Creation Research Society Quarterly 2020 56:132–142.

Cyclostratigraphy

Part III: Critique of the Milankovitch Mechanism

Michael J. Oard and John K. Reed*

Abstract

Cyclostratigraphy claims to rely on an accurate astronomical time scale and further on a clear imprint it supposedly makes on the sedimentary record. Grounded upon the Milankovitch theory, geologists first sought to apply this method to develop a timescale for Quaternary glacial/interglacial oscillations. But there are several glaring unresolved problems with this approach. Although solar radiation measurements at high latitude appear to lend support to the mechanism, the data are carefully selected, typically restricted to the summer solstice or the months of June or July. By contrast, the larger dataset for the warm half-year for the whole hemisphere shows the Milankovitch effect is very small. Moreover, geologists believe glacial episodes over the past 900,000 years have been controlled by the 100,000-year eccentricity cycle, but that cycle has a very small effect relative to other cycles. Further, glacial cycles should be out of phase between the hemispheres, yet they are not. Finally, proponents rely on correlation between Milankovitch cycles and deep-sea cores, but these appear to be the result of circular reasoning and the reinforcement syndrome.

Introduction

Cyclostratigraphy is a relatively new chronometric method. It is built on the idea that climate cycles are imprinted in the sedimentary record, and that such cycles are controlled by the predictable orbital mechanics of Earth and its solar system (Reed and Oard, 2015, 2016). Developed in the latter half of the 20th century, the method was first applied to deep sea cores to create a time scale for the Pleistocene glacial/interglacial record and subsequently extended much further back into the sedimentary record. Its popularity is driven by the promise of more precise dates than traditional dating methods can provide. Stratigraphers now believe they have an astronomical time scale, fully calibrated to 34 Ma, partly calibrated to a full eccentricity solution through the Cenozoic (~65 Ma), and calibrated via "floating" eccentricity time scales back through most of the Mesozoic (Hinnov and Hilgen, 2012).

Reed and Oard (2015) spelled out the three components of cyclostratig-

* Michael J. Oard, MS, Bozeman, Montana
John K. Reed, PhD, Birmingham, AL
Accepted for publication January 30, 2020

raphy (Figure 1). These include: (1) a reliable astronomical clock based on orbital perturbations of Earth and the solar system, (2) its accurate expression in orbitally-forced climate changes, and (3) its preservation in the sedimentary record. We leave the critique of orbital perturbations to physicists and astronomers. This paper will critique the second stage—the Milankovitch mechanism, especially its ability (or lack thereof) to produce the glacial/interglacial cycles (Oard, 1984a; 2005a). Uniformitarians see the Pleistocene climate fluctuations and resulting sediment record as an ideal example of glacial/interglacial control of sedimentation, and so this paper will focus on the Milankovitch mechanism relative to the "ice ages" of the recent past.

Superficially the Mechanism Seems Potent

It is easy to present the Milankovitch mechanism as a powerful control of climate. Graphs of solar radiation at 65°N (Figure 2), the latitude considered most sensitive to glaciation, show impressive time variations in solar radiation, from 440 W m^{-2} to 560 W m^{-2}, a peak-to-peak fluctuation of about 20% (Berger et al., 2010; Paillard, 2001). These changes supposedly correlate with glacial and stadial oscillations for the past million years. This 20% variation has caused many scientists to accept the Milankovitch mechanism as the primary control of Quaternary glacial oscillations, and even of older sedimentary cycles, back into the Precambrian. Locke (1997) stated that the Milankovitch theory was one of the three most significant paradigm changes of the 20th century—the others being plate tectonics and the proposed dinosaur-extinction impact.

Using Total Hemispheric Warm-Season Data

But appearances can be deceptive. Long term climate is *not* driven by solar radiation on one day, along one latitude, but rather by larger scale considerations, namely, the whole hemisphere and the whole caloric half-year. This is because extratropical, synoptic systems mix air from low to high latitudes, and the solar input at a single (e.g., 65°N) latitude is strongly averaged with contributions from the other latitudes in the hemisphere.

In terms of temporal averaging, Berger (1992, p. 572) did not use the warm half of the year because it muted the signal. Instead, he believed that the climate driving force could be derived from the "monthly" solar radiation change, or even that of one day—the summer solstice:

> The long-term deviations from today-values of the caloric half-year insolation introduced by Milankovitch (1941) … amount up to 3% to 4% at the maximum. However, if the monthly insolation values (Berger, 1978a) are used instead, important

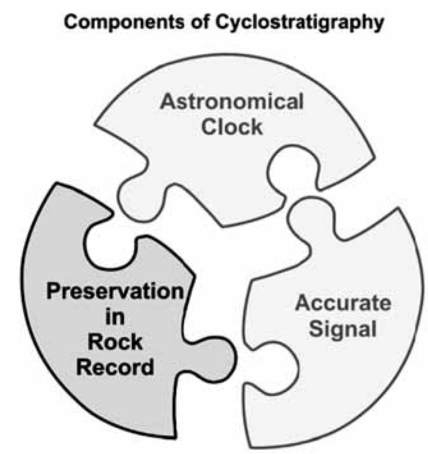

Figure 1. The components of cyclostratigraphy include a reliable clock based on orbital mechanics, the transmission of its "signal" through the Milankovitch mechanism, and its preservation in the sedimentary record. This paper critiques the Milankovitch mechanism.

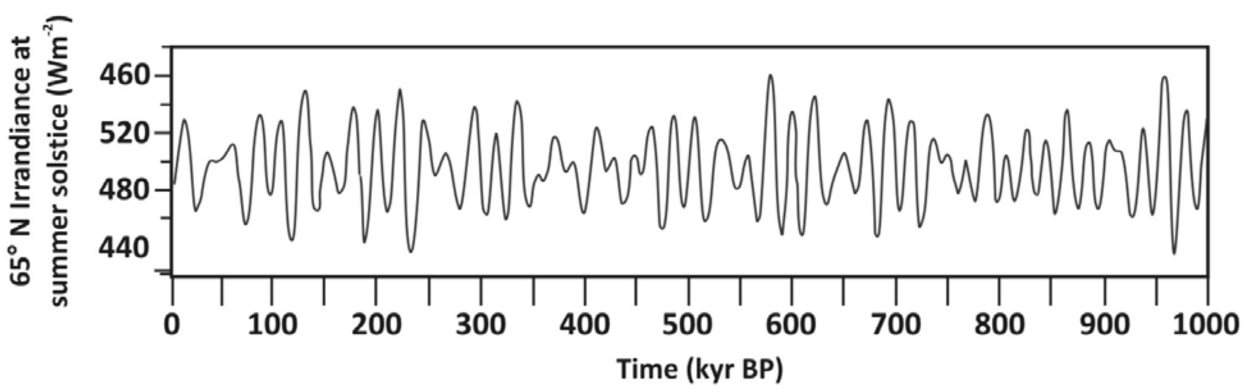

Figure 2. Change in solar radiation at 65°N for June 21st for the past million years. [Copyright 2010 by Berger et al., 2010, p. 1,976. Used in accordance with federal copyright (fair use doctrine) law. Usage by *CRSQ* does not imply endorsement of copyright holder.]

