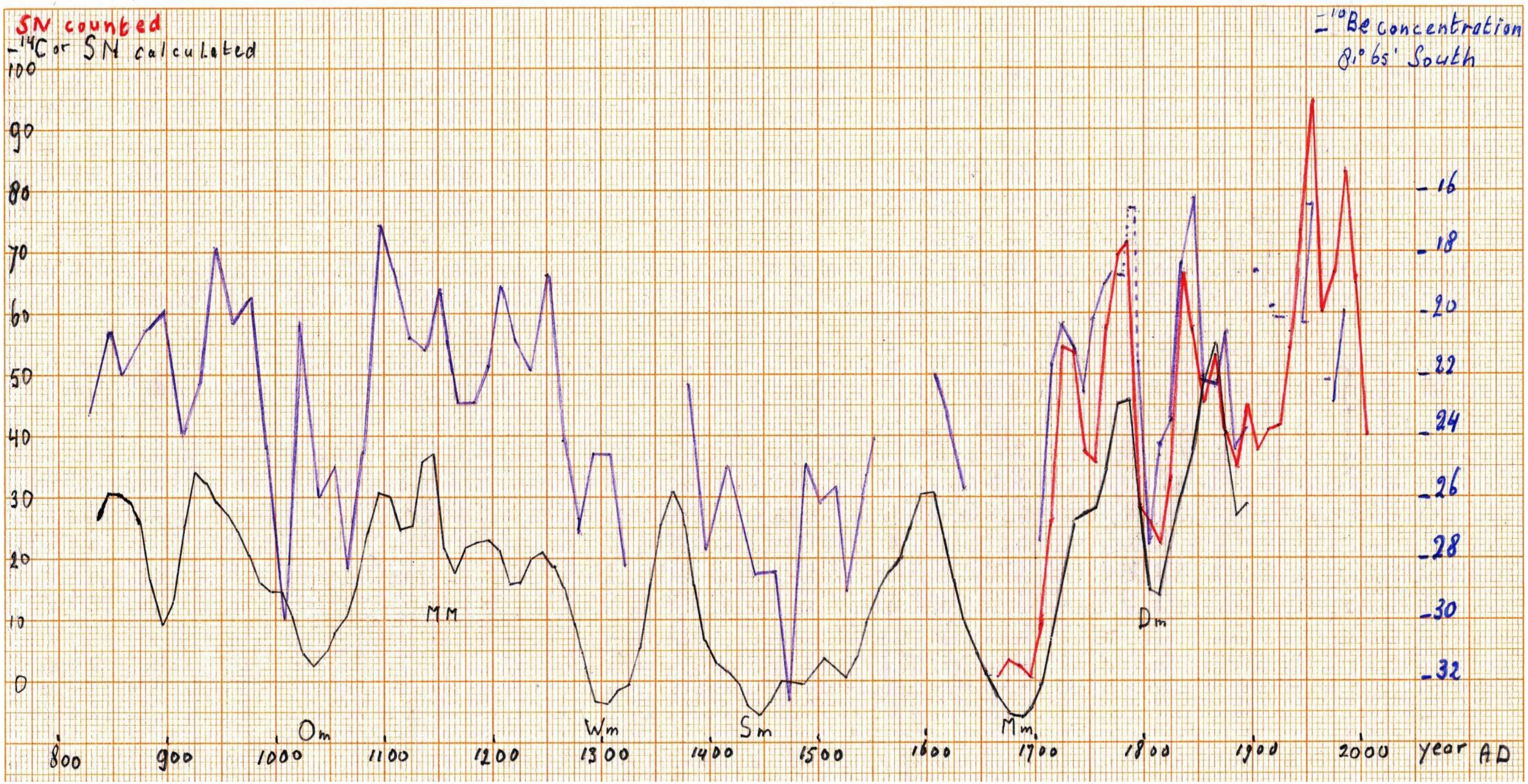
Comparison of 8 different solar proxies

In **FIG 12** the calculated SN's of SK Solanki ea [**Litt 1**] are regarded as negative ^{14}C quantities, so that they can have negative values as the tables do indicate. The black -^{14}C curve can here be compared with the purple curve for the -^{10}Be concentration of the Siple Dome ice core, following the unpublished research of K. Nishiizumi ea [**Litt 2**]. The red curve of the real counted SN, following the sunspot data of Noaa and Brussels [**Litt 3**].

