Astronomy and the Bible with Human Experience second edition
by Herb Solinsky (c) March 19, 2021

[1] Introduction

Through the senses of hearing, seeing, touching, tasting, and smelling, people today commonly experience a vast acquisition of knowledge that was not available to people in the year 1800. Many people in the United States have flown in jet planes, used cell phones to speak with people in another continent of the world, and we use computers with word processors. We know the year we were born, so we accept the fact that there was history from all the years that preceded our year of birth. We accept the known history of humankind that has come from accumulated written records, especially archaeology. All of this accumulated knowledge cannot be overlooked when we use our mind to arrive at what should be believed. We accept the Bible to be true, and desire to use it correctly, yet our understanding of it needs to have common sense in logical thinking using our accumulated knowledge built upon our vast experience, which will not contradict the Bible, but instead help us to better understand it.

All of this must be accepted as part of our arsenal of tools as we study the Bible and understand what it has to say about astronomy and the nature of the earth, including its shape and whether it does or does not rotate on an axis. Yes, indeed we must be vigilant to avoid deception because using modern computer graphics and false witnesses it is possible to be fooled into thinking that something is reality when it is not. Therefore, with any introduction of evidence we need to think deeply about whether there is deception involved and whether it should be believed.

The Bible consists of the Old Testament and the New Testament. Rom 3:1-2, “Then what advantage has the Jew? Or what is the benefit of circumcision? Great in every respect. First of all, that they were entrusted with the oracles of the Almighty.” Here the apostle Paul is telling us that the Old Testament was the Scriptures before the New Testament was written. This is the collection of writings that the Jews accepted as inspired. Other writings such as the Apocrypha and miscellaneous sectarian writings from the Dead Sea Scrolls, which includes the Book of Enoch, are not accepted as inspired by the Jews, although they have some historical value. Therefore when we seek to use the Bible as our guide, we need to reject the writings not accepted by the Jews as inspired.

[2] Ordinances of the Heavenly Bodies

Notice the word “ordinances” in the following group of verses.

Jer 31:35 “Thus says YHWH who gives [the] sun for a light [216 *ohr*] by daytime [and the] ordinances [2708 *chookah*] of [the] moon and stars for a light [216 *ohr*] [by] night, who moves [the] sea so that its waves roar. YHWH of hosts [is] His name.

Jer 31:36 “If these ordinances [2706 *chohk*] depart from before Me, says YHWH, then [the] descendants of Israel shall cease from being a nation before Me forever.”

Jer 33:25 “Thus says YHWH, if My covenant [for] daytime and night fails, and the ordinances [2708 *chookah*] I have established of [the] heavens and earth fail,

Jer 33:26 “then I will reject the descendants of Jacob and David My servant, not taking of his descendants to rule over [the] seed of Abraham, Isaac, and Jacob; for I will restore their captivity and show lovingkindness upon them.”

Job 38:33 “Do you know [the] ordinances [2708 *chookah*] of the [the] heavens? Can you set their dominion in [the] earth?”

The ordinances mentioned in the above verses collectively includes the laws by which the moon, the stars, the earth, and the heavens operate to keep them where they should be as time progresses. Since the sun is seen in the heavens, it might be inferred that the ordinances include the sun as well. The Bible does not explain what these ordinances are, but it does show that these laws of astronomy of the heavenly bodies do exist. YHWH created these ordinances and it remained for humanity to try to discover these laws by which matter is governed.

Notice the faithfulness of the moon in Ps 89:37.

Ps 89:35 “Once I have sworn by My holiness to David; I will not lie.

Ps 89:36 “His seed shall continue forever and his throne as [the] sun before Me.

Ps 89:37 “It shall be established forever like [the] moon, and [the] witness in [the] sky is faithful. Selah,”

What makes the moon a faithful witness is its dependability in following the ordinances. The moon’s faithfulness is witnessed in that at least from c. 750 BCE and into the first century of about 2000 years ago, the ancient Babylonians were able to successfully predict lunar eclipses. Many of their records of such eclipses even included the time of day of these eclipses using water clocks, were written on clay tablets that are mostly in the British Museum today. Modern computers have been used to verify the time of these ancient recorded eclipses being accurate to within an average of eight minutes of the day, so we today can judge the accuracy of their ancient water clocks. We know that the time rate of the dripping of water in a water clock varies with the temperature, so we recognize that their water clocks had to have some error. This verification of recorded eclipse history has established the historical accuracy of the dates of the Babylonian calendar back to 747 BCE. This information is well documented in the *Journal for the History of Astronomy*. I have read these articles and made photocopies of them.

The Babylonians watched the night sky and kept careful records for distinctive astronomical features for hundreds of years in order to discover cyclical repeating patterns in order to be able to predict certain astronomical events. These Babylonians were successful for achieving certain results of prediction, but they never developed

explicit mathematical formulas for general ordinances to pinpoint the exact position of heavenly bodies at anytime in the future. They tried to keep their astronomical achievements a secret by writing in the largely abandoned ancient Akkadian language with its roughly 500 symbols, but when Alexander the Great conquered the Persian Empire, he demanded that the Babylonian astronomers turn over their secrets to the Greek astronomers. After this transfer of knowledge to the Greeks, the latter attempted to convert the results of the Babylonians into geometrical formulas, but they made the incorrect assumption that these formulas were based upon circles, and specifically circles within circles in order to achieve a better prediction that was never truly accurate.

It is only with the modern theory of astronomy and the use of computers that today we are able to calculate backwards in time when ancient eclipses did occur (including the time of day of the eclipses based on the use of ancient water clocks) as recorded anciently, and we are able to verify the ancient date and time, and are therefore very confident that we fully understand the chronology and calendar involved for the Babylonians back to 747 BCE. Since the modern theory of astronomy is able to accomplish such a beautifully accurate result, including verifiable present day very accurate predictions of the locations of heavenly bodies in the sky, modern astronomers have good reason to be very confident that the ordinances of the heavenly bodies are correctly understood today.

It is no secret that it was indeed Sir Isaac Newton who first mathematically expressed the ordinances of the heavens as three physical laws of motion. In 1687 he presented a mathematical formula for gravity, even though he admitted that he could not give a detailed definition of gravity and did not know the reason that gravity worked the way it did. The reason that his mathematical formula for gravity is accepted by astronomers and mathematicians is that its results were carefully verified by observations using telescopes in many parts of the world over the centuries since 1687.

Job 26:7, “He spreads out the north over the void. He hangs [the] earth upon nothingness.”

[3] Does the Bible say that the earth cannot move?

The context plays a major role in determining when a statement in Scripture should be taken literally or in some figurative sense.

Isa 55:12 “For you shall go out with joy and be led forth in peace. The mountains and the hills shall break forth [into] singing before you and all [the] trees of the field shall clap their hands.”

In the above verse we recognize that mountains and hills do not literally sing, and trees do not literally have hands that clap. The point here is to recognize that care must be taken to examine the context and whether it is sensible to think that there is figurative

language in certain contexts that mention the earth, sun, and moon.

Personal experiences of people can play a role in helping to decide whether a Scripture is meant to be understood figuratively or literally in context.

I Chr 16:23 has the expression “sing to YHWH all the earth”.

I Chr 16:31 has the expression “let the earth be glad”.

Both of these verses appear to make the earth into a person with human abilities and feelings, so they are figurative. Both are part of the context of the same song of David in I Chr 16:8-36. Now consider the following verse in the same song.

I Chr 16:30 “Tremble before Him all the earth. Indeed [the] world [8398 *tayval*] stands-secure. It shall not be moved [4131 *moht*].”

In the following 12 places the Hebrew word *moht* has the meaning of “mentally disturbed”: Ps 10:6; 13:4; 15:5; 16:8; 21:7; 30:6; 55:22; 62:2, 6; 112:6; Prov 10:30; 12:3. For example, Ps 62:6 is “He only [is] my rock and my salvation; [He is] my defense, I shall not be mentally-disturbed [4131 *moht*].” As seen above from verses 23 and 31, the “earth” refers to “people of the earth” in this song of David. Now consider the following understanding.

I Chr 16:30 “Tremble before Him all [the people of] the earth. Indeed [the] world [8398 *tayval*] stands-secure [= its people are safe]. It [the people of the world] shall not be disturbed [4131 *moht*].”

Hence the above verse is not talking about the physical body called the earth and whether it can physically move. **Here the earth is a figure of speech that represents the people of the earth when they are in a worshipful attitude and are at mental peace.**

In the next verse we consider the opposite kind of context where YHWH is angry with the nations, and the earth is mentioned.

Jer 10:10 “But YHWH [is] Almighty in faithfulness, He is [the] living Almighty and the eternal King. At His wrath the earth quakes and nations cannot endure His indignation.”

The context of Jeremiah is one in which the Babylonian Empire is expanding through conquest and nations are falling to its power. The House of Judah is defeated at the hands of Babylon and its elite are taken captive into Babylon. The people of Judah have been disobedient to the laws of Moses and are punished in defeat and captivity. YHWH is wrathful at their disobedience. The phrase “the earth quakes” is expanded to mean “nations cannot endure His indignation”.

Here the earth is a figure of speech that represents the people of the earth when they are disobedient and punished. Thus “the earth quakes” can be expanded to

mean "the [peoples of the] earth are disturbed in punishment".

The next two verses show a similarity to Jer 10:10 in its use of the earth as a figure of speech. Here the. earth is symbolic of the people on the earth who are being punished.

