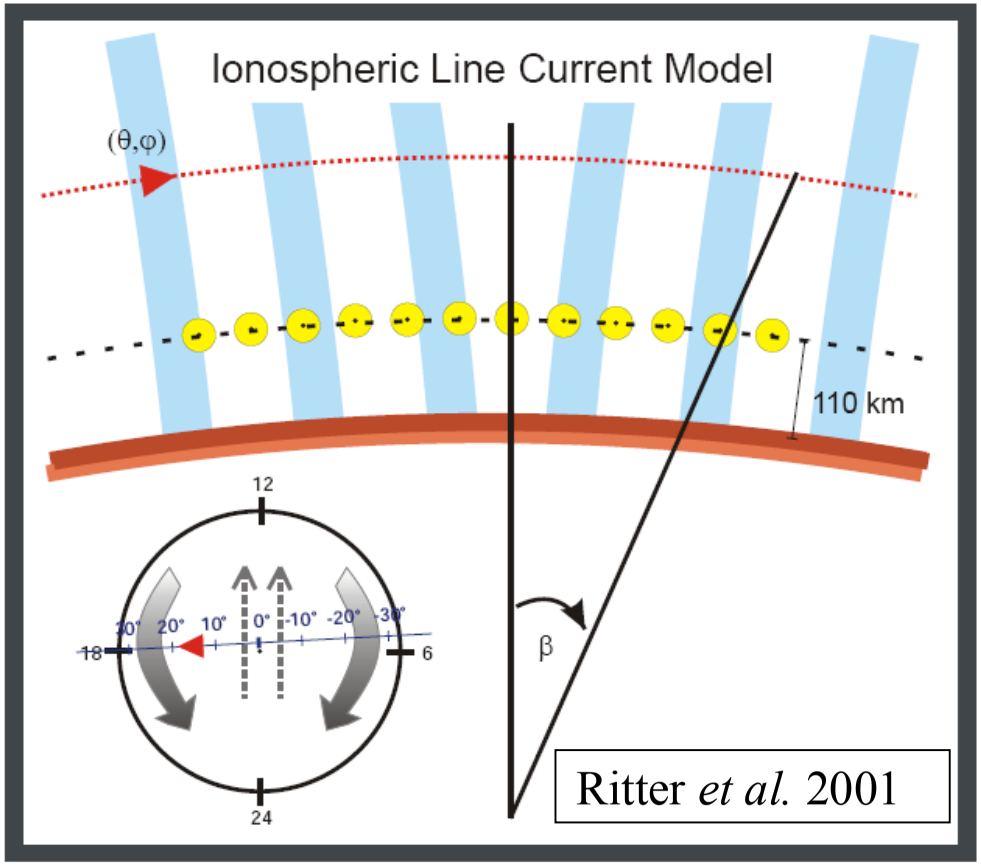




1902-1903: Robert F. Scott expedition to Discovery Bay (HUT)

