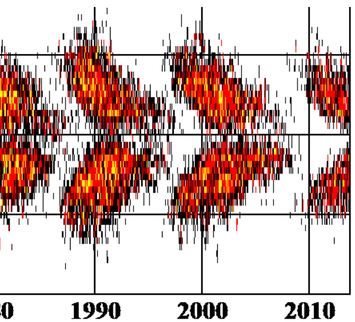
Vorlesung für Studierende aller Fakultäten: Terra-Astronomie

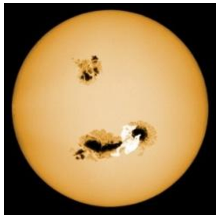
SoSe 2017: Vorlesung Mo 14:15-15:45h + Seminar Mo 15:45-17:15h (Raum)

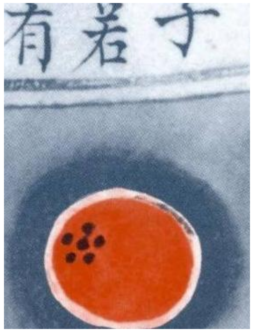
+ Übung Do 14:15-15:45h (Seminarraum Sternwarte Schillergäßchen 2)

Studium transienter Himmels-Phänomene (nahe Supernovae, Sonnen-Variabilität, Kometen etc.) mit Wirkungen auf *Terra*: Erd-Klima, Biosphäre, Weltraum-Wetter, Kultur, Literatur, etc. – untersucht mit astronomischen Methoden einschließlich *terrestrischer Archive*: u.a. Radionukleid-Vorkommen (z.B. ^{14}C) und menschliche Beobachtungsberichte.



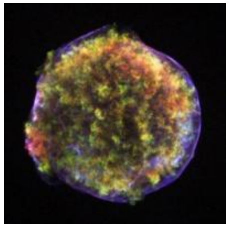
www.astro.uni-jena.de → Terra-Astronomy

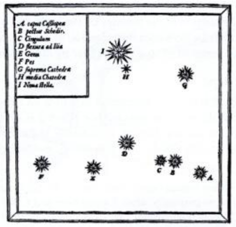




Inhalte der Vorlesung:
- Sonnenaktivität: Flecken, Aurorae, Radioisotope
- Solar-terrestial relations (Weltraumwetter)
- Halo-Displays (und ihre kulturelle Bedeutung)
- Supernovae und ihre Überreste
- historische Beobachtungen verstehen und nutzen
- Astronomie für historische Chronologie
- Kalender-Computistik etc.

Info: ralph.neuhaeuser@uni-jena.de





8 ECTS Punkte
bei erfolgreicher Teilnahme an Übungen (insbesondere für Studierende der Naturwissenschaften) und/oder erfolgreicher Teilnahme am Seminar (insbesondere für Studierende der Geisteswissenschaften)

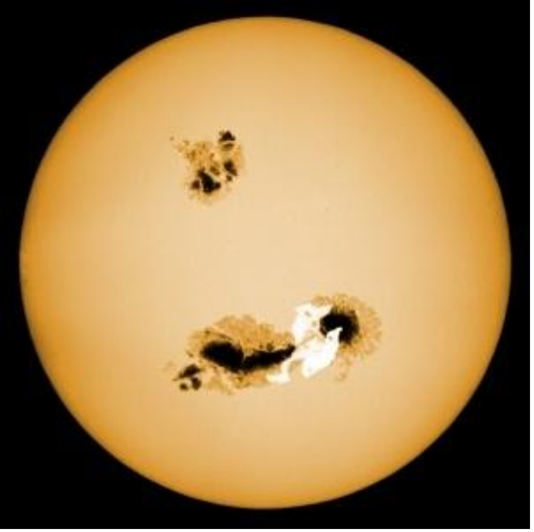
Vorlesung Terra-Astronomie

SoSe 2017, montags 14:00h s.t. bis 15:30h

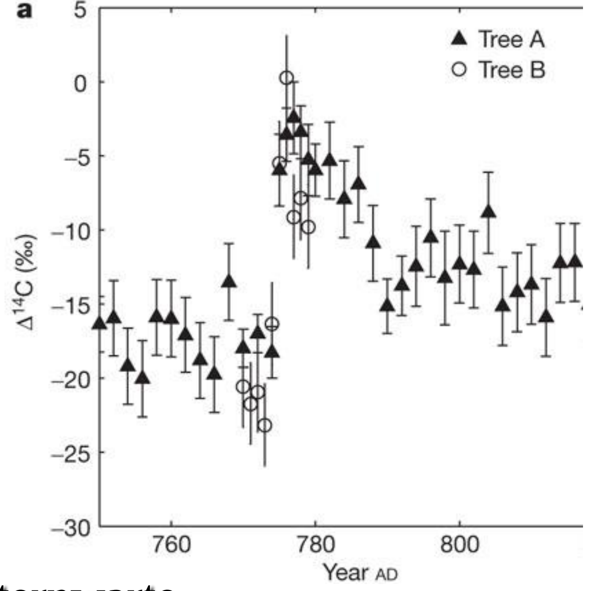
Hörsaal HS 2, Abbeanum, Fröbelstieg 1

- Mo 3.4. Einführung: Historische Beobachtungen aus Europa, Arabien und Ostasien und ihre Relevanz für die aktuelle Astronomie
- Do 6.4. System Sonne-Erde-Mond und Kalender-Systeme
- Mo 10.4. Aktivität der Sonne
- Mo 17.4. Feiertag (Ostermontag)
- Mo 24.4. Aurorae: historisch und aktuell (MSc Daniel Wagner)
- Mo 1.5. Feiertag
- Mo 8.5. Sonnenflecken: historisch und aktuell
- Mo 15.5. Radioisotope und Grand Minima der Sonnenaktivität
- Mo 22.5. Himmelsbeobachtungen in der Karolingerzeit: Wer war der Anonyme Astronom ?
- Mo 29.5. Halo-Displays und ihre kulturelle Relevanz
- Mo 5.6. Feiertag (Pfingstmontag)
- Mo 12.6. Sternentwicklung: Supernovae, Neutronensterne, Gamma-Ray-Bursts
- Mo 19.6. Historische Supernovae
- Mo 26.6. Runaway-Sterne in Supernova-Überresten
- Mo 3.7. 60-Fe in der Erdkruste - nahe Supernova vor 2 Mio Jahren ?

A



Terra-Astronomie



Ralph Neuhäuser

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Einflüsse naher Supernovae und variabler Sonnenaktivität auf die Erde

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Terra-Astronomie:

Untersuchung variabler energiereicher kosmischer Vorgänge

wie nahe Supernova-Explosionen und Sonnen-Variabilität

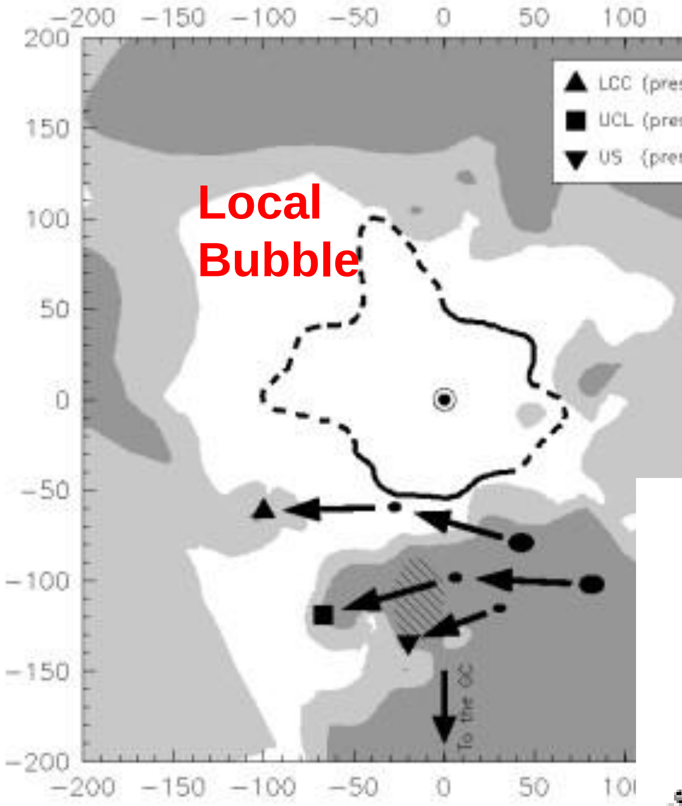
mit Wirkungen auf *Terra*: Erd-Klima, Biosphäre, Weltraum-Wetter, Kultur, etc.

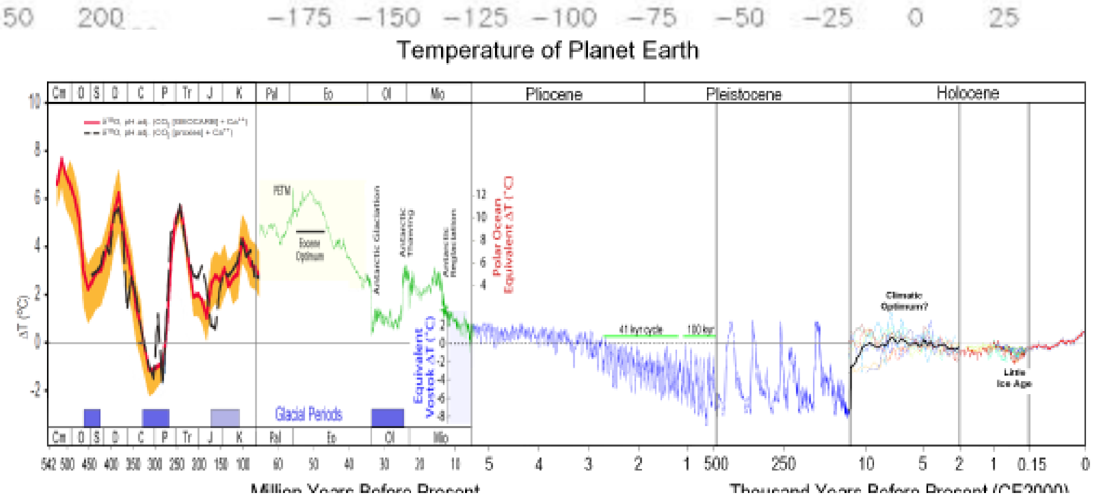
Terra-Astronomie untersucht *terrestrische Archive*, u.a. Radionukleid-Vorkommen und von Menschen verfasste Berichte, auch mit astronomischen Methoden.

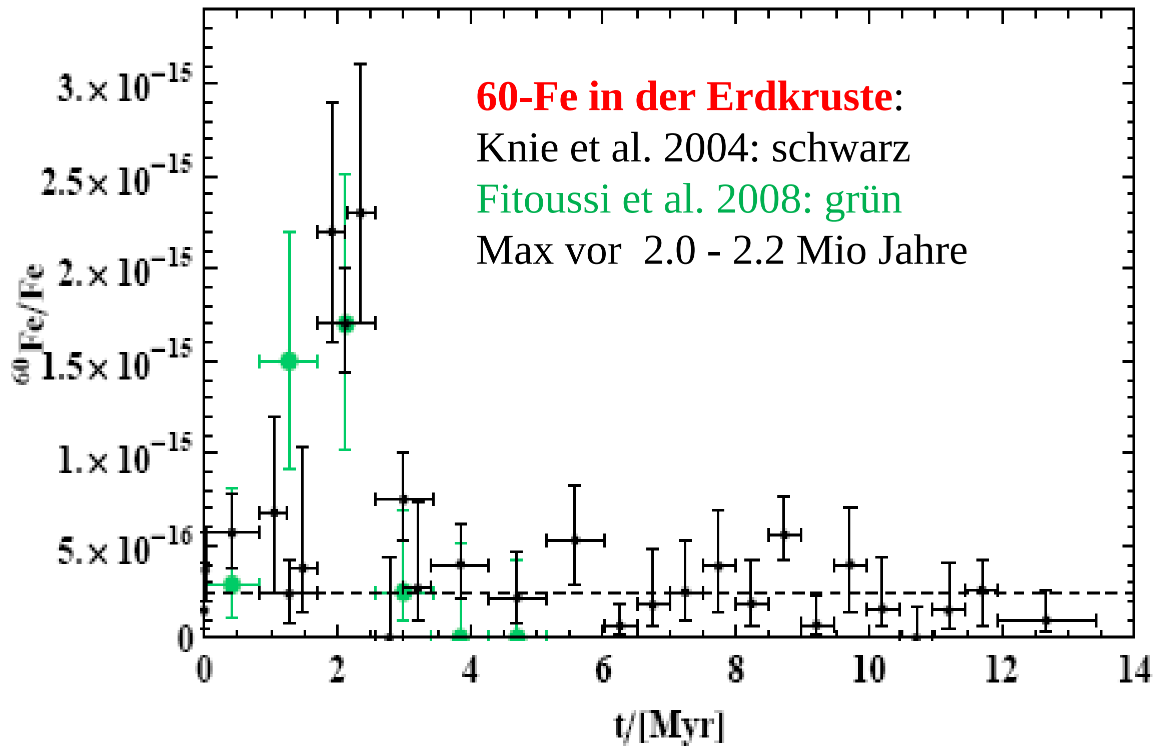
I. Historische Zeit: mindestens ~ 3000 Jahre
z.B. Rekonstruktion der Sonnenaktivität,
historische Supernovae etc.

II. Astronomische Zeitskala: Millionen Jahre (Neutronensterne, Runaway-Sterne)

Beispiel: Nahe Supernova (SN) vor 2 Mio Jahren





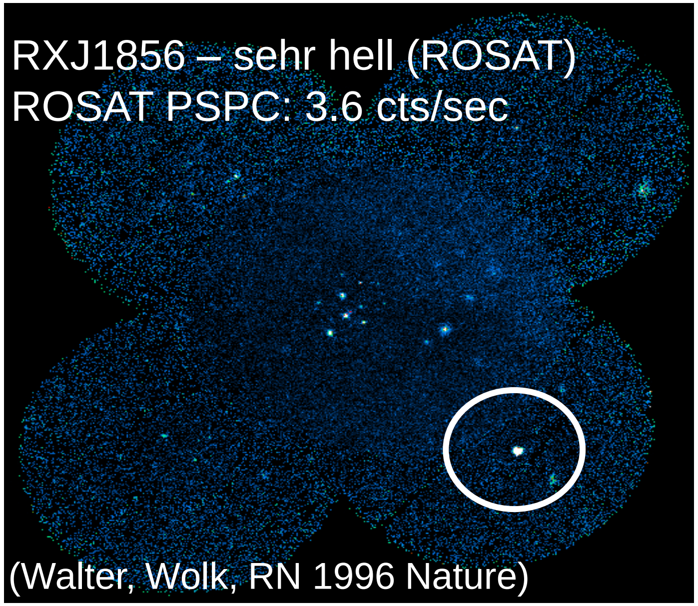


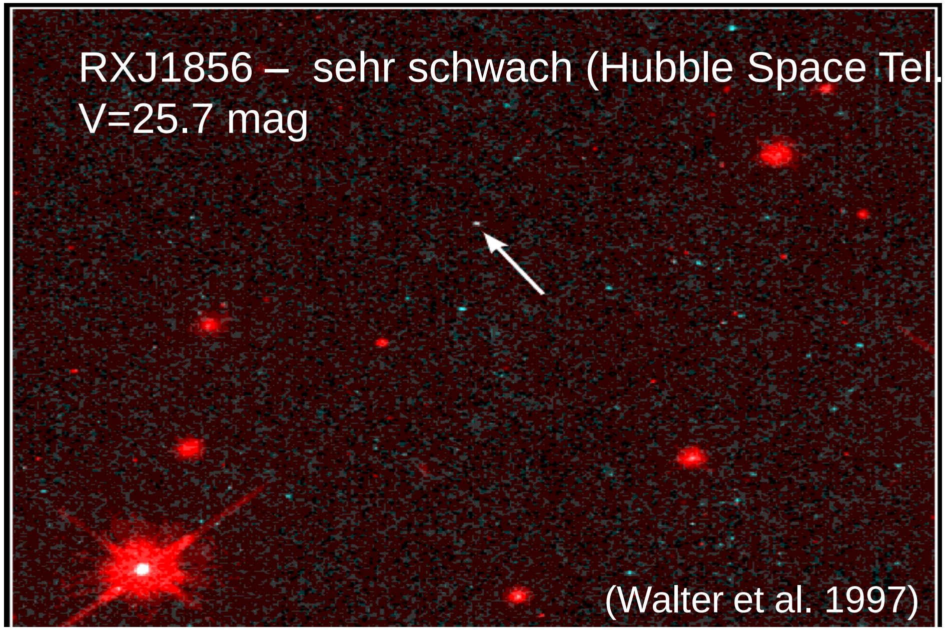
The ^{60}Fe/Fe ratio versus the age of the crust based on the new ^{10}Be dating.

Breitschwerdt et al. 1996 etc.
Breitschwerdt & Berghöfer 2002
Maiz-Appelaniz et al. 2001
Benitez et al. 2002
Fuchs et al. 2006

LCC: Lower Centaurus Crux
UCL: Upper Centaurus Lupus
US: Upper Scorpius

Isolierte Neutronsterne: Jung und nah



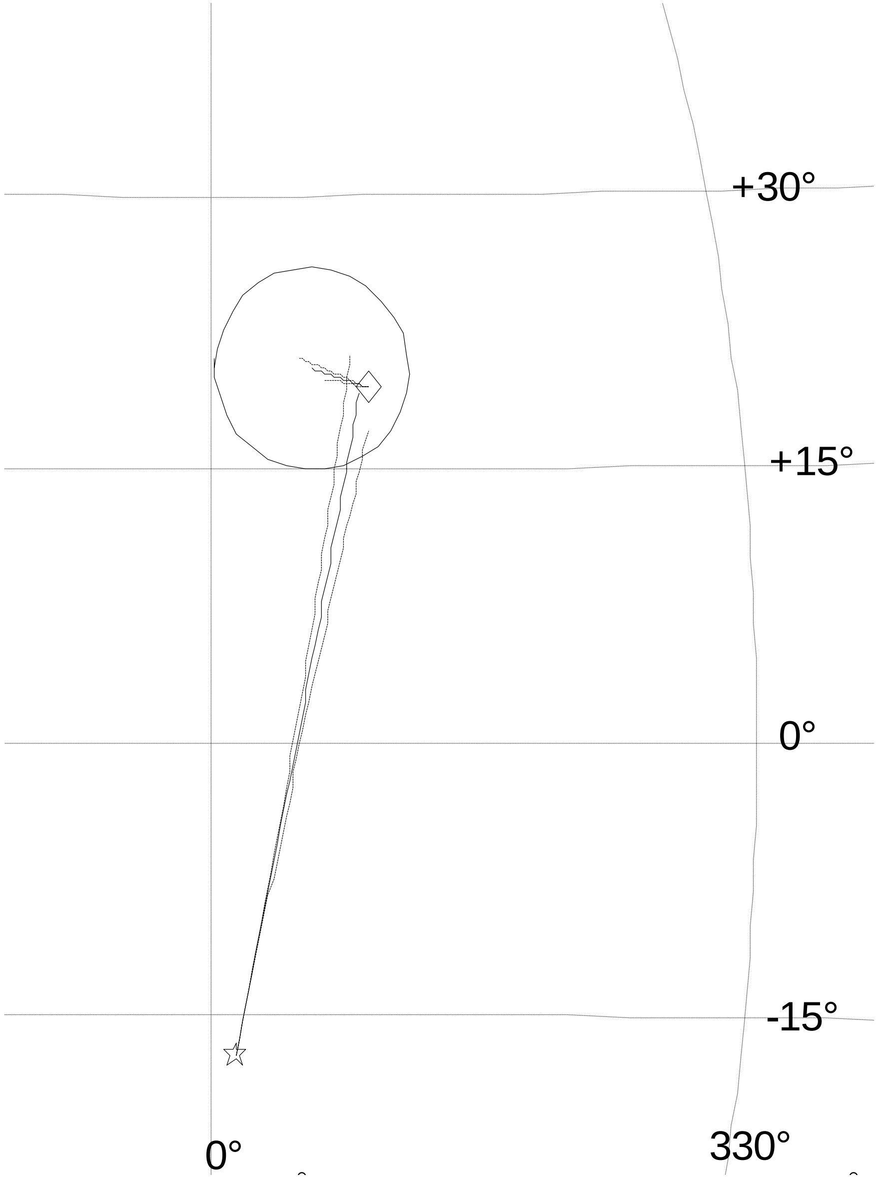


Objekt	Temp. kT [eV]	Periode [Sek]	Puls-Anteil %	Optisch [mag]	Eigenbewegung [mas/J.]
RXJ0420	44	3.45	17	B = 26.6	<123
RXJ0720	90	8.39	11	V = 26.8	108
RXJ0806	96	11.37	6	B > 24	<86
RXJ1308	86	10.31	18	~ 28.6	223
RXJ1605	96	-	<3	B = 27.2	145
RXJ1856	64	7.05	1	V = 25.7	332
RXJ2143	100	9.44	4	B = 27.0	

Ergebnis der Rückrechnung

RX J1856.5-3754

seit 1558



Predicted present day parameters of RX J1856.5-3754	
v_r [km/s]	4^{+25}_{-16}
π [mas]	$8.0^{+0.5}_{-0.5}$
μ^*_α [mas yr^{-1}]	326.7 ± 0.8
μ_δ [mas yr^{-1}]	-59.1 ± 0.7
v_{sp} [km/s]	184^{+19}_{-7}
Predicted SN position	
distance to the Sun [pc]	153^{+6}_{-6}
right ascension [deg]	$241.5^{+1.6}_{-1.1}$
declination [deg]	$-25.7^{+0.7}_{-0.8}$
time in the past [Myr]	$0.46^{+0.05}_{-0.05}$
distance from US centre [pc]	8.7 ± 2.1

Tetzlaff, Eisenbeiss, Hohle, RN, 2011, MNRAS

Ergebnis der Rückrechnung

RX J0720.4-3125

seit 1558

Assoc.	v_r [km/s]	μ_α^* [mas/yr]	μ_δ [mas/yr]	v_{sp} [km/s
→ TWA	376^{+156}_{-28}	-92.8 ± 1.4	55.3 ± 1.7	416^{+1}_{-7}
Tuc-Hor	529^{+91}_{-59}	-92.8 ± 1.4	55.3 ± 1.7	540^{+}_{-}
β Pic-Cap	491^{+119}_{-71}	-92.8 ± 1.4	55.3 ± 1.7	501^{+}_{-}
HD 141569	396^{+107}_{-41}	-92.9 ± 1.4	55.1 ± 1.7	424^{+}_{-}
AB Dor	478^{+110}_{-60}	-92.8 ± 1.4	55.3 ± 1.7	491^{+}_{-}
Col 140	$-670\ldots+590$	-92.8 ± 1.4	55.3 ± 1.7	463^{+1}_{-1}
→ Tr 10	274^{+151}_{-43}	-92.7 ± 1.4	55.6 ± 1.6	390^{+1}_{-6}
CarA	404^{+146}_{-74}	-92.7 ± 1.4	55.5 ± 1.6	427^{+1}_{-1}
Argus	388^{+158}_{-65}	-92.7 ± 1.4	55.6 ± 1.6	390^{+1}_{-9}

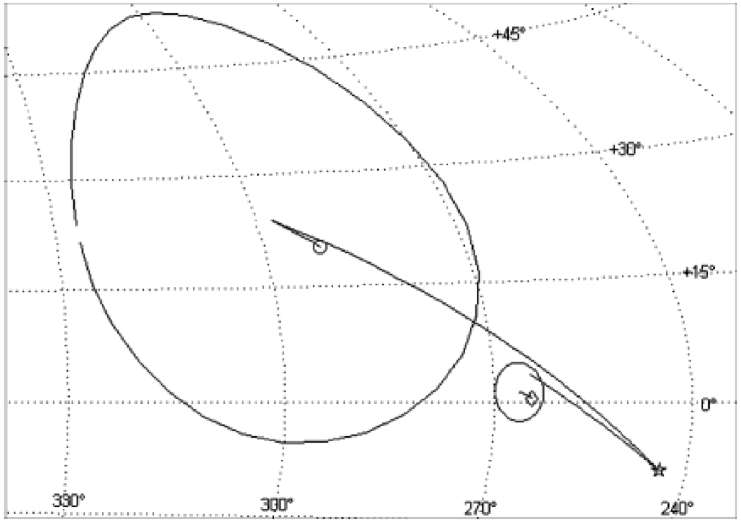


Figure 6. Past trajectories for RX J0720.4−3125 and Tr 10 and TWA, respectively, projected on a Galactic coordinate system (for particular sets of input parameters consistent with Table 6). Present positions are marked with a star for the neutron star and a diamond for Tr 10 and an open circle for TWA. Large circles reflect association extensions (radii of 23 pc for Tr 10 and 33 pc for TWA).

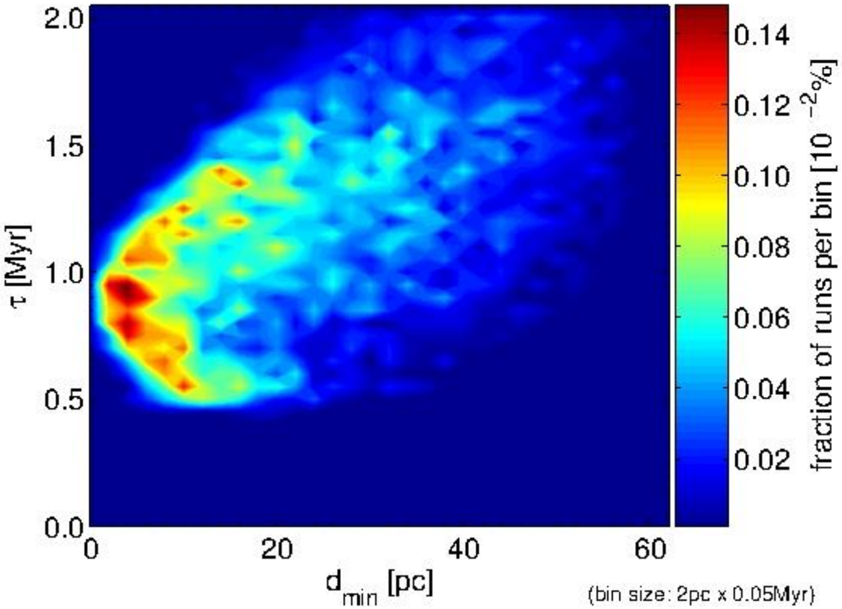
2+ Geburts-Assoziationen möglich.

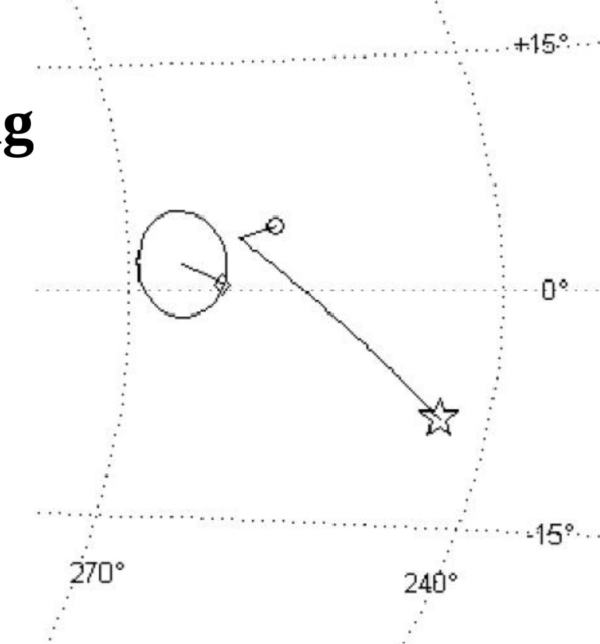
Runaway Stern als früherer Begleiter ?

Tetzlaff, Eisenbeiss, Hohle, RN, 2011, MNRAS

ler Rückrechnung

J0720.4-3125





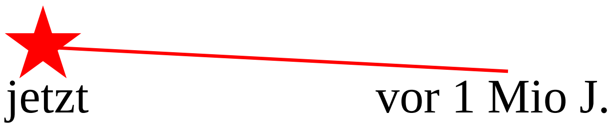
HIP	Assoc./cl.	τ [Myr]	v_r [km/s]	v_{sp} [km/s]	π [mas]	$d_\odot$ [pc]	α [°]	δ [°]	M_{prog} [$M_\odot$]
43158	Tr 10	0.70 ... 1.00	-76^{+34}_{-17}	163^{+3}_{-8}	$3.5^{+0.3}_{-0.3}$	375^{+4}_{-16}	$131.1^{+0.2}_{-1.1}$	$-38.8^{+0.4}_{-0.2}$	$\approx 13-15$
57269	Tuc-Hor	0.20 ... 0.33	511^{+143}_{-109}	592^{+103}_{-150}	$6.3^{+0.4}_{-1.0}$	27^{+3}_{-3}	$171.1^{+8.4}_{-6.4}$	$-42.4^{+0.6}_{-1.2}$	$\approx 10-12$
76304	β Pic-Cap	0.52 ... 0.70	309^{+27}_{-69}	338^{+29}_{-81}	$5.8^{+1.0}_{-0.2}$	52^{+4}_{-2}	$226.5^{+1.6}_{-1.9}$	$-20.9^{+1.6}_{-1.4}$	$\approx 19-33$

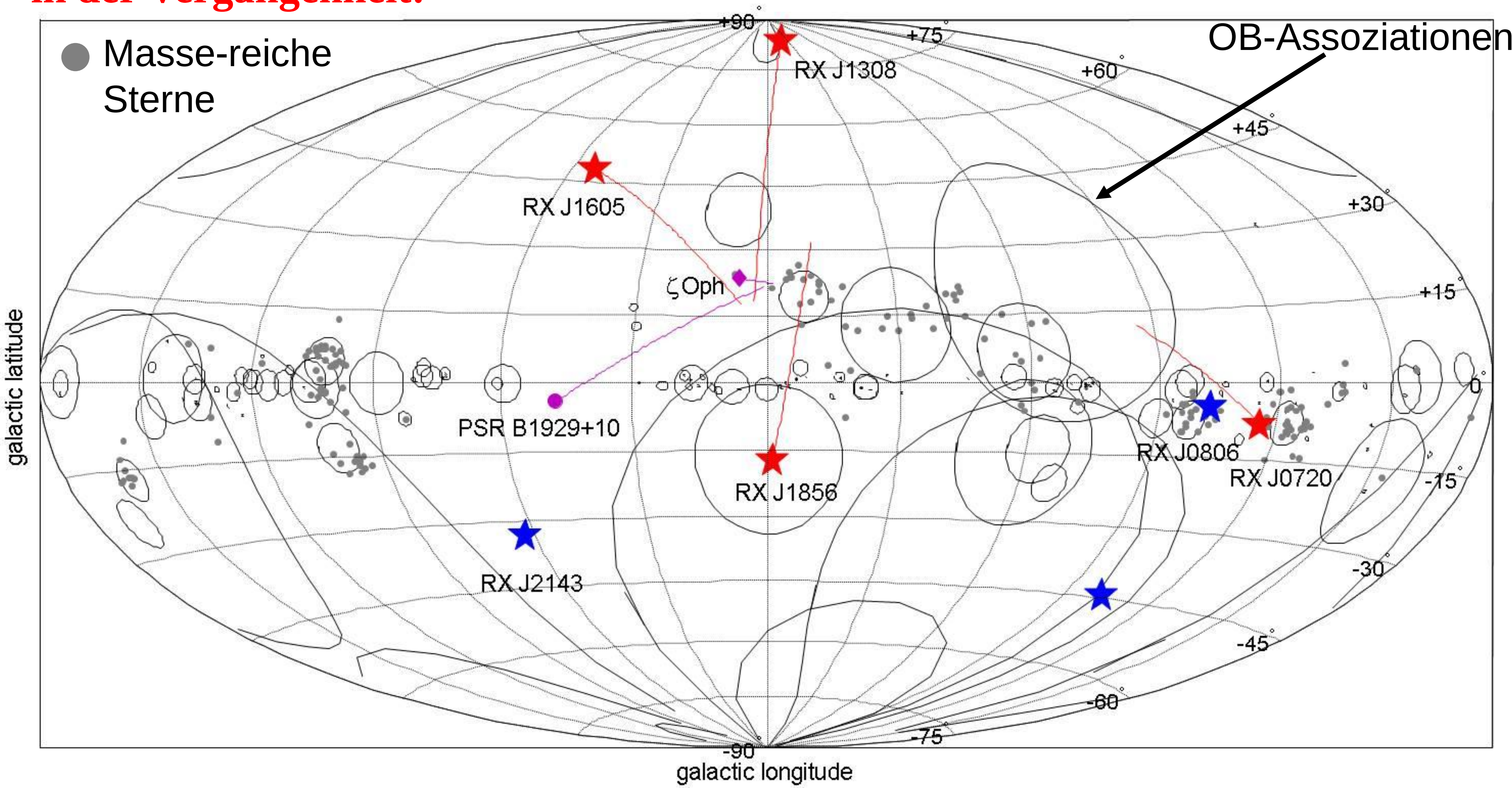
HIP 43158: B0II/III Einzelstern, $v\sin i = 96 \pm 15$ km/s
… vorheriger Begleiter des SN-Vorläufersterns ?

gemessen: $\pi = 3.6 \pm 1.6$ mas
[Eisenbeiss 2011, PhD, Jena]

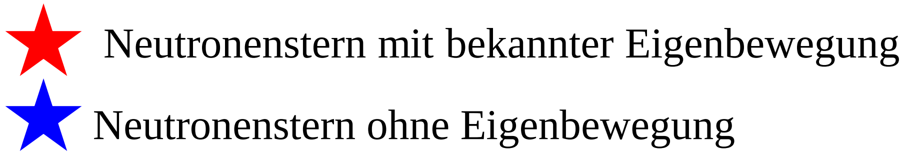
Tetzlaff, Eisenbeiss, Hohle, RN, 2011, MNRAS

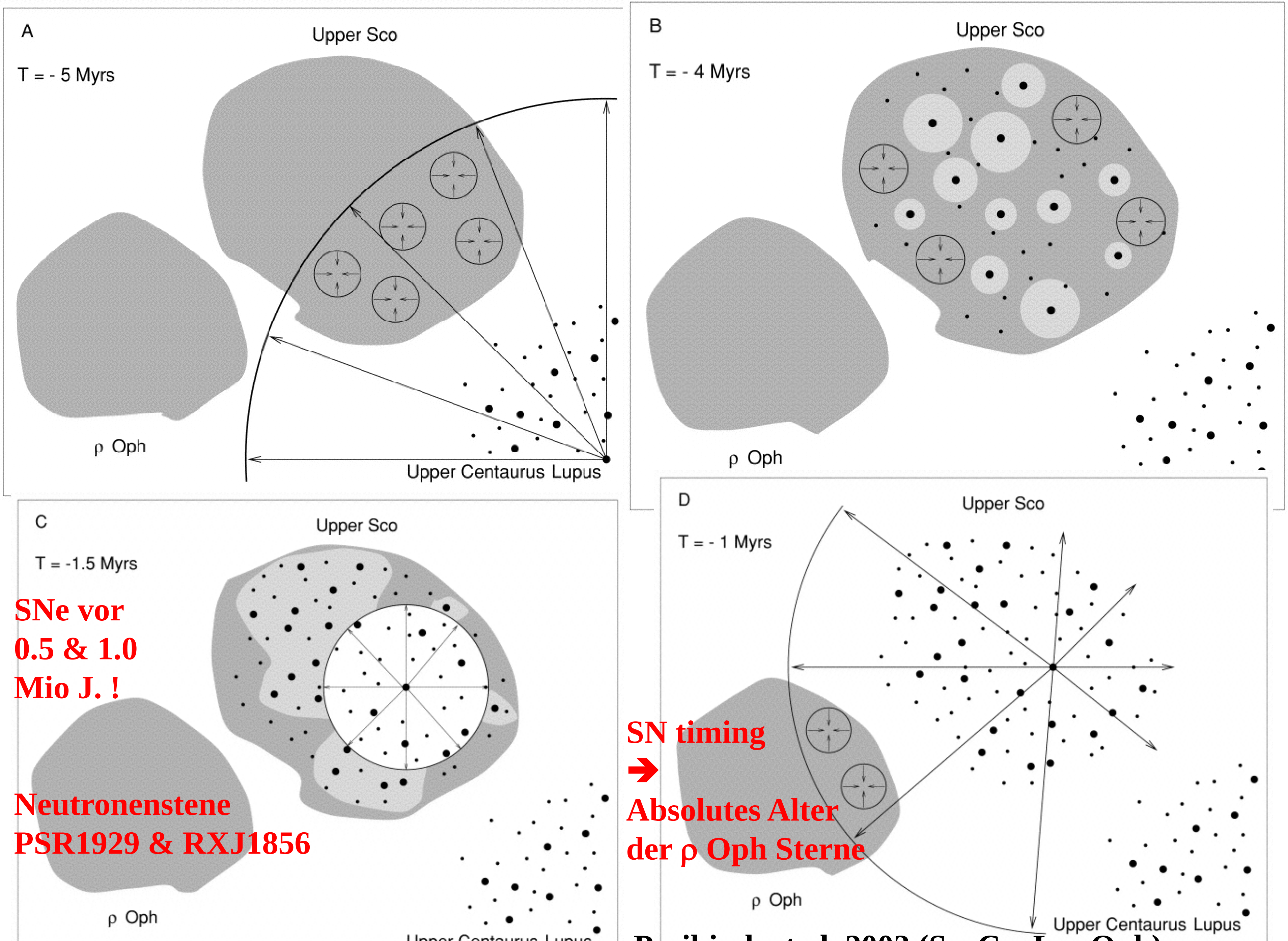
Berechnung der Bewegung isolierter junger Neutronensterne in der Vergangenheit:





Tetzlaff, RN, … 2010 … 2014





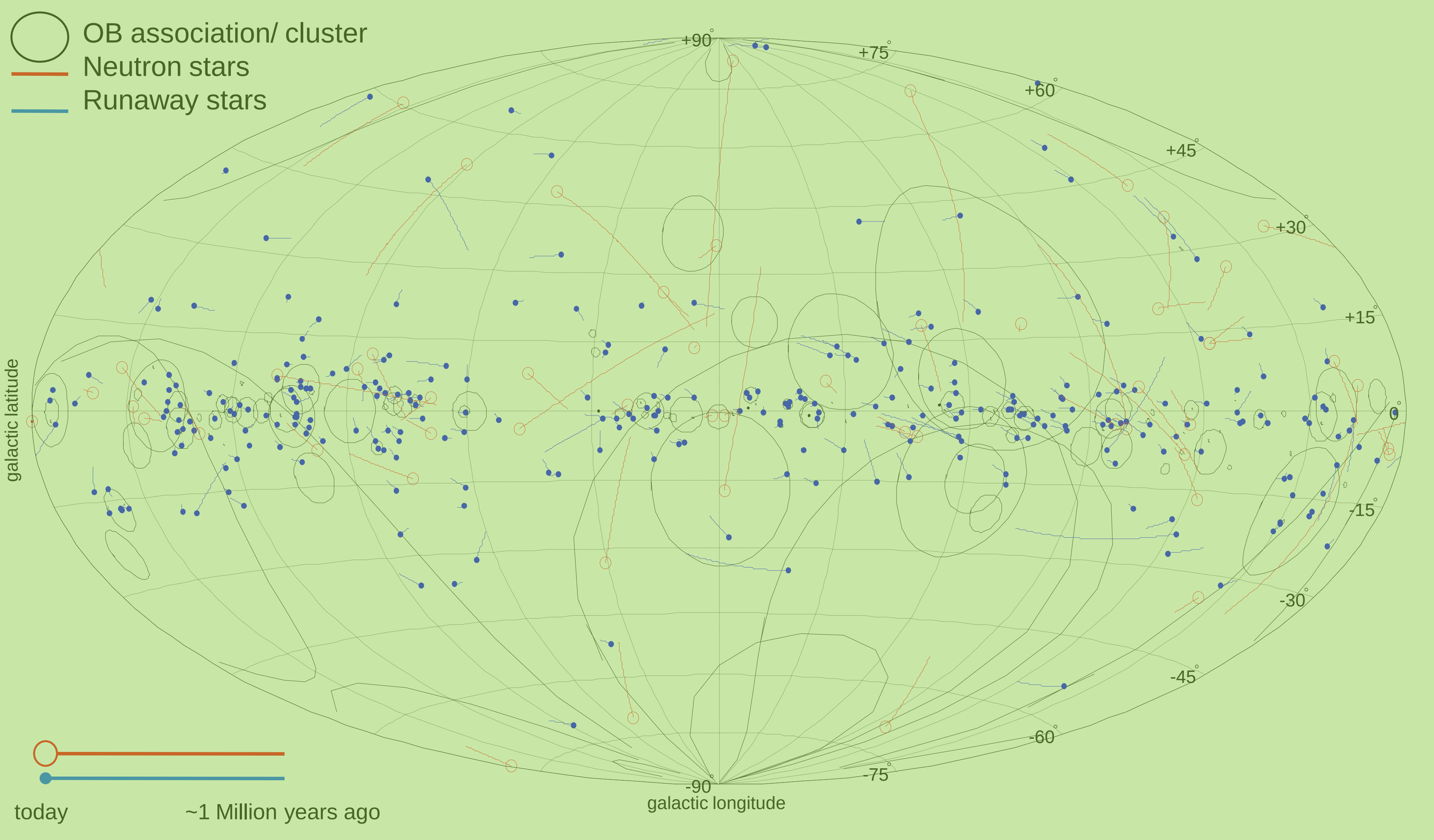
SNe vor 0.5 & 1.0 Mio J. !

Neutronenstene PSR1929 & RXJ1856

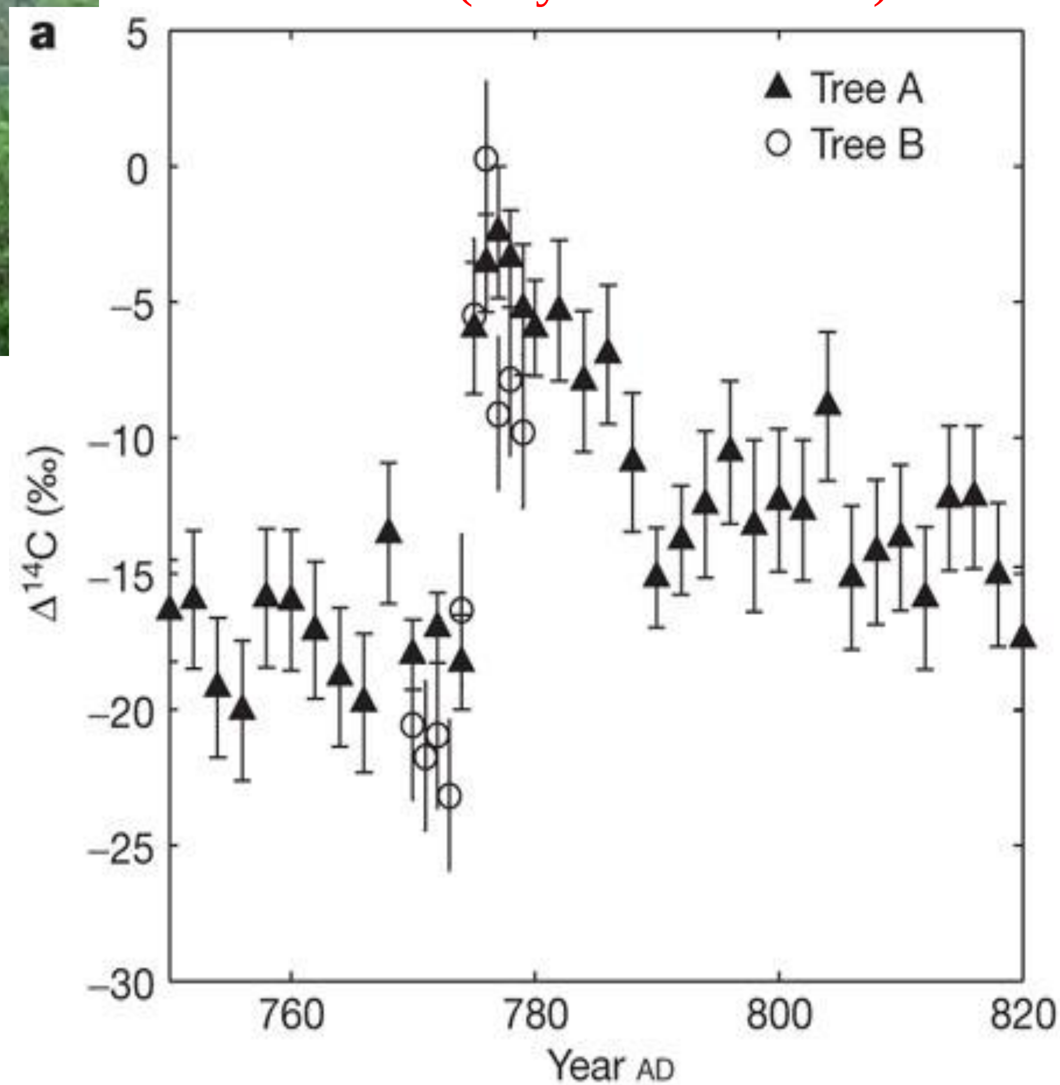
SN timing ➔ Absolutes Alter der ρ Oph Sterne

Preibisch et al. 2002 (ScoCenLupOph)

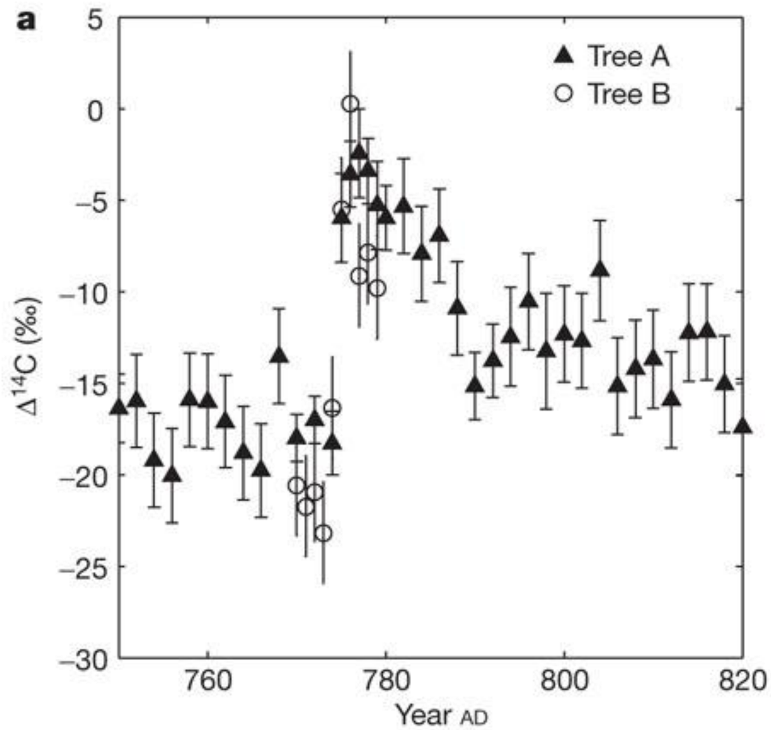
Neutronensterne, Runaway-Sterne, OB-Assoziationen …



Starker Variation
des Radiokarbon (^{14}C)
um AD 775
in japanischen Zedern
(Miyake et al. 2012)



Was war die Ursache ?



Miyake et al. 2012

Supernova ?

Gamma-ray burst ?

Sonnen-Flare ?

Sonstwas ?
(Komenteneinschlag, Magnetfeldschwankung, Vulkanausbruch, etc.)

Was war die Ursache ?

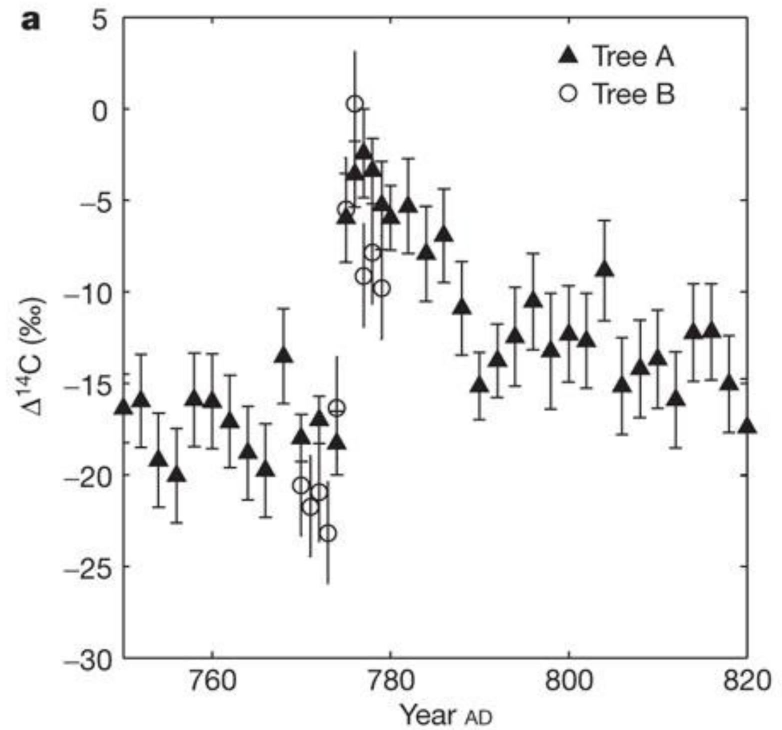
Einführung in Sonnenaktivität (kosmische Strahlung ➔ C-14)

Supernova ?

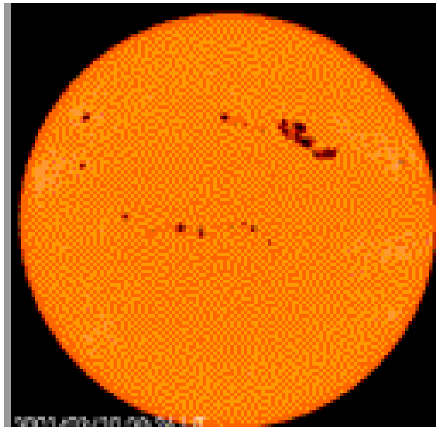
Gamma-ray burst ?

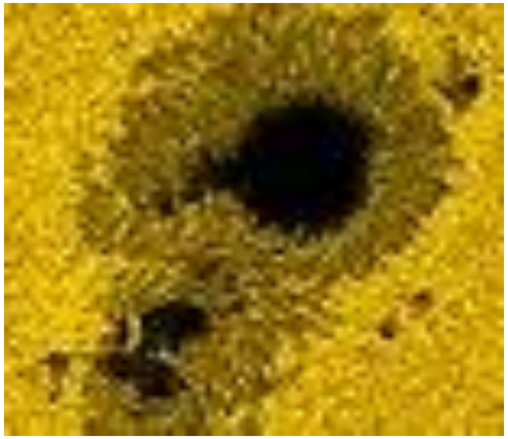
Sonnen-Flare ?

Sonstwas ?
(Komenteneinschlag, Magnetfeldschwankung, Vulkanausbruch, etc.)

