Role of Natural Cycles in the Global Climate Change

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September 2012

PART ONE

ABSTRACT

It is postulated that the decadal temperature variability in the North Hemisphere can be reconstructed relatively accurately by amplification of the solar magnetic cycle (Hale cycle) by natural oscillations emanating from the liquid part of the Earth's core, as detected in the secular changes of the Earth's magnetic field.

In this part of the of the study only circumstantial evidence will be considered, while no physical mechanism, although it is hinted at on number of occasions, will be subject of part two.

INTRODUCTION

Atmospheric temperature variability beside obvious daily and seasonal changes is also subject of number of oscillations and cycles. Among most familiar are ENSO (El Nino and La Nina) events with sporadic periodicity from 2 to 7 years, influence of 11 year solar cycle is often subject of a vigorous debate, and finally there is the Atlantic Multidecadal Oscillation or AMO, with relatively regular 9 year and approximately 65 years long cycles that can be traced back number of centuries by looking at different proxies.

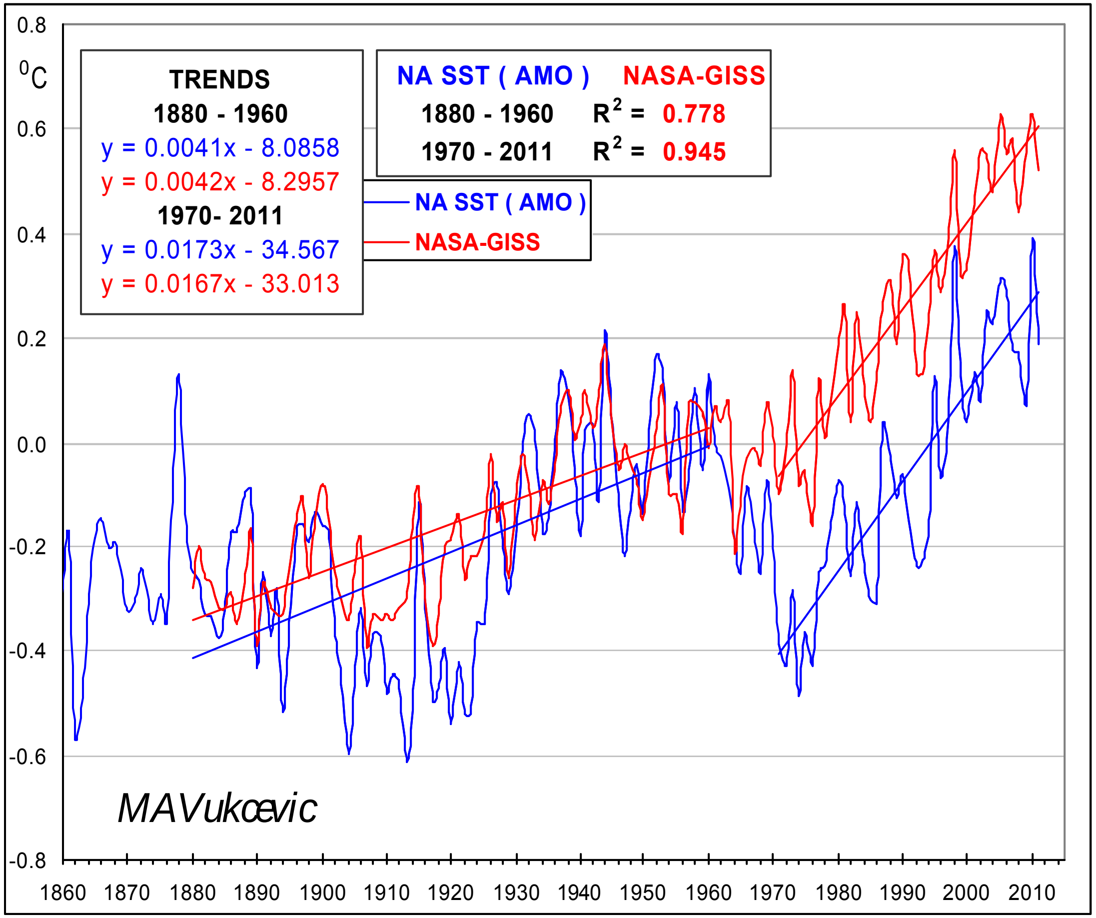
There is strong evidence of much longer cycles of warm / cold periods during the Holocene epoch, then interglacial and ice age cycles. However, these events fall outside scope of this study, since it will concentrate and be limited on the natural oscillations going no further back than 1650's, from when the first temperature instrumental records are available. Even with this relatively short period it may be possible to identify oscillations on century long scale, but many records are not long enough to establish that with the required degree of confidence.

NATURAL VARIABILITY in the Global Temperatures Data

North Atlantic’s SST natural variability (AMO) was identified in 1990s, detailed survey data of the SST are available since 1950’s.

Climate scientists note that the input from the AMO (along the ENSO) into global temperatures is a most important contributor to the natural variability. While the cause of the AMO is uncertain it is accepted that it is associated with changes in the North Atlantic’s thermohaline circulation.

If natural cause of the AMO can be identified it would represent an important step forward in the understanding the global temperatures natural variability, and show if the AMO is exclusively **or** maybe predominantly North Atlantic event with global presence.



The Berkeley Earth Surface Temperature Project (BEST) *The strongest correlation is observed between the estimates of the average land temperature Tav and AMO, the Atlantic Multidecadal oscillation, with a correlation coefficient r = 0.65 ± 0.04. (In this paper, ± refers to 1 standard error, frequently called by physicists ‘one standard deviation’.) This is the highest peak in any of the cross-correlation plots we calculated, and it occurs at zero lag.*

In graphs Fig.1 & 2 correlation factors are calculated using discrete data bins with five year averaging.

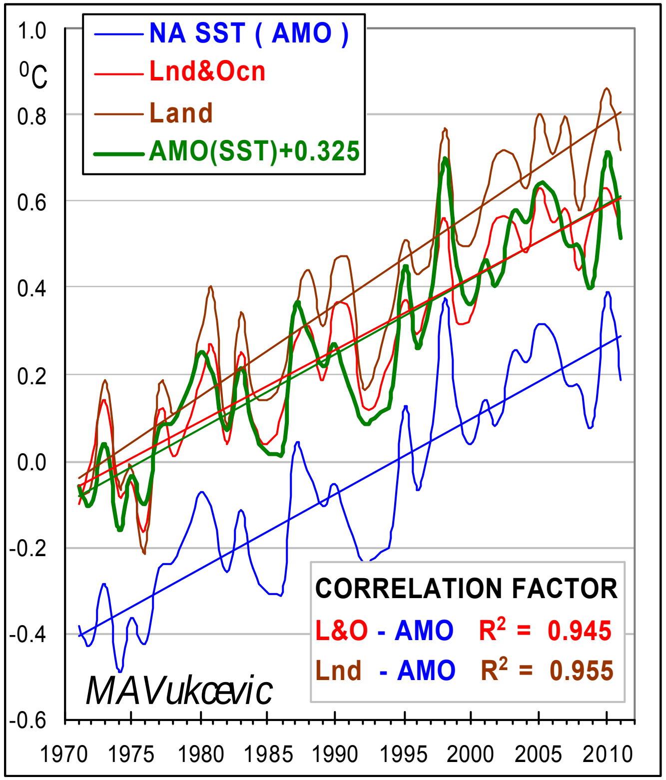


Fig. 1 & Fig. 2. – AMO & Global Temperatures exhibit high degree of correlation

The AMO DOMINATES DECADAL TEMPERATURE OSCILLATIONS IN BOTH HEMISPHERES

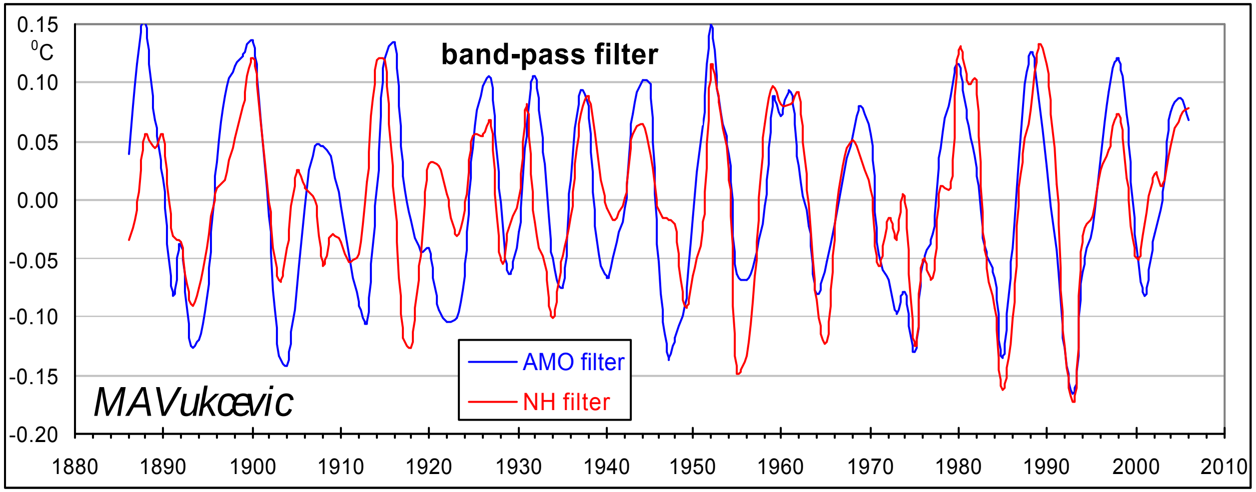


Fig. 3 – Band-pass filtered AMO & the North hemisphere's Tav (Land & Ocean) oscillations

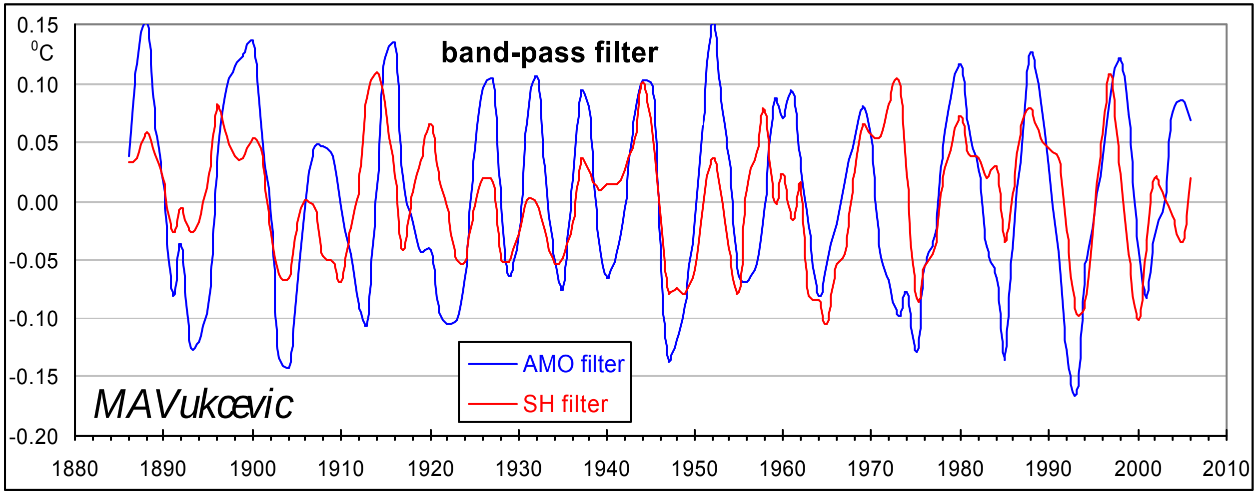


Fig. 4 – Band-pass filtered AMO & the Sorth hemisphere's Tav (Land & Ocean) oscillations

Decadal oscillations can be isolated by filtering process (subtracting 11yr moving average from 3yr ma), allowing direct visual comparison of the data correlation and the phase relationship.

$$y = \sum_{A_{n-1}}^{A_{n+1}} An/3 - \sum_{A_{n-5}}^{A_{n+5}} An/11$$

Filtering formula

Although it is true though that the AMO is strongest in the North Atlantic it may not be entirely correct to assume that the AMO type oscillations are generated exclusively in the area of the North Atlantic.

Since the South hemisphere is mainly Ocean with large heath capacity it is odd that the AMO type oscillations are result of atmospheric temperature tele-connection induction from the North Atlantic.

Oceanic currents tele-connection is also out of question since there is no time lag involved.

It is more likely that the 'AMO' is a globally generated event with the strongest dominance in the area of the North Atlantic.

Spectral composition analysis, as shown on the next page, also confirms strong AMO – global land temperatures correlation.

Since the AMO oscillates with a period close to 9 years, the 11 year solar cycle is unlikely to be the direct source of the AMO oscillations.