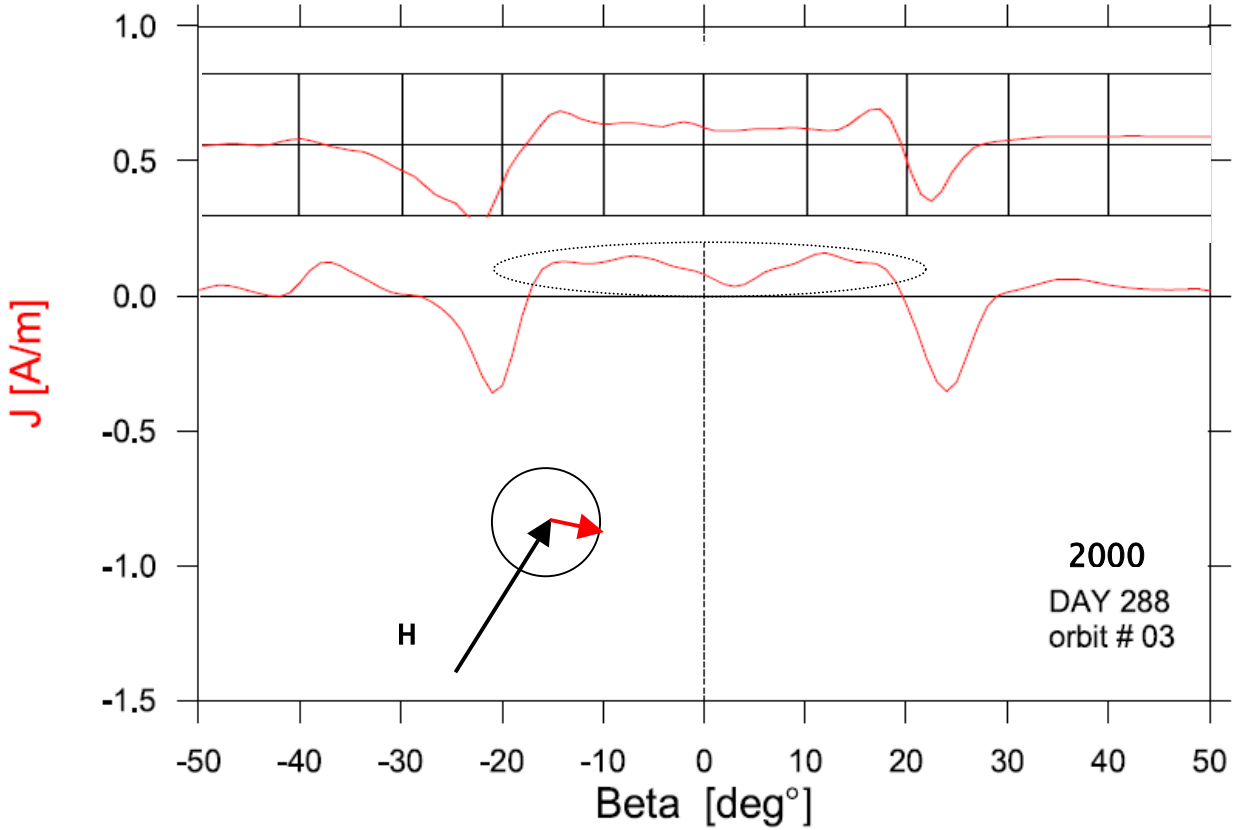
1903-1906: Roald Amundsen's Observations at Gjoahavn (GJH)

1912-1913: Australasian Antarctic Expedition (CDE)

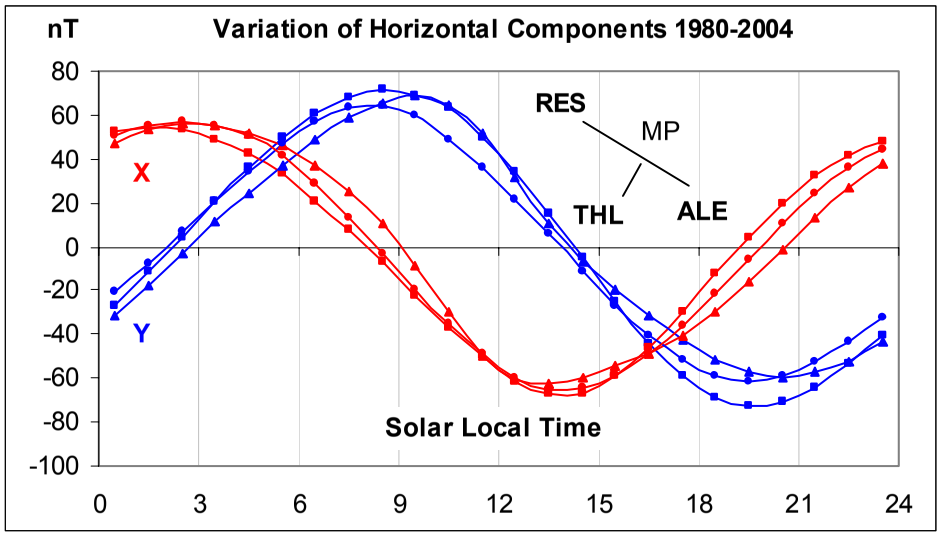


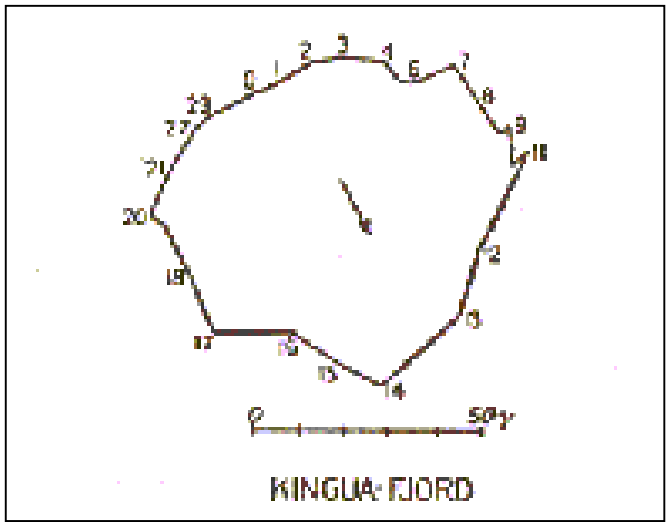
Across the polar cap flows a current in the ionosphere. This is a Hall current resulting from a Pedersen current driven by the polar cap potential. And has now been observed from above by satellites.