Ps 60:2 "You have made [the] earth tremble. You have broken it. Heal its fractures for it is moved [= disturbed = 4131 *moht*]."

Ps 82:5 "They have neither knowledge nor understanding. They walk in darkness. All [the] foundations of [the] earth are moved [= disturbed = 4131 *moht*]."

Psalm 93 is totally about the majesty and authority of YHWH to establish His will. Here the Hebrew word *moht* occurs again. When YHWH exerts His power for good, nothing will disturb the inhabitants of the earth, as the first verse indicates. It is speaking of no disturbance of the people, not physical movement of the earth. The context must be respected. When other verses above are attempted to be taken literally, they do show movement or lack of movement of the earth, but their meaning from the context shows that they are not intended to be taken literally.

Ps 93:1 "YHWH reigns in splendor, greatly adorned. YHWH is girded [with] strength. Indeed [the] world is established; it [the people] shall not be moved [= disturbed = 4131 *moht*]."

Psalm 96 is about praising the glory of YHWH in worship, and it ends with His reign over the earth in righteousness and faithfulness with implied world peace. Here the Hebrew word *moht* occurs again. When YHWH exerts His power for good, nothing will disturb the inhabitants of the earth, as this verse is indicating. Verse 11 shows personification of the earth with its rejoicing.

Ps 96:10 "Say among the nations, YHWH reigns. Indeed [the] world is established; it shall not be moved [= disturbed = 4131 *moht*]. He will judge the peoples with fairness,

Ps 96:11 "Let the heavens be glad and let the earth rejoice. Let the sea roar and all that fills it."

Psalm 104 mentions many literal aspects of the created world and its life. Verses 5 and 32 below show opposites in how they use the word earth. Also compare Ps 104:5 with Ps 82:5 above (both use the word foundations) where they show opposites, so that in order to avoid a contradiction they must have a figurative meaning in use of the earth.

Ps 104:5 "He did set [the] earth on its foundations [so that] it should not be moved [= disturbed = 4131 *moht*] for ever."

Ps 104:32 "He looks on the earth and it quakes. He touches on the mountains and they smoke."

Verse 32 shows quaking of the earth, which is moving. Yet verse 5 shows a lack of

moving. This is symbolic of His power over the people of the earth so that they may be at mental peace or be disturbed according to the will of YHWH in accordance with their behavior.

The next verse is an opposite to the earth **not** being disturbed. Again the earth is a symbol of the people on the earth.

Isa 24:19 "The earth is hopelessly broken. [The] earth is torn apart forcefully. [The] earth is moved [= disturbed = 4131 *moht*].

Scripture does not support the idea that the physical planet earth itself cannot literally move.

[4] Known History of the Belief that the Earth is approximately a Sphere

Aristotle presented three reasons for the spherical shape of the earth in his writing c. 330 BCE, although he was not the first person to claim the earth is approximately a sphere. These reasons are presented on pp. 20-21 of Wilford 2000.

The first reason relates to the stars that are visible on any single day based on the observer's location. As a person travels north and looks north, he sees certain stars appear over the horizon he did not see before going north. If that same person turns around and looks to the southern horizon where he had been before, certain other stars are no longer visible. This is explained by the blockage of sight by the earth due to its curvature.

The second reason is based upon sight from a high mast of a ship as it heads toward land on a very clear day. The person high up on the mast will see land before anyone on the deck of the ship will see land. The reason for this is that the curvature of the sea will block the sight of those on the deck.

The third reason is that during a lunar eclipse, a shadow arc of a circle will move across the partially hidden moon. The arc is accepted to be the shadow of the earth upon the moon because the eclipse was thought to be due to the earth blocking the sun, so that the full moon is partially hidden.

When Alexandria was invaded and destroyed during the fourth century, its library was demolished and much of Greek science was lost. Some copies did survive and were translated into Arabic by Arabian scholars. After a few centuries the Arabian scholars preserved the astronomy of Ptolemy, but it was not directly known by Europeans because they did not have a knowledge of Greek. Europeans had to learn from the Arabs. Europeans did not know what Aristotle had written about astronomy.

On pp. 27-28 of Lester 2009, we note, "Medieval Europeans, even the most learned geographers among them, are to this day often described as having believed that the

world was flat. But this simply isn't true. Thanks to the Arab astronomers and mathematicians, ancient Greek proofs of the earth as spherical had survived into the Middle Ages and were circulating in Europe – and at some point early in the thirteenth century an English scholar known as John of Holywood, or Sacrobosco, laid them out in an astronomical treatise appropriately titled *The Sphere*. For centuries afterward the work would be taught in schools and universities around Europe. 'If the earth were flat from east to west,' Sacrobosco wrote, 'the stars would rise as soon for Westerners as for Orientals, which is false. Also, if the earth were flat from north to south, and vice versa, the stars that were always visible to anyone would continue to be so wherever he went, which is false.'"

In other words, Sacrobosco repeated the reasoning of Aristotle to teach that the earth is spherical to Europeans from the thirteenth century onward.

[5] YHWH Spreads out the Heavens. Explaining the Heavens

The Hebrew verb *netah* (Strong's number 5186) occurs about 215 times in the Hebrew. Its meaning is not controversial and it typically means to extend, to stretch out, to spread out, to bend, and to pitch [a tent]. In the following 10 places it refers to YHWH "spreading out the heavens": Job 9:8; Ps 104:2; Isa 40:22; 42:5; 44:24; 45:12; 51:33; Jer 10:12; 51:15; Zech 12:1. Here are two of these 10 places where the context helps to show the correctness of the meaning.

Ps 104:2, "who covers Yourself with light as with a garment, who has spread out [5186 *netah*] [the] heavens like a tent.

Isa 40:22 "[It is] He [who] sits upon [the] circle [2329 *choog*] of the earth. And [its] dwellers [are] as grasshoppers. Who spreads out [5186 *netah*] [the] heavens as a curtain and draws them as a tent to dwell in?"

In Isa 40:22 the Hebrew preposition for the translation of the word "as" occurs three times. This word shows a metaphor, which by its nature introduces an analogy. Hence it is not intended to be taken literally.

The concept of spreading out the heavens relates to its creation as well as its sustenance.

Another Hebrew expression with a different verb [7554 *raka*] that has a similar idea of both creation and sustenance involves the earth instead of heaven. It uses the verb *raka* in all three instances for the earth. The question before us is the translation that is most suitable for *raka* that relates to the earth.

The following list shows all eleven places where the verb *raka* occurs.

Ex 39:3 hammered metal (gold).

Num 16:39 hammered metal (bronze).

II Sam 22:43 trampled (enemies).

Job 37:18 spread out clouds/skies.

Ps 136:6 *raka* earth.

Isa 40:19 spread it over (with gold).

Isa 42:5 *raka* earth.

Isa 44:24 *raka* earth.

Jer 10:9 hammered metal (silver).

Ezek 6:11 stomp (with feet).

Ezek 25:6 stomp (with feet).

In II Sam 22:43 the enemies of David are figuratively trampled as mud. The activity of hammering, stomping, trampling, and spreading all cause a spreading action, which is directly indicated in Job 37:18 and Isa 40:19. It would thus make sense that "*raka* earth*"* would mean spreading out the earth as a parallel to the previous expression for "spreading out the heavens".

Just as "spreading out the heavens" relates to creation and sustenance of the heavens, "spreading out the earth" relates to creation and sustenance of the earth. The idea of "spreading out" is a picturing of creating and sustaining.

There are two verses that contain both verbs *raka* and *netah*. These are Isa 42:5; 44:24. One verb is exclusively for heavens, and the other is exclusively for earth.

Isa 42:5, "Thus says the Almighty YHWH who created the heavens and stretched them out [*netah*], who spread out [*raka*] earth and what comes from it, who give breath to the people upon it and spirit to those who walk in it."

Isa 44:24, "Thus says YHWH your redeemer who formed you from the womb, I am YHWH who made everything, who spread out [*netah*] [the] heavens by Myself, who spread out [*raka*] the earth. Who was with Me?"

Another Hebrew word that relates to the verb *raka*, is its noun form *rakeeya*, Strong's number 7549. This word occurs 17 times: Gen 1:6; 1:7; 1:7; 1:7; 1:8; 1:14; 1:15; 1:17; 1:20; Ps 19:1; 150:1; Ezek 1:22; 1:23; 1:25; 1:26; 10:1; Dan 12:5. These contexts do not have sufficient detail to pinpoint the meaning of the word, so it should be inferred from its verb form *raka*, which means to spread out. The noun form should thus mean "disbursal". A disbursal is a spreading out. The KJV translates this word *rakeeya* "firmament", but most modern translations use the word "expanse". The first five places where this word occurs follow.

Gen 1:6, “And [the] Almighty said, let there be a **disbursal** [*rakeeya*] in [the] midst of the waters and let them separate waters from waters.

Gen 1:7, “And [the] Almighty made the **disbursal** and separated between the waters which [were] below [the] **disbursal** and between the waters that [were] above the **disbursal**, and it was so.

Gen 1:8, “And the Almighty called the **disbursal** heavens. And there was evening and there was morning, day two.”

From this we see that although *rakeeya* itself is not a carefully defined word, Gen 1:8 gives it the meaning *heavens*, which is clear from the following Scriptures.

II Sam 21:10 “birds of the heavens”.