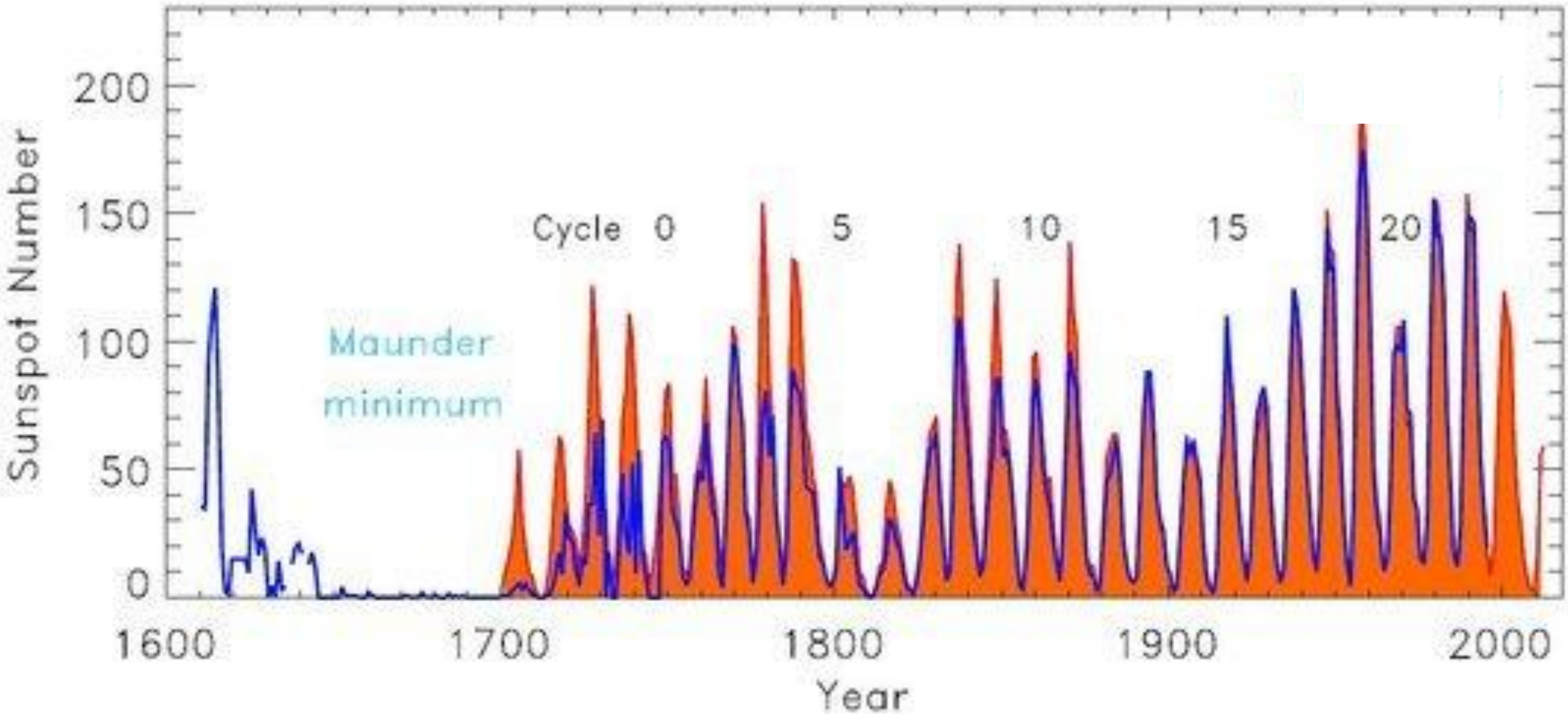


Miyake et al. 2012

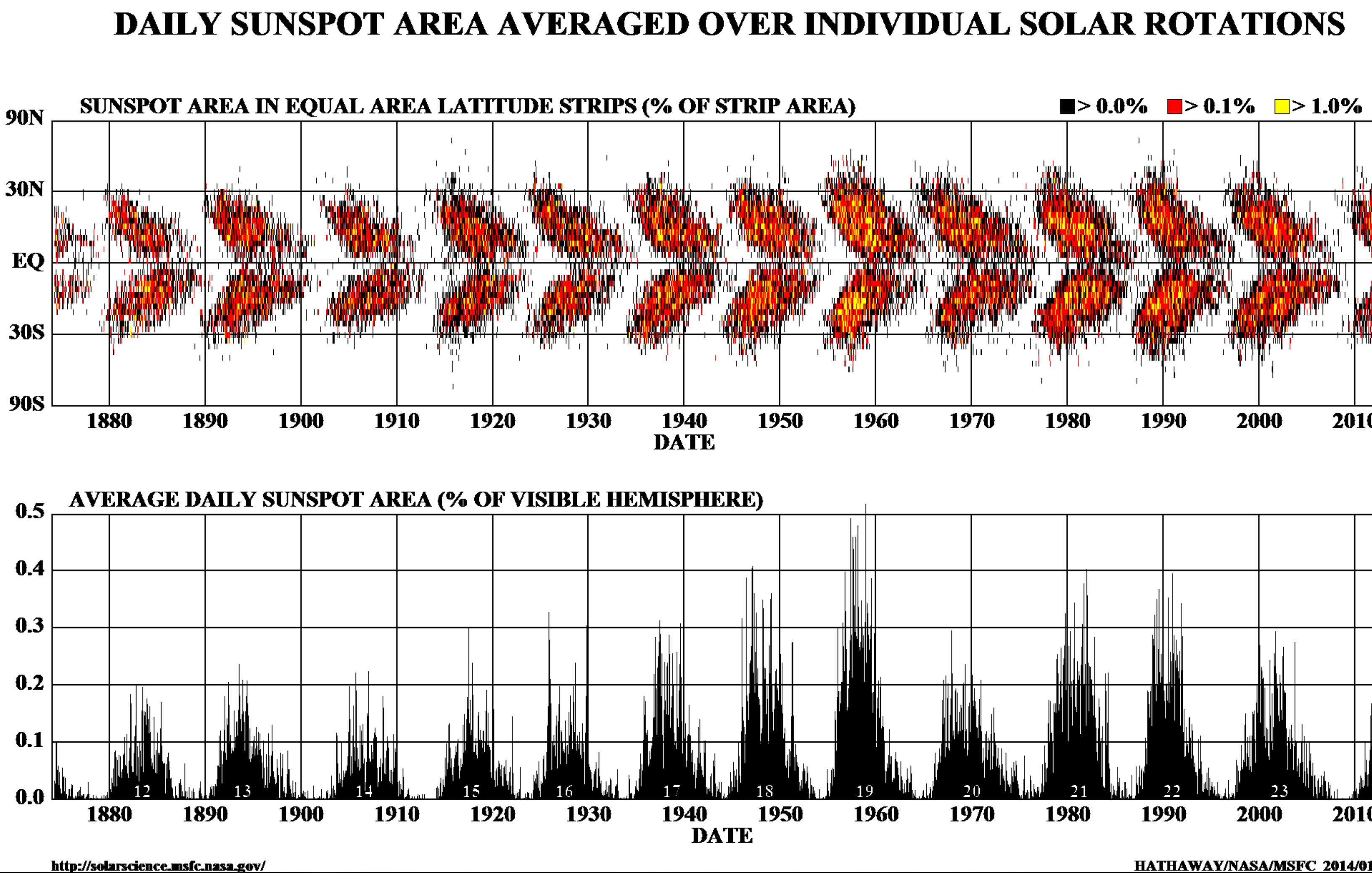




400 years telescopic sunspots with 10-11 yr Schwabe cycle

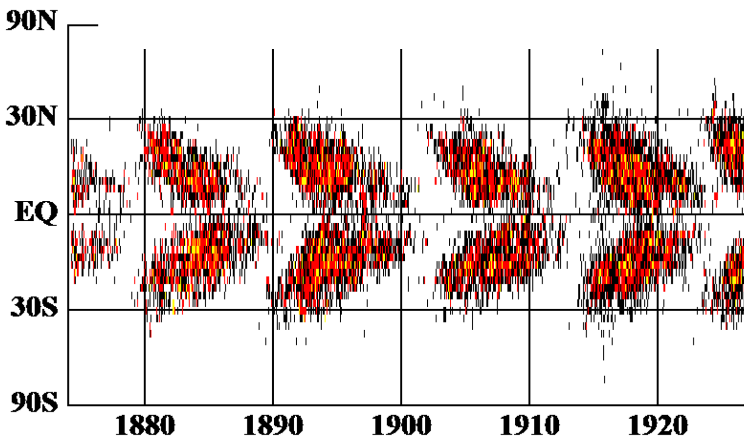


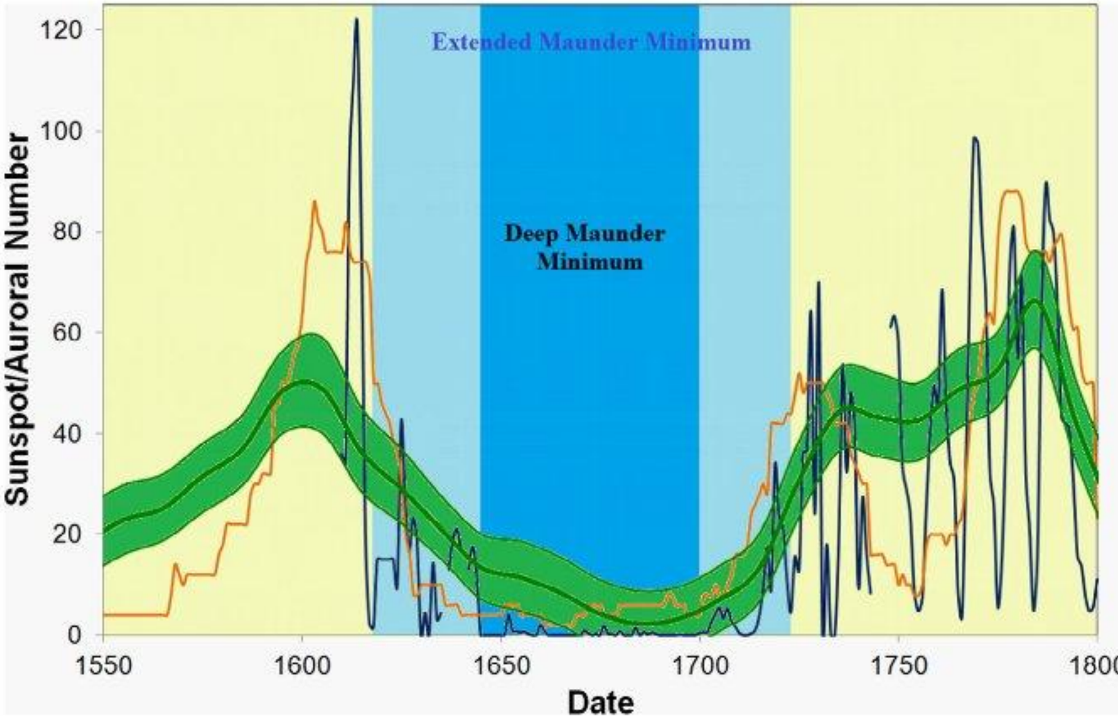
Schwabe-Zyklus der Sonnenflecken: 10.4 +/- 1.2 J. (seit 1750)

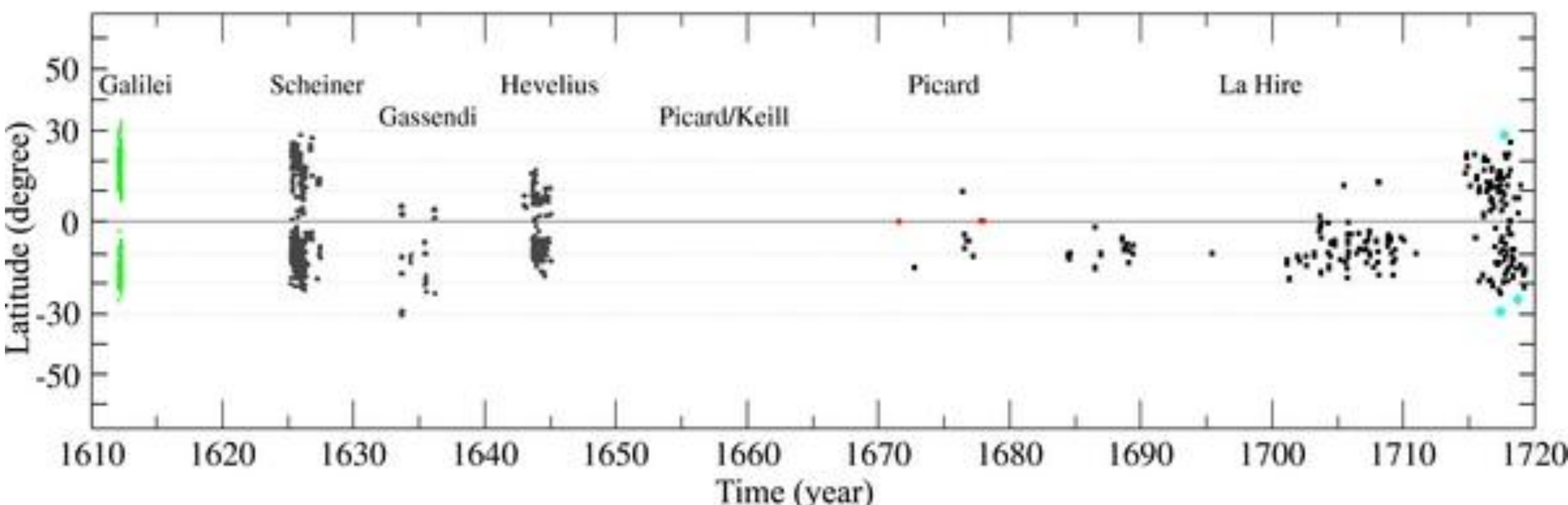


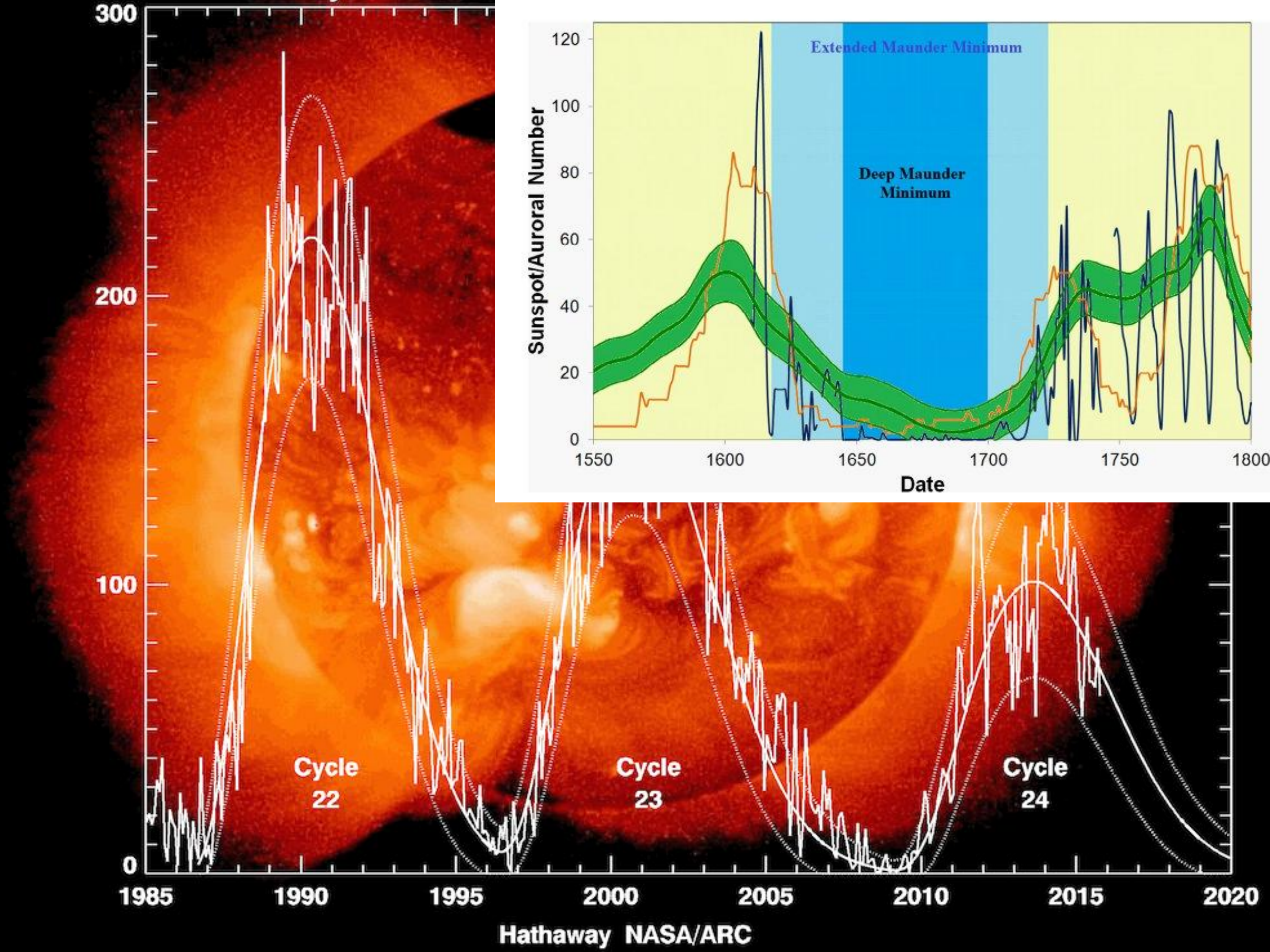
J.M. Vaquero, R.M. Trigo / New Astronomy 34 (2015) 120–122

Schwabe Zyklus im Maunder-Minumum (~ 1630-1715)?

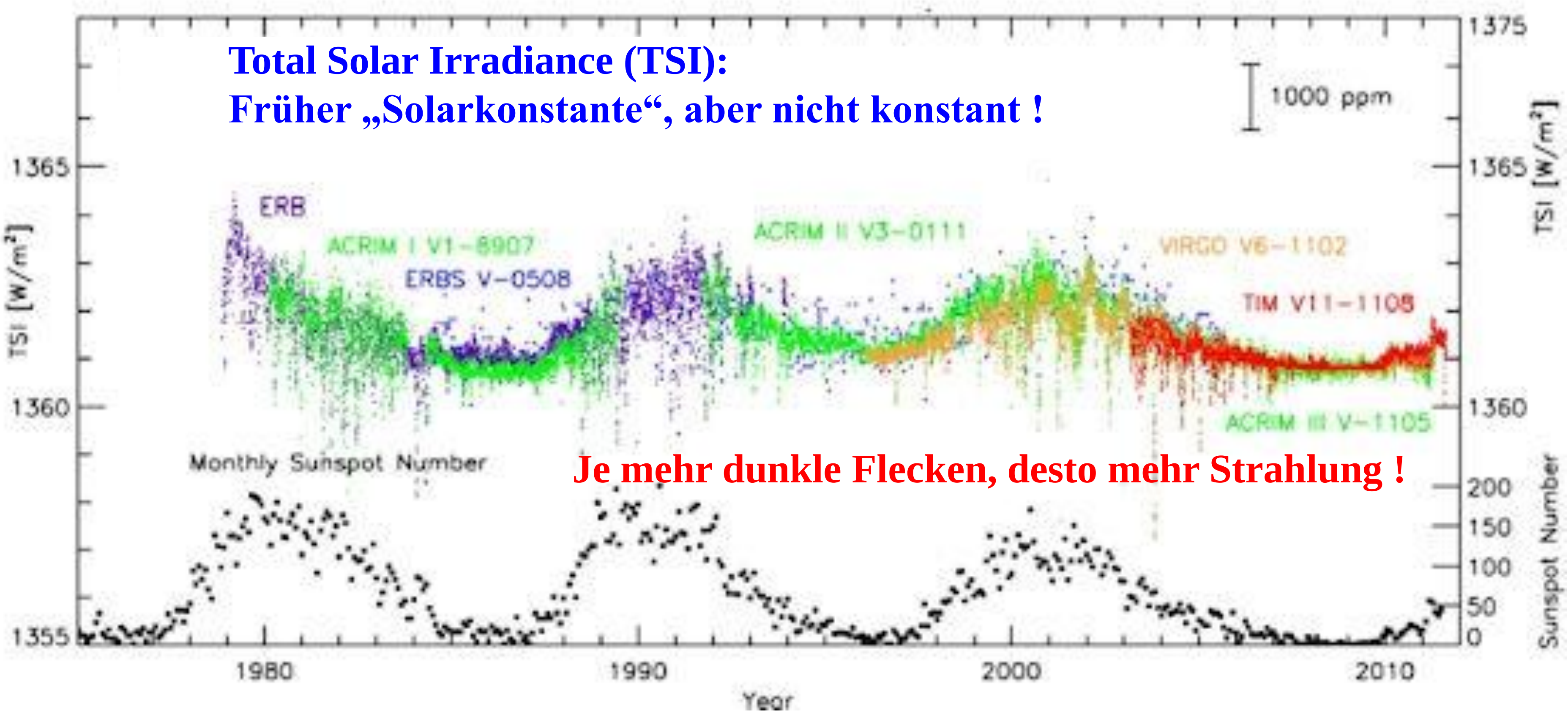








300
200
100
0
1985
1990
1995
2000
2005
2010
2015
2020
Cycle 22
Cycle 23
Cycle 24
Hathaway NASA/ARC
Extended Maunder Minimum
Deep Maunder Minimum
Sunspot/Auroral Number
120
100
80
60
40
20
0
1550
1600
1650
1700
1750
1800
Date



TSI gemessen per Satellit seit einigen Jahrzehnten.
Sonne aber 4.567 Mrd J. alt !

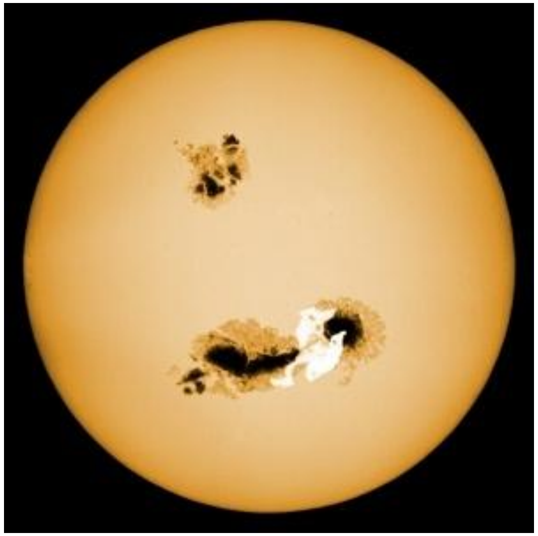
Daher wichtig: Sonnenaktivität (z.B. Flecken), beobachtet mit Teleskop seit 1609.
Sonne aber 4.567 Mrd J. alt !

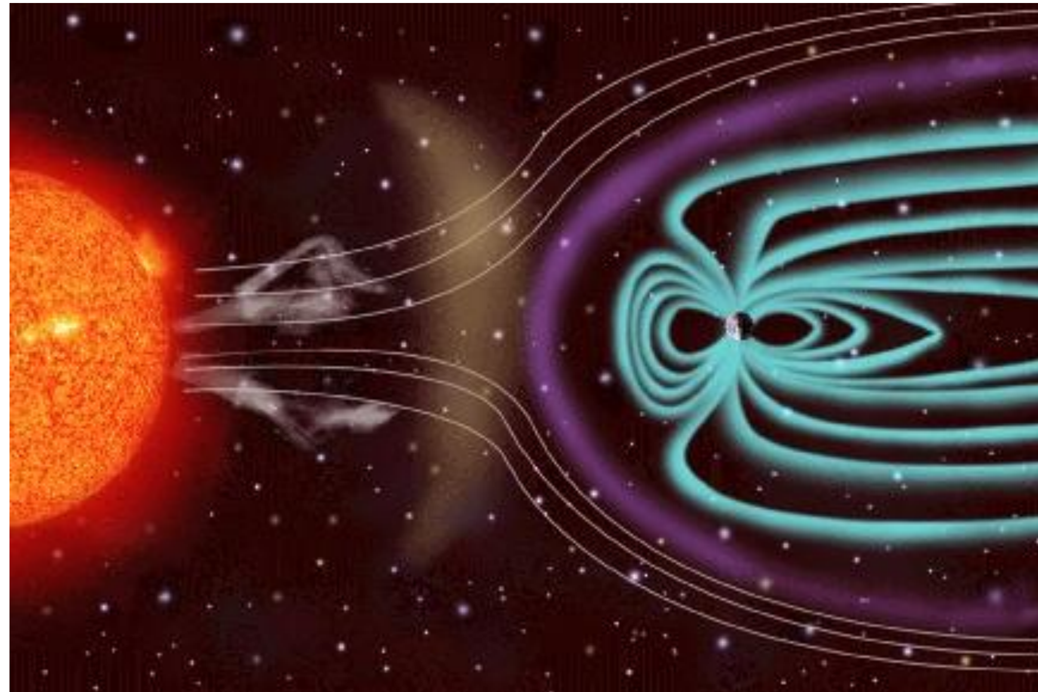
Daher auch wichtig: Aurorae seit Jahrhunderten und –Jahrtausenden.
Sonne aber Mrd J. alt !

Daher ferner wichtig: Radioisotope, deren Stärke vom Sonnenwind moduliert werden.

Mehr Sonnen-Aktivität (Flecke UND koronale Löcher)

➔ mehr Sonnen-Wind ➔ Geo-magnetische Aktivität und Aurorae

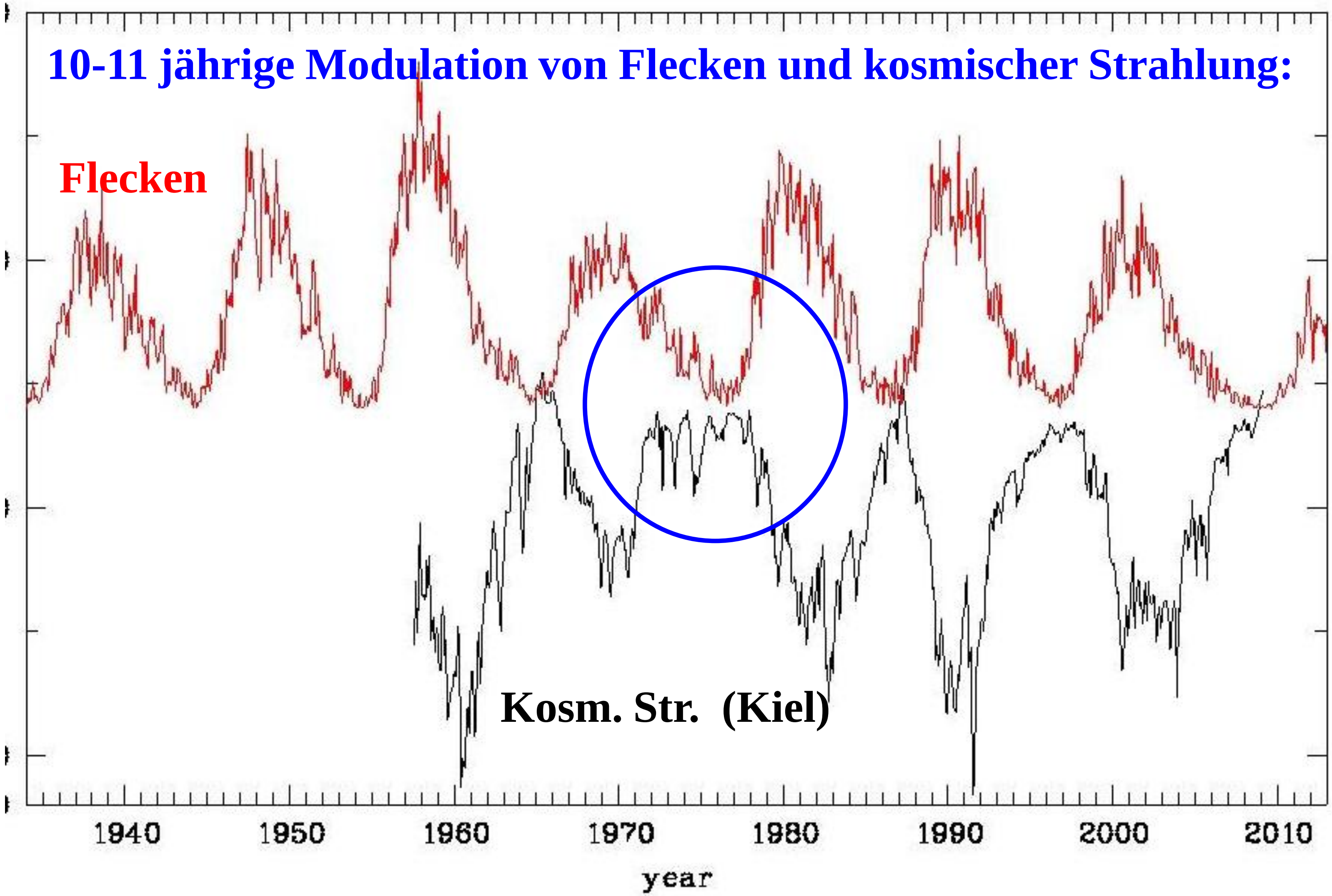




Je stärker der Sonnen-Wind,
desto weniger kosmische Strahlung
kommt ins Sonnensystem.

Weniger aktive Sonne, mehr kosm. Str.

➔ 10-11 jährige Modulation von Flecken, Aurorae und <u>kosm. Strahlung</u>. (Schwabe Zyklus)

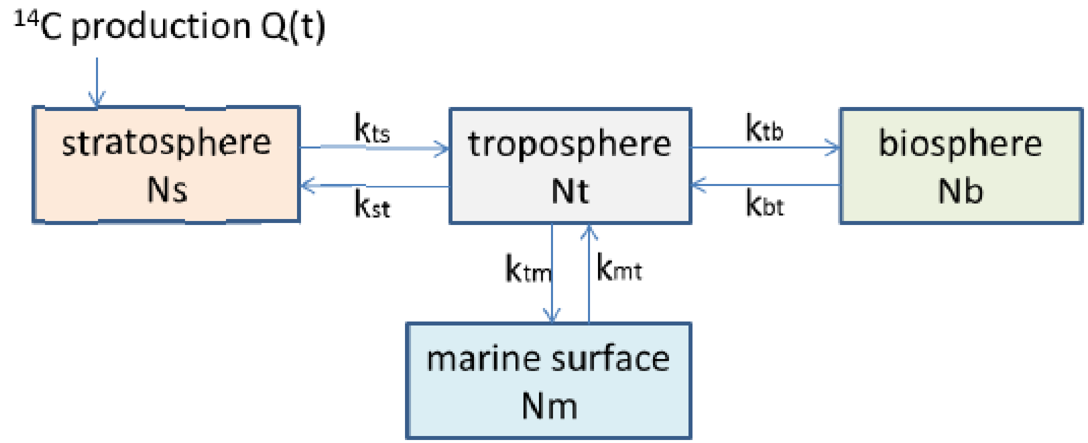


Je stärker der Sonnen-Wind, desto weniger kosmische Strahlung.

Weniger aktive Sonne, mehr kosm. Str.

➔ 10-11 jährige Modulation von Flecken, Aurorae und <u>kosm. Strahlung</u>.

^{10}Be und ^{14}C   (radio-aktive Isotope)
entstehen durch kosmische Strahlung moduliert durch Sonnenwind
(oder Gamma-Strahlung)



Kosmische Strahlung (Protonen)
➔ Spallation
➔ thermische Neutronen

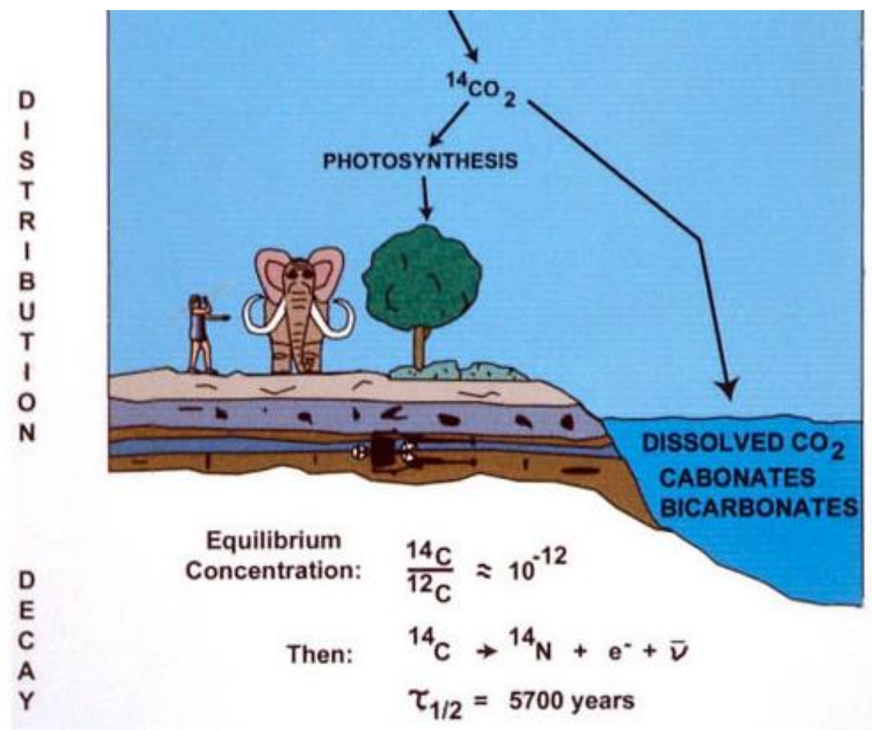
➔ $^{14}N(n,p)^{14}C$

($^{14}N+n = p+^{14}C$)

(dann ^{14}C ➔ ^{14}N
mit 5730 J. Halbwertszeit)

$^{14}N(n,p+\alpha)^{10}Be$

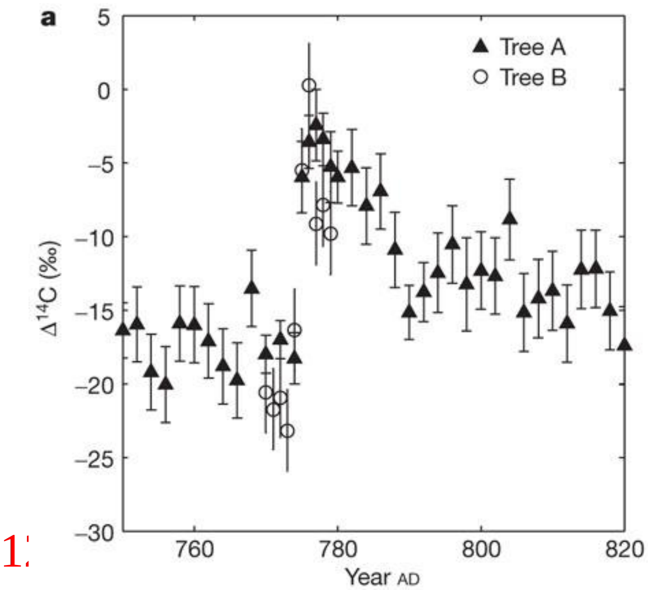
(1.36 Mio J. Halbwertszeit)



Kosmische Strahlung (Protonen)

➔ Spallation ➔ thermische Neutronen $^{14}N(n,p)^{14}C$

(dann ^{14}C ➔ ^{14}N mit 5730 J. Halbwertszeit)



Kohlenstoffbasierte Lebewesen nehmen ständig Kohlenstoff aus der Atmo durch Atmung und/oder frische Nahrung auf.

Darin hauptsächlich das stabile Isotop C-12 (C für Carbon, C-1 Neutronen) sowie etwas nicht-stabiles C-14 (2 Neutronen mehr).

Vermeintlich immer gleicher Anteil an C-14.

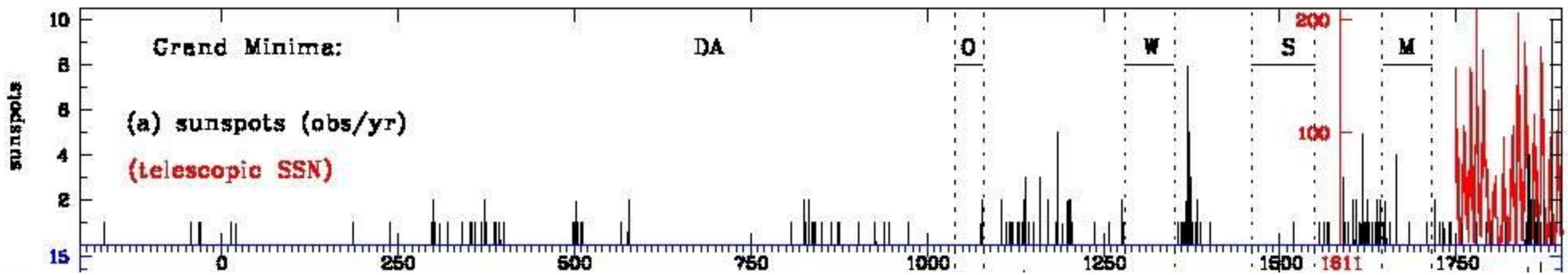
Da C-14 nicht stabil, nimmt sein Anteil in toten Lebewesen ab (Halbwertszeit).

Anteil an gemessenem C-14 in Kohlenstoff ergibt somit die Zeit seit dem Tod.

Da Bäume in jedem Jahr einen Baumring bilden, dessen Alter man kennt, kann man messen, wie viel C-14 in jedem Jahr im atmosphärischen Kohlenstoff enthalten war (lebende Bäume bis etwa 3000 Jahre alt, tote Bäume bis zu 11800 Jahre).

Dendro-Chronologie: Messung des C-14 Anteils an kohlenstoffhaltigen archäologischen Fundstücken ➔ ergibt Alter des Fundstücks (im Vergleich zu Baumringen)

Terrestrische Archive: ^{14}C, ^{10}Be, Sonnenflecken und Aurorae



Chinesische Berichte:

Eine Art Stern in der Sonne

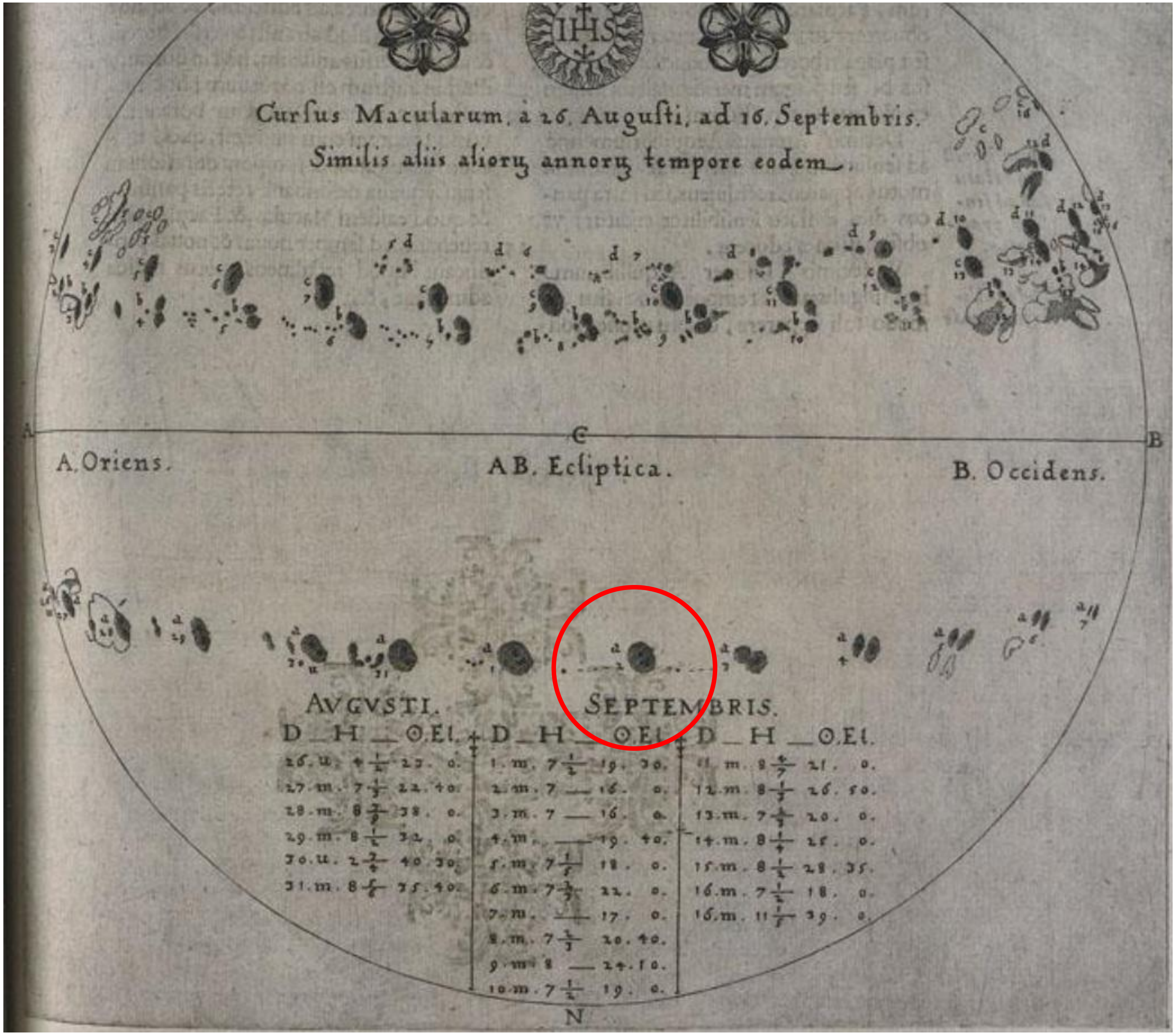
Ein Fleck auf der Sonne

Fleck vor der Sonne

Schwarzes vor der Sonne

China: *Ein Stern* ***seitlich*** *vor der Sonne* (2. Sep 1625) - ohne Teleskop !

Scheiner
(in Rom)
Sep 1625
mit Teleskop:

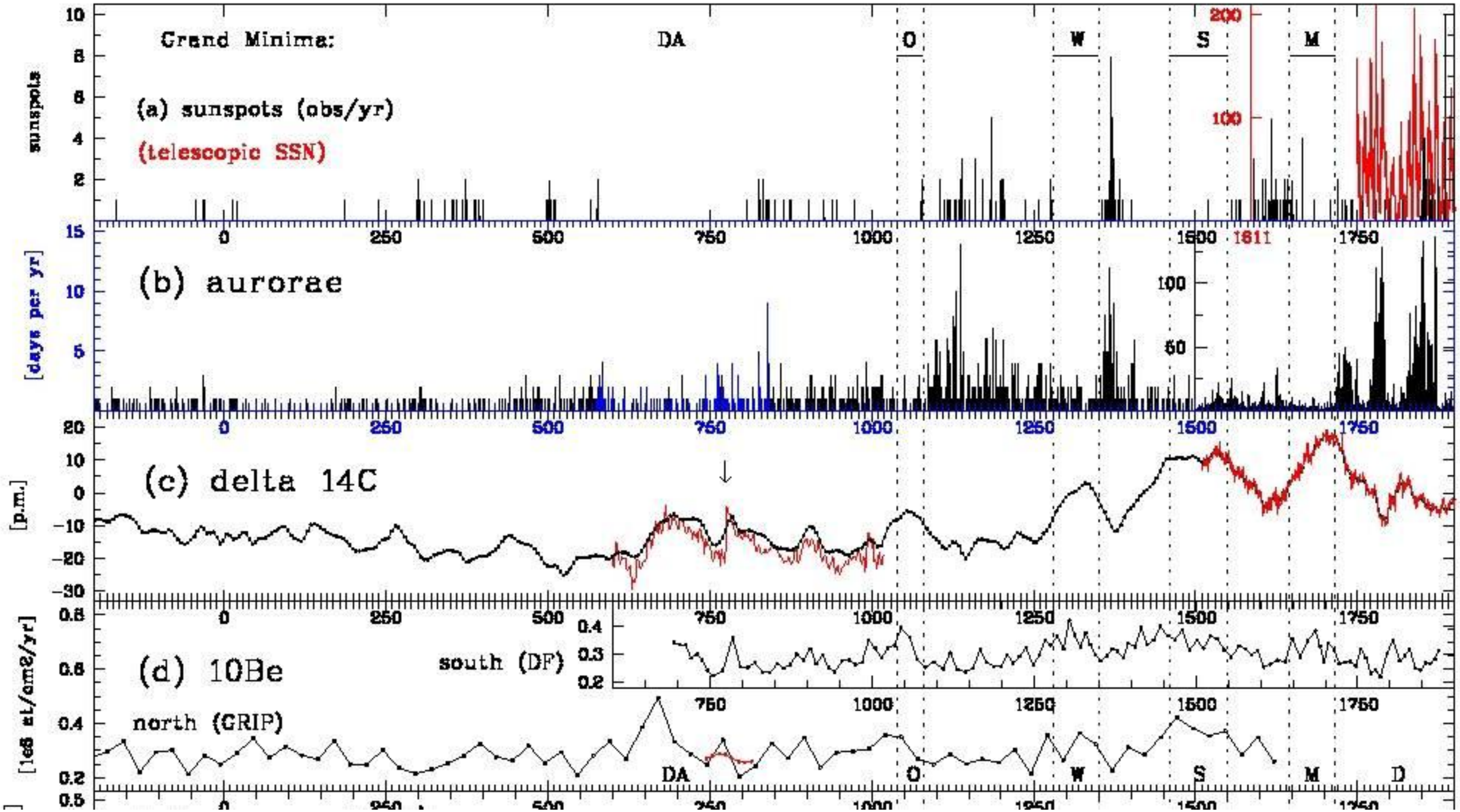


➔ *Stern* bestätigt als Fleck

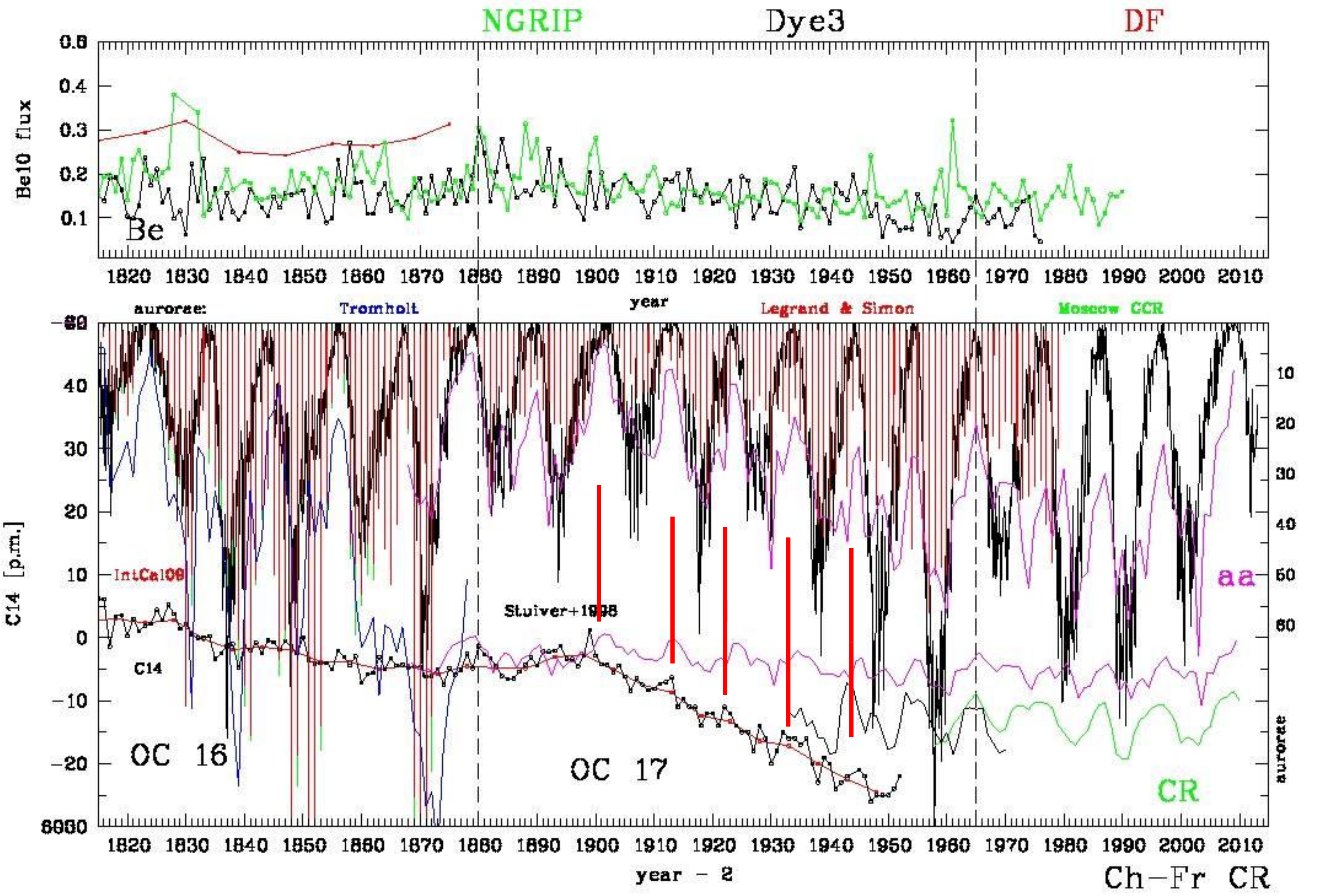
➔ ***seitlich:***
Hohe heliographische Breite (?)

Wenig Sonnen-Aktivität → wenig Wind → mehr kosm. Strahlung
→ mehr ^{14}C und ^{10}Be

Grand Minima: **D**ark **A**ge **O**ort **W**olf **S**pörer **M**aunder



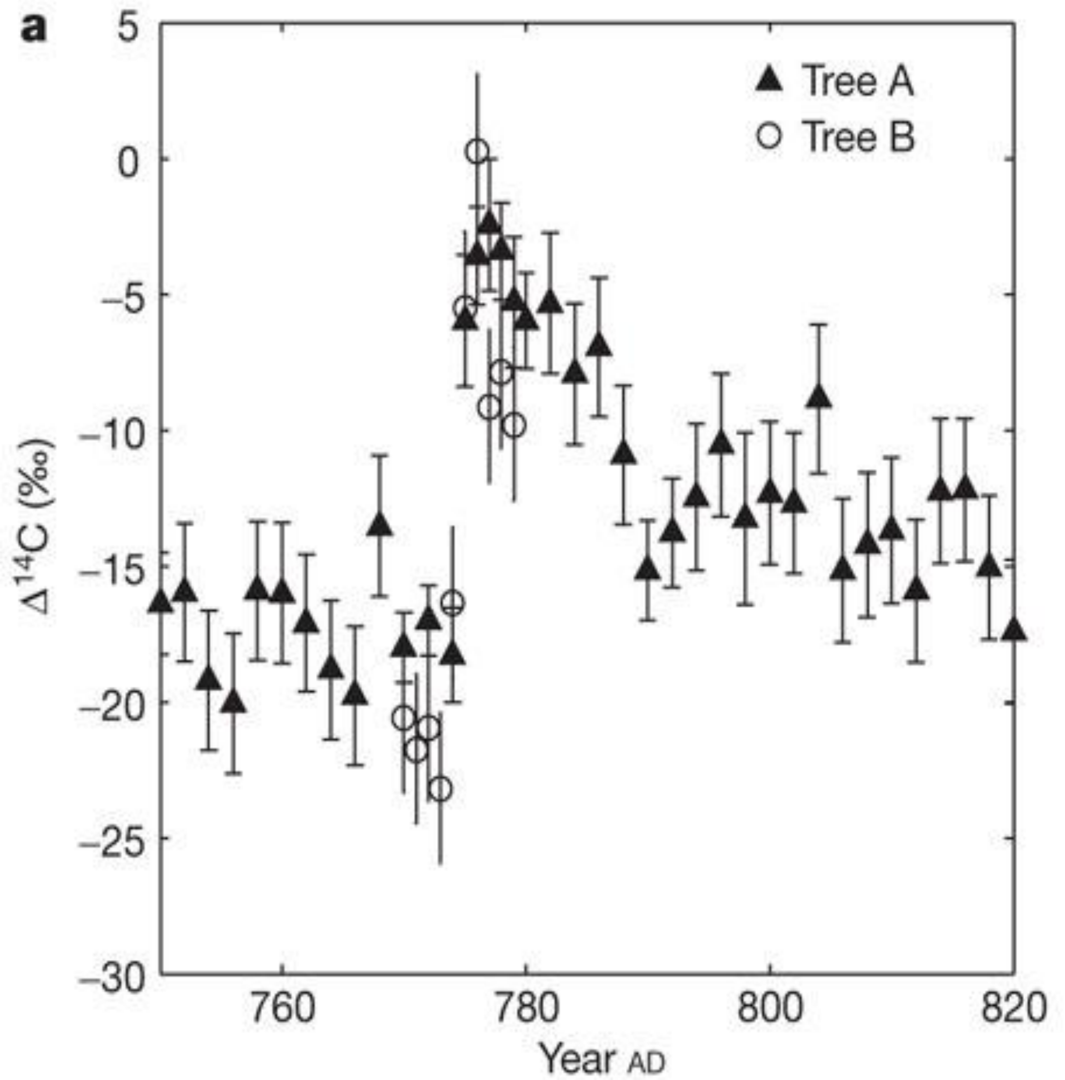
Schwabe-Zyklus bei C-14, Be-10 und kosm. Str. (?)

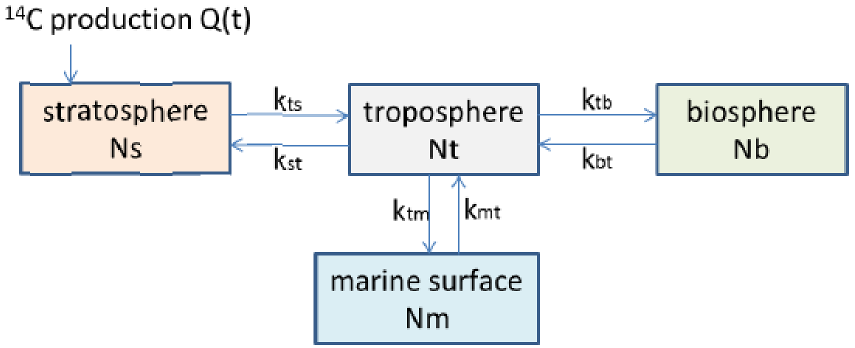


Rekonstruktion der Sonnenaktivität:

- ➔ **Sonnenflecken**
- ➔ **Aurorae**
- ➔ **C-14 und Be-10 (Sonnenwind, kosmische Strahlung)**
- ➔ **Kometen:**
  Schweiflänge, Helligkeit, Sichtbarkeitsdauer, Häufigkeit
- ➔ **Sichtbarkeit bzw. Helligkeit der Korona bei totaler SoFi**
- ➔ **Helligkeit von reflektierenden (Klein-)Körpern im SoSy.**

Starker Variation
des Radiokarbon (^{14}C)
um AD 775
in japanischen Zedern
(Miyake et al. 2012)





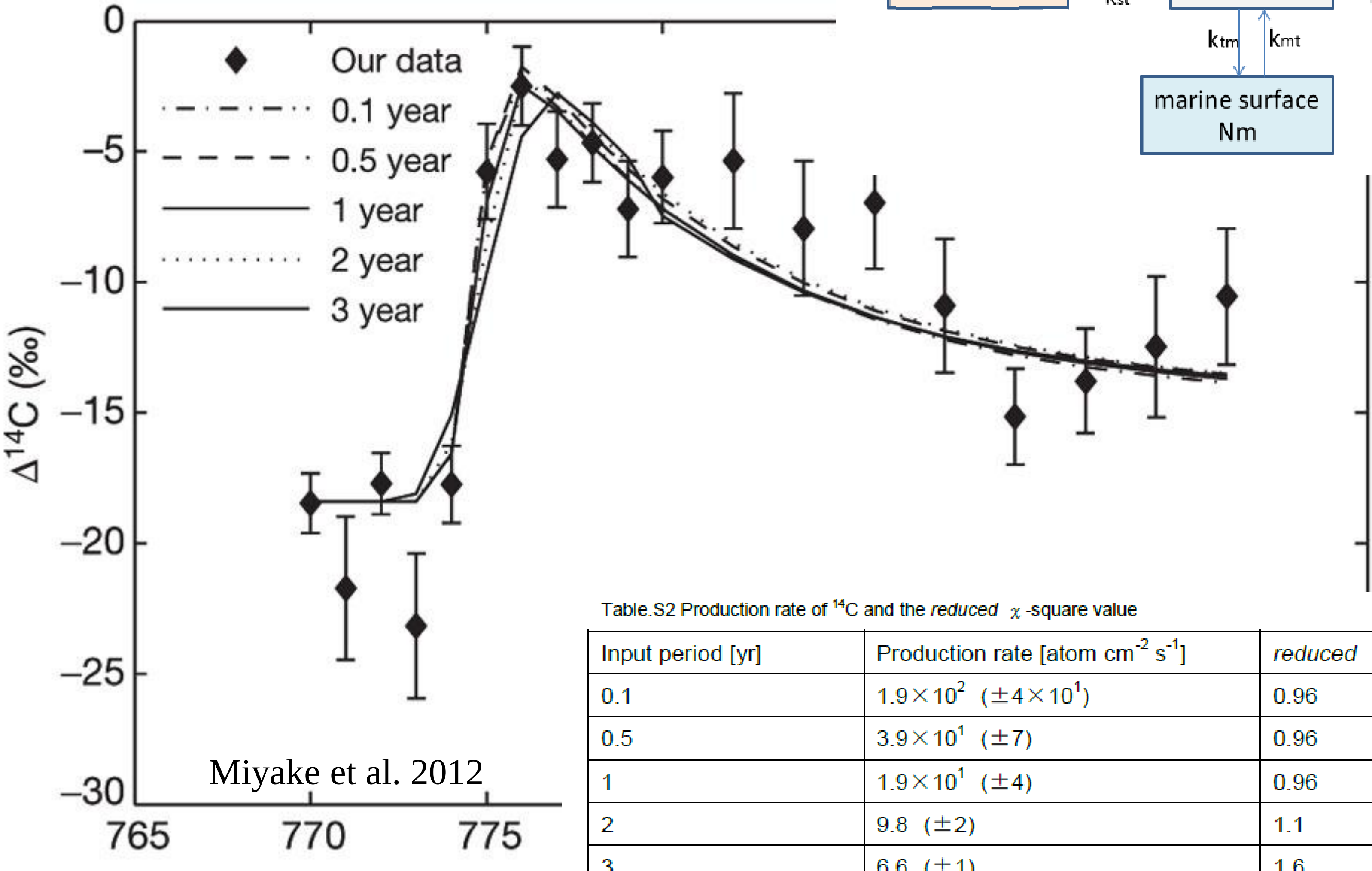


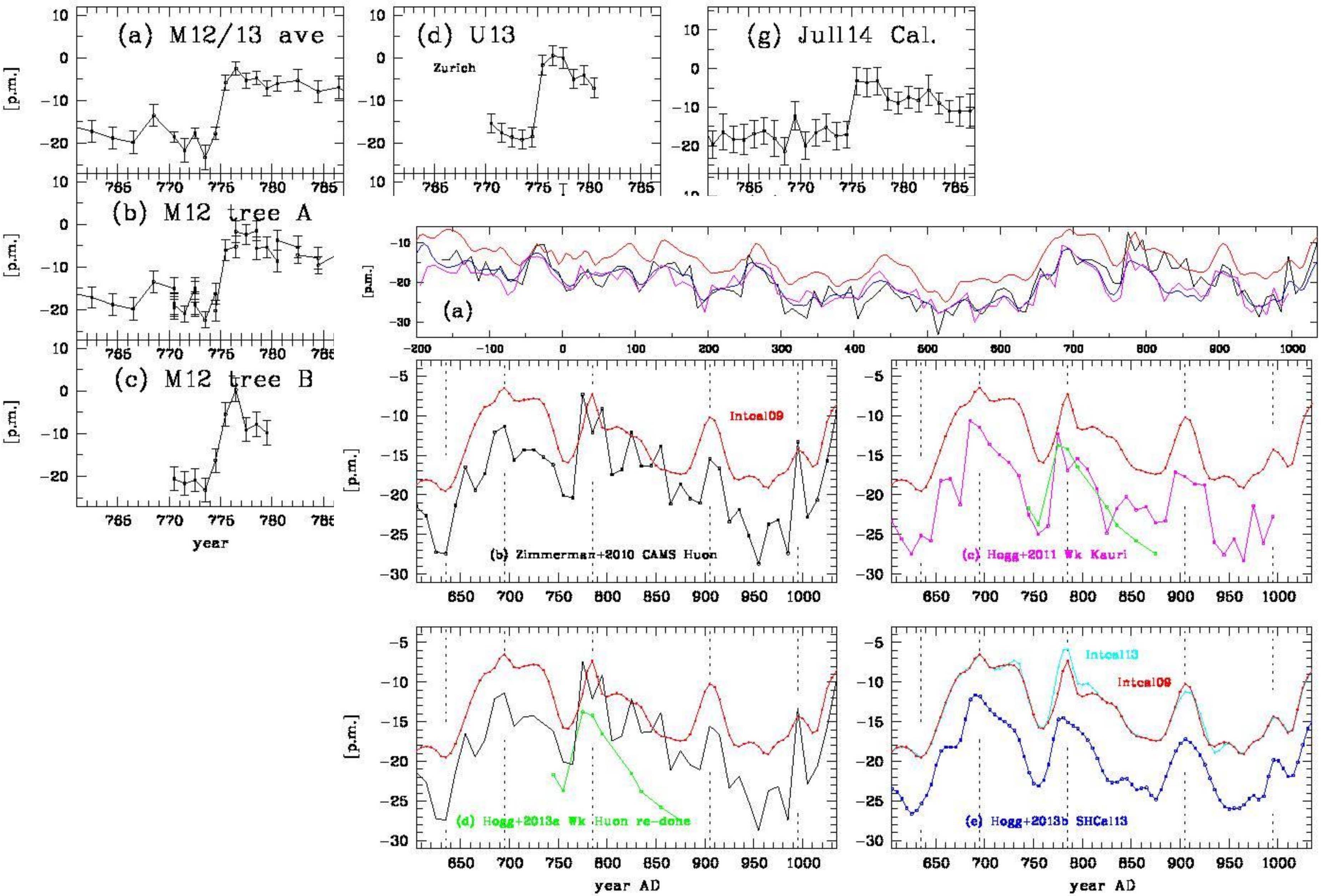
Table.S2 Production rate of ^{14}C and the *reduced* χ -square value

Input period [yr]	Production rate [atom cm^{-2} s^{-1}]	*reduced* χ -squared value
0.1	1.9×10^{2} (±4×10^{1})	0.96
0.5	3.9×10^{1} (±7)	0.96
1	1.9×10^{1} (±4)	0.96
2	9.8 (±2)	1.1
3	6.6 (±1)	1.6

(7.0 +/- 1.5) x 10^{24} erg γ-Strahlen-Input auf die Erde (oberhalb 10 MeV)

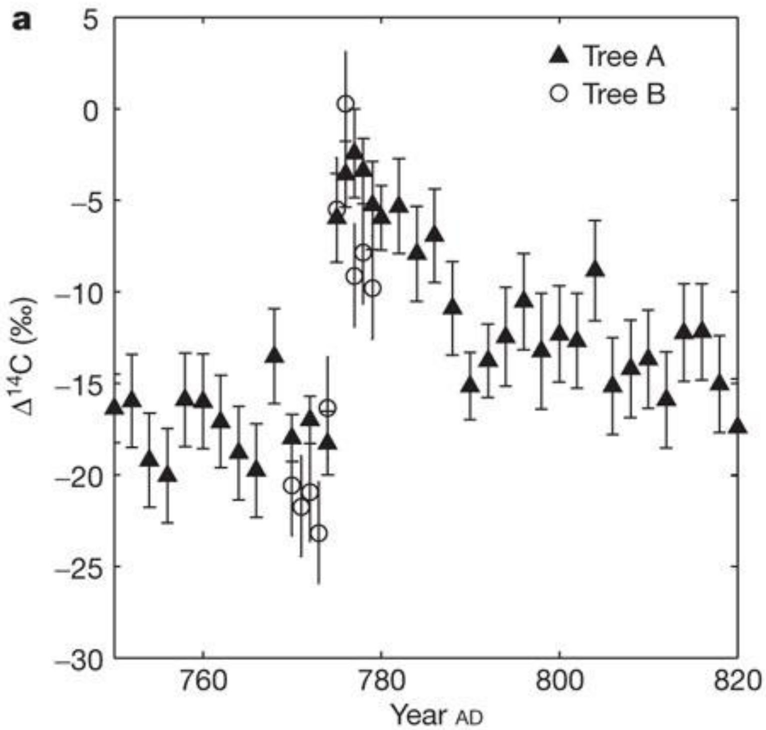
oder

(8 +/- 2) x 10^{25} erg (Protonen-Input) als solare Protonen (2 x 10^{35} erg auf der Sonne)



(a) M12/13 ave
(d) U13
Zurich
(g) Jull14 Cal.
(b) M12 tree A
(c) M12 tree B
[p.m.]
year
(a)
(b) Zimmerman+2010 CAMS Huon
Intcal09
(c) Hogg+2011 Wk Kauri
(d) Hogg+2013a Wk Huon re-done
(e) Hogg+2013b SHCal13
Intcal13
Intcal09
year AD

Was war die Ursache ?