Ionospheric Hall Line Current from CHAMP Magnetometer

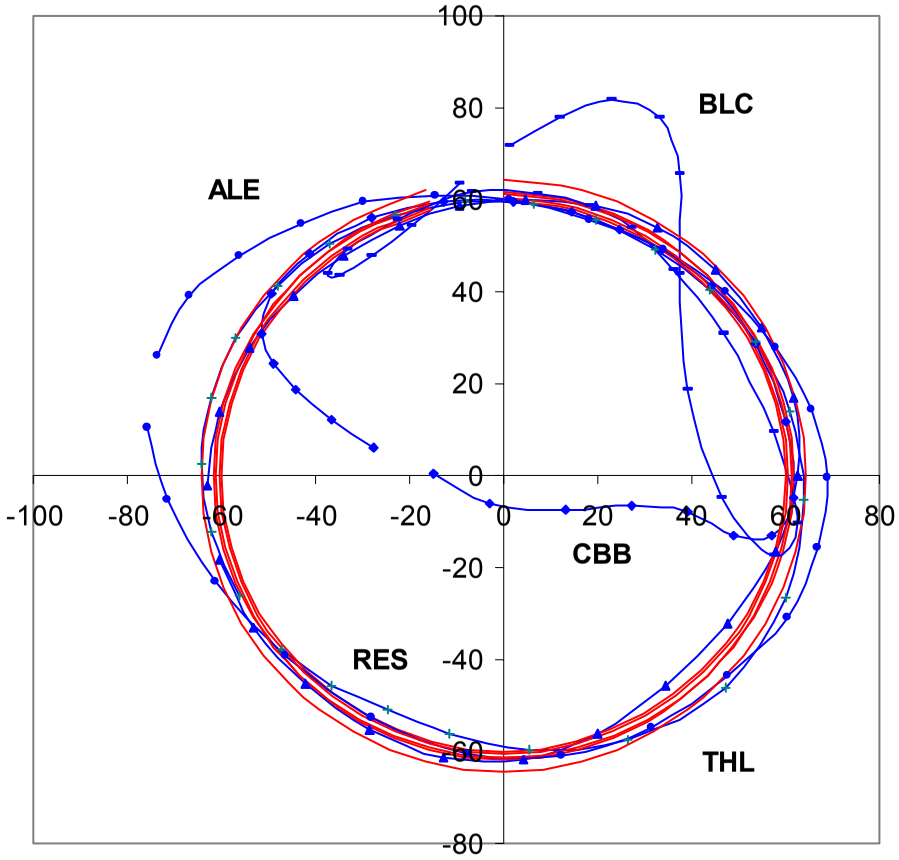


The current produces a rotating magnetic effect (→) observable on the ground.