SPECTRAL COMPOSITION of PRINCIPAL COMPONENTS

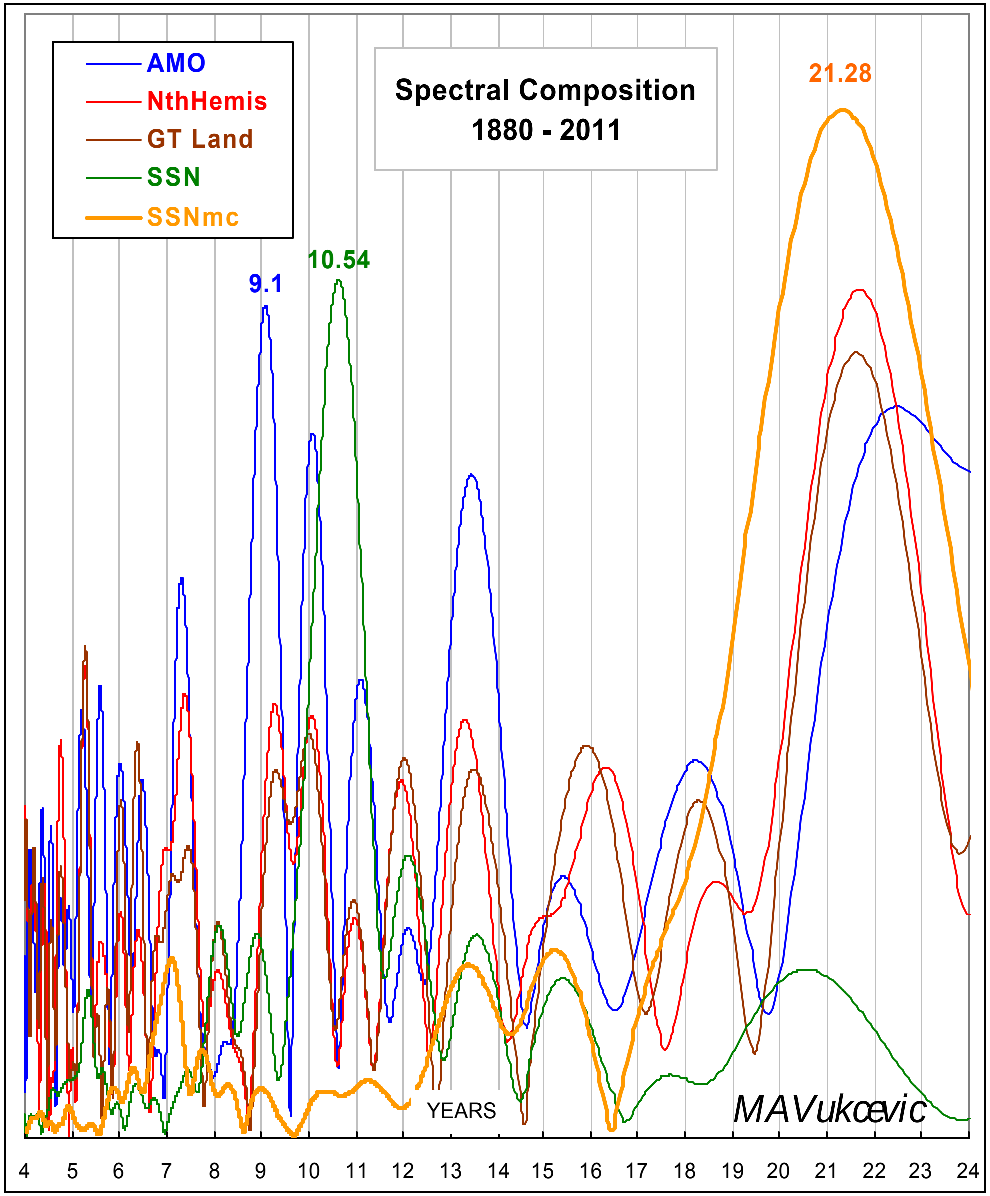


Fig. 5 Composite of spectral responses for the temperatures and solar activity

Notes:

- **1.** Sunspot Number SSN and magnetic Hale cycle SSNmc are normally derived from the SIDC annual smoothed number. Accuracy of the spectra is increased by using monthly unsmoothed number (1910-2011) calculating to a period of **10.43 years** (verified by a leading solar scientist from Stanford University).
- **2.** Spectral analysis is based on a frequency sweep correlation method, rather than the more familiar Fourier power spectrum analysis. To reduce effect of the limited length used data sets (130 data points for 130 years long record) Muller - MacDonald method is applied. Data sets are symmetrically padded with zeros to the total of 2000 data points in order to yield the intermediate frequencies, which otherwise may fail to register.
- **3.** Spectra values are normalised to the same amplitude scale.

Results:

- **SSN** shows as expected a single frequency with period at just under 11 years (10.54 yr).
- **SSNmc (Sunspot magnetic cycle)** Solar coronal mass ejections CMEs in the even-numbered solar cycles tend to hit Earth with a leading edge that is magnetized north. Such CMEs open a breach and load the magnetosphere with plasma starting a geomagnetic storm. To take account of this cycle are given polarity to form SSNmc.

SSNmc has a strong singular response, but this time at 21.28 years, near twice the SSN's period; difference may be due to fact that solar cycle minima in the annual range is rounded to whole number and uncertainty of the cycles minima cross-over time.

- **AMO** has the more ambiguous spectral response with number of major components of which 9.1 is strongest but there is a degree of uncertainty about 22yr, close enough to the 21.2 year period of the SSNmc. Strength of the 9.1 year period increases certainty (BEST 9.1±0.4), but number of other components (7, 10, 13 years), not the natural harmonics of 9.1 or 21.2 year frequencies, indicate that 9.1 year period may not be a natural fundamental but a cross-modulation product.
- **North Hemisphere & Global Land Temperatures**, selected as the data sets with the least inbuilt uncertainty, show number of minor frequencies, respond weakly to normal sunspot cycle (TSI-total solar irradiance), more strongly to the AMO, but by far the strongest response is at the frequency almost identical to the solar magnetic cycle SSNmc.

AMO, GLOBAL TEMPERATURES AND SOLAR OSCILLATIONS

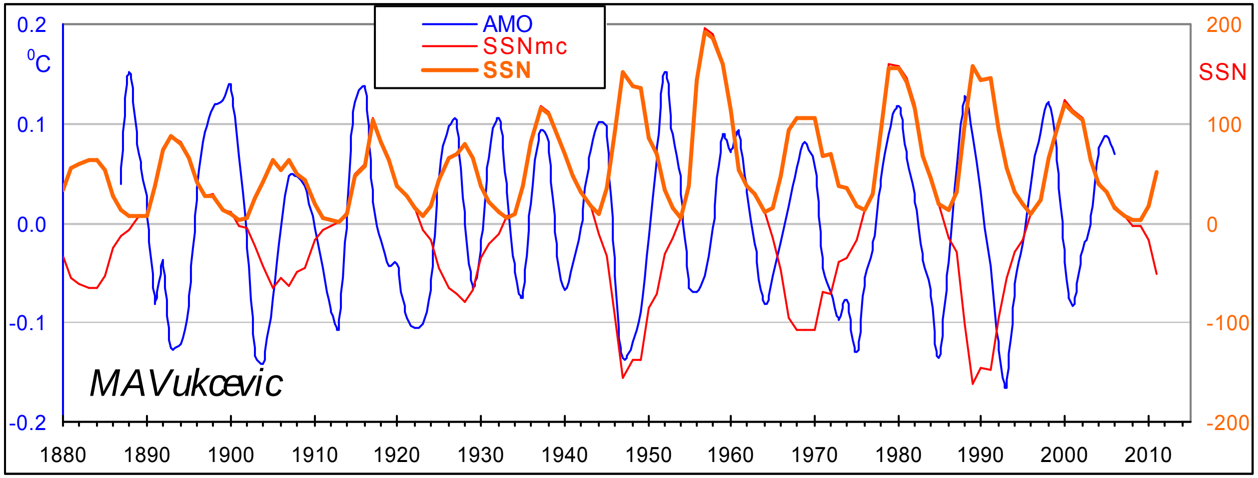


Fig. 6 AMO does not display significant time coincidence with SSN or SSNmc cycles

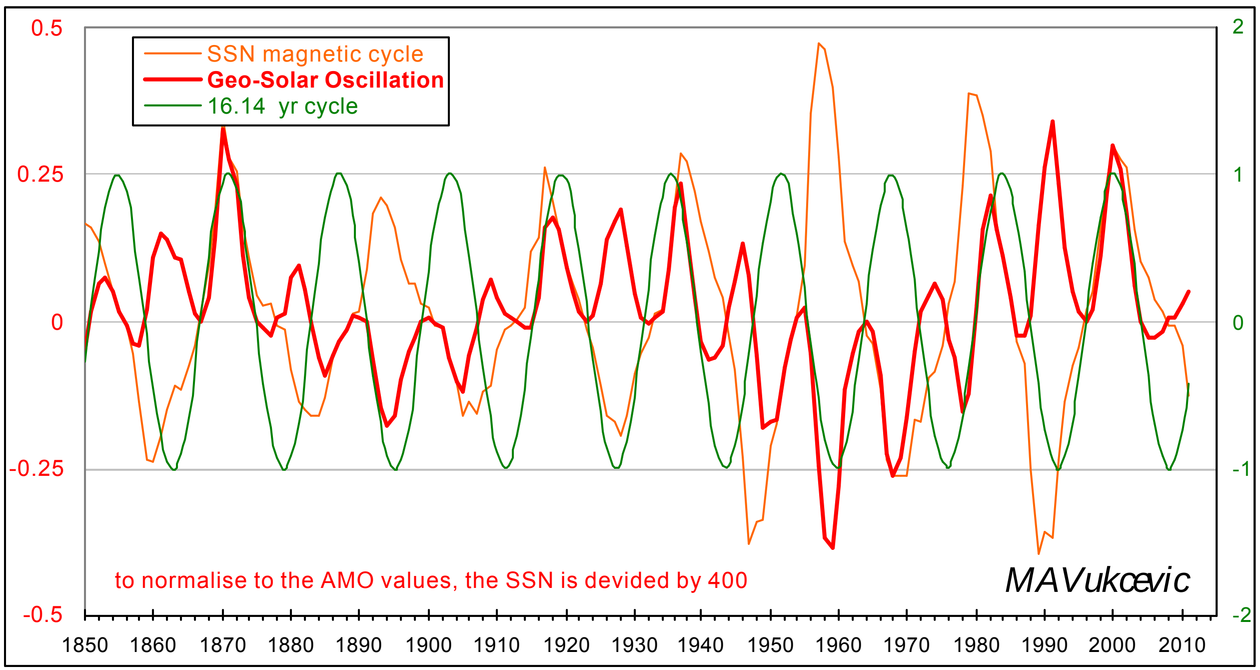


Fig. 7 Geo-Solar cycle is obtained by multiplying SSNmc with 16.14yr cycle

Time-line coincidence between the AMO and the sunspot (SSN and SSNmc) cycles is sporadic and doesn't suggest direct relationship.

Assuming that the AMO frequency is as suggested, the result of a possible cross-modulation, than the intermediary oscillation's period canl be calculated as

$1/T_x = 1/T_{amo} - 1/(2 \times T_{ssn})$

where T_{amo} = 9.1yr T_{ssn} = 2x10.43yr giving the resultant period:

T_x =16.1416 years

Multiplying the SSNmc by 16.14 cycle

Y_N =SSNmc x Cos[2pi(N–2002)/16.14] produces graphic image (**Fig. 7**) which has the same form and short term trends as the familiar AMO data plot.

Pphase reference set at year 2000, time of the last SSNmax, but any ±n*16yr point would yield the same result.

Arithmetic here suggests:

Multiplication = Amplification

i.e. multiplication of two variables implies that intensity of one variable is physically amplified or attenuated by intensity of the other.

Since 16 year component is not present in the solar oscillation, assumption has to be that it is naturally Earth-generated, hence combination of two (SSNmc x 16.14 cycle) is given name:

GEO-SOLAR OSCILLATION – GSO

See appendix 1 for the SSnmc data set

GEO-SOLAR OSILLATION and the AMO

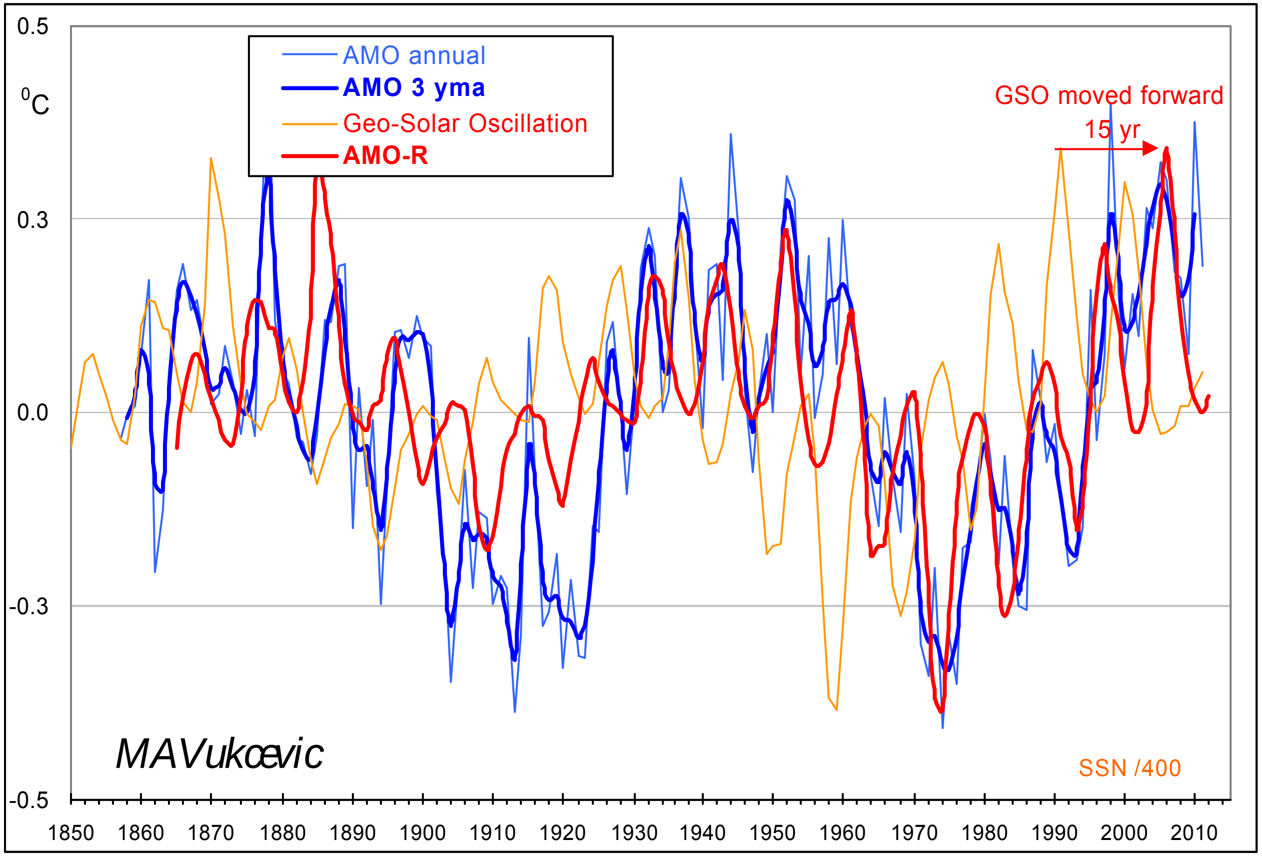


Fig. 8 – GSO cycle when moved forward by 15 years (AMO-R) is a good match for the AMO

The GSO waveform appear to be a good match for the AMO (exception is the 1940's extra AMO cycle), it also could be considered as a valuable reconstruction for the AMO, based on non-proxy data, it will be also referred to as **the AMO-R** (all 3 year moving averages - 3 yma, are calculated by using a 1-2-1 binomial weighting).

The GSO spectrum matches accurately 9.1 year period for the AMO indirectly associated with the SSNmc 2x10.54, peak, while the second AMO peak at 10 year is associated with second (and somewhat lower SSNmc 2x11.04 peak. higher At the higher ~ 65 year period two spectra are almost identical, confirming that the proverbial

"~ 60 year cycle" is not a natural fundamental oscillation but a cross-modulation product

Existence of the 16 year period fundamental oscillation is unknown to the climate science or geophysics, but as the author has found out that should not be so.