FIG 12



Also are mentioned here the recent large solar minima, the Maunder min. (Mm), the Spörer m. (Sm), the Wolf m. (Wm), the Oort m (Om), the relative Dalton m. (Dm) and the medieval maximum (MM). It strikes that there is a very good correlation; between the real counted SN and the Siple Dome figures even better than with the calculated SN. However, also are some differences, especially in the Oort minimum should have been an interval of more solar activity following to the ^{10}Be data of Siple Dome. This can have many reasons, but an interesting possible cause is that the ^{10}Be is more sensible as a proxy of the Sun than ^{14}C. Despite of the time resolution of Solanki's tables, which here ever is 1 in 10 years and that of the Siple Dome ^{10}Be tables is smaller being for this period about 1 in 30 years, it still is possible that the ^{10}Be indicates a real solar maximum at 1045 AD, which is missed by the ^{14}C. Yet by the long residence time of the ^{14}C in the atmosphere and the carbon cycle this radionuclide can skip short during solar variations, which are recorded by the ^{10}Be with a residence time of 1 to 2 year. So the -^{10}Be concentration is a more sensible parameter for the magnetic activity of the Sun than the -^{14}C quantity and this can be fulfilled if the time resolution of the ^{10}Be becomes large enough. The resolution of the ^{10}Be data in the Siple Dome tables after 1698 AD suddenly becomes very high to about and varies than between about 0,5 and 2 years, but with many gaps in the observations, some of more than 10 years. It than comes true that the data of the ^{10}Be concentration can fluctuate much even within one year. Because of this and the gaps it is impossible to draw a continuous line as an expression of the data from the table.

Probably, large atmospheric variations can be excluded and the Sun is in fact the dominant cause of these very short term ^{10}Be variations. Than the proxies -^{10}Be and -^{14}C are **indirect** parameters for the **local** solar magnetic activity on Earth, thus for the local earth-magnetic field. Because the terrestrial input in the earth-magnetic field does not have variations in these frequencies by far, this is solar input. The radio nuclide proxy is another signal, different from the sunspot number (SN). The counted SN is a more direct parameter for only a part of the solar magnetic activity, the toroidal fields and it is not local. The SN gives information about the toroidal magnetic activity of the total visible hemisphere of the Sun, whereas the radio nuclide proxies do have direct information about how the Earth is hit by the solar magnetic activity (toroidal and polonoidal). So the ^{10}Be concentrations of Siple Dome also are related to the intensity of the southern aurora. The aurora intensities, however are measures for the **change** in the size and direction of the earth-magnetic field and thus the solar magnetic field on Earth, whereas the radio nuclide proxies give information about the size of the magnetic field. So as algebraic functions the aurora intensities are the derivatives of the nuclide proxies and so they are directly connected as are the intensities of the solar wind in particles and the magnetic wind with the radio nuclide proxies.

In **FIG 12b** still more curves of solar proxies are drawn in, of different locations and the **FIG 4b** is added for more comparison. At the top of **FIG 12b** is the thin black curve (e) of the -^{10}Be concentration taken from the data of the GRIP (Greenland) ice core (72,58^{o} North and 37,63^{o} West), by the research of F. Yiou ea [**Litt 4].** Only from the period 1465 – 1645 AD data are available here, but the time resolution is high, about 1 in 5 year. The purple curve (c) of the West Antarctic Siple Dome ice core are from Nishiizumi and the fat black curve (b) from Solanki of the -^{14}C data are the same as in **FIG 9**, as well as the red curve (a) of the counted SN. Under the -^{14}C or calculated SN now is added in **FIG 12b** the brown curve (f) of the -^{10}Be concentration from East Antarctica. These data are produced by the research of a Japanese team with K. Horiuchi [**Litt 5**] ea at the ice core of Dome Fuji (77,32^{o} South and 39,7^{o} East). The time resolution of the Dome Fuji data is about 1 in 10 years. Below this brown curve of the -^{10}Be concentration also is drawn the thin black curve (G) of -1x the^{10}Be flux in 10^5 atoms at a cm^2 per year. The researchers calculated various fluxes from the concentration and advised this 5 running δ^{18}O as the best proxy for the production of ^{10}Be. The maximal values of the ^{10}Be concentration do indicate also the large solar minima, but with more different values, so that the Spörer minimum seems for instance deeper than the Maunder minimum.