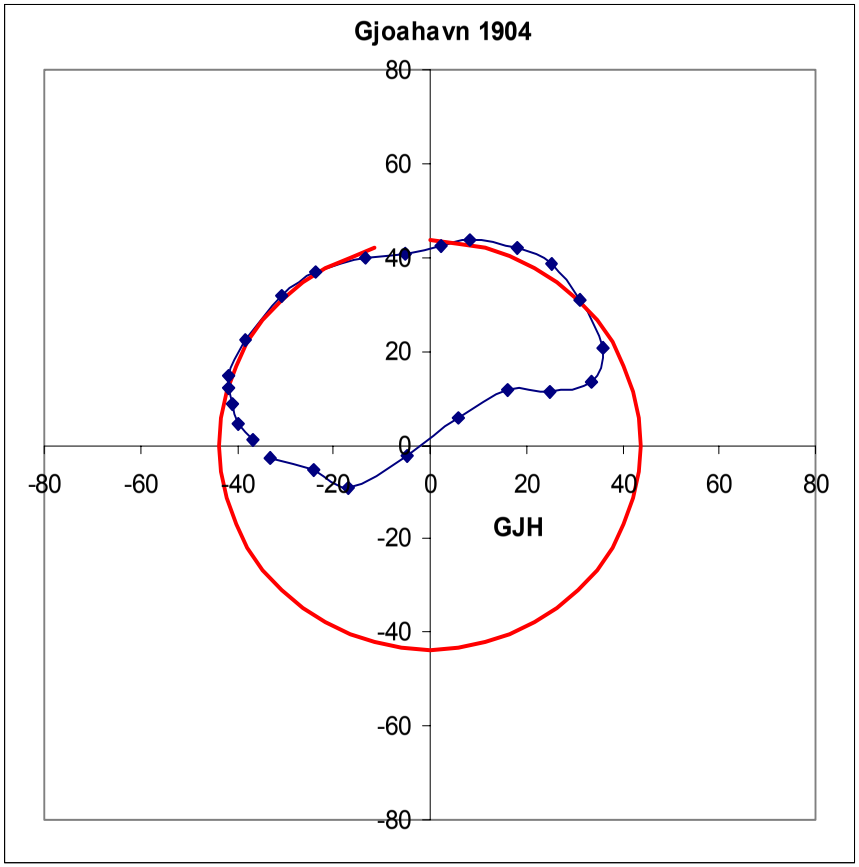
Because the current is fixed with respect to the sun, the earth rotates underneath the current and the magnetic effect is organized in **Solar** Local Time (not magnetic local time). This makes it meaningful to plot the effect in terms of its X (North) and Y (East) components (two sine curves 6 hours apart, left) or as a vector diagram showing the movements of the end point of the effect vector in Y-X coordinates (right), showing a circular path. This has been known for a long time: The right-hand plot is from the First Polar Year 1882-1883. The effect is (easily) observed whenever a station is "inside" the auroral zone.

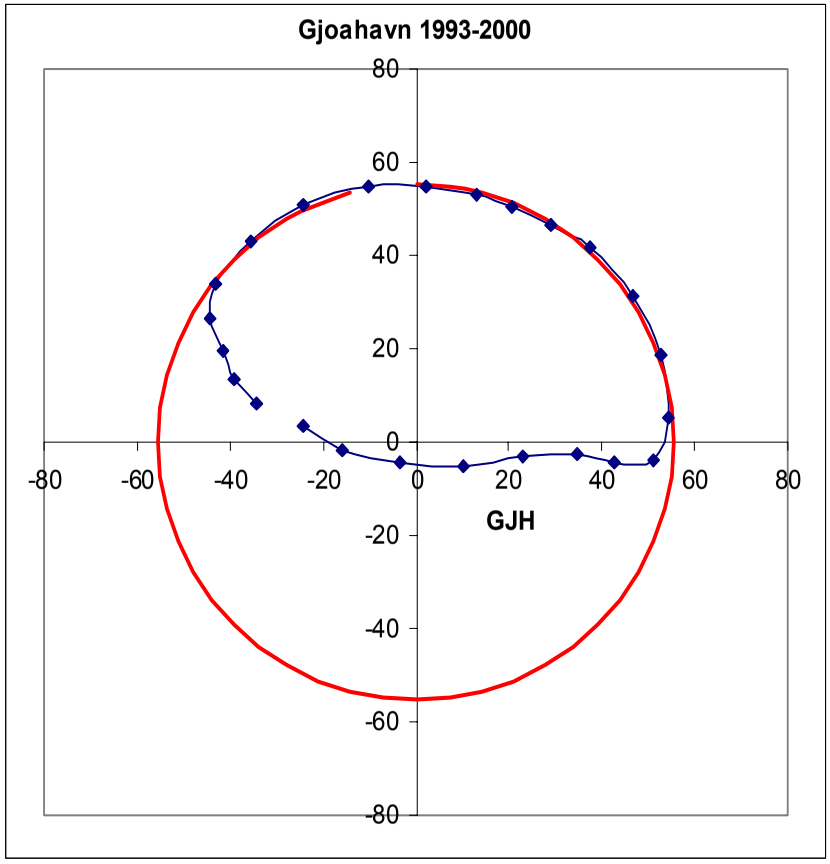


For stations (ALE, THL, RES) that are well inside the auroral oval, the path is a neat circle (ALE is slightly perturbed by induction effects) whose radius (the amplitude of the effect) is constant across the polar cap.

