by Dr. Danny R. Faulkner

Introduction

As I have previously discussed, belief that the earth is flat has rapidly grown of late, largely through dissemination via countless Internet sites and the influence of social media. Unfortunately, many Christians have fallen prey to this, misled into believing that the Bible teaches the earth is flat and that, until five centuries ago, the church likewise taught that the earth is flat. In this article, I will examine many of the biblical passages that supposedly teach that the earth is flat, and I will show that in fact they do not. But before doing so, I must respond to two false assumptions mentioned above—that the church historically taught that the earth is flat and that this changed 500 years ago.

As the medieval scholar Geoffrey Burton Russell ably demonstrated,[1] contrary to common misconception, the medieval church did not teach that the earth was flat. Thomas Aquinas introduced Aristotelian thought into medieval church teaching. Writing in the fourth century BC, Aristotle clearly taught that the earth was spherical. In the early second century BC, Eratosthenes accurately measured the circumference of the spherical earth. Claudius Ptolemy's Almagest, from the early second century AD, provided a useful model for calculating the positions of heavenly bodies. While this model was geocentric, it did not promote a flat earth, but instead was based upon a spherical earth. The works of Aristotle, Eratosthenes, and Ptolemy were all widely available and discussed in the late medieval period, and continued to be through the transition to the Renaissance. Given the clear record of history, why is it so commonly believed today that most people, and especially the church, thought that the earth was flat?

GIVEN THE CLEAR RECORD OF HISTORY, WHY IS IT SO COMMONLY BELIEVED TODAY THAT MOST PEOPLE, AND ESPECIALLY THE CHURCH, THOUGHT THAT THE EARTH WAS FLAT?

This misconception is easily traced to the writings of two late nineteenth-century sceptics, John William Draper and Andrew Dickson White, who invented the conflict thesis. The conflict thesis holds that religion in general, and Christianity in particular, held back progress. The contention of the conflict thesis was that medieval Europe was gripped with superstition (Christianity) that prevented intellectual advancement, and it was only after man's reason reasserted itself during the Renaissance that man slowly became unshackled from religious dogma, bringing about the Enlightenment. It is true that four centuries ago the Roman Catholic Church opposed Galileo's teaching of the heliocentric theory. According to the conflict thesis, it was the alleged geocentric teaching of the Bible that caused the Roman Catholic Church to oppose Galileo. However, the historical record demonstrates that it was the teachings of Aristotle and Ptolemy that played the major role in that conflict.[2] That is, the Galileo affair was a battle between two scientific theories—geocentrism and heliocentrism—with the Bible

playing a very minor role. Hence, the conflict thesis reinterpreted the Galileo affair into something that it was not.

The promoters of the conflict thesis also retold the story of Christopher Columbus. Most people today persist in the belief that at the time of Columbus, nearly everyone thought that the earth was flat. According to the story, Columbus was one of the few people who thought the earth was spherical, and he understood that on a spherical earth one could sail westward from Europe to reach India and China. Supposedly, Columbus had to argue against strong objections coming from those who thought that the earth was flat to get support for his expedition. Finally, according to the story, Columbus managed to complete a voyage to the New World, and when he returned to Europe, people realized that Columbus was right — the world was round and not flat. Really? How did sailing from Europe to the Caribbean and back to Europe prove that the world was spherical? It didn't. The truth is that no one told Columbus he could not reach the Far East by sailing west. Everyone knew that it was possible, because everyone knew that the earth was spherical. The problem was that the earth was very large. Most people understood that the distance westward from Europe to the Far East was far greater than going eastward (a look at any globe proves this). The question was not how possible it was to reach Asia by going westward, but rather how feasible it was. The belief was that the ocean between Europe and Asia was vast, with little or no land in between. At the time of Columbus, voyages over open water were very risky, and ships rarely sailed more than three days out of the sight of land. A voyage westward across the ocean to Asia would have required months, with no opportunity for resupply or rescue along the way if problems developed.

The facts of history refute the commonly held story about Christopher Columbus. Much of the work supporting a flat earth today uncritically repeats and builds upon this false view. The flat earth movement began in the mid-nineteenth century, the same time that the conflict thesis was being developed. While the sceptics were ridiculing the Bible for allegedly teaching that the earth is flat, early flat-earthers foolishly accepted this false claim. Undoubtedly, the recent surge of interest in the flat earth among Christians has been fuelled by the (false) belief that the Bible teaches that the earth is flat. Those who have enlisted in the flat-earth movement of late apparently are ignorant of the fact that those who promoted the conflict thesis made the same arguments to discredit the Bible. This could be ironic, or perhaps it is not. It is possible that certain people promoting the flat-earth today are doing so to discredit the Bible and Christianity all over again. If so, then Christians who have been misled into believing that the earth is flat have foolishly fallen into the trap. Let us examine the Scriptures to see what they say. We shall find that promoters of the flat earth do not handle them any better than they handle history.