Deut 1:10, “stars of the heavens”.

II Cor 12:2-4 speaks of the third heaven, which it calls paradise. Ps 11:4, “[the] throne of YHWH [is] in [the] heavens”.

When climatologists began to study the atmosphere, they sent up balloons inflated with helium (the least dense gas) carrying instruments to measure aspects of the atmosphere. As the balloons went higher, the atmosphere became less dense. The atmosphere is where the “birds of the heavens” fly (II Sam 21:10 above). The **disbursal** must include the atmosphere, which is the lowest heaven (Gen 1:8). The atmosphere is not dense at all, especially when one goes higher above sea level.

[6] Directions from the Center of the Earth

Ezek 5:5 “This says [the] Lord YHWH, ‘This [is] Jerusalem. I have set her in [the] center of the nations with countries round about her.’”

Ezek 38:10 “This says [the] Lord YHWH, ‘It shall come to pass on that day [that] things shall come upon your [= enemies of Israel’s] mind and you shall think an evil thought’,

Ezek 38:11 “and you shall say, ‘I will go up against [the] land of unwalled villages [= Israel]. I will go against those who are at rest [= Israel], that dwell safely, all of them dwelling without walls and having neither bars nor gates’

Ezek 38:12 “to take spoil and to seize prey, to turn your hand against [the former] desolate places that are inhabited [by Israel], and against [the] people who were gathered out of [the] nations [= Israel], who have obtained cattle and goods, who dwell upon [the] center of the earth.”

Above, Jerusalem is called the center of the nations in Ezek 5:5. Israel is called the center of the earth in Ezek 38:12. The reason for this is indicated in the following Scriptures.

Ps 135:21 “Blessed be YHWH from Zion, who dwells [in] Jerusalem. Praise Yah.”

Ps 132:13 “For YHWH has chosen in Zion. He has desired [it] for His dwelling place.

Ps 132:14 “This [is] My resting place forever. Here I will dwell, for I have desired it.”

Zech 12:2 “Pay-attention! I will make Jerusalem a cup of drunkenness to all the peoples round-about when they lay siege against Judah and against Jerusalem.

Zech 12:3 “And on that day I will make Jerusalem a heavy stone for all the peoples. All who lift it will be severely wounded. All [the] nations of the earth shall come together against it.”

Isa 2:1 “The word that Isaiah, son of Amoz, saw concerning Judah and Jerusalem.

Isa 2:2 “It shall come to pass in the latter days [the] mountain of [the] house of YHWH shall be established as [the] head of the mountains and it shall be raised above [the] hills and all of the nations shall flow to it.

Isa 2:3 “And many peoples shall come and say, ‘Let us go up to [the] mountain of YHWH, to [the] house of [the] Almighty of Jacob that He may teach us His ways and that we may walk in His paths’, for [the] law will go forth out of Zion and [the] Word of YHWH from Jerusalem.”

This shows that the use of the word “center” in Ezek 5:5 and 38:12 relates to the dwelling place of YHWH, the place of the major prophetic end-time battle, the seat of world government of the future, and the seat of Israel’s government in the past. When biblical directions are mentioned, they emanate from the location of Jerusalem because that is the geographical focal point of Scripture. All four directions are mentioned in relation to the direction of travel of the sun with Israel or Jerusalem at the center.

Josh 12:1 “Now these [are the] kings of the land whom [the] children of Israel defeated, whose lands they acquired across the Jordan [River]toward [the] rising-place [4217 *meezrach*] of the sun from [the] valley of Arnon through-to Mount Hermon with all the Arabah eastward [4217 *meezrach*].”

The next two verses both refer to the Mediterranean Sea as the Great Sea, one verse calling it the western boundary and the other verse calling it the direction of the going-away of the sun.

Num 34:6 “Now your border [at the] west [3220 *yam*] shall be the Great Sea, and this border shall be your border [at the] west [3220 *yam*].”

Josh 23:4 “Notice! I have divided to you those nations that remain for an inheritance for your tribes from the Jordan [River] with all the nations that I have cut off to the Great Sea toward the going-away of the sun.”

Collectively the above three verses show that the sun rises in the east and goes away in the west. The directions of north and south are known from the cold compared to the heat in the following two verses.

Luke 12:55 “And when a south wind [is] blowing, you say that there will be heat; and it occurs.”

Job 37:9 “From the south comes the storm, and from [the] north comes [the] cold.”

When I spent ten weeks in Australia, having come there by jet plane from South Carolina, I experienced that when it was summer in South Carolina, it was winter in Australia. I spent seven weeks in Sydney and three weeks in Melbourne. While in Australia, I traveled from Sydney further south to Melbourne and it was colder. This is the opposite of the direction of cold and heat in Luke 12:55 and Job 37:9. This shows that directions for hot and cold from Israel is opposite to directions for hot and cold in Australia. This indicates that biblical directions are based upon Israel as the center. More will soon be said about biblical directions.

[7] The Earth is called a Circle

Isa 40:21 “Have you not known? Have you not heard? Has it not been told to you from [the] beginning? Have you not understood from [the] foundations of the earth?

Isa 40:22 “[It is] He [who] sits upon [the] circle [2329 *choog*] of the earth. And [its] dwellers [are] as grasshoppers. Who spreads out [the] heavens as a curtain and draws them as a tent to dwell in?”

Prov 8:27 “In His establishing [the] heavens I [was] there; in His engraving a circle [2329 *choog*] upon the face [6440 pnay] of [the] abyss [8415 *thom*].”

In Prov 8:27 the word “face” is the same word as a person’s face, and its meaning is flexible depending on the context. The Hebrew word for “abyss” also appears in Gen 1:2, “And the earth was / became without form and void and darkness [was / became] upon [the] face [6440 pnay] of [the] abyss [8415 *thom*] and [the] spirit of [the] Almighty was moving over [the] face [6440 pnay] of the waters.” There is no need to attempt to force the flexible word “face” to have the same meaning in all contexts. The word “abyss” is often translated “deep”, which does not tell us much.

In both contexts above (Proverbs and Isaiah), the same Hebrew word for circle is used, and it would appear that both are referring to the earth as a circle. Further discussion will have to decide the question of whether this is referring to a flat circle or an approximately round sphere.

The same Hebrew word *choog* is used in Job 22:14. In this context Eliphaz is responding to Job who keeps declaring his own innocence. Here Eliphaz continues to assume that

Job has committed some significant sin and mocks Job by pretending that YHWH is not capable of seeing Job as Job really is. Hence in this verse Eliphaz says that YHWH cannot see Job through the thick clouds that cover YHWH's view.

Job 22:14 "Thick clouds [are] a covering for Him [= YHWH] so He cannot see [Job], and He walks above the volume [2329 *choog*] of [the] heavens."

Gen 1:26 mentions the "birds of the heavens", so that the heavens occupy a volume or region or vault. Here the Hebrew word *choog* is descriptive of the heavens as occupying some volume. From this use of *choog* it cannot be asserted that *choog* **must** mean that the earth is a flat circle. It takes more reasoning to clarify this.

[8] The Sun's Yearly Walk going South and Turning North, from King Solomon

Ecclesiastes mentions the sun [8121 *shemesh*] more than any other book of the Bible - 35 times! Eccl 1:1 shows that its author is Solomon, and I Ki 3:12 shows that he was given the wisest mind among humans. Here he makes a profound statement about the sun that is typically mistranslated because most translators do not understand it. This statement gets specific about the sun's motion as seen from the earth, but the profound nature of this is only noticed if care is taken to preserve the Hebrew word order and if the translator exercises effort to allow the Hebrew to make sense!

Eccl 1:5-6 [MEV] "The sun comes up and the sun goes down, and hurries to the place where it rises. It [the sun] moves to the south, and then moves around to the north; the wind continually travels around, and keeps turning on its circuit."

A literal translation of Eccl 1:5-6 with special attention to keeping the word order the same as it is in the Hebrew text is:

Eccl 1:5, "And rises the sun and goes-away the sun and to its place it pants, rising it there [again].

Eccl 1:6A, It [the sun] goes toward south and turns around toward north.

Eccl 1:6B, Turns around, turns around goes the wind, and on its circuits returns the wind."

Page 55 of Zlotowitz translates Eccl 1:5-6, "And the sun rises and the sun sets - then to its place it rushes; there is rises again. It goes toward the south and veers toward the north; the wind goes round and round, and on its rounds the wind returns."

During the years 391-405 CE Jerome translated the Old Testament from Hebrew to Latin, which, except for the Psalms, became the Latin Vulgate. Page 307 of Japhet gives the following careful translation from Jerome's Vulgate for Eccl 1:5-6, (additions in square brackets are made by Japhet), "The sun rises and [the sun] sets and returns to its place. It rises there, goes to the south and turns about to the north. As it circles the world

around goes the spirit, and upon its circuit returns [the spirit].” Jerome made this rhyme in the Latin.