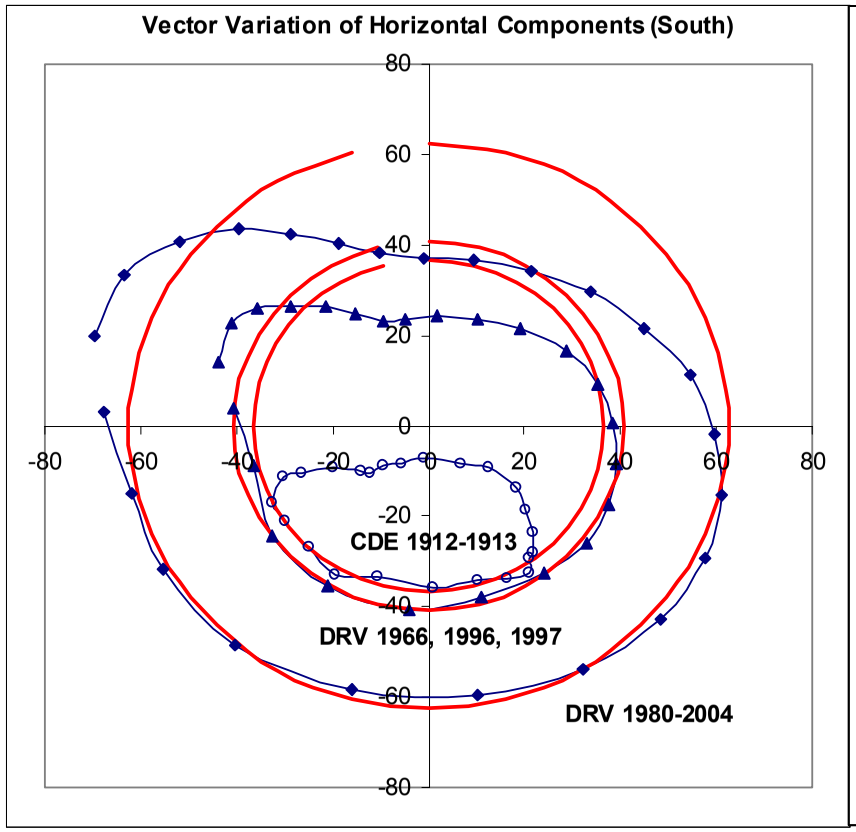
Stations (CBB , BLC, and GJH) that are only well inside the oval part of the time show a effect that follows the nominal circular path as long as they stay inside, but are perturbed by the dayside cusp currents when not in the polar cap.

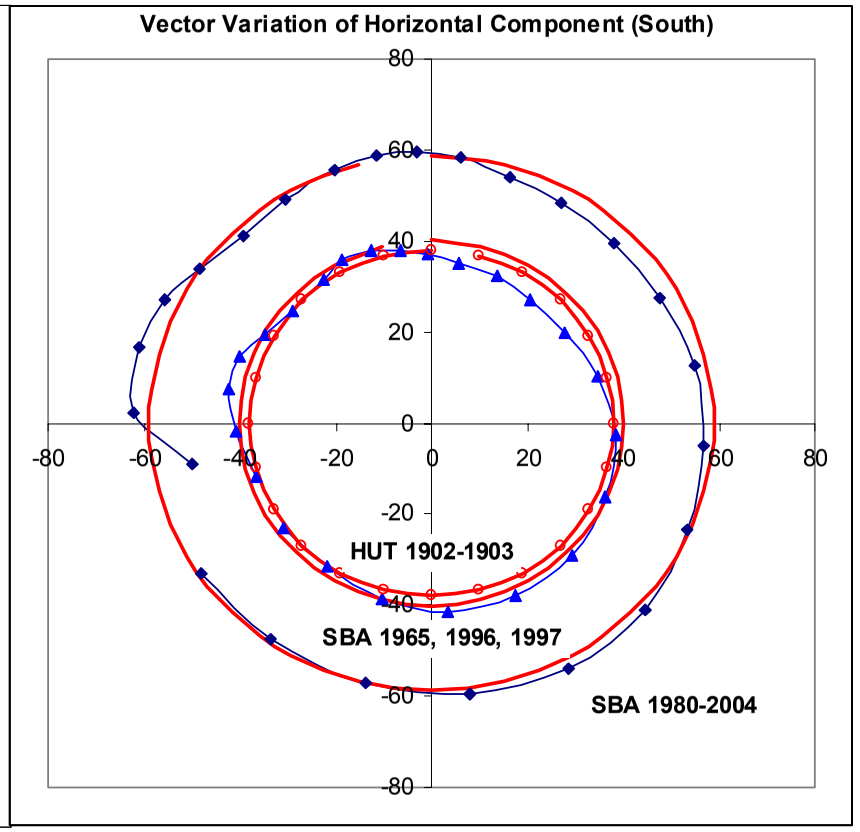
The size of the circular piece of the path is constant in space, but vary in time.



