A Preliminary note on Holocene climate

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version: 24Oct07, initial draft email sent 23Oct07
(Figures 5 & 6 added from Howell "Mega-Life & Mega-Death")

WARNING: This is a very incomplete draft still under development, with no immediate intent to publish. This paper is a component of work on glaciation.
(see www.BillHowell.ca/Climate and sun/Howell - Glaciation models for the last 6 million years.pdf)

Modelling and conclusions are still being updated/ corrected, but most work is being halted for other priorities, perhaps resuming in Q1 2008, as part of a personal project on the sun, climate, and civilisations:
(see www.BillHowell.ca/Civilisations and sun/Howell - Mega-Life, Mega-Death and the Sun II, towards a quasi-predictive model of the rise and fall of civilisations.pdf)

Mini-Comments

Conceptually rough and incomplete adaptations of Milankovic models for solar insolation have been made to account for relative movements between the sun and the solar system barycenter over part of the Holocene period (3,000 BCE to present). The sun-barycenter movements are of the same order of magnitude as the eccentricity changes to the Earth's orbit (very roughly 100 and 400 ky timeframes), and the latter are commonly suspected of being one of the drivers of glaciation cycles. Consequently, potential climate impacts of sun-barycenter movements over decadal timescales could be appreciable. These calculations have likely been carried out by many other groups, but no comparison has been made at this time.

At first glance, the adapted models show (visually) interesting relationships to decadal variability in solar activity, but not to century-scale variations (eg solar minima, mini-ice ages and warm periods), nor to Holocene-scale time periods.

Partial attempts were made to include solar irradiance from 3000 BCE to present, based on geological proxies (14C, 10Be) and an adaptation/extrapolation of a model for sunspots-irradiance (together I call this a Solanki-Tapping correction). However, changes over this timescale do NOT (again visually) seem to relate to the sun-barycenter movements. No attempt has been made to base solar activity changes on the sun-barycenter movements, which has been the theme of many scientists from the very beginning of modelling of solar activity cycles, although this has seemingly not worked out in practice. (Maybe Antonio Pou can get that to work?).

At this very preliminary stage, conceptual and software errors are guaranteed, but at least the results so far are encouraging.

Some Details:

1. Figure 1 & 2: "standard" solar insolation (that is, not including solar variability such as sunspots, solar minima etc etc) for a given latitude (or even a given month for global averages) does not follow sun-barycenter envelopes, but does seem to be somewhat related or constrained by it. This is no surprise, as the calculations incorporate the sun-barycenter movements in a very approximate way.

2. Figure 1: A periodicity of ~180 years is also visually apparent in the insolation data and that is close to well known periodicities from the literature (Charvatova, Fairbridge etc ~179, some climate data ~200-500 year Suess cycle etc). It will be easier to see the periodicity if you make a transparency of the graph, and slide it along the axis.

3. Figure 3: It's very interesting to me to see the apparent "frequency difference" between solar activity and sun-barycenter movements, as might be expected with a non-linear coupling(s) between driving and driven systems. This is also reminiscent of the influenza pandemic data, which occasionally "skip a solar cycle" since 1830 (Tapping, Mathias, Surkan 2001 & 2006).

4. Figure 3: Major solar minima ("freezers") or maxima ("scorchers") do not seem to be related to the sun-barycenter movements as analysed in this paper, although perhaps phasing relationships might show something. However, there is absolutely no accounting in this paper for the internal dynamics of the sun, and surely that must be considered/ modelled (Charbonneu's group, Thomson's g-mode observations from ?1995?)

5. Figure 3: Current models do NOT yet blend the irradiance variations with the Milankovic-Barycenter predictions. Figures 5 and 6 show results (Howell etal 2007 "Mega Life...") from blending the Milankovic-only trends with solar irradiance variations. All three together is an obvious next step, along with estimates of how magnetic field variations and galactic rays modulate cloud cover and climate (and pandemics...).