Miyake et al. 2012

Supernova ?

Gamma-ray burst ?

Sonnen-Flare ?

Sonstwas ?
(Komenteneinschlag, Magnetfeldschwankung, Vulkanausbruch, etc.)

Was war die Ursache ?

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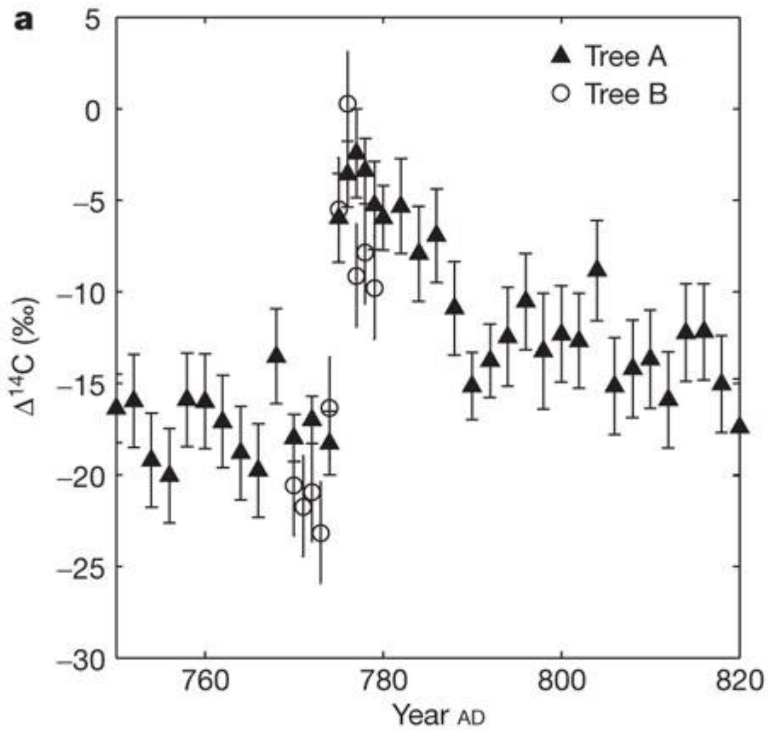


Miyake et al. 2012

Anglo-Saxon Chronicle:
„This year also appeared in the heavens a red crucifix, after sunset.“
Presumably for AD 774 (J. Allen, Correspondence to Nature, 2012)

Allen: *„… hints at the presence of a supernova largely hidden behind a dust cloud, which would scatter and absorb all light bar a trickle of red. The resulting supernova remnant would be invisible.“*

… invisible in optical, but not in X- and gamma-rays, so obviously wrong.

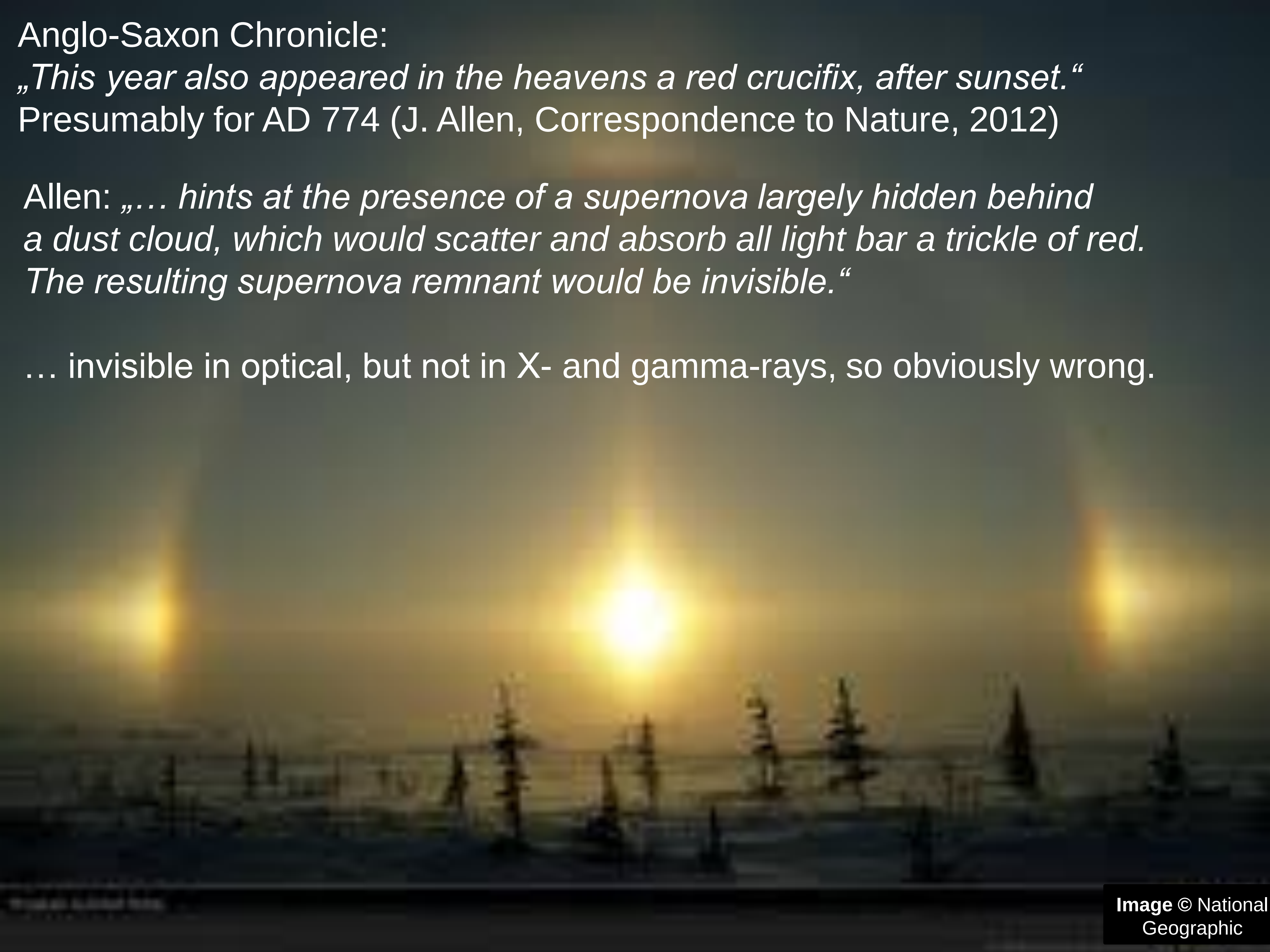
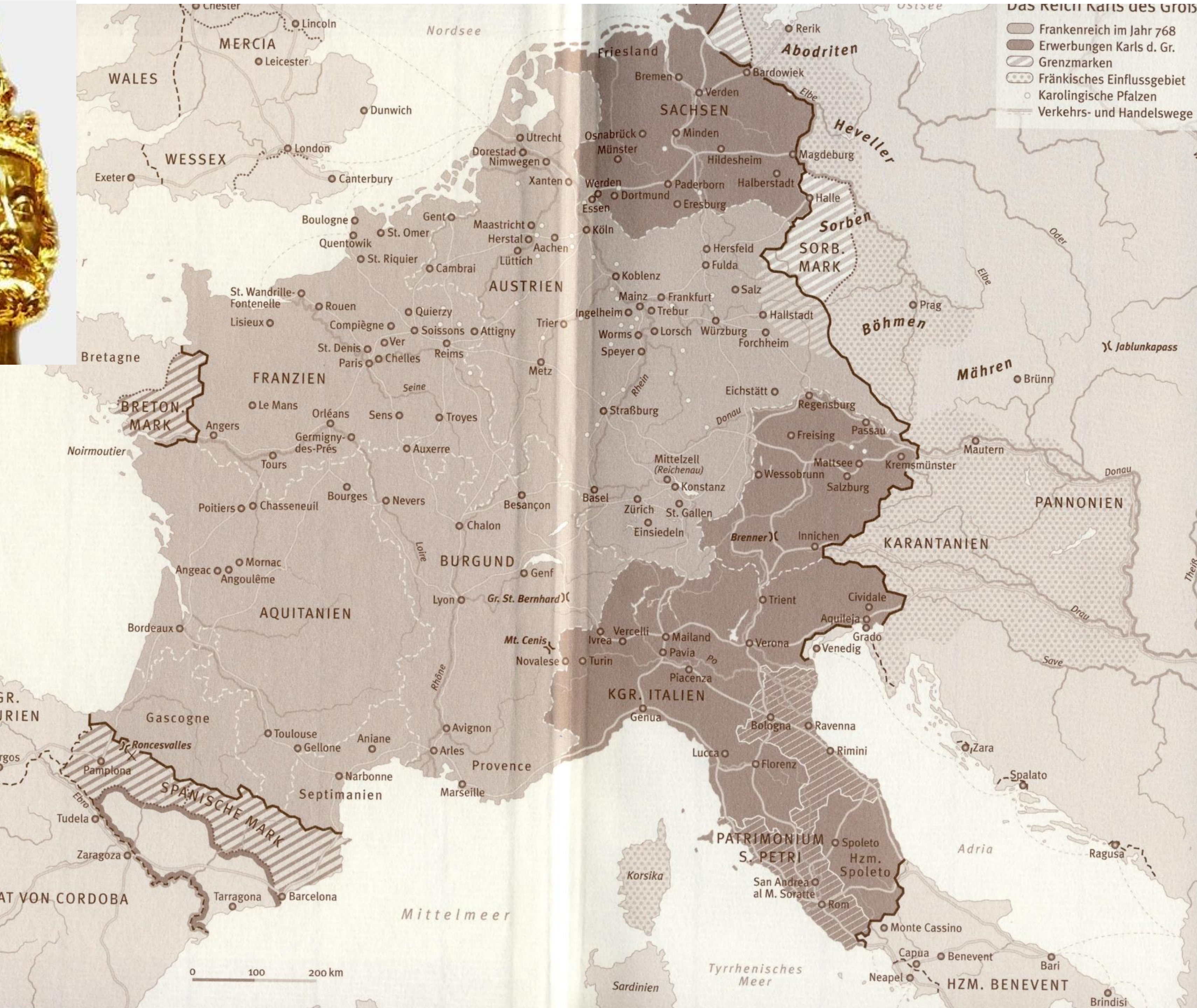


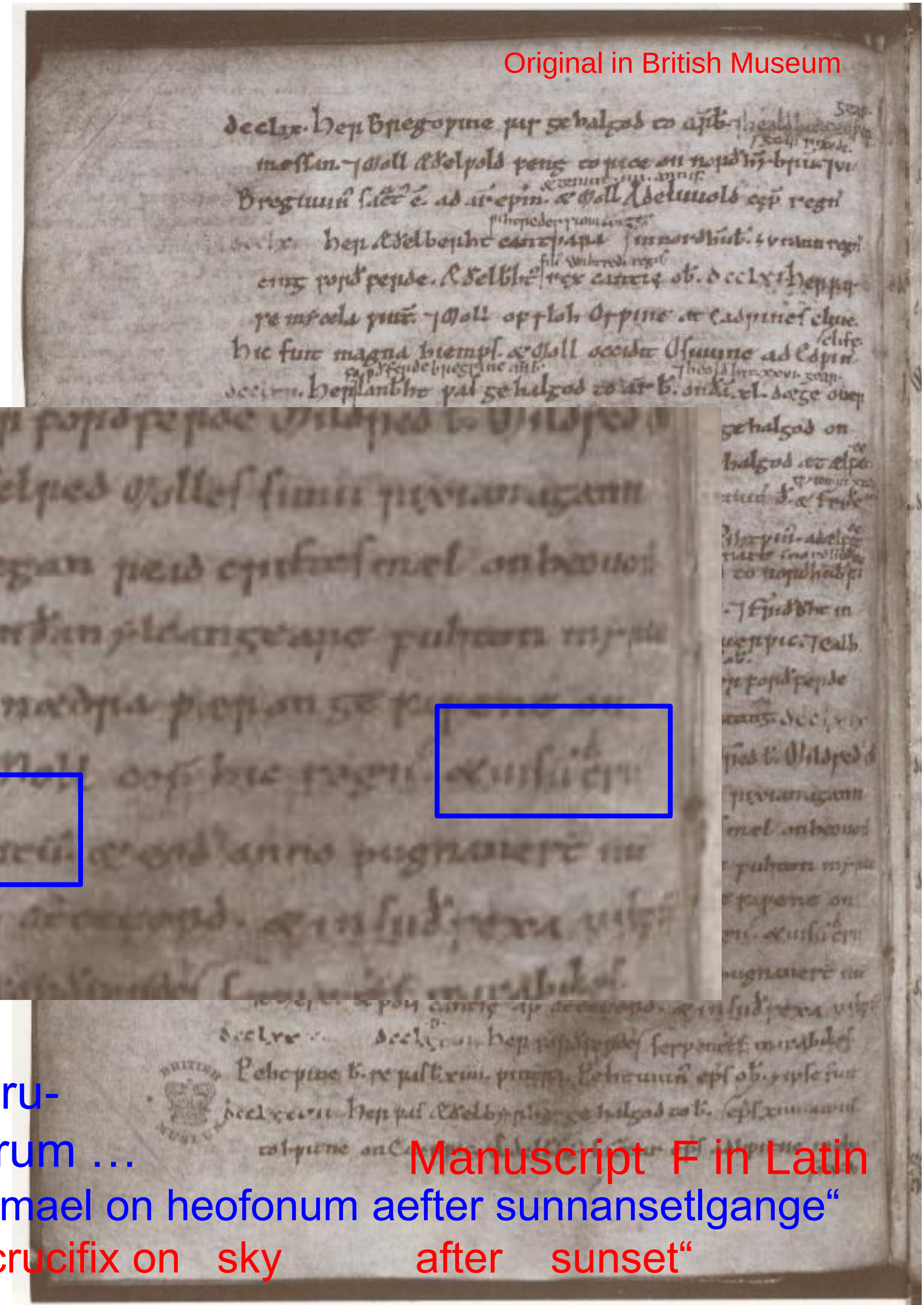
Image © National Geographic

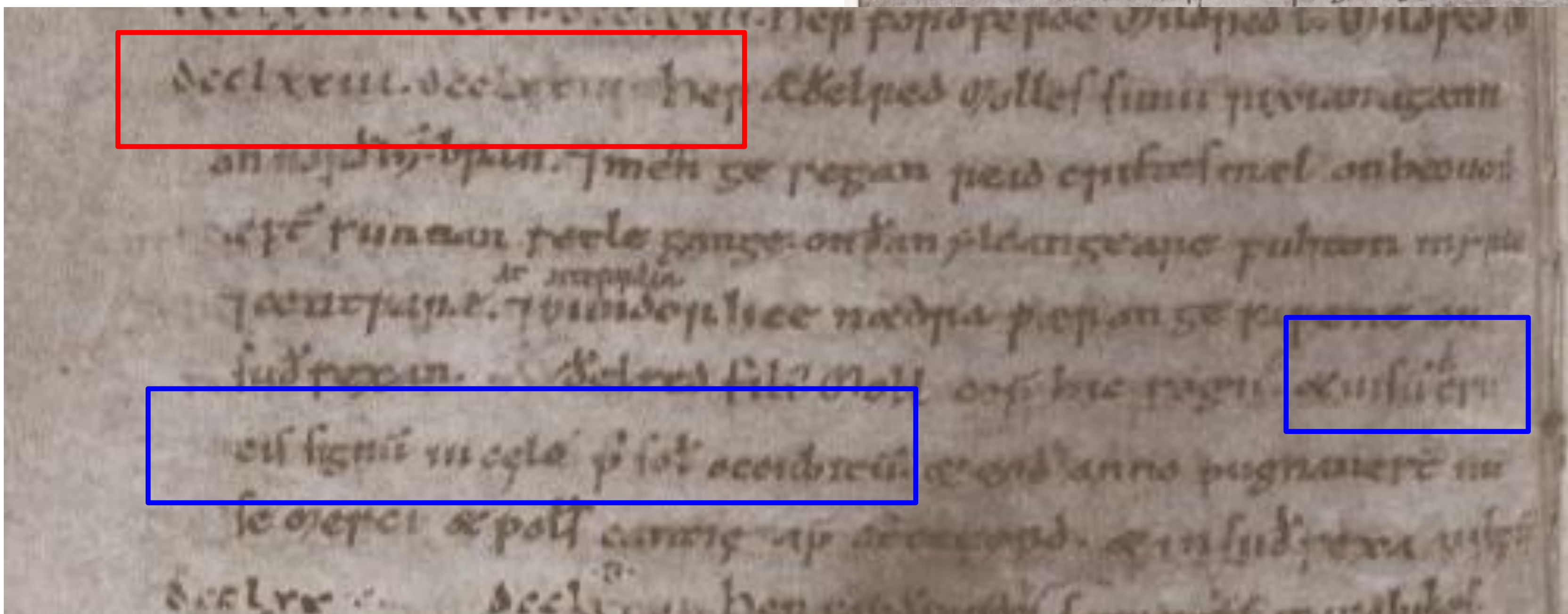


Frankenreich im Jahr 768
Erwerbungen Karls d. Gr.
Grenzmarken
Fränkisches Einflussgebiet
Karolingische Pfalzen
Verkehrs- und Handelswege
Nordsee
Mittelmeer
Tyrrhenisches Meer
Adria
Lincoln
MERCIA
Leicester
WALES
Dunwich
London
WESSEX
Exeter
Canterbury
Bretagne
BRETON. MARK
Noirmoutier
Friesland
Abodriten
Rerik
Bardowiek
Bremen
Verden
SACHSEN
Elbe
Heveller
Osnabrück
Minden
Münster
Hildesheim
Magdeburg
Utrecht
Dorestad
Nimwegen
Xanten
Werden
Essen
Dortmund
Paderborn
Eresburg
Halberstadt
Halle
Sorben
SORB. MARK
Oder
Boulogne
Gent
Maastricht
St. Omer
Quentowik
Herstal
Aachen
Köln
Lüttich
St. Riquier
Cambrai
Hersfeld
Fulda
AUSTRIEN
Koblenz
Salz
St. Wandrille-Fontenelle
Rouen
Mainz
Frankfurt
Trebur
Ingelheim
Hallstadt
Prag
Lisieux
Quierzy
Compiègne
Soissons
Attigny
Trier
Worms
Lorsch
Würzburg
Forchheim
Böhmen
Ver
St. Denis
Chelles
Paris
Reims
Speyer
Jablunkapass
Metz
FRANZIEN
Seine
Eichstätt
Mähren
Brünn
Le Mans
Orléans
Sens
Troyes
Straßburg
Rhein
Donau
Regensburg
Angers
Germigny-des-Prés
Auxerre
Freising
Passau
Tours
Mittelzell (Reichenau)
Mattsee
Kremsmünster
Mautern
Wessobrunn
Salzburg
Bourges
Konstanz
Poitiers
Chasseneuil
Nevers
Besançon
Basel
Zürich
St. Gallen
PANNONIEN
Chalon
Einsiedeln
Brenner
Innichen
KARANTANIEN
Loire
BURGUND
Angeac
Mornac
Angoulême
Genf
Lyon
Gr. St. Bernhard
Trient
Cividale
Aquileja
Grado
AQUITANIEN
Bordeaux
Mt. Cenis
Vercelli
Ivrea
Mailand
Pavia
Verona
Venedig
Drau
Novalese
Turin
Po
Piacenza
Save
KGR. ASTURIEN
KGR. ITALIEN
Rhône
Gascogne
Genua
Avignon
Bologna
Ravenna
Toulouse
Roncesvalles
Aniane
Gellone
Arles
Burgos
Lucca
Rimini
Zara
Pamplona
Provence
Florenz
Narbonne
Spalato
Ebro
SPANISCHE MARK
Septimanien
Marseille
Tudela
PATRIMONIUM S. PETRI
Spoleto
Hzm. Spoleto
Zaragoza
Ragusa
Korsika
San Andrea al M. Soratte
EMIRAT VON CORDOBA
Tarragona
Barcelona
Rom
Tajo
Monte Cassino
Toledo
Capua
Benevent
Bari
0
100
200 km
Sardinien
Neapel
HZM. BENEVENT
Brindisi

A red crucifix after sunset ?

Anglo-Saxon Chronicle:
„This year also appeared
in the heavens a red crucifix,
after sunset.“





773. 774 …

… & … cru-
cis signum in coelo p(ost) sol occidirum …

old english: „Her ooeowde read Cristes mael on heofonum aefter sunnansetlgange“

new english: „And also a red cross/crucifix on sky after sunset“

A red crucifix after sunset ?

Anglo-Saxon Chronicle:
„This year also appeared
in the heavens a red crucifix,
after sunset.“

Suggested as absorbed supernova for AD 774 in a *Correspondence to Nature* by J.Allen (2012)

Presumably for AD 774 (Allen)

„cross“ or „crucifix“ cannot be a supernova, because:

(1) extended / resolved object would be at least 18“ (naked eye), at 5000 to 50,000 km/s a few days within explosion still within few pc, then a mass extinction level event on Earth (excluded).

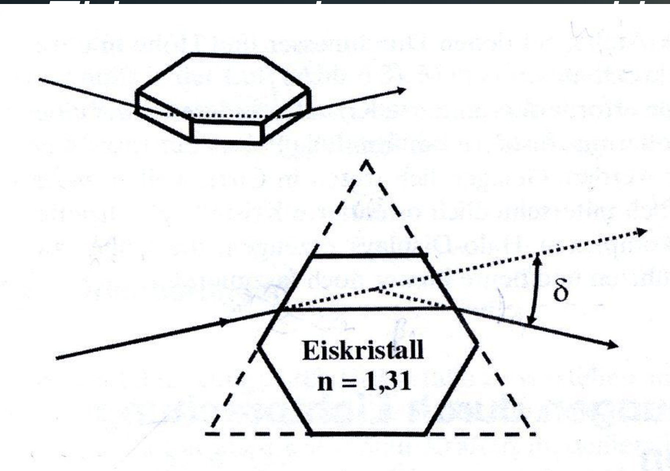
(2) Historic SNe never observed for only one evening.

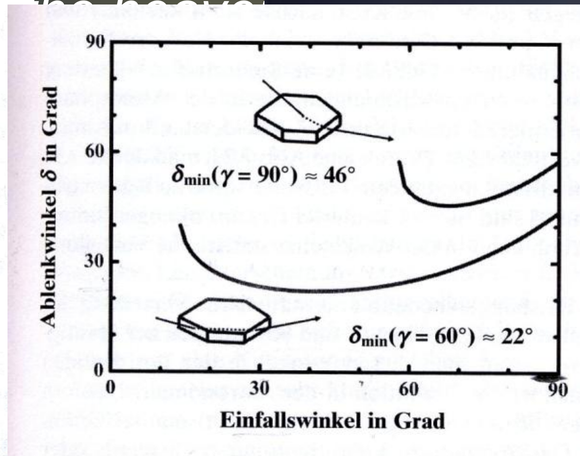
(3) Given observed energy in AD 774/5 (7e24 erg at Earth) and typical SNe (1e51 erg), a SN would be at 120 pc (or at 260 pc, if over-luminous).

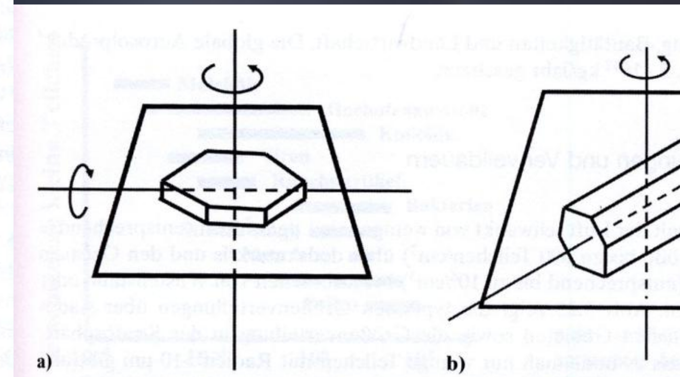
(4) Even if behind strong extinction, SN remnant would be visible today as strong X-ray, γ-ray, radio, and Hα source.

Etc. etc.

Anglo-Saxon Chronicle:







Red Cross: Parhelion with horizontal arc, sun-dogs, and vertical pillar (or paraselene if really *after sunset*)

Image © National Geographic

„774. This year also appeared in the heavens a **red** crucifix, after sunset;
the Mercians and the men of Kent fought at Otford;
and wonderful serpents [marvellous adders] were seen
in the land of the South-Saxons."

Aurora? (Gibbons & Werner, Usoskin et al., Zhou et al.)

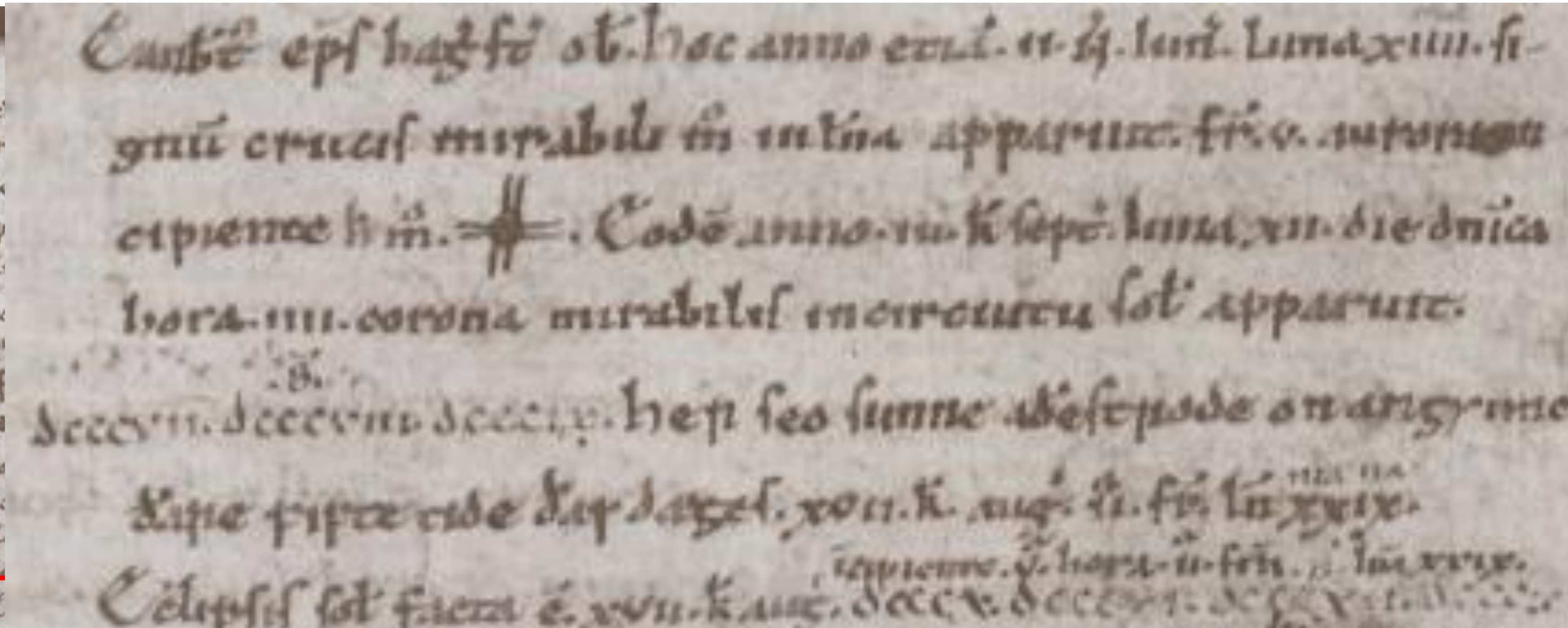
Airglow nach Gammablitz? (Harald Lesch)

Supernova? (Allen, Firestone)

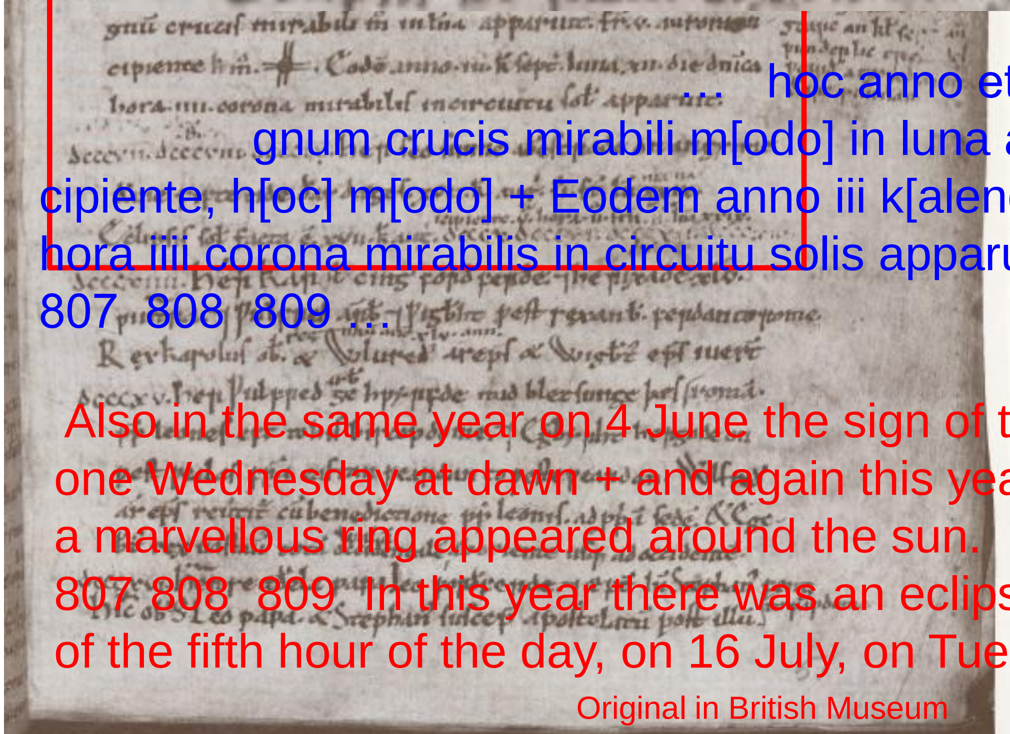
Dating: 776 [774, 773]

Aurora previously also according to
Jeremiah (1870), Johnson (1880)
Schöning (1760), Lowe (1870), Fritz (1873) [„rubea signa"]
Link (1962), Silverman (online)

As Halo: Newton (1972)



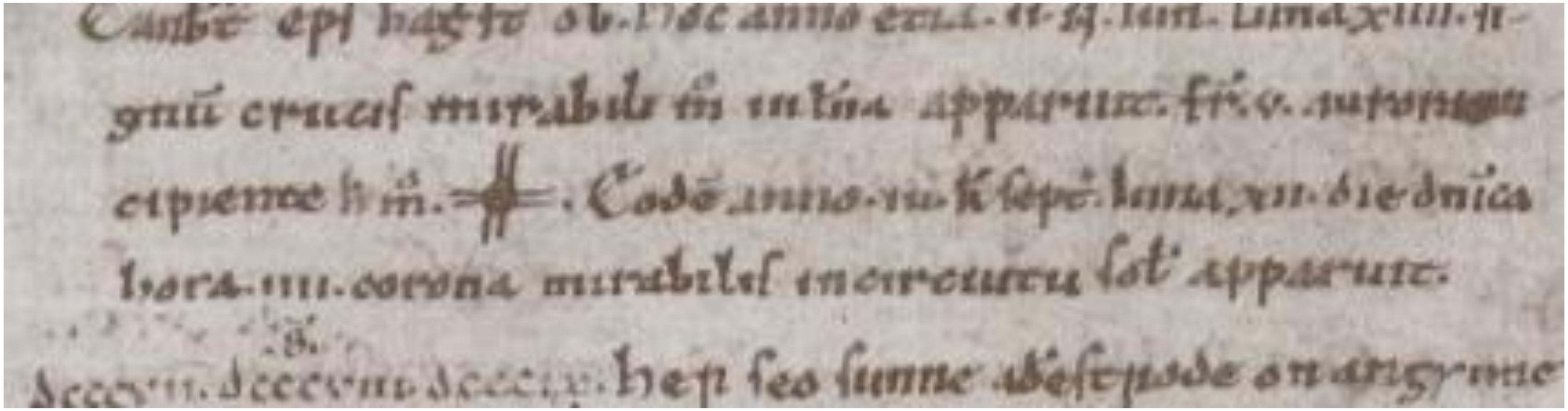
… hoc anno etiam ii n[onas] Iunii luna xiiii si-
gnum crucis mirabili m[odo] in luna apparuit f[e]r[ia] v aurora in-
cipiente, h[oc] m[odo] + Eodem anno iii k[alendas] sept[embris] luna xii die d[omi]nica
hora iiii corona mirabilis in circuitu solis apparuit.
807 808 809 …

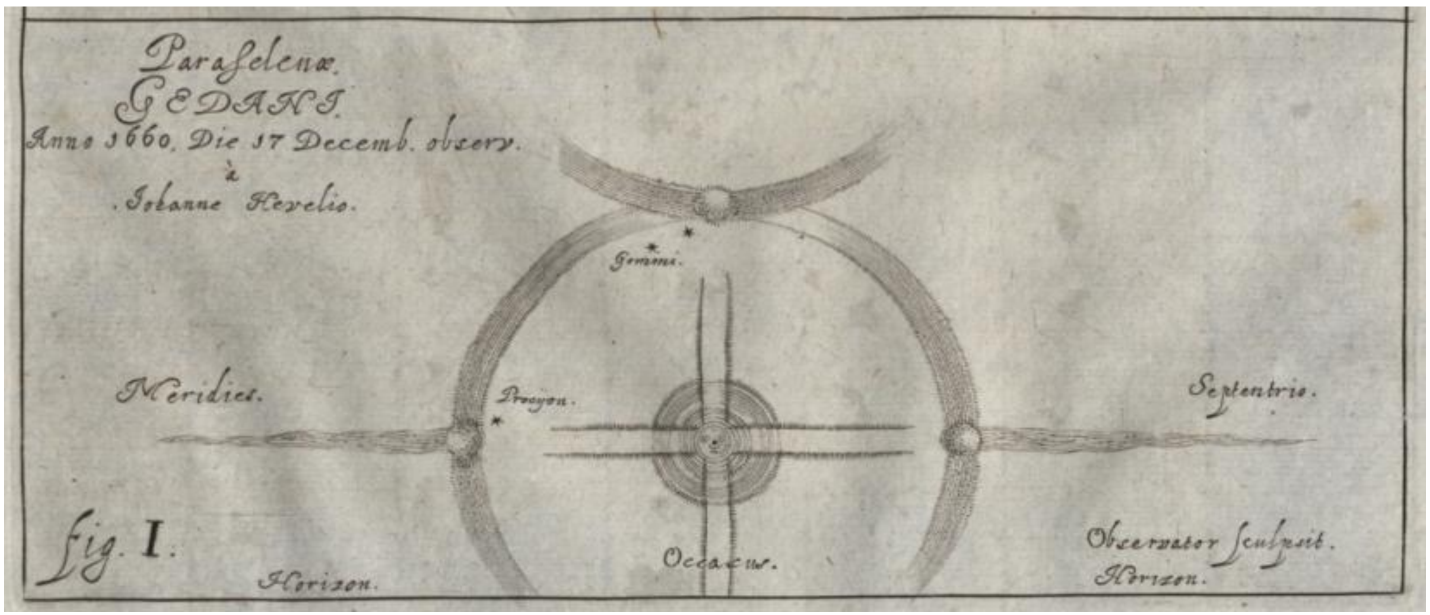


Also in the same year on 4 June the sign of the holy cross appeared in the moon
one Wednesday at dawn + and again this year on Sunday, 30 August,
a marvellous ring appeared around the sun.
807 808 809 In this year there was an eclipse of the sun at the beginning
of the fifth hour of the day, on 16 July, on Tuesday, the 29th day of the moon.

Original in British Museum

4 June 806 **cross around Moon** [full moon 4/5 June]





Hevelius (1662): 17 December 1660 „**über den echten Mond** selbst [breitete sich] – was äußerst selten ist – ein überaus großes, … silberfarbenes **Kreuz** aus. Es war so sehr glänzend und lichtvoll, dass es selbst bis zum Aufgang der Sonne deutlich … strahlte.“

TABLE A.IX-1

METEOROLOGICAL REPORTS FROM THE BRITISH ISLES

Date	Source, Events, Comments
762	Ulster, great snow
776	Anglo-Saxon Chronicle, red cross in sky after sunset
806 Jun 4	Domitiani Latini, cross about the moon, gives a drawing. Near dawn.
806 Aug 30	Domitiani Latini, halo around the sun at the 4th hour
909 May 6	Scotorum, two suns
969	Four Masters, two equal suns
1014 Sep 28	Anglo-Saxon Chronicle, Domitiani Latini, sea destroyed many villages in England
1072	Worcester, severe cold
1089	William of Malmesbury [ca. 1125], bad harvest
1091 Oct 17	William of Malmesbury [ca. 1125], storm blew off the roof of Bow Church in London
1092	William of Malmesbury [ca. 1125], Salisbury Cathedral struck by lightning on S. Osmund's Day
1092 and 1093	Four Masters, great snow and cold both years
1093	William of Malmesbury [ca. 1125], bad floods and ice
1094	William of Malmesbury [ca. 1125], crops failed with ensuing famine
1097 Sep 29	Florence, cross in the sky

TABLE A.IX-1 (Continued)

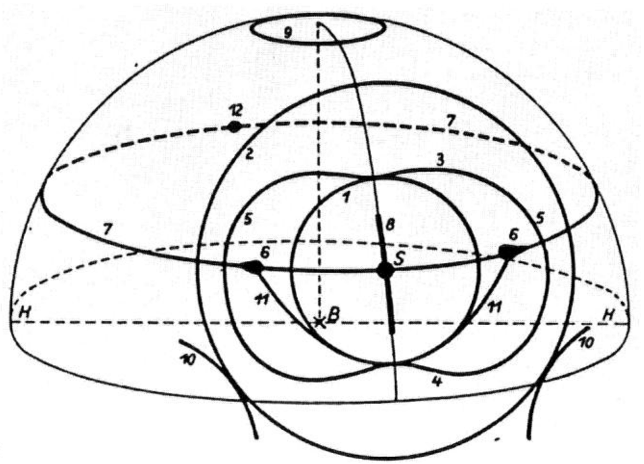
Date	Source, Events, Comments
1099 Nov 3	Anglo-Saxon Chronicle and Melrose, probably a tidal wave with many drowned; William [ca. 1125] has a flood in the Thames in 1099.
1104 Jun 7	Ralph of Coggeshall, many circles around sun; Matthew Paris says 4.
1105 or 1106	Wykes and Florence respectively; two full moons seen on Holy Thursday
1114 Oct 10	Eadmer, extremely low tide in Medway and Thames
1156 Oct	Wykes, cross about the moon
1164 Sep 18	Wykes, 3 circles around the sun at the 9th hour; they disappeared and soon 2 suns appeared.
1172 Dec 25	Diceto, Ralph of Coggeshall, tremendous thunderstorm
1177 Dec 1	Diceto, damaging windstorm
1178 Jan 12	Waverley, great flood in Holland
1179 Jan 7	Gervase, great storm
1184 Feb 1	Wykes, thunderstorm
1191	Wykes, sign of the cross with a crucified figure on it
1200	Matthew Paris, dated "before Christmas", 5 moons
1201 Aug	Wykes, flooding
1205	Worcester, I believe in December, two full moons seen in the daytime
1208 May	Wendover, 3 crosses in the sky seen in Holland
1217 Apr 26	Worcester, 2 suns

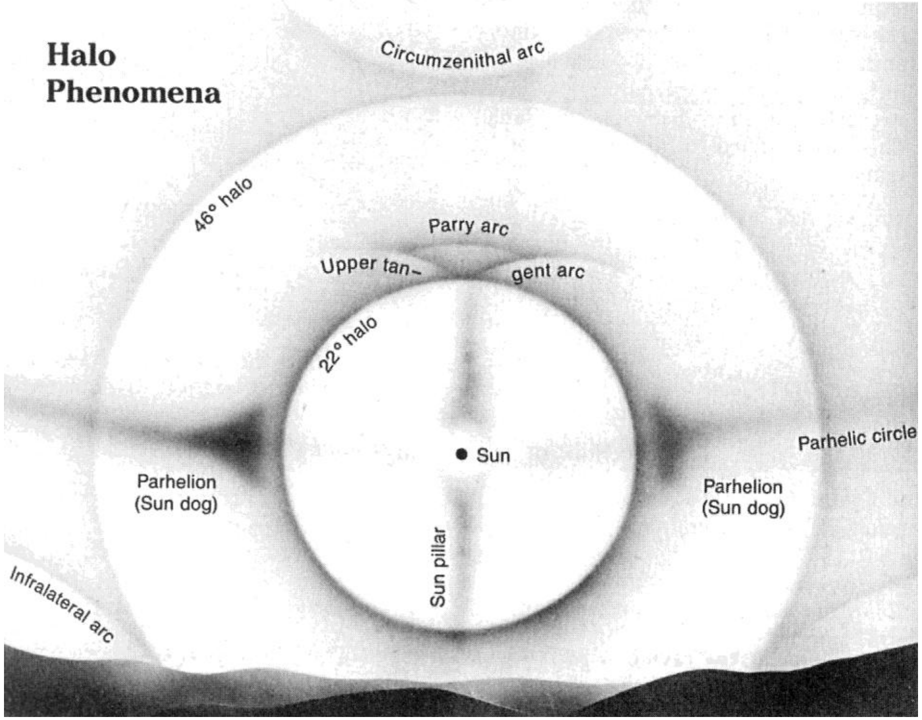
Newton (1972) lists six such sightings from AD 776 to 1208

Parhelion bei der Sonne

(bzw. Paraselene bei Mond):

Eiskristalle
reflektieren und brechen
Sonnenlicht
in der Luft bzw. in Zirruswolken



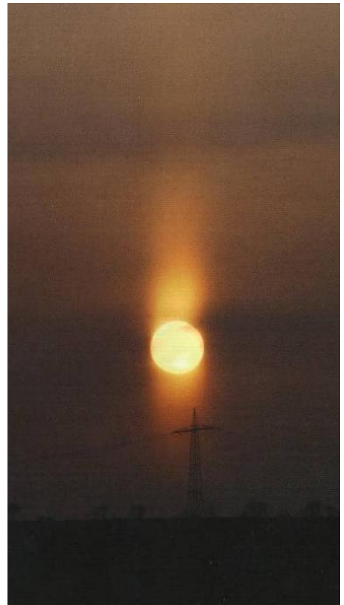


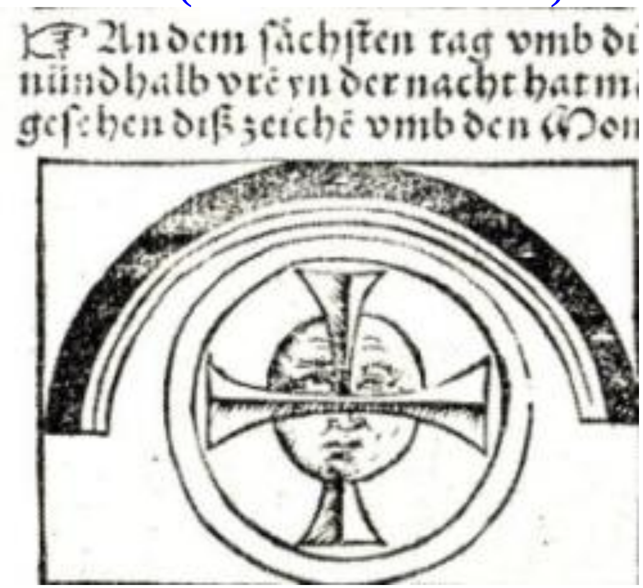
Crusius, Annales Suevicae III (Latin):

18. Jan. 1529: „Vier Kometen erschienen, entgegengesetzt ausgerichtet, mit Schweifen in die vier Himmelsrichtungen zeigend.“

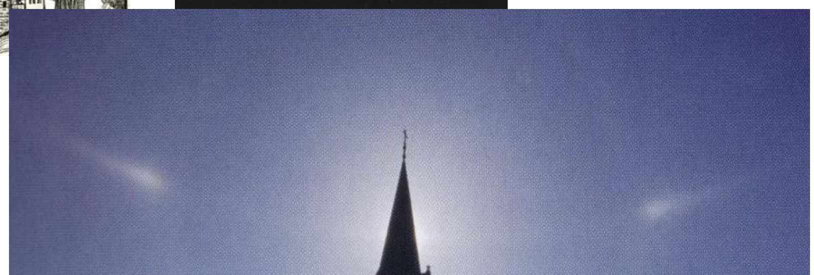
(Link 1962: Aurora)

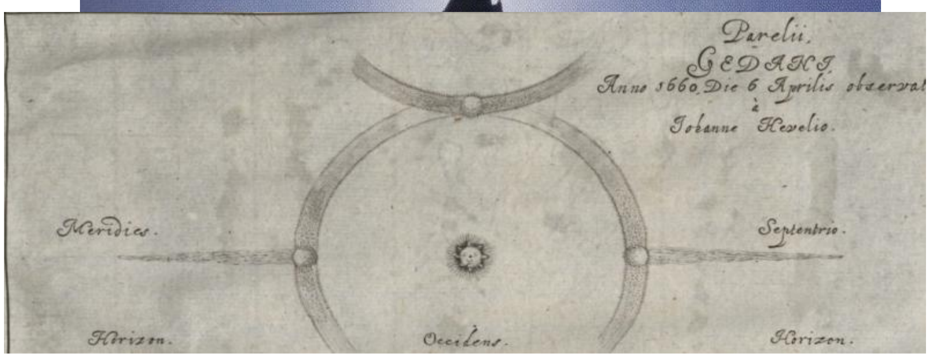
Halo-Phänomen
Lichtsäule
(60 x pro Jahr)





6. Apr. 1660
Hevelius, Polen:
„drei Sonnen, zusammen mit der wahren, mit langen weißen Schweifen von der Sonne weggerichtet …“





Halo-Phänomene werden z.T. als „cometes“ bzw. „Komet“ bezeichnet !

Moon bow (lunar rainbow)
over Kihei, Maui, Hawaii

**„The moon bow is very rare …
have seen it only twice in my life.“
(Aristotle, Meteorology)**

How would you call these phenomena?

Two birds … flying

… landing?

a giant

Dragon

Angel

Fire sword

Parhelion Sichtung AD 310 durch Konstantin I.
(Weiß 1993, Giradet 2010)

Eusebius, Vita des Kaisers Konstantin I.:
… als der Tag bereits sich zu neigen begann, habe er [Kostantin] mit eigenen Augen gesehen, wie er sagte, dass am Himmel das Siegeszeichen des **Kreuzes**, das aus Licht bestand, die Sonne überlagerte …
Staunen habe ihn über das Schauspiel da ergriffen ebenso wie das gesamte Heer.

Bald danach gewann Konstantin eine wichtige Schlacht und wurde zum Alleinherrscher (des Westens) und förderte das Christentum.

Anglo-Saxon Chronicle (ASC):

medieval English on asc.jebbo.co.uk/b/b-L.html

modern English in Garmonsway (1953) or Whitelock (1979)

compiled under King Alfred of Wessex (King AD 871-899) in AD 890/1
based on at least eight (otherwise lost) sources
and then continued until AD 977 to 1153

originally started with Easter tables

six major versions (different copies) available
(manuscripts A to E in English, F bilingual Latin-English, almost identical to E)

year mostly starts on Dec 25 (Christmas day),
in particular before AD 725 and after AD 955,

or on Sep 24 preceding Jan 1, e.g. the solar eclipse of AD 878 Oct 29 is listed
under AD 879, because the author ended the year AD 878 on Sep 23.

Start of the year:

Mar 25 preceeding Jan 1 (Annunciation Stylus Pisanus)

Jan 1 (Roman civil year)

Roman Easter (in Roman-Christian Europe, until AD 800),

Greek/Byzantine Easter (for orthodox-Christian areas),

Sep 1 (Greek or Byzantine Indication date),

Sep 24 preceeding Jan 1 (Caesarean Indication date),

Dec 25 (Christmas day, since AD 800 / 801),

Mar 25 following Jan 1 (Annunciation Stylus Florentinus),

New moon 12 lunar month after the last start of a new (lunar) year (in arabic/muslim areas)

Etc.