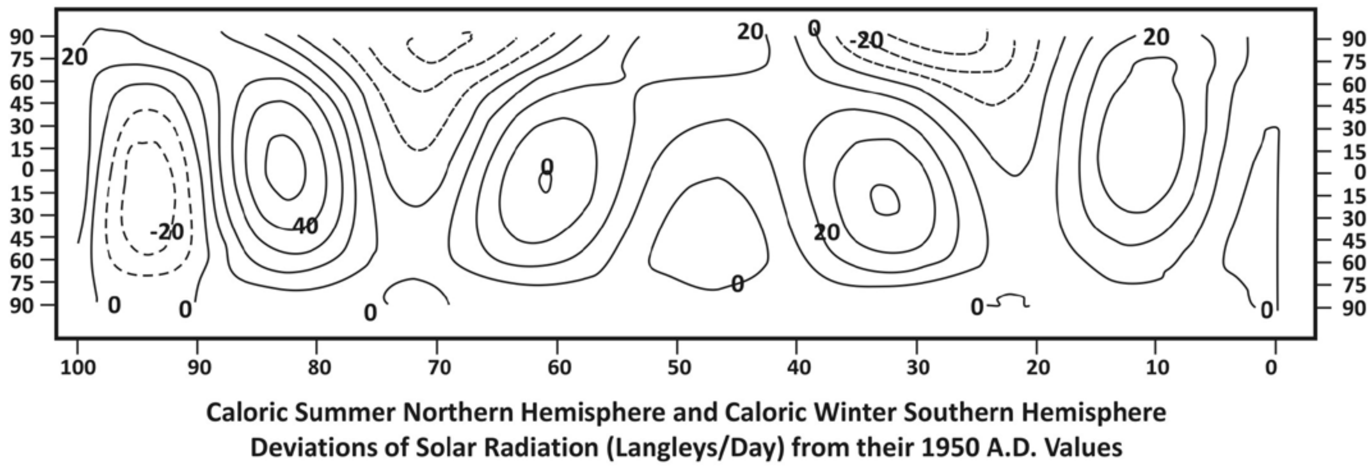

Figure 3. The Northern Hemisphere summer half-year and the Southern Hemisphere winter half-year for the past 100 kyr. [Copyright 1978 by Berger, 1978, *Quaternary Research*, p. 145. Used in accordance with federal copyright (fair use doctrine) law. Usage by *CRSQ* does not imply endorsement of copyright holder.]

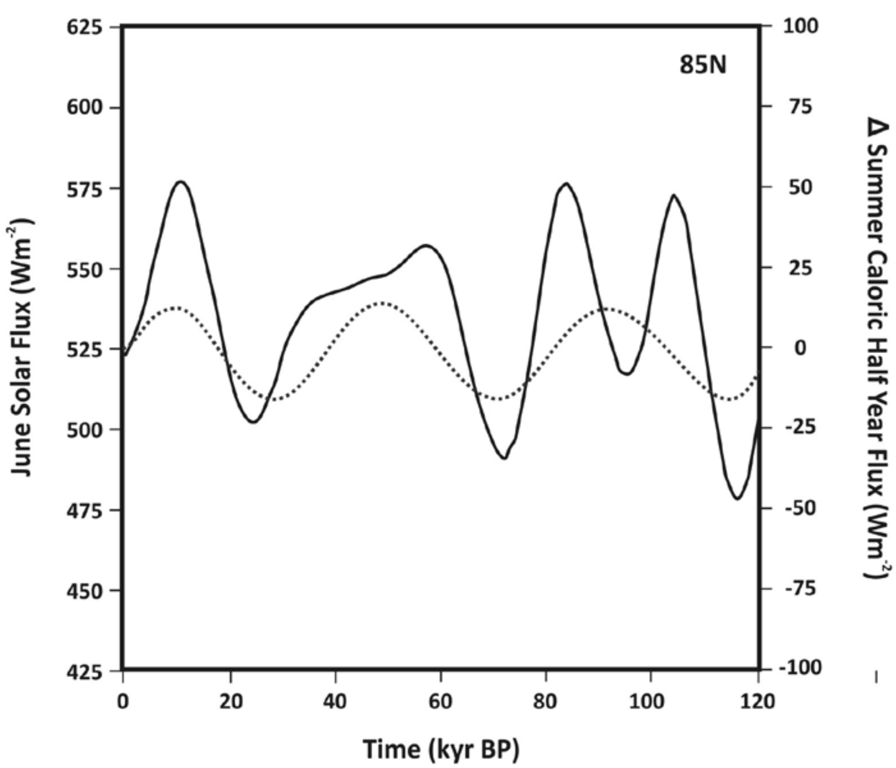

Figure 4. A comparison of June solar radiation at the top of the atmosphere (solid line) with the summer half-year (dashed line) over the past 120,000 years in W m^{-2} at the latitude of 85°N. [Copyright 1990 from Ledley, 1990, p. 145. Used in accordance with federal copyright (fair use doctrine) law. Usage by *CRSQ* does not imply endorsement of copyright holder.]

fluctuations masked by the half-year averaging method become easily recognizable.

When Berger used the summer half-year (warmest six months) to calculate the variation (Figure 3), he found that the insolation anomalies shrank to a maximum of 3% to 4%. Figure 4 shows a comparison of June solar radiation at 85°N at the top of the atmosphere (solid line) with the summer half-year (dashed line) over the past 120,000 years in W m^{-2} (Ledley, 1990). June variations for those criteria ranged over about 75 W m^{-2}, or 15% of the total. However, the comparative variation for the summer half-year was only about 25 W m^{-2}, about 5% of the total. This value would be even less for the entire hemisphere (Figure 3). Parameters used to model Earth's climate are quite sensitive to latitude and time.