   Note that it is NOT necessary to assume that sun-barycenter movements have any relationship with solar activity, in order to show very important insolation effects as shown in Figures 1&2. ***However, if it is ever shown that sun-barycenter movements have even a minor influence on solar irradiance variations, it could GREATLY help the predictability of the total solar insolation!*** There will still be a huge "unpredictable" component of the insolation, so one could not ignore that. (Keep in mind that Figures 1&2 show insolation values based on a "standard" solar constant datum of 1368 W/m2).

6. Figure 4: A fine-detailed view of the sun-barycenter movements and the Solanki-Tapping proxy-model for irradiance doesn't visually stand out as a relationship.

7. Figure 4: Note that the global annual insolation for any particular month (here 21Mar-20Apr shifted perhaps 10 days is shown) has a far greater variance than the annual global average

insolation. That should be obvious, but it's easy to forget the details.

8. Figure 5: It is dangerous to take too myopic a view of sun-Earth interactions, and of course this note covers less than "half a deck of cards". Shown are guesstimates of the relative importance of longer-term Milankovic insolation changes compared to solar irradiance variability over the last 11,000 years. Of course this doesn't even account for items in the "What's Missing" list a few pages down.

9. Figure 5: Note that no albedo modelling is included...

10. Figure 6: Major solar minima/maxima really show up on the short term, and that is a starting point for a very solar-centric view of history in preparation, inspired by Hoyte & Schatten, and WH Soon.

11. Figure 7: Long-term glaciations provide a very "loose" but important context to modern climate models. It's easy to forget them too. While simple models can explain much of the historical proxy data (ice core, or as shown here, marine isotope for > 1 My records), I have not prepared "statistics" on the "natural variance" expected from historical data (hopefully different regions, timeframes). This is critical background when interpreting modern trends.

Warnings about my "simple, naive model for sun-barycenter movements, incorporated into Milankovic models for insolation"

- I suspect that conceptual errors have led to an exaggeration of the insolation effects of the sun-barycenter effects, as earlier software "kludges" gave much smaller variations.
- No corrections have been made to the angles due to the "displaced" position of the sun, and that is critically important to insolation changes.
- Two completely different software were "merged" together to produce the results, and this will have likely involved some conceptual and modelling "mis-matches".
- My immediate need is to give a presentation to potato growers. Does anybody know anything about GROWING potatoes? I'm an expert at eating them, so I guess that's half-way.