Does the Bible Teach that the Earth has an Edge?

Nearly everyone understands that a sphere does not have an edge. Indeed, we can travel indefinitely around a sphere and never reach a boundary or edge. On the other hand, if the earth is flat, it must have an edge somewhere, unless the earth is an infinite plane. However, few people today suggest the latter, and no one in the ancient world did. Bible sceptics are fond of pointing out that the phrase "four corners of the earth" appears three times in the Bible. Surely, the sceptics claim, this must refer to a flat, square earth—thus proving that the Bible teaches a flat earth. At the very least, they reason, this shows that the Bible writers believed one of the flat earth cosmologies of the ancient world, thus proving that the Bible is not inspired, but that the people who wrote the Bible merely reflected the world-view of their times. There are some examples of flat earth cosmologies from the ancient world, but they always consisted of a flat, round earth. A circle was considered a much more perfect shape than a square, so none of the ancient flat earth cosmologies involve a square earth. If a square flat earth were the cosmology of the Bible, then it would have been at odds with every other ancient flat earth cosmology. Therefore, this attempt by the sceptics to claim that the Bible teaches a flat earth does not square (pun intended) with the facts of history.

IF THE VERSES THAT MENTION THE EARTH'S FOUR CORNERS DO NOT REFER TO A FLAT EARTH, THEN TO WHAT DO THEY REFER?

If the verses that mention the earth's four corners do not refer to a flat earth, then to what do they refer? Let me begin with Revelation 7:1, which speaks of four angels standing on the four corners of the earth and restraining the four winds of the earth. Even the most ardent students of hyper-literal interpretation of the Bible acknowledge the frequent poetic elements and the use of imagery in the book of Revelation. This extends to the many occasions where numbers appear in the book of Revelation. In this one verse, the number four appears three times. In each usage, the things mentioned are intimately tied together, so there is a one-to-one correspondence between each of the three groups of four.

The four winds refer to the four directions from which winds can come: north, south, east, and west. We often use this nomenclature today, such as saying that the wind is "out of the west." The repetition of the number four ("four angels . . . four corners . . . four winds") ties each angel and each corner with one of the four compass directions. Therefore, there is no warrant to interpret these four corners literally, particularly when it does not match any cosmology.

The phrase "four corners of the earth" probably was an idiom in the Apostle John's time, much as it is in English today, referring to every distant location on the earth. This is the meaning from the context of Revelation 20:7–8, the other occurrence of the phrase "four corners of the earth" in the book of Revelation (the King James Version has the word quarter here rather than corner, though the Greek word is the same in both Revelation 7:1 and 20:7–8). Idioms in one language can be difficult to translate into another language, because a literal translation may be meaningless in the target language (imagine how a literal translation of our idiom "You're pulling my leg!" would be understood in other languages). It is probable that the English idiomatic understanding of "the four corners of the earth," referring to the remotest parts of the earth, stems from Revelation 20:7–8. From an evaluation of its context, we may conclude that this is also the meaning of "the four corners of the earth" in Isaiah 11:12, the third appearance of this phrase in the Bible. It's use there generally is understood to be idiomatic. Bible sceptics frequently use these three verses to argue that Scripture teaches that the earth is flat. While some promoters of the flat earth use these three verses, many do not. Why? They probably realize that a square earth with corners does not agree with their model of a round, flat earth. This is a notable omission. How would Christians who believe in a flat earth because they earnestly believe that is what the Bible teaches handle these three verses? They likely would interpret them much as I have. However, once one admits that some biblical passages which supposedly teach a flat earth are idiomatic, it is difficult to claim that similar passages are not also idiomatic. For instance, the phrase "ends of the earth" appears 28 times in the King James Version, and, if taken literally, suggest that the earth has an edge, which would rule out a spherical earth.

However, critical evaluation of each of these 28 instances of the phrase "ends of the earth" in their respective contexts shows plainly that this phrase too is an idiomatic expression. For example, in 12 of the 28 occurrences, the Hebrew word ʾep̄es ("extremity, end") used in construct with ʾereṣ ("earth"), evidences that the biblical authors intend this phrase as a reference to the uttermost reaches of the inhabitable world. The fact that this phrase sometimes is used to speak not of the distant parts of the earth itself, but rather of the people who inhabit these remote places (e.g., Psalm 67:7; 98:3; Isaiah 45:22) argues strongly against this phrase being used to indicate that the earth has a physical edge.