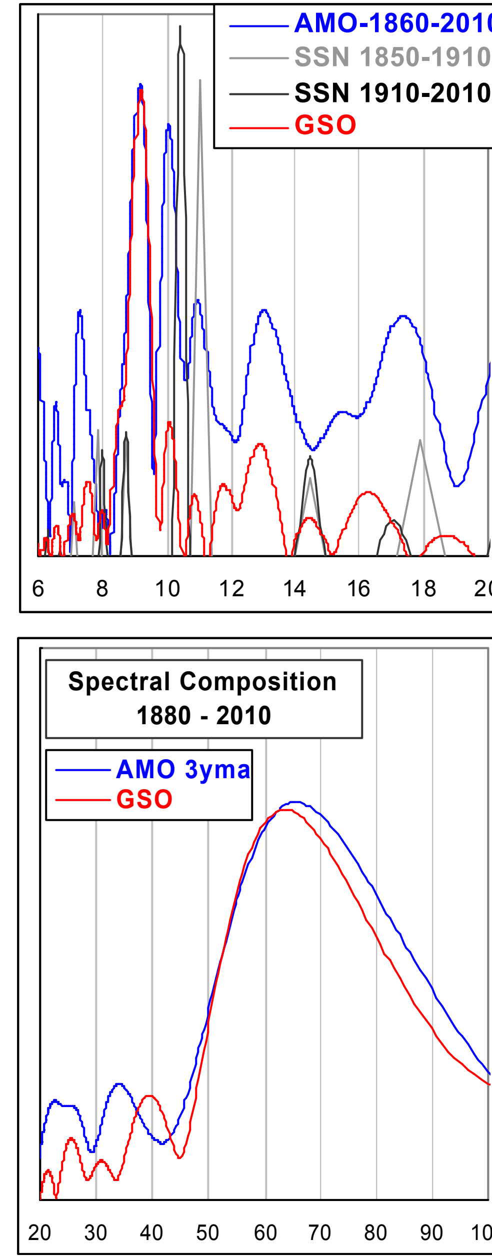


Fig. 9a & 9b – GSO and the AMO's spectra are almost identical at main peaks of 9 an 65 years

The intermediary range of frequencies is of much lesser prominence. The 15 year delay may be of some concern; but there is also a similar delay between the AMO and NAO (more details on the next page).

GEO-SOLAR OSILLATION and the NAO

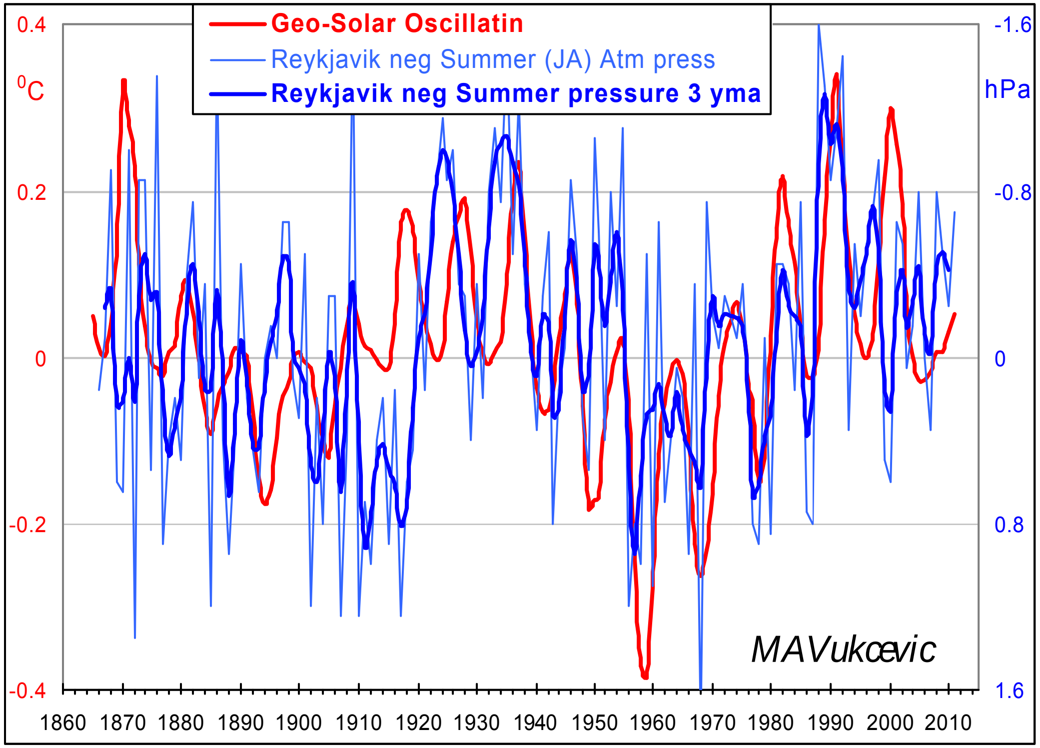


Fig. 12 – GSO & Reykjavik summer atmospheric pressure NO DELAY

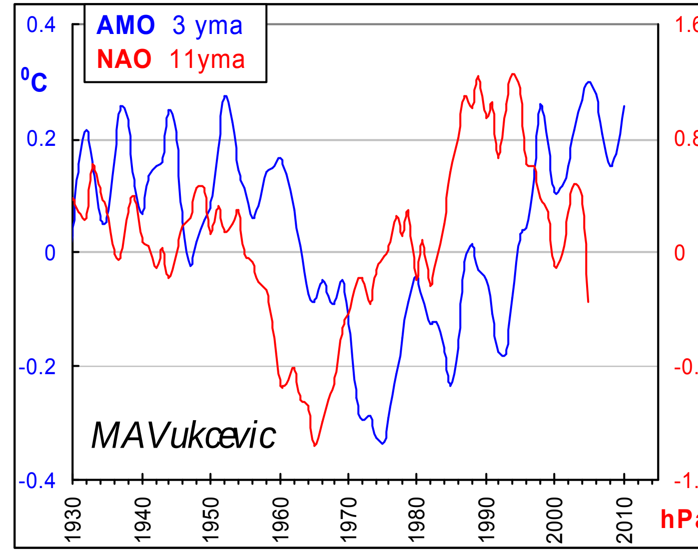


Fig. 10 – AMO delayed to the NAO ~ 11 years

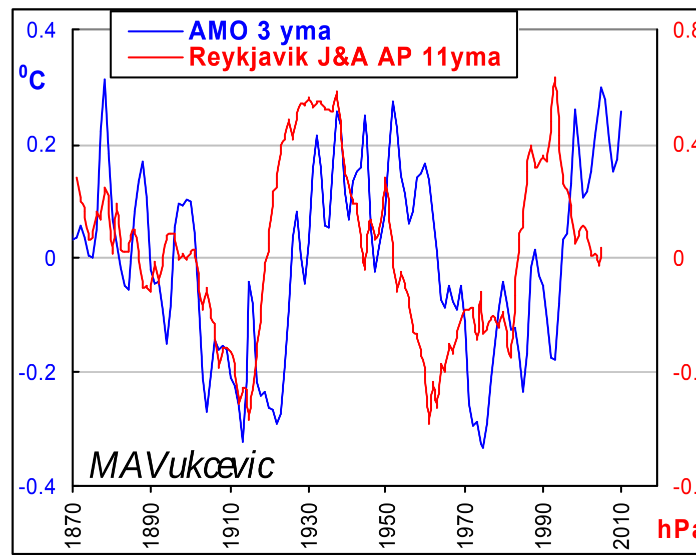


Fig. 11 – AMO lags the Reykjavik pressure by 11 years

North Atlantic Oscillation – NAO is defined as the change in the difference of atmospheric pressure at the sea level between two specific locations: Ponta Delgada, Azores and Stykkisholmur/Reykjavik, Iceland.

Fig. 12 – shows that the Reykjavik's summer (negative) atmospheric pressure is directly related the Geo-Solar Oscillation with no delay indicating the atmospheric pressure response is immediate, while SST responds with a delay.

AMO 3yma – NAO 11yma has correlation factor of $R^2 = 0.763$ for 1925 – 2010 period with 11 year delay taken into account. Reykjavik's summer (July & August) (negative) atmospheric pressure has high correlation with the AMO for 1870 -2010 period, when pressure curve moved forward by 11 years

More details on the complex AMO–NAO/ atmospheric pressure relationship at http://hal.archives-ouvertes.fr/docs/00/64/12/35/PDF/NorthAtlanticOscillations-I.pdf
however in view of the new findings this unusual occurrence will be revisited.

GEO-SOLAR OSCILLATION and the HEMISPHERES

Since the GSO waveform is a direct product of two trend-less oscillations, than resultant also has a zero trend. In view of this to compare the temperature anomalies with the GSO, it is necessary to de-trend the relevant temperature's data sets.

The GSO appear to be fundamental to the Atlantic Multidecadal Oscillation, it is (as expected) found that the global temperatures also show strong correlation to the GSO.

Fig. 14 – shows North Hemisphere's follows the GSO's cycle with occasional oscillations damping effect as in 1960-1975 and 1995-2010 periods on a steep up/down slope. This could be either result of oceanic inertia of much larger Pacific or external factors such as aerosols or GHGs. On the plus side the 1900-30 the GSO–NH's temps correlation is stronger than the GSO–AMO for the same period. (Fig. 13).

In general the SH's temperature oscillations (Fig. 15) are far weaker than those in the North (note temps scale's difference), possibly function of much larger oceanic volumes, hence the Southern hemisphere shows much weaker correlation to the GSO than the North hemisphere.

Identifying 16 year oscillation's source is of fundamental importance.