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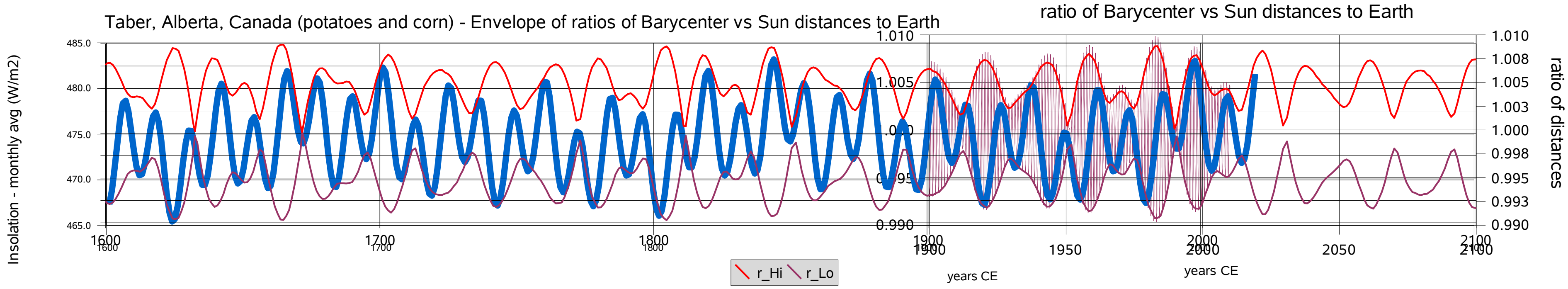
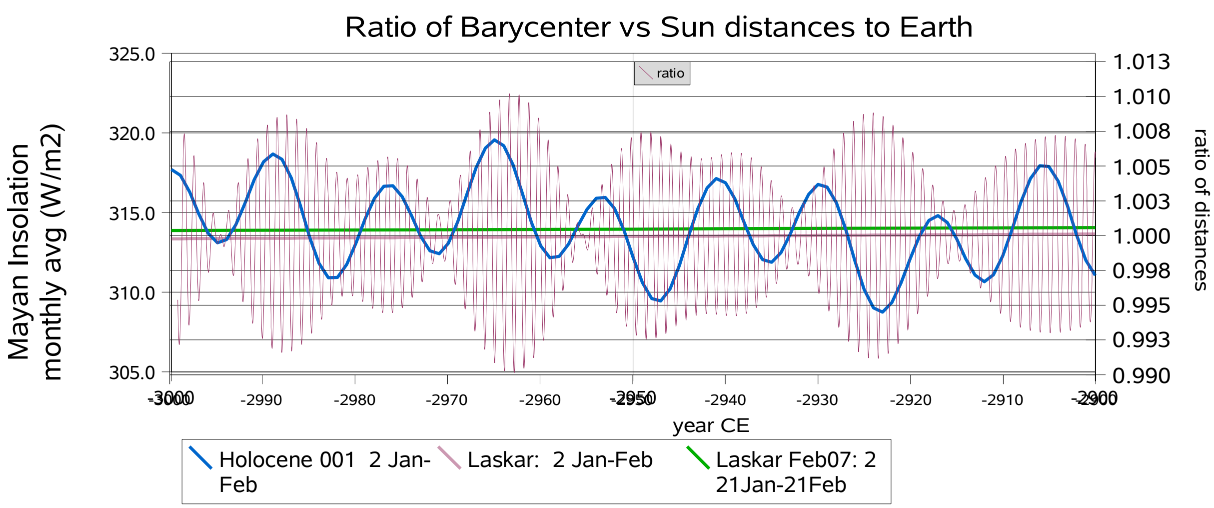
Figure 1: Note: the graph below is NOT a fit! It is merely an overlay of three separate graphs. If you make a transparency and slide it across the graph below, you will see the ~180 y periodicity, but it's not exact.



blue curve = May-Jun "standard" insolation for Taber, Alberta 50° latitude (1368 W/m2 solar constant)
red curve - upper envelope of barycenter-sun ratio of distances to Earth