More calendar issues:

(days given backwards counted inclusively)

Nonae: 7th day of March, May, July, and October
(months which had 31 days already in the late pre-Julian Roman republican calendar),
but 5th day of the other months

Idus: 15th day of March, May, July, and October and the 13th day of the other months,

Kalendae: (English: calends) for the 1st day and 2nd half of the months

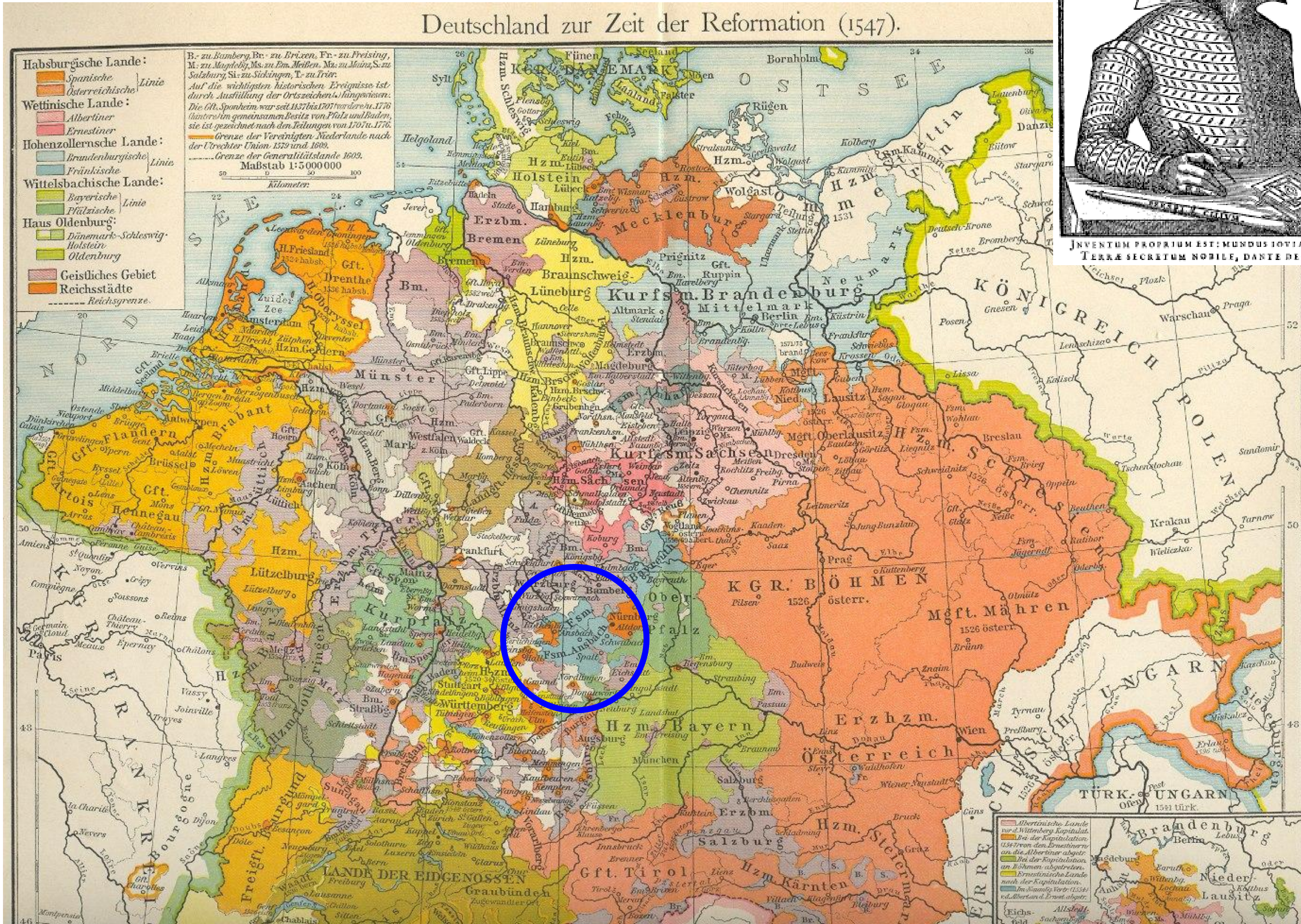
e.g. 5th calends June = 28 May

➔**24-hour day** = first 12 hours dark night, then 12 **sun-dial** hours bright day

➔ **leap day:** dies bi-sextus (following 24 Feb)

➔**Julian** calendar until 15 Oct 1582, then jump by 10 days to **Gregorian** calendar

Simon Marius (1573 -1624, Ansbach): bei Markgraf von Brandenburg-Ansbach



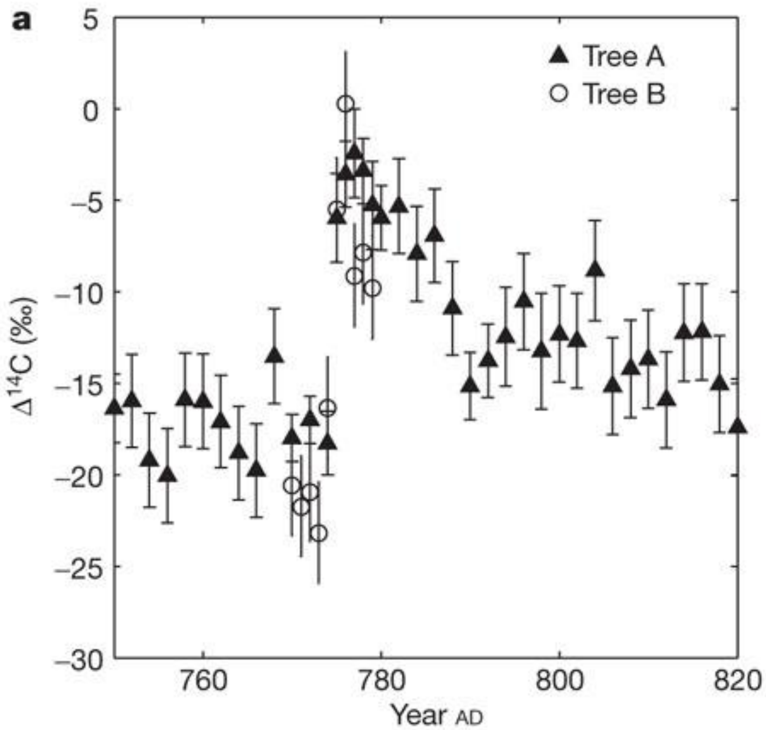
Was war die Ursache ?

Supernova (ernsthaft) ?

Gamma-ray burst ?

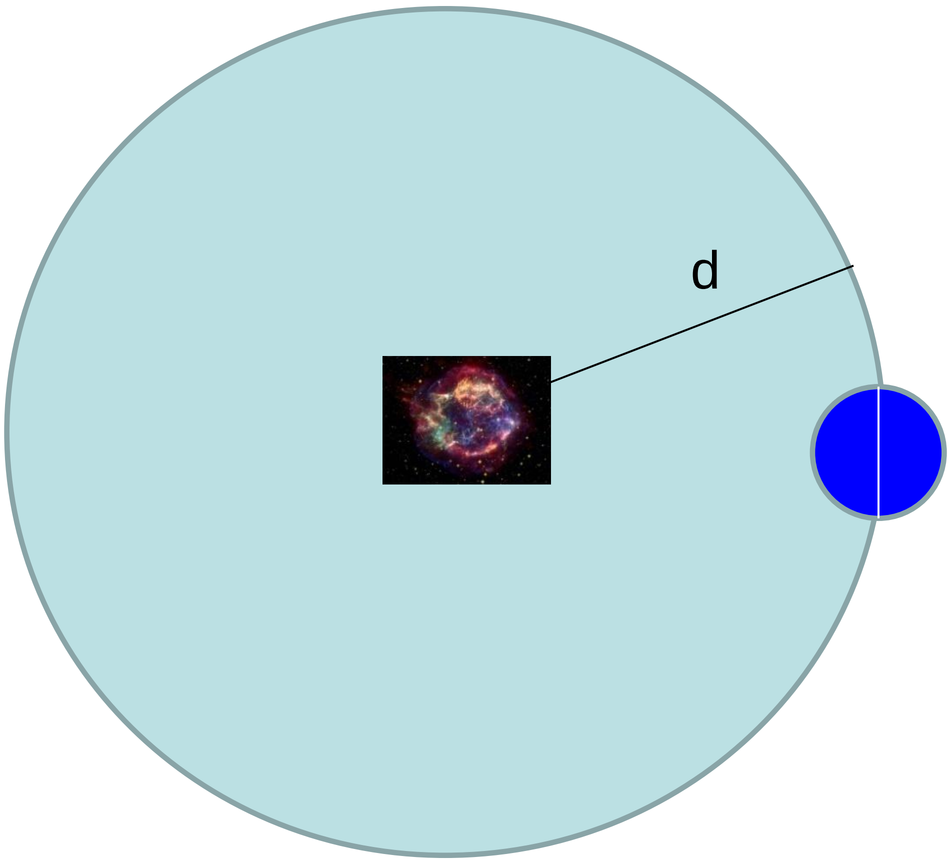
Sonnen-Flare ?

Sonstwas ?
(Komenteneinschlag, Magnetfeldschwankung, Vulkanausbruch, etc.)



Miyake et al. 2012

A supernova ?



SN at distance d
between event and Earth

Energy E(event) to spread
homogeneous to surface area
of sphere around event

$$4 \cdot \pi \cdot d^2$$

We have to multiply
SN output E(event) = 1e51 erg
by g = 0.01 for gamma-rays.

$$\frac{E_{\mathrm{event}} \cdot g}{E_{\mathrm{obs}}} = \frac{4 \cdot \pi \cdot d^2}{\pi \cdot R^2}$$

E(obs) = 7e24 erg in AD 774/5

A supernova ?

$$\frac{E_{\text{event}} \cdot g}{E_{\text{obs}}} = \frac{4 \cdot \pi \cdot d^2}{\pi \cdot R^2}$$

For E(obs) = 7e24 erg as in AD 774/5,

and for E(event) = 1e51 with g=0.01 (supernova),

it would have to happen at **d = 124 pc**

Any SN sighting around AD 774/5 ?

Any young SN remnant that close ?

Any young neutron star that close ?

Historische Supernovae (~2000 Jahre)

Table 1 Historic supernovae in the last 2000 yr. There are several Galactic historic SN sightings since 185 (sorted here by time), but no SN sighting within 200 yr around AD 774/5. This listing shows that SNe were observed before and after the AD 774/5 event. Also, the SNRs Vela Jr and Cas A are listed, because they were considered in M12 to be possibly related to the AD 774/5 event; at the end of the table, we list six more SNRs, which should be related to recent SNe given the ages of the pulsars and/or SNRs; however, all those eight SNRs are all too distant for the AD 774/5 event (if that were a normal SN at ∼ 124 pc); Vela Jr is too young given its expansion velocity.

SN	Location	Ext. Av	Peak magnitude		Supernova remnant				Neutron star				SN type
Year	δ [°]	[mag]	hist.	Equ. (3)	G name	d [kpc]	age [kyr]	Ref	name	d [kpc]	age [kyr]	Ref	& Ref.
185 ?	Cen −59	6.3(3.2)[1]	−8(2)[2]	−3 to 8	320.4-1.2	5.0(1.6)	1.7-20	1,3	1513-5908	3.3-8.4	≤ 1.56	3-5	cc(?),2,(a)
369 ?	(b) ∼ 65		≤ 2[6]										?,6
386	Sgr −19	8.7(3.4)[7,8]	∼ 2[9]	0 to 10	11.2-0.3	5.0(6)	0.4-3.4	10-15	1811-1925		≤ 23.3	16,17	II,16-18
393	Sco −39	3.9(2.4)[19]	−1(1)[20,21]	−8 to 2	347.3-0.5	1.4(5)	1.6-9.0	19-23	CCO (c)			(c)	cc(?),(c)
1006	Lup −42	0.32(3)[2]	−7.5[24]	−8 to −7	327.6+14.6	2.18(8)		24-26	none				Ia,(d),27
1054	Tau +22	∼ 1.1[28]	−4.8[28]	−7 to −3	184.6-5.8	2.0(5)	0.953 (21)	29-31	0534+2200	2.0-2.5	≤ 1.24	32,33,115	II,Crab,32
1181	Cas +64	1.3(0.2)[34]	∼ 0.7[2]	−6 to −2	130.7+3.1	2.9(3)	0.8-7.0	34-37	0205+6449	3.2-7.5	≤ 5.37	33-39	II,2,40,41
1572	Cas +65	2.25(16)[2]	−4.5[2]	−6 to −5	120.1+1.4	2.25(16)	∼ 441	2,42	none	(Tycho's SN)			Ia,43
1604	Oph −20	3.27(14)[2]	−3.0[2,9,44]	−3 to −4	4.5+6.8	3.4(3)	∼ 409	2,45	none	(Kepler's SN)			Ia,(e)
Other young SNRs considered in Miyake et al. 2012													
∼ 1300	Vel −46	1.63(98)[46]		−12 to −3	266.2-1.2	0.20 - 1	0.4-4.3	47-50	CCO	(Vela Jr)		(f)	cc(?),47,48
∼ 1680	Cas +58	11.6(2.6)[49]	(g)	3 to 11	111.7-2.1	$3.5^{+0.3}_{-0.1}$	∼ 333	51,52	CCO	(Cas A)		53	IIb,54

~ 9 + 2 historische Supernovae seit ~2000 Jahren

(alle innerhalb von 5 kpc):

9 beobachtet in China (z.T. zudem in Korea und Japan),

3 beobachtet in Europa (SN 1006, Tycho 1572, Kepler 1604),

4 beobachtet in Arabien (SN 1006, 1054, 1572, 1604),

+ 2 ggf. gar nicht bemerkt: Vel Jr. und Cas A (?)

Supernova ?

E(obs) = 7e24 erg in AD 774/5,
E(event) = 1e51 erg mit 1% gamma (Supernova),
dann Entfernung d = 124 pc

Table 1 Historic supernovae in the last 2000 yr. There are several Galactic historic SN sightings since 185 (sorted here by time), but no SN sighting within 200 yr around AD 774/5. This listing shows that SNe were observed before and after the AD 774/5 event. Also, the SNRs Vela Jr and Cas A are listed, because they were considered in M12 to be possibly related to the AD 774/5 event; at the end of the table, we list six more SNRs, which should be related to recent SNe given the ages of the pulsars and/or SNRs; however, all those eight SNRs are all too distant for the AD 774/5 event (if that were a normal SN at ~ 124 pc); Vela Jr is too young given its expansion velocity.

SN	Location	Ext. Av	Peak magnitude		Supernova remnant				Neutron star				SN type
Year	δ [°]	[mag]	hist.	Equ. (3)	G name	d [kpc]	age [kyr]	Ref	name	d [kpc]	age [kyr]	Ref	& Ref.
185 ?	Cen −59	6.3(3.2)[1]	−8(2)[2]	−3 to 8	320.4-1.2	5.0(1.6)	1.7-20	1,3	1513-5908	3.3-8.4	≤ 1.56	3-5	cc(?),2,(a)
369 ?	(b) ~ 65		≤ 2[6]										?,6
386	Sgr −19	8.7(3.4)[7,8]	~ 2[9]	0 to 10	11.2-0.3	5.0(6)	0.4-3.4	10-15	1811-1925		≤ 23.3	16,17	II,16-18
393	Sco −39	3.9(2.4)[19]	−1(1)[20,21]	−8 to 2	347.3-0.5	1.4(5)	1.6-9.0	19-23	CCO (c)			(c)	cc(?),(c)
1006	Lup −42	0.32(3)[2]	−7.5[24]	−8 to −7	327.6+14.6	2.18(8)		24-26	none				Ia,(d),27
1054	Tau +22	~ 1.1[28]	−4.8[28]	−7 to −3	184.6-5.8	2.0(5)	0.953 (21)	29-31	0534+2200	2.0-2.5	≤ 1.24	32,33,115	II,Crab,32
1181	Cas +64	1.3(0.2)[34]	~ 0.7[2]	−6 to −2	130.7+3.1	2.9(3)	0.8-7.0	34-37	0205+6449	3.2-7.5	≤ 5.37	33-39	II,2,40,41
1572	Cas +65	2.25(16)[2]	−4.5[2]	−6 to −5	120.1+1.4	2.25(16)	~ 441	2,42	none	(Tycho's SN)			Ia,43
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~ 1680	Cas +58	11.6(2.6)[49]	(g)	3 to 11	111.7-2.1	$3.5^{+0.3}_{-0.1}$	~ 333	51,52	CCO	(Cas A)		53	IIb,54

Keine nahe historische Supernova vor ~ 1240 Jahren.
Und keine historische SN so nah !

Neutron Stars ?

Not sufficiently young and at the same time sufficiently nearby

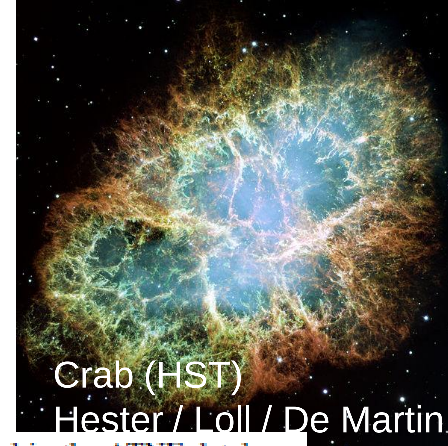


Table 3 Young neutron stars. All known neutron stars with characteristic age younger than 2500 yr found in the ATNF database (Manchester et al. 2005) or other literature plus those neutron stars mentioned in Tables 1 and 2 or possibly be related to historic SNe and/or young SNRs, sorted by right ascension. None of them can be related to the AD 774/5 event, if it was a normal SN at ~ 124 to 260 pc: All of them are too distant (for the pulsars with unknown distances, the SNRs distance is given, also too far away), some of them are also too young.

Name J2000.0	Ref	Period P [s]	P-dot [s/s]	Ref	Distance [kpc]	Ref	SNR	Ref	Age (a) [yr]	Remarks
J0205+6449	38	0.0657	1.9e-13	38,39	3.2-7.5	33	G130.7+3.1	36	5370	SN 1181
J0525-6607	145	8.0470	6.5e-11	146	48	147	N49	147	1960	in LMC
J0534+2200	32	0.0331	4.2e-13	115	2.0-2.5	33	Crab	30	1240	SN 1054
J0540-6919	148	0.0505	4.8e-13	149	48.1	33	G279.7-31.5	150	1670	in LMC
J0855-4644	151	0.0647	7.3e-15	151	0.3-10	151,152	Vela Jr ?	152	141000	152
J1119-6127	57	0.408	4.0e-12	59	2.4-8	57	G292.2-0.5	58	1610	
J1124-5916	121	0.1355	7.5e-13	153	1.2-8	154	G292.0+1.8	121	2850	
J1513-5908	4	0.1516	1.5e-12	5	3.3-8.4	3	G320.4-1.2	4	1560	SN 185 ?
J1550-5418	61	2.0698	2.3e-11	61	4 or 9	60,61	G327.2-0.1	60	1410	AXP
J1617-5055	156	0.0694	1.35e-13	156	6.46	58,148	G332.4-0.4	129	8130	
J1627-41	157	2.5945	1.9e-11	136	11	132	G337.0-0.1	134,135	2200	SGR
J1714-3810	142	3.8	6.40e-11	142	7-14	142	G348.7+0.3	100	950	AXP
J1808-2024	158	7.5559	5-8e-10	159,161	7-18.6	160,162			160-218	SGR
J1811-1925	16	0.0647	4.4e-14	17	4.4-6.6 (b)	11,12	G11.2-0.3	16	23300	SN 386
J1813-1749	84	0.0447	1.5e-13	84	4-4.5 (b)	82,83	G12.8-0.0	82	4600	
J1833-1034	164	0.0619	2.0e-13	90	3.3-4.4	33,165	G21.5-0.9	89,164	4850	
J1841-0456	95	11.7789	4.5e-11	97	7.5-10.6	92	G27.4+0.0	95	4180	AXP
J1846-0258	164	0.3266	7.1e-12	75	~ 6	71	G29.7-0.3	71	723	Kes 75
J1907+0919	65	5.1689	7.8e-11	66	5-7.7 (b)	63,64	G42.8+0.6	64	1050	SGR
J1930+1852	109	0.1369	7.5e-13	109	3.2-13.2	109,110	G54.1+0.3	111	2900	

Young nearby SN remnant ?

For E(obs) = 7e24 erg as in AD 774/5,
and for E(event) = 1e51 with g=0.01 (supernova),
it would have to happen at d = 124 pc

Table 2 **Young Supernova Remnants.** All known Galactic Supernova Remnants (SNRs) with a possible age from ~ 150 to 2000 yr, found in Guseinov et al. (2003a,b) or Green (2009) or considered as counterpart to an historical SN or with a pulsar with characteristic age from ~ 150 to 2000 yr (Table 3) - sorted by galactic longitude. None of them can be related to the AD 774/5 event, even if that would have been a normal SN with SNR, because they are all too distant (and Vela Jr is too young).

Name (Green)	Position α (J2000.0)	δ	Size [']	Distance [kpc]	Ref	SNR Age [yr]	Ref	SN year	Pulsar [yr]	Remarks or Ref.
G0.9+0.1	17:47	-28:09	8	5.9-13	63,76	1000-7000	77			a
G1.9+0.3	17:48	-27:10	1.5	6.9-20	63,78	100-150	78-81			
G4.5+6.8	17:30	-21:29	3	3.1-3.7	2	409		1604		SN Ia,Kepler
G11.2-0.3	18:11	-19:25	4	4.4-5.6	11,12,18,19	400-3400	14,15	386	23300	16,17,b
G12.8-0.0	18:13	-17:49	3	4-4.5	82,83	285-2500	82		4600	82-84
G18.9-1.1	18:29	-12:58	33	2-3.4	63,85	2000-6000	86,87			
G21.5-0.9	18:33	-10:35	4	4.1-5.5	63,88	200-1600	89		4850	90,q
G27.4+0.0	18:41	-04:56	4	6-10.6	63,92,93	500-2700	92-96		4180	Kes73,97,c
G29.7-0.3	18:46	-02:59	3	5.1-7.5	71	700-1000	71-73		723	74,d
G31.9+0.0	18:49	-00:55	7x5	7.2-8.5	98	4000-4600	98			r
G39.2-0.3	19:04	05:28	7	6.0-11.3	99,100	1000-7100	94,101			3C396
G41.1-0.3	19:07	07:08	3.5	6.2-12.8	100-103	600-5300	104-106			3C397,e
G42.8+0.6	19:07	09:05	24	5-7.7	63,64	10000	64		1050	66,f
G43.3-0.2	19:11	09:06	4x3	5.3-9	50,63	700-3000	107,108			W49B
G54.1+0.3	19:30	18:52	1.5	3.2-12	109,110	1500-6000	109		2900	109-111
G74.9+1.2	20:16	37:12	8x6	6.1-12	106,112	3000-5000	113,115			SN BC 532 ? (91)
G111.7-2.1	23:23	58:48	5	3.4-3.8	51	~ 333	52	~ 1680		Cas A,g
G120.1+1.4	00:25	64:09	8	2.09-2.41	2	~ 441		1572		SN Ia,Tycho,43
G130.7+3.1	02:05	64:49	9x5	2.6-3.2	34,35	800-7000	35,37	1181	5370	38
G184.6-5.8	05:34	22:01	7x5	1.5-2.5	29	959	31	1054	1240	115,Crab
G266.2-1.2	08:52	-46:20	120	0.20-1	47,48	420-4300	47-50	~ 1300	CCO	Vela Jr
G291.0-0.1	11:11	-60:38	14	3.5-5.6	63,117,118	1300-10000	117,118		CCO ?	118
G292.2-0.5	11:19	-61:28	20x15	2.4-8.8	55-58	~ 1700	58		1610	57
G292.0+1.8	11:24	-59:16	10	3.7-6.1	(o)	1600-3400	120-124		2850	121,122
G315.4-2.3	14:43	-62:30	42	0.4-3.2	107,125	400-3100	125	185 ?		126,139
G320.4-1.2	15:14	-59:08	35	3.3-6.6	3	1700-20000	1,3	185 ?	1560	4,127,139
G327.2-0.1	15:50	-54:18	5	4-9	60,61	≤ 1410	61		1410	60,61,j
G327.6+14.6	15:02	-41:56	30	2.10-2.26	24	~ 1007	24	1006		SN Ia
G332.4-0.4	16:17	-51:02	10	1.6-4.7	63,125	300-4000	128,129		8130	k
G337.0-0.1	16:35	-47:36	1.5	9.6-11	65,132,135	1000-5000	132		2200	132-136,l
G337.2+0.1	16:35	-47:20	14	5.4-5.6	65,137,138	1000-4600	137,138			
G347.3-0.5	17:13	-39:45	60	0.9-1.9	19-23	1600-9000	19-23	393 ?	CCO	15,22,m
G348.5-0.0	17:15	-38 28	10	≤ 6.3	141			393 ?		141
G348.5+0.1	17:14	-38:32	15	6.3-9.5	141	~ 1500	20	393 ?	CCO	20,CTB37A
G348.7+0.3	17:13	-38:11	17	4.4-13.7	65,100	350-4900	143,144	393 ?	950	142,CTB37B

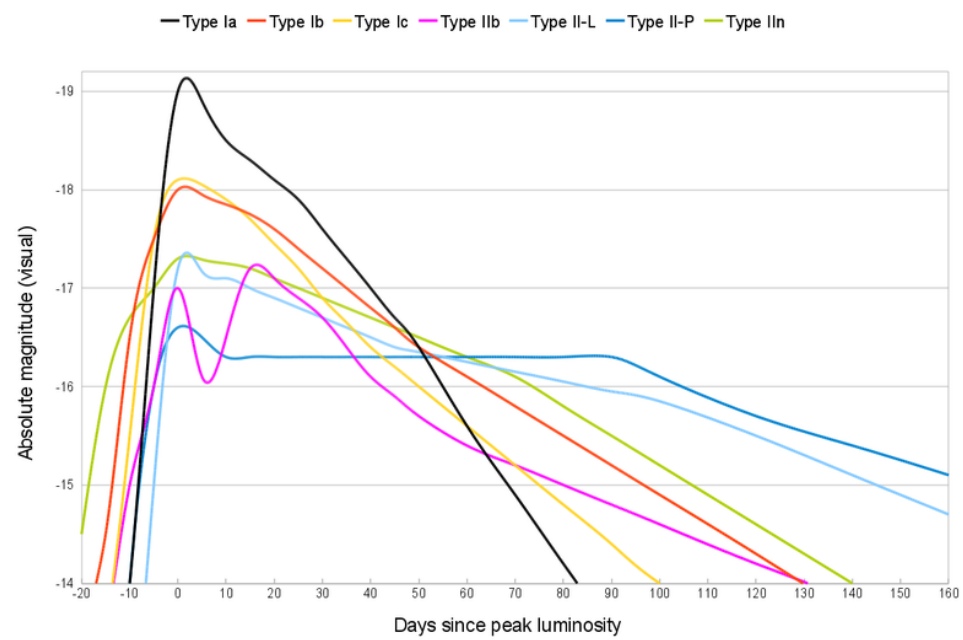
R)

Absorbed supernova ?

For E(obs) = 7e24 erg as in AD 774/5,
and for E(event) = 1e51 with g=0.01 (supernova),
it would have to happen at d = 124 pc

No historical record
due to strong absorption ?

For M = -20.3 (SN Ibc),
or M = -19.5 (SN Ia)
to M = -17 mag (SN II-P)
at 260 to 124 pc,



to avoid historical discovery (brighter than m = 0 or 2 mag),
we need absorption A_V = 13 or 15 mag (at least).

Hambaryan & RN 2013 MNRAS

Absorbed supernova ?

For E(obs) = 7e24 erg as in AD 774/5,
and for E(event) = 1e51 with g=0.01 (supernova),
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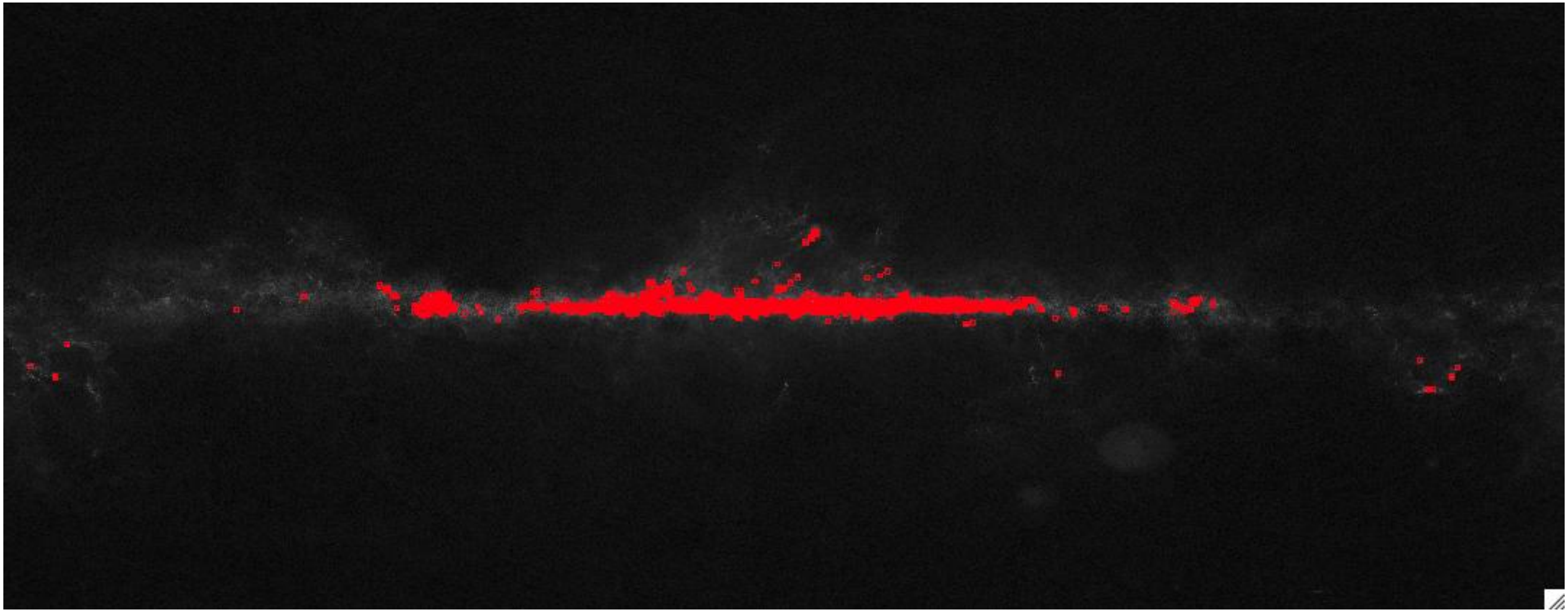
Where on sky absorption A_V = 13 mag ?



Dobashi 2011 PASJ from 2MASS JHK:
56 squ. deg. with A_V of at least 13 mag

For E(obs) = 7e24 erg as in AD 774/5,
and for E(event) = 1e51 with g=0.01 (supernova),
it would have to happen at d = 124 pc

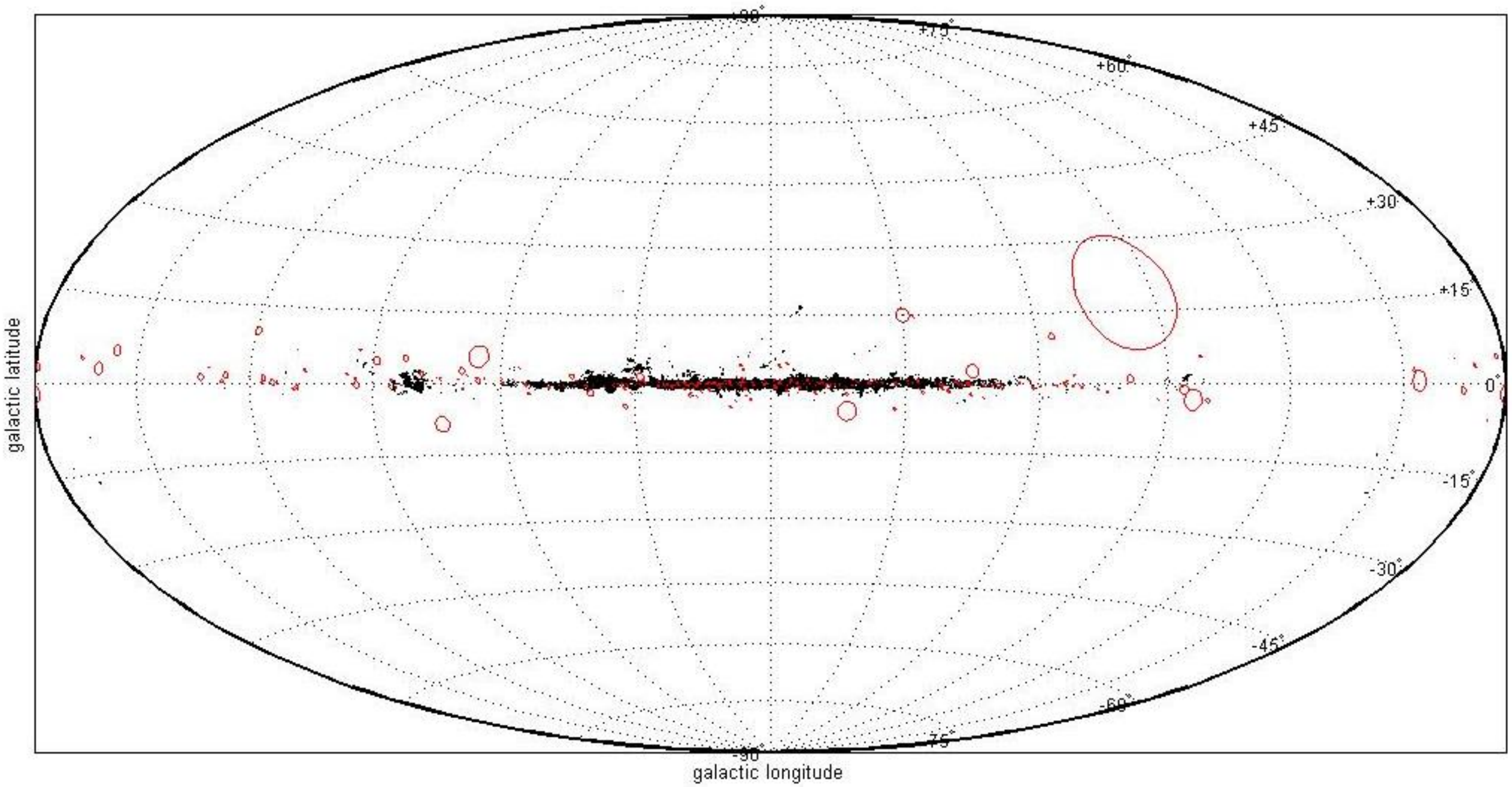
Absorbed supernova ?

Where on sky absorption Av = 13 mag ?

Regions with Av of at least 13 mag …………… Black dots (Dobashi 2011, 2MASS)

but which clouds are within 124 pc ?

SNRs (red circles) would be visible behind strong absorption



Absorbed supernova ?

B68 (Alves et al. 2001 Nat.)

Table 4 **Nearby clouds on the sky with absorption A_V of at least 13 mag.** We list known nearby clouds (as small areas on the sky) with absorption $A_V \geq 13$ mag, first those up to 124 pc, then those outside 124 pc, but up to 260 pc, in each group sorted by right ascension α (J2000.0).

α	δ	Name of cloud(s)	arc min^2	dist [pc]	Ref	α	δ	Name of cloud(s)	arc min^2	dist [pc]	Ref
Clouds with distances up to 124 pc											
15:45:09	-02:52:45	L183	55	110	12	16:26:27	-24:33:16	L1681	4	119	16
16:27:01	-24:34:21	L1686	729	119	16	16:27:58	-24:33:43	ρ Oph H-MM1	1	119	15
16:26:01	-24:26:45	ρ Oph	315	119	4,6	16:32:13	-24:25:04	L1689 B2	155	119	16
						Sum of area for clouds up to 124 pc:			1.57 deg^2		
Clouds with distances above 124 pc, but up to 260 pc											
03:25-44	30.22-30.04	Perseus (b)	937	250	20	16:12:43	-52:15:36	BHR 113	3	200	17
04:13:52	28:13:19	Tau-1 (a)	2	153	11	16:37:28	-35:13:54	BHR 144	13	170	17
04:17:12	27:48:00	L1495 B211	250	153	3	17:04:27	-36:08:24	BHR 149	3	200	17
04:18:28	28:27:16	Tau-4 (a)	1	153	11	17:10:44	-40:31:35	Sc 11	50	150	16
04:18:41	28:17:00	L1495 B10	2800	153	3	17:11:23	-27:25:59	Pipe B59	15	130	1
04:19:15	28:14:36	Tau-6 (a)	1	153	11	17:11:23	-40:37:34	FeSt 2-215	80	150	16
04:21:09	28:02:03	Tau-7 (a)	2	153	11	17:11:39	-40:13:07	Sc 13	65	150	16
04:21:10	27:03:00	L1495 B213	250	153	3	17:21:12	-26:42:00	Pipe Stem E	7	130	2
04:23:34	28:03:01	Tau-8 (a)	1	153	11	17:22:36	-27:04:30	Pipe Stem W	3	130	2
04:24:16	26:36:05	L1495 B216	30	153	3	17:22:36	-23:48:00	Pipe Smoke	1	130	2
04:26:29	28:37:08	Tau-9 (a)	1	153	11	17:22:39	-23:50:04	B68	11000	125	8
04:27:38	26:07:00	L1495 B217	30	153	3	17:28:12	-26:24:00	Pipe Shank	1	130	2
04:28:16	26:19:36	L1495 B218	30	153	3	17:34:00	-25:45:00	Pipe Bowl	110	130	2
04:29:21	28:32:36	Tau-10 (a)	5	153	11	17:35:48	-25:33:02	FeSt 1-457	2	130	5
04:32:09	28:28:39	Tau-11 (a)	1	153	11	18:02:58	-27:52:04	CB 107	1	180	13
04:39:10	26:24:00	TMC 1NW	3	153	14	18:05:55	-18:25:10	CB 110	1	180	9
04:41:20	26:45:00	TMC 1NE	50	153	14	18:15:37	-18:11:58	B92	314	120	16
06:09:49	13:39:23	L1591-3	660	250	16	18:22:45	-01:42:40	CB 134	1	260	9
11:04:00	-77:40:00	Cha I	6	160	22	18:25:39	-11:47:25	LM 271	255	200	16
11:07:07	-62:05:48	BHR 59	13	250	17	18:27:50	-10:13:13	L423	80	200	16
12:31:39	-63:43:43	Coalsack	20000	150	10	18:27:51	-11:27:31	L411	50	200	16
12:43:08	-62:06:02	FeSt2-142	314	150	16	18:30:00	01:12:00	Serpens	126	250	20
12:58:12	-63:19:11	FeSt 1-226	96000	150	16	18:32:32	-08:57:44	B 101	155	200	16
12:58:54	-61:20:17	CoS 7	50	150	16	18:32:53	-09:13:50	CB 147	90	200	16
13:07:40	-77:00:00	DC 303	3	150	19	18:32:46	-09:13:50	L443	530	200	16
13:18:47	-62:41:58	CoS 10	80	150	16	18:39:14	-06:38:21	LM 282	115	200	16
13:19:31	-62:33:26	CoS 12	50	150	16	18:39:18	-06:37:45	L497	255	200	16
15:42:20	-52:49:06	BHR 111	30	250	17	19:00:54	-36:54:00	CrA On-1	50	129	18
16:06:18	-45:55:18	BHR 117	1	250	17	19:01:54	-36:57:08	R CrA	700	129	2
16:09:19	-39:04:49	Lupus 3	60	230	7	19:17:00	-18:01:52	CB 131	1	180	9
						Sum of area for clouds above 124 pc, but up to 260 pc:					

Remarks: (a) Cloud core number from table given in Pineda et al. 2010; (b) range of coordinates given.

References: (1) Roman-Zuniga et al. 2012, (2) Roman-Zuniga et al. 2010, (3) Schmalzl et al. 2010, (4) Lombardi et al. 2008, (5) Aguti et al. 2007, (6) Ridge et al. 2006, (7) Teixeira et al. 2005, (8) Alves et al. 2001, (9) Kandori et al. 2005, (10) Racca et al. 2002, (11) Pineda et al. 2010, (12) Pagani et al. 2004 and priv. comm. with L. Pagani, (13) Campeggio et al. 2004, (14) Malinen et al. 2012, (15) Johnstone et al. 2004, (16) Dutra & Bica 2002, (17) Racca et al. 2009, (18) Juvela et al. 2008, (19) Kainulainen et al. 2007, (20) Sadavoy et al. 2010, (21) Neuhäuser & Forbrich 2008, (22)

Absorbed supernova ?

Where on sky absorptio

For E
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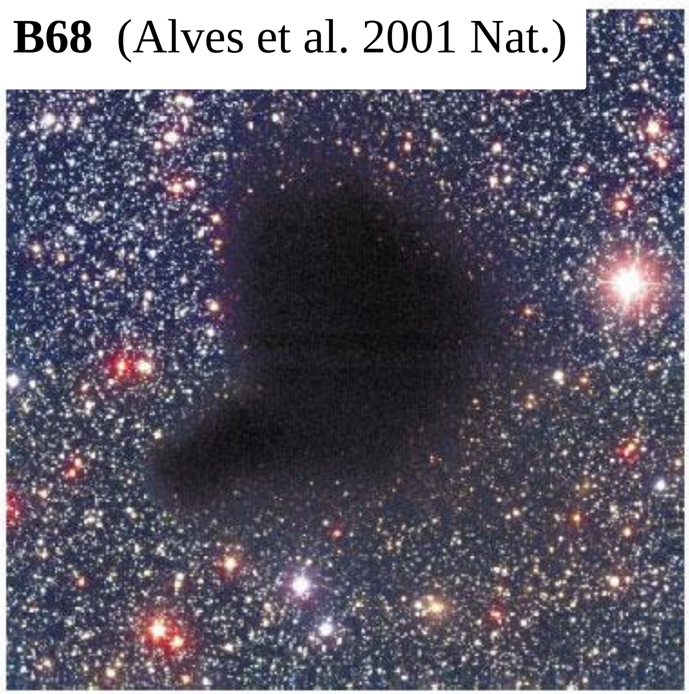
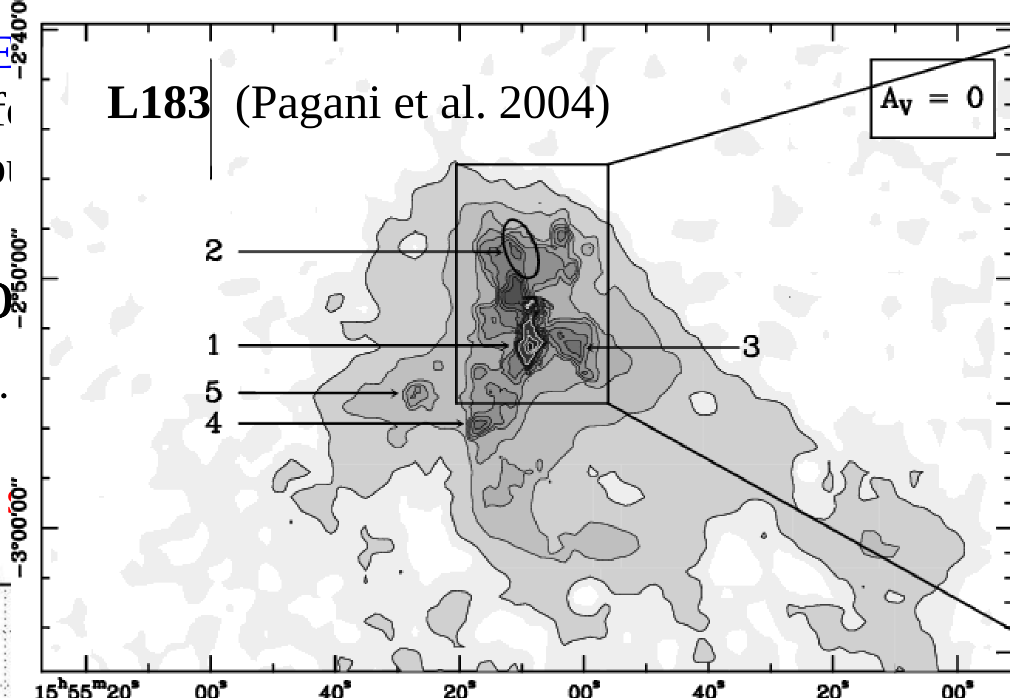
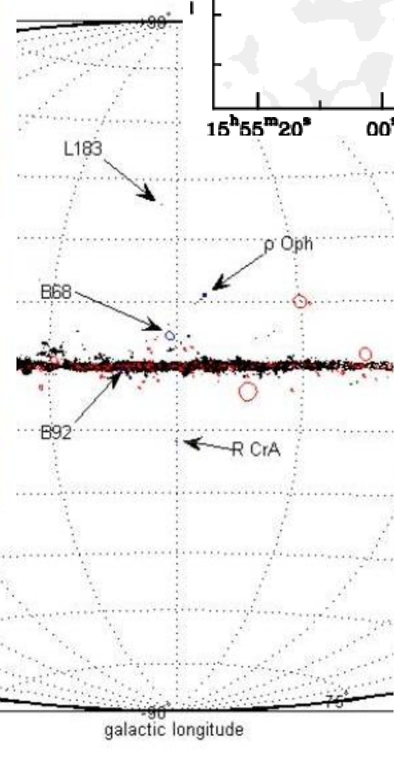
it wo

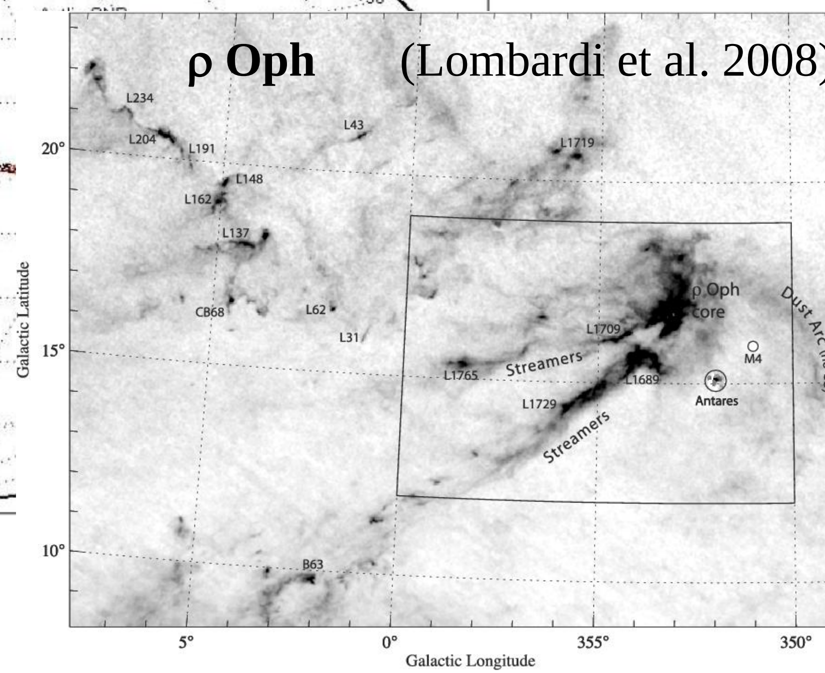
………

behind







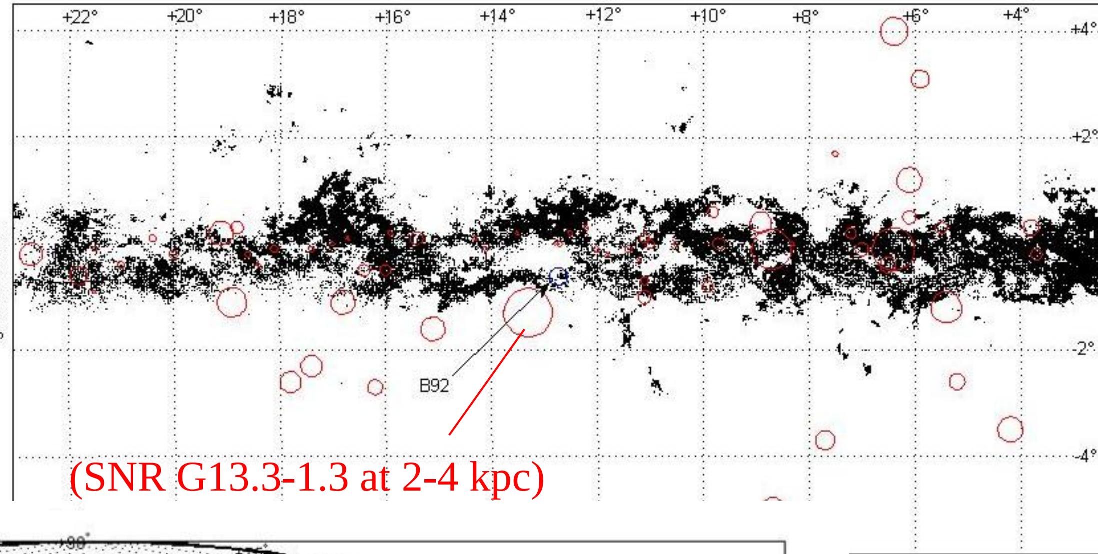


Absorbed supernova ?

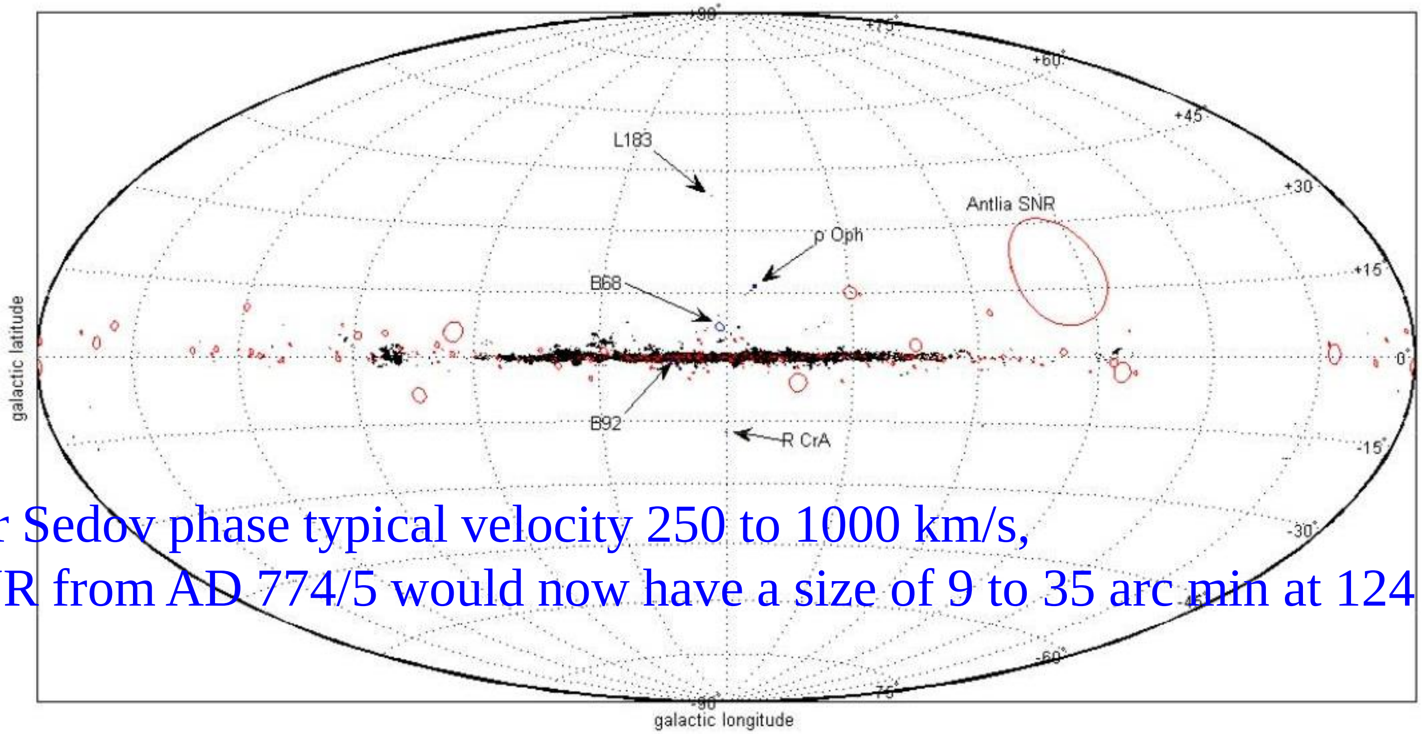
Where on sky absor

Regions with Av of at least 13 mag …

SNRs (red circles) would be visible be



(SNR G13.3-1.3 at 2-4 kpc)



For Sedov phase typical velocity 250 to 1000 km/s,
SNR from AD 774/5 would now have a size of 9 to 35 arc min at 124 pc.

Missing SNR very unlikely (deep X-ray pointings done)

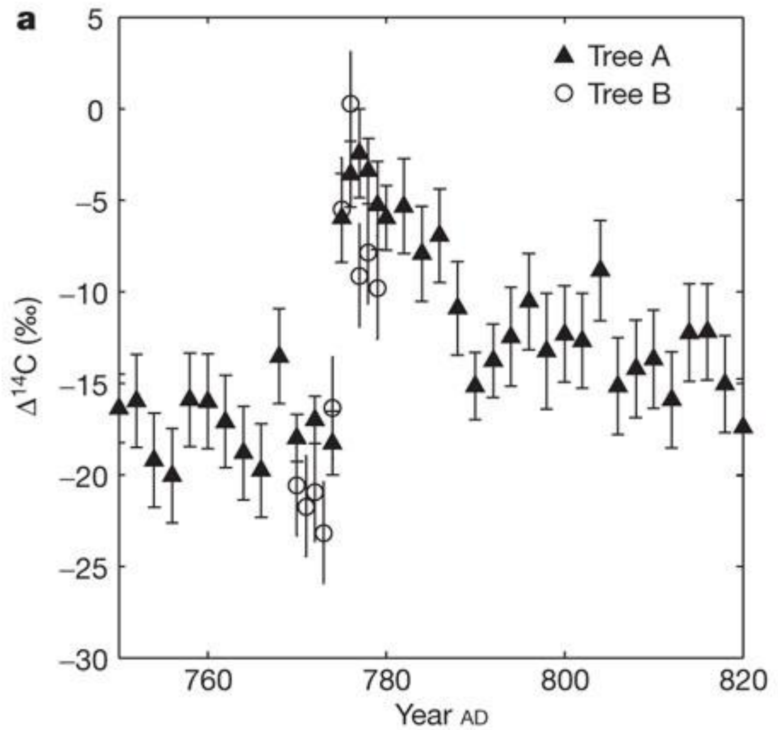
Was war die Ursache ?

Supernova ? Nein, zu schwach
nichts beobachtet

Gamma-ray burst ?

Sonnen-Flare ?

Sonstwas ?
(Komenteneinschlag, Magnetfeldschwankung, Vulkanausbruch, etc.)



Miyake et al. 2012

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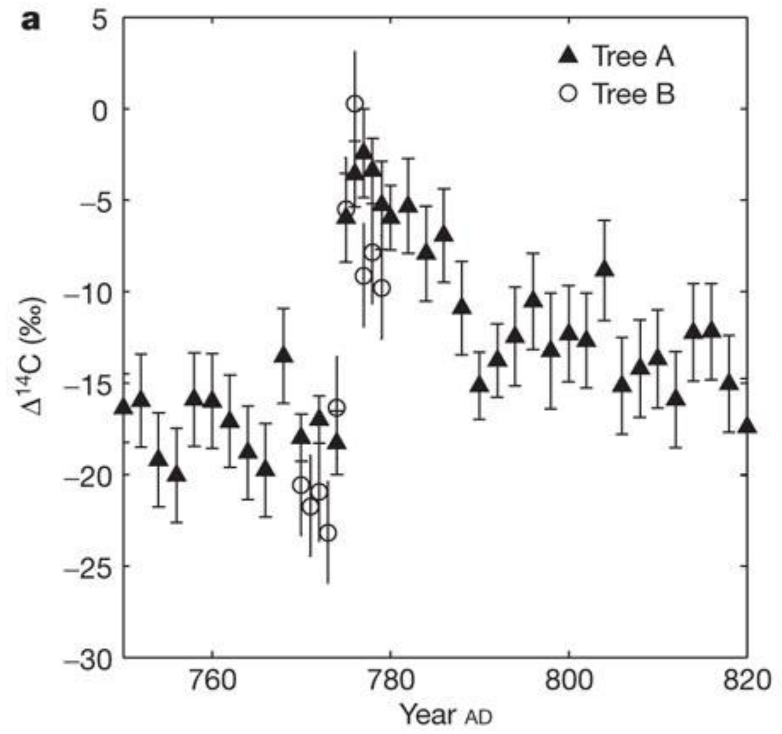
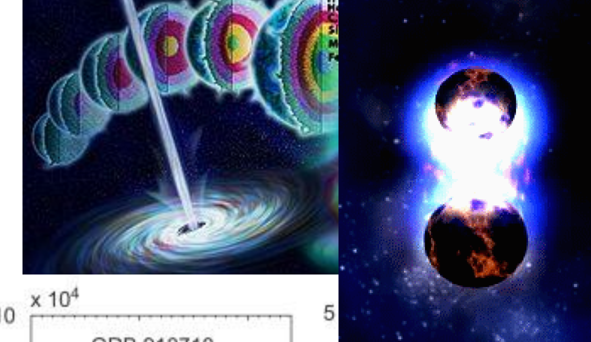
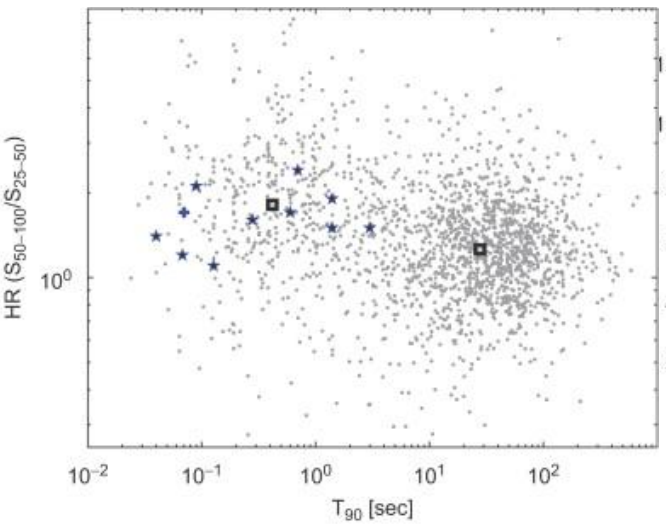
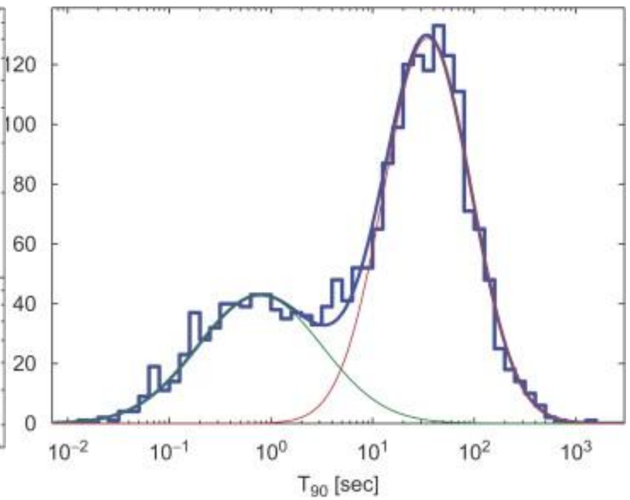


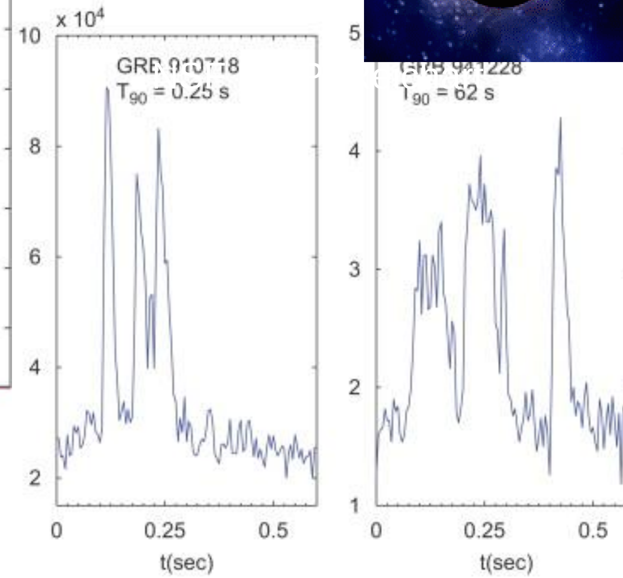
Miyake et al. 2012

Kurzer gamma ray burst ?