Huybers (2006) emphasized that temperature changes sufficient to trigger glaciation could not be based on one day or month but had to account for all days when the average temperature exceeds freezing. For the middle and high latitudes, this is typically the warmest

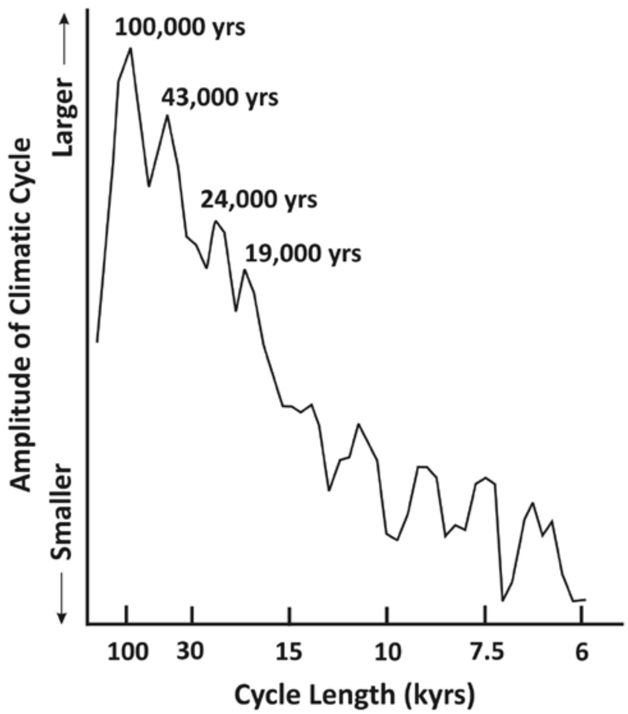

Figure 5. Power spectrum analysis of deep-sea core data used in Hays et al., 1976. Power spectrum analysis shows the strength of the frequencies that affect a time series. Notice that the strength just happens to match the Milankovitch cycles with the 100 kyr eccentricity predominating. [Copyright from Imbrie and Imbrie, 1979, p. 171. Used in accordance with federal copyright (fair use doctrine) law. Usage by *CRSQ* does not imply endorsement of copyright holder].

4–6 months; this is why earlier researchers used data for the entire summer half-year. Vernekar (1972) determined solar radiation changes at the top of the atmosphere for the whole Earth for the summer and winter half-years for the past two million years, as well as predicting the next 120,000 years.

These more extensive data showed that solar radiation is sensitive to latitude. Variations during the past 35,000 years were much less at 75°N and 65°N than at 85°N (cf., Figure 4). In fact, solar radiation was actually *above* normal in low and middle latitudes of the Northern Hemisphere at the same time (Berger, 1978, Figure 3)! Figure 3 shows the net solar radiation change, in langleys per day (langley: amount of solar radiation in calories absorbed on a cm^2 in one minute) received at the top of the atmosphere in the Northern Hemisphere summer half-year (Southern Hemisphere winter half-year) for the past 100 kyr. Berger's (1978) calculations are similar to Vernekar's (1972). This compares with the current average solar radiation at 65°N, between April 1 and September 30 (close to the warmest 6 months), received at the top of that atmosphere. It was about 750 langleys/day (Anonymous, 1956). This shows why an entire hemisphere for the six warmest months must be used in calculating the climate.

Based on Figure 3, uniformitarians apparently believe the most intense recent glaciation, between 40 and 20 ka, was triggered by reduced forcing (cooling) of ~20 langleys/day at the polar latitudes. This solar radiation anomaly for those *high latitudes* was only ~ 2% to 3%, which is small. Since climate is a function of the entire hemisphere, and since the key zones for glaciation are claimed to be the middle and high latitudes, insolation shifts in the small zone corresponding to latitudes between 65°N and 85°N is simply not representative. Furthermore, when the *above normal* low and middle latitudes are added to the analysis, the insolation anomaly drops to less than 1% of normal for the Northern Hemisphere, which is insignificant. If the Milankovitch mechanism is grossly insufficient for that intense cold pulse of the last ice age, how can it control climate all the time?

Moreover, the high-latitude cooler temperature anomaly around 35 ka was not long enough to trigger significant glaciation. Another major uncertainty is whether the insolation changes shown in Figure 3 actually translate into cooler temperatures. Compensating, or negative feedback, mechanisms would ameliorate reduced insolation at high latitudes. Given lower temperatures at high latitudes and warmer temperatures at middle latitudes, the resulting change in the temperature gradient would strengthen the jet stream, according to the thermal wind equation. The result would be more storms moving cold air southward and warm air northward. Overall, enhanced poleward transport of heat by both atmosphere and oceans (the main source of heat transfer north of 50°N in the winter) would tend to even out the temperature anomaly:

> When the pole cools in winter, the north-south temperature gradient increases, tending to produce more northward heat transport which would counteract the cooling. A colder pole would also produce less outgoing IR [infrared] radiation which would also counteract cooling (Robock, 1983, p. 993, brackets ours).

Milankovitch Mechanism Far Too Weak

The fundamental problem with the Milankovitch theory is that Northern Hemisphere summer radiation variations for the past 35,000 years are simply too small to trigger or maintain an ice age. When all the relevant factors are considered, the apparent local, short time scale anomalies used to promote the theory shrink to yield a negligible effect on climate.

Since climate is a complex system with many negative feedback mechanisms to keep it stable, the Milankovitch mechanism would have to exert a considerable effect to initiate an ice age. Past scientists have long noted this profound challenge (Budyko, 1977; Paltridge and Platt, 1976; Simpson, 1940; Van Woerkom, 1953), as do a current minority today. It is ironic that the research which claimed otherwise (Hays et al., 1976) is now claimed to be invalid and worthy of retraction (Hebert, 2016a, b, c; 2017).

Radiation specialists Paltridge and Platt (1976, p. 60), stated: "However, Milankovitch's proposition that the variability is sufficient to explain certain changes of the extent of polar ice is questionable to say the least…." Polar researcher Washburn (1980, p. 648) stated: "Yet the mechanism and quantitative adequacy of the effect pose major difficulties…." Sir Fred Hoyle (1981, p. 77) was more direct:

> If I were to assert that a glacial condition could be induced in a room supplied during winter with night-storage heaters simply by taking an ice cube into the room, the proposition would be no more unlikely than the Milankovitch theory.