In general I never use the Septuagint translation (abbreviated LXX) as a means of understanding some seldom used Hebrew words or difficult passages of the Hebrew Bible because it often shows mere guesses for the Greek translation, so it is not reliable as an ancient indicator of the meaning of the Hebrew Bible. With proper care there can be some instances in which the LXX may resolve an ambiguity. Among all of the books of the LXX, Ecclesiastes stands apart in a special way. Page 7 of Seow reveals, “The translation technique of LXX Ecclesiastes is unique among the books in the Bible, so that one may say with a reasonable amount of certainty that the translator is not the same as for any other books. The translation shows a number of features that are typical of the works of Aquila of Pontus, a second-century (CE) gentile convert to Judaism. Aquila, a pupil of the famous Rabbi Aqiba is best known for his translation of the Hebrew Bible into literalistic Greek [about 130 CE], among other reasons, to provide Jews who spoke Greek but did not read Hebrew or Aramaic with a translation that would reflect the Hebrew as much as possible. Thus, the Hebrew word order is rigidly adhered to and all details in Hebrew are represented, even when they seem awkward or even nonsensical in Greek.”

While scholars debate whether Aquila was the translator of Ecclesiastes in the LXX, we do know that the LXX for Ecclesiastes is literal and sticks very closely to the Hebrew. The commonly available translation of the LXX by Brenton translates Eccl 1:5-6, “And the sun arises, and the sun goes down and draws toward its place; arising there it proceeds southward, and goes round toward the north. The wind goes round and round, and the wind returns to its circuits.” This translation reflects the fact that the word for “wind” does not occur in the Greek until after the word for “north”. In fact, the Greek word order after “north” is “round round courses the wind”, so Brenton's translation does put “wind” earlier in the verse than the Greek indicates. The Greek word *pneuma*, Strong's number 4151, is used for wind, which is the translation of the Hebrew word *ruach*, Strong's number 7307. Page 300 of Japhet translates the LXX more literally, “And the sun rises and the sun sets and draws to its place. It rises there, goes to the south and turns about to the north. Turns about, turning goes the *ruach* (*pneuma*), and upon its circuit returns the *ruach* (*pneuma*).” In footnote 31 on page 301 Japhet remarks, “This faithfulness to the MT [Massoretic Text of the Hebrew] is particularly striking when it creates forms which are awkward in the Greek.”

Pages 298-299 of Japhet point out that Rashi, the well known Jewish commentator of the late middle ages, also treats the sun as the subject in Eccl 1:6.

The Syriac language is an offshoot of first century Aramaic and is thus a Semitic language that has affinities to Hebrew. The Syriac Peshitta is a translation from the

Hebrew Bible that was made about 200 CE. The Peshitta in its literal word order, is in agreement with the Hebrew text of Eccl 1:5-6 in continuing with the sun as the subject of Eccl 1:6A. However, George M. Lamsa's English translation from the Syriac Peshitta departs from the literal view and translates it as if the wind were the subject at the beginning of verse 6. Lamsa often departs from the Syriac to agree with the KJV. Lamsa's translation is not reliable in representing the Syriac Peshitta.

Page xi of Sternberg translates Eccl 1:5-6A, "The sun rises and the sun sets and hastens to its place and rises there. It walks to the south and returns to the north."

In Sternberg's above translation the word "walks" comes from the Hebrew word *halach*, Strong's number 1980, which is typically used in reference to people walking, yet it is used in other ways for the movement of inanimate objects. However, from the viewpoint of an observer on earth, the position of the sun at sunset from day to day does change in distinct increments as a "walk", and the position of the shadow cast by a narrow object at noontime from day to day also changes in distinct increments as a "walk". These changes do form a south-north yearly cycle as will now be explained.

[9] The South - North Yearly Cycle indicated in Eccl 1:6A

A person who views sunsets daily from the same place at which there is a clear view of the horizon might notice that the sun does not set at the same part of the horizon each day. He might think of performing the following experiment to determine the daily change in the position of the sun at sunset.

Permanently place a straight board with its top long edge even with the western horizon as it would be seen from several feet away from the middle of the board. Also place an object with a sighting point so that the middle of the board is several feet from the sighting point. Each day near sunset make a mark on the board where the board crosses the line of sight from the sighting point to the middle of the sun. For accuracy this should be done when the center of the sun is at the horizon.

If this is done from anywhere in the north temperate zone, for example Jerusalem, during the coldest part of the year, the daily marks on the board keep going north (to the right). During the hottest part of the year the daily marks on the board keep going south (to the left). For several days while the temperature is beginning to get hot, the marks will be at about the spot that is the furthest right (north) of the marks. These marks will be very close together on the board. The middle day of this group is the day of the summer solstice. For several days while the temperature is beginning to get cold, the marks will be at about the spot that is the furthest left (south) of the marks. These marks will be very close together on the board. The middle day of this group is the day of the winter solstice. The word "solstice" means "stopping of the sun" which describes the state of the marks at the solstices. At all other times of the year the marks are well

separated from one another while heading north, or well separated from one another while heading south.

The marks on the board are furthest from one another at the midpoint between the solstice marks because the south-north motion of the sun is fastest at these points. The mark closest to the midpoint while the marks are heading north is the mark at the vernal equinox. The mark closest to the midpoint while the marks are heading south is the mark at the autumnal equinox. Although this method determines the equinoxes quite precisely by first knowing the solstices, it is not necessary to know the day of the solstices precisely because the marks barely change for several days about a solstice. Page xii of Sternberg is one of several sources that discusses this.

Eccl 1:6A is a description of the daily walking of the sun at the horizon when beginning at the far north and heading south, and later turning around and heading north. A knowledge of this cycle shows that the endpoints are distinctive, and these are the solstices. The midpoints are also distinctive, and these are the equinoxes. Thus Eccl 1:6A shows an awareness of the four seasons: summer, fall, winter, spring.

[10] The Collection of Paths of the Sun during the Daytime through the Year

When a total of 366 marks is made on the board in the above experiment, then a complete cycle will be made for one year, based on a year composed of about 365.25 days. It is damaging to the eye to look at the sun in the sky during the daytime, except near sunset. However, the sun's path in the sky may be judged by looking at the sun's shadow as cast by the upper tip of a vertical object fixed in the ground. There will be a most northern path of the sun at the summer solstice and a most southern path of the sun at the winter solstice. If we avoid looking at the sun during the daytime to protect our eyes, then we mentally think of the sun as being in a tent into which we choose not to look directly.

The collection of all these paths of the sun in the sky during one year of 366 days forms a wide band in the sky that may be described as a tent in the sky.

The sun must remain in its annual tent in the sky, and the observer does not want to look directly within the tent to preserve the health of his eyes. This relates to a literal translation of Ps 19:4-6 when it is understood as describing this annual tent for the sun in the sky. This concept of the annual tent is especially noted from verse 6 where the Hebrew word *tkufah* (Strong's number 8622) appears. All four places in the Hebrew Bible where *tkufah* appears may be consistently and meaningfully translated as one of the four seasons of summer, autumn, winter, or spring, although in one of the four places the word *tkufah* occurs in the plural and refers to two seasons. Verse 6 describes the season of heat, which begins with the summer solstice, and thus relates to the *tkufah* here as the summer-season. It is the use of *tkufah* for the summer season in verse 6 that

makes the context the tent of all the paths of the sun. This is not speaking of a single day, just as Eccl 1:6A is not speaking of a single day.

The fact that the sun is responsible for the heat during the daytime is recognized in Ex 16:21; I Sam 11:9; Neh 7:3; Jonah 4:8. The end of Ps 19:6 states “nothing is covered from its [the sun's] heat”.

Ps 19:4, “Their [= the heavenly bodies] trail has gone through all the earth, and into [the] end [7097 *katseh* BDB p. 892 left middle] of [the] world. Their-decrees [4405 *meelah* BDB p. 576 left bottom] for [the] sun have established a tent [= boundaries of travel during the course of a full year] in them [= in the decrees].

Ps 19:5, And he [= the sun] goes out from his chamber as a bridegroom. He rejoices like a mighty [man] to run its path [734 *orach* BDB p. 73 left middle].

Ps 19:6, He [= the sun] goes forth [4161 *motsa* BDB p. 425 right middle] from [the] end [7097 *katseh* BDB p. 892 left middle] of the heavens and his summer-season [8622 *tkufah* BDB p. 880 right bottom] in-accordance-with [the] ends-of-them [7098 *katsah* BDB p. 892 right top], and nothing is covered from its heat.”

In verse 6 above “the end of the heavens” is a reference to the sun’s most northern path at the summer solstice. The most northern path of this tent (in verse 4) is called the Tropic of Cancer. The most southern path of this tent is called the Tropic of Capricorn.

To satisfy the reader’s curiosity about the other three places where *tkufah* occurs, the following are shown.

II Chr 24:23, “And it came to be during [the] spring-season [= *tkufah*] of the year [the] army of Aram marched against him.”

I Sam 1:20, “And it came to be at-the-close-of [two] full seasons [= *tkufah* in the plural] Hannah conceived, and she gave birth to a son.”

Ex 34:22 is, “And you shall observe [the] Feast of Weeks, [the] firstfruits of [the] harvest of wheat, and [the] Feast of the Ingathering [during the] autumn-season [= *tkufah*] of the year.”

The understanding of Eccl 1:6A along with the four uses of *tkufah* show an awareness of the four seasons and how the annual rain pattern and agricultural pattern match up with these seasons. The astronomical forces that relate the heavenly bodies to the annual repetitive pattern of the four seasons is not described in the Bible, and this was left for humanity to discover.

[11] The Sun, Moon, and Stars show a difference between Daytime and Night

Jer 31:35, “Thus says YHWH who gives [the] sun for a light [216 *ohr*] by day [and the] ordinances [2708 chookah] of [the] moon and stars for a light [216 *ohr*] [by] night, who

moves [the] sea so that its waves roar. YHWH of hosts [is] His name."