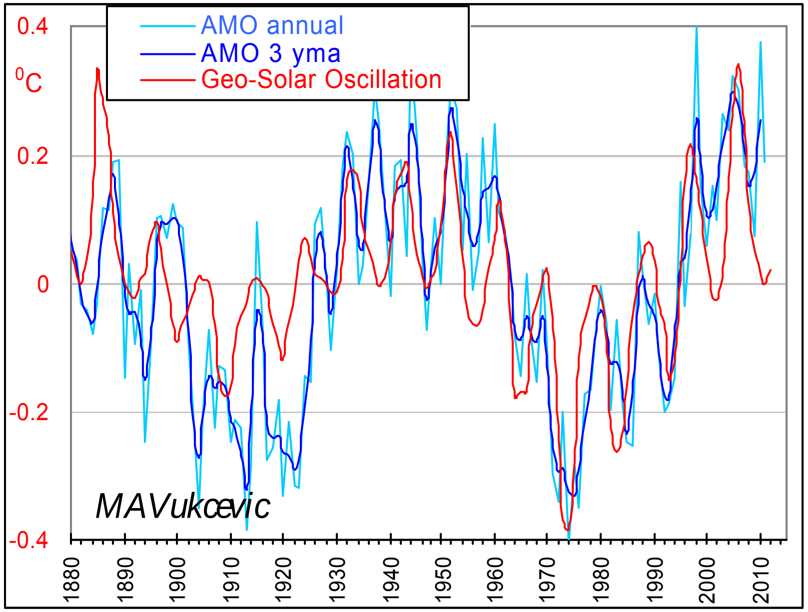


Fig. 13 – GSO and AMO

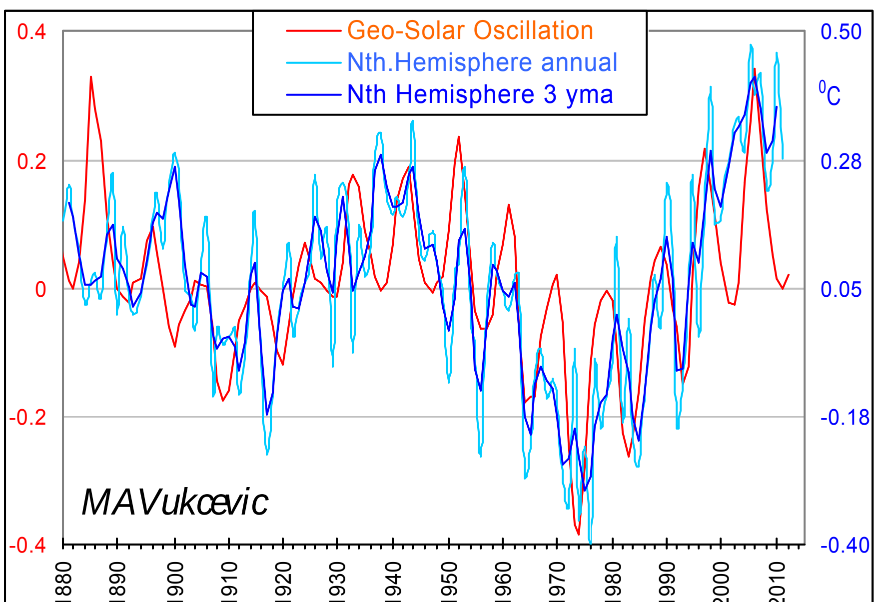


Fig. 14 – GSO and the Hemisphere's temperature

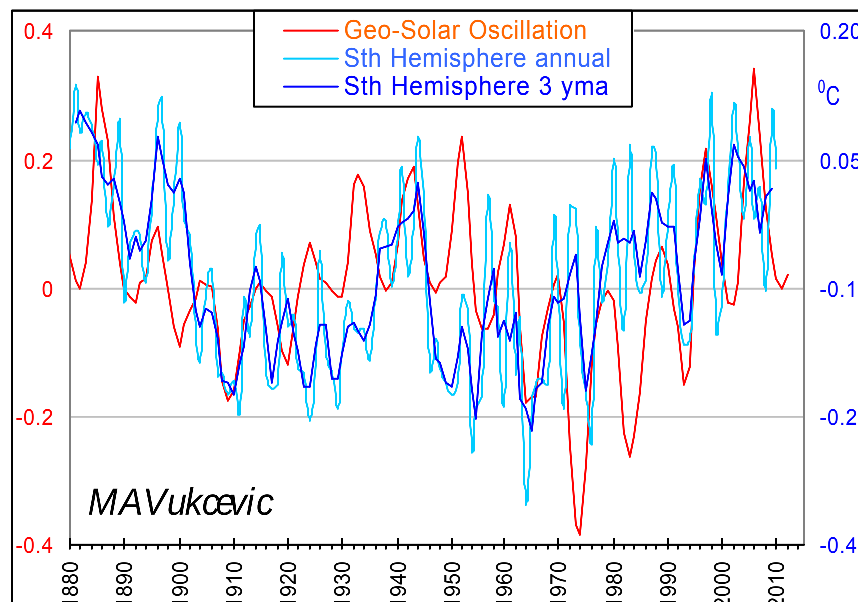


Fig. 14a – GSO and the South Hemisphere's temperature

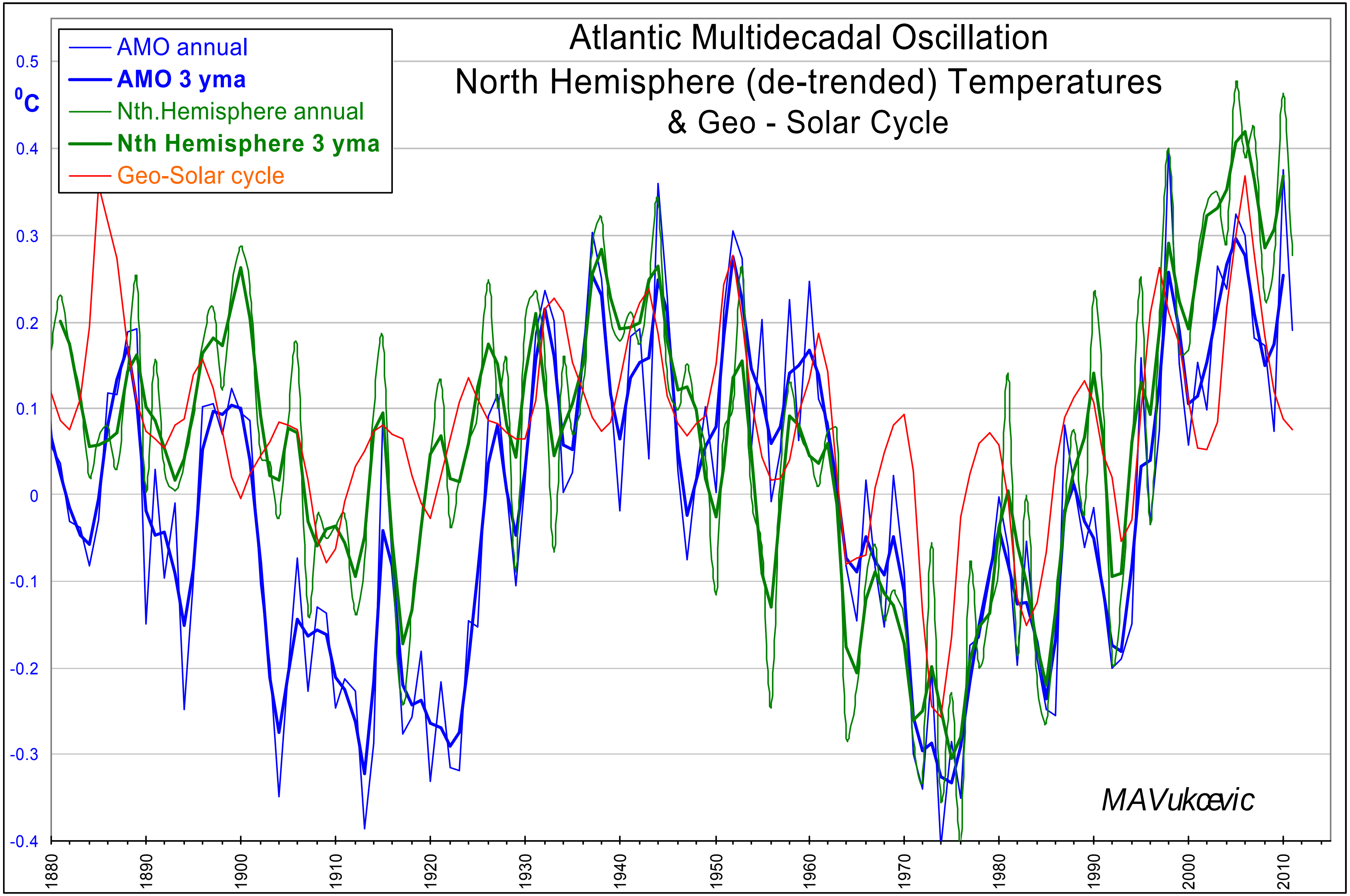


Fig. 15 Geo-Solar, North Atlantic the North Hemisphere's Oscillations

NEXT : IDENTIFYING SOURCE OF THE 16 YEAR OSCILLATIONS!

ARCTIC TEMPERATURE and the AMO

It is generally understood that the AMO, which is derived from the North Atlantic's SST, is generated in the area of the Sub-polar Gyre. This area is only few degrees of latitude outside the Arctic Circle. It would be expected that the Arctic temperature trends would be similar to those of the SST, and indeed this appear to be the case with exception that it appears the Arctic's temperature precedes changes to the North Atlantic's SST.

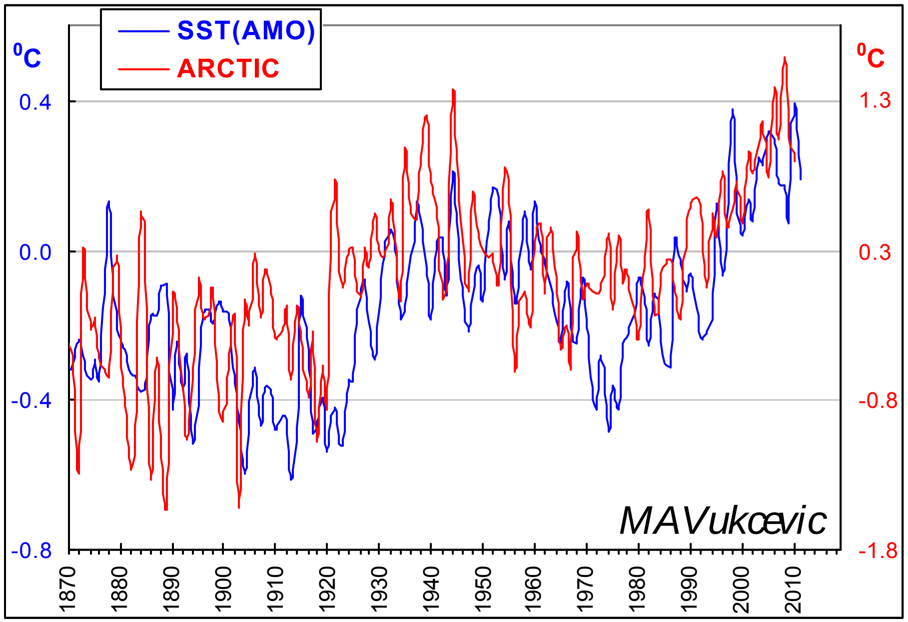


Fig. 16 – Arctic temperature trends precede the N. Atlantic SST

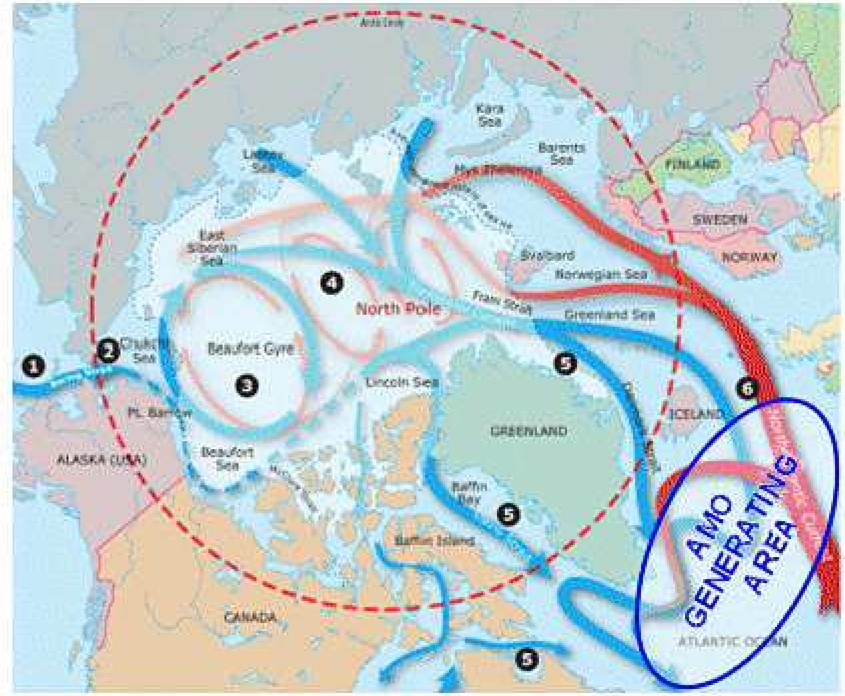


Fig. 16 – AMO is generated just outside the Arctic Circle

Oceanic circulation namely **Gulf Stream** delivers large amounts of heat northward into the high latitudes. The currents reach deep into the Arctic Ocean.

The **Sub-polar Gyre** (the AMO generating area) is the engine of the heat transport across the North Atlantic, it is also the region of intense ocean and atmosphere interaction, and one of the most complex and possibly most studied ocean current systems anywhere.

The **Beaufort Gyre** system plays a flywheel role and stabilizes the climate of the entire Arctic region.

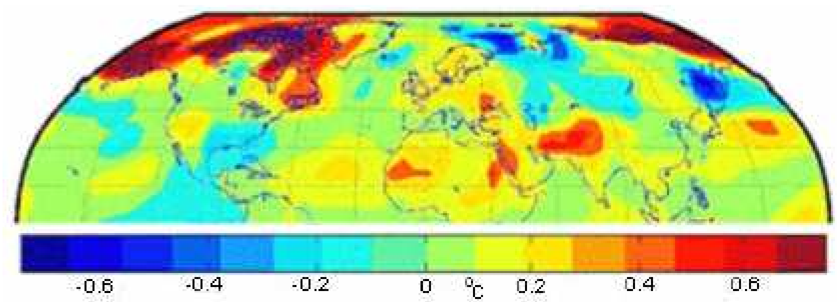
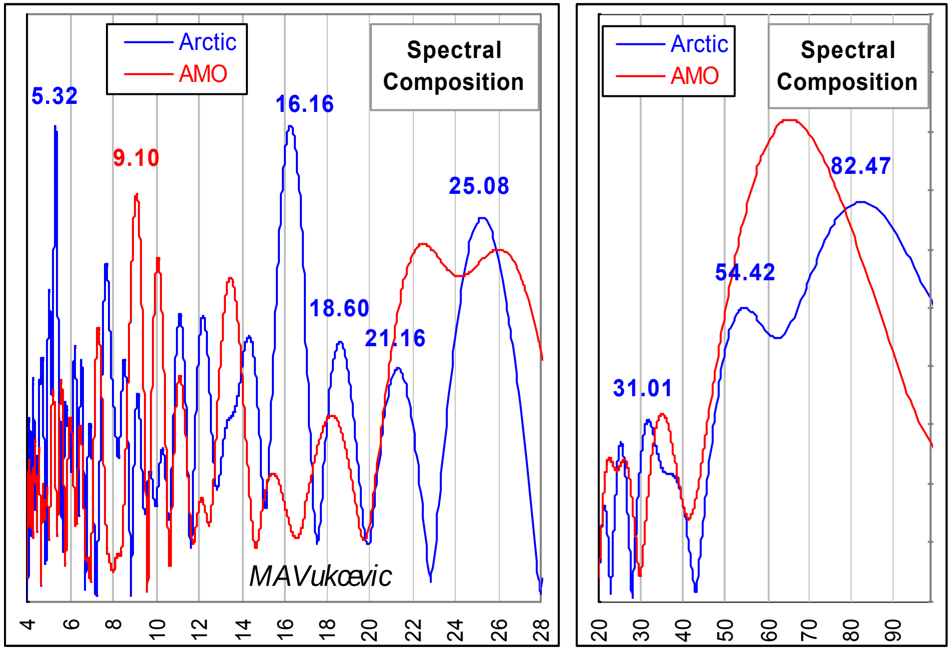


Fig. 17 – Nth Hemisphere temperature deviation from the mean

Another unusual property of the of the Arctic temperature is that the deviation from the mean is much higher then rest of the globe, this is attributed to the "polar amplification" which is thought to be result of positive feedbacks from the retreat of ice and snow and other lesser reasons.

ARCTIC SPECTRUM REVEALS STRONG 16 YEAR PERIOD OSCILLATION

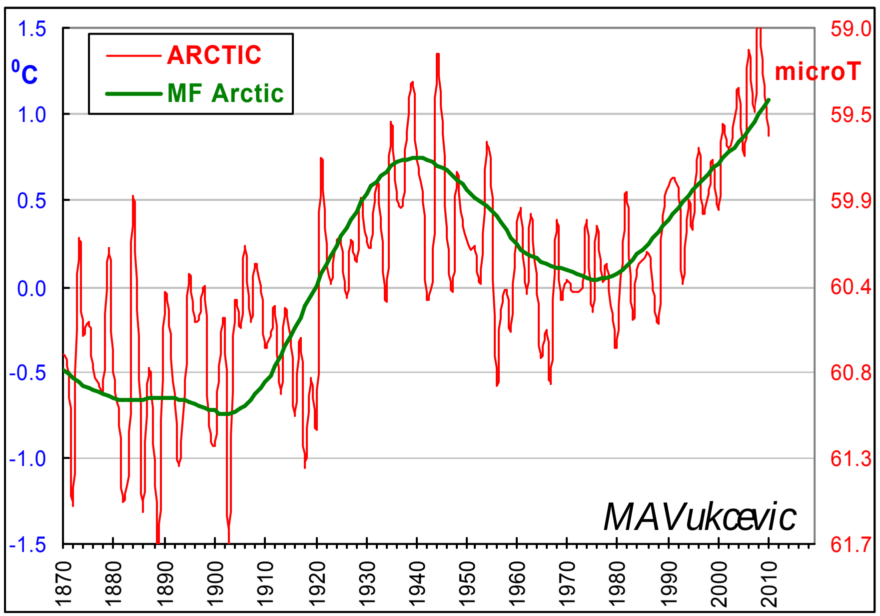


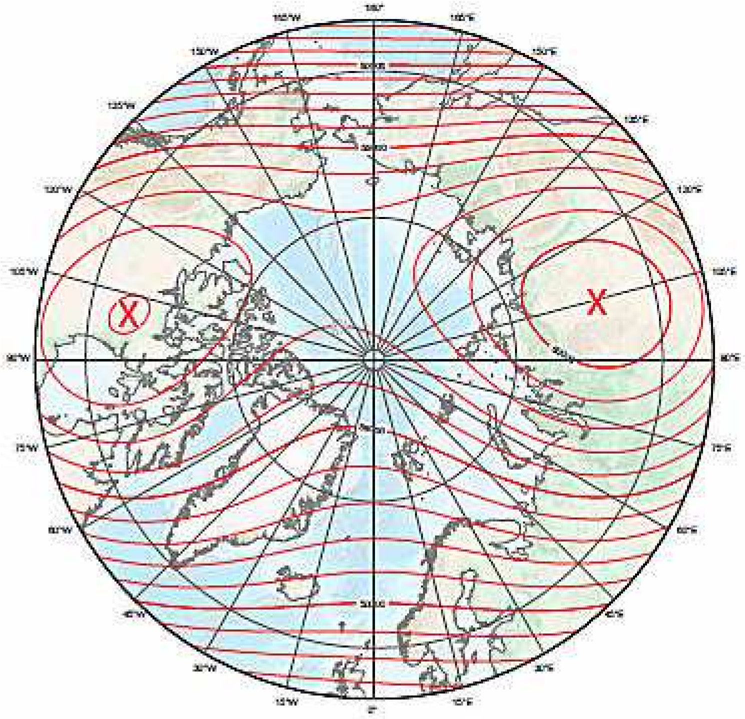
Spectral composition of the Arctic temperature, beside very prominent 16.16 period, also contains other key frequencies with periods: 5.3□ENSO, 18.6□luni-solar tides & 21.16□SSNmc years. but no AMO or the strong and direct SSN association. It is important to note the longer periods of 25, 31, 54 and 84 years.