His "night storage heaters" represent the high latitude heat transport and decreased infrared radiation mechanisms, which would be enhanced during high latitude cooling caused by less solar radiation. The self-regulating work of the atmosphere and ocean is a significant obstacle against orbital forcing.

Since uniformitarian scientists "know" the theory is correct, and since these insolation changes are small, they have concluded that our climate sensitivity to greenhouse gas increases must be high—regardless of the apparent self-regulation of the climate system. In other words, the Milankovitch theory leads secular scientists to believe that our climate is unstable, which eventually leads to public climate alarmism. Moreover, the "abrupt climate changes" seen in the glacial part of Greenland ice cores is also fueling the global warming alarmism. However, based on observations of greenhouse gas increases and temperature changes, the effect of carbon dioxide increase is rather small (Oard, 2011; 2017).

The Eccentricity Problem

Total insolation variation for the summer half-year (Figure 4) is caused primarily by the obliquity and precession cycles—the latter being the stronger (Reed and Oard, 2015). Geologists believe that recent "ice ages" occurred approximately every 100 kyr over the past 900 kyr, but cycled every 40 kyr prior to that time (Oard, 2005b), for a total of ~50 Quaternary glacial/interglacial cycles over the past 2.6 million years (Pillans and Gibbard, 2012). If true, the recent ice ages are linked to the eccentricity cycle, not the stronger precession and obliquity cycles. The effect of eccentricity on insolation is less than 0.17% (Berger, 1977), or about 1% to 2% of the strength of the obliquity and precession cycles! How could this very small effect override stronger ones, much less cause glacial cycles?

Moreover, glacial *maxima* correspond to eccentricity *minima* in insolation (Fischer and Bottjer, 1991). Scientists now talk about the "eccentricity problem" or the "100 kyr Problem." Paillard (2001, p. 325) states:

> Nevertheless, several problems in classical astronomical theory of paleoclimate have indeed been identified: (1) The main cyclicity in the paleoclimatic record is close to 100,000 years, but there is no significant orbitally induced changes in the radiative forcing of the Earth in this frequency range (the '100-kyr Problem').

Carl Wunch (2004, p. 1,001) of MIT equated the eccentricity cycle to chance:

> Evidence cited to support the hypothesis that the 100 Ka glacial/interglacial cycles are controlled by the quasi-periodic insolation [solar] forcing is likely indistinguishable from chance…

As a result, climate scientists have worked over the past 40 years to find an amplifying factor or positive feedback mechanism to boost the effect of Hoyle's "ice cube" and trigger an ice age:

> The dominant 100,000-year response of ice sheets is not externally forced [from the Milankovitch mechanism], nor does it result from internal resonance. Internal forcing appears to play at most a minor role. The origin of this signal lies mainly in internal feedbacks (CO_2 and ice albedo) that drive the gradual build-up of large ice sheets and then their rapid destruction (Ruddiman, 2006, p. 3092, brackets ours).

Are CO_2 and albedo valid mechanisms? Ice albedo is a positive feedback: cooler temperatures result in snow cover that increases the albedo. However, CO_2 does not provide a significant "boost" for the Milankovitch mechanism (Posmentier and Soon, 2005). Scientists keep searching for other auxiliary hypotheses. Abe-Ouchi et al. (2013) proposed that ice sheets spread to lower, warmer latitudes by isostatic downwarping of the crust and upper mantle. But lower, thinner ice sheets would be more vulnerable to warming and rapid melting. They all beg the question of the inadequacy of the Milankovitch theory.

The Phase Problem

A third major difficulty is the "phase problem." Precessional effects on insolation are more significant than eccentricity, but precessional changes trigger opposite effects between hemispheres. Although the 100 kyr eccentricity cycle supposedly caused the last nine ice ages, precession supposedly modulated it by controlling stadials and interstadials (shorter-period ice age fluctuations). Adhémar (1842) predicted that ice ages would vary on an 11,000-year cycle (half the precessional cycle), appearing first in one hemisphere and then the other, with a corresponding interglacial in the opposite hemisphere. His fundamental idea is still valid (Oard, 2014), just not what is actually seen in the uniformitarian interpretation of climate data. Major and minor glacial cycles should oscillate between hemispheres, but geologists claim that they were in phase, though they cannot explain the physics:

> And we don't understand why ice ages occur in both hemispheres simultaneously when the changes in solar irradiance from orbital variations have opposite effects in the north and south (Schrag, 2000, p. 23).

Others note this problem in timing peak glaciation and warming in the two hemispheres:

> A multimillennial LLGM [Local Last Glacial Maximum] for the APIS [Antarctic Peninsula Ice Sheet] and some sectors of the EAIS [East Antarctic Ice Sheet] and WAIS [West Antarctic Ice Sheet], with onset at ~28 to 29 ka and termination at ~19 ka, is remarkably similar to that established for NH [Northern Hemisphere] ice sheets, suggesting synchronization of the hemispheric ice sheets through a common forcing. It has long been recognized that local summer insolation is out of phase between the two hemispheres and hence cannot explain the synchronization…. (Weber et al., 2011, p. 1267, brackets ours).

The in-phase relationship between the two hemispheres begs the question of the relationship between climate between north and south:

> However, these findings [in-phase relationship] pose the question of how the Northern Hemisphere solar forcing is transferred to the Southern Hemisphere, and why Southern Hemisphere local insolation changes have no imprint on the Antarctic temperature record. Variations in greenhouse gas concentrations are too weak to explain the interhemispheric link; there exists no evidence that atmospheric dynamics can directly transfer the orbital signal to the Southern Hemisphere, and changes in the thermohaline [ocean] circulation are thought to favour an asymmetric pattern (Laepple et al., 2011, p. 91, brackets ours).

Why are the two hemispheres in phase? Warming in one should correspond with cooling in the other. Temperatures today are largely determined by the *local* solar radiation (Laepple et al., 2011), and there appears to be no mechanism for transferring the Northern Hemisphere orbital signal to the Southern Hemisphere.