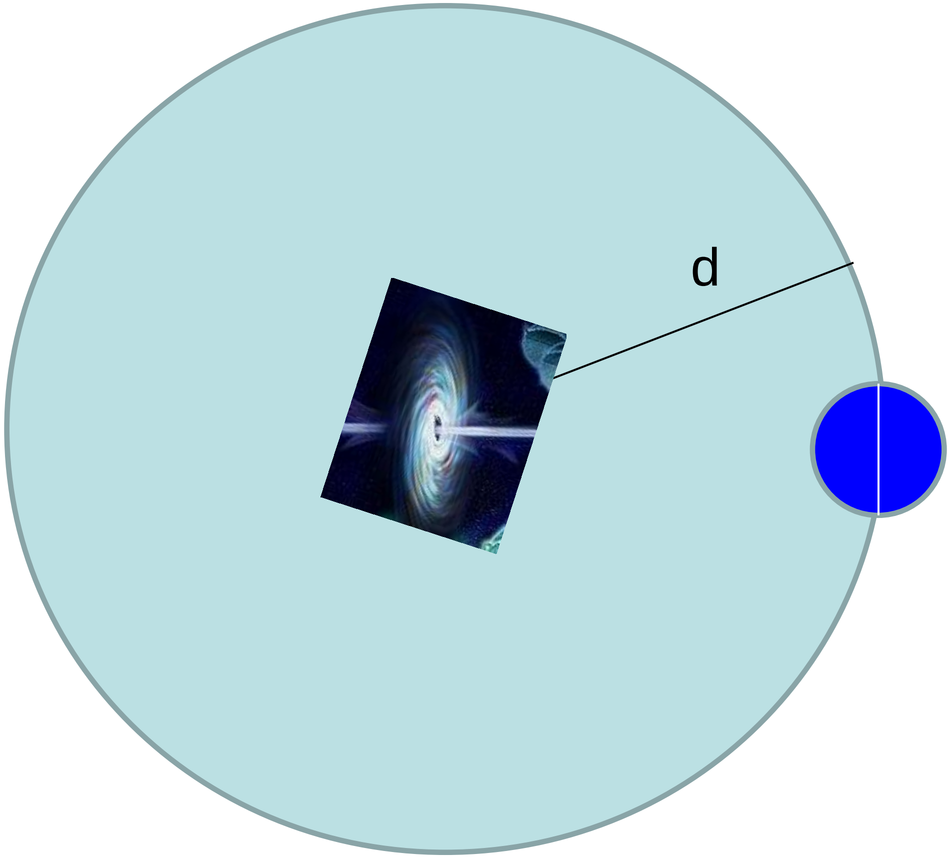


Kurze gamma ray bursts: < 2 Sek.
(und härter als lange GRBs = SNe sehr masse-reicher Sterne).

Kurze GRBs vermutlich Verschmelzungen kompakter Sterne:
2 Schwarze Löcher, 2 Neutronensterne, ggf. 2 Weiße Zwerge

Keine SN-Lichtkurve, kein SN-Überrest, kein afterglow !

A short GRB ?



$$\frac{E_{\text{event}} \cdot g}{E_{\text{obs}}} = \frac{4 \cdot \pi \cdot d^2}{\pi \cdot R^2}$$

GRB at distance d between event and Earth

Energy E(event) to spread homogeneous to surface area of sphere around event

$$4 \cdot \pi \cdot d^2$$

Energy E(obs) to hit Earth under solid angle

$$\pi \cdot R^2$$

with Earth radius R.

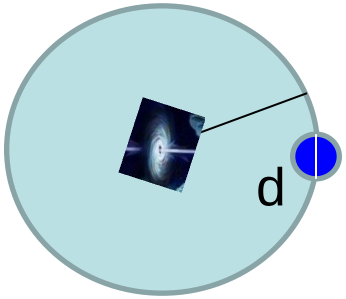
We have to multiply the short GRB energy 1e49…52 erg (Nakar 2007, Berger 2007 …) by g = 0.1 to 1 for gamma-rays.

E(obs) = 7e24 erg in AD 774/5

A short GRB ?

(1) Energetics

$$\frac{E_{\mathrm{event}} \cdot g}{E_{\mathrm{obs}}} = \frac{4 \cdot \pi \cdot d^2}{\pi \cdot R^2}$$



For E(obs) = 7e24 erg as in AD 774/5,

and for E(event) = 1e49…52 with g = 0.1 to 1 (short GRB),

it would have to happen at d = 0.1 to 4 kpc

i.e. within our Galaxy.

Events at that distance range are well possible !

➔ Energetics ok !

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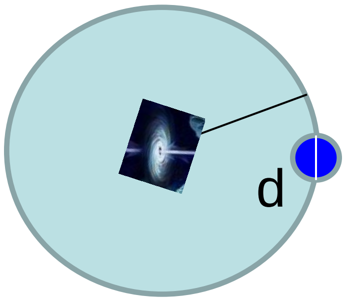
A short GRB ?



(1) Energetics – con´d

It would have to happen at d = 0.1 to 4 kpc

Strong cosmic- and gamma-ray event !

For short GRBs,
neither normal afterglows as for long GRBs
nor long-term optical emission as for normal SNe.

No supernova remnants for short GRBs !!!

➔ Energetics <u>and missing SNR ok !</u>

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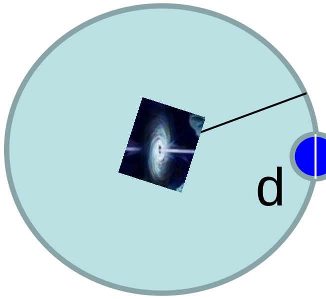
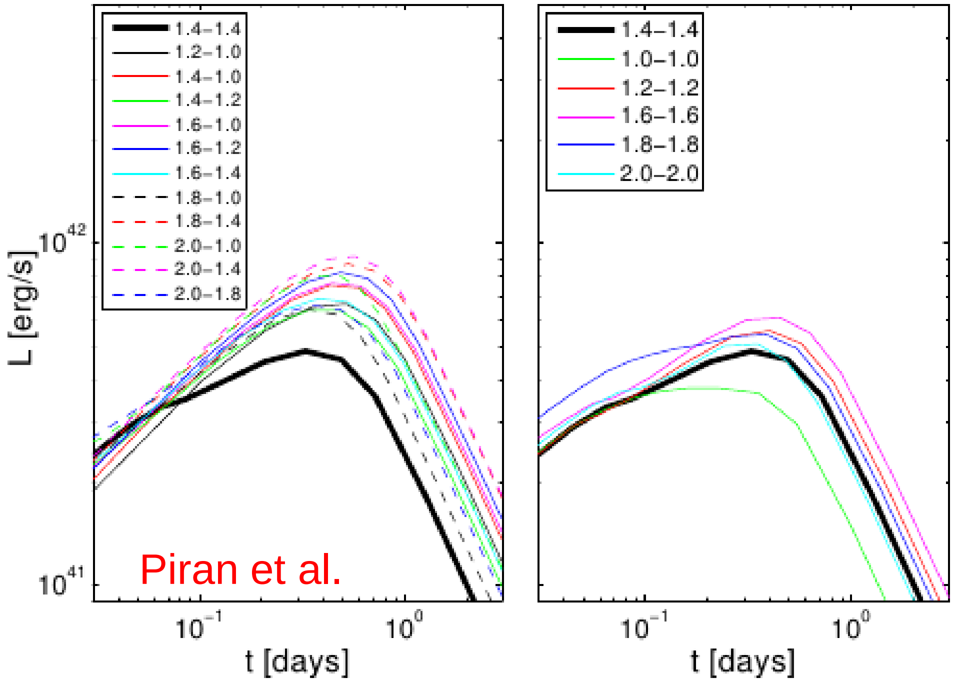
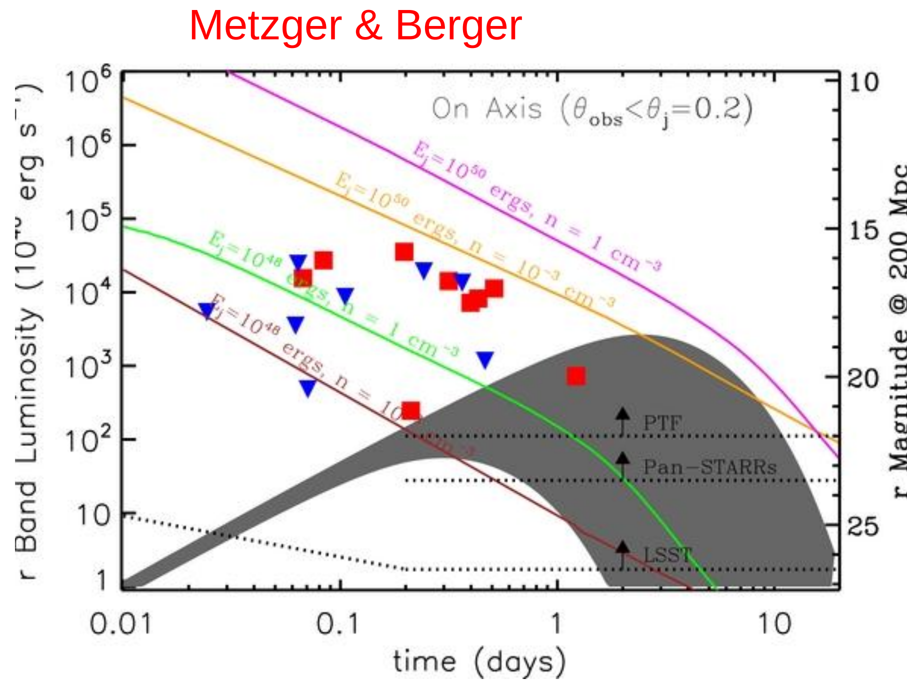
A short GRB ? (1) Energetics – con´d



Short transient optical event ? „afterglow“ / „kilonova“

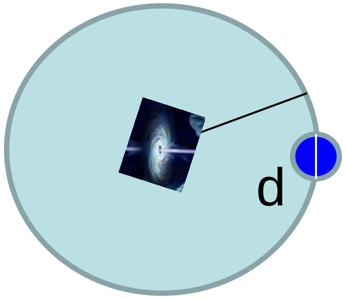
(Metzger & Berger 2012, Piran et al. 2012)





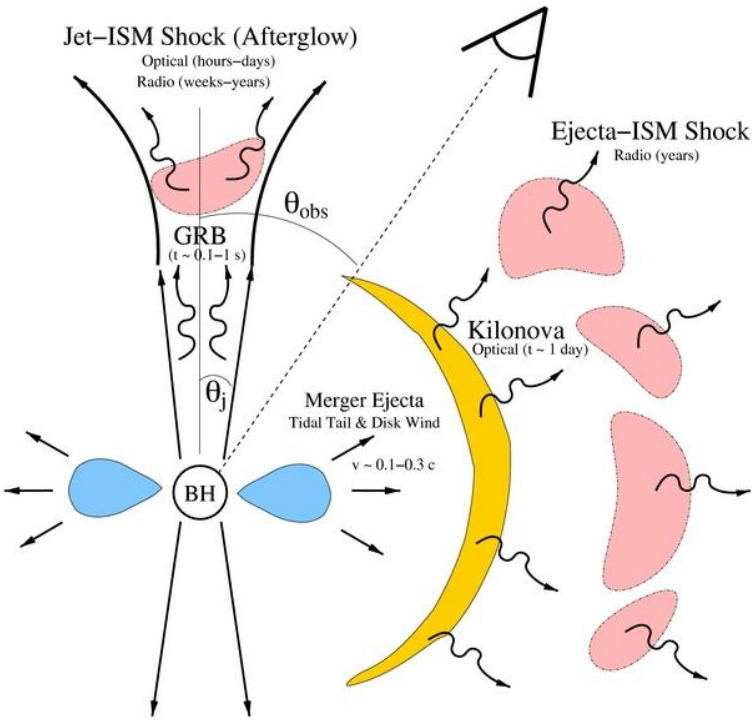
At 0.1 kpc to 4 kpc, expected peak is m = -10 to -2 mag, i.e. detectable.

A short GRB ? (1) Energetics – con´d



Short transient optical event

(Metzger & Berger 2012, Piran et al. 2012)



At 0.1 kpc to 4 kpc,
expected peak is m = -10 to -2 mag,
i.e. detectable.

Non-detection possibly due to
short time-scale, strong absorption,
bad weather, conjunction with Sun,
over unpopulated area, etc., i.e. not surprising.

➔Energy, missing SNR, missing optical detection ok for sGRB

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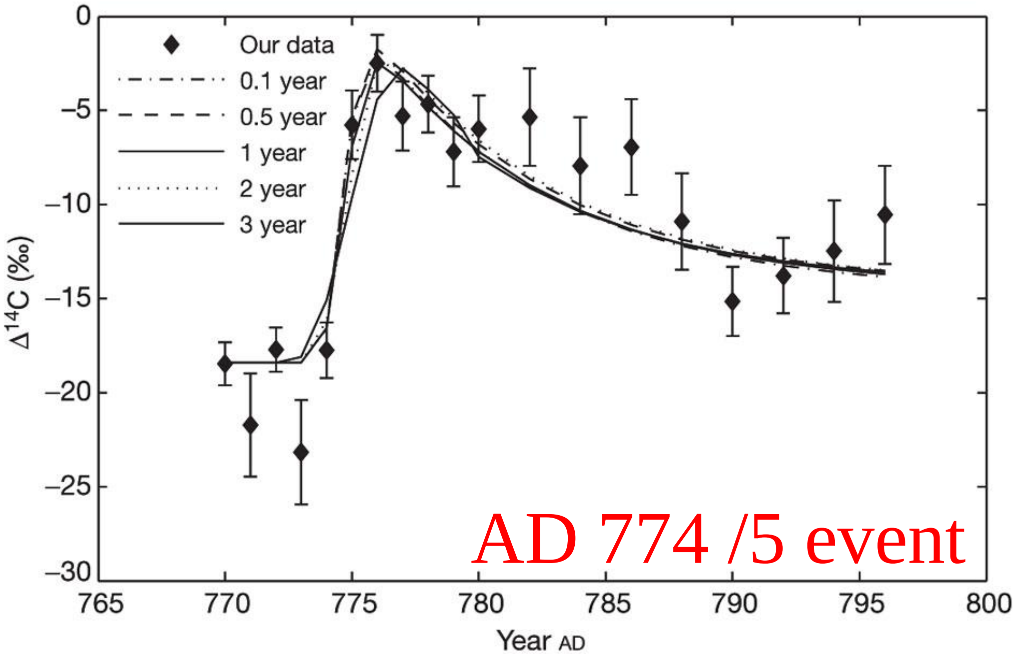
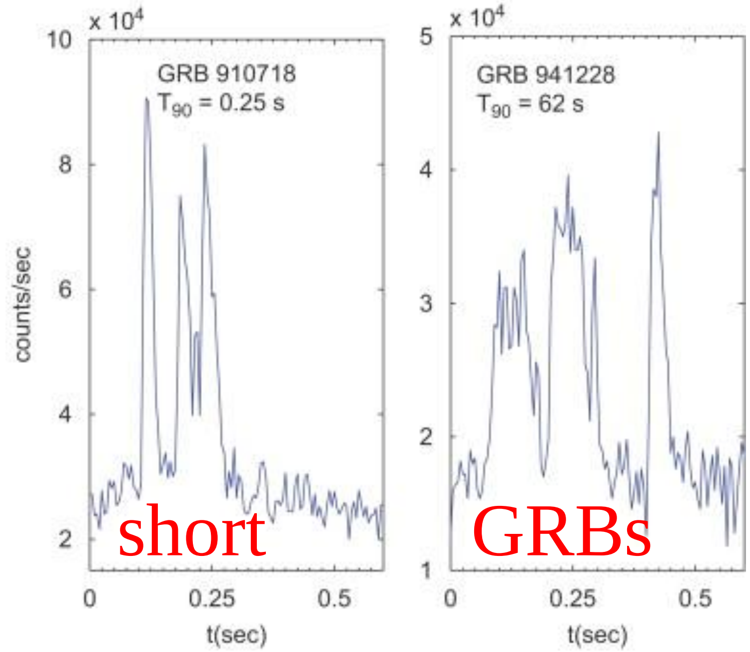
A short GRB ? (2) time-scale

Since short GRBs are shorter than ~ 2 sec,

the AD 774 / 5 event is consistent with that short time-scale.





➔Time-scale of AD 774/5 event ok for short GRB!

(also ok for long GRB)

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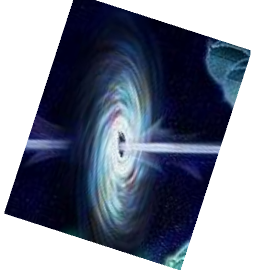
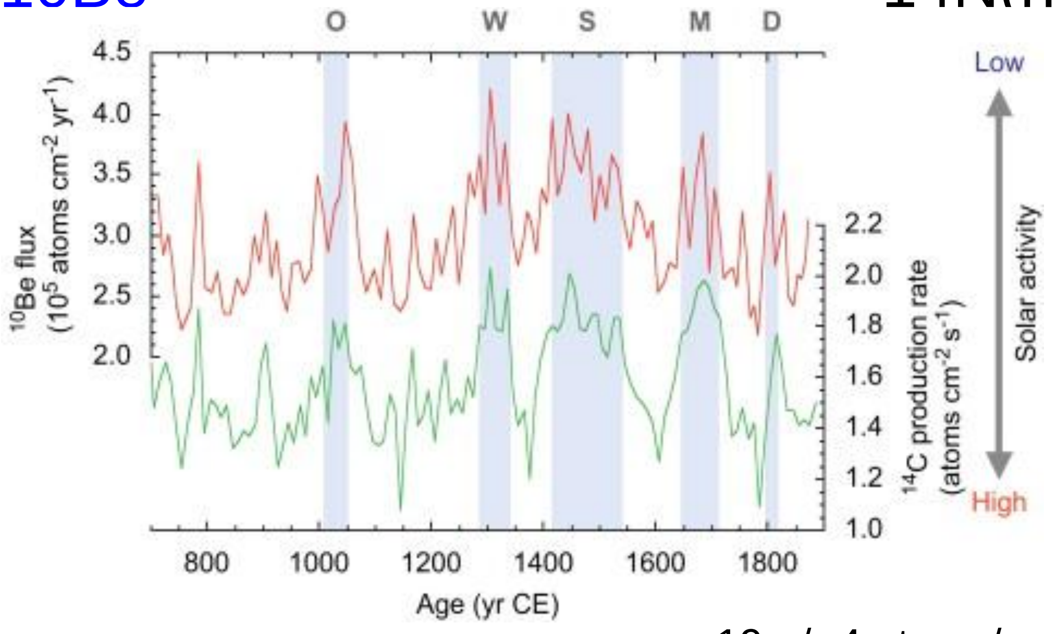
A short GRB ? (3) spectrum

^{14}C and ^{10}Be rise in accordance



14N(n,p+α)10Be

14N(n,p)14C



30% increase in ^{10}Be flux over 0.031 atoms/cm2/s b/g with 10 yr time resolution.

19 +/- 4 atoms/cm2/s ^{14}C flux over 2.05 atoms/cm2/s b/g within < 1 yr.

➔Differential production yield:

> 270 +/- 140 times more ^{14}C than ^{10}Be

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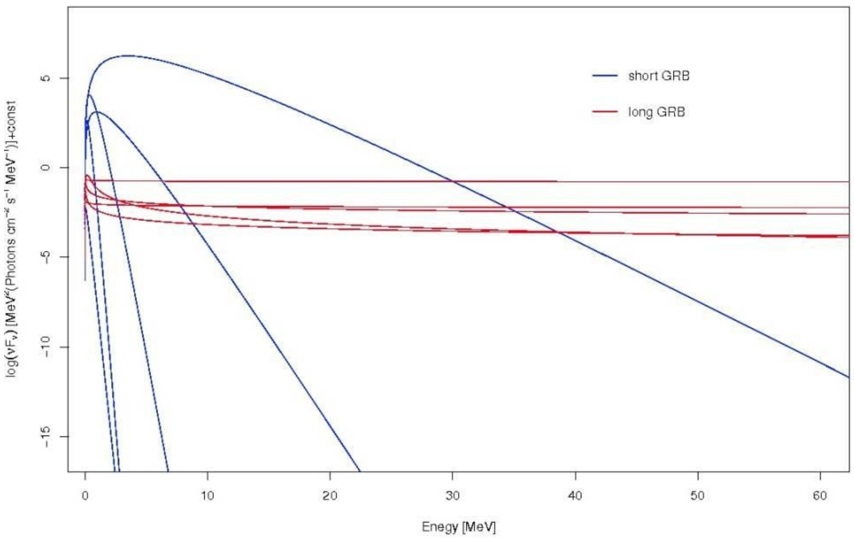
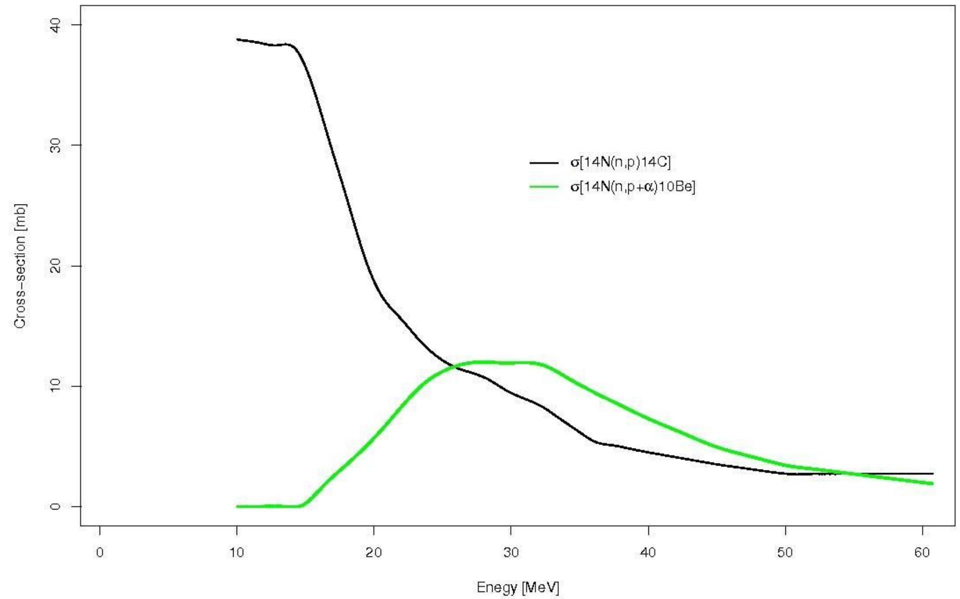
A short GRB ?   (3) spectrum – con´d

➔ Differential production yield:
> 270 +/- 140 times
more 14C than 10Be





$$Sp(E) \sim E^{\alpha} \times e^{(-E/E_0)}$$

Sources for cross-sections:
www-nds.iaea.org
Dimbylow 1980 Phys.Med.Bio.
Burger & Ebert 1981 Neutr.Dosim.

(and long GRBs, Band fct)

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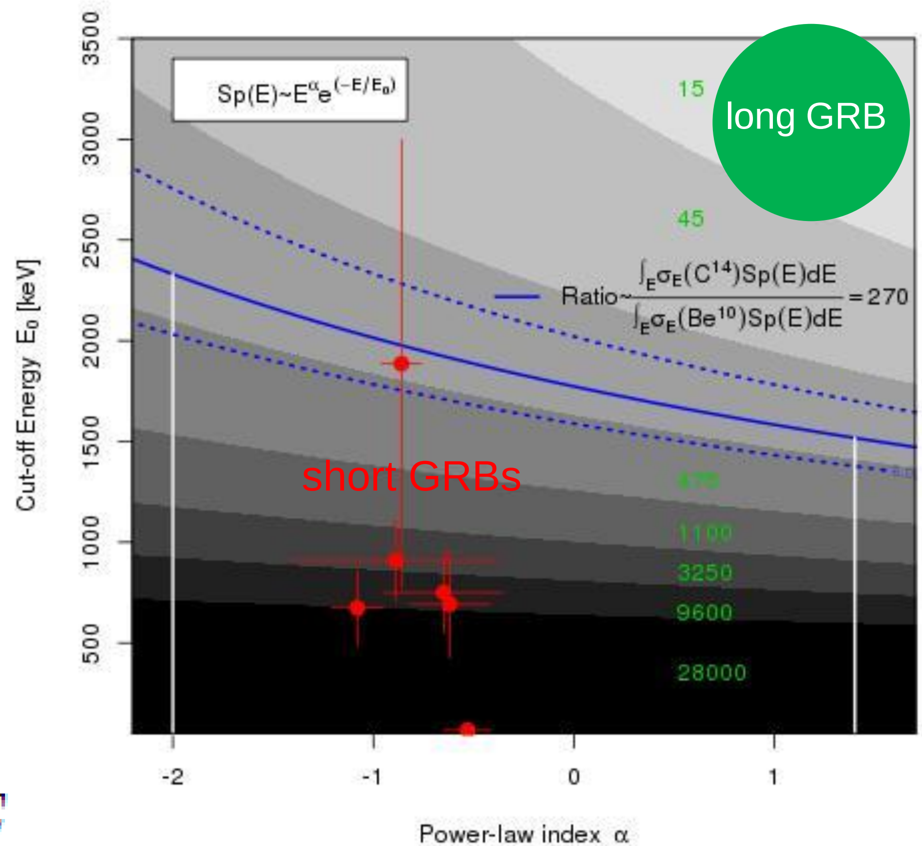
A short GRB ? (3) spectrum – con´d

$$Sp(E) \sim E^{\alpha} \times e^{(-E/E_0)}$$

14N(n,p+α)10Be

14N(n,p)14C

➔Differential production yield: > 270 +/- 140 times more 14C than 10Be



compared to real spectra of short GRBs (Ghirlanda et al. 2009 A&A)

$$ratio = \frac{\int_E \sigma(^{14}C) \times Sp(E)\ dE}{\int_E \sigma(^{10}Be) \times Sp(E)\ dE}$$

Pavlov et al. (2013, MNRAS) confirm HN13 calculation with more detailed calculations (GEANT)

➔Differential production yields consistent with short GRB spectra !

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A short GRB ?

(4) No extinction level event on Earth …

Short GRB would have to happen at d = 0.1 to 4 kpc

Extinction level event not observed for AD 774 / 5,

but expected ?

Depending on energy, 1e49 … 1e52 erg,
it would have to happen outside of ~ 1 kpc
(scaled from long GRB effects studied by Thomas et al. 2005 ApJ).

→ Missing mass extinction event ok !

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A short GRB ? (5) Rates of short GRBs and mergers

Rates of short GRBs:
8 (5 … 13) sGRB per Gpc3 per yr (Coward et al. 2012)

For 0.003 galaxies per Mpc3,
then one short GRB in 375 (231 … 600) kyr per galaxy,
or <u>one short GRB in 3750 (2310 … 6000) kyr within 4 kpc</u>
(with E > 1e49 erg)

Rates of neutron star mergers:
13 (3 … 190) mergers per Myr (double NSs, Kim et al. 2010)
or
15 (0.3 … 50) mergers per Myr (pop. syn., Dominik et al. 2012)

Beaming of short GRBs:
fraction f = 0.01 to 0.13 (of full solid angle) observed.

Using f = 0.13, most optimistic is
<u>one merger in 410 kyr within 4 kpc beamed at us</u>.

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Short GRB due to a merger of two White Dwarfs
or an accretion-induced collapse of a White Dwarf ?

Then a magnetar can form (Bucciantini et al. 2012).
if as short GRB, then without SNR

Table 1: Young neutron stars at 1-4 kpc without SNR. We list pulsar name with position for J2000.0, rotation/pulse period P, period derivative $\dot{P}$, distance, and characteristic age $\tau = 1/2 \cdot (P/\dot{P})$, data from Manchester et al. (2005) or McGill SGR/AXP catalog (footnote 2).

Name J2000.0	Period P [s]	P-dot [s/s]	Dist. [kpc]	Age [kyr]	Re-mark
SGR 0418+5729	9.0784	$\leqslant 0.0006$	~ 2	$\geqslant 24$	
PSR J1048+5832	0.1237	9.6e-14	2.98	20.3	FGL
PSR J1708-4009	11.0013	1.9e-11	3.08	9.01	AXP
PSR J1740-3015	0.6069	4.6e-13	3.28	20.6	
PSR J1809-1943	5.5404	7.8e-12	3.57	11.3	AXP

3 magnetars w/o SNR within 4 kpc !

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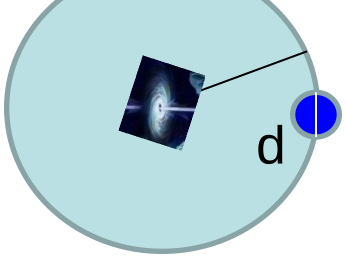
Kurzer GRB

$$\frac{E_{\mathrm{event}} \cdot g}{E_{\mathrm{obs}}} = \frac{4 \cdot \pi \cdot d^2}{\pi \cdot R^2}$$



Energetik:
E(event) = 1e49…52 erg (kurzer GRB)
➔ 0.1 bis 4 kpc (ok, in unserer Galaxie)

Zeitskala:
Bis zu 2 Sek., d.h. konsistent mit 14C Anstieg (ggf. < 1 J.)

Weder SN-Lichtkurve, noch Afterglow, noch SN Überrest: ok

Kein Massensterben auf der Erde im Jahre 774/5 –
Ok falls weiter entfernt als 1 kpc (3300 Lj)

Spektrum:
Typische Spektren kurzer GRBs sind konsistent mit
Produktionsraten von 14C und 10Be !

Short GRB konsistent mit allen Observablen !
(aber sehr sehr selten)

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From chronology of Al-Tabari about AD 622 – 923, here for fall AD 775:

ذكر الخبر عن وصاياه

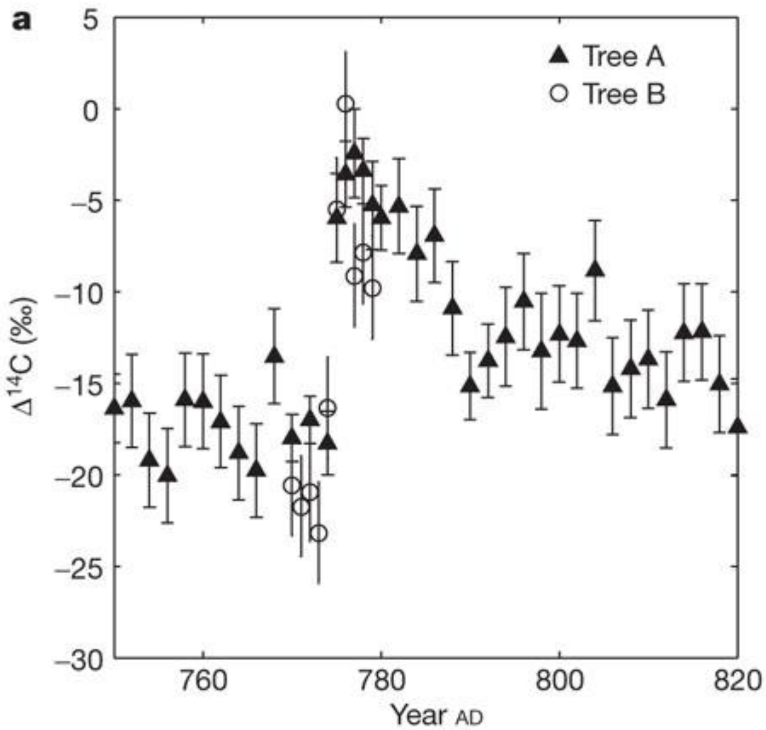
ذكر عن الهيثم بن عدي أن المنصور أوصى المهدي في هذه السنة لما شخص
متوجها إلى مكة في شوال ، وقد نزل قصر عبدويه ، وأقام بهذا القصر أياما
والمهدي معه يوصيه ، وكان انقض في مقامه بقصر عبدويه كوكب ، لثلاث بقين
من شوال بعد إضاءة الفجر ، وبقي أثره بيّنًا إلى طلوع الشمس ، فأوصاه بالمال

„The last will of Kalife Al-Mansur … (travel from Bagdad to Mekka)
And it was on the way to Mekka in Qasr Abdaweiah, a star (kawkab) was setting,
on the 28th of month Shuwwal (end of AD 775 Aug) …
Its remains / rays / traces (athar) were seen from beginning of dawn to sunrise.“

Transient event like nova or supernova (or even optical GRB) ?
Or just a meteor / bolide ?
kawkab and athar also used for the 2 known arabic supernova reports (SN 1006 and SN 1054)

RN & Kunitzsch 2014

Was war die Ursache ?



Miyake et al. 2012

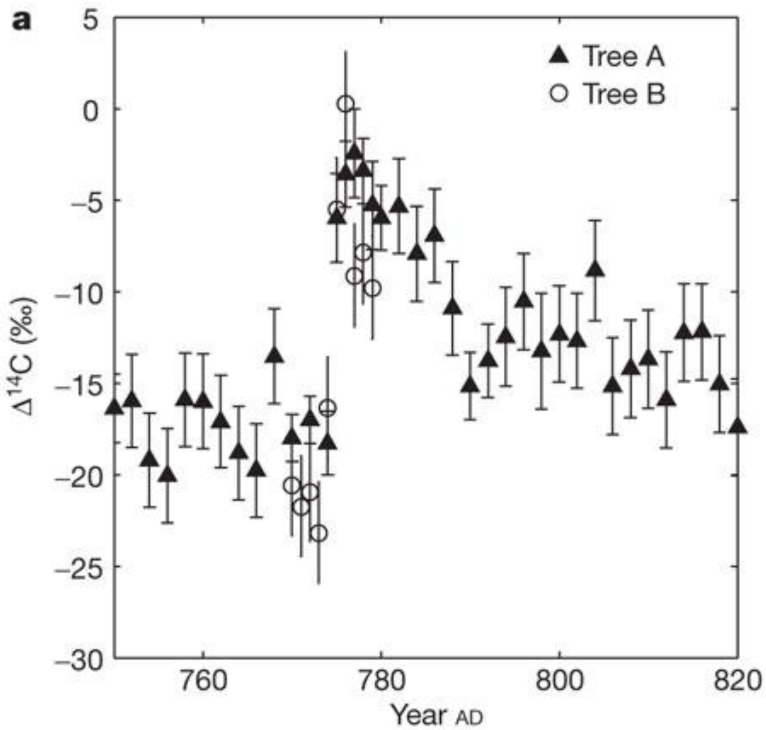
Supernova ? Nein, zu schwach

Gamma-ray burst ? zu selten

Sonnen-Flare ?

Sonstwas ?
(Komenteneinschlag, Magnetfeldschwankung, Vulkanausbruch, etc.)

Was war die Ursache ?



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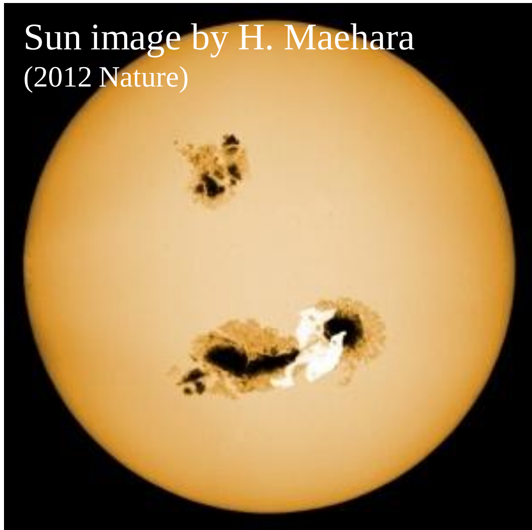
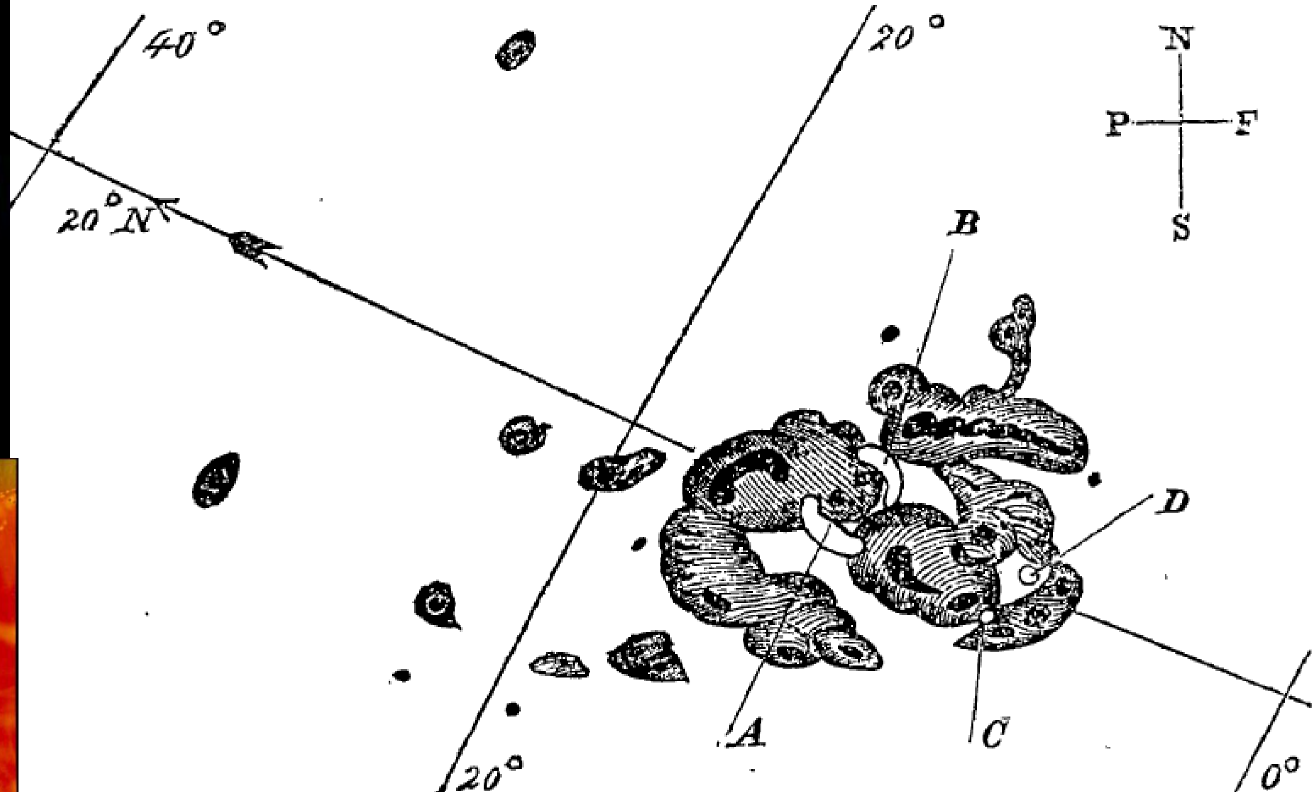
Sonnen-Flare ?



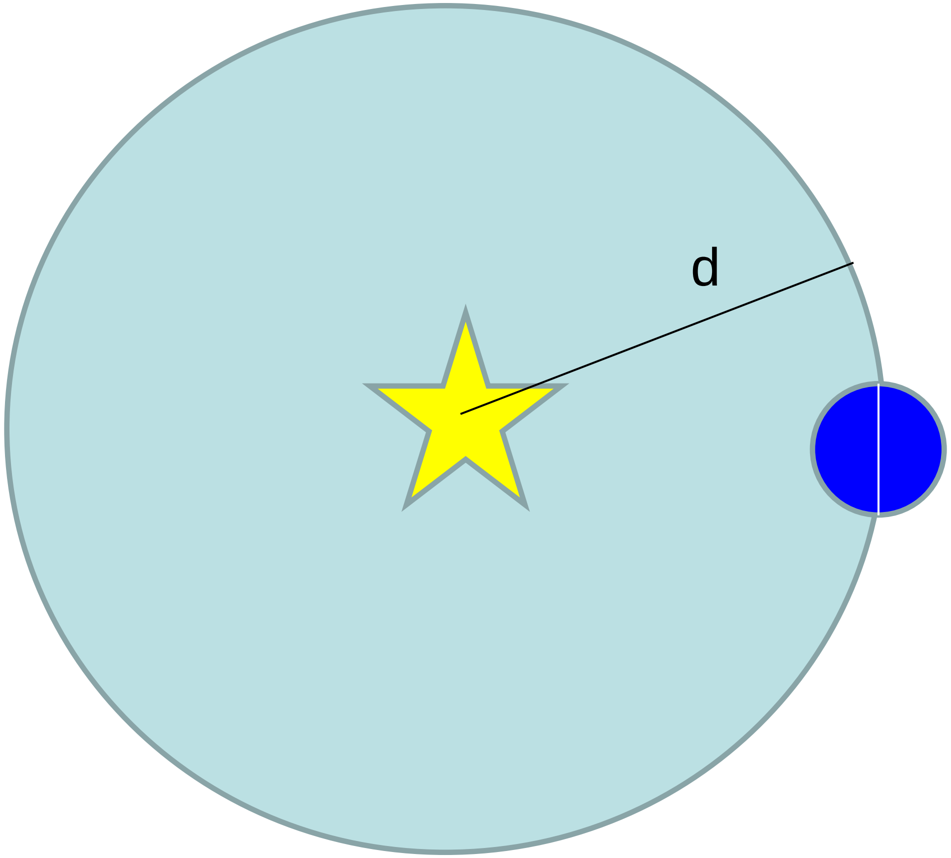


Carrington 1859 MNRAS

Der angeblich bisher stärkste Sonnen-Flare (Carrington-Flare) hatte 10^{32} erg Energie.

Dann müssten um AD 774 / 5 weltweit starke Aurorae beobachtet worden sein !!!

Energetics



Flare at distance d between event and Earth

Energy E_{event} to spread homogeneous to whole sphere around event with area

$$4 \cdot \pi \cdot d^2$$

Energy E_{obs} to hit Earth under solid angle

$$\pi \cdot R^2$$

with Earth radius R.

$$\frac{E_{\text{event}}}{E_{\text{obs}}} = \frac{4 \cdot \pi \cdot d^2}{\pi \cdot R^2}$$

$E_{obs} = 8 \times 10^{25}$ erg in protons

➔Need 2×10^{35} erg at Sun

Miyake et al. 2012: Differential production ratio of ^{14}C to ^{10}Be (> 270 +/- 140)
and: if solar flare, then 2 x 10^{35} erg at Sun ➔ **<u>2000 x stronger than Carrington</u>**

Melott & Thomas (2012), Thomas et al. (2013):

AD 774/5 as solar flare with lowest possible angle of 24 deg.
Then, considering isotroptic equivalent energy,
less strong flare (by a factor of 100) would be needed
➔ <u>20 x stronger than Carrington</u>

Usoskin at al. (2013): 4 to 6 times less ^{14}C produced in AD 774/5 !
➔ <u>~ 4 stronger than Carrington</u>
And observed ratio of ^{14}C to ^{10}Be > 54 +/- 28 only

Differential production ratio of ^{14}C to ^{10}Be due to solar flare expected:

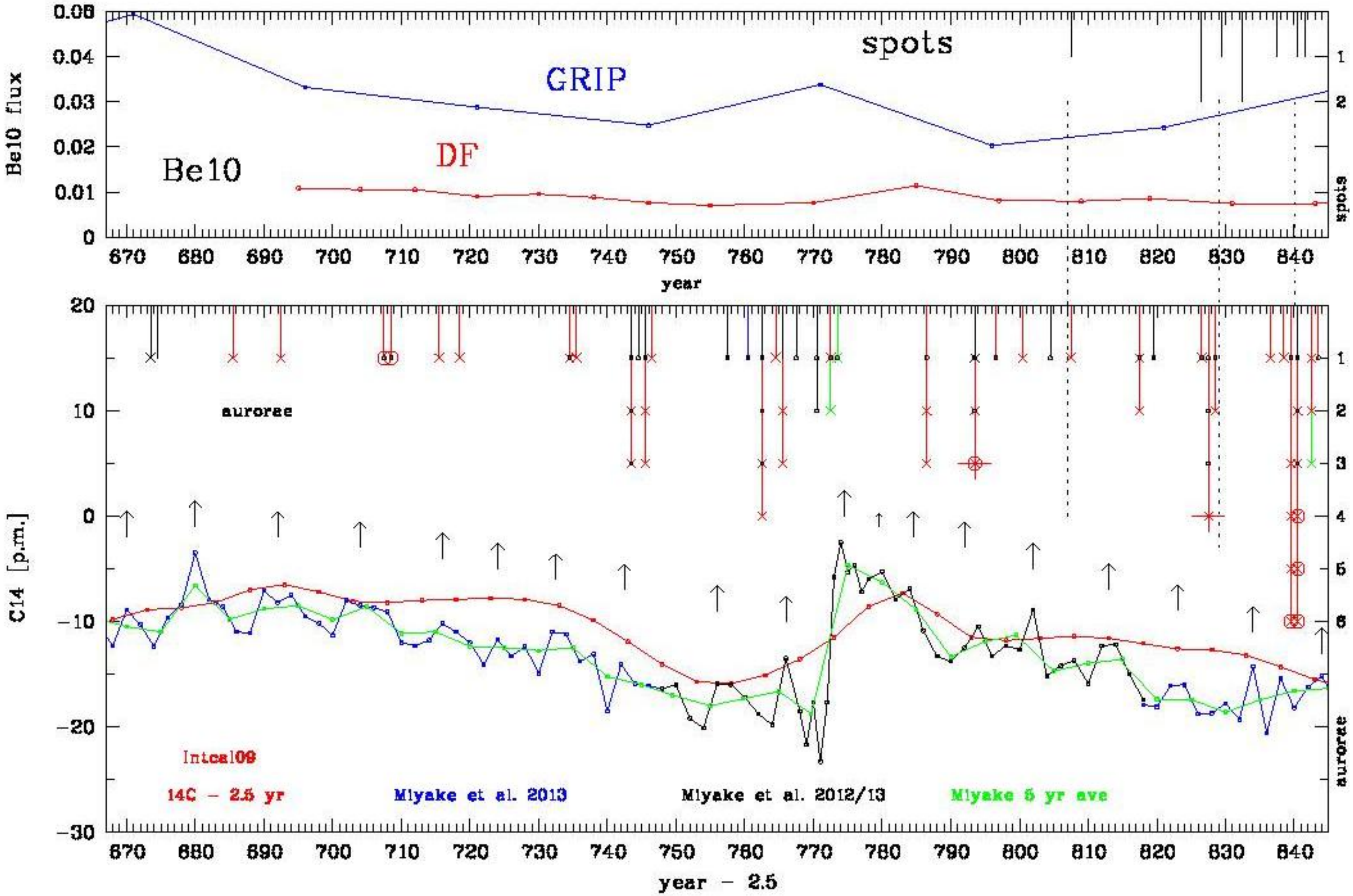
Usoskin et al. (2006): ~ 25 times more ^{14}C than ^{10}Be

Usoskin (2008 Liv. Rev.): „… solar energetic particle effect negligible in ^{14}C."

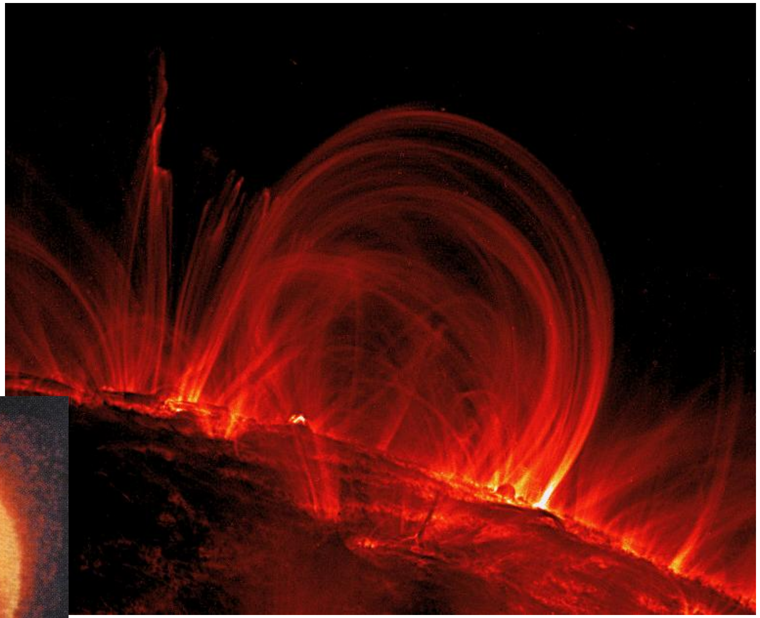
Usoskin & Kovaltsov (2012): ~ 38 times more ^{14}C than ^{10}Be

Usoskin (2013 Liv. Rev.): „issue inconclusive"

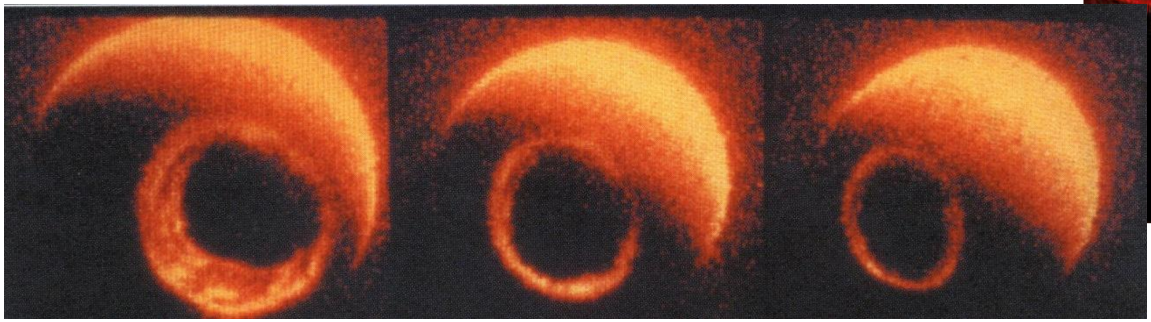
If super-flare ~5 times stronger than Carrington, then super-aurorae ?



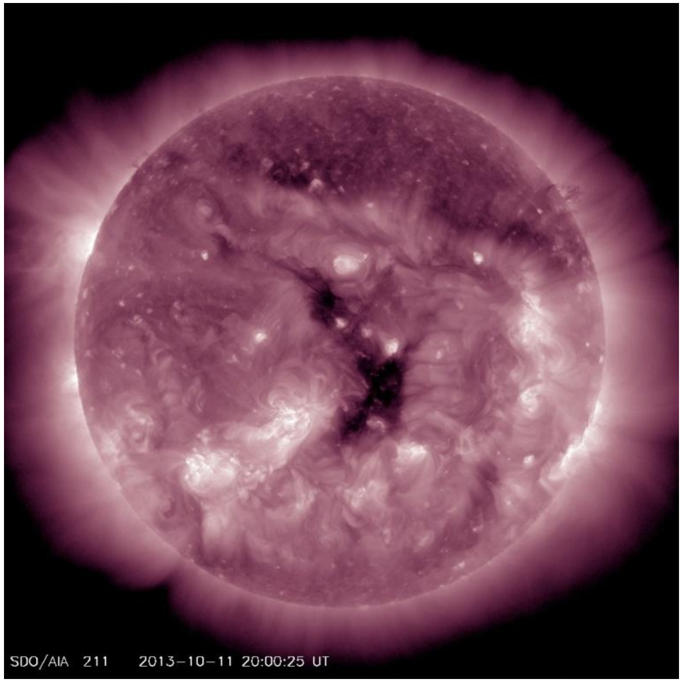
Arten von Aurorae:



➔Transiente Schock-Aktivität wie
Coronal Mass Ejections (CMEs): ~ 1/3



➔ Stabile koronale Löcher + Hochgeschw.-Wind: ~ ½



➔ Andere:
- Neutral current sheet crossing
- Stabe aurora red arcs
  (due to ring current disturbence)

Kriterien: Farbe (z.B. rot), nördlich, Dynamik, Nacht

Our aurora catalogue:

→ **at night** (+ constellations / 0 twilight / - close to moon)

→ **towards north** (0 east-west / - south)

→ **colour** (+ red, green,blue,blood / 0 white,black,bright)

→ **dynamics** (+ fire,fight / 0 rays)

→ **repetition in next night(s)**

→ N = 0 potential

N = 1 possible

N = 2 very possible

N = 3 probable

N = 4 very probable

N = 5 certain

Neuh & Neuh 2015

Aurora? Fünf Kriterien → **Positiv-** und **Ausschussliste**

→ während *einer* Nacht

\+ Sternbilder | **0** Morgen- und Abenddämmerung | - tagsüber, tagelang, Mond-/Sonnennähe

→ tendenziell nördliche Ausrichtung

\+ nördliche Sterne | **0** Zenit, Ost-West-Richtung | - südliche Ausrichtung

→ Aurora-typische Farben

\+ Blut/Feuer … | **0** weiß/schwarz, hell, leuchtend …

→ Aurora-typische Veränderung/Dynamik

\+ Feuer; Pulse, … bewegen, kämpfen | **0** Dunst, Nebel, Strahlen … ausgedehnt, ausgebreitet …

→ ggf. abgeschwächte Wiederholung in den unmittelbar nächsten Nächten

→ N = 0 potential

N = 1 possible

N = 2 very possible

N = 3 probable

N = 4 very probable

N = 5 certain

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Aurora sightings from AD 575 to 841

N: number of criteria for aurorae fullfilled. Fully independant events are separated by full horizontal lines. See text for details. References at bottom of table.