Arctic temperature is unique in another respect related to a discovery by the author (M. A. Vukcevic) some time ago (refered to in a number of web climate blogs), identifying high correlation (R^2 = 0.6) between the Arctic□s temperature and the Earth□s magnetic field vertical component Bz (Fig. 19). This is calculated as an arithmetic average between two poles caused by bifurcation of the Earth□s magnetic field in the Northern hemisphere (Fig. 20). Data: http://www.epm.geophys.ethz.ch/~cfinlay/gufm1/model/gufm1

Earth□s magnetic field may reveal source of the 16 year oscillation, the vital component of this analysis

Fig. 18 □ Arctic temperature and the AMO spectra (left)
Fig. 19 □ Arctic temps correlates to the Geo MF (lower left)
Fig. 20 □ North Hemisphere magnetic field Bz (below)





EARTH and its INNER CORE OSCILLATIONS

Earth's magnetic field results from movements of molten iron and nickel within its liquid outer core. These flows, which are caused by interactions between Earth's core and its mantle, are neither even, nor evenly distributed. The electrical currents generated by these flows result in a magnetic field, which is uneven, moves around in location and varies in strength over time.

Number of oscillations originate at the boundary between Earth's core and its mantle have been identified, oscillations travel inward toward the inner core with decreasing strength.

Patterns of variations found in the Earth's core match up directly with the shape of the Earth's magnetic field.

Four of these oscillations occurring at periods of 85, 50, 35 and 28. Since the scientist's data set for the Earth's core goes back to 1840, the recurrence period of the longest oscillations (85 and 50 years) is less well determined than those of shorter periods. Oscillations with similar periods were identified in the Arctic temperature spectrum as well as in the much longer and more accurate Central England Temperature (CET) records.

Inner core Oscillations	85	50	35	28
Arctic spectrum	82	54	32	25
AMO	-	64	35	22-26
CET	90	55	35	28

Detailed analysis of the geomagnetic data (A. Jackson *et al*) revels oscillations of higher frequencies than those included in the table, including the all important 16 year period.

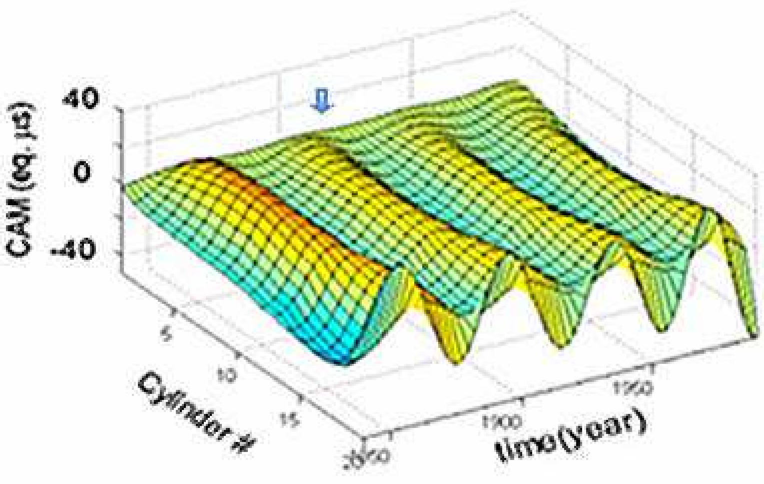


Fig. 22 – Waves of motion, occurring within the liquid core

Science/AAAS http://www.sciencemag.org/content/328/5981/1014
NASA http://www.jpl.nasa.gov/news/features.cfm?feature=2420

Earth's rotation, movements in Earth's core, angular momentum and the length of an Earth day (LOD)

Changes in circulation of the world oceans and atmosphere affect the length of an Earth day (LOD). Longer fluctuations are too large to be explained by the motions of Earth's atmosphere and ocean, it is understood that they are due to the flow of liquid iron within Earth's outer core, where Earth's magnetic field originates.

While it is not possible to observe how fluid flows interact with Earth's mantle directly, this can be deduced from observations of Earth's magnetic field at the surface.

Magnetic data have shown that the flow of liquid iron in Earth's outer core oscillates, in waves of motion that last for decades with timescales that correspond closely to long-term variations in Earth's length of day.

The EARTH’S MAGNETIC FIELD and its RATE OF CHANGE at the CORE-MANTLE INTERFACE

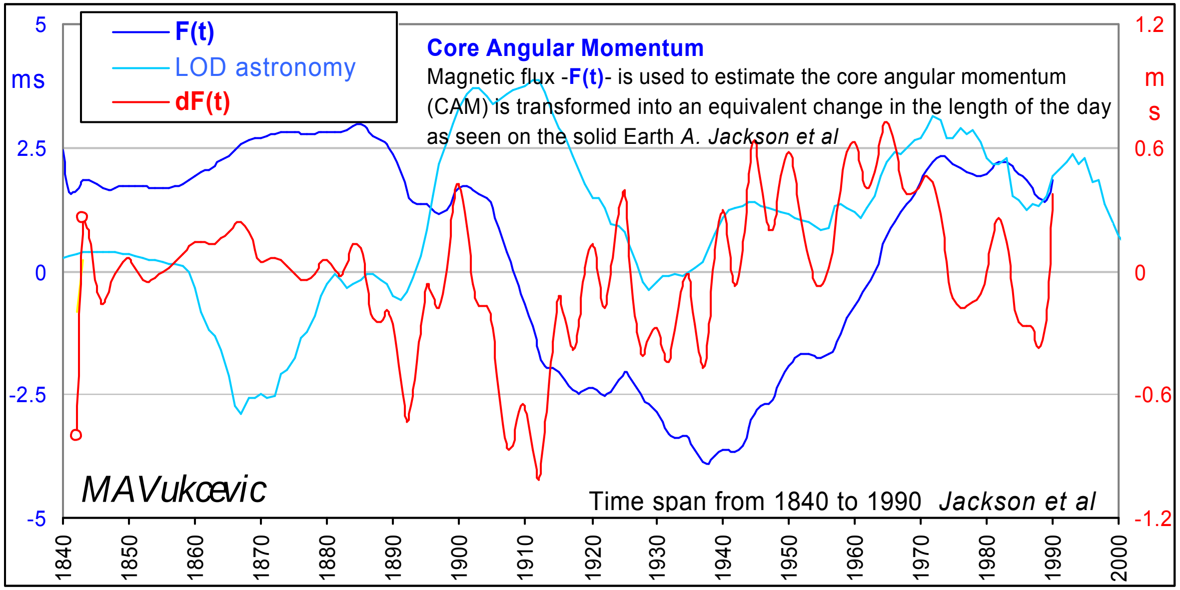


Fig. 23 – Core angular momentum changes transposed into the equivalent LOD / F(t)

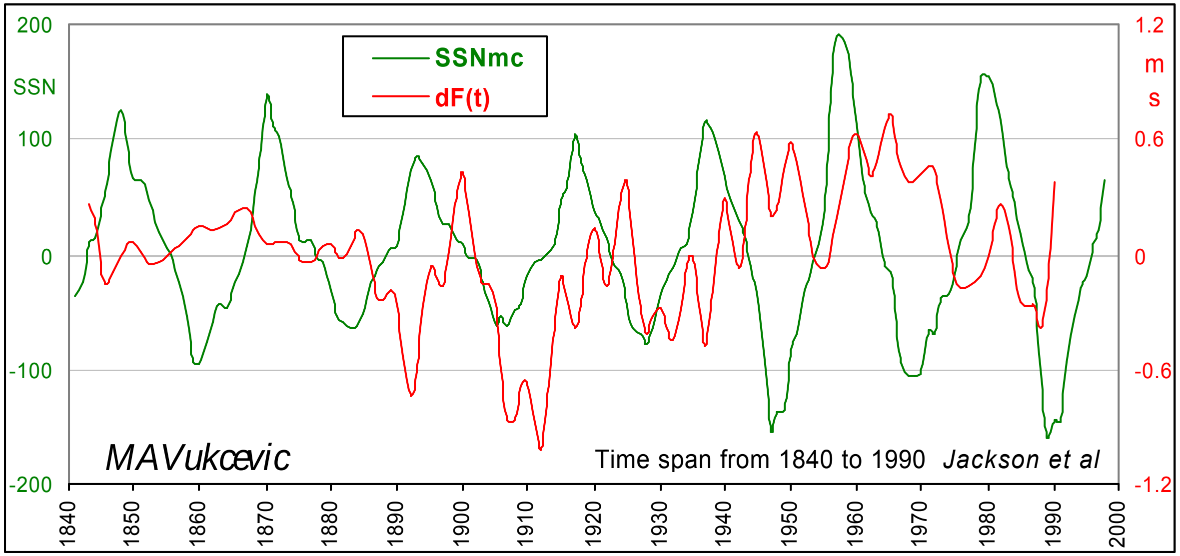


Fig. 24 – dF(t) compared to the Sunspot magnetic cycle

Extract from *Jackson et al* research

The zonal toroidal components of a fully time-dependent geostrophic flow constructed under the frozen flux hypothesis are used to estimate the core angular momentum (CAM).

- Sampling time interval: 1 year

- Time span from 1840.0 to 1990.0

- Data unit: Excess length of the day in milliseconds over standard day of 86400 sec.

The CAM is then transformed into an equivalent change in the length of the day as seen on the solid Earth by conservation of angular momentum. The predictions only give relative changes in the “length of day – LOD, therefore an arbitrary offset should be chosen in order that the predictions agree reasonably well with the LOD series from astronomical observations. A value of 3.25 milliseconds has been added to the predictions to give the values presented here

http://www.astro.oma.be/SBC/data1.html

Three different data series are given, rough, smooth and intermediate; the rough data series is used for this analysis.

The “LOD” related to the CAM and calculated from the magnetic field is not same as the LOD’s astronomical value, but most likely it is its greatest contributor. Variable referring to the magnetic field rate of change is a time function **F(t)**, from which a short term rate of change i.e. “acceleration” **dF(t)** is calculated over period of 2 years i.e.

$$dF(t)_N = (F_N - F_{N-2})$$

Similar **dF(t)** values are obtained if 1 or 3 year period is used, . From Fig. 21 can be observed that there is some similarity in trends of the solar magnetic cycle and the biannual changes in the **dF(t)** values, the feature worth of more attention. Initial value for 1842 is an obvious outlier and it has been rejected

The EARTH's CORE OSCILLATION's SPECTRUM and SOLAR CYCLES

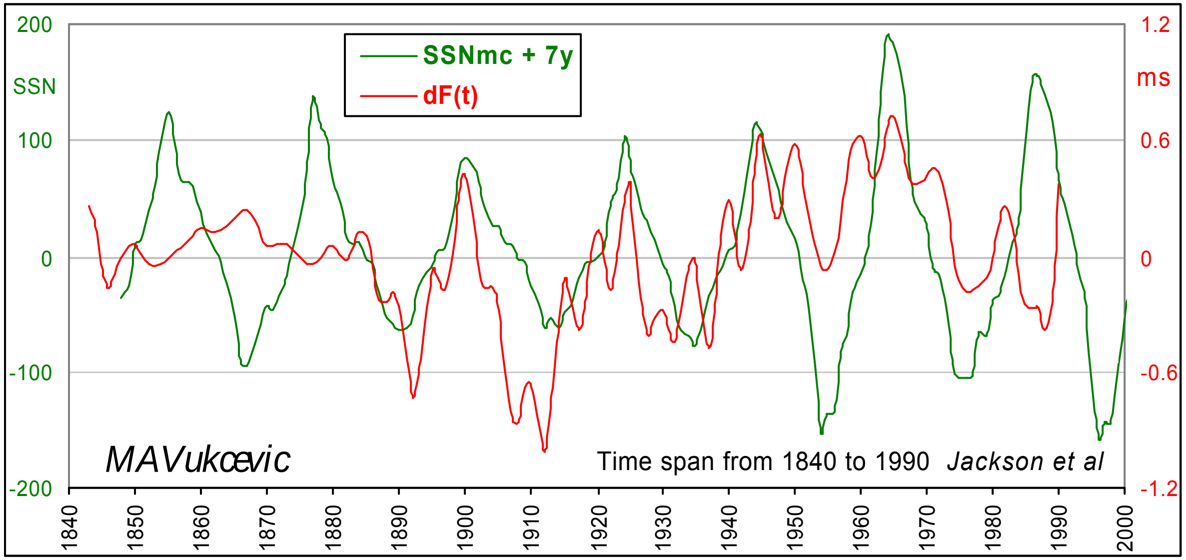


Fig. 25 – dF(t) compared to the 7 year advanced Sunspot magnetic cycle

When the solar magnetic cycle is moved forward by about 7 years, it shows that there is some synchronicity between SSNmc and change in the **dF(t)**, this is also time difference between the sunspot cycle and its precursor, the preceding solar polar field cycle's maximum.

This synchronising is not known to science but it could be validated by another finding by the author (M.A. Vukcevic), whereby changes in the Antarctica's magnetic field does closely correlate to the changes in closed solar magnetic flux that generates bright solar faculae (discussed in pages ahead).

Most fascinating part of the above finding and of fundamental importance to the climate and possibly for number of other branches of the natural sciences, is the spectral content of the change in time function **dF(t)**.