Scientists are looking for solutions. Some propose that Antarctica is in synch with the Northern Hemisphere because of changes in the seasonal proportion of snow (Fujita, 2011; Laepple et al., 2011). Oxygen isotope ratios in ice cores are used as a proxy for temperature; lower ratios correspond to cooler temperatures. But if more snow falls in winter, the average annual oxygen isotope ratio will become more negative, suggesting cooler *temperatures* that may or may not have occurred (Oard, 2005a). Some researchers suggest that a Northern Hemisphere high-latitude solar radiation minimum—corresponding to an ice age and low oxygen isotope ratios in Greenland ice cores—would cause more winter snow in the Southern Hemisphere and a lower oxygen isotope ratio. In this way, both hemispheres would show similar trends in their oxygen isotope ratios. However, it is difficult to prove a large change in the timing of annual snowfall (Oard, 2014), especially a long time ago.

Other Problems

There are other problems (Oard, 2007). Milankovitch theory cannot explain the onset of the first Pleistocene ice age (~ 2.6 Ma), and why there have not *always* been regularly cycling ice ages. Miall (2010) appeared to argue for this using sea level curves, supposedly driven by glacial cycles. Orbital mechanics have supposedly remained constant for at least tens of millions of years, and geologists claim to see orbital forcing of sedimentary cycles well back into the Phanerozoic and even the Precambrian. So, why did ice sheets suddenly appear in areas they had previously been absent? "How the glaciation in the north got started in the first place 2.75 million years ago is another enigma" (Kerr, 1999, p. 505). Although the beginning of the Pleistocene has been pushed back to 2.6 Ma, this is only an approximate starting date of the glacial/interglacial cycle. Besides the secular dating systems are not precise enough to start all ice ages at 2.6 Ma. Some ice age deposits are pushed back into the late Pliocene. Plate tectonics provides no help since the plates have generally been at the same latitude for tens of millions of years.

Furthermore, why did the 41 kyr obliquity cycle only drive glacial cycles between 2.6 Ma to 900 kyr? Why did the periodicity suddenly switch to 100 kyr? Many acknowledge the problem of switching cycles at 900 kyrs ago: "The timing of this transition and its causes pose one of the most perplexing problems in palaeoclimate research" (Rutherford and D'Hondt, 2000, p. 72).

Even though obliquity has a greater effect on insolation than eccentricity, it is still not enough to trigger an ice age. In Hoyle's analogy, it merely brings a slightly larger ice cube into the room. Ironically, the precession cycle has the strongest effect on insolation, but glacial/interglacial cycles do not oscillate at that frequency:

> But a major problem exists for the standard orbital hypothesis of glaciation: Late Pliocene and early Pleistocene glacial cycles occur at intervals of 40 ky … matching the obliquity period, but have negligible 20-ky variability … The origins of strong obliquity over precession-period glacial variability during the early Pleistocene remain unresolved (Huybers, 2006, p. 508).

Furthermore, all three Milankovitch mechanisms have multiple periodicities. Why have glacial cycles not followed all of them, if ice ages are driven by insolation changes?

Deep-Sea Cores

A primary reason scientists accept the Milankovitch theory is the apparent correlation with proxies like oxygen isotope ratios in deep sea cores (Figure 5), dating to Hays et al. (1976). Despite Hebert (2016a, b, c; 2017) having shown many problems with that paper, correlations between these curves at hundreds of deep-sea coring sites and in ice cores from Greenland have built up a large quantitative evidence set.

But if built on bad assumptions or methods, the quantity matters little. There are subjective elements in the process. First, absolute dates in the cores are questionable. The dating methods vary; some are radiometric, some based on biostratigraphy, and some on paleomagnetism. There are many reasons to reject these dating methods (Hebert, 2014; Oard, 2005a; Reed, 2013). Circular reasoning and the reinforcement syndrome are valid causes for dates, oxygen isotope excursions, and Milankovitch curves to "match." Subtle manipulation is common (Hebert, 2014; Oard, 1984b; 1985). Even Antarctic ice cores have been manipulated to agree with deep-sea cores (Oard, 2005a).

Second, oxygen isotope curves are fraught with uncertainties (Oard, 1984b; 2005a). The equation that determines oxygen isotope ratios in foraminifera has two unknowns: temperature and the oxygen isotope ratio of the seawater when the shells formed. These dual variables make any solution an educated guess. Furthermore, different kinds of foraminifera exhibit distinct oxygen isotope signatures. Planktonic foraminifera calcify their shells at varying depths. Since temperature varies with depth, another variable is added. So do seasonal and local changes in temperature and salinity. Even deep ocean environments, where benthonic foraminifera live, show evidence of past temperature changes (Bowen, 1978, p. 67; Kerr, 1982). Bottom temperatures are determined by high latitude atmospheric temperatures that cool the water, which sinks. Within the uniformitarian paradigm, just glacial/interglacial temperature differences should cause changes in bottom temperatures. Furthermore, when foraminifera shells begin to dissolve, the ratio of oxygen isotopes can vary with the extent of dissolution. Sometimes the effect of dissolution is difficult to detect (Schrag, 1999; Oard, 2003). Once a shell reaches the bottom of the ocean, it is subject to dissolution, reworking from bottom currents, and bioturbation. Bioturbation will smooth out $\delta^{18}O$ ratios. Uniformitarian scientists believe that bioturbation just smooths out the "noise," and not the presumed glacial/interglacial $\delta^{18}O$ changes. However, this belief assumes a certain bioturbation depth and sedimentation rate.

Despite these uncertainties, the use of spectral analysis, which measures the strength of cycles in a time series, seems impressive, but it depends critically upon an accurate time series. If there is a hiatus caused by erosion or some other process, or a change in sedimentation rate, the sampling times assumed by the spectral analysis procedure are no longer valid. Bailey and Smith (2009) noted that hiatuses are ubiquitous at *all* scales, and often undetected.

One potential explanation for the correlation of dates, ice ages, sedimentary series, and Milankovitch spectral peaks is subjectivity on the part of the investigator—circular reasoning and the reinforcement syndrome. Hebert (2014, p. 297) summarizes:

> Uniformitarian scientists claim that chemical clues within the seafloor sediments tell a "story" of climate change over millions of years and that this "story" agrees well with expectations of the astronomical (or Milankovitch) theory of Pleistocene ice ages. Yet secular scientists routinely use the astronomical theory to date the seafloor sediments in a technique called "orbital tuning." Of course, this argument is circular, since the astronomical theory of ice ages is simply assumed to be correct and is used as a framework for interpreting chemical clues within the seafloor sediments.