Year	location	reported text (original language or remark from lit. in brackets) [our comment]	N	Ref.	their sources
757	Nan-yang, China	Chih-te reign-period, 2nd year, 1st month, day ping-tzu (13). At Nan-yang, at night, there were four white rainbows. They stretched upwards for more than 100 chang.	1	YSW	K73 f. Hs-in-T'ang-shu
757	China	(K73: probable to very probable, Feb 20 at 33N 113E, 100 chang = 1000 feet) [possible, neither paraselene nor night rainbow as new moon Feb 22/23]		K73	T'ang-shu
760	China	Ch'ien-yuan reign-period, 3rd year, 6th month (Jul/Aug). At dusk, there were 3 blue vapours in the NW. [possible, maybe parhelion or paraselene because at dusk at sunset in NW]	1	YSW	DC80 f. Hsin-t'ang-shu
762	Shanxi, China	Pao-ying reign-period, 2nd year, 4th month, day jen-tzu (49). At night, a red light like flames was seen in the NW. Its blazing flames strechted across the sky and penetrated Tzu-wei [Ziwei near κ Dra in XPJ]. It gradually floated towards E and spread to the N. It shone brilliantly for several tens of li. After a long time then it was dispersed.	4	YSW	K73 f. Chiu-t'ang--shu, T'ang-hui-yao
762		(K73: very probable, May 1 at 34N 109E, date from Chiu-t'ang-shu more reliable, 1 li = 576 m) [very probable, new moon Apr 28/29]		K73	see above

Chih-te Regierungsperiode, 2. Jahr, 1. Monat, Tag ping-tzu (13). In Nan-yang gab es bei Nacht vier weiße Regenbögen. Sie dehnten sich nach oben aus um mehr als 100 chang. (Tang)
Datum 20.2.757.

Pao-ying Regierungsperiode, 2. Jahr, 4. Monat, Tag jen-tzu (49). Bei Nacht war ein rotes Licht wie Flammen im NW zu sehen. Seine flackernden Flammen dehnten sich über den ganzen Himmel aus und drangen in Tzu-wei ein [nahe κ Dra]. Es schwebte nach und nach nach Osten und breitete sich nach Norden aus. Es schien glänzend für mehrere zehn li. Nach einer langen Zeit verschwand es. (Tang)
Datum 1.5.762 (Neumond 28./29.4.)

References are M33 (Mairan 1733), J70 (Jeremiah 1870), F73 (Fritz 1873), M56 (Matsushita 1956), L62 (Link 1962), S64 (Schove 1964), N72 (Newton 1972), K73, K74 (Keimatsu 1973, 1974), D79 (Dall'Olmo 1979), DC80 (Dai & Chen 1980), MAMN83 (Mac Airt & Mac Niocaill 1983), S84 (Schove 1984), YSW (Yau et al. 1995), B96 (Bone 1996), MB97 (McCarthy & Breen 1997), XPJ (Xu et al. 2000), U13 (Usoskin et al. 2013), and NN (this work).
(*) We give our new translation (D79 not fully correct).
C. for *Chronicle*, *f.* for *from*.

(Neuh. & Neuh. 2015)

Aurora sightings from AD 575 to 841

N: number of criteria for aurorae fullfilled. Fully independant events are separated by full horizontal lines. See text for details. References at bottom of table.

Year	location	reported text (original language or remark from lit. in brackets) [our comment]	N	Ref.	their sources
793	Arabia	In this year (177 hidschra, i.e occurred a (violent) wind, and Sunday (i.e. the night of Satu Then there was a further over Tuesday-Wednesday), the 28t overshadowing of the heaven [very probable, new moon M			orth 1989 Tabari
793	Europe	F73: large (Gross) [source no			nning
793	Northumbria, England	In this year terrible portents a these were exceptional high w air. A great famine soon follo harrying of the heathen miser [event with *heathen* men was of Durham; hence, the date gi correct date is Jun 8] [very po			o- n C.
793	England	S84: ca. AD 793 aurorae are			
793	England	terrific lightnings, and dragon (visi sunt flammei dracones v			er Rolls f. oveden
793	England	N72: dragon flames seen			Sax. C.
793	England	and terribly burning dragons (795: et dracones per aera horride ardentes volitare videbantur) [L62: maybe AD 793]			h. Westm. f. Flores Hist.

In diesem Jahr gab es schreckliche Vorzeichen über Nordengland, die die Einwohner verängstigten: Es gab besonders hohe Winde und plötzliche Aufhellungen, und man sah feurige Drachen durch die Luft fliegen. Eine Hungersnot folgte kurz nach diesen Zeichen, und kurz danach im selben Jahr, (793) am 8. Juni, zerstörten Wikinger Gottes Kirche in Lindisfarne durch Angriff und Mord. (Angel-Sächsische Chronik)

References are M33 (Mairan 1733), J70 (Jeremiah 1870), F73 (Fritz 1873), M56 (Matsushita 1956), L62 (Link 1962), S64 (Schove 1964), N72 (Newton 1972), K73, K74 (Keimatsu 1973, 1974), D79 (Dall'Olmo 1979), DC80 (Dai & Chen 1980), MAMN83 (Mac Airt & Mac Niocaill 1983), S84 (Schove 1984), YSW (Yau et al. 1995), B96 (Bone 1996), MB97 (McCarthy & Breen 1997), XPJ (Xu et al. 2000), U13 (Usoskin et al. 2013), and NN (this work).

(*) We give our new translation (D79 not fully correct).

C. for *Chronicle*, *f.* for *from*.

وغزا الصائفة فيها عبد الرزاق بن عبد الحميد التغلبي .
وكان فيها – فيما ذكر الواقدي – ريح وظلمة وحمرة ليلة الأحد لأربع
ليال بقين من المحرم ، ثم كانت ظلمة ليلة الأربعاء ، لليلتين بقيتا من المحرم من
هذه السنة ، ثم كانت ريح وظلمة شديدة يوم الجمعة لليلة خلت من صفر .

Arabic reports about aurorae, e.g. for AD 793 by al-Ṭabarī:

AD 793 May, Iraq: In this year (177 h = AD 793 Apr 18 - 794 Apr 6), according to what al-Wāqidī has mentioned, there occurred a (violent) wind [ḥīr], and overshadowing/darkness [ẓulma] (of the heavens) and a redness [ḥumra] (in the sky), on the night of Sunday, the 26th of al-Muḥarram [793 May]. Then there was a further overshadowing (of the heavens) on the night of Wednesday, the 28th of al-Muḥarram [May 15], and then a violent wind and intense overshadowing of the heavens on Friday, 2nd Safar [May 19].

ASC: before 8 June 793

Aurora sightings from AD 575 to 841

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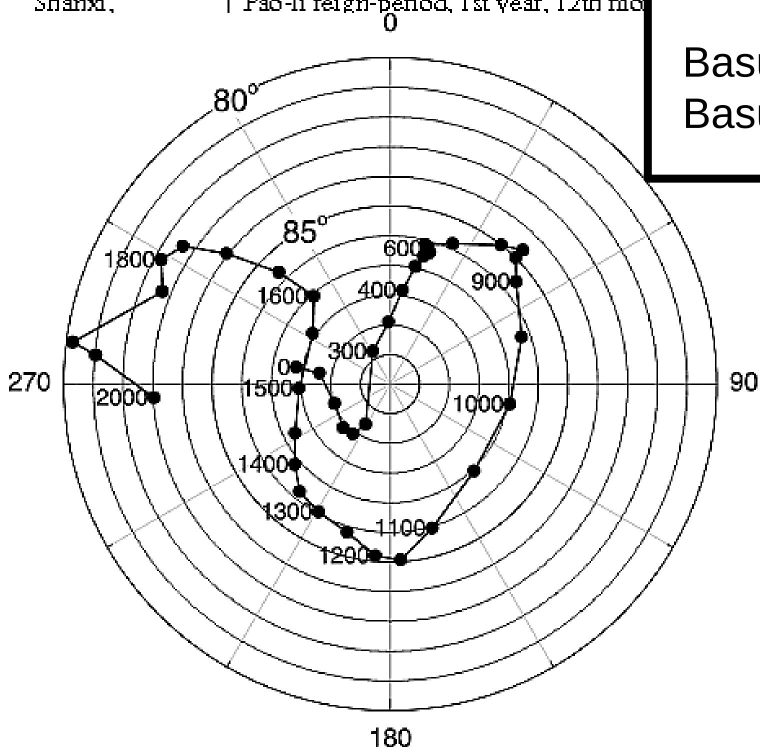
Year	location	reported text (original language or remark from lit. in brackets) [our comment]	N	Ref.	their sources
807	Germany	F73: 803: swords of extraordinary size in the air (Schwerter von ausserordentlicher Grösse in der Luft) (L62: correct is AD 807, Lycosthenes mis-dated and doubled to AD 803 and 808)		F73	Frobesius f. Lycosthenes
807	Central Europe	F73: large armies on sky (Grosse Armeen am Himmel) (AD 808 Jan 28, Feb 1) (L62: AD 807 Feb aurora mis-dated by Lycosthenes: 808 Item 4 Cal fuit eclipsis lunae, et apparuerunt acies in eadem nocte mirae magnitudinis]		F73	Frobesius, Mairan f. Lycosthenes
816 817	Yemen	A reddish glow appeared in the sky and stayed until late at night. (some time during the muslim year running from Aug 816 to Jul 817) [very possible]	2	B05	Ibn-al-Qasim (1689)
817	Germany	in same year fiery war armies appeared in sky in October [very possible] (Eodem anno mense Octobri igneae acies apparuerunt in coelo) N72: Oct	2	L62 N72	Xanten Xanten
817	Iraq	On friday night, a reddish glow appeared in the sky and stayed until late at night. Later on it disappeared but two red columns remained until the dawn. [very possible] (B06: 817 Oct 29) [same month as above sighting in Germany, but first sentence like AD 816/7 above]	2	B06	Ibn Al-Athir
819	Shanxi, China	There was a white rainbow, 5 feet wide, extending from east to west over the sky. (K74: doubtful, Jan 6 at 34N 109E) [possible, moon's first quarter Jan 6/7]	1	K74	T'ang-shu
826	Shanxi,	Pao-li reign-period, 1st year, 12th mo			
		and three other (BCD in K74) reports) different texts: day chi-yu or day i-yu) that month, hence all four reports on the same day]		K74	
		d fiery, and pale-yellow burning. humano rutilantes sanguine,	3	L62 F73	Vita Ludovici, Eginhardi Fulda Schönning, Fulda
		. (47). In the N direction, there was a red vapour.) [very possible, full moon May 14/15]	2	YSW K74	K74 f. Hsin-t'ang-shu T'ang-shu
		2). At night, in the NW there was a red vapour. ipse in northern America and Europe]	3	YSW K74	K74 f. Hsin-t'ang-shu T'ang-shu
		(40). In the capital, there was seen n Sep 8/9]	1	YSW	K74 f. Hsin-t'ang-shu

Basurah, 2005, SoPh 225, 209
Basurah, 2006, J. Atm. Phys. Solar-Terr. Physics 68, 937



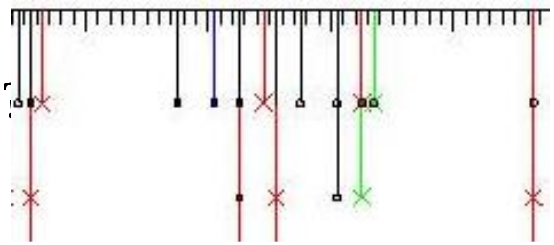
Geomagnet Pole über Vorderasien ~AD 700-900

Candidate Aurorae in the 770s:

770 Jun 20, Xian, China: “In the **NW**, a white vapour extended across the sky.” (Keimatsu) N=1, moon's last quarter Jun 20/21, possible aurora (?)

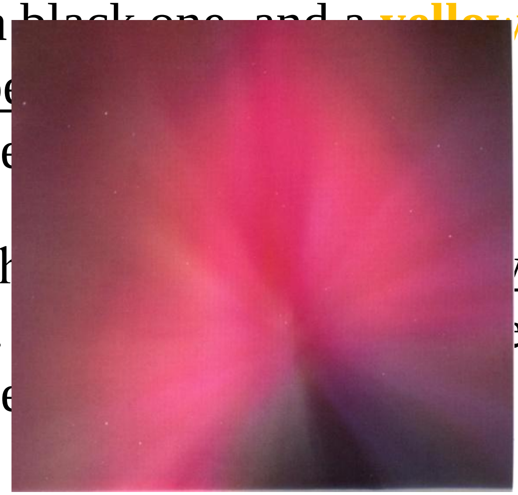
770 Jul 20, Xian, China: “A white vapour appeared in the **NW** direction. It extended accross the sky.” (Keimatsu), N=1, moon's last quarter Jul 2, possible aurora (?)

772 Sep 29, Ireland: “The assembly of the hand-clapping at which occurred lightning and thunder like the day of judgment. The hand-clapping on St Michael's Day 29 Sep which called **fire from heaven**.” (Usoskin)
N=2, new moon Oct 1, very possible aurora or thunderstrom



772 summer, Amida, Turkey: “Another sign appeared in the **northern** side …
ne, a black one, and a yellow one …
shape
twee … at corn harvest: summer 772

: “Th … year ago in the **northern** region
ar … … e …” (Dall’Olmo)
twee … in Haziran: 773 June

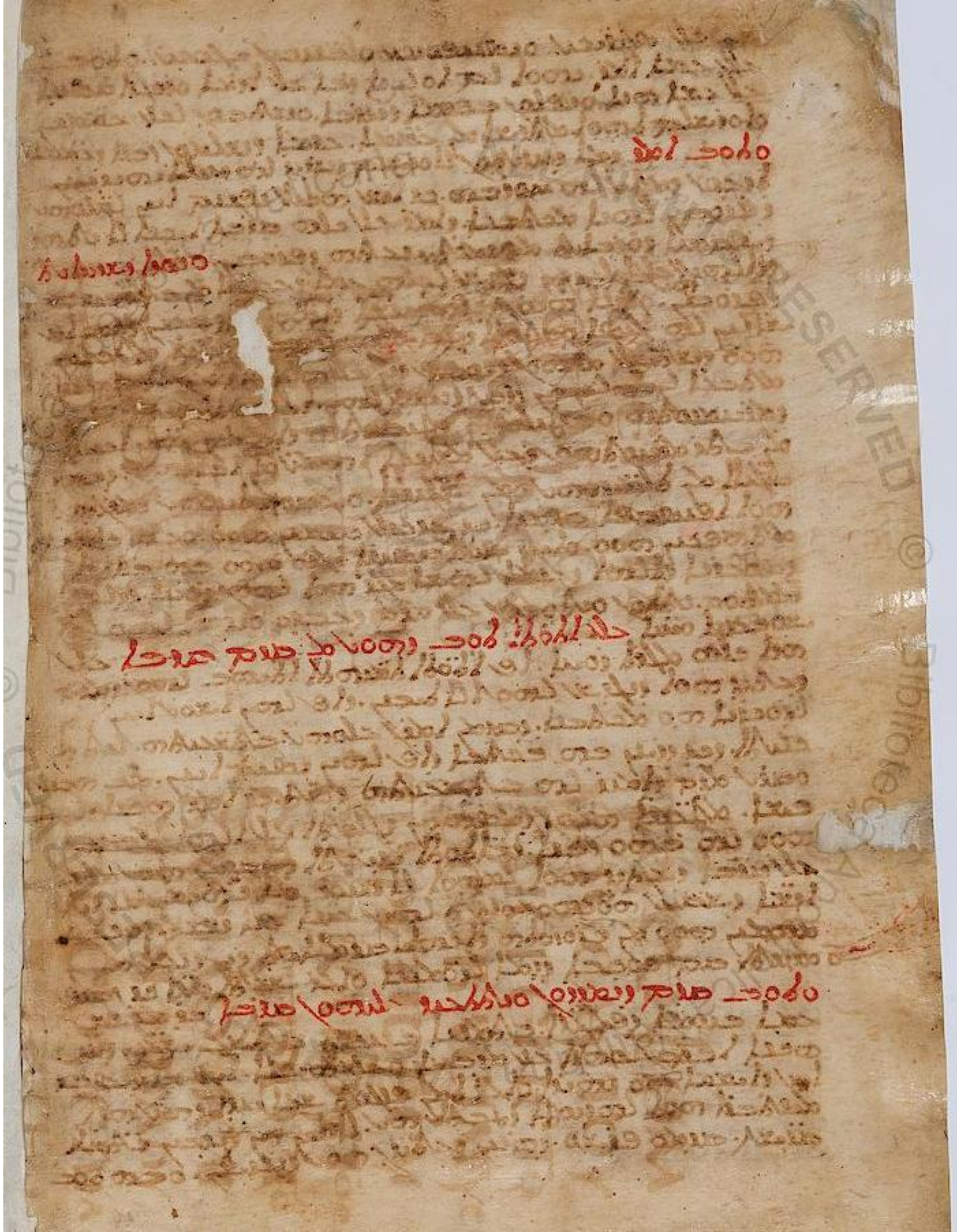


Chronik von Zuqnin
aus Amida (= Diyabakır, Türkei),
beendet AD 775/6,
auf Alt-Syrisch (Palimpsest)

772: Ein anderes Zeichen erschien im Norden …
das war sein Anblick: Ein roter Strahl, ein grüner,
ein schwarzer und ein gelber. Es bewegte sich vom
Boden nach oben: Sobald ein Strahl niederging,
stieg ein anderer auf. Während es beobachtet wurde,
gab es 70 Veränderungen.

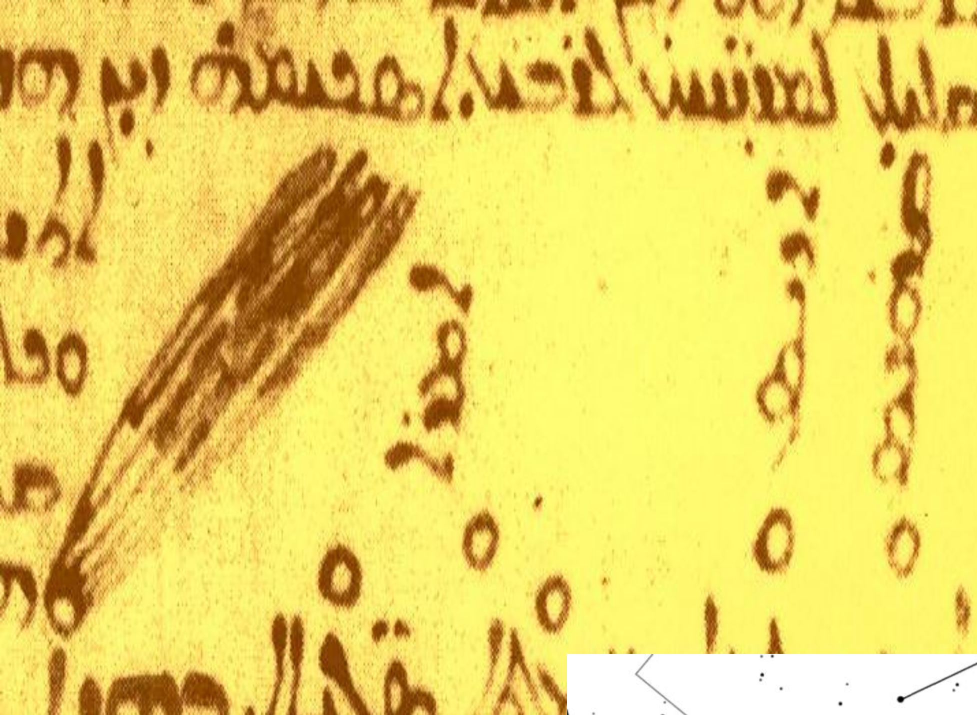
An einem Freitag im
Sommer AD 772

Und an einem Freitag
im Juni AD 773



First ~ 100 folios
Palimpsest
(syriac on greek)
Translated to English
by Harrak

Halley AD 66
over Jerusalem



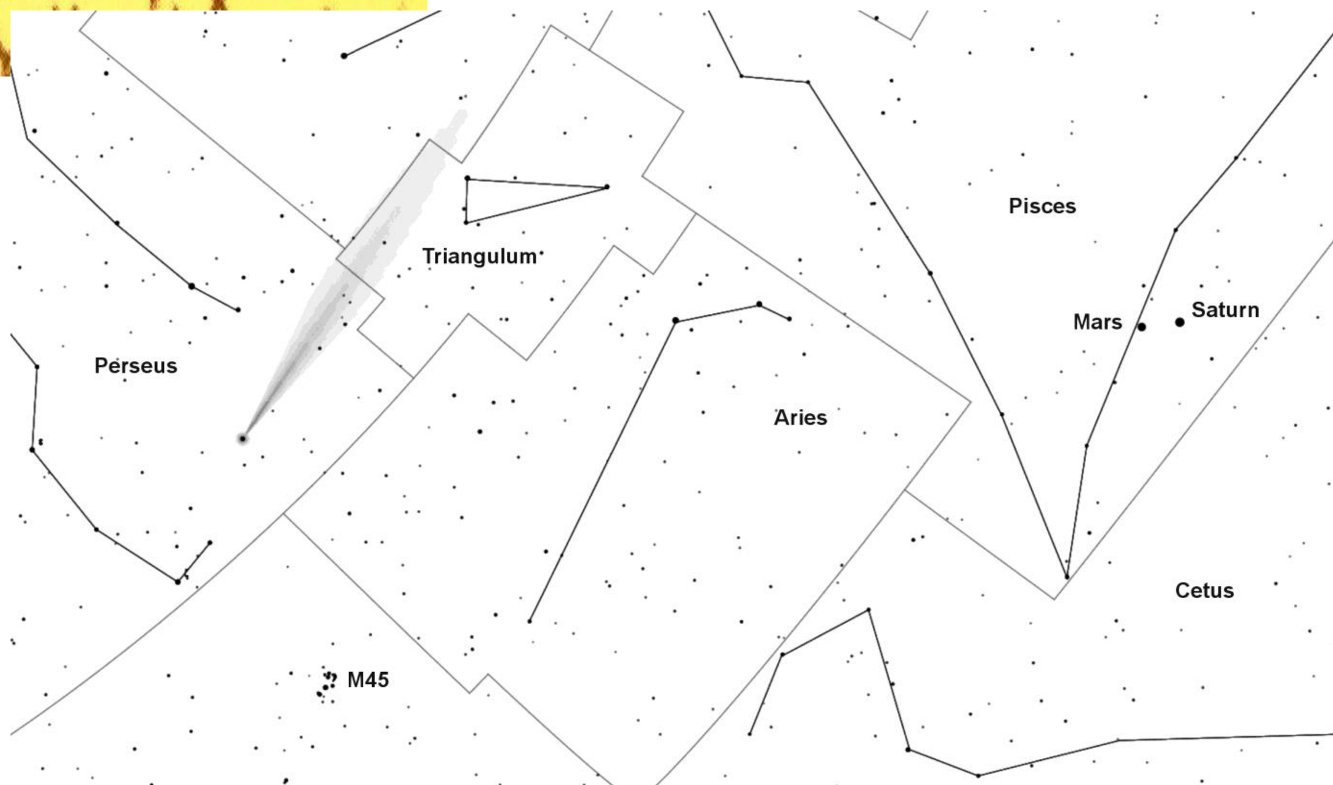
← From the Chronicle of Zuqnin in Amida (today Diyabakir, Turkey), finished in AD 775/6, written in Syriac.

Ares = Mars

Kronos = Saturn

Comet Halley

Aries



AD 772 / 773

Are these the expected super-strong aurorae ?



No !

No extra C-14 peaks around 793 nor 817 !

Aurora sightings from AD 575 to 841

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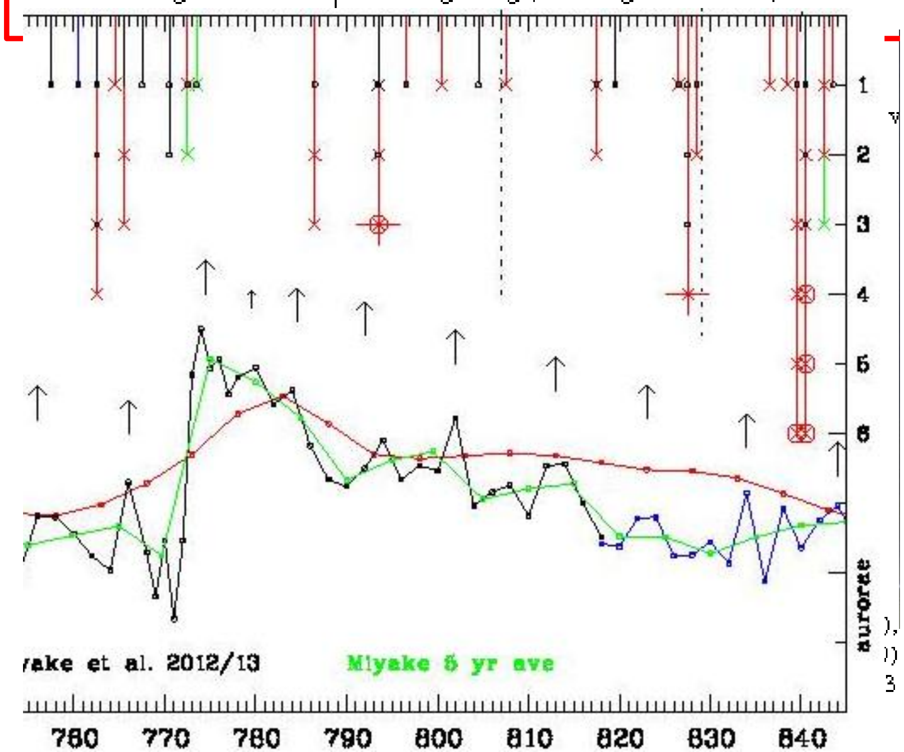
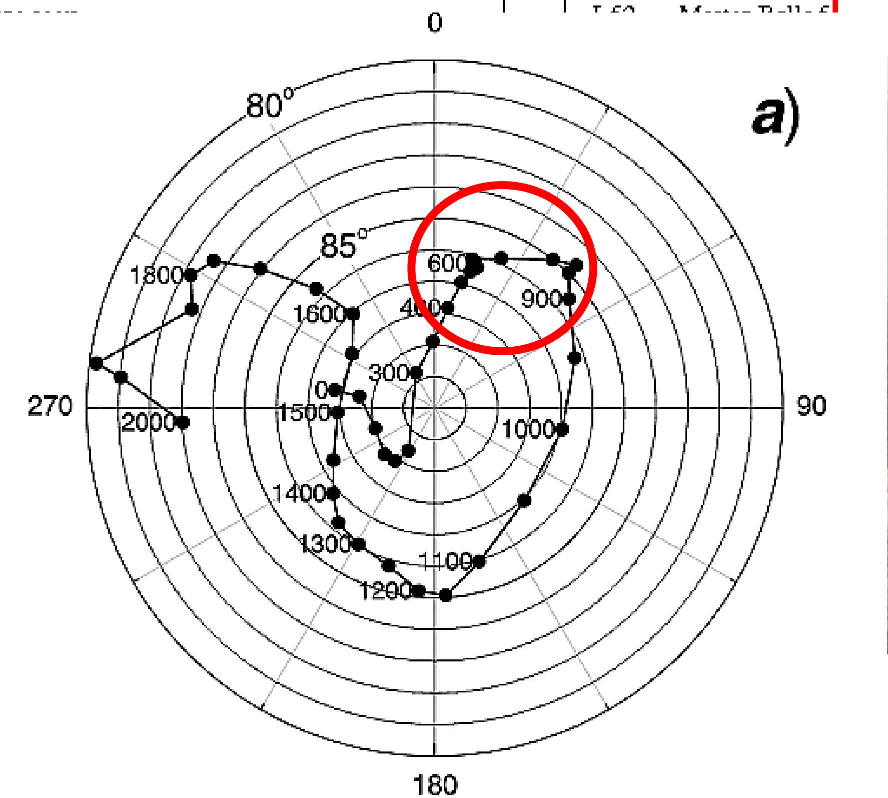
793	Arabia	In this year (177 hidschra, i.e. 793 Apr 18 - 794 Apr 6), according to what al-Waqidi has mentioned, there occurred a (violent) wind, and overshadowing (of the heavens) and a redness (in the sky), on the night of Sunday (i.e. the night of Saturday-Sunday, but actually Monday), the 26th of al-Muharram (793 May 13). Then there was a further overshadowing (of the heavens) on the night of Wednesday (i.e. the night of Tuesday-Wednesday), the 28th of al-Muharram (793 May 15), and then a violent wind and intense overshadowing of the heavens on Friday (actually Sunday), the 2nd of Safar (793 May 19). [very probable, new moon May 14/15, solar eclipse on May 14 in America, aurorae May 13-19]	4	NN	Bosworth 1989 f. al-Tabari
793	Europe	F73: large (Gross) [source not found, potential, maybe same as next]	0	F73	Schöning
793	Northumbria, England	In this year terrible portents appeared over Northumbria, and miserably frightened the inhabitants: these were exceptional high winds and flashes of lightning, and fiery dragons were seen flying in the air. A great famine soon followed these signs; and a little after that in the same year on 8 Jan, the harrying of the heathen miserably destroyed God's church in Lindisfarne by rapine and slaugther. [event with *heathen* men was first viking attac to England AD 793 Jun 8 according to Simeon of Durham; hence, the date given above in the Anglo-Saxon Chronicle text (Jan 8) is wrong, correct date is Jun 8] [very possible]	2	J70	Anglo-Saxon C.
793	England	S84: ca. AD 793 aurorae are seen in N Europe (fiery flying dragons and rain of blood)		S84	
793	England	terrific lightnings, and dragons in the air, and strokes			





Fragliche Fälle:

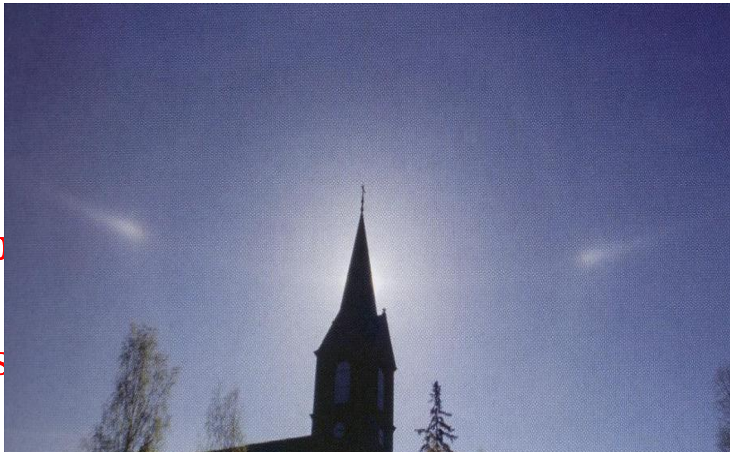
773 Unterdessen erschienen einigen Christen in der **Burg (Fritzlar)** sowie einigen Heiden, die bei diesem Heer waren, zwei junge Leute auf Schimmeln [bzw. in weiß] (juvenes in albis), die diese Kirche vor dem Feuer schützten. (Fränkische Chronik) N = 0 ? **Nebensonne(n) im Osten**

774 (?) „Her ooeowde read Cristes mael on heofonum aefter sunnansetlgange"
Es wurde auch gesehen ein rotes Christusmal (Kreuz) am Himmel bei/nach Sonnenuntergang.
(Angel-Sächsische Chronik) N = 1 – 2 **?** **Parhelion-Lichtkreuz**
Allen (2012, Nature Corr.) und Gibbons & Werner (2012, Nature Corr.):
Supernova in 774 oder Aurora in 776 ?

776 Man habe, etwas wie zwei Schilde in roter Farbe flammen und sich über dieser Kirche **(Syburg bei Dortmund)** bewegen gesehen. (Fränkische Chronik) N = 2 ?
Nebensonnen im Süden

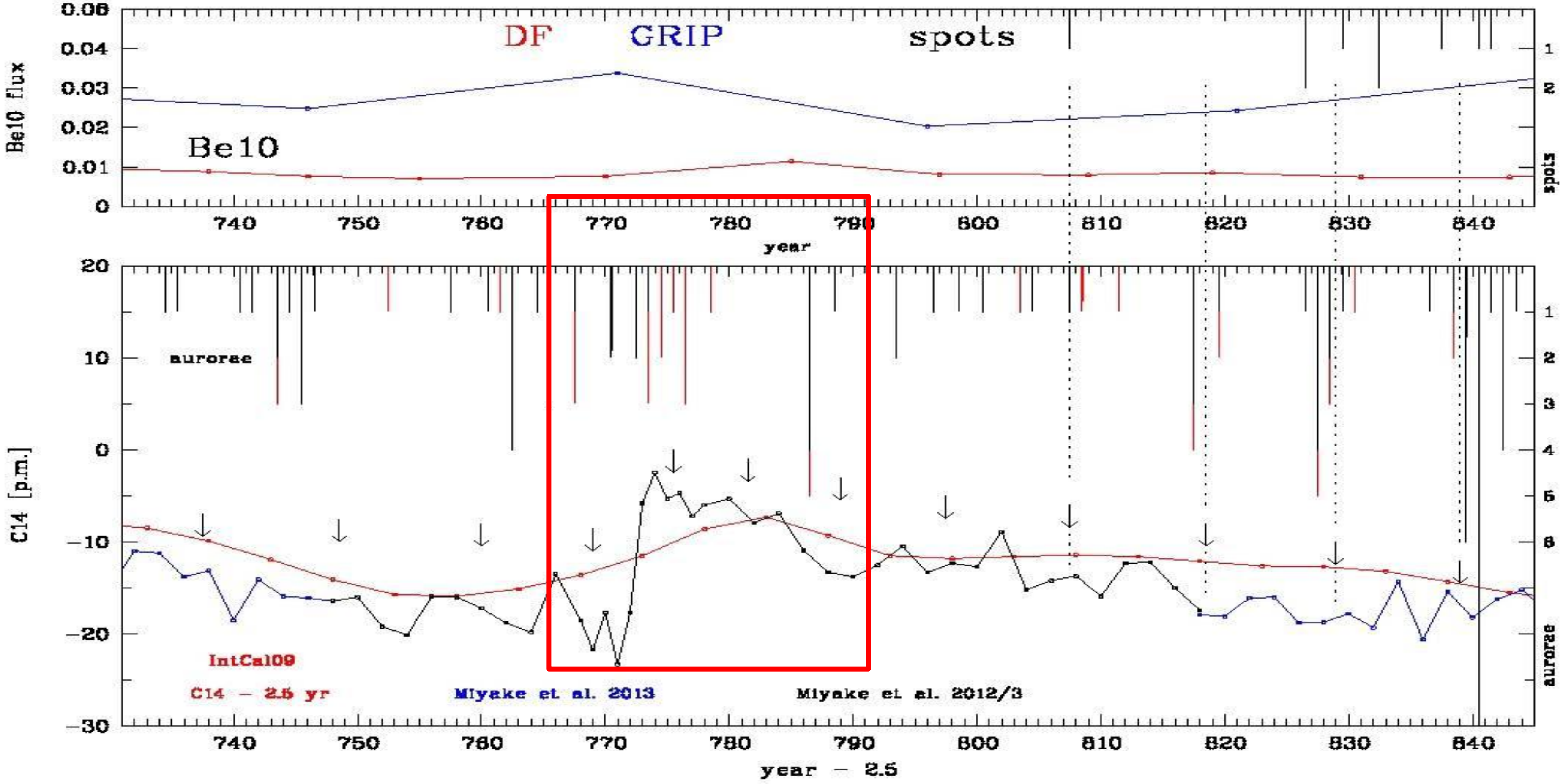
Gibbons & Werner (2012, Nature Corr.): Aurora in 776 ?

Usoskin et al. (2013 **Auro**
und sehen darin ein
somit Indiz für Son 4 Ans



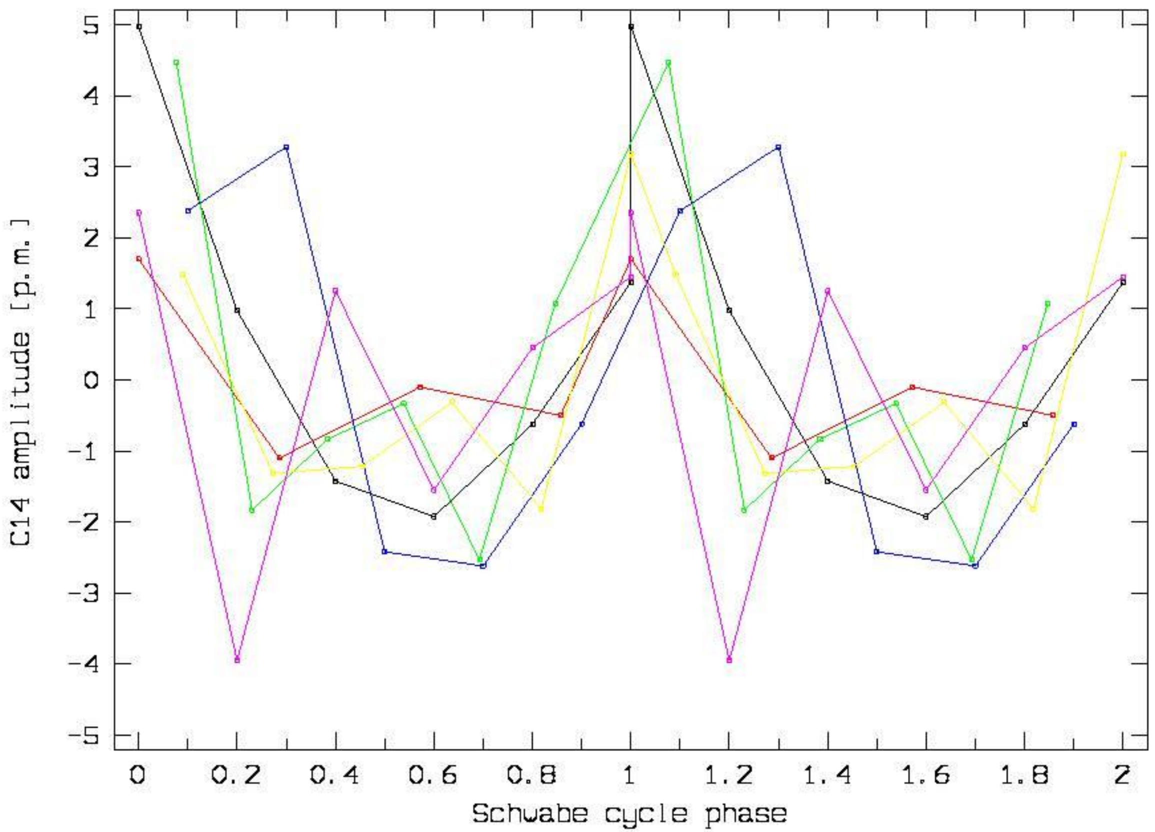
Aurorae around 775

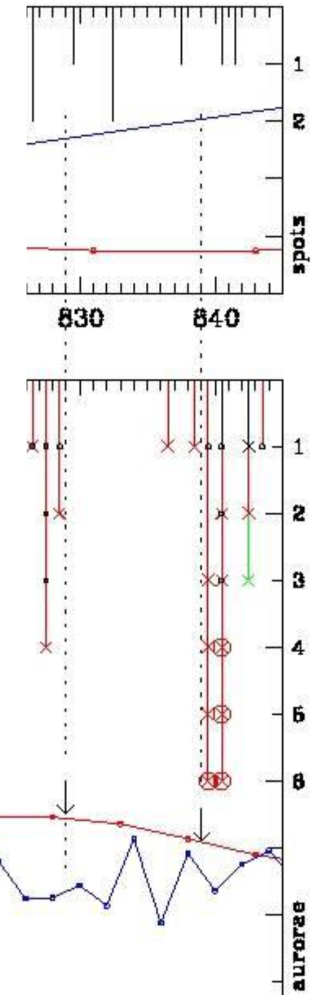
„true“ plus „false“

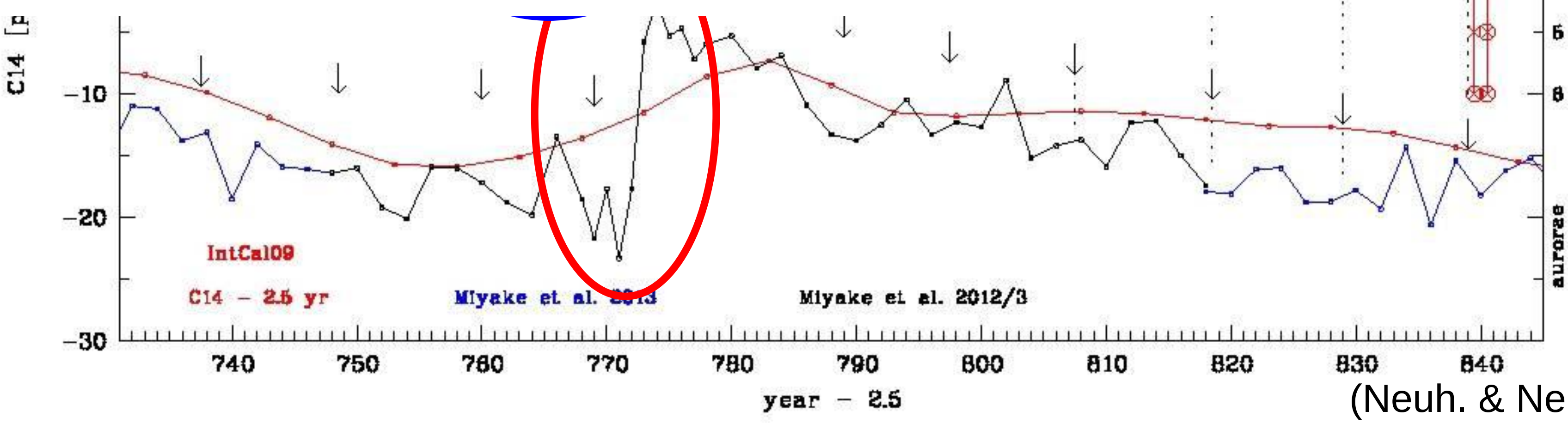


Neuh & Neuh 2015

ße Schlachtreihen …
ner schwarzer Fleck,
g und als es wegzog,

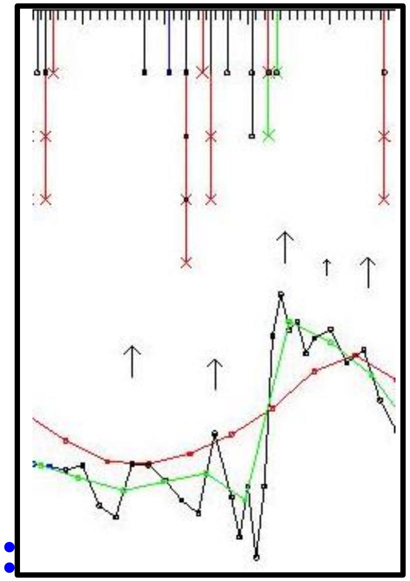






(Neuh. & Neuh. 2015)

Problems for interpretation as solar super-flare:



➔ **No sunspot sightings for decades around AD 775.**

➔ **No aurorae after AD 773 for 13 yr**
(but several in the 760s).

➔ **Carrington event 1859 not detected in ^{14}C (nor ^{10}Be): If 775 were a super-flare (12 p.m. in 1 yr) ~6 x stronger than Carrington, the latter should have been detected (~2 p.m.).**

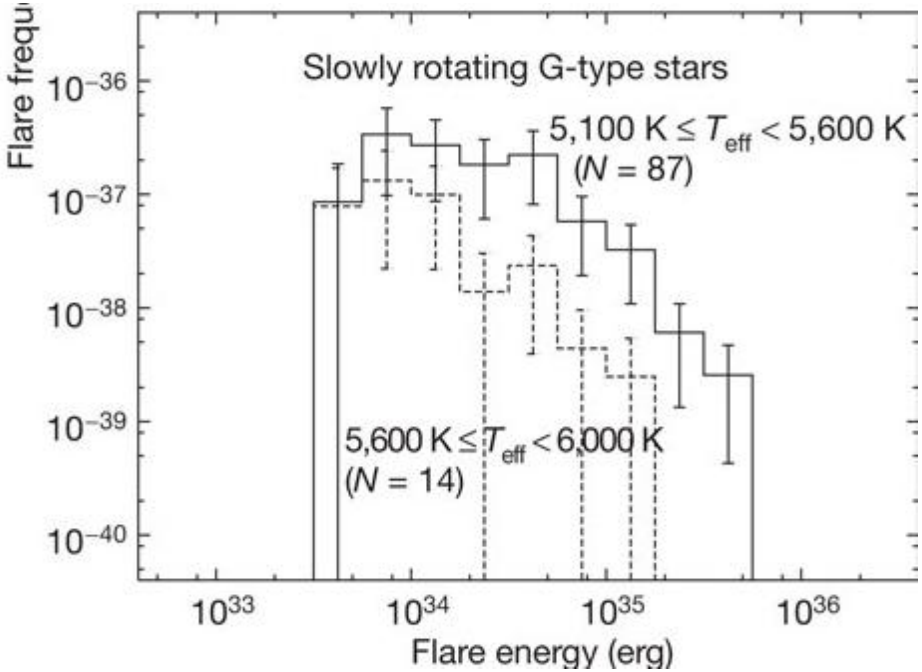
➔ **Cliver et al. (2014): Scaled to SPE 1956, AD 775 as flare would be ~X230 – problematic by comparison with 1945-1995.**

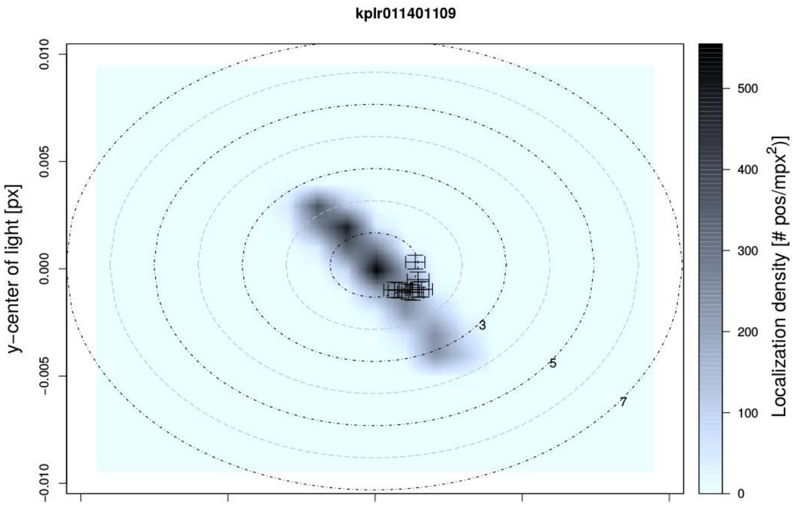
➔ **Flare with 10^{34} erg would cover 12% of the solar surface – impossible, because magnetic field of the Sun is not large enough** (Schrijver et al. 2012, Aulanier et al. (2013).

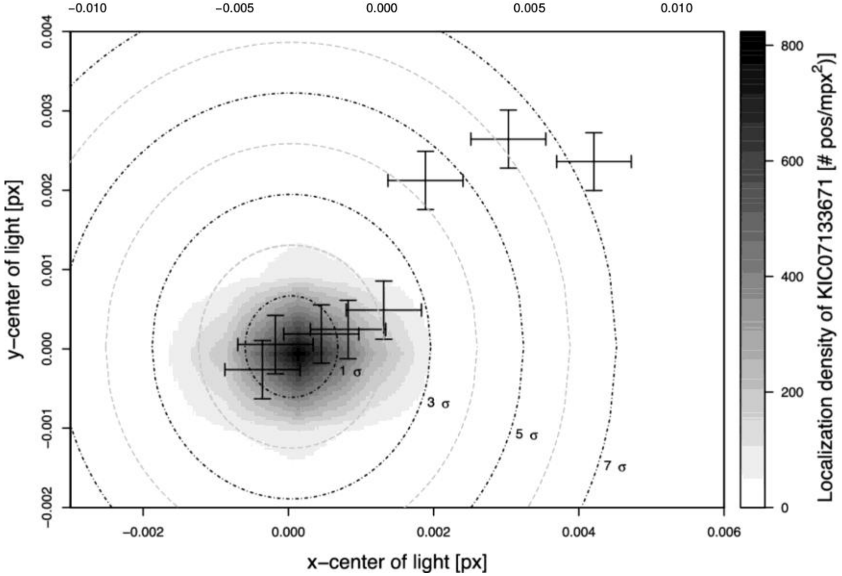
➔ Equating effective plasma pressure of solar magnetosheet and magnetic pressure of the Earth dipole field, the largest possible storm would be ~2 times larger than the Carrington event (Vasyliunas 2011).

➔ **Stellar super-flares highly uncertain (Kitze+RN 2014, etc.).**

Re-analysis of Kepler data on early G-type stars (PhD thesis by Manfred Kitze, U Jena)





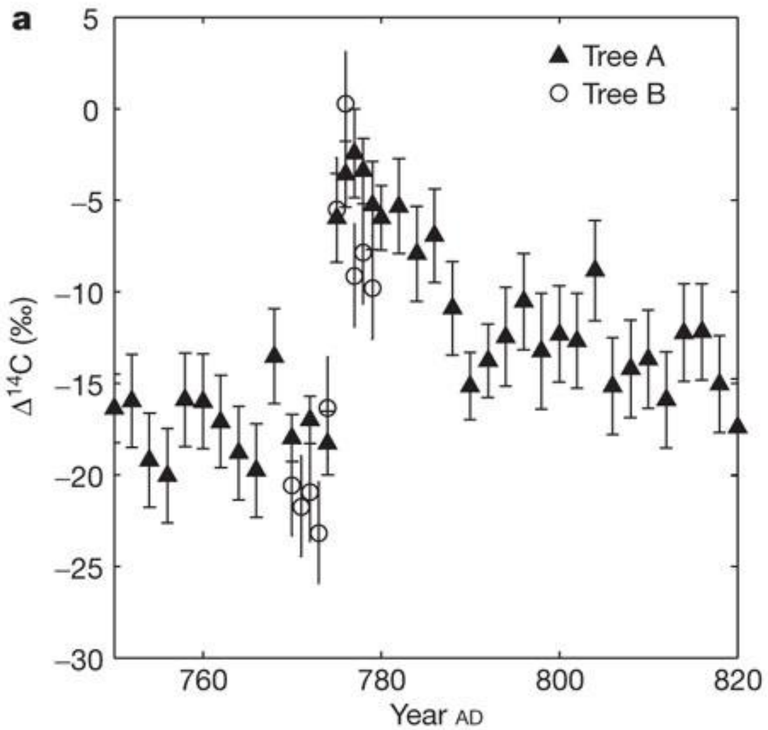


Many G-type stars with super-flares, but:
- either much younger than our Sun
- or close multiples (interacting)
- or flare happened on a different star
- or multiple super-flares within 4 yr
- or „flare“ is just one data point, etc.

76 super-flares left (unresolved multiples or high magnetic fields ?)

(Wichmann et al. 2014: at least some G-type Kepler super-flare stars are GIANTs)

Was war die Ursache ?



Miyake et al. 2012

Supernova ? Nein, zu schwach

Gamma-ray burst ? zu selten

Sonnen-Flare ? no

Sonstwas ?
(Komenteneinschlag, Magnetfeldschwankung, Vulkanausbruch, etc.)

Was war die Ursache ?

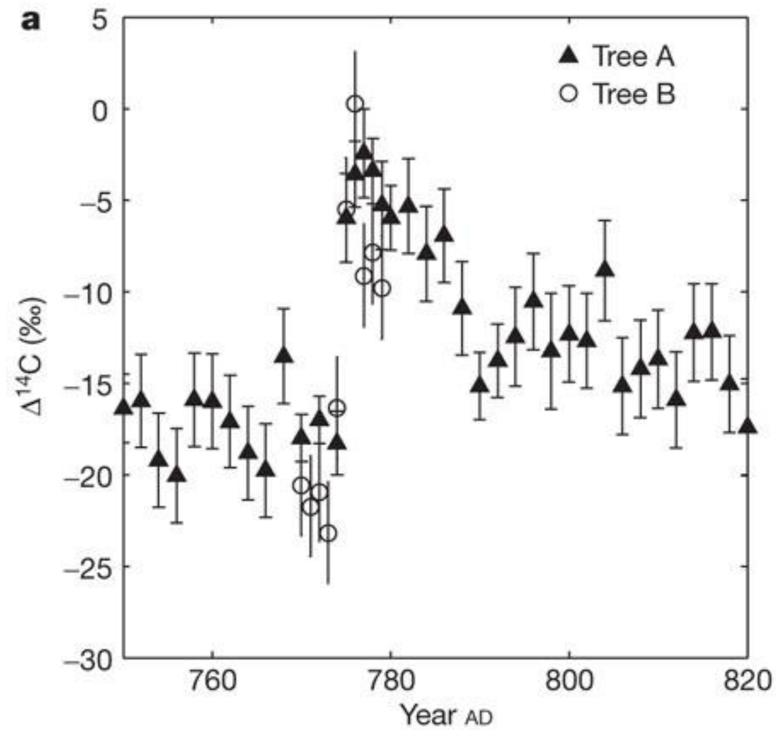
Supernova ? Nein, zu schwach

Gamma-ray burst ? zu selten

Sonnen-Flare ? no

Sonstwas ?

(Komenteneinschlag, Magnetfeldschwankung, Vulkanausbruch, etc.)



Miyake et al. 2012

In very cold spring and summer, some trees do not form a new tree ring (Mann et al. 2012 Nat. Geosc.)