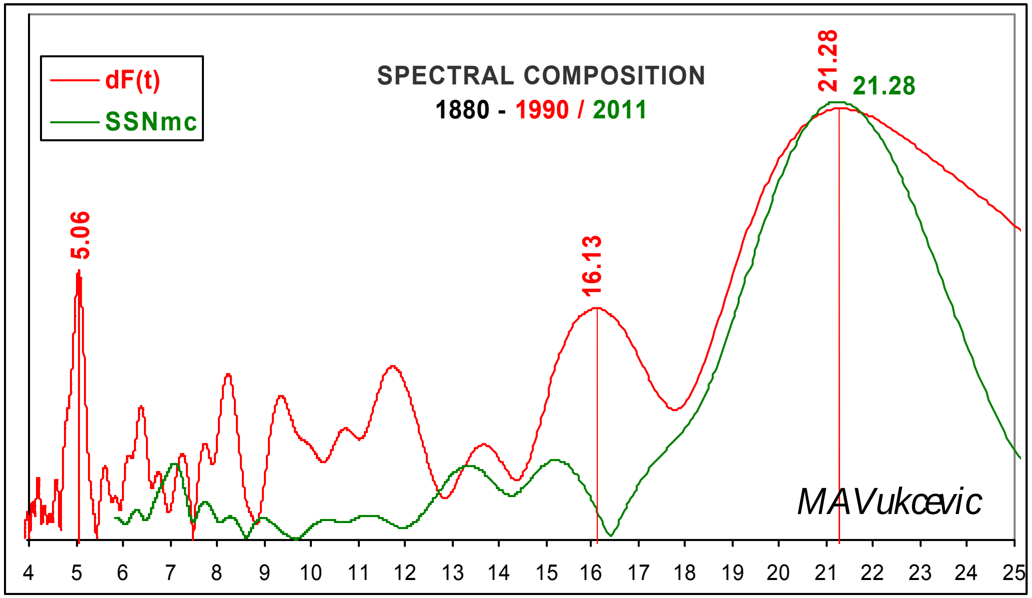


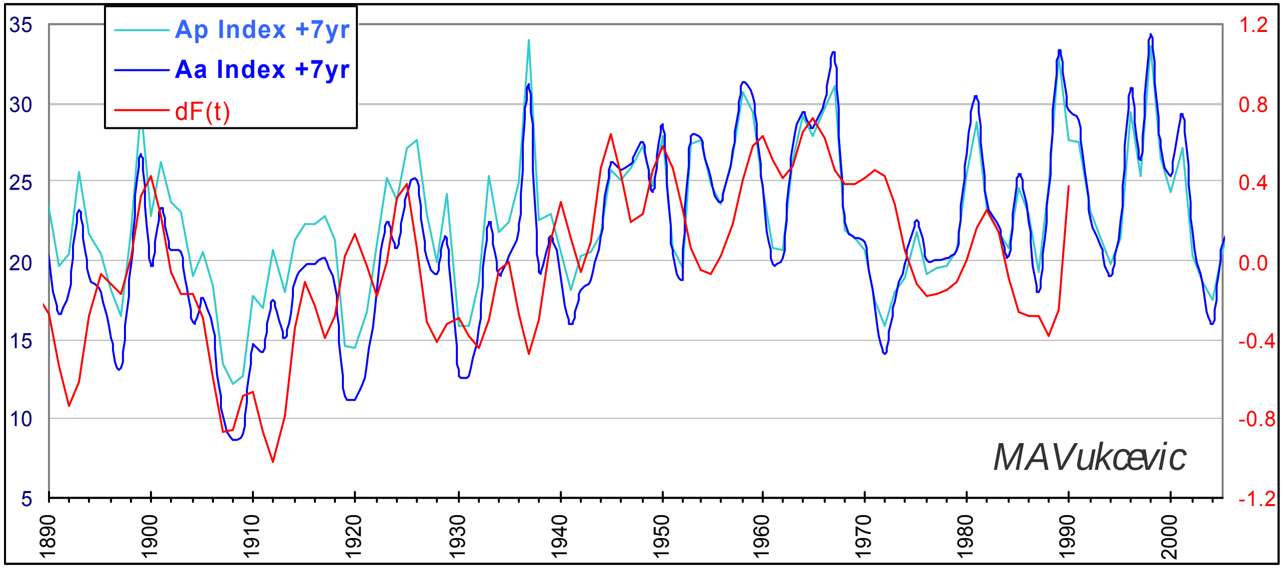
Fig. 26 – dF(t) & Solar magnetic cycle spectral composition

- **dF(t) has 3 dominant periods 21.22, 16.13 & 5 years**
- **21.22 year period is same as the sun's magnetic (Hale) cycle, but not necessarily induced by it.**
- **16.13 year period is almost identical to the calculated 16.14 years period, and very close with main component of 16.16 year in the Arctic's temperature spectrum** (page 11).
- **5.03 year period is within margin of error what is found in the Arctic temperature and the ENSO.**

There is a possibility that the both AMO frequency constituents are the Earth core originated, but then 22 year cycle needs to have same amplitude modulation as the sunspot cycle, therefore assumption that 22 year cycle is from direct solar input.

Source of the 16 year oscillation has been identified and its presence fond in the Arctic temperature spectrum it would be useful to identify further evidence of links between solar magnetic cycle and the Earth's magnetic field, with further physical manifestation of the 16 year period.

GEOMAGNETIC ACTIVITY INDEX and GEO-SOLAR CYCLE

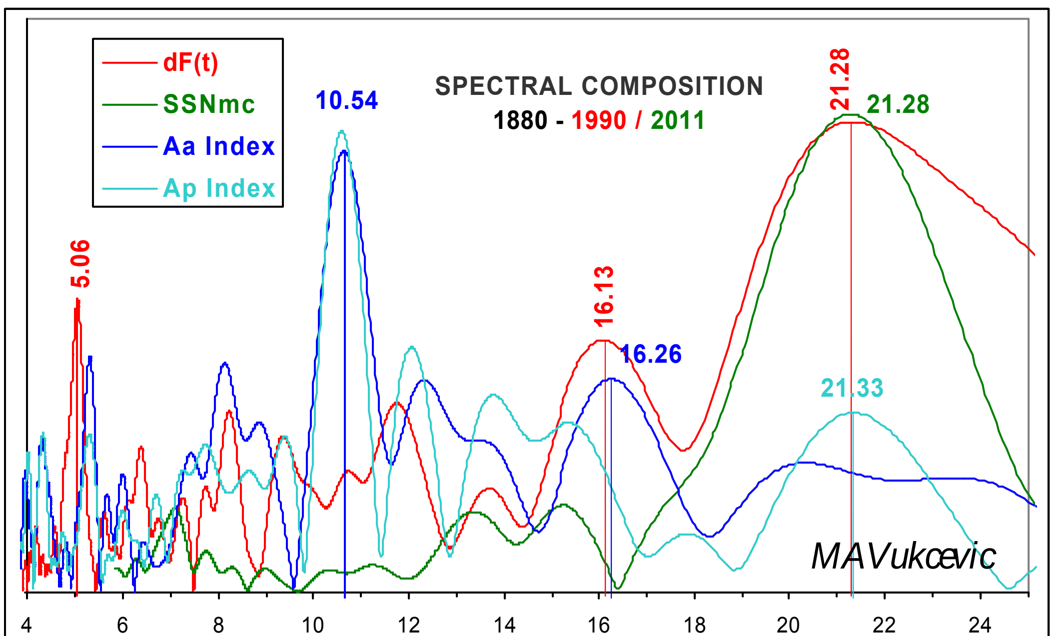


Change in the geomagnetic intensity is result of the secular change in the Earth’s magnetic field and the short term impact from the solar activity; number of indices recording instrumental value of these changes.

The **Aa index** of geomagnetic activity is a proxy for the strength and phase properties of the solar dynamo. Both Aa and the sunspot number SSN show strong 11 year cycles, however they identical or synchronous.

Parts of the Aa index are associated with the toroidal and parts with poloidal solar magnetic field. The correlation between SSN and Aa is about 0.47

Fig. 27 – dF(t) compared to the Aa / Ap geomagnetic indices



The **Ap index** is a record of the level of geomagnetic activity measured across the globe for a given day.

29 < Ap < 50 minor storm
50 <= Ap < 100 major storm
Ap >= 100 severe storm

Visual observation of Fig. 27 shows that there is a good correlation of the Earth’s core **dF(t)** time function and the Aa/Ap geomagnetic indices.

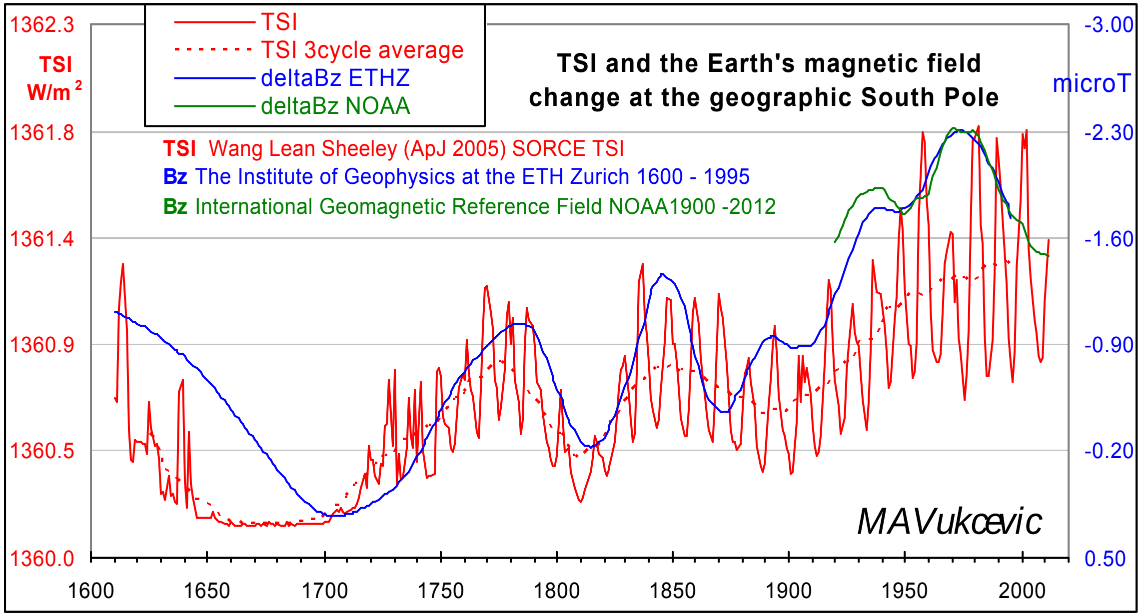
The Aa spectrum which takes into account the Earth’s magnetic field change shows 16.26 year is within the margin of error to 16.13 year found in **dF(t)** (Fig. 28, p.13), as well as 10.48 yr (SSN cycle) and 33 year associated with values as tabulated on page 11.

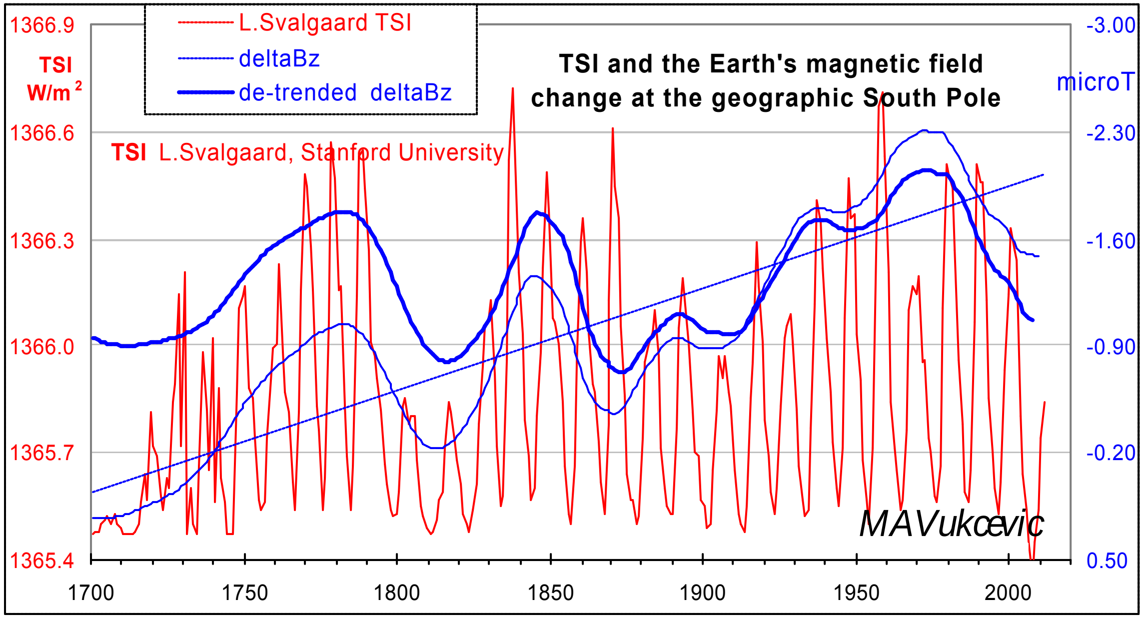
The Ap index shows only SSN (10.54yr) and 21.33 (SSNmc) associated with solar activity but no 16 year cycle, hence it can be concluded that 16 year cycle is the Earth generated oscillation.

Long term connection (or possibly response) of the Earth’s magnetic field to the solar activity is considered on next page.

Fig. 28 – Spectral composition of the Aa/Ap indices

EARTH’s MAGNETIC FIELD CHANGE at the GEOGRAPHIC SOUTH POLE





Total Solar Irradiance upon Earth the TSI is the total frequency spectrum of electromagnetic radiation given off by the Sun.

Fig. 29 – delta Bz & TSI by Wang et al (left)

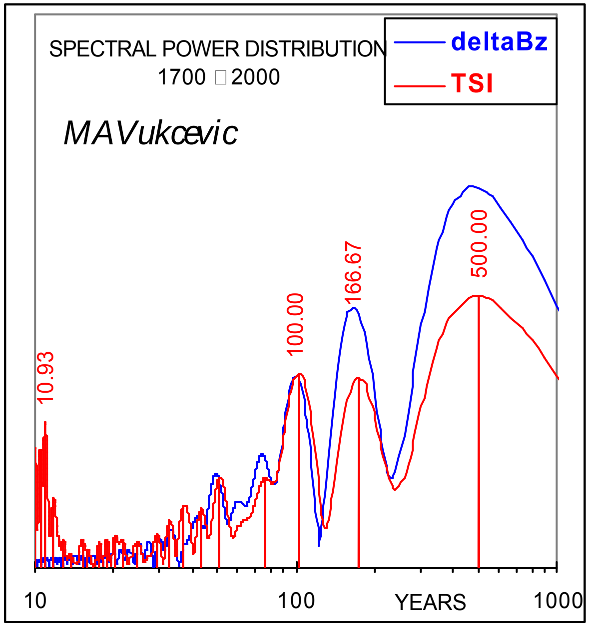
Fig.30 – delta Bz & TSI by Svalgaard (left down)

- TSI by Wang et al is based on the long-term evolution of the closed solar magnetic flux.
- Changes in the Antarctic's magnetic field, delta Bz is computed on a bi-decadal scale.
- L. Svalgaard (Stanford) is reconstruction of TSI with a near zero up-trend since 1700.
- Correlation: delta Bz -. Wang TSI R^2=0.55 direct TSI averaged across 3 sunspot cycles R^2=0.77.

Relationship of the Earth’s magnetic field strength in the Antarctic and the TSI (proxy for the solar magnetic output) was unknown to either solar science or geophysics prior to 2012 discovery by the author (M. A. Vukcevic).