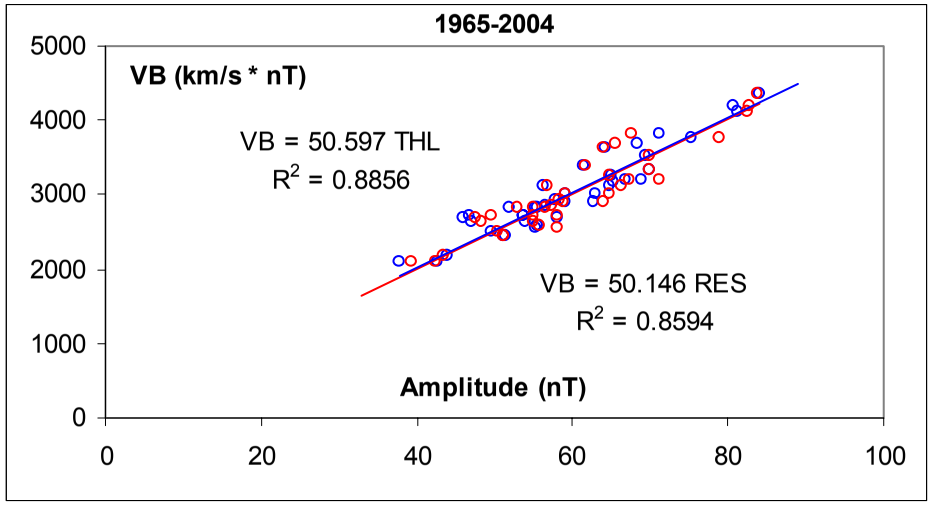


GJH is similar to CBB in being only a part-time polar cap station. Note the change of size of the circle between 1904 and 1993-2000. We shall use the size at a given time as a proxy for the polar field potential at that time.

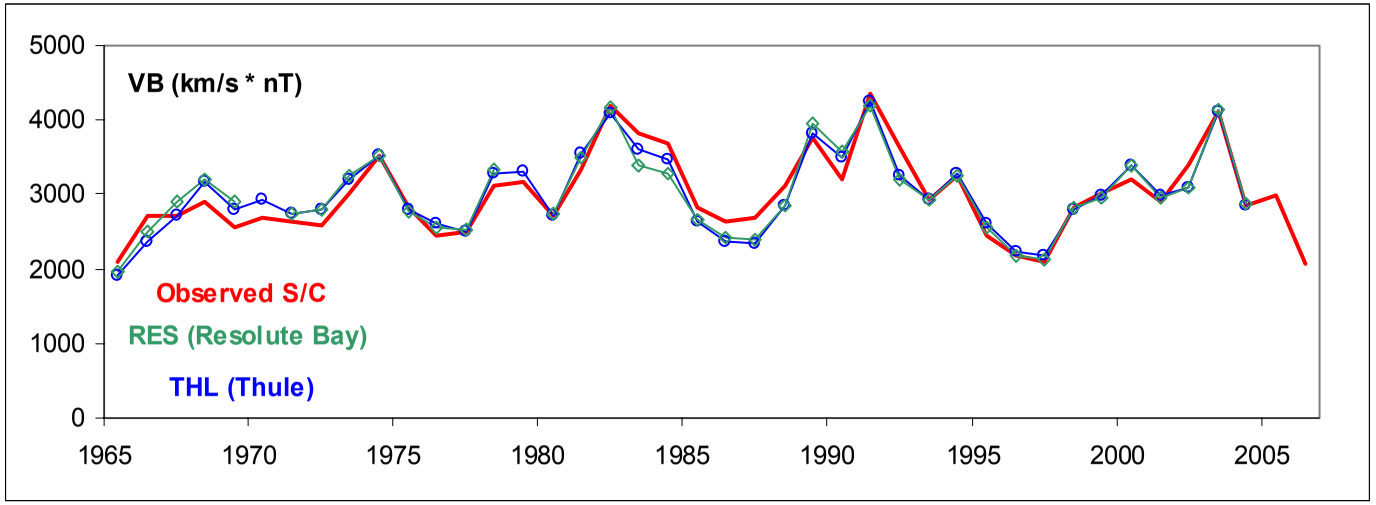




Vector diagrams for HUT, SBA, CDE, and DRV (in the Southern Hemisphere). The daytime perturbations are now "on the other side" of the diagram, but the circular portions are still discernable and can be fitted for each station and interval. I have only a total range for HUT because of its problems with too sensitive H records.