Do Heights in the Bible Teach the Earth is Flat?

Perhaps the most bizarre argument that the Bible teaches a flat earth relies on Daniel 4:11, which reads,

The tree grew and became strong, and its top reached to heaven, and it was visible to the end of the whole earth.

This description is repeated almost word-for-word in Daniel 4:20. Both sceptics and the flat-earthers reason that on a spherical earth it would not be possible for a tree to be visible from the entire earth, but such a tree could be visible anywhere on a flat earth. But what is the context of these verses? The fourth chapter of Daniel is the account of Nebuchadnezzar's second dream. Verse 4 directly quotes the words of Nebuchadnezzar stating that he had a dream. Verses 10–17 quote Nebuchadnezzar describing the content of his dream. Note that this is a dream. With their wild and fantastic elements, dreams hardly are statements about reality, let alone cosmology. It is remarkable that anyone would construe the content of a pagan king's dream recorded in Scripture as evidence that the Bible teaches that the earth is flat.[3] Verses 19–27 contain Daniel's interpretation of Nebuchadnezzar's dream, and verses 28–37 recount the fulfilment of the dream. Key to the dream's interpretation is the identification of Nebuchadnezzar with the tree in his dream (verses 20–22). Immediately, one ought to see that since the tree represents Nebuchadnezzar, it is not a literal tree (though, being in a dream, the tree wouldn't be literal anyway). Furthermore, the literal fulfilment of the dream does not involve a tree in any way, reinforcing the non-literal nature of the tree. Even if the dream correctly reflected the cosmology of Nebuchadnezzar (assuming he thought that the earth was flat), it hardly constitutes evidence that the Bible teaches the earth is flat. Rather, the Bible merely records the thinking of Nebuchadnezzar.

The same sort of reasoning is used to argue that Matthew 4:8 teaches a flat earth. Matthew 4:1–11 gives an account of the temptation of Jesus. The temptation began in the wilderness, after Jesus had fasted for 40 days and nights. Satan first tempted Jesus to change stones into bread to satisfy Jesus' hunger (Matthew 4:3). Presumably, this was while still in the wilderness. Next, the devil took Jesus to the pinnacle of the Temple in Jerusalem and suggested that Jesus cast himself down (Matthew 4:5). Note that there was considerable distance between the wilderness and the Temple (at least 50 miles). Did Satan instantly and literally transport Jesus from the wilderness to Jerusalem? Or did Satan present this view to Jesus while still in the wilderness, perhaps in a vision? Matthew 4:8 records the third temptation: **Again, the devil took him to a very high mountain and showed him all the kingdoms of the world and their glory. (ESV)**

Those who wish to argue for a biblical flat earth point out that all the kingdoms of the earth would be visible from a tall mountain only if the earth is flat. However, if this mountain of Matthew 4:8 with its view of the entire earth is literal, then where is it? Those who pursue this line of reasoning have never determined the location of this hypothetical mountain. If this mountain is hypothetical even on a flat earth, then this verse hardly constitutes proof that the Bible teaches the earth is flat. But does this verse truly imply the visibility of the entire earth from the peak of this mountain?

The other two synoptic gospels also record the temptation of Christ (Mark 1:12–13; Luke 4:1–13), though Mark's account has no details. The details of Luke's account match many of the details of Matthew's record, but there are differences. For instance, the second and third temptations are switched. This is not a difficulty, if one allows that either or both accounts of the temptation of Christ are treated thematically rather than chronologically. Those who claim the Bible teaches a flat earth concentrate on Matthew's account but largely ignore Luke's gospel in this matter. Notice the differences between Matthew 4:8 (above) and Luke 4:5:

And the devil took him up and showed him all the kingdoms of the world in a moment of time. (ESV)
Notice that no mountain is mentioned, but merely that the devil took Jesus "up" (earlier translations based upon the Textus Receptus do have the word mountain, but the Greek word for mountain does

not appear in the other manuscripts, so its inclusion in the Textus Receptus probably came from an addition from a copier who was knowledgeable of Matthew's parallel account). This is a relatively minor point, but it may have some bearing on whether the mountain that Matthew recorded literally was a tall mountain from which all the world's kingdoms could be viewed. One more detail in Luke's gospel sheds light on this question. Luke stated that the devil showed Jesus all the kingdoms of the world "in an instant of time." The emphasis is not on where Jesus was, but what Jesus saw. This was not a grand panorama that took some time to absorb. Rather, the glory of all the world's empires was shown to Jesus all at once. This sounds more like a vision rather than a vista. There may not have been a mountain involved, but, more likely, it probably refers to a high, desolate spot, probably in the wilderness, where the third temptation, and its attendant vision, occurred. No wonder those who promote the flat earth normally concentrate on Matthew 4:8 while ignoring Luke 4:5. As mentioned above, one might incorrectly infer from Matthew 4:8 that there actually is a mountain so high that the earth's entire surface is visible from it, but by interpreting Scripture in terms of Scripture, one can see that this is incorrect.

Is the Firmament a Dome over the Earth?

The cosmology of the flat earth holds that a dome covers a circular, flat earth, with its edge resting on the earth beyond the ice wall of Antarctica. The stars are affixed to this dome, while the sun and moon are above the earth but beneath the dome. Some have called this a snow-globe cosmology, because of its resemblance to a snow-globe. Supposedly, this is the cosmology that the Bible teaches. Ironically, sceptics make the same argument, but their intent is to discredit the Bible. Few flat-earthers appear to be aware of this fact or the irony. Let us examine the Scriptures that supposedly support this cosmology. Key in this discussion is the firmament. The Hebrew word rāqîa‘ is translated as firmament in the King James Version. It appears a total of 17 times in the Old Testament, with over half of the occurrences (nine times) in chapter 1 of Genesis alone. The word is a noun that derives from the Hebrew root rq‘, meaning to stamp out.[4] An example of this action is to stamp or pound a metal into thin sheets. This is a common practice with gold, because gold is so malleable. Gilding is the process of attaching gold leaf to objects, giving the impression that the objects are pure gold. For instance, the Ark of the Covenant was gilded with gold leaf over acacia wood (Exodus 25:10–11). Gold leaf can be pounded or rolled so thin that bright light can be seen through it. From the meaning of this word, we can deduce that the rāqîa‘ is something that has been pounded or stretched out.

FROM THE MEANING OF THIS WORD, WE CAN DEDUCE THAT THE RĀQÎA‘ IS SOMETHING THAT HAS BEEN POUNDED OR STRETCHED OUT.

Unfortunately, some people reason that since this is an action frequently done to a metal, the thing being stretched out must have some physical property common with metals. Metals often are hard, so, according to this reasoning, the rāqîa‘ must be hard. This certainly is the sense of the archaic English word firmament, which has a common root with the word firm. However, is this the intended meaning? Not all metals are hard; and gold, which is involved in the best example illustrating the Hebrew root from which the Hebrew noun rāqîa‘ comes, definitely is not hard. Therefore, it is questionable if the rāqîa‘ is something that is hard. It is more likely that the intended meaning of rāqîa‘ is related to the process of stamping out, not a physical property of the thing subjected to the process. The process has the effect of spreading out a substance, or possibly making the substance thin. This is why many more modern translations of the Bible render rāqîa‘ as expanse rather than firmament.

The first use of the word rāqîa‘ in the Bible probably is helpful in deciphering its meaning. This is found in Genesis 1:6, the beginning of the Day Two creation account. The Day Two creation account begins with God’s declaration that there be a rāqîa‘ to divide the waters from the waters. The next verse tells us that God made the rāqîa‘ and divided the waters that were below the rāqîa‘ from the waters that were above the rāqîa‘. Thus, the word rāqîa‘ appears three times in this verse. Before declaring an end to Day Two in Genesis 1:8, God called the rāqîa‘ “heaven.” Therefore, the Hebrew word rāqîa‘ appears five times in the Day Two account.

There are several observations that we can make from this passage. First, the waters that God divided were the waters mentioned in Genesis 1:2. It is clear that the waters that God separated below must refer to surface water (mostly oceans) on the earth. But what are the waters above the rāqîa‘? How we answer that question will depend upon what we understand the rāqîa‘ is. Notice that God equated the rāqîa‘ with heaven. The Hebrew word šāmayim is translated as “heaven” most of the more than 400 times it occurs in the Old Testament, as it is here.

Interpreting Scripture in terms of Scripture, we find reinforcement of the equation of the rāqîa‘ with heaven. At least eleven verses in the Old Testament speak of God stretching out the heavens (Job 9:8; Psalm 104:2; Isaiah 40:22; 42:5; 44:24; 45:12; 48:13; 51:13; Jeremiah 10:12; 51:15; Zechariah 12:1). On Day Two, God made the rāqîa‘, something that is spread or stretched out. Furthermore, God called the rāqîa‘ heaven. The stretching of the heavens probably refers to when God made the rāqîa‘.