Earth magnetic data:
http://www.epm.geophys.ethz.ch/~cfinlay/gufm1/model/gufm1

Fig. 31 – delta Bz and TSI spectra (below)



SOLAR EARTH AND GLOBAL TEMPERATURE MULTI-DECADAL OSCILLATIONS

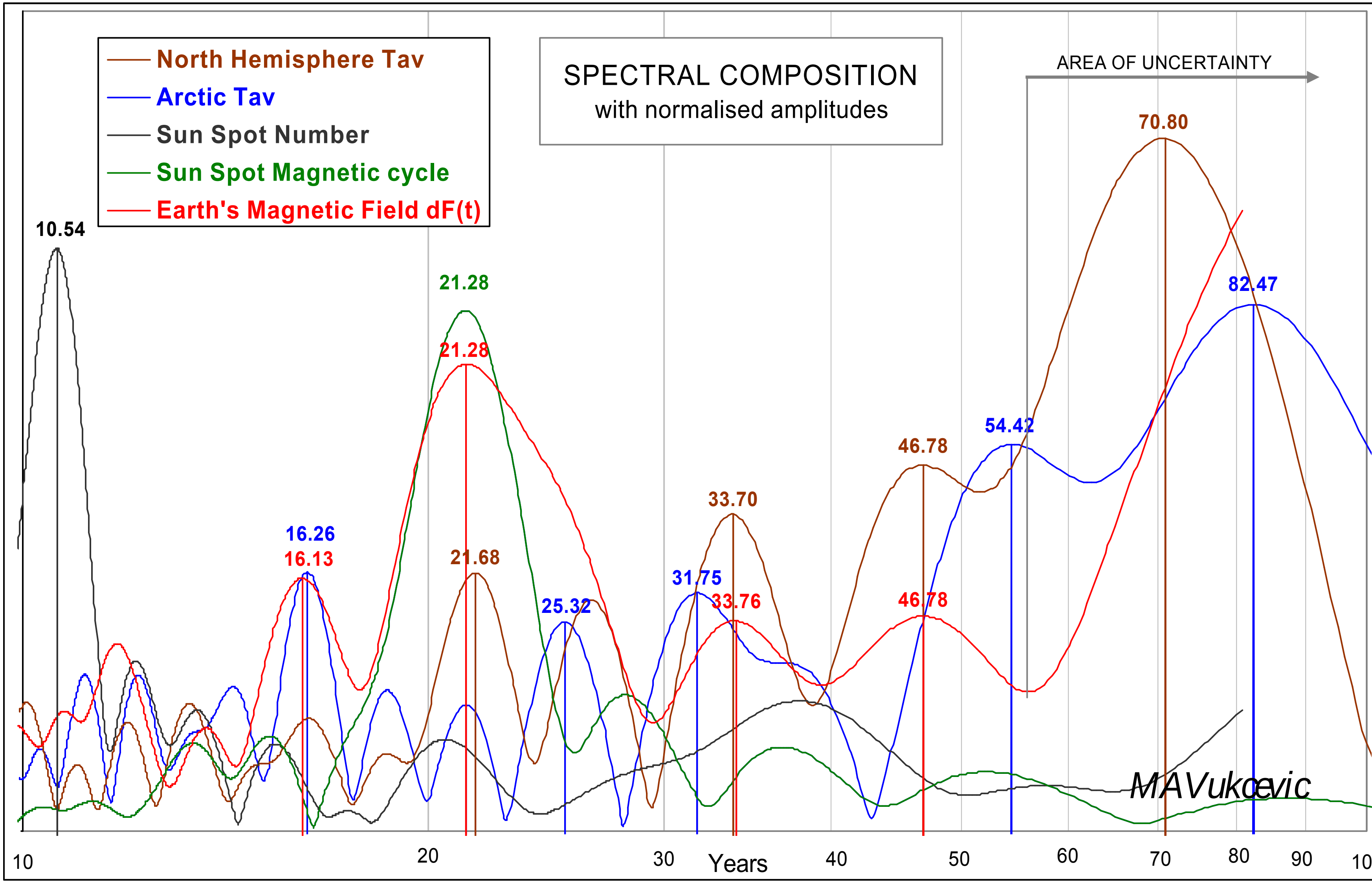


Fig. 32 Assembly of multi-decadal oscillations in temperatures, solar and geo-magnetic oscillations

RECONSTRUCTING the AMO (AMO-R) by EXTENDING GSO BACK to 1710

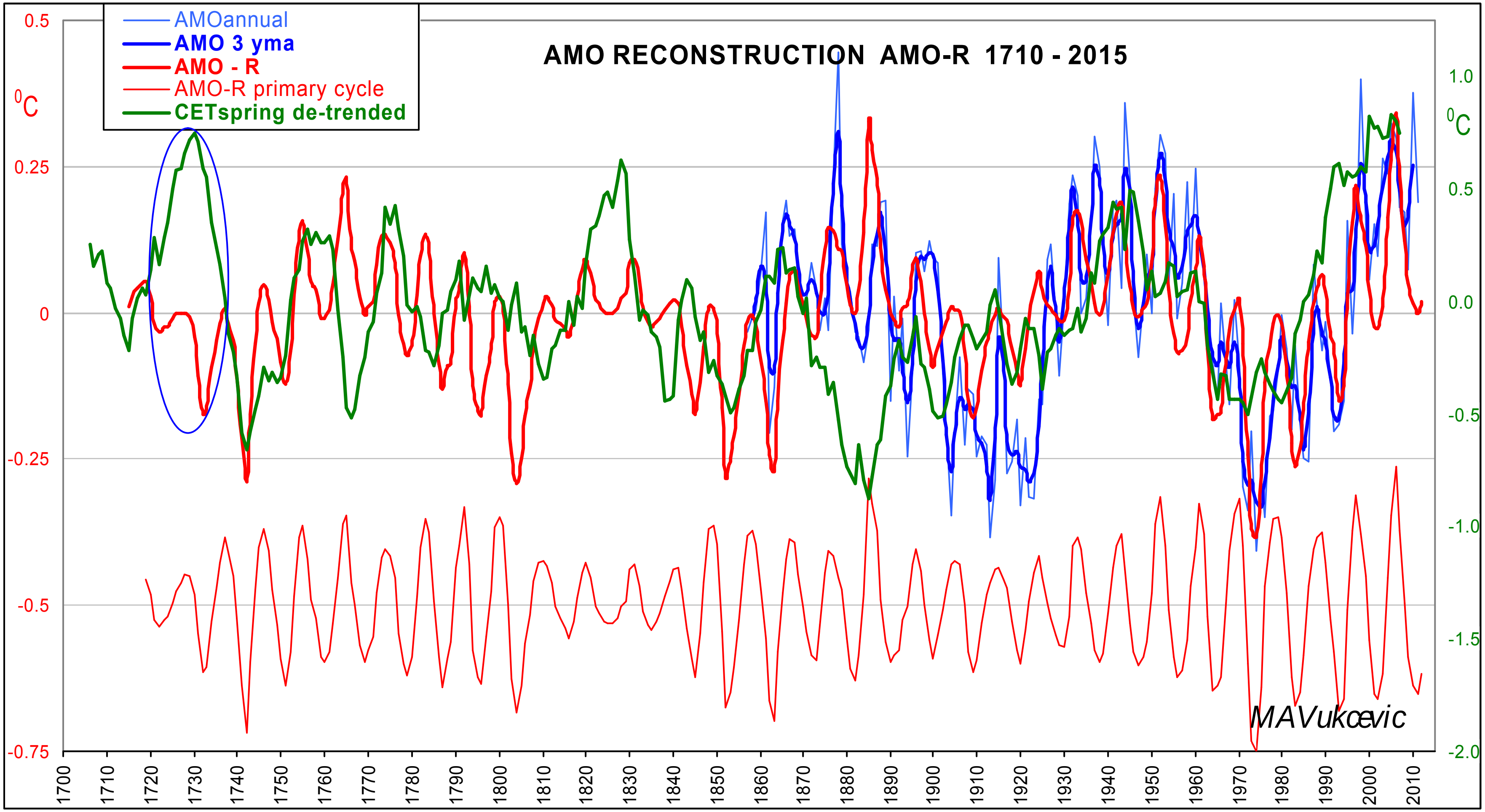


Fig. 33 AMO R compared to the CET components + the AMO R s extracted primary cycles with of 9.1 year period

Available sunspot data of a reasonable accuracy are available since 1700, thus the GSO can be extended only as far.

The Central England Temperature -CET spring de-trended temperatures (due to often prevailing westerly winds) are to some degree related to the surface temperatures of the adjacent Atlantic Ocean. It can be noted that the CET does occasionally run in counter phase with the AMO as in 1730s, 1830s and 1880s.

From the above illustration it can be concluded that from about 1735 the AMO-R is indeed of sufficient quality to justify further attention.

The AMO-R primary cycle is extracted by using simple band-pass filtering formula (3 yma 11 yma), as outlined on page 3. The AMO primary cycle will be used in the further validity verification process, by comparing to the CET June temperatures.

CET data: http://www.metoffice.gov.uk/hadobs/hadcet/cetml1659on.dat

The AMO –R PRIMARY CYCLE is COMPARED to the CET –JUNE OSCILLATIONS

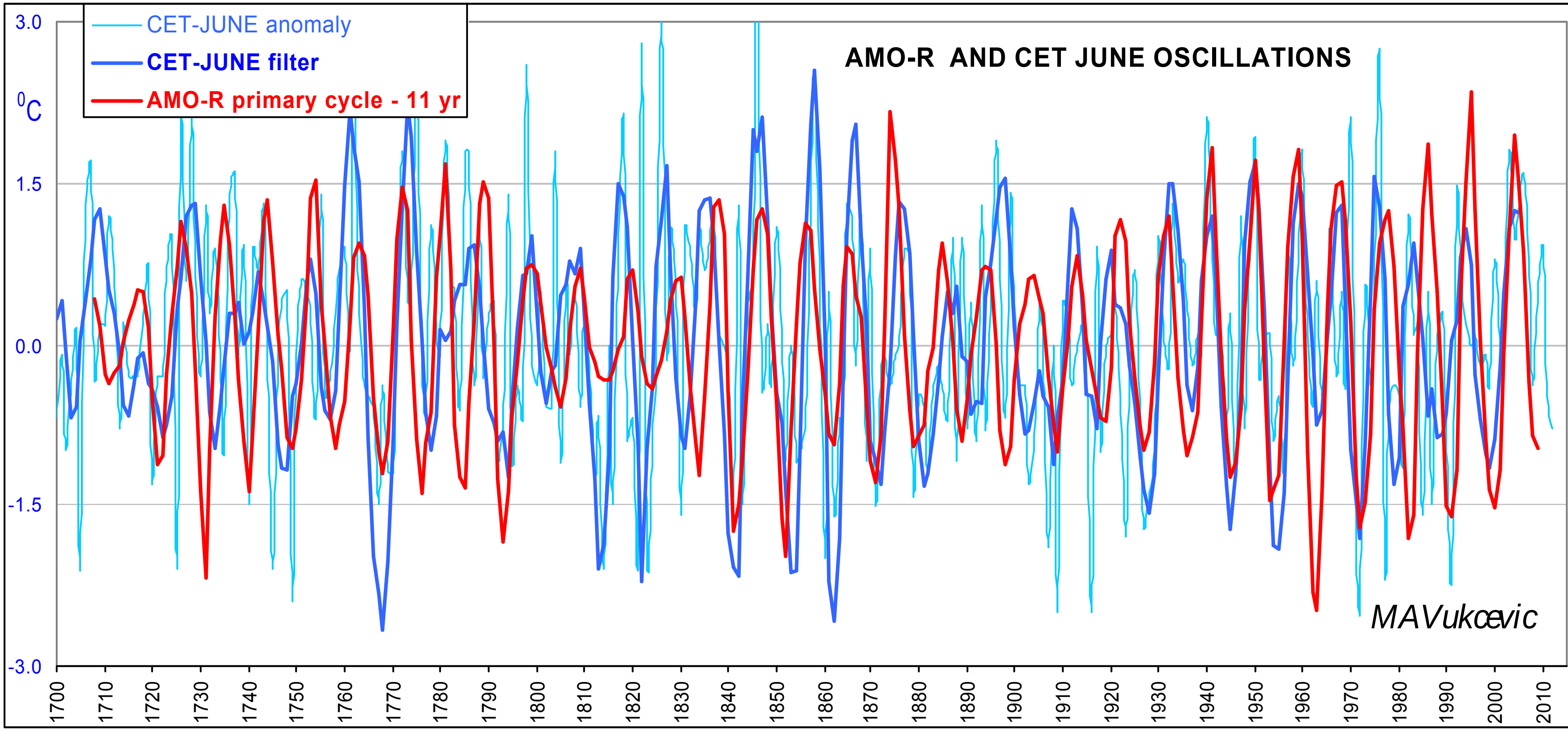


Fig. 34 – AMO–R primary cycle & the CET June’s filter extracted decadal oscillations

Month of June when the insolation is at its highest (solar input at its maximum) and the nearby Atlantic SST is still on the rise has a unique property of being ‘trend-less’ for period over 300 years long (1700 to present), i.e. its inter-annual changes are what appear to be random oscillation around its zero trend. It is possibly a unique temperature data set among many thousands of the world temperature records having not only a zero long term trend, but also almost regular ~ 9 year period oscillations.

Comparing visually two oscillations (AMO-R and the CET-June) shows good agreement with occasional drift out of phase and then back in phase. It is now possible with certain degree of confidence to conclude that the above AMO reconstruction is very likely good representation of the North Atlantic sea surface temperature multi-decadal oscillations.

It should be noted that the both the AMO and consequently AMO-R are naturally delayed in relation to the CET and the CET-June waveforms by some 4 years. As it was noted on page 7 (Fig. 11) the AMO has also a non-stationary delay of about 11 years to the northern component of the NAO.

June data: http://www.metoffice.gov.uk/hadobs/hadcet/cetml1659on.dat

The AMO and NAO RECONSTRUCTIONS COMPARED

There are also reconstructions of other climate indices which can be related to the AMO. Fig. 17 shows a positive result of a the ANO-R comparison to the summer July August NAO by C. Folland, UK Met Office Hadley Centre.

On interdecadal time scales, both modeling and observational results indicate that SNAO variations are partly related to the Atlantic multidecadal oscillation.

Reconstruction of NAO variations back to 1706 is based on tree-ring records from specimens collected in Norway and United Kingdom.

Currently summer NAO advances the AMO by about a decade (see page 7, Fig. 11) .

The phase relationship between the AMO and NAO across centuries is a non-stationary one. Here the AMO-R and the NAO are in phase, but eventually the NAO has moved ahead,

From the above comparison it would appear that the Folland's NAO reconstruction shows that the tree-ring data are equally well correlated to the AMO.