bordeaux curve - lower envelope of barycenter-sun ratio of distances to Earth

Figure 2: This "close up" of Mayan Jan-Feb insolation shows finer detail in the sun-barycenter movements. OK, it's a bit early by a few thousand years for the Mayans (and a bit too high, at 22° latitude, as well) .



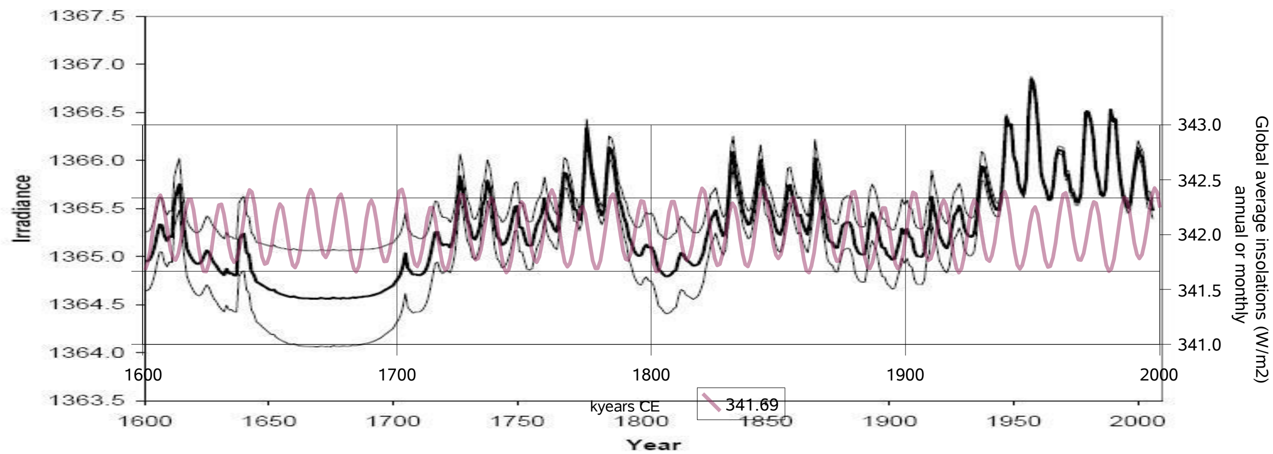


Figure 9. The central (thick) line shows the modelled irradiance values and the thin lines above and below bound the variable space containing 90% of the plots obtained in the Monte Carlo simulation.