Heaven generally is understood as being above us. Depending on the context, the word can refer to that which is immediately above us, where flying birds, clouds, and rain are. It also can refer to the realm of astronomical bodies. Finally, it often refers to the abode of God. “Heaven” has all these meanings, both in modern use and in the Bible. Does the rāqîa‘ refer to all of these meanings, or just some of those meanings?

The other appearances of the word rāqîa‘ in the Genesis 1 creation account can help in answering this question. The next use of the word rāqîa‘ is in the Day Four account of creation (Genesis 1:14–19), where it appears three times. Each time it appears in conjunction with the Hebrew word šāmayim. The best way to express this relationship in English is with the prepositional phrase, “expanse of heaven.” This construction emphasizes, lest there be any doubt, that the thing mentioned in the Day Four account is the thing that God made on Day Two. In Genesis 1:14, God commanded that there be lights in the firmament of heaven. Genesis 1:15 expands the command that they be for lights in the firmament of heaven. Genesis 1:17–18 states that God made the lights and set them in the firmament of heaven. It is clear here that the lights are the heavenly bodies, the greater and lesser lights, and the stars also (Genesis 1:16). Therefore, the firmament of heaven (the rāqîa‘) is where God placed the heavenly, or astronomical, bodies. Today we would call this outer space, or simply space.

THE MOST NATURAL UNDERSTANDING OF THE DAY FOUR CREATION ACCOUNT IS THAT ALL HEAVENLY BODIES ARE LOCATED IN THE RĀQÎA‘.

As an aside, some flat-earthers appear to make a distinction here that is unwarranted. They argue that the stars are embedded in a dome above the earth (the rāqîa‘), but they hold that the sun and moon (the greater and lesser lights) are below the dome while still above the earth (this conforms to most flat earth cosmologies today). This requires artificially distinguishing the stars from the greater and lesser lights in Genesis 1:17, so that it is only the greater and lesser lights that are placed in (that is,

inside) the rāqîa‘ in Genesis 1:17, while the stars are effectively placed on the surface of the rāqîa‘. Flat-earthers who pursue this distinction suggest that the phrase “in the firmament of heaven” of Genesis 1:17 (and possibly Genesis 1:14–15 as well) ought to be understood as “inside the firmament of heaven.” That is, God placed the sun and moon inside the firmament, much as one might place an object inside a container, such as a box. The box does not indicate the object’s location but merely contains the object. However, the Hebrew text (and even the English text) does not permit this. The masculine plural pronoun of verse 17 refers back to the sun, moon, and stars collectively, and the verse does not distinguish as to their placement. The most natural understanding of the Day Four creation account is that all heavenly bodies are located in the rāqîa‘. Again, today we call this space.

How far down to the earth does the rāqîa‘ extend? The final use of the word in Genesis 1, in the Day Five creation account, is helpful in answering that question. In describing the creation of flying things, Genesis 1:20 uses the phrase “expanse of heaven” to describe where they fly. While this phrase is the same as its three appearances in the Day Four account, the wording before that phrase is different. The Hebrew literally states that the birds were to fly “upon the face of the expanse of heaven.” This could mean that the birds fly on this side of the firmament of heaven or in the near side of the firmament of heaven. If the former, then the rāqîa‘ may not extend down to the where the birds fly. If the latter, it may include where birds fly. Either way, the rāqîa‘ would appear to include what we today would call outer space and much, if not all, of earth’s atmosphere. Keep in mind that the distinction between the earth’s atmosphere and outer space is of modern origin. Furthermore, even in today’s parlance, there is no clear delineation as to where the atmosphere ends and space begins. Neither the modern understanding nor the ancient one is necessarily right or wrong; they are just different.

The next use of the word rāqîa‘ (the tenth time in the Old Testament) does not occur until Psalm 19:1. The meaning there is consistent with what I have concluded from Genesis 1. The comparative parallelism of the two statements of Psalm 19:1 indicate that the rāqîa‘ and the šāmayim are the same thing, something that Genesis 1:8 already equated. Furthermore, Psalm 19:4b–6 describes the motion of the sun in the heavens (equivalent to the rāqîa‘), further enforcing the understanding gleaned from Genesis 1.