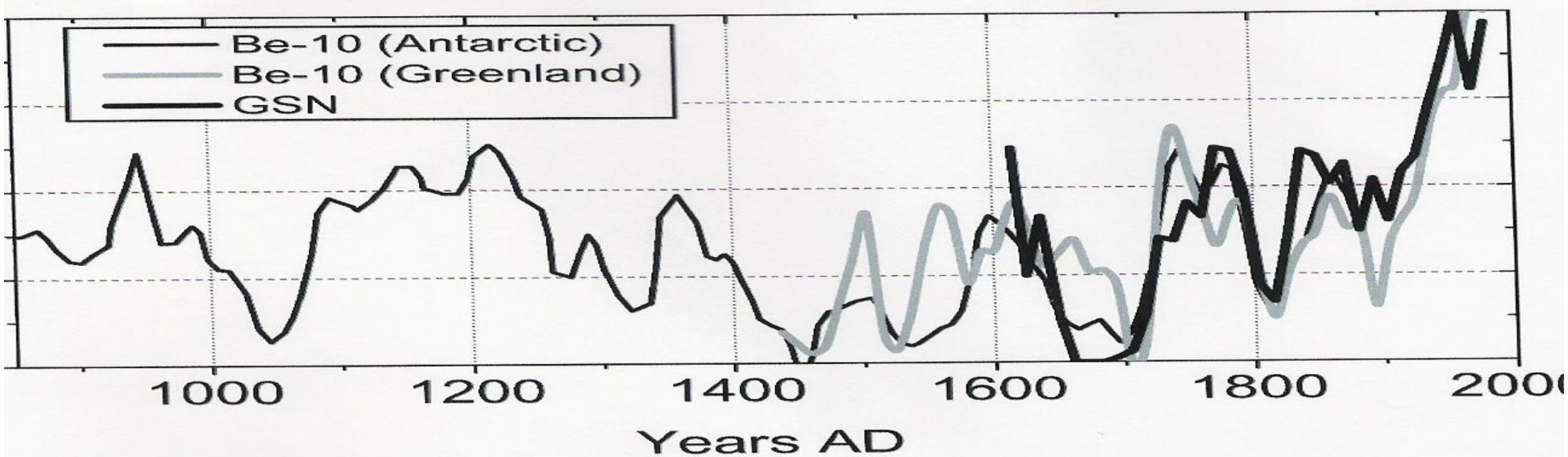


FIG 4b

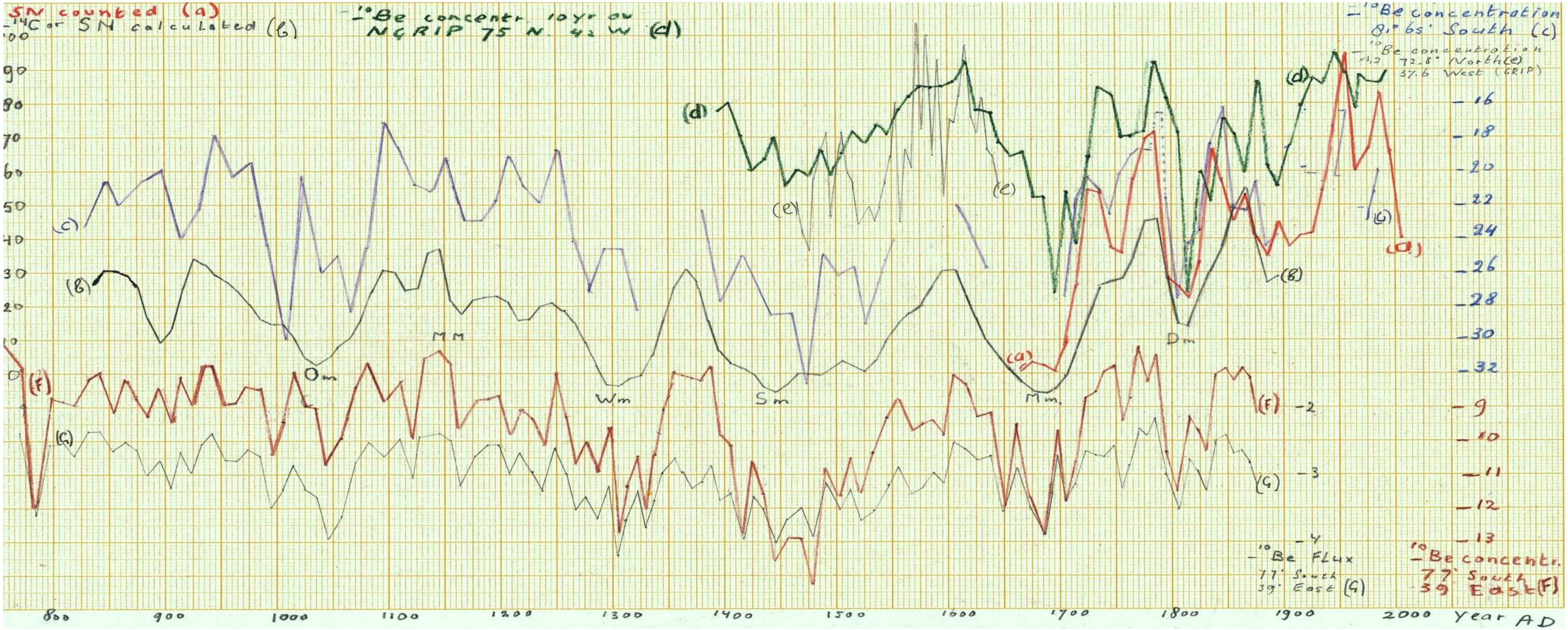


FIG 12b

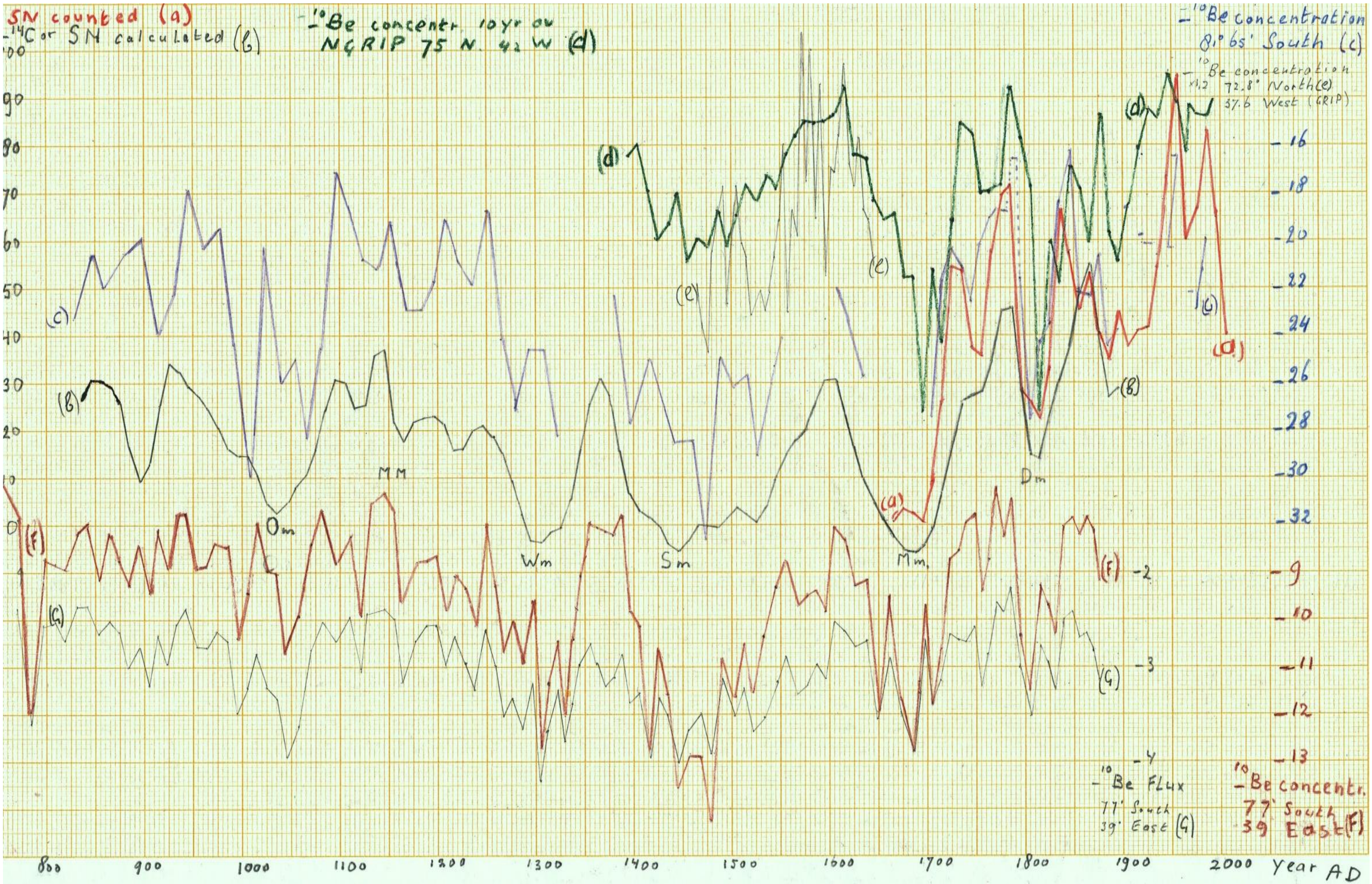

SN counted (a)
-14C or SN calculated (b)
-10Be concentr. 10yr av NGRIP 75 N. 42 W (d)
-10Be concentration 81° 65' South (c)
-10Be concentration 72.8° North (e) 37.6 West (GRIP)
MM
Om
Wm
Sm
Mm
Dm
-10Be Flux 77' South 39' East (G)
-10Be concentr. 77' South 39 East (F)
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Year AD

FIG 12b

The maxima of the flux are much equal and the curve of the flux has more similarity with the curve of the other proxies here. Especially in the extreme dry climate of east Antarctica a larger part of the beryllium and other dust particles may fall dry to the surface and for that dry deposition the flux has the best information about the production, but at the wet deposition (within snowflakes) the concentration gives better information