Here we note the phrase *sun for a light by day*, so that the Bible teaches that the sun is the source of light in the daytime. Isa 60:19 also shows that the sun is a light by day.

Ps 136:7, "To Him who made the great lights [216 *ohr*] ..."

Ps 136:8, "The sun to rule in [the] daytime ..."

Ps 136:9, "The moon and the stars to rule in [the] night ..."

[12] At one moment there is Daytime in one place while it is Night elsewhere

The context of Luke 17 below is seen in the following verse.

Mat 24:3 "What [is] the sign of Your coming and the end of the age?"

Luke 17:31 "In that day [he] who will be on the housetop, let him not come down to take his goods [from] the house. And likewise, he in the field, let him not turn back to the things behind.

Luke 17:32 "Remember Lot's wife.

Luke 17:33 "Whoever seeks to save his life, [he] will lose it. And whoever will lose it, he will preserve it.

Luke 17:34 "I say to you, In that night two will be on one bed; the one will be taken and the other will be left.

Luke 17:35 "Two will be grinding together; the one will be taken and the other will be left.

Luke 17:36 "Two will be in the field; the one will be taken and the other will be left."

The above description shows that for some people it will be daytime and for others it will be night. Hence the sun will be seen for some people but it will be absent for others.

[13] The Invention of the Compass and the North and South Poles of the Earth

As a child I played with a toy compass and magnets. I accepted from personal experience that these showed a reality. When a magnet is placed next to a compass, the compass points to one pole of the magnet.

The compass is a very simple mechanical device having an iron bar that is allowed to float in a liquid with a support in the middle so that it may be seen to maintain a specific direction if it is moved (assuming that there is no magnet nearby). One of the sides of the iron bar will always be pointed in the direction of north because of its attraction by the magnetic north pole of the earth. Although it is now known that the magnetic north pole of the earth is not exactly at the true north pole, it is close to it. Hence for all

practical purposes the use of a compass shows the direction of north. Once the direction of north is known, the other directions of east, west, and south are known.

A compass is an example of an iron bar that is attracted to a magnet, where the magnet is the earth. Every magnet has a north pole and a south pole. The function of a compass depends upon the earth acting as a magnet, thus having a north pole and a south pole. Therefore, the practical use of a compass demonstrates the existence of a north magnetic pole and a south magnetic pole of the earth.

The compass was invented in ancient China, but it was not made known to the rest of the world at that time. In Europe the compass was discovered c. 1280, and its use was eventually applied to travel by ship on the oceans. Trade was very profitable and this motivated shipping on the oceans. Without the compass, the direction of travel by ship on the oceans was approximately possible during the daytime by looking at the position of the sun, but at night is was only possible if and when the stars could be seen. World shipping was very greatly enhanced after the compass was used on ships so that a steering wheel could alter the rudder and thus keep the direction of the ship as desired according to the compass.

[14] Ships going around the World

Page 115 of Barnett states, “Amerigo Vespucci discovered South America in 1499, Balboa sailed into the Pacific Ocean in 1513; and in 1522, just three decades after Columbus’ journey, the survivors of Magellan’s great voyage had made it around the world.” Ship travel around the world demonstrated that by traveling west by ship, eventually the ship will return to where it had been when it began.

[15] Time Zones and Phone calls

As described above in Psalm 19, the sun’s tent shows all its annual paths to be within the tropic zones of the earth. When going into Canada in the north or oppositely into Argentina in the south, the temperature is colder. Since the sun is responsible for the heat, the rays of light-heat from the sun must be less intense to the regions of the earth when going far north and far south. At the equinoxes the sun’s path is going exactly east-west, and this east-west direction shows perfect agreement with one wall of the three greatest pyramids in Egypt.

Ancient people did not have clocks that were accurate enough to determine a day at which daytime and night were equal in length of time, so this test could not have been the ancient meaning of equinox regardless of the Latin meaning of the word equinox. Assume that you are in an area that is level on the ground and there are no nearby tall objects. If an upright pole is placed in the ground so that it cannot move, then during the daytime, the shadow of the top of the pole will touch the ground at some point. From a few hours before noon through a few hours after noon, the shadow of the tip of the pole

will show a path on the ground. This path will be a straight line only on the two days of the year that are equinoxes. On those days the line will show the exact east-west direction.

During the equinoxes during the daytime, if perpendicular lines to the sun's path are drawn on the earth, they will show the true north-south direction on the earth. This north-south direction (called lines of longitude on maps) has been separated into 24 equal intervals for the 24 hours of the sundown-to-sundown day. Each interval is 15 degrees of the 360 degree circle.

John 11:9, "Are there not 12 hours in the daytime." But without accurate clocks in ancient times, these were not exactly 12 equal time intervals. In modern times, each of these 24 intervals of longitude is called a time zone. If the line of a time zone goes through a very populated area of the earth, then sometimes it is artificially moved to wiggle around a populated area to avoid inconvenience.

The goal of time zones is that the time of day on the clock indicates the approximate condition within daylight or night in different places on the earth. For example, 6:00 am is the time at which most people wake up in the morning regardless of where they live, unless they have a non-typical workday.

When I took a plane trip from South Carolina to Australia for a business trip of ten weeks, I had occasions to speak over the phone with company management in South Carolina. It was night for them when it was daytime for me. The time zones for them corroborated the observed difference in night compared to daytime.

For more than six months in the year 2017 I had business phone calls at least once each week with a coworker from India. Some of our typical phone conversation corroborated the condition of night in India compared to daytime in my location in Oklahoma that was harmonious with our respective time zones.

Time zones and long distance phone calls prove that there is a gradual uniform shift in when the sun sets in different parts of the world. This is corroborated by travel via ship and airplane. I have flown across the Atlantic Ocean from New York to Germany as well as from Pennsylvania to Scotland. I have also flown across the Pacific Ocean from South Carolina to Australia.

On the first day of the seventh biblical month in the year 2017, a personal friend named Tony Suckla was in India on the phone with another friend named Roeben Shalom who was in Texas. Tony told Roeben that he was seeing the sun rise in the east in the morning while Roeben was seeing the sun setting in the west toward the evening. They were looking at the same sun at the same time, but about 12 hours apart in their time zones. They were looking at the moon from opposite parts of the earth where it was early morning for one person and early evening for the other person.

From the use of time zones, the earth is obviously connected all around in the approximate east-west direction of the sun's apparent movement as seen from the earth. The only way to explain the uniformity of time zones with a gradually changing sunset that is corroborated by phone calls is to accept the concept that the earth is approximately a sphere rather than a flat circle.

[16] Making World Maps on a Flat Surface

Here is a repeat from one paragraph of the last chapter. During the equinoxes during the daytime, if perpendicular lines to the sun's east-west path are drawn on the earth, they will show the true north-south direction on the earth. These north-south direction lines are called lines of longitude and are shown on maps. These lines of longitude have been separated into 24 equal intervals for the 24 hours of the day. Each interval is 15 degrees of the 360 degree circle (24 x 15 = 360).

Lines that are perpendicular to the lines of longitude are called lines of latitude and are seen on maps. The lines of latitude show east-west. Maps are most often drawn so that east is shown to the right and north is shown upwards. This convention of direction in flat maps was first well documented by Ptolemy c. 150 CE in his book *Geograpgy* (Wilford 2000 pp, 31-38). Ptolemy was not aware of North America and South America, so this was absent in his map of the world, which had considerable inaccuracies due to his limited knowledge. Ptolemy did give some credit to the Greek astronomer Hipparchus who lived 300 years before him for both astronomy and cartography (= the science of making maps). Both of these Greeks followed in the footsteps of Aristotle in accepting the spherical nature of the earth. Ptolemy drew his world map in an oval manner in recognition of his understanding that the earth is spherical.

When world maps are made, it is typical to see lines of latitude and of longitude on the world map. The most typical world map shows a giant rectangle with lines of longitude to be vertical straight lines, and lines of latitude to be horizontal straight lines. There is a problem with this type of map. One desirable goal of any map is to draw it so that one inch in one place represents the same distance as one inch in another place. This may be called proportional accuracy in distances.

When surveying instruments were invented to accurately measure distances, this worked well to depict proportional accuracy for local maps that were flat, but when the whole earth was mapped, such a scheme of parallel straight lines prevented proportional accuracy. The north pole is a single point on the earth, and all lines of longitude slowly converge to that same point while traveling north. The lines of longitude get closer toward one another in true distance as they approach the north pole. In order for lines of longitude to be drawn on a flat map with straight vertical lines of longitude, these lines cannot come closer together, so it must distort proportional accuracy in distances.

In other words, a flat map of the whole earth cannot preserve proportional accuracy in distances. This is another way of showing that the world cannot be flat.

[17] The Pendulum of Leon Foucault in 1851

This is the first of several chapters that will discuss the subject of whether the earth rotates about an axis, and it will introduce the subject.

Mal 1:11, "For from the rising of [the] sun and until its entrance, My name [is] great among [the] nations, and in every place incense is being offered to My name and a clean offering, for My name [is] great among them says YHWH of hosts."