What about the remaining seven times that the Hebrew word rāqîa‘ appears in the Old Testament outside of Genesis 1 and Psalm 19? The word appears one more time in Psalms, in Psalm 150:1, which reads, in the King James Version,

Praise ye the LORD. Praise God in his sanctuary: praise him in the firmament of his power.

Because word order is different in different languages, some passages, such as this one, can be tricky to translate. The King James translators attempted to follow Hebrew word order in this verse. Consequently, the final two words, “his power,” clearly refer to God, though this is a bit awkward in English. The English Standard Version changed the word order slightly so that the final phrase reads, **“his mighty heavens.”** That is, the word mighty, a synonym for power, modifies the rāqîa‘, rather than being descriptive of God (also notice that the ESV translated rāqîa‘ “heavens” here, perhaps based upon God calling the rāqîa‘ “heaven” in Genesis 1:8). This translation shifts the meaning, but is that difference in meaning consequential? God made the expanse, so if the expanse is mighty, God is even mightier yet. However, the King James Version probably is the correct translation, though the word order is awkward. In the New English Translation, the second part of this verse reads **“Praise Him in the sky, which testifies to His strength!”** This wording, while different from the King James, more clearly gets across the meaning intended by the King James Version. Furthermore, this reading is consistent with the very clear meaning of Psalm 19:1.

The word rāqîa‘ appears once in the book of Daniel. The context is established in Daniel 12:1–2 as the eschaton, when the resurrection of the dead will occur, some to eternal life and others to eternal punishment. In the King James Version, Daniel 12:3 reads,

And they that be wise shall shine as the brightness of the firmament; and they that turn many to righteousness as the stars for ever and ever.

Notice the parallelism contained in these two similes separated by a semicolon and the conjunction and. Clearly, the "wise" of the first simile and "they that turn many to righteousness" of the second simile are the same people, forcing at least a rough equivalence between the things that they are compared to. The first simile says that the wise will shine like the brightness of the rāqîa‘. In the second simile, the words shine and brightness are omitted; but those words are understood, which further enforces the parallelism. Indeed, the people who turn many to righteousness are likened to the stars, which shine brightly. Furthermore, from the Day Four creation account of Genesis 1, we know that the stars are located in the rāqîa‘. Therefore, the rāqîa‘ of Daniel 12:3 clearly refers to the same thing found in Genesis 1 and Psalm 19:1.

The final five appearances of the word rāqîa‘ are in Ezekiel, four times in the first chapter and once in chapter 10. Ezekiel 1:1–3 sets the scene: Ezekiel was with other exiles along the Chebar Canal (or river) when the heavens opened and he beheld a vision. The indication is that Ezekiel's companions did not see the vision, but that he alone did. Did God transport Ezekiel to heaven, where he either literally saw the things of his vision or God revealed them to him, much as what one might experience in a dream. We do not know for certain, but, given the description, the latter would seem more likely. Furthermore, the vision of Ezekiel 11 clearly is of the latter type (Ezekiel 11:1, 24).

The first things that Ezekiel saw were four living creatures that resembled men, but each had four faces. Each creature had feet and wings and a wheel. The creatures moved about together, and as they moved, the wheels went with them. Ezekiel described the creatures as bright and colourful (Ezekiel 1:7, 13, 16). Throughout Ezekiel's description of his vision, he repeatedly used the words like and likeness. Clearly, Ezekiel had difficulty describing the indescribable, so he expressed what he saw in terms of things familiar to him. As such, it is improper to take these comparisons literally. In Ezekiel 1:22, the prophet recorded that above the heads of the four creatures there was something like a rāqîa‘. Again, notice the use of simile: Ezekiel did not say that it was a rāqîa‘, but that it was like a rāqîa‘. On the other hand, what God made on Day Two was not like a rāqîa‘; it was a rāqîa‘. Given the difficulty that Ezekiel had in describing what he saw, we cannot be sure exactly what this expanse was. One possibility is that it merely was an expanse, or gap, between the four creatures and what was above. What was above? Ezekiel 1:23 describes the four creature's wings under the expanse. Ezekiel 1:25 records that a voice came from above the expanse, and Ezekiel 1:26 states that there was something like a throne above the expanse. From Ezekiel 1:28, we know that this is the throne of God. Therefore, this gap could have been between the creatures and the throne of God.