Some scientists hint at this, for instance that the power spectrum results are very sensitive to *pre-processing* of the data: "A key problem with spectral analysis of [time] series of this type is that results are extremely sensitive to the methods used to pre-process the data" (Roe and Allen, 1999, p. 2260). Miall and Miall (2004) called it a "black box" technique, although Miall has since toned down his criticism.

Moreover, the spectra that purport to show "orbital tuning" rely on the overarching scaffolding of the geological time scale (Hebert, 2014). Since that framework is assumed to be valid, solutions are biased to agree with it. Pisias et al. (1984, pp. 841–842, brackets ours) write:

> The first assumption [the time scale of the data series is known]

> is a major problem in the study of paleoclimate records. With the exception of three-ring [sic] studies and annually laminated sediment [varves], there are no direct means of measuring time in a geological section. In studies of deep-sea sediments, samples can be taken at known depths in the sediment column but the ages of each sample are not directly measured. The assumption of constant sediment accumulation rates is often made so that depth in section can be related to time, but in many parts of the world's ocean this assumption has been shown to be false. Thus, much effort has been directed towards the establishment of a highly accurate geologic time scale for the last several hundred thousand years (Hays et al., 1976) … These works have used the hypothesis of orbital forcing of climate change to adjust the time scale of geologic records to better "fit" the calculated orbital parameters. This approch [sic] reduces the independence of geologic records as verification of Milankovitch hypotheses…

Since the scientists that revived the Milankovitch theory in the 1960s and 1970s were strong supporters of the theory, we suspect a subjective bias that pushed data to fit the preconceived theory (Oard, 1984b). Bias is stronger than most think in scientific research and many published results cannot be reproduced (Bohannon, 2015; Nuzzo, 2015; Open Science Collaboration, 2015). In the case of Milankovitch cycles, the spectral analyses of the deep sea cores may have caused any spectral trends in the cores to be considered evidence that the theory was correct. Just as evolution is "seen" in the fossil record by its true believers, so also Milankovitch cycles are readily apparent to anyone with the correct "lens." Moreover, there are significant spectral peaks that show non-Milankovitch frequencies. (Elkibbi and Rial, 2001)

The Reinforcement Syndrome

In the 1950s and 1960s, dating methods for deep-sea cores were inaccurate, and likely are today. That problem is masked by confidence in the Milankovitch theory. Current interpretations may well be a form of circular reasoning called the reinforcement syndrome. It is a psychological phenomenon observed in scientific research when a concept or hypothesis is repeatedly reinforced by a quantity of data, even if it is not true (Oard, 1997; 2013a). For example, a junior scientist may work to develop the theory of a well-respected, senior scientist. People are biased towards obtaining and maintaining funding. Once a hypothesis becomes ingrained, it is difficult to dislodge. The hypothesis becomes an assumption. Then, investigations are designed, and data made to fit. That is where the Milankovitch mechanism stands today, after being rejected twice (Oard, 1984a).

Because cyclostratigraphy offers absolute dates that are orders of magnitude more precise than other methods, geologists are motivated to use it. Broecker (1984, p. 687) stated that he *had believed* in the mechanism since the early 1960s, and was convinced that statistical correlations with deep sea cores would prove it, *post hoc*:

> The chronology of insolation maxima that is calculated from the known periodicities of the tilt and precession of the earth's axis and from the earth's orbital eccentricity can be compared with curves based on absolute dating of events in climate-controlled systems. Agreement of the two curves over several cycles would provide strong evidence for a cause-and-effect relationship (Broecker, 1966, p. 299).

Broecker went on to claim that the Milankovitch mechanism was verified by "accurate dating" of deep-sea cores. This was first done by the watershed research of Hays *et al*. (1976). However, Broecker found the *tilt and precession cycles predominated* in the cores over the past few hundred thousand years: "Changes in climate occur in response to periodic variations in the earth's tilt and precession" (Broecker, 1966, p. 299). Although the tilt and precession cycles still show an influence in solar radiation curves of the past, the uniformitarian ice ages and the foundation of cyclostratigraphic dating in older sedimentary rocks is linked to the eccentricity cycle. Was his belief in the theory driving his data analysis? Does that subjective element continue to intrude? The rapid acceptance and expansion of the method and the confidence of geologists that they will eventually be able to use it to more precisely date rocks into the Precambrian suggests a bandwagon effect.

Geologists claim that they are able to see billions of years of evolution in the rock record. It should not be surprising that they can find elements of that same record that support their new method. And, of course, the new method will go on to prove the "effect" of orbital forcing on Earth's past climate.

Milankovitch Mechanism Now the Basis for High-Precision Dating

The Milankovitch mechanism has become the *ruling paradigm* in climate research, and is rapidly assuming that role in high-precision stratigraphic dating. All climate related data, as well as dating methods, are made to fit the theory (Oard, 1985). Scientists even "tune" data sets, such as deep-sea cores, to the cycles by adjusting the sedimentation rate (Kerr, 1983). This is circular reasoning:

> However, interpreting results based on orbital tuning can lead to circular reasoning, because the presence of an orbital signal is commonly assumed before it is tested. Furthermore, the outcome depends on choosing an appropriate target curve and/or frequency for tuning. As a

result, astrochronology may provide multiple unconstrained orbital interpretations for a given stratigraphy… (Aswasereelert et al., 2013, p. 216).

Summary

The Milankovitch mechanism is claimed to be capable of driving major climate fluctuation, even to the degree of producing extreme glaciation episodes, which in turn is expressed in the stratigraphical record. But confidence that the Milankovitch mechanism can exert such influence comes primarily from data selection, by naively focusing on its effect over a tiny portion of the Earth's surface. The Earth's climate system is complex and involves major latitudinal heat transport. When all the data—a whole hemisphere for the summer half-year—is used, the Milankovitch driver is found to be extremely small. All three Milankovitch cycles have a limited effect on insolation, although that has not deterred the theory's advocates from correlating each of them to glacial/interglacial and stadial/interstadial cycles, particularly the 100 kyr eccentricity cycle. Those who acknowledge the embarrassing weakness of the signal have focused in vain on finding amplification mechanisms. Beyond this fundamental problem of the weakness of the signal, they offer no credible solution for other problems, such as the lack of opposite precessional cycles between the hemispheres. Further, no satisfactory reason can be given for the onset of Quaternary glaciation in the face of the same orbital mechanism back into deep time, or for the transition from 40 kyr precessional glacial cycles to the recent 100 kyr eccentricity cycle. As with other methods of natural history, circular reasoning is always a peril; "verification" of the astronomical curves by deep-sea cores requires a correct and independent time scale for those sediments, but such a time scale is not available. The revival of the astronomical theory of ice ages in the 1960s and 1970s is therefore more a case study on the scientists who promote it than it is on natural history.