about the production. The green curve (d) at the top of FIG 12b are -10Be date of the NGRIP(Greenland) site. The research is from AM Berggren ea [**Litt 6**]. The annual 10Be data of these tables are averaged to 1 on 20 year.

Note also the very narrow connection with the curves of **FIG 4b** that are published on Wikipedia**.** The curve on **FIG 4b** of the Antarctica -^{10}Be data (site?) is described by IG Usoskin [**Litt 7**]. It is still more resembling the calculated SN from the -^{14}C of **FIG 12** than does the curve with the Siple Dome -^{10}Be data of **FIG 12**. The Greenland **–**^{10}Be curve of **FIG 4b** is from the Dye-3 ice core, also described by IG Usoskin.

The data with a higher time resolution in the tables here are averaged to 1 on 20 years for a better survey on the curves.

The reliability of ^{10}Be and other radio nuclides as solar proxy in fact is generally accepted by scientists as for the more recent time, because of the abundance of these correlations. Especially the articles of IG Usoskin give more profound, but good understandable information at this topic [**Litt 8, 9**]

Also are more studied the Sun → climate connections for recent periods, while during the whole Holocene the temperature variations seldom exceed 2 degrees centigrade and internal fluctuations are an important determining factor for this smaller variations. The large fast temperature variations during the glacial and the glacial – Holocene transition are more likely determined by solar forcing, but here the Sun → climate connections are not studied or denied by scientists. Now suddenly the radio nuclide proxies for the Sun are not reliable for that period?!

Literature:

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9 Usoskin IG personal literature list: http://cc.oulu.fi/~usoskin/personal/List.html