This certainly appears to literally describe an upward movement of the sun, and the question is whether this is the only way to understand this and other similar Scriptures. If one understands this as simply showing what a person on the earth sees with his eyes, then it does not necessarily have to be understood this way. Outward appearance does not necessarily show what is real. For example, the physical relationship between two objects that appear to be getting closer to one another depends upon what is moving and what is still. Perhaps the most natural way to take Mal 1:11 is in a literal way that would indicate the movement of the sun rather than the earth, but this remains to be discussed. To some extent it depends upon what a person knows and what evidence a person has based upon what one knows.

Before discussing the matter in the title of this chapter, it seems worthwhile to discuss the reason that astronomers view this issue in a different way than layman who are not familiar with astronomy.

Astronomers who observe heavenly bodies in the sky with a telescope have a different kind of experience than others who do not. By looking at details of the planets Mercury and Venus over a long period of nights, one sees evidence from certain distinctive features that cause one to accept what his eyes see, namely that Mercury and Venus rotate about an axis., and that these planets appear to be moving around the sun rather than around the earth.

If Mercury and Venus are moving around the sun, then why not the earth also? If Mercury and Venus are rotating about an axis, then why not the earth also? This is only an attempt to reason by analogy, but it is not evidence. Astronomers who observed the heavens with a telescope, had a strong intuition that the sun is much more massive than the earth, and it is expected that they should ask themselves whether it is more sensible to think that the least weighty body is encircling the greater, or vice versa. This is an attempt to reason by intuition, but is not real evidence.

Matters changed a great deal when Isaac Newton (1642-1727) provided a mathematical relationship of three laws of motion and a mathematical description of gravity, both of

which enabled a very accurate prediction of the location in the sky of heavenly bodies that could be observed with a telescope. Following in the footsteps of Newton, Pierre LaPlace (1749-1827) gave a full presentation for mathematically expressing the orbits of heavenly bodies and related astronomy called celestial mechanics.

Building upon the foundation laid by Newton and then by LaPlace, astronomers who used telescopes became convinced that the earth rotated about an axis. From Carter and Carter 2002 p. 36, LaPlace made the statement, “all of astronomy … depends upon the invariability of the earth’s axis of rotation upon the terrestrial spheroid [earth] and upon uniformity of this rotation.” Actually, as we shall see in a chapter below, this is an exaggeration that LaPlace did not have the ability to fully understand in his day.

The above was not written to attempt to coerce the reader into accepting the idea that the earth rotates about an axis, but rather to avoid being mentally dogmatic before evidence is brought to bear on the matter. Now to the subject of this chapter.

The pendulum clock was invented by Christiaan Huygens in 1656 and one year later he and an assistant built the first one. About 1660, grandfather clocks based upon the pendulum became popular because of their accuracy and dependability (Barnett 1998 p. 103).

It is strange that it was not until 1851 that the talented French inventor and machinist Leon Foucault conceived of and demonstrated to a distinguished audience of mathematicians and scientists in Paris that the earth rotates on its axis using a special kind of pendulum that he invented for this specific purpose.

In a grandfather clock the pendulum is forced to swing in one plane that is not permitted to change. Contrary to this, Foucault’s pendulum was designed to freely swing at its point of swinging with minimal friction. The goal of its construction was to allow it to swing its its initial plane so that its plane would remain unaffected by anything outside of itself. Foucault’s pendulum had a steel wire that was over 34 feet long (Aczel 2003 p. 91)) and a ball that was 28 kg (Tobin 2003 p. 147, over 61 pounds). It began its movement with a long swing and minimal friction so that it could continue swinging for a relatively long time. To prevent any initial wobble of the pendulum, it was stationary and suspended by a string so it could not move until the signal to begin. When the time arrived for it to begin swinging, a match was lit upon the string so that it did not wobble due to human touch. At the bottom of the weighty swinging bob there was an attached steel stylus just long enough to make a small indentation across wet sand as it reached its low point, so that the lines in the sand could be seen to shift in angle over time. The shifting angle would demonstrate that the earth was turning while the slowly swinging pendulum was remaining in its original plane due to almost no friction and the lengthy wire and heavy ball.

The original demonstration by Foucault before a crowd of mathematicians and scientists was in Paris on February 3, 1851 at the famous Paris Observatory. People were invited to witness the experiment for one hour starting at 2:00 pm. He knew that the pendulum would gradually stop due to gravitation, but one hour would be sufficient for the experiment with little slowing due to the long wire and the heavy ball. During the prior month Foucault had already tested the concept on a smaller less dramatic scale in his own basement so that he had confidence it would succeed and he would not be embarrassed before the distinguished audience. He had previously assisted physicists in Paris in making machines for their experiments. They already knew of his skills as a machinist, but he had no advanced degree and was not recognized as a scientist. The audience was able to witness the increasing changing angle in the sand as the time progressed. They immediately recognized the demonstration of the rotation of the earth as seen below the pendulum.

Tobin 2003 pp. 148-149 states, "By early June [1851] a pendulum was under trial in the Radcliffe Library in Oxford. Others swung in Bristol, Dublin, Liverpool and York. In France pendulums were set up in Rennes and in the cathedral in the royal city of Rheims, while others were erected in Rome by the Vatican astronomer Father Angelo Secchi, in Geneva by some of de la Rive's colleagues, in Cologne, in Florence, in Ghent, in Brussels, in Colombo, in Rio de Janeiro and doubtless in many other places. Pendulum mania even extended to the United States, where the experiment was repeated in at least twenty five cities and towns during the summer of 1851 (Fig. 9.18)."

Thus the original experiment was repeated in many places in 1851 with no claims of a hoax.

[18] The Time length of the 24-hour Day is Increasing

In the U. S. Navel Observatory in Washington D. C. there is an atomic cesium clock that keeps very accurate time, even down to one-millionth of a second. It is electronically connected to a similar clock in Paris. The time difference between communication of these two clocks is so accurate that it can measure the very minor continental drift of the Atlantic Ocean between the two continents. I once visited this clock and was given a tour. This clock and a few others like it in the world enable the sensing of very tiny increases in the length of the 24-hour day of the earth!

On p. 460 of Bell 2019, we note, “Atomic clocks began to be used in the 1950s and 1960s to precisely reckon the passing of time, using the frequency of stable atomic-energy-level transitions in elements such as cesium.”

What causes the tiny increase in the length of the day? One major cause is the gravitational force of the moon upon oceans ***against*** the land at the shores and the land

region that is under the water! How? The tug against the land is slowing the earth in its ***rotation*** upon its axis!

On p. 450 of Bell we, see, “In the 26 years from 1972 to 1998, 22 leap seconds were added to keep UTC time in sync with the Earth’s slowing spin. In the 20 years since 1999, however, the rate of slowing of Earth’s spin has decreased, and only five leap seconds have had to be added.”

The molten inner core of the earth is gradually shifting in unknown ways against the outer solid mantel of the earth, and the gravitational force of the moon upon the molten core ***against*** the mantel varies. This causes the variation in the rate of rotation of the earth to be unpredictable.

The technical term for the difference in time due to a slowing of the earth’s rotation is named “Delta T” (= change in time). One clever method for Delta T to be estimated from the time of recorded eclipses until today is to take the average in the recorded time of eclipses during an interval of years and mathematically determine the value of Delta T that would be needed to make the astronomical observations agree with the known theory. Without using Delta T, the calculations would be very close to a perfect match, but with the use of Delta T in the calculations, the match is much more in agreement. In summary, ancient eclipse records help to estimate the value of Delta T through time back to c. 750 BCE.

The accurate measuring of time along with the knowledge of ancient eclipse records with the application of the mathematical principles of astronomy is certainly a corroboration of the rotation of the earth because it provides a physical reason for Delta T through the moon’s gravitational force tugging the oceans and the earth’s molten core.

[19] Communication Satellites and the Dishes on the Ground

Today there are many thousands of adjusted and aimed dishes on the ground at different facilities upon the earth so that each is aimed to continuously point to only one satellite (among many satellites) that are circling around the earth at the same rate at which the earth is rotating on its axis. How do we know this? It is because of the path (trajectory) of launching these satellites into orbit, and the laws set forth by Newton and LaPlace that are verified by telescopic observation and the reality of communication with dishes on the ground. The dishes can be seen, communication is seen to be established with equipment in the building near each dish, and many thousands of people will not pay for this unless it works. The totality of such satellites is referred to as a constellation, although the same word is used in reference to a star group that forms a pattern.

This makes it rare to ever have to adjust the dishes on the ground that receive the communication signals from the satellites. The whole theory of physics that puts these satellites into orbit is based upon the knowledge of the rotation of the earth and the

whole enterprise would be impossible if the earth would not rotate once per day. Certainly it is possible for a layman to deny the reasoning about this, but without education, how can it make sense to deny the reality or postulate a competing group of laws of motion that work differently, yet are verifiable by telescopic observation?

The communication satellite is launched so that at the start of its path it goes up vertically, but soon its path curves and settles at an altitude that makes the satellite's centrifugal force (to try to go out of its orbit) equal to the gravitational force to pull it to the earth. Hence each satellite achieves a stable orbit.

Thus the thousands of dishes on the ground are a witness to the whole theory of the physics that demonstrates the rotation of the earth by the launched satellites that communicate with these dishes.

Some early attempts by astronomers to demonstrate that the earth rotates failed to convince the public, either because of a logical flaw or because it was too difficult for the public to understand.

In 1610 Galileo, using his telescope, was able to demonstrate that the planets Mercury and Venus rotated about an axis. The logical flaw is that what happened to Mercury and Venus did not prove that the earth also rotated.