Finally, it is important to point out that God Himself in Scripture has revealed sufficient detail concerning the Earth's physical past to infer a time scale for the recent glaciation event. As previous publications have elaborated, an ice age lasting only a few centuries followed the Noahic Flood that itself occurred merely a few millennia ago (Oard, 2004; 2013b). This record of the Earth's past is anchored in the words and the authenticity of Jesus Himself and hence is unshakable. In this light the Milankovich time scale is yet another example of the foolishness to which human reasoning apart from God's revelation inevitably leads.

References

Abe-Ouchi, A., F. Saito, K. Kawamura, M.E. Raymo, J. Okuno, K. Takahashi, and H. Blatter. 2013. Insolation-driven 100,000-year glacial cycles and hysteresis of ice-sheet volume. *Nature* 500:190–193.

Adhémar, J. 1842. *Les Révolutions de la Mer, Déluges Périodiques*. Carilian Gourey et V. Dalmort, Paris, FR.

Anonymous, 1956. *Snow Hydrology*. U.S. Army Corps of Engineers, plate 5–1, Figure 3.

Aswasereelert, W., S.R. Meyers, A.R. Carroll, S.E. Peters, M.E. Smith, and K.L. Feigl. 2013. Basin-scale cyclostratigraphy of the green River Formation, Wyoming. *GSA Bulletin* 125(1/2):216–228.

Bailey, R.J. and D.G. Smith. 2009. Scaling in stratigraphic data series: implications for practical stratigraphy, *First Break* 10:57–66.

Berger, A.L. 1977. Support for the astronomical theory of climatic change. *Nature* 269:44–45.

Berger, A.L. 1978. Long-term variations of caloric insolation resulting from the Earth's orbital elements. *Quaternary Research* 9:139–167.

Berger, A.L. 1992. Astronomical theory of paleoclimates and the last glacial-interglacial cycle. *Quaternary Science Reviews* 11:571–581.

Berger, A.L., M.F. Loutre, and Q. Yin. 2010. Total irradiation during any time interval of the year using elliptic integrals. *Quaternary Science Reviews* 29:1968–1982.

Bohannon, J. 2015. Many psychology papers fail replication tests. *Science* 349:910–911.

Bowen, D.Q. 1978. *Quaternary Geology: A Stratigraphic Framework for Multidisciplinary Work*, p. 67. Pergamon Press, New York, NY.

Broecker, W.S. 1966. Absolute dating and the astronomical theory of glaciation. *Science* 151:299–304.

Broecker, W.S. 1984. Terminations; in: Berger, A.L. *et al.* (editors), *Milankovitch and Climate*, pp. 687–698. D. Reidel Publishing Co., Dordrecht, NL.

Budyko, M. 1977. *Climate Changes*. American Geophysical Union, Washington, D.C.

Elkibbi, M. and J.A. Rial. 2001. An outsider's review of the astronomical theory of the climate: is the eccentricity-driven insolation the main driver of the ice ages? *Earth-Science Reviews* 56:161–177.

Fischer, A.G. and D.J. Bottjer. 1991. Orbital forcing and sedimentary sequences. *Journal of Sedimentary Petrology* 61(7):1063–1069.

Fujita, K. 2011. Another Antarctic rhythm. *Nature* 471:45–46.

Hays, J.D., J. Imbrie, and N.J. Shackleton. 1976. Variations in the Earth's orbit: pacemaker of the ice ages. *Science* 194:1121–1132.

Hebert, J. 2014. Circular reasoning in the dating of deep seafloor sediments and ice cores: the orbital tuning method. *Answers Research Journal* 7:297–309.

Hebert, J. 2016a. Should the "Pacemaker of the Ice Ages" Paper Be Retracted? Revisiting an Iconic Argument for Milankovitch Climate Forcing, Part 1. *Answers Research Journal* 9:29–56.

Hebert, J. 2016b. Revisiting an Iconic Argument for Milankovitch Climate Forcing: Should the "Pacemaker of the Ice Ages"

Paper Be Retracted? Part 2. *Answers Research Journal* 9:131–147.

Hebert, J. 2016c. Revisiting an Iconic Argument for Milankovitch Climate Forcing: Should the "Pacemaker of the Ice Ages" Paper Be Retracted? Part 3. *Answers Research Journal* 9:229–255.

Hebert, J. 2017. The "Pacemaker of the Ice Ages" Paper Revisited: Closing a Loophole in the Refutation of a Key Argument for Milankovitch Climate Forcing. *Creation Research Society Quarterly* 54: 133–148.

Hinnov, L.A. and Hilgen, F.J. 2012. Cyclostratigraphy and astrochronology. In Gradstein, F.M., Ogg, J.G., Schmitz, M., and Ogg, G. (editors). *A Geologic Time Scale 2012*, pp. 63–83. Cambridge University Press, Cambridge, UK.

Hoyle, F. 1981. *Ice, the Ultimate Human Catastrophe*. Continuum, New York, NY.

Huybers, P. 2006. Early Pleistocene glacial cycles and the integrated summer insolation forcing. *Science* 313:508–511.

Imbrie, J. and Imbrie, K.P. 1979. *Ice Ages: Solving the Mystery*. Enslow Publishers, Short Hills, NJ.

Kerr, R.A. 1982. The fickleness of the deep sea. *Science* 218:670.

Kerr, R.A. 1983. Precisely measuring the past million years. *Science* 221:1041.

Kerr, R.A. 1999. Why the ice ages don't keep time. *Science* 285:503–505.

Laepple, T., M. Werner, and G. Lohmann. 2011. Synchronicity of Antarctic temperatures and local solar insolation on orbital timescales, *Nature* 471:91–94.