Figure 3: from Tapping etal. Notice the slightly different "frequency" of solar activity versus sun-barycenter movements. (see Thomson etal)

Figure 4: Solar activity proxies and global solar insolation (annual and for a month) since 3000 BC
Bordeaux curve - Solanki-Tapping proxy indicator of solar activity
Pink curve - global monthly average insolation for Mar-Apr
Red curve - global annual average insolation

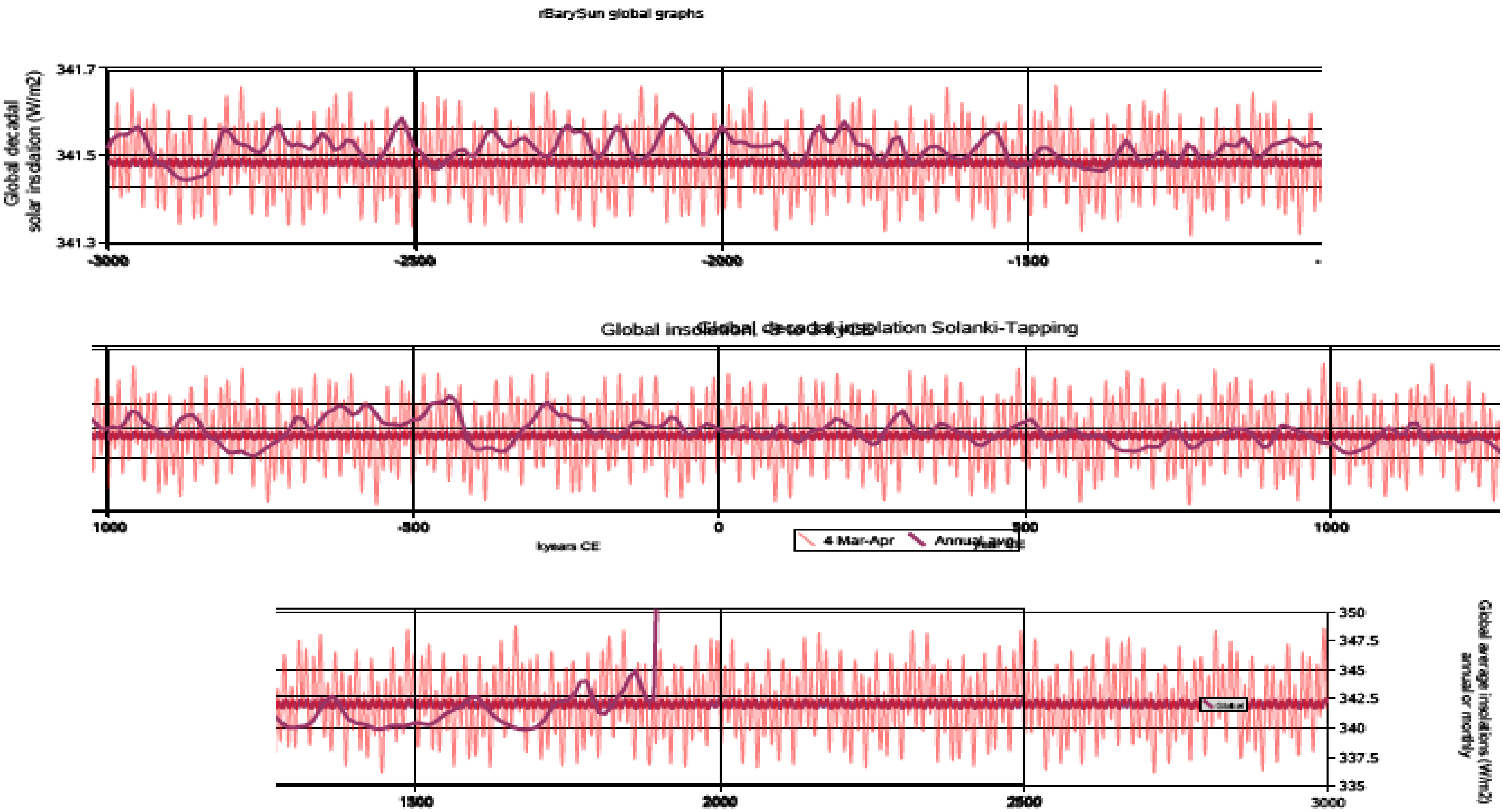
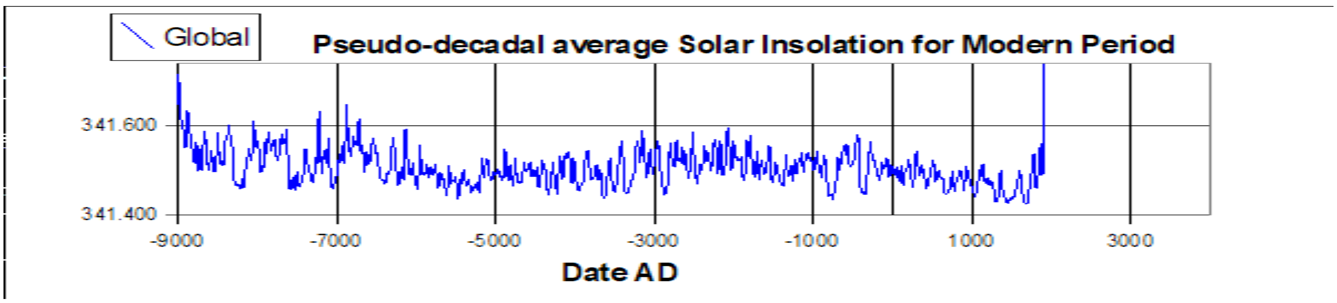