Aczel 2003 p. 42 states, "In 1729 [this is after the death of Newton in 1727], the astronomer James Bradley (1693-1762) found an annual aberration in the positions of fixed stars, which could [seemingly] only be explained scientifically by a rotating Earth in orbit around the sun. The observations involved parallax: a triangulation using measured angles to distant stars. These angles were slightly different in the summer from their values observed in winter, and the aberration had to be due to the fact that Earth was located at different positions along its course around the Sun at different times of the year." Another account of this discovery is in Liu pp. 162-163. Astronomers should not expect the public to be convinced by this because it requires a knowledge of concepts of advanced astronomical physics along with intuition that accompanies this knowledge.

[20] The Global Positioning System (GPS)

Today, while driving a car, people have the ability to use a cell phone to type in the address of a desired destination, and then listen to a voice give us directions as we drive in order to reach our destination. This is made possible by the constellation of satellites put into orbit around the earth as discussed above, as well as the Global Positioning System (GPS) technology that is partly on the ground in tracking stations that communicate with the satellites.

In Carter and Carter 2002 p.25, we note, "Over the past twenty plus years GPS has

evolved into a truly global ‘utility’ that provides position and navigation services to users in all nations.”

On p. 26 we note, “Satellites must be repositioned periodically by using onboard thrusters.”

On p. 28 we note, “The knowledge required to make GPS work well enough for scientific applications, or even to land an aircraft in zero visibility weather conditions, took scientists hundreds of years to learn, through a process once described by the thirteenth century English friar Roger Bacon as ‘winnowing the truth and the reason from what we see.’”

In other words, the theory that makes GPS work, which people in the U. S. have become accustomed to without knowing the technology that makes it work, is itself proved by the use of instruments and observations that verify it all. The rotation of the earth is part of the package that makes it work. The GPS is a witness to it.

[21] Temperate Zone Winds and Typical Ocean Tides

In 2010 and 2011 I went on business trips to Edmonton, Alberta, Canada. I learned that temperature in Edmonton in the coldest parts of the winter gets down to between -30 and -40 degrees F. When I looked on a map of the world, I discovered that Edmonton was at the same latitude as London, England. I marveled at this because I knew that London never got that cold. It was the northeastern winds from the Atlantic Ocean that made London much warmer than Edmonton. It was instructive to learn what caused the northeastern winds from the Atlantic Ocean to behave as they did. This is part of the subject called oceanography. Pages from Sverdrup and Duxbury 2005 are referenced below.

Heat on the earth is largely determined by the following three (from p.192), “(1) seasonal changes in Earth’s surface temperature due to solar heating, (2) the addition of the large continental land blocks, and (3) the difference in heat capacity of land and water.”

The third factor is then elaborated on p. 192, “Both ocean and land surface remain warm at the equatorial latitudes and cold at the polar latitudes all through thee year, but the middle latitudes have seasonal temperature changes, ranging from warm in summer to cold in winter. Keep in mind that land surface temperatures have a greater seasonal fluctuation than ocean surface temperatures because the heat capacity of the ocean water is greater than the heat capacity of land and because ocean water has the ability to transfer heat from the surface to depth in summer and from depth to the surface in winter. Land does not transfer heat in this way.”

The above loosely says that in temperate zones oceans can store heat in the summer for

later release in the winter. This does point out one difference between Edmonton and London. Edmonton is surrounded by land for a long distance, while London has the Atlantic Ocean to its west. Wind into Edmonton ***will not*** carry heat in the winter. Wind into London ***going northeast*** over the Atlantic Ocean ***will*** carry heat in the winter. Why will wind from the Atlantic Ocean blow ***northeast*** into London? That is the next goal to explain. The discussion will only focus on the northern hemisphere because our goal is to explain the difference between the temperature of Edmonton compared to London during winter as an illustration to keep this chapter relatively brief. A more complete discussion for both hemispheres with greater detail appears on pp. 188-196.

Speed equals distance traveled per hour. The distance all around the earth at the equator is 24,960 miles, and it takes 24 hours for the earth to rotate one time. Hence the earth's speed of rotation at the equator is 24,960 divided by 24 = 1040 miles per hour. However, at each latitude away from the equator going north, the distance around the earth decreases because of the approximate spherical shape of the earth (circumference of a circle = 3.14159 x diameter, where the Greek letter pi is used for that number). Due to the earth's rotation, the eastward speed of the earth's surface is greatest at the equator (1040 miles per hour), and this speed decreases while going to latitudes closer to the North Pole or South Pole. Latitude is measured in degrees north or degrees south. The North Pole is at 90 degrees north, and the South Pole is at 90 degrees south. The following chart that provides some figures from the northern hemisphere only, is taken from page 188.

On p. 191 we note, "Wind belts are formed when air flows over Earth's surface from regions of higher atmospheric pressure to areas of lower atmospheric pressure."

The higher atmospheric pressure in the tropical zone causes air to flow north in the north temperate zone, and south in the south temperate zone.

Chart Showing Eastern speed of the Earth's Surface based upon Latitude

Latitude	Speed in kilometers per hour	Speed in miles per hour
90 degrees north (North Pole)	0	0
75 degrees north	433	269
60 degrees north	837	520
45 degrees north	1184	735
30 degrees north	1450	900
15 degrees north	1617	1004
0 degrees north (equator)	1674	1040

In the north temperate zone where the atmosphere blows north, then **because of the greater eastward speed of the wind from the south**, the wind will blow northeast instead of only north (relative to the earth's surface). This effect is due to the earth's rotation and its spherical shape as outlined in the above chart with speeds. The greater eastward speed of the wind from the south is referred to as centrifugal force on p. 189. The mathematics of this was first worked out by Gaspard Gustave de Cariolis (1792-1843) and is called the Cariolis effect after him.

This is an outline of the reason that the warm air blows northeast in the north temperate zone over the Atlantic Ocean that causes London to be kept warm in its winter.

The reasoning and the mathematics depend on the spherical nature of the earth and its rotation along with an understanding of centrifugal force.

Our attention is now turned to ocean tides.

On pp. 7-9 Cartwright 1999 reviews the earliest known history of writings about tides. The earliest is Seleucus of Babylon (c. 150 BCE) who was followed by the Greek Posidonius (135-51 BCE). Their own writings have not survived, but later writers have striven to quote from them. These quotations are difficult to understand except for the fact that both attribute influence of the moon as a major factor for the tides.

William Thomson traveled the world investigating and witnessing tides, and he published his book in 2017. On p. 2 he wrote, "When the peak of a wave passes a beach, it is high tide and the trough brings low tide. The height difference between peaks and troughs is known as the tidal range, and this can be anywhere between 52.5 feet (16 meters) in Canada's Bay of Fundy to less than 11.8 inches (30 centimeters) in the Mediterranean." On the same page, Thomson continues, "Although the tidal range is different from beach to beach, the element that powers the tide wave is universal. Differing gravitational forces around the world, exerted by the combined pull from the

moon and sun, cause the oceans to bulge into peaks and troughs. The rotation of the earth then powers the motion of these waves." On p. 4 Thomson wrote, "The most common tidal cycle around the world is called semidiurnal, with two highs and two lows in a lunar day. Unlike a solar day lasting 24 hours, a lunar day lasts for [about] 24 hours 50 minutes. The additional 50 minutes is a result of the simultaneous rotation of the earth and orbit of the moon." The moon's travel around the earth averages an advancement of about 50 minutes per 24-hours. He wrote, "This explains why, on average, there are 12 hours 25 minutes between high tides and 6 hours 12 ½ minutes between high and low." On p. 6 he wrote, "When the sun and moon are aligned with the earth (during full and new moons) the combined gravitational pull creates dramatic tides called springs. These have nothing at all to do with the season, but mean 'to spring forth with energy'."

[22] Polar Motion declared by Seth Chandler, Jr.

For about 150 years astronomers around the world were baffled by a mystery. A full account of the history of this mystery was presented in Carter and Carter 2002.

First some clarification of a term is needed. The earth's north pole is defined as the place on the surface of the earth in the north where the axis of the earth goes through that surface. Hence the translated meaning of the concept of "variation in latitude" is that the north pole does not remain in one exact location, but it varies. The phrase "polar motion" refers to the north pole and is an alternate way of speaking of the variation of the latitude. If the north pole shifts, then the latitude of a place on the earth shifts with it, because the latitude is determined by the angle from the north pole.

The mystery began during the years 1726-1742 when the British astronomer James Bradley (1693-1762) recorded the position of certain stars at multiple times (p.188). He discovered that the latitude for the same star seemed to vary rather than remain the same, although the variation was only small. The latitude was determined by measuring the angle from the observer's location to one distant star in the north using an astronomical instrument. The mystery was to discover the cause of this observed variation in latitude. On p.35 we note, "Over the next 150 years attempts to repeat Bradley's observations yielded inconsistent and confusing results." Some astronomers were attempting to look for a single periodic cycle of the north pole that would provide the solution to the mystery of the drifting latitude, but there was none. They were looking for a periodic cycle that physically considered the earth to be a solid mass, but ultimately this assumption proved to be false.

Three possible causes were proposed for the discrepancy (or variation) in the latitude that was observed by Bradley and others that tried to duplicate his work (pp. 35-36): (1) minor errors associated with the instrument used; (2) variations in atmospheric refraction; or (3) a true variation in latitude.