We express the polar cap potential in terms of the solar wind electric field V**x**B as the product of solar wind speed V and magnetic field B. Here we show the close relation between VB and the amplitude of the horizontal variation for THL and for RES (no real difference).



We can use this relation to calculate VB from the ground data and compare with space-craft data.

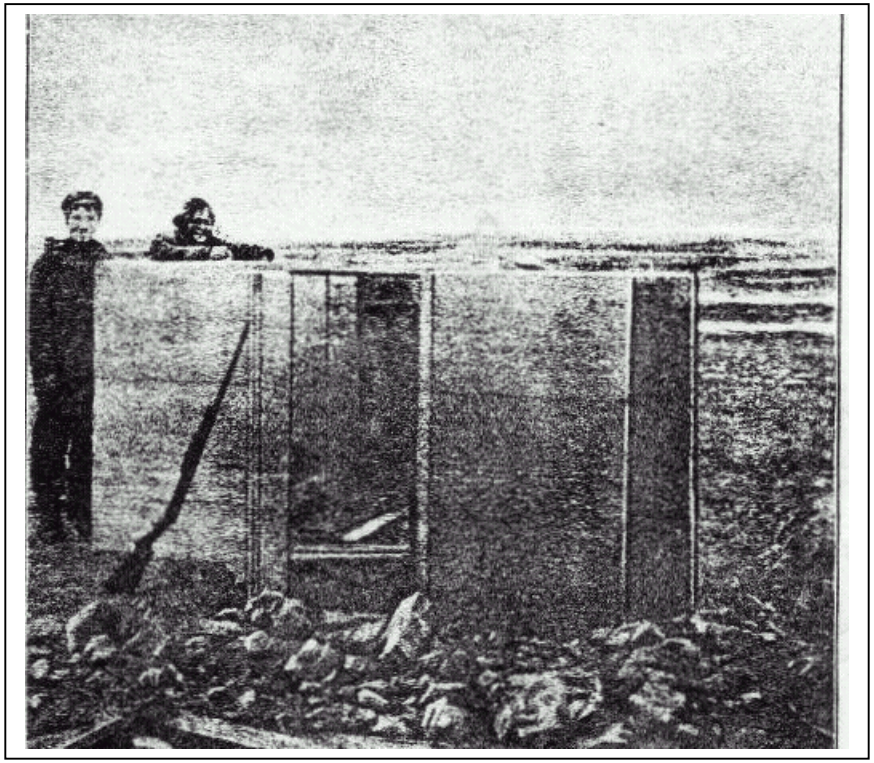
Putting it all together. Red is output, Black and Blue are input parameters.

Station	Amplitude nT	IMF B nT	SW V km/s	V*B	V*B/Ampl.	Interval
All N	61.45	7.06	447	3156	**51.36**	1980-2004
GJH	43.67	**6.08**	**369**	2243	51.36	1904
All N	55.35	6.28	451	2832	**51.17**	1993-2000
GJH	55.37	6.28	451	2833	51.17	1993-2000
All S	60.61	7.06	447	3156	**52.07**	1980-2004
All S	40.43	5.27	406	2136	**52.83**	1965,96,97
CDE	36.57	**5.33**	**360**	1918	52.45	1912-1913
HUT	~38	**5.39**	**370**	1993	52.45	1902-1903
Mean	GJH CDE HUT	**5.60**				1902-1913
Mean	IMF Obs	**5.63**		Last 12 months		2005-2006
All N	ALE	THL	RES	CBB	BLC	
All S	DRV	SBA				