Ledley, T.S. 1990. The impact of Milankovitch solar radiation variations on sea-ice and air temperature in a coupled energy-balance climate-sea-ice model. *Annals of Glaciology* 14:144–147.

Locke, W. 1997. Letter to editor. *Science News* 151(17):260.

Miall, A.D. 2010. *The Geology of Stratigraphic Sequences, second edition*. Springer-Verlag, New York, NY.

Miall, A.D. and C.E. Miall. 2004. Empiricism and model-building in stratigraphy: around the hermeneutic circle in the pursuit of stratigraphic correlation. *Stratigraphy* 1(1):27–46.

Nuzzo, R. 2015. Fooling ourselves: humans are remarkably good at self-deception but growing concern about reproducibility is driving many researchers to seek ways to fight their own worst instincts. *Nature* 526:182–185.

Oard, M.J. 1984a. Ice ages: the mystery solved? Part I: the inadequacy of a uniformitarian ice age. *Creation Research Society Quarterly* 21(2):66–76.

Oard, M.J. 1984b. Ice ages: the mystery solved? Part II: the manipulation of deep-sea cores. *Creation Research Society Quarterly* 21(3):125–137.

Oard, M.J. 1985. Ice ages: the mystery solved? Part III: paleomagnetic stratigraphy and data manipulation. *Creation Research Society Quarterly* 21(4):170–181.

Oard, M.J. 1997. *Ancient Ice Ages or Gigantic Submarine Landslides?* pp. 9–17. Creation Research Society Books, Chino Valley, AZ.

Oard, M.J. 2003. The 'cool-tropics paradox' in palaeoclimatology. *Journal of Creation* 17(1):6–8.

Oard, M.J. 2004. *Frozen in Time: Woolly Mammoths, the Ice Age, and the Biblical Key to Their Secrets*. Master Books, Green Forest, AR.

Oard, M.J. 2005a. *The Frozen Record: Examining the Ice Core History of the Greenland and Antarctic Ice Sheets.* Institute for Creation Research, Dallas, TX.

Oard, M.J. 2005b. The astronomical theory of the Ice Age becomes more complicated. *Journal of Creation* 19(2):16–18.

Oard, M.J. 2007. Astronomical troubles for the astronomical hypothesis of ice ages. *Journal of Creation* 21(3):19–23.

Oard, M.J. 2011. *The Great Global Warming Debate* (DVD). Creation Ministries International, Powder Springs, GA.

Oard, M.J. 2013a. The reinforcement syndrome ubiquitous in the earth sciences. *Journal of Creation* 27(3):13–16.

Oard, M.J. 2013b. *The Great Ice Age: Evidence from the Flood for Its Quick Formation and Melting* (DVD). Awesome Science Media, Richfield, WA.

Oard, M.J. 2014. Phase problem with the astronomical theory. *Journal of Creation* 28(2):11–13.

Oard, M.J., 2017. Get the Facts: Hurricanes and Global Warming. AnswersinGenesis.org, (accessed November 3, 2019).

Open Science Collaboration, 2015. Estimating the reproducibility of psychological science. *Science* 349:943, aac4716-1-aac4716-8.

Paillard, D. 2001. Glacial cycles: toward a new paradigm. *Reviews of Geophysics* 39(3):325–346.

Paltridge, G.W. and G.M.R. Platt. 1976. *Radiation Processes in Meteorology and Climatology*. Elsevier Scientific Publishing Co, New York, NY.

Pillans, B. and P. Gibbard. 2012. The Quaternary Period; in: Gradstein, F.M., J.G. Ogg, M. Schmitz, and G. Ogg, (editors), *The Geologic Time Scale 2012*, pp. 979–1010. Elsevier, New York, NY.

Pisias, N., P. Pestiaux, H. Dalfes, and K. Herterich. 1984. Estimation of climate spectra; in: Berger, A.L. *et al.* (editors), *Milankovitch and Climate*, pp. 841–845. D. Reidel Publishing Co., Dordrecht, NL.

Posmentier, E.S. and W. Soon. 2005. Limitations of computer predictions of the effects of carbon dioxide on climate; in: Michaels, P.J. (editor), *Shattered Consensus: The True State of Global Warming*, pp. 241–281. Rowman & Littlefield, Lanham, MD.

Reed, J.K. 2013. *Rocks Aren't Clocks: A Critique of the Geologic Timescale*. Creation Book Publishers, Powder Springs, GA.

Reed, J.K. and M.J. Oard. 2015. Cyclostratigraphy, part I: what is cyclostratigraphy? *Creation Research Society Quarterly* 52(2):95–105.

Reed, J.K. and M.J. Oard, 2016. Cyclostratigraphy, part II: history of the method. *Creation Research Society Quarterly* 53(2):103–109.

Robock, A. 1983. Ice and snow feedbacks and the latitudinal and seasonal distribution of climate sensitivity. *Journal of Atmospheric Sciences* 40:986–997.

Roe, G.H. and M.R. Allen. 1999. A comparison of competing explanations for the

100,000-yr ice age cycle. *Geophysical Research Letters* 26(15):2259–2262.

Ruddiman, W.F. 2006. Orbital changes and climate. *Quaternary Science Reviews* 25:3092–3112.

Rutherford, S. and S. D'Hondt. 2000. Early onset and tropical forcing of 100,000-year Pleistocene glacial cycles. *Nature* 408:72–75.

Schrag, D.P. 2000. Of ice and elephants. *Nature* 404:23–24.

Simpson, G.C. 1940. Possible causes of changes in climate and their limitations. *Linnean Society of London Proceedings* 152:190–219.

Van Woerkom, A.J.J. 1953. The astronomical theory of climate change; in: Shapley, H. (Ed.), *Climate Change*, pp. 147–157. Harvard University Press, Cambridge, MA.

Vernekar, A.D. 1972. Long-period global variations of incoming solar radiation. *Meteorological Monograph* 12(34):1–21 and tables.

Washburn, A.L. 1980. Focus on polar research. *Science* 204:643–652.

Weber, M.E., P.U. Clark, W. Ricken, J.X. Mitrovica, S.W. Hostetler, and G. Kuhn. 2011. Interhemispheric ice-sheet synchronicity during the last glacial maximum. *Science* 334:1265–1269.

Wunsch, C. 2004. Quantitative estimates of the Milankovitch-forced contribution to observed Quaternary climate change. *Quaternary Science Reviews* 19(2):1001–1012.