The computational history of the solution lies in its hero, Seth Carlo Chandler, Jr. (1846-1913) who never went to college, yet he submitted many astronomical papers that were published over many years. At the age of 15 he graduated from high school in Boston, and then began doing computations for the noted mathematician Benjamin Peirce. The computations were to simplify the results of astronomical observations using logarithms and trigonometry. After this he began doing similar work for the most noted astronomer in the U. S. at the time – Benjamin Gould. On p. 41 we note, "As Gould's aide, Chandler began to learn the mathematics, including spherical geometry and the least squares adjustment [for making accurate functions from several sample numbers], that were required to go beyond the cookbook procedures he had followed while working under Peirce." Chandler learned to use telescopes and other astronomical instruments as well as to write proper technical reports. Chandler never learned the astronomical theory upon which orbits were based, yet he learned how to accurately compute orbits from a small number of observations. He studied the design of astronomical instruments and eventually recognized how to simplify the designs and improve them while lowering the cost of manufacture. He designed two different astronomical instruments. The second, which he named the **almucantar**, was more important. In 1884 and 1885 he wrote journal articles explaining their design and how they worked. In 1885 Chandler published his first observational results using the almucantar in which he first suggested the existence of variation of latitude (p. 218), which was the solution to the mystery that lasted for 150 years.

The accurate transit instrument that was used for measuring the latitude of a star had a very large number of parts, many of which were expensive. The large number of parts made it very difficult to have confidence in the possible source of a small error that may have been caused by the instrument. The almucantar replaced this complex expensive instrument, having about one-tenth the number of parts and it was easier to use. Moreover, after a few minor adjustments, its construction gave Chandler great confidence in its lack of errors, and this was very critical for Chandler's great achievement in solving the mystery that had perplexed astronomers for about 150 years.

Chandler wrote about the almucantar (from p. 98), "I feel justified in claiming that in accuracy, efficiency and convenience, this construction, for moderate-sized instruments, is superior to the transit instrument, while it is very much cheaper."

On p. 107 we note, "In 1896 Chandler was awarded the gold medal of the Royal Astronomical Society of London for 'his discussion of the variation of latitude, his work on variable stars, and other astronomical investigations.'"

Some of the words of the president of the Royal Astronomical Society of London, A. A. Common, in presenting the award to Chandler, were (p. 198), "Remembering that the variation of latitude was not much more than suspected some five years ago [but to

Chandler eleven years ago], and that there was not even suspicion of the true law of variation (except, perhaps in the fertile brain of our medalist [= Chandler]), the proposition to now print such tables of prediction side by side with tables of the planets is somewhat startling. But a careful examination of Mr. Chandler's work forces upon us the conviction his confidence in it is justifiable … the close accordance of results derived from such a large number of independent sources is a guarantee of the accuracy of the law finally adopted."

When studying the numbers that were produced from Chandler's observations along with the observations of others, he eventually found that two separate periodic cycles taken together could produce the observations. He published this result in a paper on November 4, 1892 (p. 181).

Simon Newcomb (1835-1909) is the most acclaimed astronomer of the nineteenth century in the U. S. He was well versed in the mathematics and theoretical physics related to astronomy and fluid dynamics. This is a basic contrast to Chandler's lack of education in advanced theory and studies that required a knowledge of calculus. Newcomb became aware of the results of Chandler after Chandler published a partial explanation of his results on November 23, 1891 in *Astronomical Journal,* which was edited by Chandler after Gould's death. Newcomb was swift to provide a physical and theoretical explanation only one month later. On p. 168 we note, "In the 23 December 1891 issue of *Astronomical Journal*, Simon Newcomb opened his paper with the following: 'Mr. Chandler's remarkable discovery, that the apparent variation in terrestrial [= earth] latitude may be accounted for by supposing a revolution of the axis of rotation of the earth around that of figure [= the average axis of rotation], in a period of 427 days, is in such discord with the received [historical] theory of the earth's rotation that, at first, I was disposed to doubt the possibility. But I am now able to point out the *vera causa* [true cause] which affords a complete explanation of this period.'" Later on the same page the quote from Newcomb continued, "'But, as a matter of fact, the fluidity of the ocean plays an important part in the phenomenon, as does also the elasticity of the earth.'" The complex language will not be continued here. On p. 171 the following quote from Newcomb appears, "Those geologists who have given special attention to the subject regard it as well established that the earth yields under the weight of deposits as if it were a thin crust floating upon a liquid interior, and must therefore be a viscous solid, if a solid at all." Newcomb soon added mathematical theory to his explanation.

Thus the credit for the discovery and its two periodic cycles goes to Chandler, but the explanation of the cause goes to Newcomb.

A summary given on p. 167 states, "Chandler's approach followed the classical Baconian scientific method. He had observed a natural phenomenon (variation of

latitude), he had examined the observations to determine relations and connections, and he had determined the natural law that governed the phenomenon. In fact, Chandler had gone beyond the inductive process, meeting at least the spirit of Newcomb's additional components of the scientific method – deduction and scientific verification. After developing the mathematical formula, complete with exact numbers, Chandler had investigated a wide variety of observations (collected by different observers using different instruments at different locations and times, and even for different purposes), in order to verify his law of the variation of latitude."

[23] The Antarctica

The reason this chapter is included is to dispel misinformation that I have witnessed on the internet.

The land around the south pole is called the Antarctica. Its land size has been measured and books on world geography write that it is slightly less than twice the size of Australia. Several nations have made a territorial claim to parts of the Antarctica, but no nation has attempted to settle there due its extreme cold and lack of plant life. In 1961 the Antarctic Treaty was signed which prohibited military activities there to maintain peace in that area, but scientific activities were permitted by the treaty. It is expected that at some time in the future, if some valuable minerals are discovered there, then disputes may arise concerning the rights to mining on the Antarctica.

An account of a personal corroborating experience is provided by author P. T. Harris. Harris 2020 p. 77 states, "In 1998 I was the leader of the Antarctic Cooperative Research Center's paleoenvironment program based in Hobart Tasmania. Our team carried out investigations into the history of the Antarctic ice sheet and the Antarctic marine environment. Antarctic research is an international endeavor, and our team had joined up with a group from Italy's national geophysics research institute, Istituto Nazionale di Oceanografia Sperimentale (OGS), for a joint Antarctic expedition."

A summarized account of the race to be the first team to reach the South Pole is presented in Bell 2019. On p. 304 Bell wrote, "The task [to reach the South Pole] was known ahead of time to be quite a different challenge, in that the South Pole, unlike the North, was on an ice sheet above a continental landmass. This meant that an 800-mile (1,300-kilometer) overland trek in harsh wintery conditions would be required." In 1911 two teams vied for the prize. Bell wrote, "[Robert] Scott and four team members [from Britain] reached the South Pole on January 17, 1912, only to find a small tent flying the Norwegian flag, placed there five weeks earlier by rival Roald Amundsen and his team of four men from the expedition of the ship *Fram*."

One view of a flat world map is designed to show the north pole at the center, and the remainder of the world as a large circle with straight lines drawn from this center to the

edge of the circle. These straight lines are called lines of longitude in this type of world map. Circles on this map are called lines of latitude. The goal of this kind of map is to show the nations surrounding the North Pole. Such a map shows all land areas near the South Pole to be much wider in proportion to their true areas compared to other parts of the world. The greatest distortion of all is the South Pole, which is really one point. But in this map, it is the greatest circle on the outer boundary of the map, and is therefore unreal. To an unsuspecting person who imagines this to be a realistic map, this map promotes the hoax that there is no South Pole and that the southernmost part of the earth is the most vast part of the earth in land area.

[24] Summary

There is a saying "seeing is believing". When Aristotle gave three reasons for his belief that the earth is appropriately spherical, his reasons were all based on human experience of what could be observed without the benefit of knowing about ships that sailed around the world, without airplanes, and without telescopes and modern astronomy to accompany it. Now we have those additional discoveries and a rich history to document the achievement of these matters. We also have modern inventions such as the cell phone that gives us the ability to speak with people from different time zones who are able to give testimony to conditions of a gradually changing sunset that slowly goes through each time zone during a 24-hour day. We have the GPS navigational system that functions because of communication with a constellation of man made satellites. These satellites were put up in orbits because we understand the physical forces and the mathematics behind these orbits. This is only possible if the knowledge that put them there is correct. This knowledge is based upon the earth being approximately spherical and the rotation of the earth on its axis.

In Carter and Carter 2002 on p. 27 we note, "Changes in the rate of rotation of earth (length-of-day) result in displacements in longitude of the entire constellation of satellites. Changes in the orientation of the earth's axis of rotation in space change the inclination of the orbits of the satellites." This makes it necessary to make some gradual changes to the orbits of these satellites in order to keep the GPS system working accurately. GPS is only possible if our understanding of the pattern of rotation of the earth on its axis is a reality.

On pp. 20-21 we note, "Of course Chandler could never have anticipated that his discovery would one day be important to global navigation. In his time, the variation of latitude was purely of scientific interest." The implication of this is that the use of the GPS that is common today is evidence, unless you deny all history associated with this, that the earth rotates on its axis.

We see and experience modern inventions whose technology is a witness to the accuracy of our understanding of modern astronomy, which includes the spherical nature of the

earth and the fact that it has an axis and it rotates on that axis. Correctly interpreting the Bible does not lead to conflict with what we have learned about the earth.

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