However, there is another possibility. Ezekiel 1:22 compares the appearance of this expanse to a "crystal." The King James uses the phrase "terrible crystal." Unfortunately, the word terrible has changed meaning in the past four centuries. It's original meaning is best rendered today as awesome or awe-inspiring. Indeed, several modern English translations use the word "awesome." (Interestingly, the Geneva Bible, which predates the King James Version, uses the word "wonderful," which still reads well today.) What does it mean to be a crystal? One must be careful, because the modern and ancient definitions are different. In the ancient world, a crystal was any substance that was solid and transparent. Examples include glass, quartz, rock salt, diamond, and other precious stones that transmit

light. Except for glass, these crystals had naturally occurring facets. However, glass, particularly lead glass, can be cut to produce facets. Today we define a crystal as a substance having an orderly array of atoms or molecules. This orderly array is responsible for the natural cleavage along facets of crystals (following the ancient definition). Nearly all solid substances have a crystal structure, so most crystals (in the modern sense) are not transparent. It is important that we understand the word in the ancient sense, not the modern sense. The word translated "crystal" here elsewhere in the Old Testament is translated as "ice." In the ancient sense, ice would have been considered a crystal, because it was hard and transparent. In the modern sense, ice is a crystal too, because it has a hexagonal crystal structure. Whether in the modern sense or in the ancient sense, should we view this expanse that Ezekiel described as a literal crystal? Probably not. Ezekiel compared what he saw to an expanse, but he furthermore compared its appearance to a crystal, the emphasis being on the light that it gave off. That is, it shined, glowed, sparkled, or had a hue like a crystal. We might describe what Ezekiel saw as an aura.

THE RĀQÎA‘ OF EZEKIEL CHAPTERS 1 AND 10 IS NOT THE RĀQÎA‘ FOUND ELSEWHERE IN THE OLD TESTAMENT.

A later vision commences in Ezekiel 8, with Ezekiel 10 being a part of that vision. Ezekiel 10:1 mentions a rāqîa‘ above the heads of the cherubim with what appeared to be a throne above. If this sounds similar to Ezekiel 1, it is. The description of the cherubim in Ezekiel 10:9–14 is similar to the description of the four living creatures in Ezekiel 1:5–21. Indeed, Ezekiel twice states that these cherubim were the same as the four living creatures that he sees in his vision by the Chebar Canal (Ezekiel 10:15, 20–22). To reiterate, the rāqîa‘ of Ezekiel chapters 1 and 10 is not the rāqîa‘ found elsewhere in the Old Testament. It is an error to blithely equate these two very different meanings.

Both sceptics and flat-earthers alike miss this point. Absent this distinction, it is very easy to think that the thing Ezekiel described as being like a rāqîa‘ is the same as the rāqîa‘ God made on Day Two, and hence derive properties of the latter from the former. With the many similarities between the visions of Ezekiel briefly discussed above and the Apostle John's description of part of his vision in Revelation 4:6–8, the problem is compounded by gleaning properties of the Day Two rāqîa‘ from what the book of Revelation tells us. For instance, Revelation 4:6a states that before God's throne there was a sea of glass, like crystal. Assuming that this sea of glass is below God's throne, and noting that Ezekiel mentioned God's throne above an expanse (Ezekiel 1:26; 10:1), one might conclude that Ezekiel's expanse and John's sea of glass are the same thing, viewed from opposite sides. However, if one equates every mention of the rāqîa‘ in the Old Testament, then it follows that John's sea of glass is the rāqîa‘ that God made on Day Two. To many who espouse the snow-globe earth, this is perfectly in line with Isaiah 66:1, which says the heaven is God's throne and the earth is His footstool. That is, in the snow-globe model, God sits immediately above the dome over the flat earth.

For those who insist on taking everything in the Bible as woodenly literal, this is fraught with problems. For instance, Isaiah 66:1 states that heaven is God's throne, but Ezekiel and John made it clear that God's throne is in heaven. Both cannot be literally true. Furthermore, God is spirit (John 4:24), and hence does not possess a physical body. The many instances of anthropomorphisms in the Bible, suggesting such things as God having hands (Psalm 8:3; Isaiah 66:2) or eyes (Proverbs 15:2) clearly are not literal. There also is an inconsistency in the flat-earth argument here. Flat-earthers believe that the firmament is a transparent dome over the earth, and hence is curved. On the other hand, no body of water is curved, but rather all seas have flat surfaces. But John described a sea of glass, which, by every other use, must be flat, so why is this one curved?