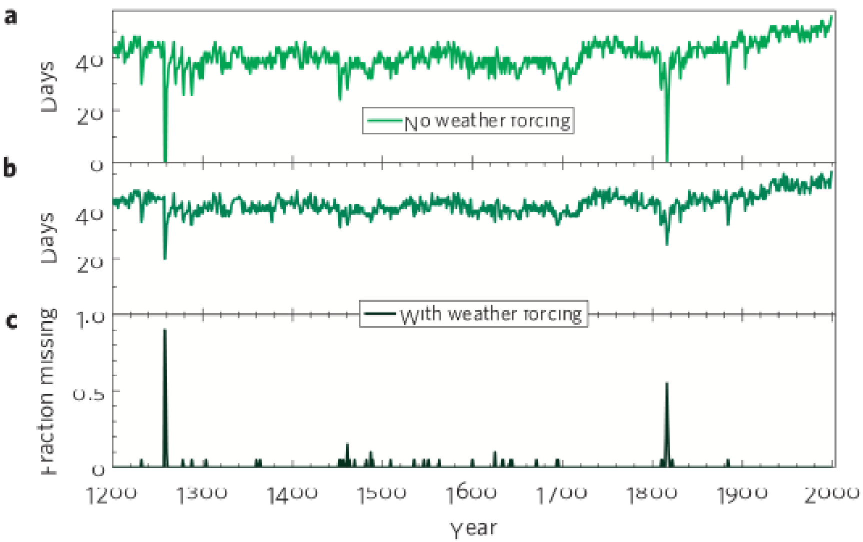
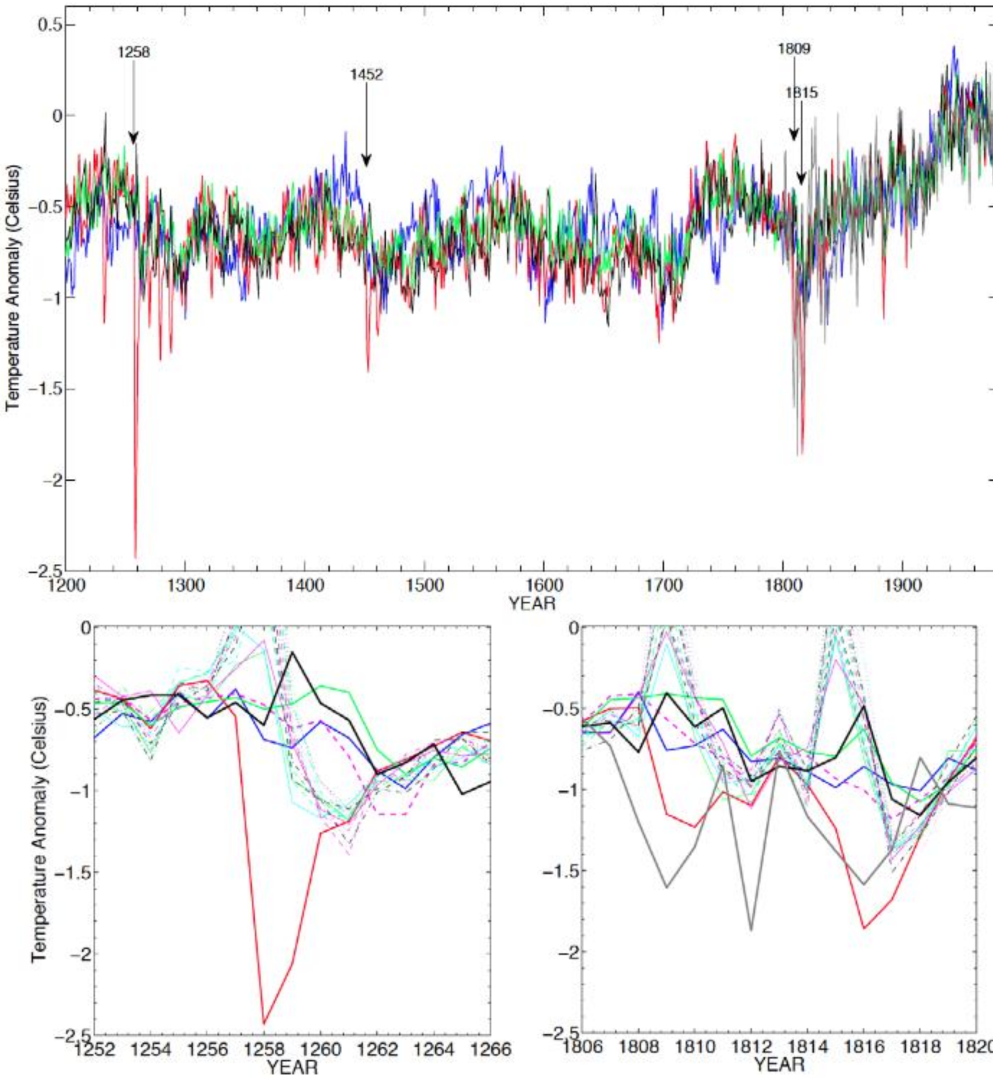
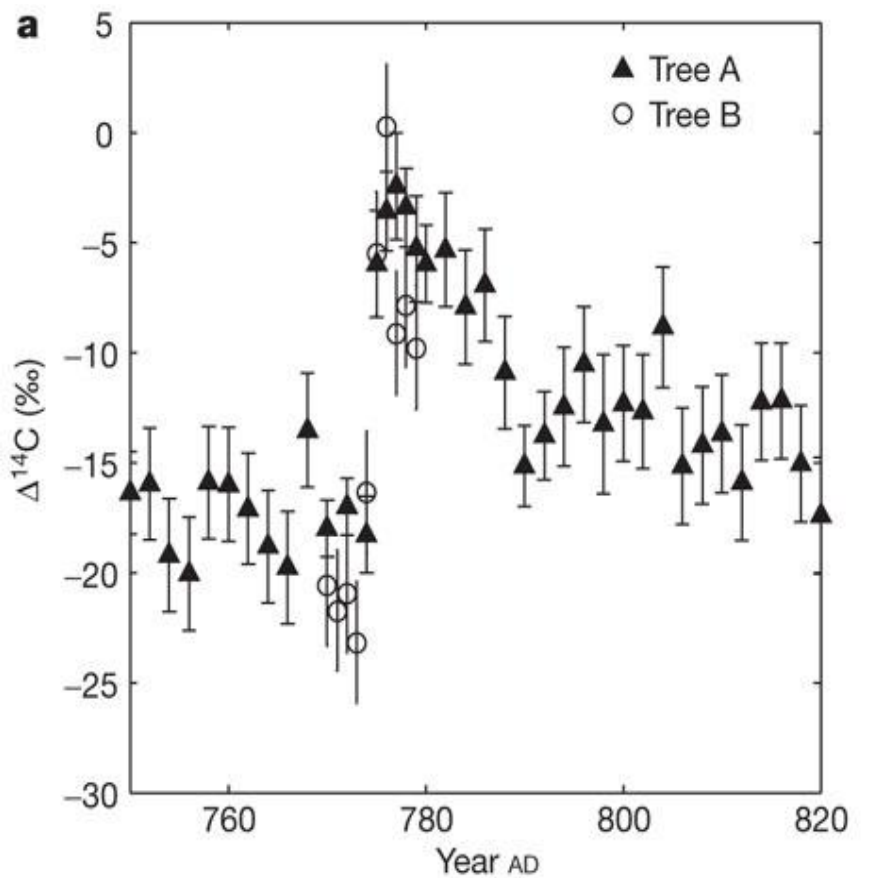


Figure 3 | Growing-season statistics. a,b, Estimated average length of the growing season (number of days of non-zero growth) based on the biological growth model driven by the GCM simulation without stochastic weather forcing (**a**) and with stochastic weather forcing (**b**). **c**, For the latter case, the fraction of the 20 regional series for which we infer a 'missing ring' for each year.

Tree rings and volcanic cooling



Short rise (7σ) within 1 yr



Difference in dating,
if no tree ring was formed
in 1 to few years ?!

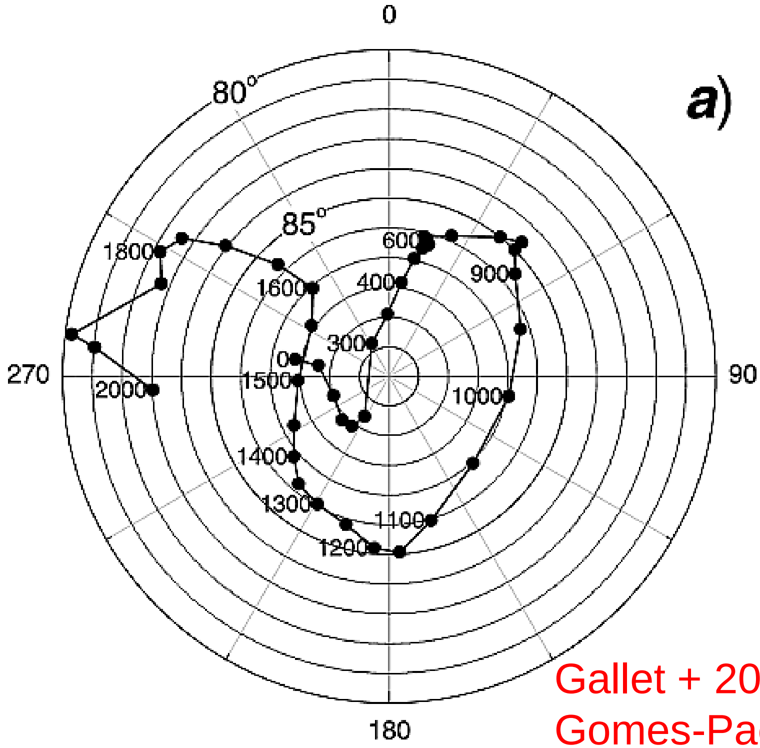
Event was earlier (772 / 773)

Difference in dating,
if 2 tree rings were formed
within one year ?!

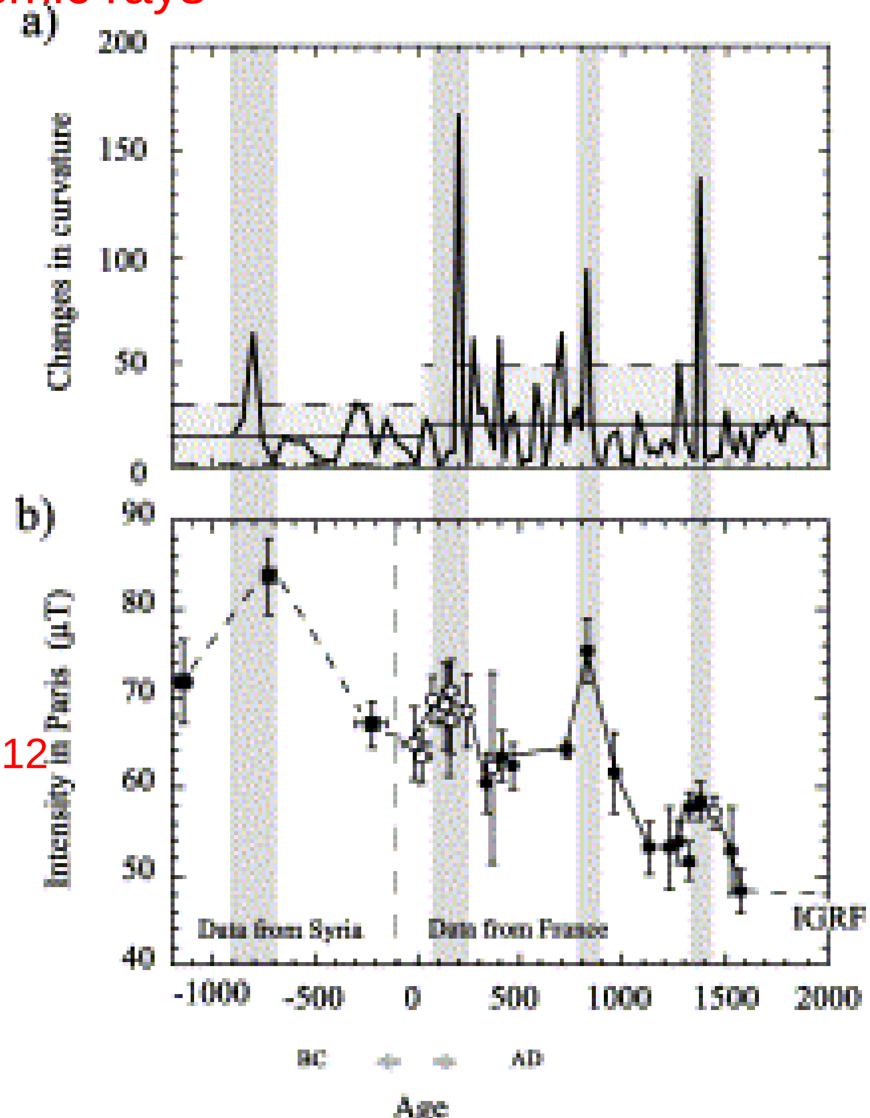
Event was later (776 / 777 …)

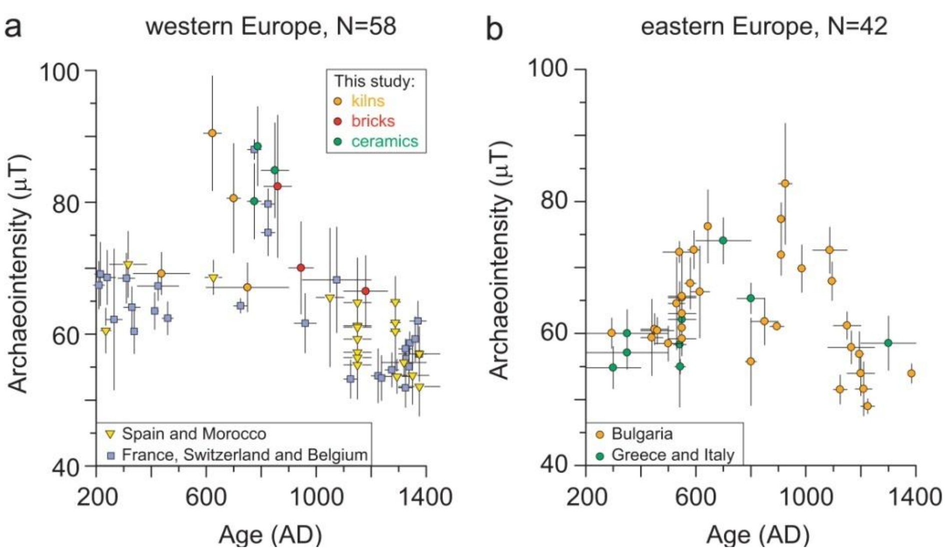
Or even no event at all (if no tree rings were formed in the years before the apparent spike)

Geomagnetic field: shields Earth from cosmic rays



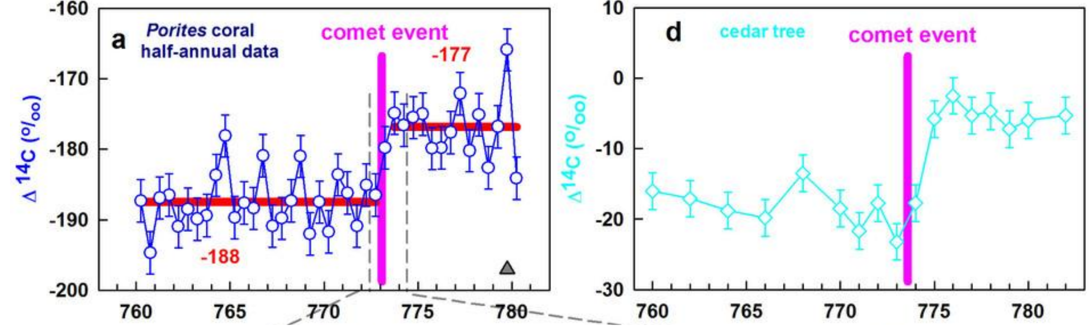
Gallet + 2006
Gomes-Paccard + 2012

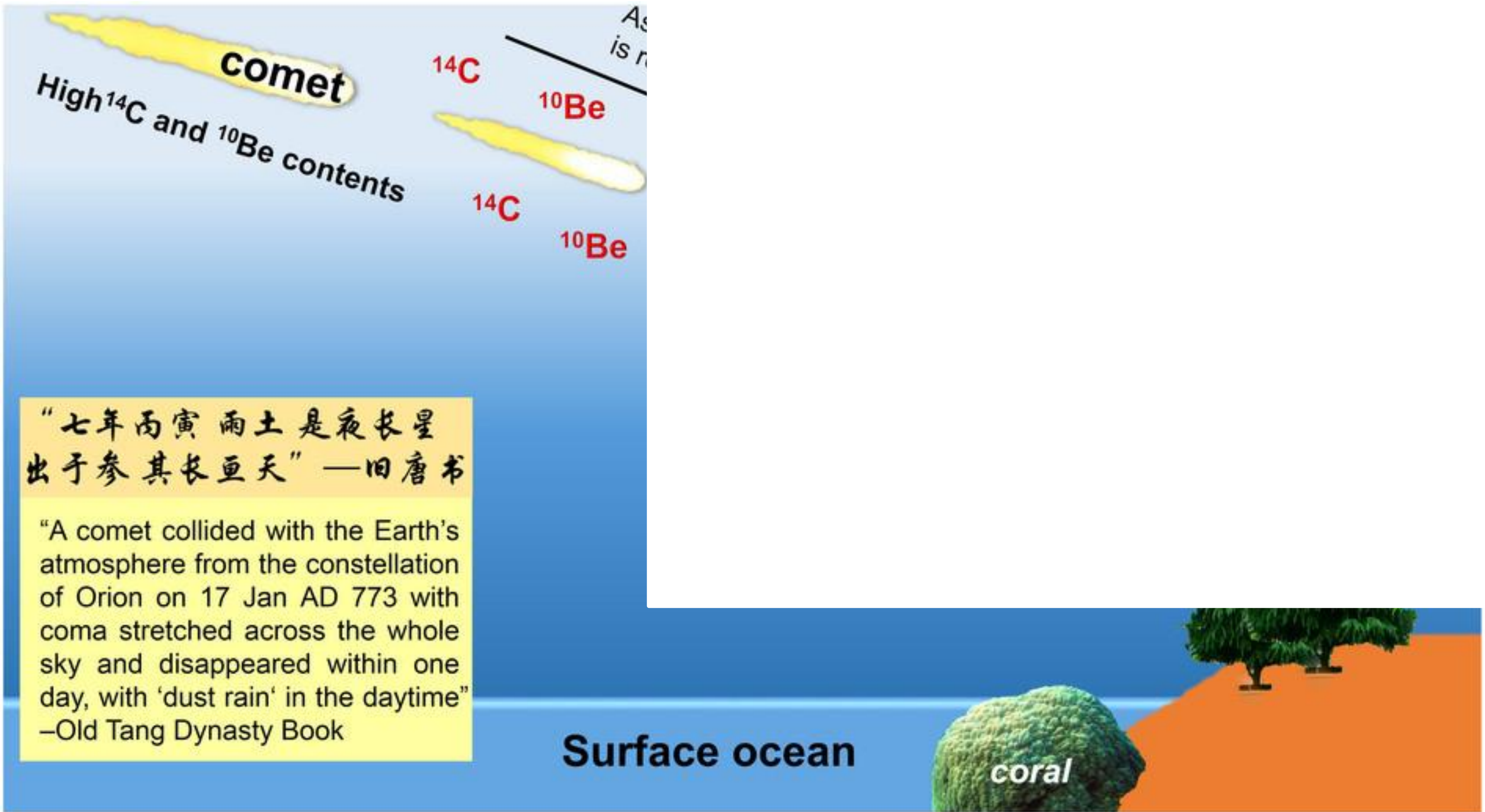




Around AD 800: Large directional change, broad peak, and deep short minimum ➔ Relation to cosmic-ray peak ?

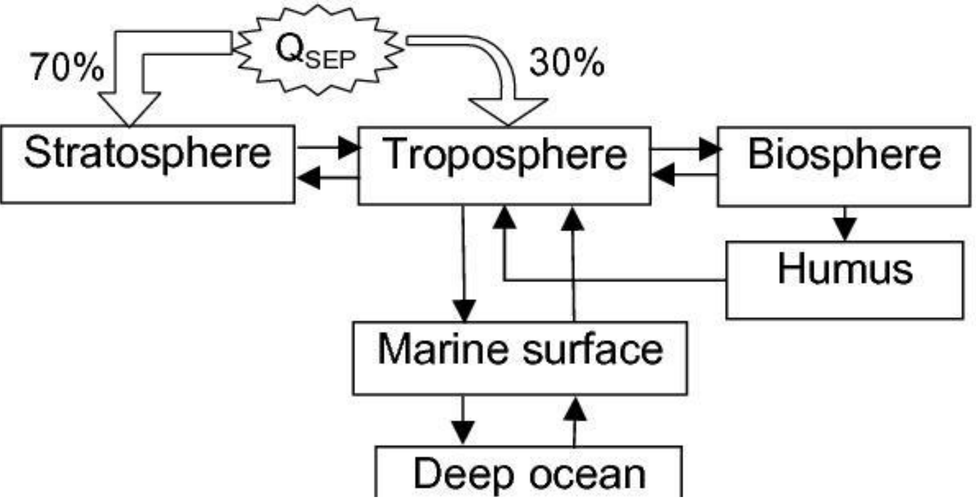
Liu et al. (2014 Nat SR):
Kometeneinschlag

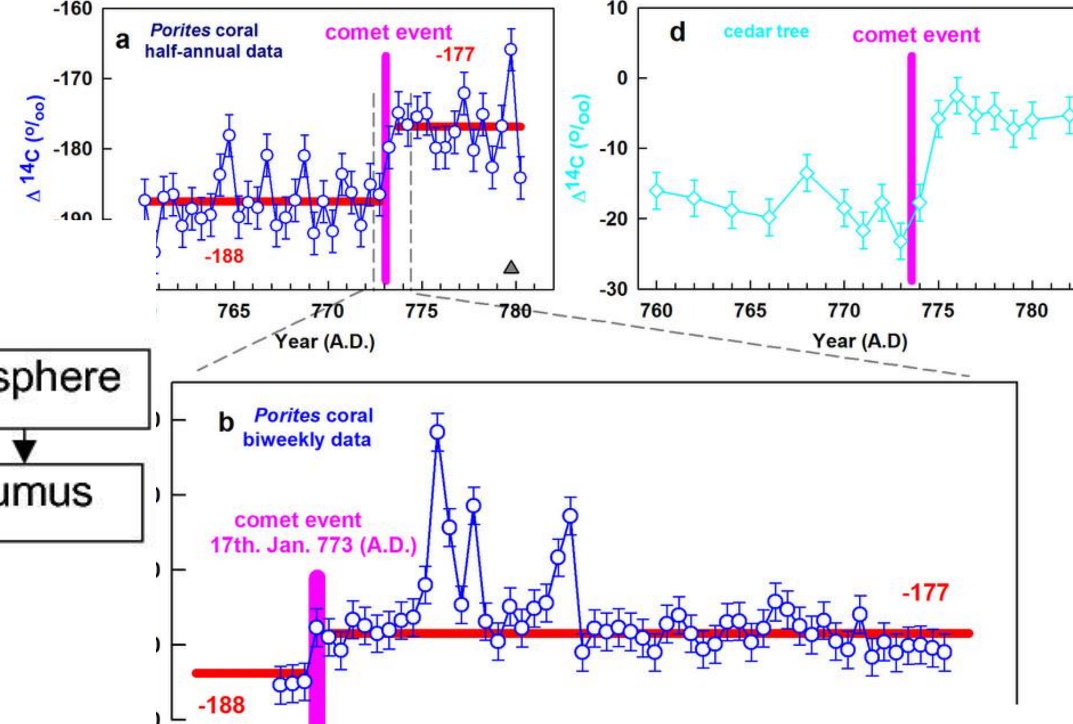


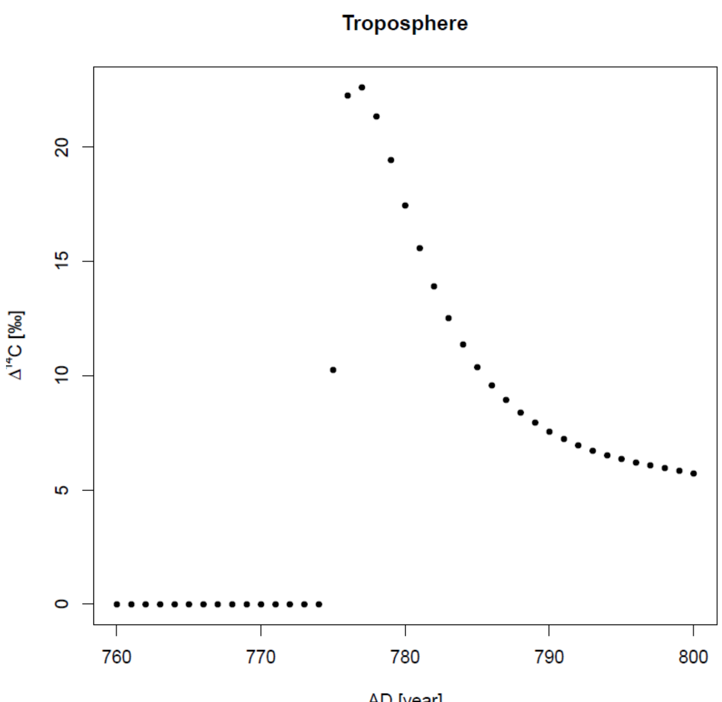


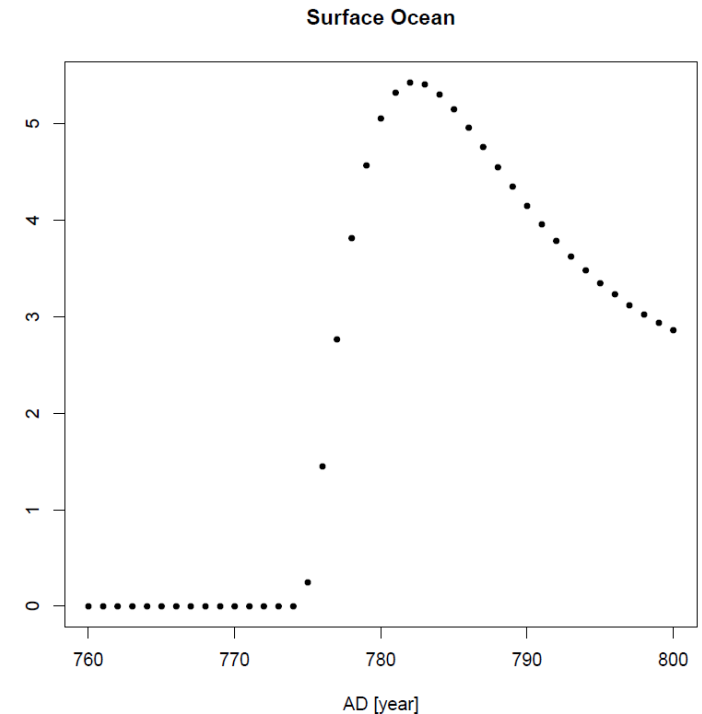
Liu et al. (2014 Nat SR)

But:







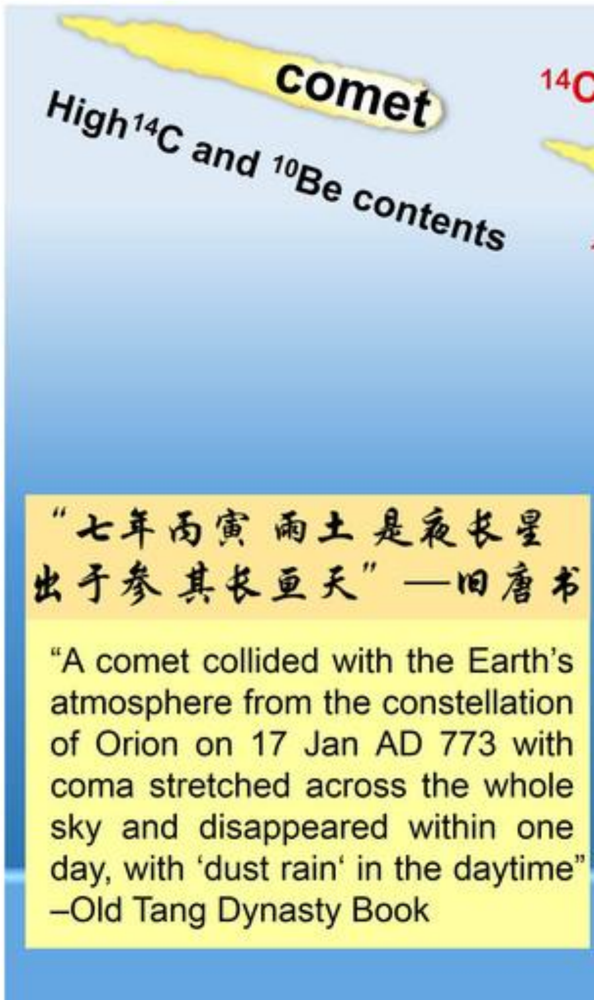


Liu et al. (2014 Nat SR), **<u>but:</u>**

True Chinese text reads:

On 773 Jan 17 it rained down dust, and there was a long star that emerged beneath Orion. Its length traversed the sky. Long stars belong to the class of comets.

(observed later also in Japan)



Astron. Nachr. / AN **999**, No. 88, 789 – 792 (2014) / **DOI** ***please set DOI!***

The Chinese comet observation in AD 773 January

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Received 2014, accepted
Published online

Key words comet AD 773, 14-C event AD 774/5

The strong ^{14}C increase in the year AD 774/5 detected in one German and two Japanese trees was recently suggested to have been caused by an impact of a comet onto Earth and a deposition of large amounts of ^{14}C into the atmosphere (Liu et al. 2014). The authors supported their claim using a report of a historic Chinese observation of a comet ostensibly colliding with Earth's atmosphere in AD 773 January. We show here that the Chinese text presented by those authors is not an original historic text, but that it is comprised of several different sources. Moreover, the translation presented in Liu et al. is misleading and inaccurate. We give the exact Chinese wordings and our English translations. According to the original sources, the Chinese observed a comet in mid January 773, but they report neither a collision nor a large coma, just a long tail. Also, there is no report in any of the source texts about *dust rain in the daytime* as claimed by Liu et al. (2014), but simply a normal dust storm. Ho (1962) reports sightings of this comet in China on AD 773 Jan 15 and/or 17 and in Japan on AD 773 Jan 20 (Ho 1962). At the relevant historic time, the Chinese held that comets were produced within the Earth's atmosphere, so that it would have been impossible for them to report a *collision* of a comet with Earth's atmosphere. The translation and conclusions made by Liu et al. (2014) are not supported by the historical record. Therefore, postulating a sudden increase in ^{14}C in corals off the Chinese coast precisely in mid January 773 (Liu et al. 2014) is not justified given just the ^{230}Th dating for AD 783 ± 14.

Liu Xu 劉昫, *The Old History of the Tang Dynasty* (*Jiu Tang shu* 舊唐書)

(1) 十二月丙寅，雨土。是夜，長星出於參。

(2) 十二月甲子，太白入羽林。丙寅，雨土，是夜，長星出于參。

Ouyang Xiu 歐陽修, *The New History of the Tang Dynasty* (*Xin Tang shu* 新唐書)

(3) 十二月丙寅，雨土，有長星出于參。

(4) 七年十二月丙寅，有長星于參下，其長亙天。長星，彗屬。參，唐星也。

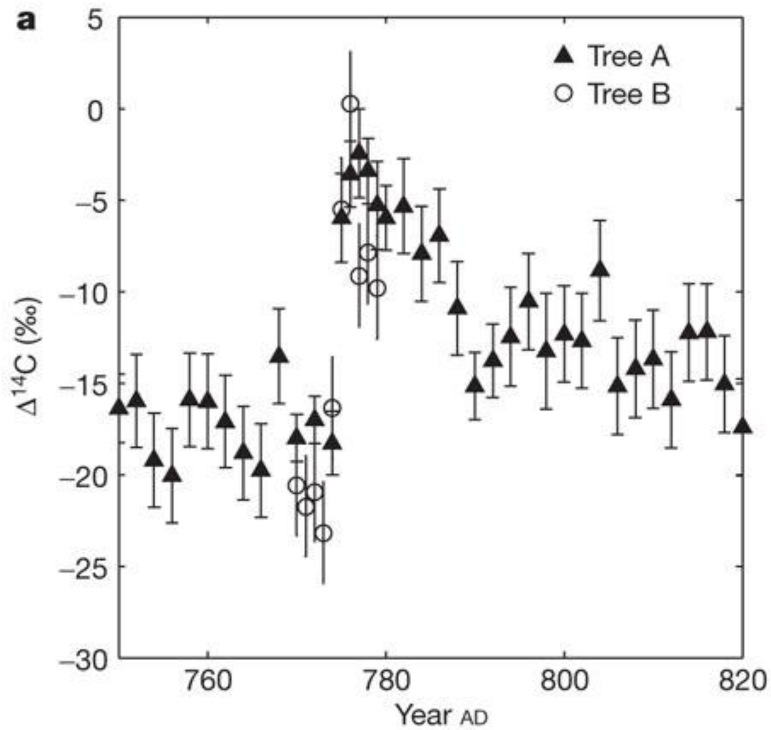
Wang Pu 王溥, *Essential Records of the Tang Dynasty* (*Tang Hui yao* 唐會要)

(5) 七年十二月二十日，長星見。

Ma Duanlin 馬端臨, *Comprehensive Investigation of Historical Documents* (*Wenxian tongkao* 文獻通考)

(6) 七年十二月丙寅，有長星於參下，其長亘天。長星，彗屬。參，唐星也。

Was war die Ursache ?



Miyake et al. 2012

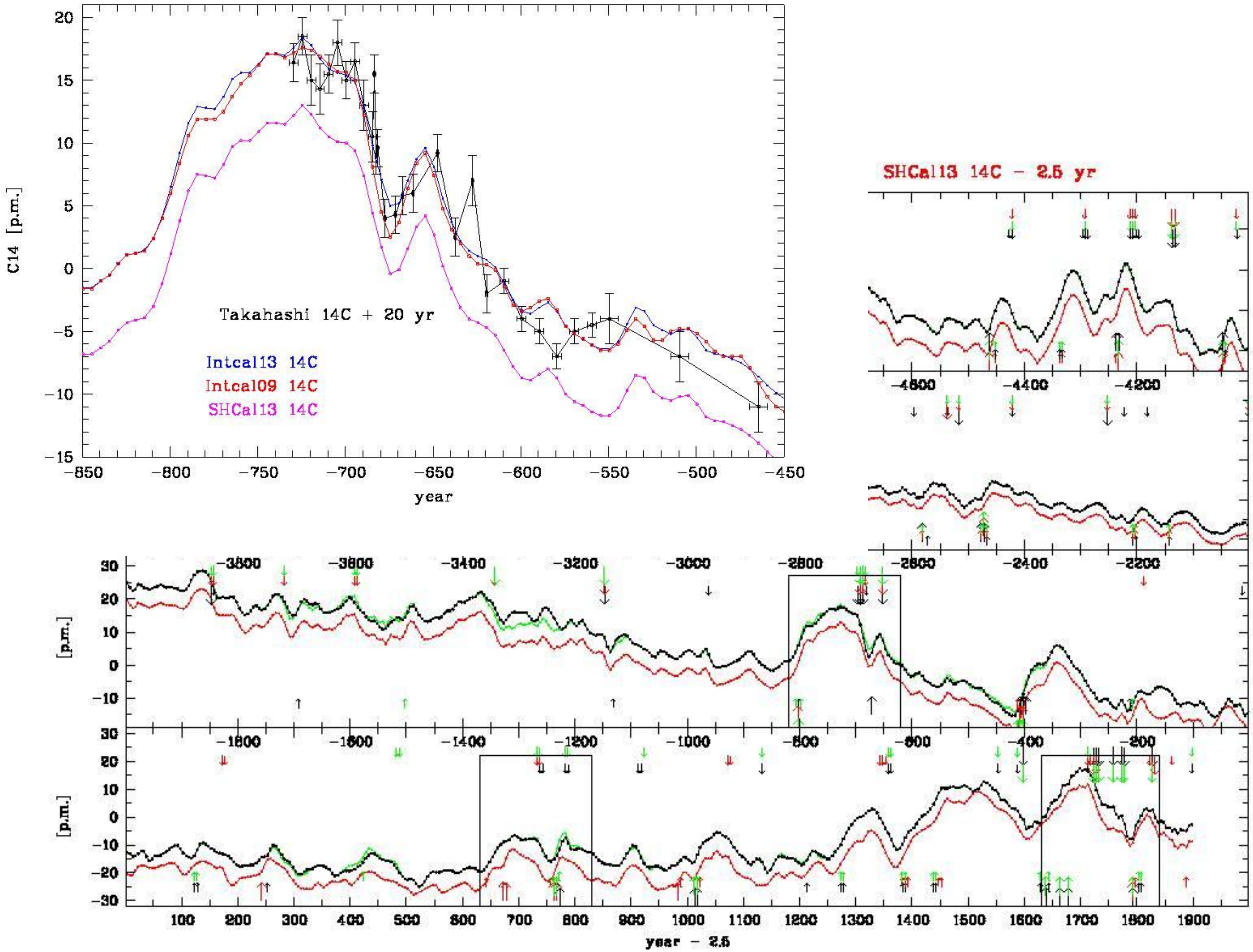
Supernova ? Nein, zu schwach

Gamma-ray burst ? zu selten

Sonnen-Flare ? no

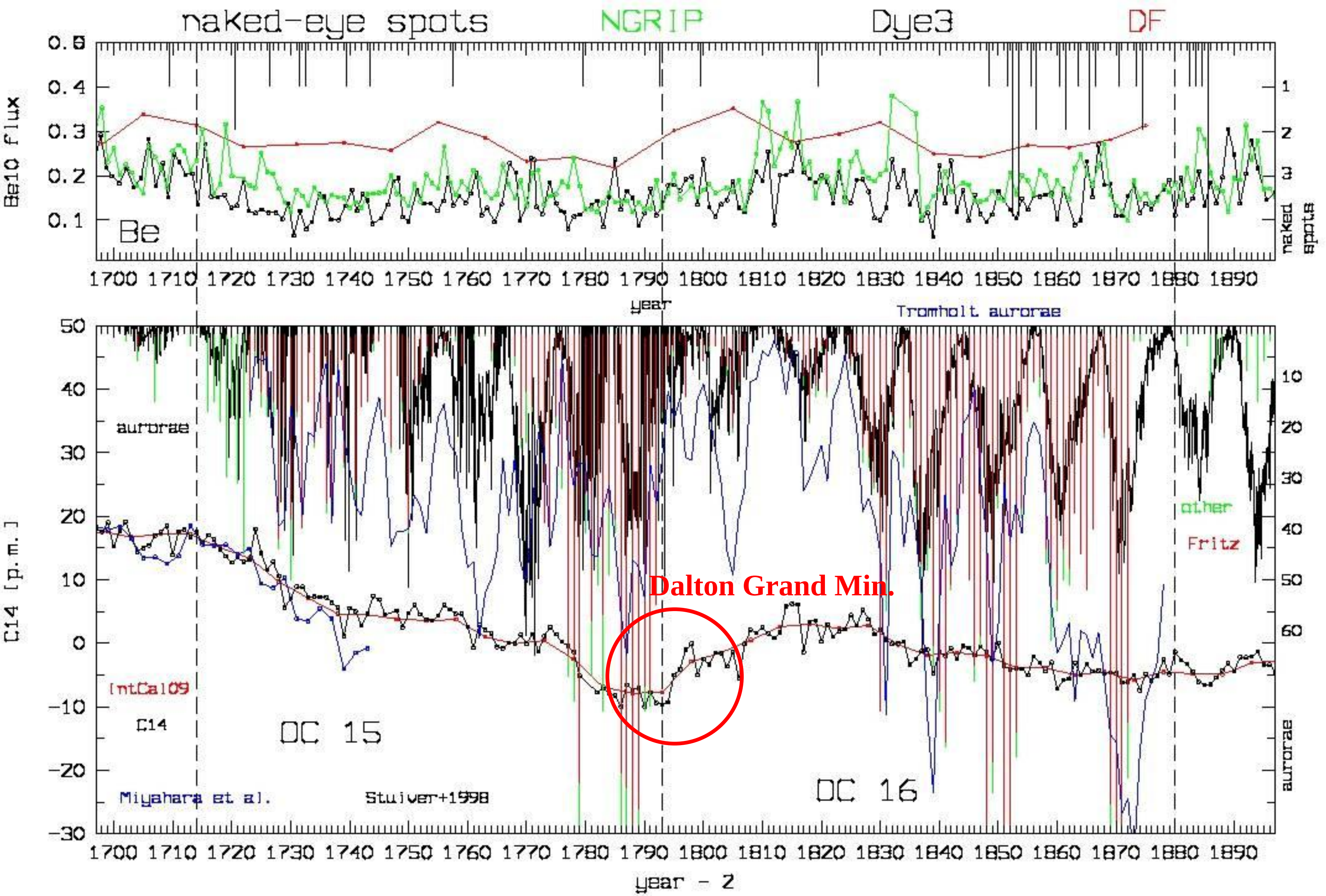
Sonstwas ?

Komenteneinschlag, Magnetfeldschwankung, Vulkanausbruch, etc.



Takahashi 14C + 20 yr
Intcal13 14C
Intcal09 14C
SHCal13 14C
C14 [p.m.]
year
SHCal13 14C - 2.5 yr
[p.m.]
[p.m.]
year - 2.5

AD 1700 – 1900

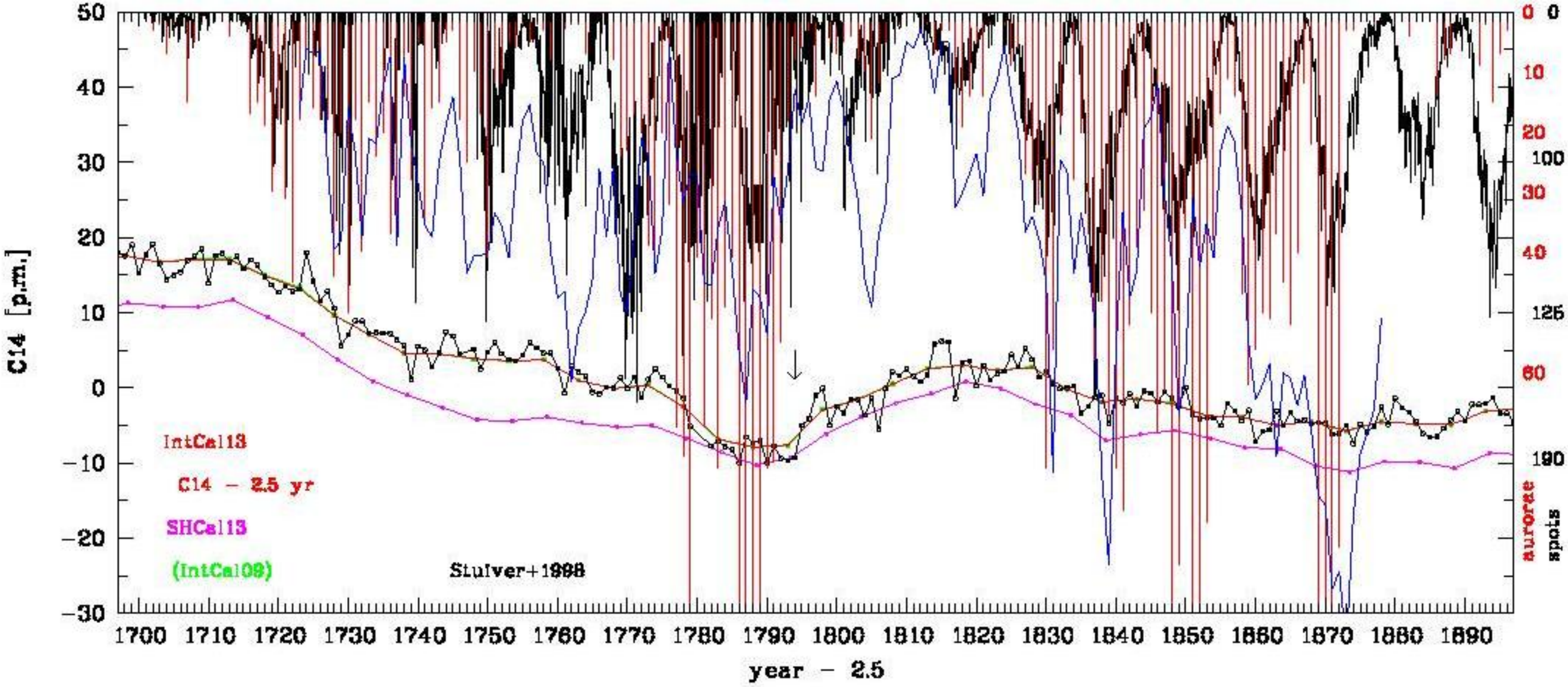


naked-eye spots
NGRIP
Dye3
DF
Be10 flux
Be
naked spots
year
Tromholt aurorae
aurorae
other
Fritz
C14 [p.m.]
Dalton Grand Min.
IntCal09
C14
DC 15
DC 16
Miyahara et al.
Stuiver+1998
year - 2

Maunder Minimum ended AD 1712/15.

Aurora level increases from cycle minimum to minimum.

sunspots, aurorae (Tromholt, Fritz), ^{14}C



(1) At the end of the Grand Maximum (~1790) ➔ low ^{14}C level

(2) Decline of strong Schwabe cycle no. 4 (~ 1793) ➔ ^{14}C rises

(3) Weak activity in Dalton (~1800-1830) ➔ ^{14}C level high

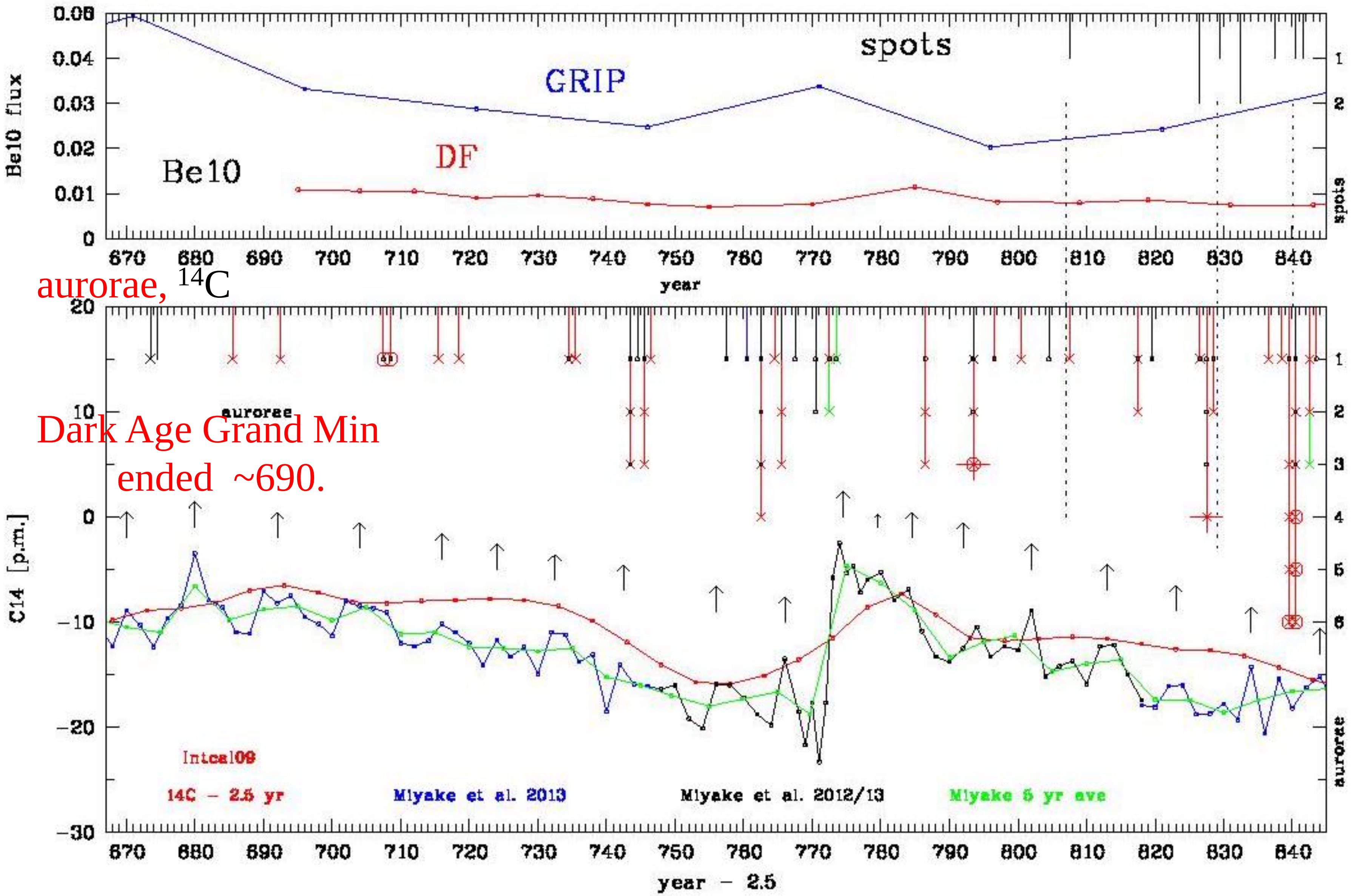
Maunder Minimum ended AD 1712/15.

Aurora level increases from cycle minimum to minimum.

sunspots, aurorae, ^{14}C

Same around AD 774/5 ?

(1) At the end of the Grand Maximum (~1790) ➔ low ^{14}C level
(2) Decline of strong Schwabe cycle no. 4 (~ 1793) ➔ ^{14}C rises
(3) Weak activity in Dalton (~1800-1830) ➔ ^{14}C level high



aurorae, ^{14}C

Dark Age Grand Min ended ~690.

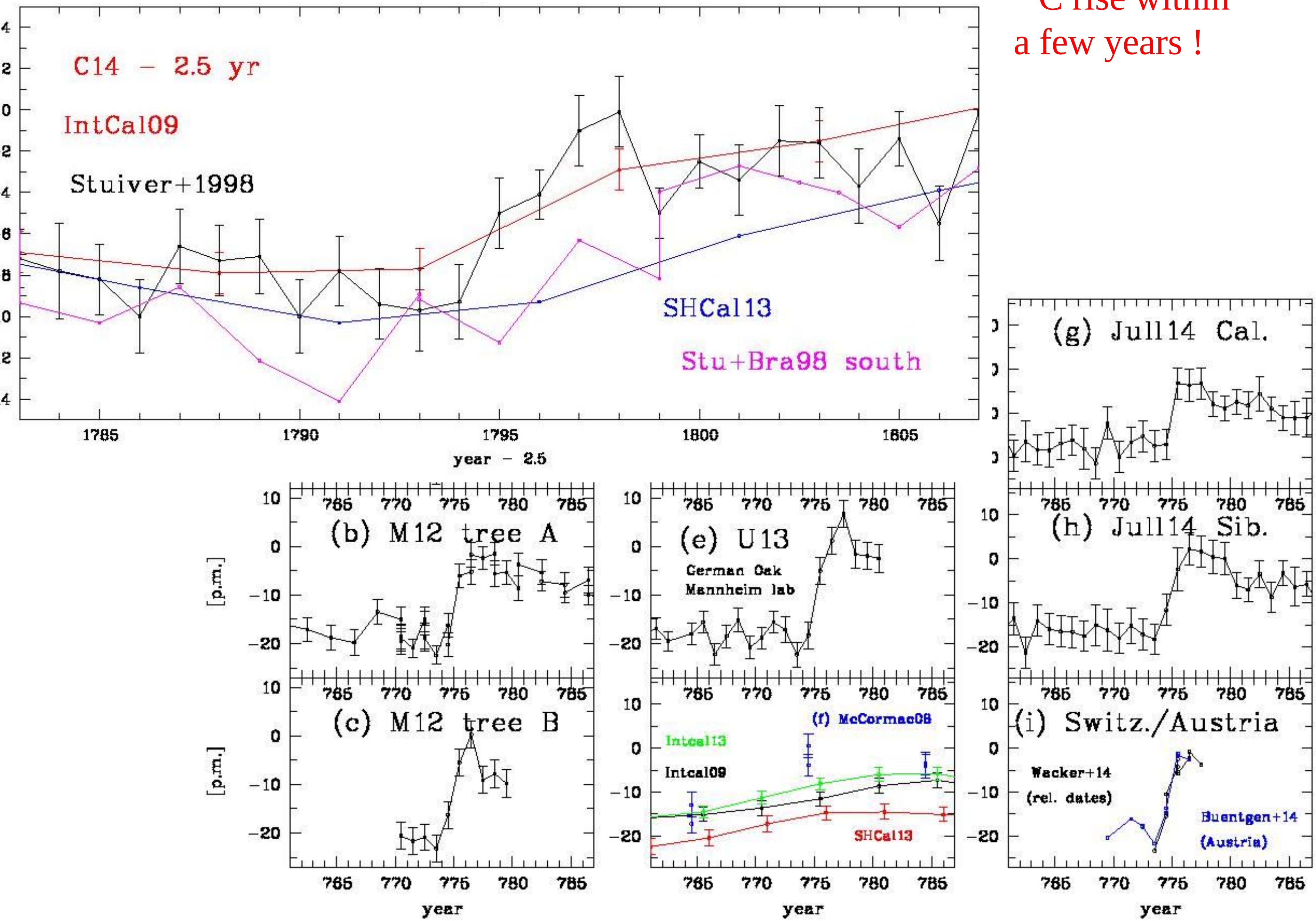
(1) At the end of the Grand Maximum (~770) ➔ low ^{14}C level

(2) Decline of strong Schwabe cycle no. 4 (~ 774) ➔ ^{14}C rises

(3) Weak activity ➔ ^{14}C level high

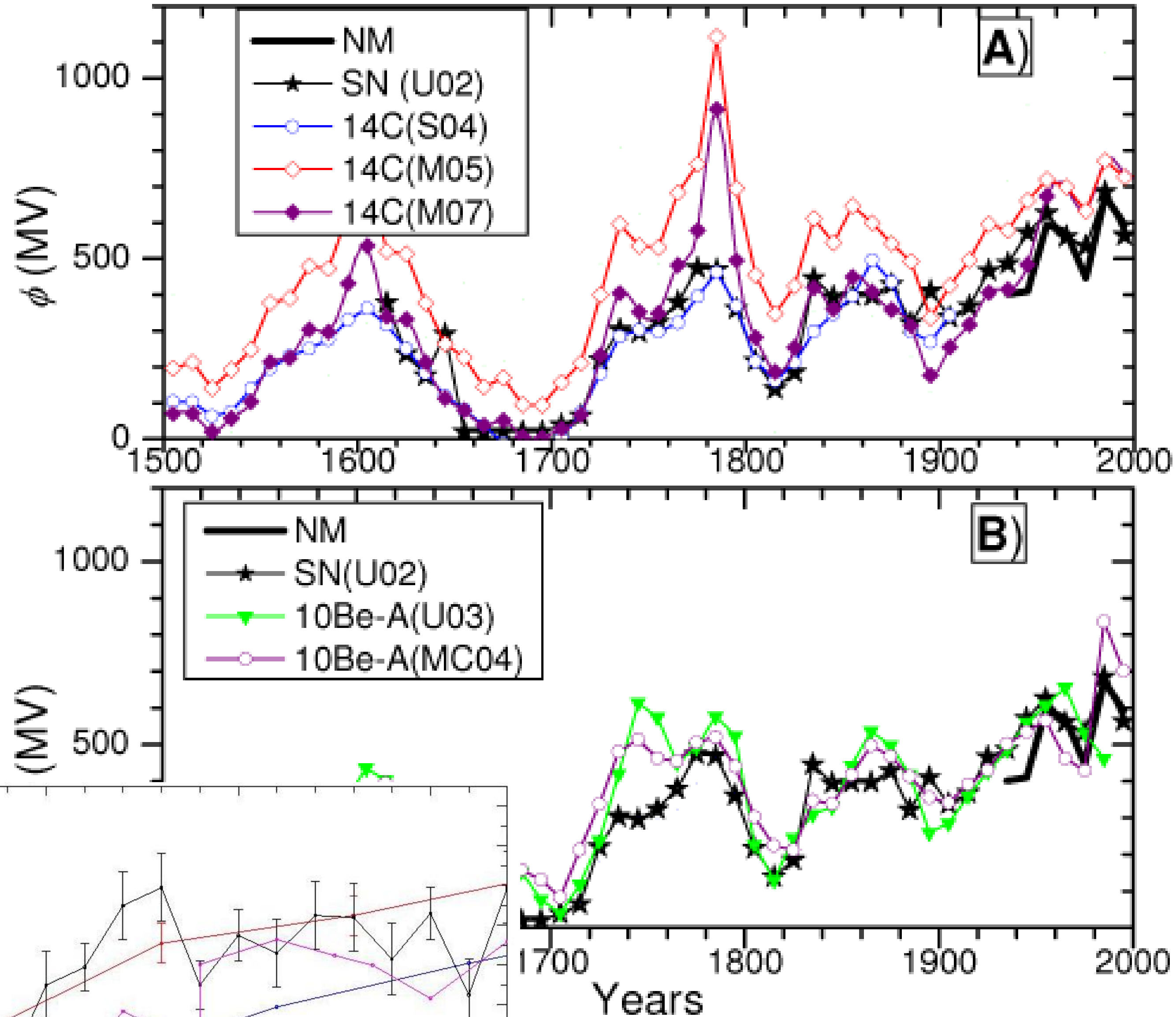
Neuh & Neuh 2015

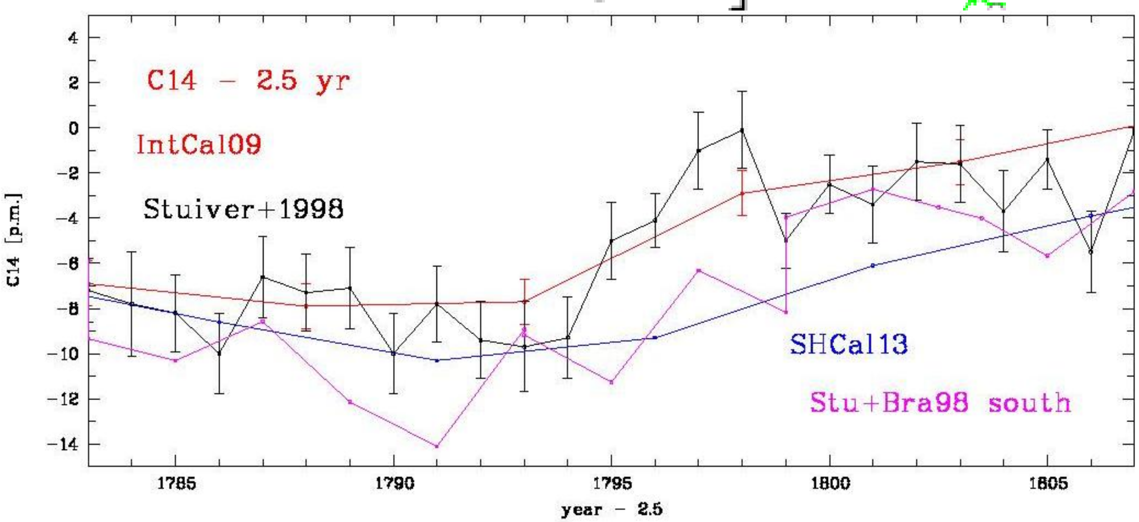
^{14}C rise within a few years !