Figure 5: Holocene epoch - global and regional insolation
Reference: Laskar etal www.BillHowell.ca (see Howell "Mega Life...")
Here's a "bigger view" of the Holocene. Note how the millenial-scale Milankovic trends are HUGE compared to KNOWN solar irradiance variability, but perhaps we don't know much about long-term solar variability (i.e. ~100 ky or greater, even 6 My of glaciations).



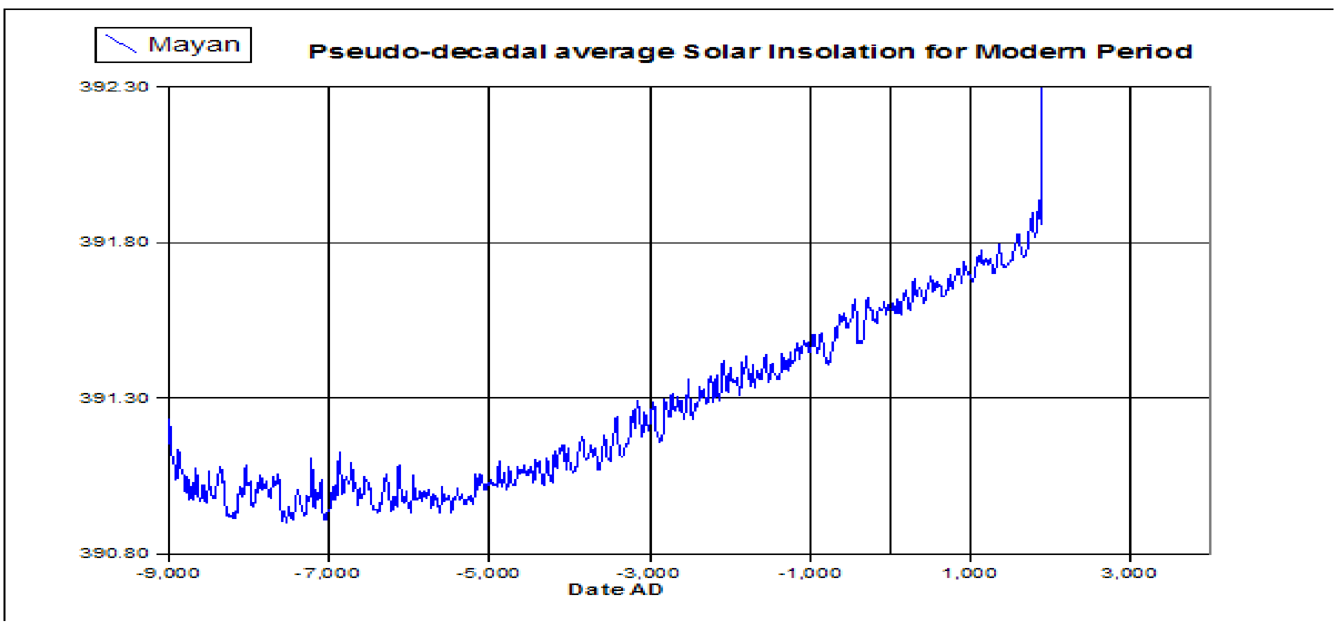
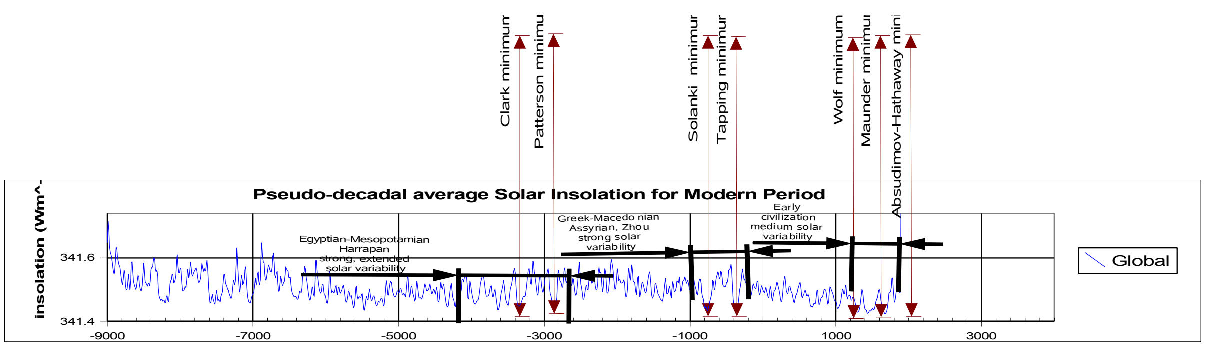