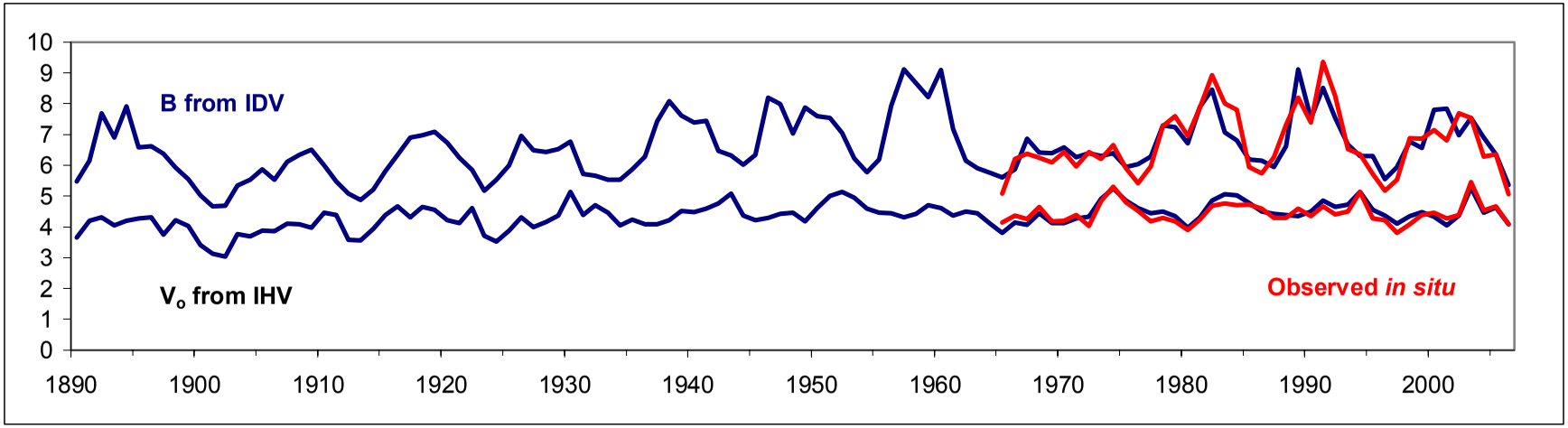
Solar wind speeds before the space age are computed from the IHV and IDV geomagnetic indices.

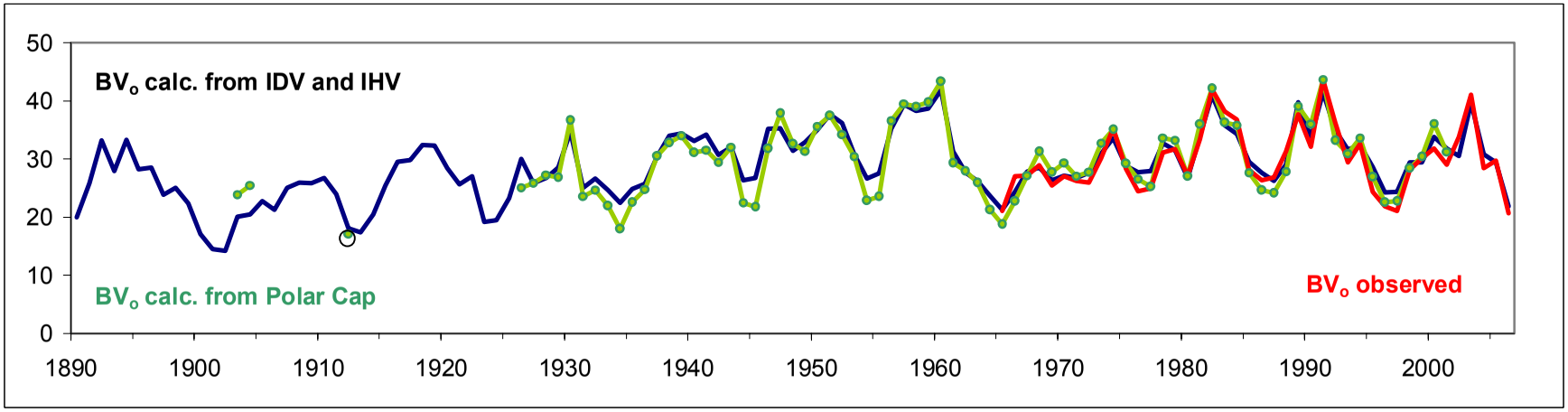
Fig. 4.—Entrance to the Magnetograph House on a fine Spring Day. E. N. Webb climbing

One of my observers enjoying a fine spring day at Cape Denison close to Dumont d'Urville, 1912.



Magnetic variometer hut at Gjoahavn





The big picture: Solar wind climatology