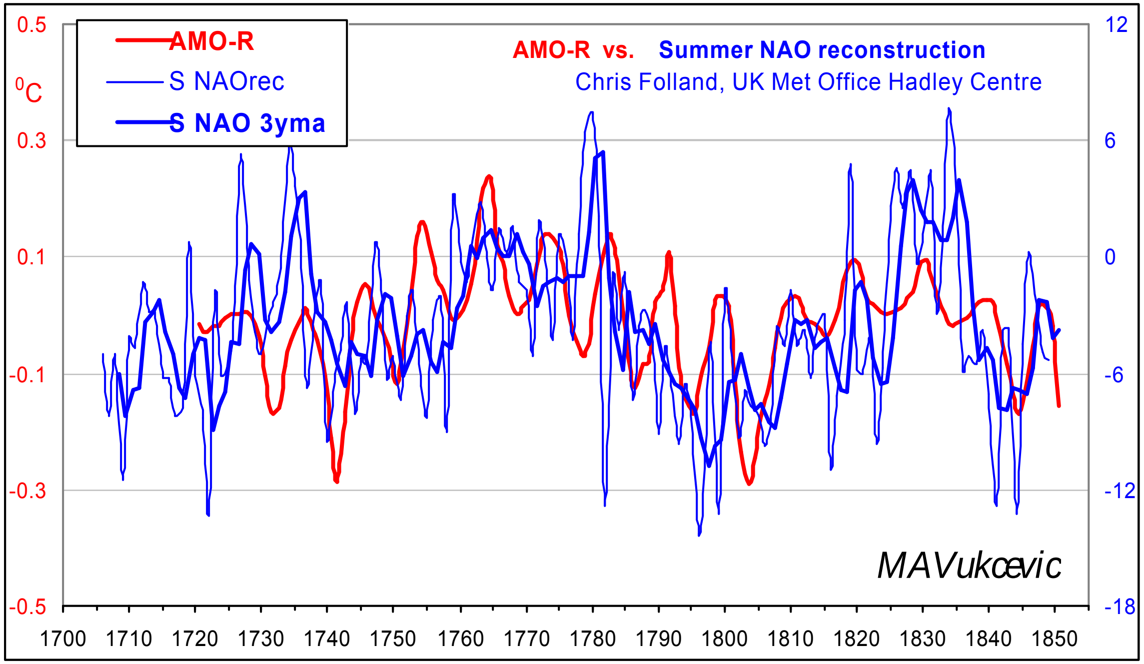


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Fig. 36 The AMO-R compared to a reconstruction of summer NAO (July August)

Correlation after 1850 is not as strong (non-stationary correlation), but here object wass to verify the AMO-R decadal changes validity for pre 1860 period, where no the North Atlantic SST data is available.

data: ftp://ftp.ncdc.noaa.gov/pub/data/paleo/treering/reconstructions/snao-folland2009.txt

The AMO–R CORRELATES to the STALAGMITE GROWTH from NW SCOTLAND

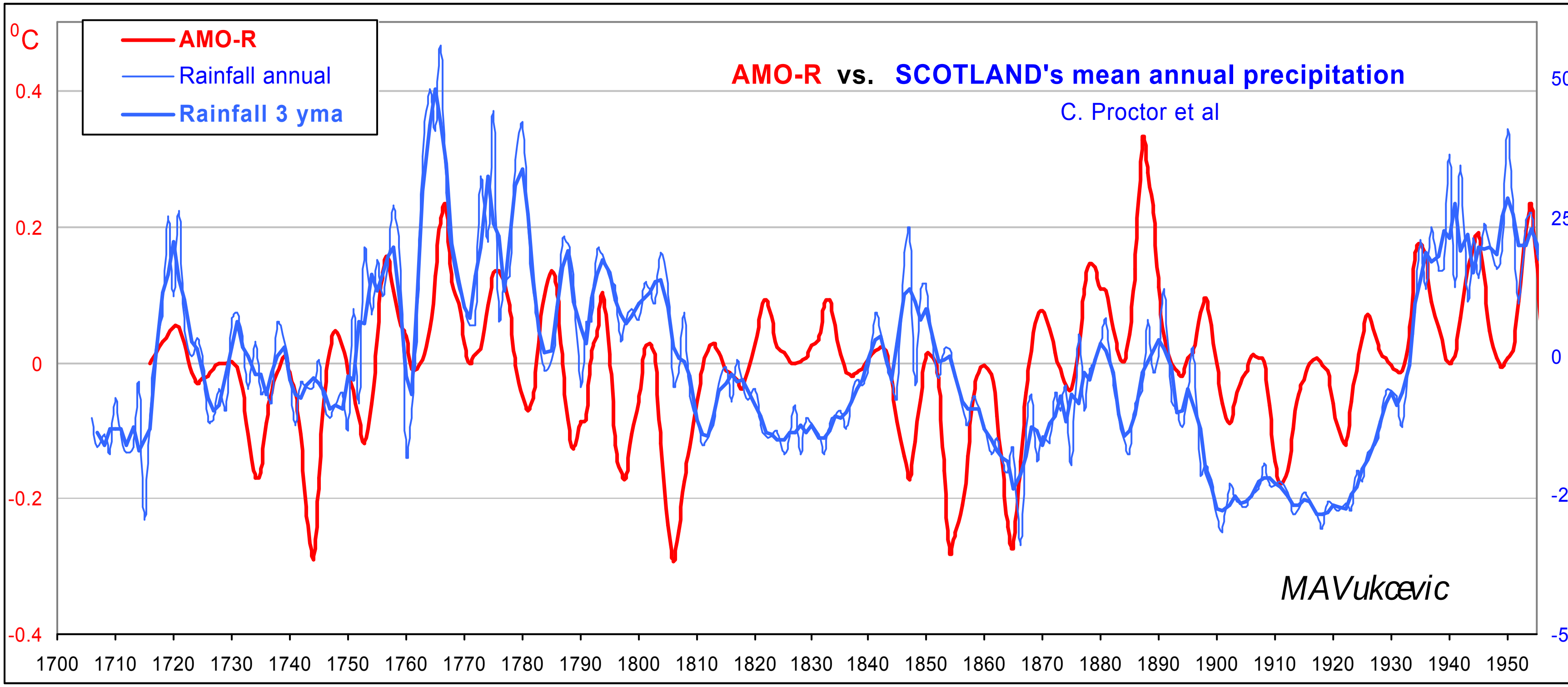

Fig. 38 – The AMO-R compared to a reconstruction of a rainfall in NW Scotland based on the local stalagmite growth

The above reconstruction by C.J. Proctor et al (one of two reconstructions from the same team) is yet another strong positive confirmation. One notable difference is period 1810-1840, following cooling during Dalton solar minimum, but it is known fact that the rainfall is usually lower during colder periods. Proctor et al comment:

Annual band counting on three radiometrically dated stalagmites from NW Scotland, provides a record of growth rate variations for the last 3000 years. Over the period of instrumental meteorological records we have a good historical calibration with local climate (mean annual temperature/mean annual precipitation), regional climate (North Atlantic Oscillation) and sea surface temperature (SST; strongest at 65-70°N, 15-20°W), although the correlation with the latter breaks down prior to the instrumental record.

The above 'although the correlation with the latter breaks down prior to the instrumental record' is possibly based on the AMO reconstruction by Mann et al, which appear not to correlate with any of the above references used here.

There is little difference between two Proctor et al reconstruction, while the initial one shows slightly better correlation with AMO-R.

AMO-R has satisfactory degree of correlation with four references used (CET spring-summer, CET-June, NAO summer and the stalagmite based rainfall reconstruction), on basis of which it can be **concluded with high degree of confidence that the AMO-R is indeed good representation of the past AMO oscillations.**

Proctor et al data: ftp://ftp.ncdc.noaa.gov/pub/data/paleo/speleothem/scotland/assynt96.txt & ftp://ftp.ncdc.noaa.gov/pub/data/paleo/speleothem/scotland/scotland_data.txt

AMO RECONSTRUCTIONS AND GEO-SOLAR CYCLE

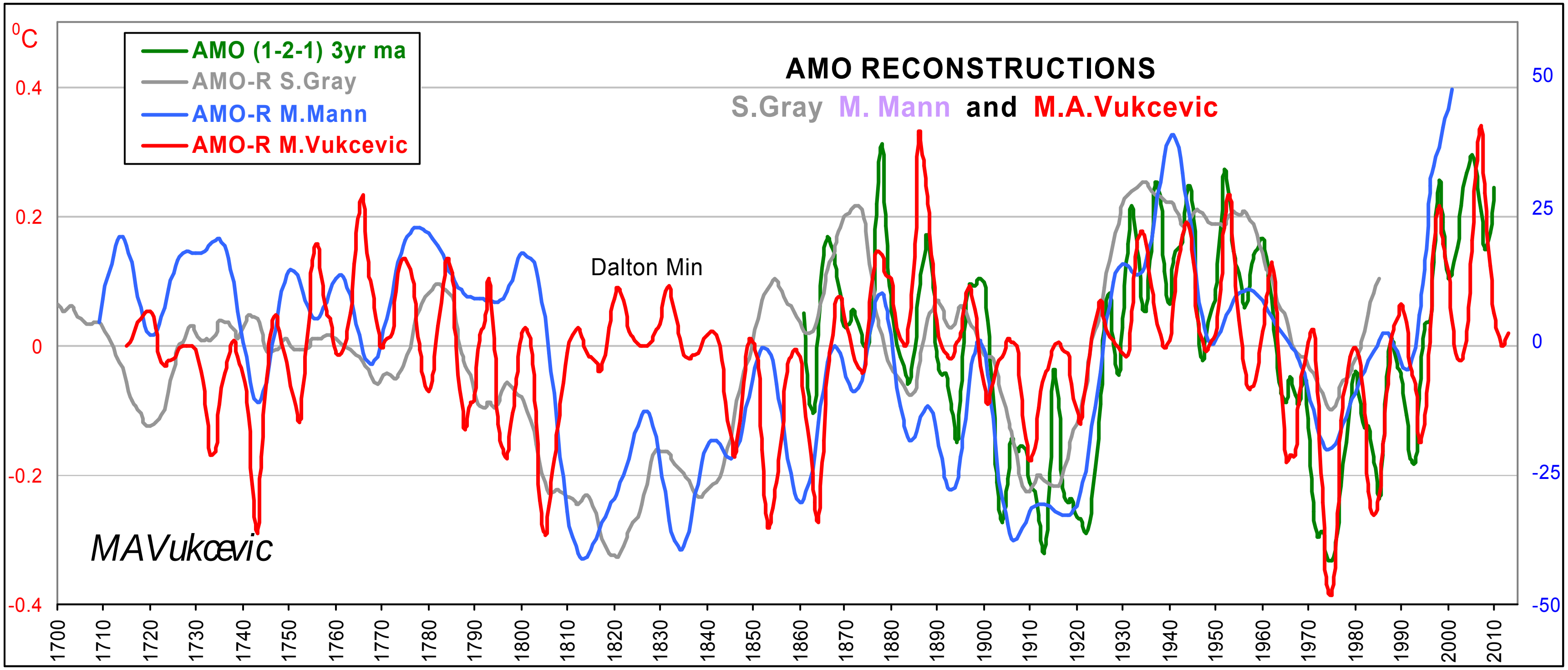

Fig. 39 The Geo-Solar cycle compared to two better known AMO reconstructions

Geo-Solar cycle is based on the solar magnetic field amplification by the Earth's core oscillations and hence it has no reference to any climatic factors caused by major volcanic eruptions, e.g. Mayon & Tambora at time of the Dalton minimum, or number of Icelandic eruptions in the early 1900s. More details and analysis will be added.

Gray data: ftp://ftp.ncdc.noaa.gov/pub/data/paleo/treering/reconstructions/amo-gray2004.txt
Mann data: http://climexp.knmi.nl/data/iamo_manna.txt

By implementing proposal from the Bern 2012 SSN and TSI workshop, namely increasing by 10% sunspot number count prior to 1800 somewhat better overall amplitude agreement is obtained in the quoted AMO-R reconstruction comparisons (pages 18 24).

CONCLUSION

Aim of this project was to demonstrate that circumstantial evidence from the events, that can not be influenced by climatic change, points to direct link with the temperature oscillations in the Northern Hemisphere.

Initial pages show the strong similarity between the decadal fluctuations of the North Atlantic sea surface temperature and temperatures relating to the rest of the North Hemisphere, and to a lesser degree for the South Hemisphere. This was to some extent confirmed by spectral analysis of the relevant data sets.

No such similarity was found in direct comparison either to solar sunspot or magnetic (Hale) cycle, but it was found that the crucial temperature spectral component is identical with the Hale cycle frequency.

Analysis of the Arctic temperatures pointed to a possible geomagnetic link, and indeed that such link was identified in the spectrum of the Earth's magnetic core oscillations.

Strong possibility of interaction of two sets of magnetic oscillations, the solar on one side and the Earth's core on the other, has provided the crucial breakthrough in identifying the cause and the source of natural climate change on both decadal and multidecadal scale.

Part two of this study would be devoted to exploring of the laws of physics and the mechanisms which may be responsible for the temperature oscillations.

Web Links:

Data:

http://www.esrl.noaa.gov/psd/data/correlation/amon.us.long.mean.data
http://data.giss.nasa.gov/gistemp/_tabledata3/ZonAnn.Ts.txt
http://data.giss.nasa.gov/gistemp/_tabledata3/ZonAnn.Ts+dSST.txt
ftp://ftp.ncdc.noaa.gov/pub/data/paleo/treering/reconstructions/snao-folland2009.txt
ftp://ftp.ncdc.noaa.gov/pub/data/paleo/speleothem/scotland/assynt96.txt
ftp://ftp.ncdc.noaa.gov/pub/data/paleo/speleothem/scotland/scotland_data.txt
ftp://ftp.ncdc.noaa.gov/pub/data/paleo/treering/reconstructions/amo-gray2004.txt
http://climexp.knmi.nl/data/iamo_manna.txt
http://www.astro.oma.be/SBC/data1.html
http://www.epm.geophys.ethz.ch/~cfinlay/gufm1/model/gufm1

Referencies:

http://berkeleyearth.org/pdf/berkeley-earth-decadal-variations.pdf
http://hal.archives-ouvertes.fr/docs/00/64/12/35/PDF/NorthAtlanticOscillations-I.pdf
http://www.jpl.nasa.gov/news/features.cfm?feature=2420)
http://www.sciencemag.org/content/328/5981/1014
ftp://ftp.flaterco.com/xtide/tidal_datums_and_their_applications.pdf
http://journals.ametsoc.org/doi/full/10.1175/JCLI4193.1