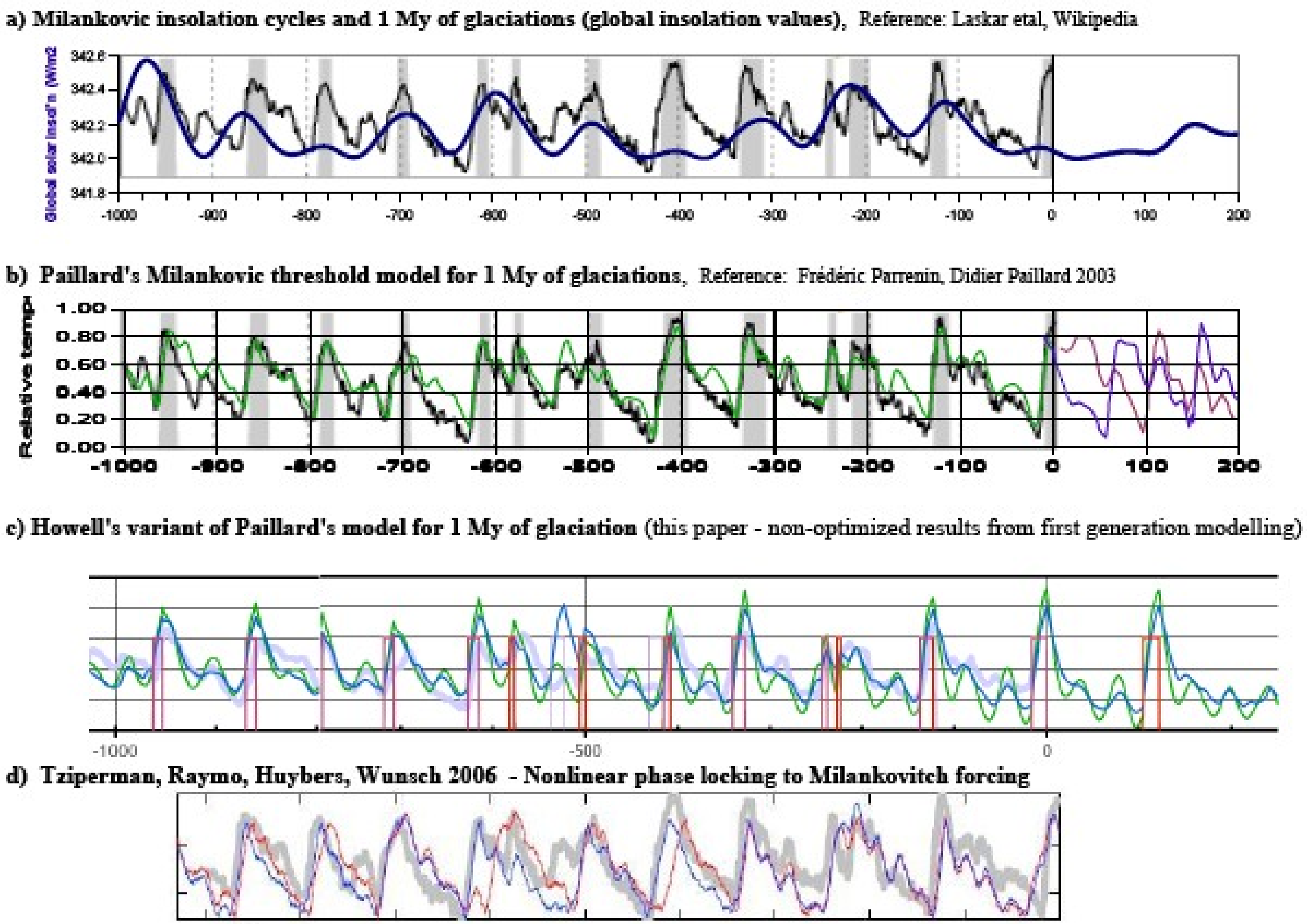
Figure 6: Holocene epoch - solar shocks
(Note: refer to the much larger chart on my website!)
Reference: Laskar etal, Solanki etal, Tapping etal, www.BillHowell.ca



Historical Kingdoms, Ages, periods are not coherent nor well-defined.
Even within small geographical areas there can be high diversity and divergence of fates.
However, archaeologists/ historieans have found it useful to describe periods.
If nothing else, it helps communication.

Figure 7: The following graph is from (Howell draft glaciation paper), but it illustrates that very simple models describe glaciations quite well. The greatest challenge is to predict the timing and duration of "deglaciation phases" (see Parrenin & Paillard).

Figure ?? - Graphs of recent glaciation models over the last 1 MyBP



What's missing?

This draft only deals with "less than half a deck of cards" insofar as dominant or suspected climate drivers (the sun, and only the sun), mediators (astronomy, geology, albedo), and climate reservoirs (oceans and glaciers).