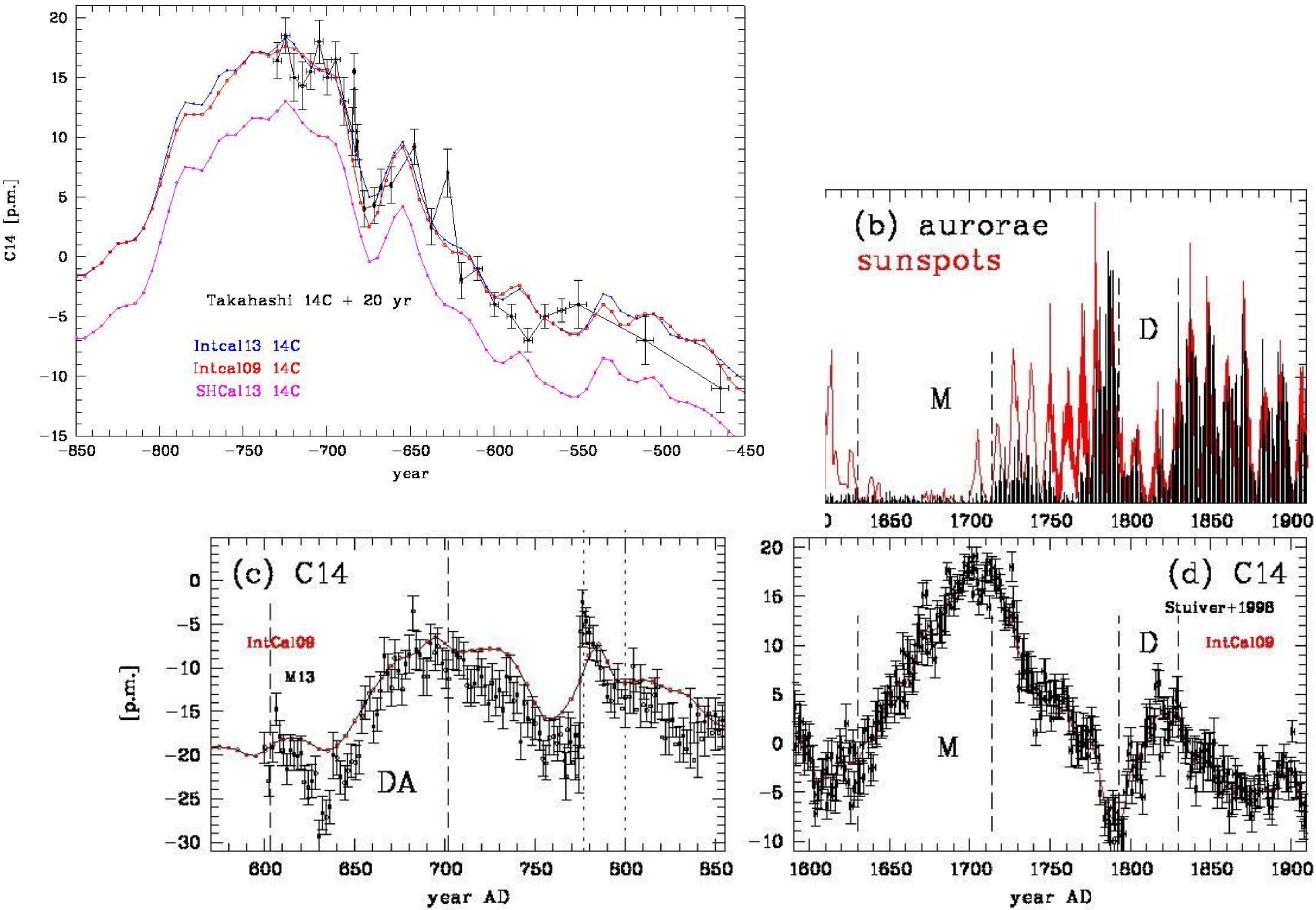


Living Review Usoskin:

Fast strong drop in
solar modultion potential
is indeed possible,
e.g. around 1795

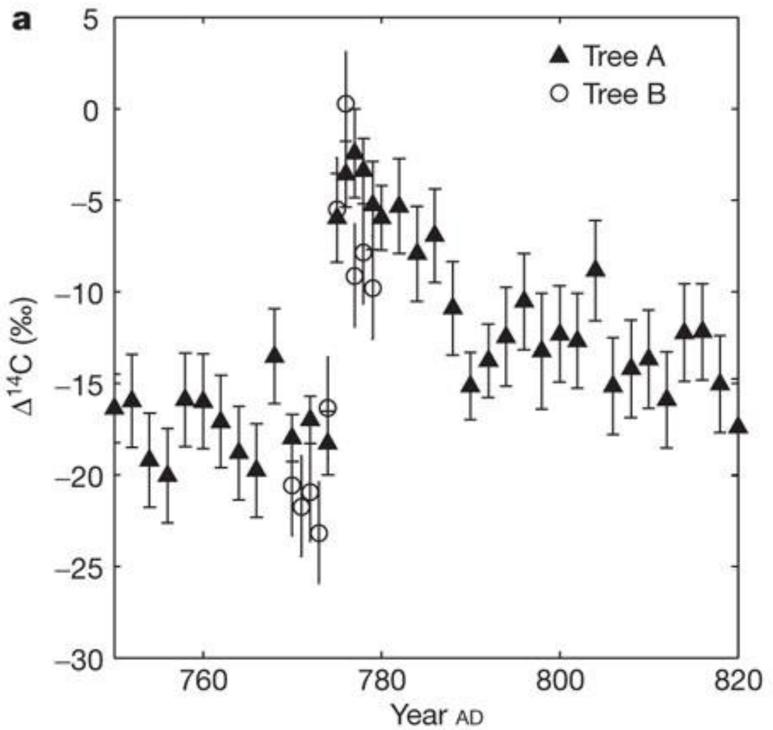






Takahashi 14C + 20 yr
Intcal13 14C
Intcal09 14C
SHCal13 14C
C14 [p.m.]
year
(b) aurorae
sunspots
M
D
(c) C14
IntCal09
M13
DA
[p.m.]
year AD
(d) C14
Stuiver+1998
IntCal09
M
D
year AD

Was war die Ursache ?



Miyake et al. 2012

Supernova ? Nein, zu schwach

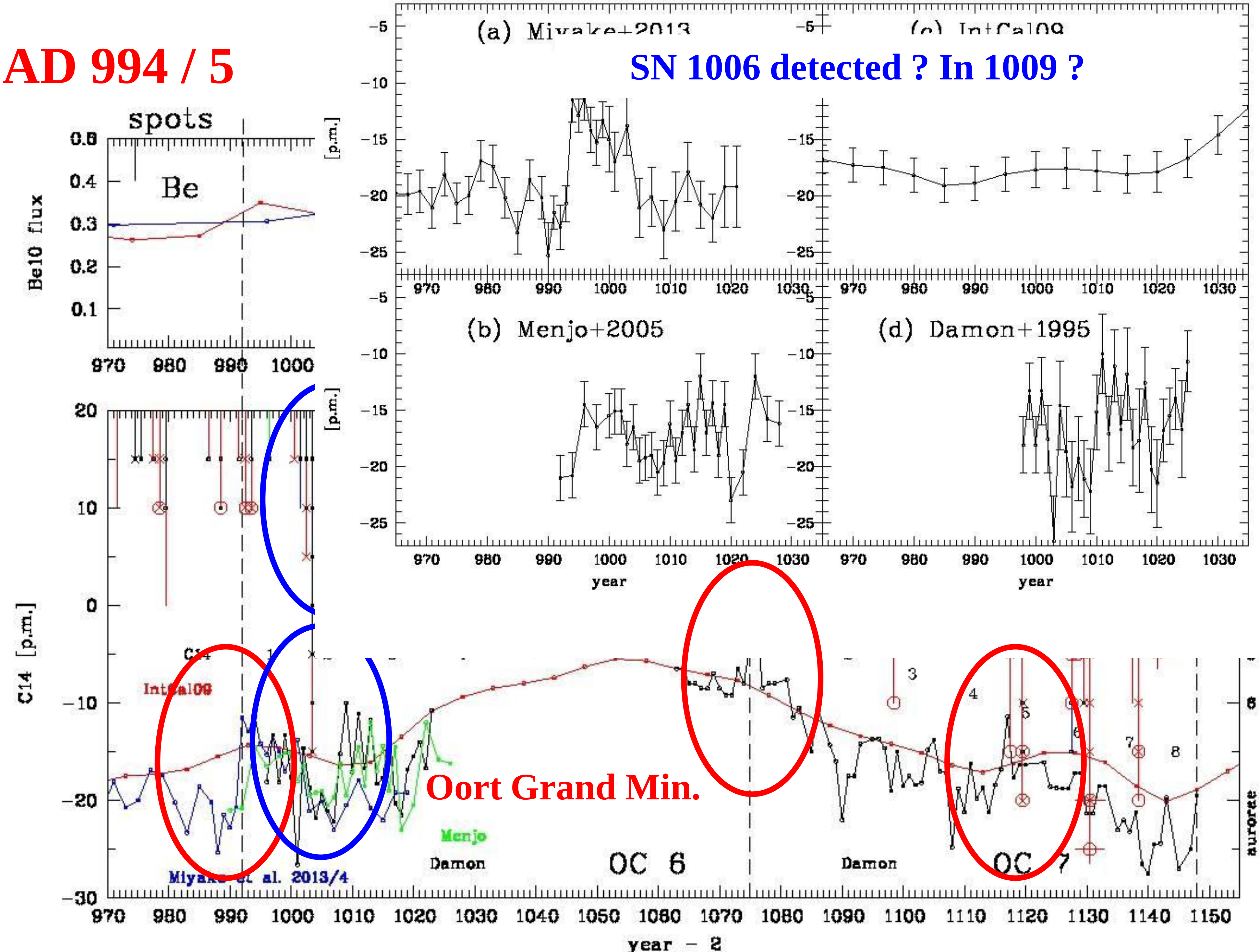
Gamma-ray burst ? zu selten

Sonnen-Flare ? no

Sonstwas ? Sonnenaktivitätsabfall

(um AD 775, 994, 1795, und BC 671)

AD 994 / 5



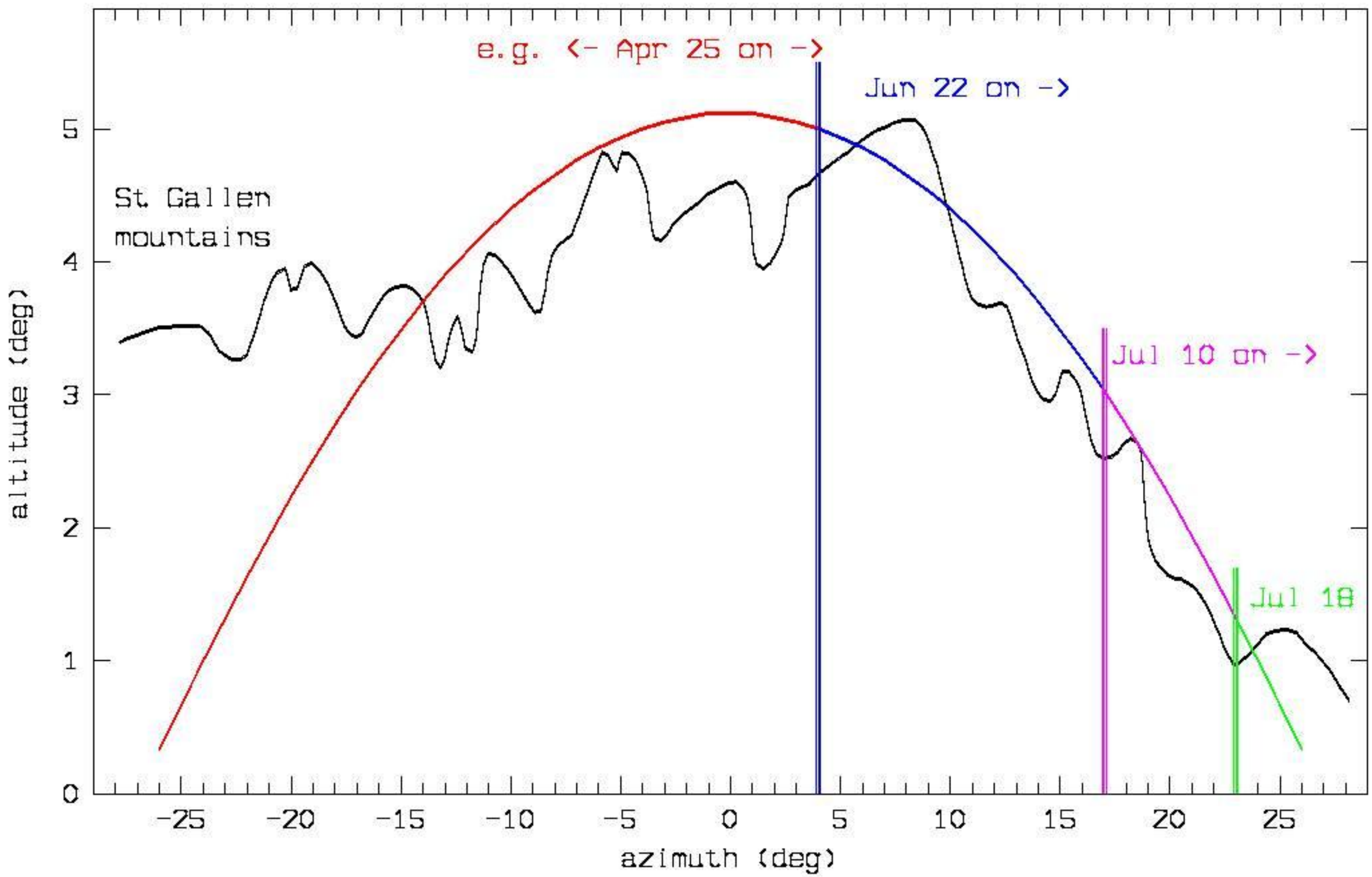
A fast strong drop in solar activity ➔ less solar wind ➔ more cosmic rays and ^{14}C

SN 1006:

St. Gallen: A new star of large size twinckled much … and was sometimes not seen at all (behind mountain tops). It was seen for three month in the far south below all other constellations ➔ southern declination limit -39 degree

SN 1006:

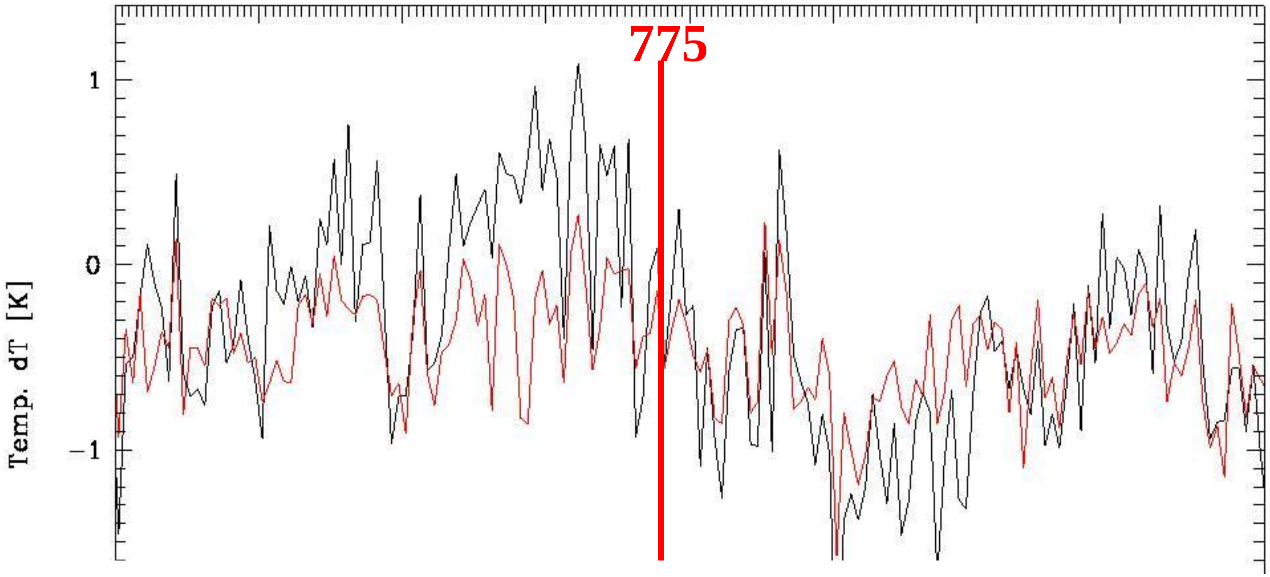
St. Gallen: A new star of large size twinckled much … and was sometimes not seen at all (behind mountain tops). It was seen for three month in the far south below all other constellations ➔ southern declination limit -39 degree

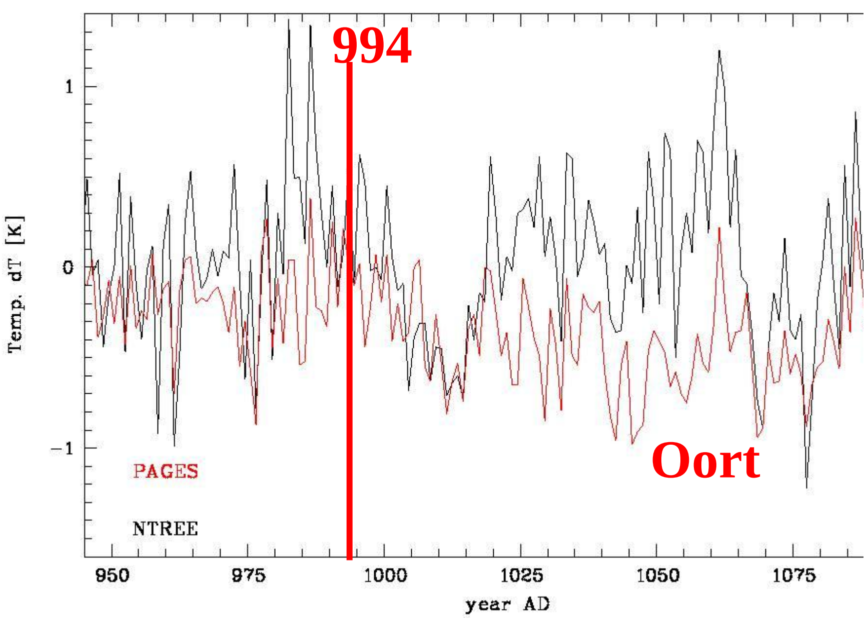


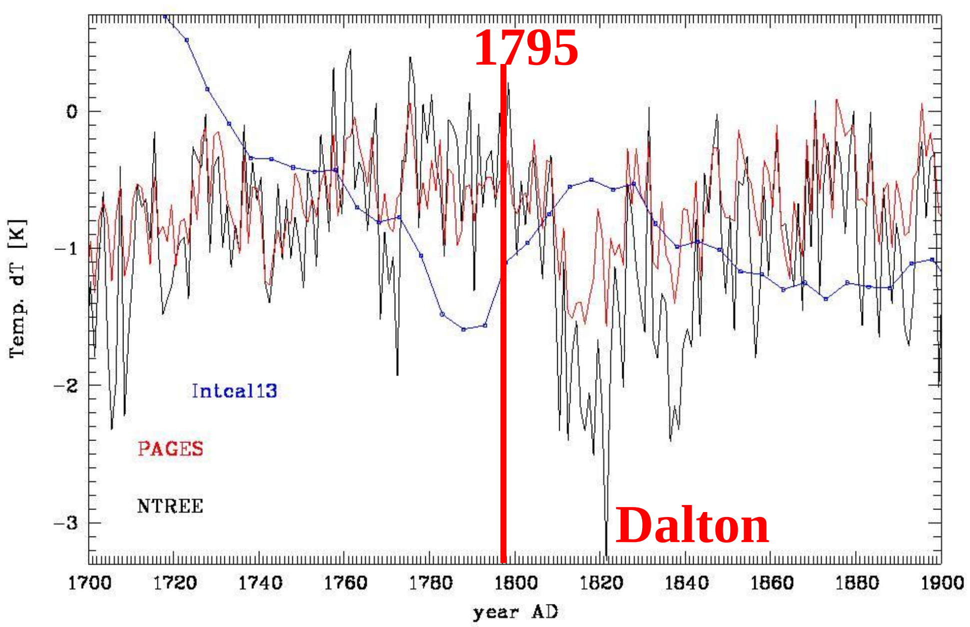
RN+ 2017 in press

If 775 due to solar activity decline, then temperature decline on Earth expected …

(which would not be expected after a solar super-flare)



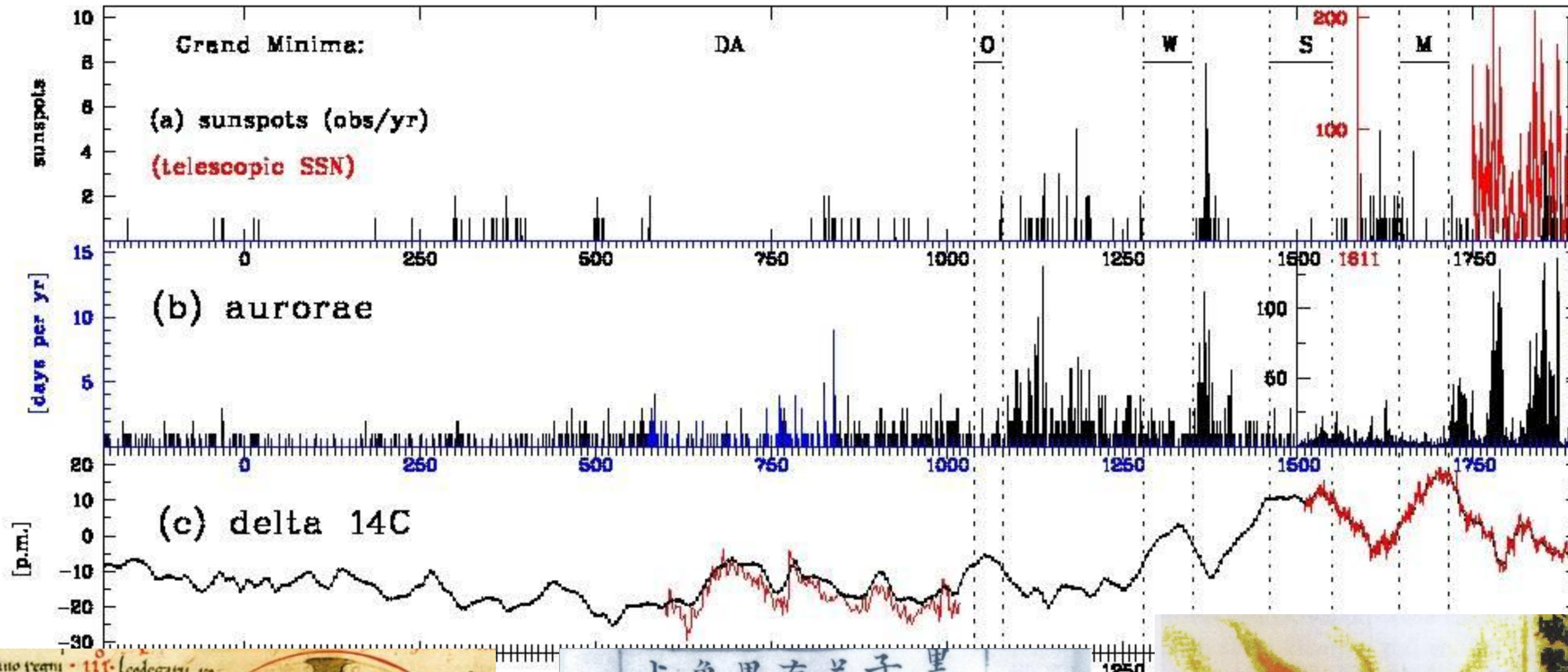


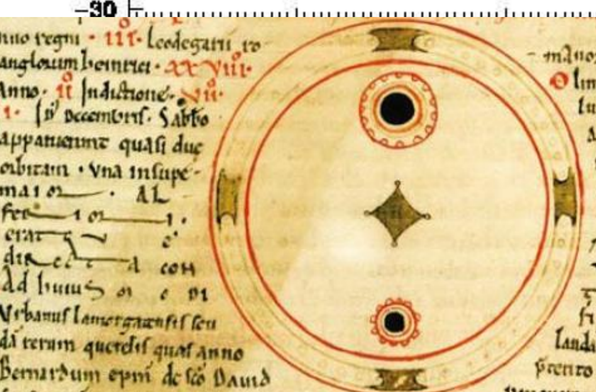


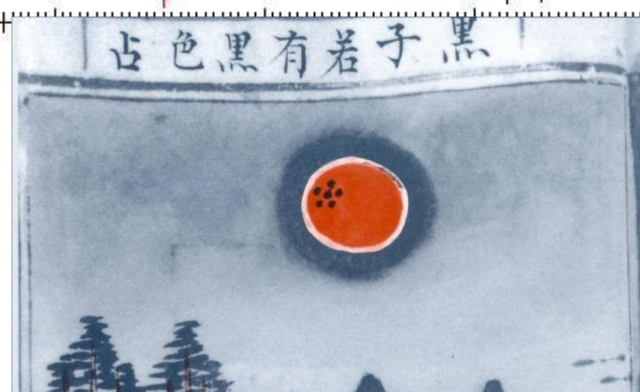
Reconstruction of solar activity for the last 3000+ years with sunspots, aurorae, and radioisotopes

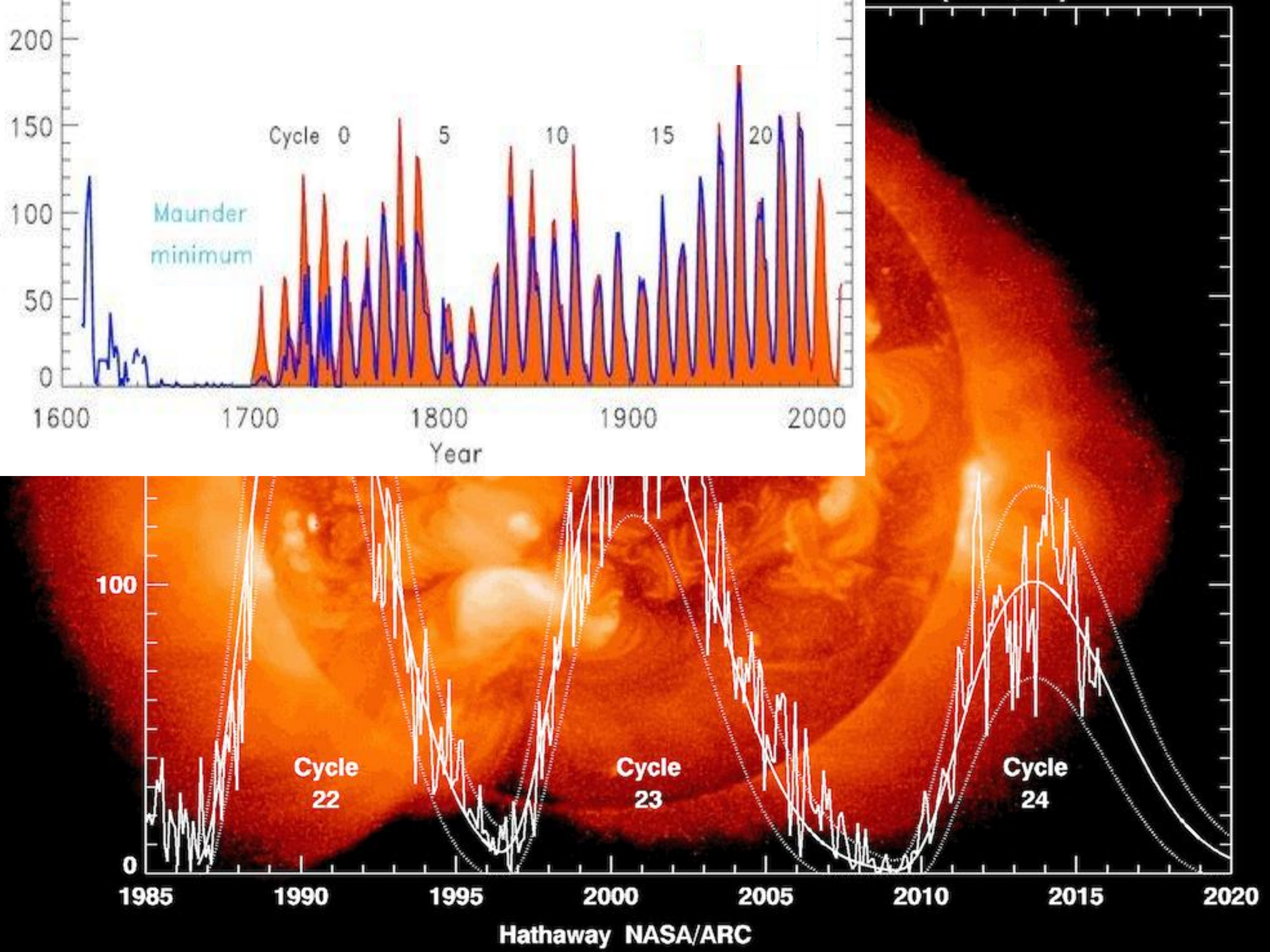
Grand Minima:

Oort **W**olf **S**pörer **M**aunder








200
150
100
50
0
Cycle 0
5
10
15
20
Maunder
minimum
1600
1700
1800
1900
2000
Year
100
0
Cycle
22
Cycle
23
Cycle
24
1985
1990
1995
2000
2005
2010
2015
2020
Hathaway NASA/ARC

Rekonstruktion der Sonnenaktivität:

- ➔ **Sonnenflecken**
- ➔ **Aurorae**
- ➔ **C-14 und Be-10 (also kosmische Strahlung)**
- ➔ **Kometen:**
  Schweiflänge, Helligkeit, Sichtbarkeitsdauer, Häufigkeit
- ➔ **Sichtbarkeit bzw. Helligkeit der Korona bei totaler SoFi**
- ➔ **Helligkeit von reflektierenden (Klein-)Körpern im SoSy.**

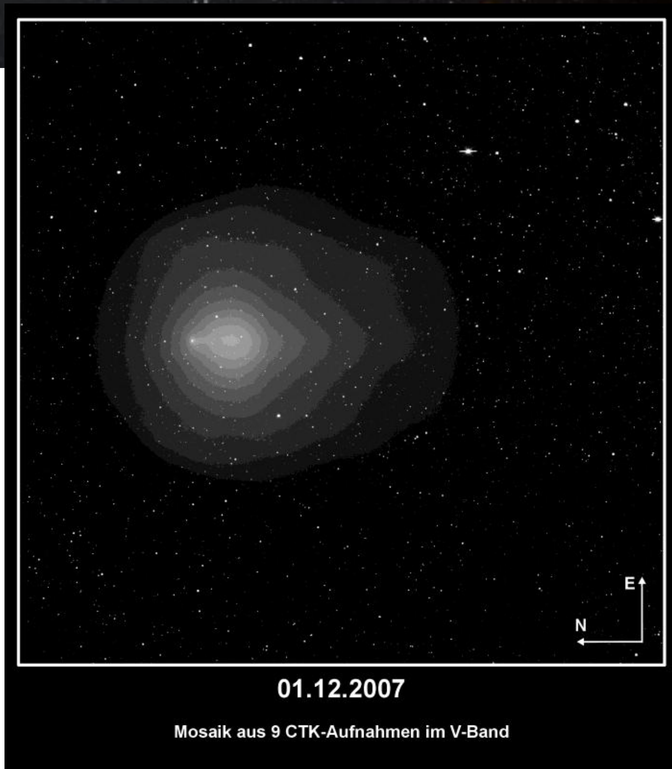
$$m = M + 5 \log (d) + 2.5\, n \log (r)$$

absolute Helligkeit M bei 1 au,

Entfernung d in au zwischen Erde und Komet,

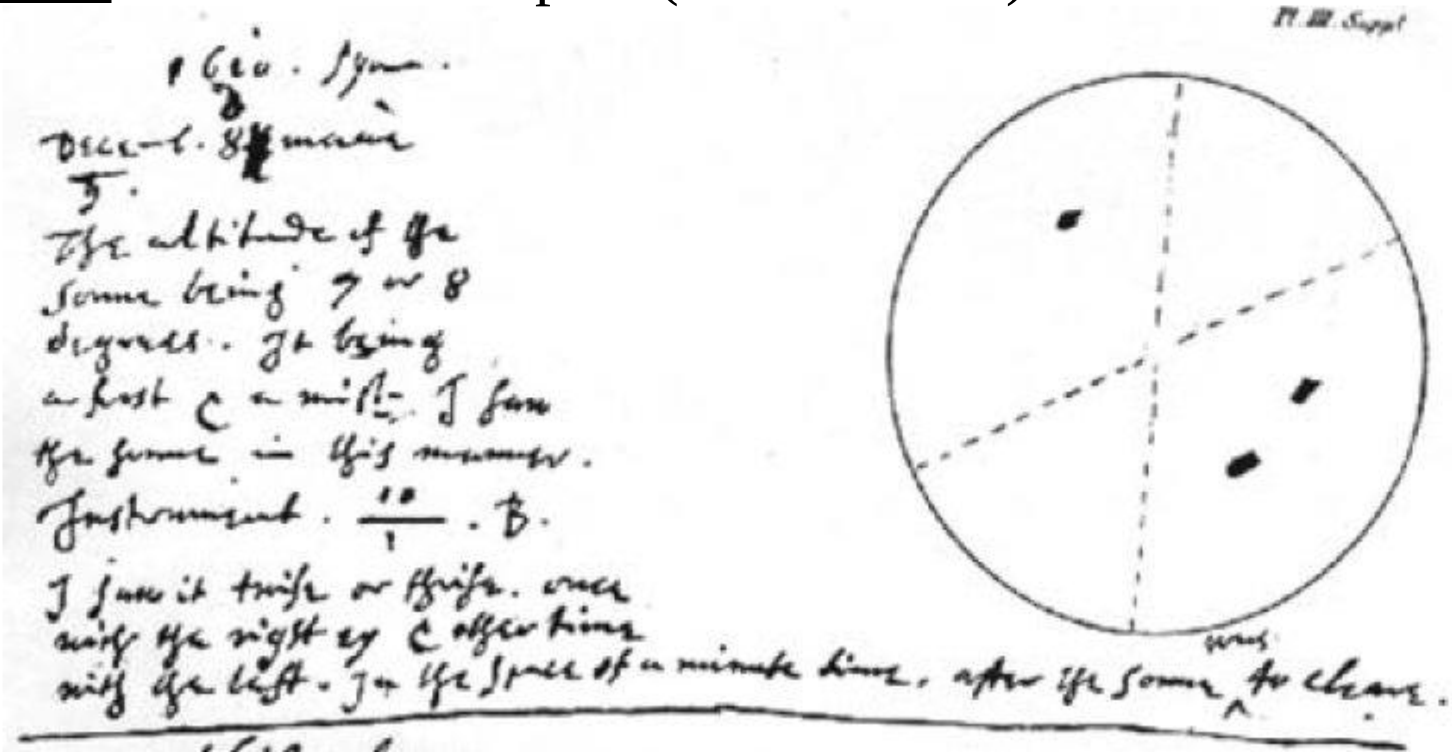
Aktivitäts-Parameter n hängt von Sonnen- und Kometen-Aktivität ab (n=2 für reine Reflektion),

Entfernung r in au zwischen Komet und Sonne.



Galileo Galilei (1564-1642, Italy):
Telescopic observations of spots (Dec 1610)

Thomas Harriot (1560-1621, England):
First datable observation of spots (18 Dec 1610)



„1610 Syon, Decemb. 8, mane [Saturday]. The altitude of the Sonne being 7 or 8 degrees. It being a frost & a mist. I saw the sonne in this manner. Instrument. 10/1. B.
I saw it twice or thrice, once with the right ey & other time with the left. In the space of a minute time, after the Sonne was to cleare.“

Joachim Jungius on 1611 May 30 (jul.) = 1611 June 9 (greg.)

Jungius:

"Observatio Vespertina pridie Pentecosten ... 30. Maii"

(„evening observation day before pentecost ... 30 May", jul.)

"Vertex resp. Poli"

(to „celestial pole")

"Vertex resp. eclipsis"

(to „ecliptic pole")

"ortus" (east)

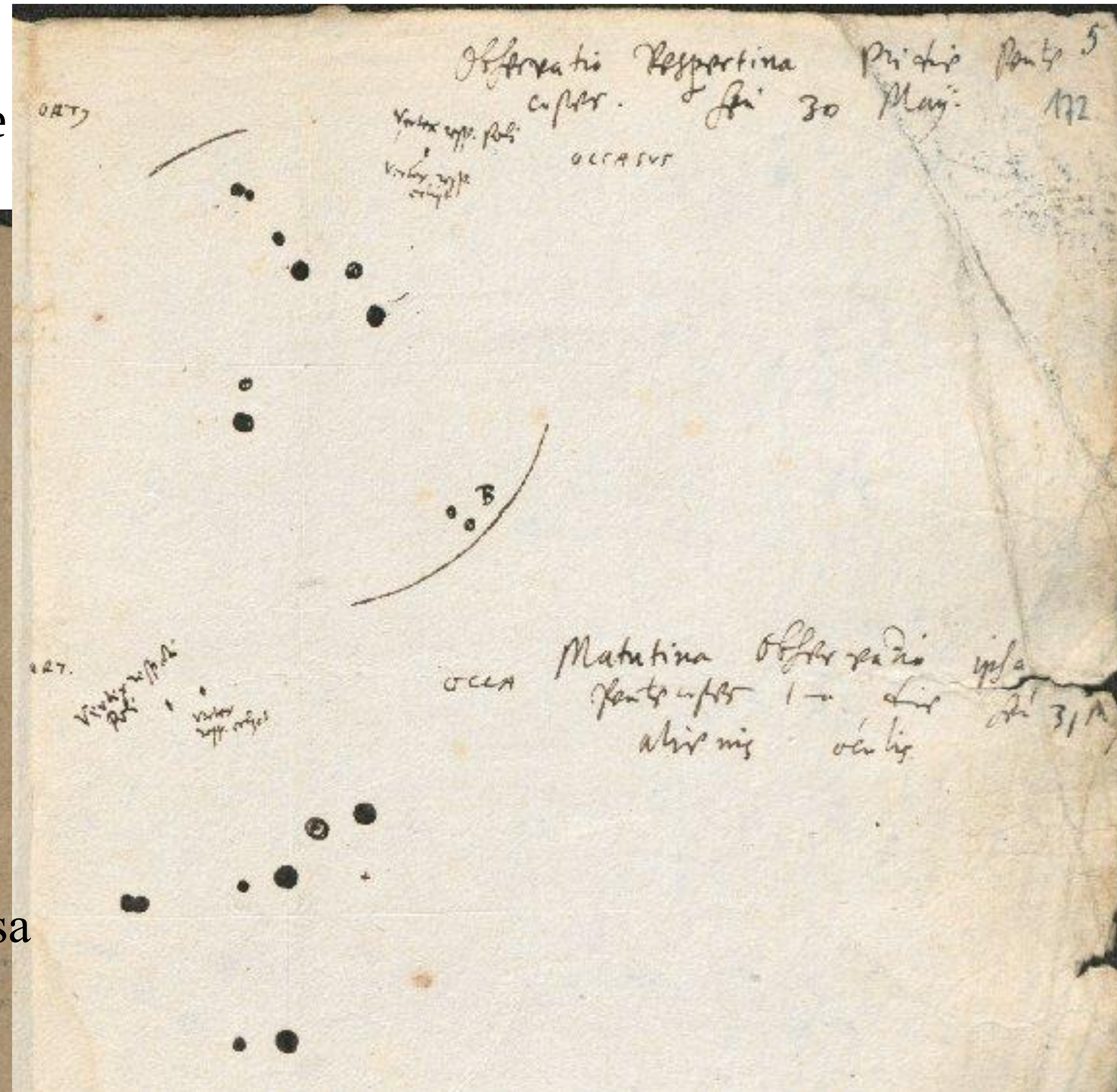
"occasus" (west)

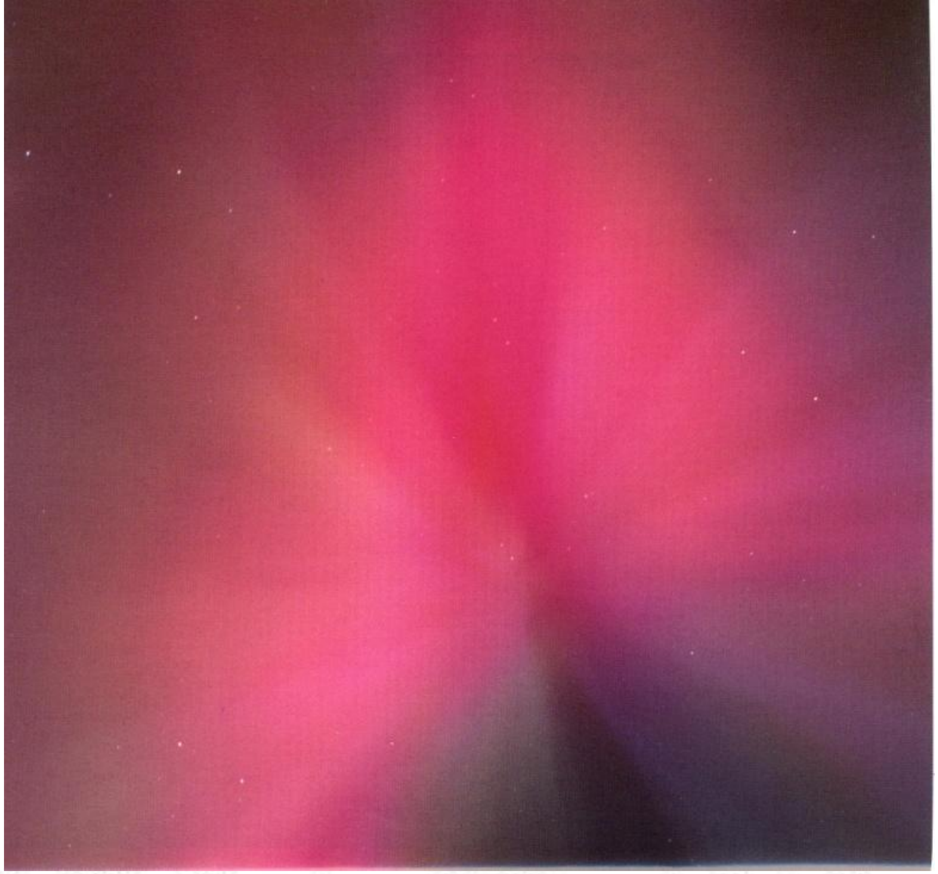
… 31. Maii Matutina observatio ipsa

Alienis oculis

Jungius (Giessen)

MS at U Hamburg





(Sachs and Hunger 1989):

"GE$_6$ 29 *a-ku$_6$-ku$_6$ -(ku$_6$)-tu$_4$ ina* ŠÚ KUR 2 DA[NNA....]"

"Night of the 29th, red glow flared up in the west; two double-[hours...]".

ina ŠÚ

S&H: „in the west"

Gelb +64: „when dusk was falling"
(d.h. Dämmerung, aber „Night")

(i) "If in Sivan (month III) an *akukutu* blazes, there will be hostility in the land."

(ii) "If the day? becomes overcast and there is an *akukutu* in the sky..."

(iii) "If the night (sky) is tinged with a fiery light and an *akukutu* flares up..."

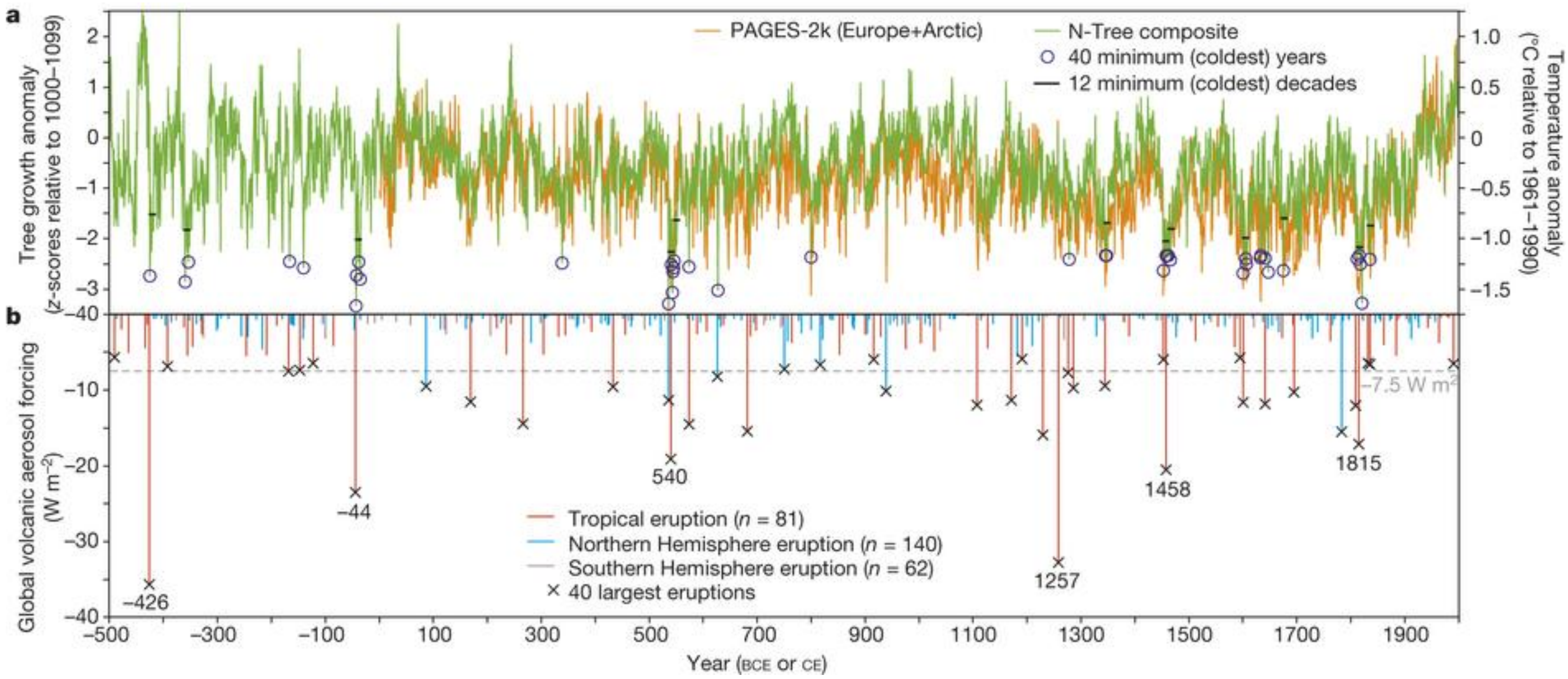
(iv) "If an *akukutu* is high up in the south..." ?

akukutu **(wörtlich ?)**

S&H: „red glow"

Gelb +64: „since akukutu denotes an exceptional meteorological phenomenon of bad portent,
it probably refers to the aurora"

Volcanic eruptions during the Dark Ages



Sigl et al. 2015

Start of the Dark Ages – with a volcanic eruption AD 536 (?)

Strong eruptions can cause dust-related atmospheric phenomena for several days to few years like

- turbid and whitish sky,
- stars including sun and moon appearing fainter,
- abnormally strong, fiery, purple light during twilight,
- a Bishop's ring with a bluish-whitish disk around the sun,
- green, pale blue, and azure blue sun and moon.

(Minnaert, 1993, Light and color in the outdoors, Springer New York)

For A.D. 536/537 there are reports only from the Mediterranean:

- "sun ... dark ... shorn of its natural splendor",
- "as if it were a blue-colored sun",
- "bodies which cast no mid-day shadow",
- "rays of the stars have been darkened with an unusual color",
- "sun becomes dim ... nearly a whole year”

(e.g. Stothers 1999)

And no such reports from professional Chinese court astronomers.

Start of the Dark Ages – with a volcanic eruption AD 536 (?)

Another report newly found:

Syriac Chronicle of Zuqnīn for SE 842, i.e. AD 530/531
in the translation by Amir Harrak (1999):
"The year eight hundred and fourty-two (AD 530/531):
The sun darkened and its eclipse lasted one and a half year, that is, eighteen months. Although the rays were seen two or three hours (a day), they were weak, just as fruit never became fully ripe and all the wine tasted like sour grapes." (possibly mis-dated by a few years)

Similar in other Near East chronicles:
- Elias: an "eclipse" of sun and moon lasted 15 months from AD 536 Mar 24 to AD 537 June 24,
- Agapius: solar "eclipse" in SE 846 (A.D. 534/535) lasting 14 months,
- Bar Hebraeus: "eclipse" for 14 months

www.astro.uni-jena.de → Terra-Astronomy

Terra-Astronomie:

Untersuchung variabler energiereicher kosmischer Vorgänge

wie nahe Supernova-Explosionen und Sonnen-Variabilität

mit Wirkungen auf *Terra*: Erd-Klima, Biosphäre, Weltraum-Wetter, Kultur, etc.

Terra-Astronomie untersucht *terrestrische Archive*, u.a. Radionukleid-Vorkommen und von Menschen verfasste Berichte, auch mit astronomischen Methoden.

I. Historische Zeit: mindestens ~ 3000 Jahre

z.B. Rekonstruktion der Sonnenaktivität,

historische Supernovae etc.

II. Astronomische Zeitskala: Millionen Jahre (Neutronensterne, Runaway-Sterne)

Historische Beobachtungen als Quellen - Probleme:

6 Beispiele

Grundsätzlich keine historisch-kritische Exegese, sondern „Steinbruch“

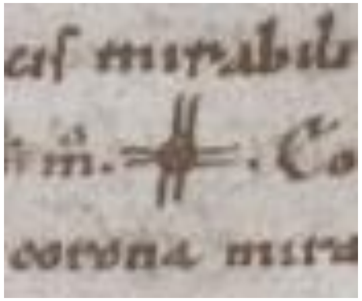
(z.B. Allen: „quick google research“ zu red cross in AD 774/5)

- Keine kritische Text-Edition (Abschreibfehler, Varianten, etc.)

  (nur ein MS)

- Keine Prüfung der Datierung (welcher Kalender ?) (AD 774 statt 776)

- Keine Konsultation alter MSS (Zeichnungen ?)



- Übersetzungsprobleme (cross/crucifix, sky/heaven)

- keine Berücksichtigung des Kontextes

  z.B. für ideologisches Kriterium

- Entwicklung von Wort-Bedeutung (*æfter* auch *während*)

  und Begriffen, z.B. lat. *cometes* bzw. arab. *nayzak:*

  seit ~1600 nur Komet i.h.S.,

  vorher auch für Novae / Supernovae

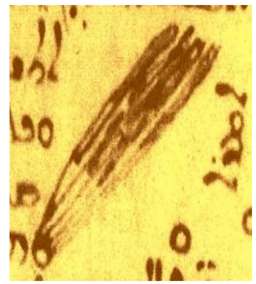
Unkritische Kategorisierung

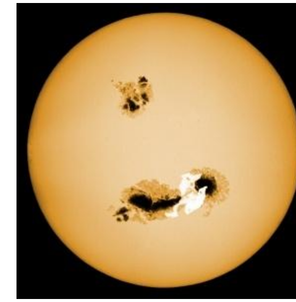
(z.B. *red cross* als supernova, aurora, airglow) www.astro.uni-jena.de → Terra-Astronomy

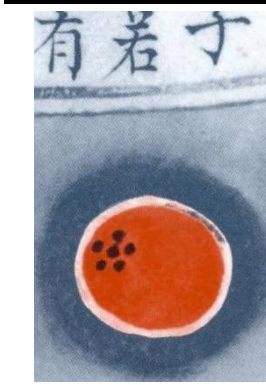
Himmelszeichen –

Globalkatalog historischer Beobachtungen transienter Phänomene

- **Aurorae**
- **Sonnenflecken**
- **Kometen**
- **Novae und Supernovae**
- **(ggf. Meteore und Halos)**







Aus allen Kulturkreisen: Europa, Nahost, Fernost, etc.
(ggf. nur für die vor-teleskopische Zeit bis 1609)

Bisherige Kataloge unvollständig und teils fehlerhaft …

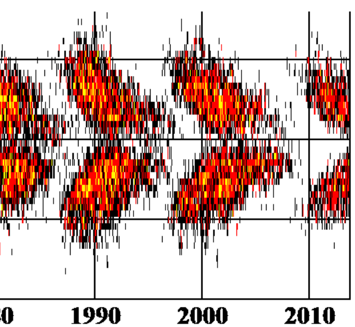
<u>Trans-disziplinäre Unternehmung für</u>
(Kultur-)Astronomie, Meteorologie, Geophysik, Philologie, Wissenschaftstheorie, Literatur-/Kulturwissenschaft, Geschichtswissenschaft, Chronologie, etc.

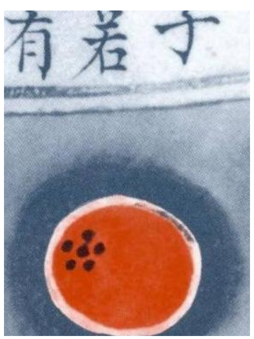
Vorlesung für Studierende aller Fakultäten: Terra-Astronomie

SoSe 2017: Vorlesung Mo 14:15-15:45h + Seminar Mo 15:45-17:15h (Raum)

+ Übung Do 14:15-15:45h (Seminarraum Sternwarte Schillergäßchen 2)

Studium transienter Himmels-Phänomene (nahe Supernovae, Sonnen-Variabilität, Kometen etc.) mit Wirkungen auf *Terra*: Erd-Klima, Biosphäre, Weltraum-Wetter, Kultur, Literatur, etc. – untersucht mit astronomischen Methoden einschließlich *terrestrischer Archive*: u.a. Radionukleid-Vorkommen (z.B. ^{14}C) und menschliche Beobachtungsberichte.





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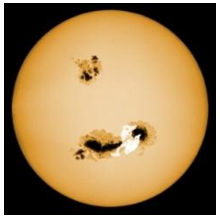
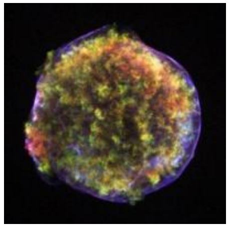
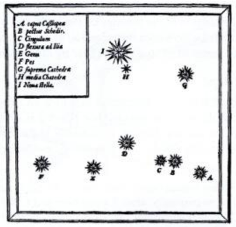


Inhalte der Vorlesung:

- Sonnenaktivität: Flecken, Aurorae, Radioisotope
- Solar-terrestial relations (Weltraumwetter)
- Halo-Displays (und ihre kulturelle Bedeutung)
- Supernovae und ihre Überreste
- historische Beobachtungen verstehen und nutzen
- Astronomie für historische Chronologie
- Kalender-Computistik etc.

Info: ralph.neuhaeuser@uni-jena.de





8 ECTS Punkte
bei erfolgreicher Teilnahme an Übungen (insbesondere für Studierende der Naturwissenschaften) und/oder erfolgreicher Teilnahme am Seminar (insbesondere für Studierende der Geisteswissenschaften)