Included:

- Earth axis obliquity and precession
- Solar-barycenter movements
- Earth orbit eccentricity
- Latitudinal differences on Earth

Missing:

- Solar variability at all timescales (while data is available for decadal scales, comparatively little is known of the solar minima and the "deglaciation" periods at ~100 ky intervals). At least the Solanki-Tapping irradiance model can be used in conjunction with the insolation models based on the "standard solar constant".
- Dynamic analysis (including chaos theory)
- Solar axis obliquity and precession, and the asymmetry (latitudinal and longitudinal) of solar irradiance
- Spectral composition of solar irradiance
- Albedo - cloud, snow/ice, ocean water, plants, etc. Mid-to-long term (thousands of years to millions of years) glaciation models are very important here, as is seasonal snow coverage. The influence of galactic rays on cloud covers appears more-and-more to be a major potential factor.
- Earth orbit's inclination with respect to galactic plane (~100 ky?)
- Time-lags associated with climate reservoirs (ocean and glaciers)
- Water vapour GHG effects (forget CO_2 above ~40 to 60 ppm, until the water vapour role is well-resolved, and after many other more important intermediates are addressed)

Although glaciation and albedo are partially dealt with in the current draft of the 6 My glaciation model, that work has not yet been extended to the Holocene period.

What's Next?

1. Find proper models that fully account for the effect of sun-barycenter movements on insolation (latitude, periods of time), failing that convince Laskar etal, or Huybers etal, or Giorgini etal to do it, or do it myself (fat chance).
2. Find information on solar obliquity/ precession, and statistical distributions of solar irradiance (eg Maunder butterfly diagrams).
3. Hopefully a galactic-ray-solar irradiance/ helio-geo-magentic field, cloud, galactic ray quantitative relationship will emerge soon (?Friis-Christensen? & Svensmark)

References

This is a very incomplete set of references - see the associated draft papers for a more complete list. Only work used directly in the concepts/ calculations/ graphs is cited below.

1. W J R Alexander, F Bailey, D B Bredenkamp, A van der Merwe and N Willemse 2007 "Linkages between solar activity, climate predictability and water resource development" Journal of the South African Institution of Civil Engineering, Volume 32 49 Number 2 June 2007

2. Paul Charbonneau 2002 "The rise and fall of the first sunspot model" JHA xxxiii Science History Publications Ltd. - Provided by the NASA Astrophysics data system

3. Ivanka Charvatova, Jaroslav Strestik 2004 "Periodicities between 6 and 16 years in surface air temperature in possible relation to solar inertial motion" Journal of Atmospheric and Solar-Terrestrial Physics 66 (2004) pp219-227

4. Jon Giorgini ?date? "Sun-barycenter movements effect on the Earth-sun distance" NASA JPL Ephemeris data by Horizons On-Line Ephemeris System, Jon.Giorgini@jpl.nasa.gov http://ssd.jpl.nasa.gov/

5. Bill Howell, www.billhowell.ca/Climate and sun/Howell - Glaciation models for the last 6 million years.pdf

6. Donna Howell etal, www.billhowell.ca/Civilisations and sun/Howell - Mega-Life, Mega-Death and the Sun II, towards a quasi-predictive model of the rise and fall of civilisations.pdf

7. Cynthia Kuo, Craig Lindberg, David J. Thomson "Coherence established between atmospheric carbon dioxide and global temperature" Nature, vol343, 22Feb1990, p709-714

8. Theodor Landscheidt "Solar System Barycenter Ephemeris - Jon Giorgini of JPL calcs" http://landscheidt.auditblogs.com/6000-year-ephemeris

9. J. Laskar, P. Robutel, F. Joutel, M. Gastineau, A.C.M. Correia, B. Levrard 2004 "A long term numerical solution for the insolation quantities of the Earth" Astronomy & Astrophysics manuscript no. La˙2004 May 23, 2004 http://www.imcce.fr/fr/presentation/equipes/ASD/preprints/prep.2004/La_2004_prep.pdf

10. Richard Mackey 2007 "Rhodes Fairbridge and the idea that the solar system regulates the Earth’s climate" Journal of Coastal Research SI 50 955 - 968 ICS2007 (Proceedings) Australia ISSN 0749.0208

11. Antonio Pou. Ecology Professor. Universidad Autonoma. Spain, conversations August 2007

12. K.F. Tapping, D. Boteler, A. Crouch, P. Charbonneau, A. Manson, H. Paquette "Solar magnetic activity and total irradiance since the Maunder minimum" ?Journal vol/n/pp? Springer Science & Business Media. Printed in the USA 2006 27pp

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