The flat-earthers use one more verse which does not contain the word rāqîa‘, but a related word. It is Job 37:18, where Elihu asked Job,

Hast thou with him spread out the sky, which is strong, and as a molten looking glass? (KJV)

There are several reasons why one must be careful in gleaning the meaning of this verse. First, this one verse is within a textual unit (Job 37:14–18), which poetically uses weather phenomena to illustrate the overwhelming power and wisdom of God—so teaching cosmology is not the point. Second, these are the words of Elihu, not God. While the Bible is inspired, not everything recorded in the Bible is necessarily true. This is a truthful record of what Elihu said, because God saw fit to preserve Elihu's speech, but that does not mean that Elihu was speaking infallibly. Therefore, if Elihu's words contain cosmological information, it merely reflects his understanding and not necessarily reality. Third, the book of Job contains language and idioms that are unique to it, and many are difficult to translate. Also, Job, being ancient Hebrew poetry, evidences many examples of imagery and phenomenological language. Job 37:18 contains a particularly challenging case of imagery.

Notice that the word sky appears in this verse rather than firmament. This is because the Hebrew word rāqîa‘ is not in the text, but rather šeḥāqîm (the plural of šaḥaq) is used. What does this Hebrew word mean? It appears in its various forms 21 times in the Old Testament. Five times it appears in the book of Job, as it does in Job 37:18. In the other four occurrences, the King James Version translates it as "clouds" (Job 35:5; 36:28; 37:21; 38:37). Note that one of these other four verses (Job 37:21) is within the immediate literary context of Elihu's speech. Furthermore, within that same context, Elihu uses two other Hebrew words to describe clouds (‘ānān in 37:15, and ‘āb in 37:16). Therefore, šeḥāqîm in Job 37:18 likely ought to be translated as "clouds" as well. Accordingly, Elihu here is not even addressing cosmology; if anything, he is commenting on weather phenomena.

What about the term "looking glass?" This is an archaic term for a mirror, and so more modern translations render it as such. The word "molten" is a bit misleading, because today we might think of this as being in a hot, liquid state. In ancient times, mirrors were made of polished metal, typically bronze. Mirrors were manufactured by casting them, so when cast they were molten, but when in use they were solidified. The terminology here probably refers to how the mirror was manufactured, so today it would be best translated as a "cast mirror" (as in many modern Bible translations).

What of the phrase "which is strong?" The King James Version has it modifying the word sky (or, as we have seen, the word which ought to be translated "clouds"). However, in the Hebrew text, the phrase underlying the translation ("which is strong") modifies the word translated "looking glass/ mirror." As such, Elihu is not saying that the sky (or clouds) is strong, but rather he is comparing it in appearance to a strong (firm or hard) mirror. This makes sense, for even today we refer to severely overcast conditions as a "leaden sky." Clearly, Elihu is not talking about a solid dome over the earth.
Discussion

From this brief survey of relevant Old Testament passages, there is no clear evidence that the rāqîa‘ is a solid dome over the earth. Rather, the rāqîa‘ likely is what we today would call space and much of the earth's atmosphere. Furthermore, biblical passages that supposedly indicate the earth is flat do no such thing. This being the case, why do flat-earthers and sceptics alike think that the rāqîa‘ is a hard dome surrounding a flat earth? The development of that false idea has a long history, which I can only briefly summarize here.

WHY DO FLAT-EARTHERS AND SCEPTICS ALIKE THINK THAT THE RĀQÎA‘ IS A HARD DOME SURROUNDING A FLAT EARTH?

The Septuagint was a third-century BC translation of the Old Testament from Hebrew to Greek. The need for this translation was that many Jews of the time no longer could speak or read Hebrew. This was particularly true of Jews of the Diaspora, of which many were living in Alexandria, Egypt, where the Septuagint translation was done. Alexandria was a major Greek city and was a centre of Greek learning and culture. Consequently, the people of Alexandria, including its Jews, were heavily Hellenized: and so the Jews of Alexandria were familiar with the then-current science.

The Greek cosmology of the time held to a spherical earth concentric within a much larger solid, transparent sphere on which the stars were affixed (the celestial sphere). The sun, moon, and five naked-eye planets moved on smaller spheres within the celestial sphere. The Greek word stereoma, referring to something hard, was used to describe the celestial sphere. Since Hellenized Jews of the time were aware of this cosmology, it is no accident that the Septuagint translated the rāqîa‘ as stereoma, apparently in an attempt to accommodate the cosmology of their day. The earliest known Jewish writings that address cosmology are from the medieval period, and they reflect medieval cosmology described above. Therefore, we have no knowledge of what specific cosmology the ancient Hebrews believed. However, the Greek word that the Septuagint translators chose is a strong clue as to what at least Hellenized Jews of the ancient world thought. It likely was a spherical earth centred in the celestial sphere. This is very different from a vaulted dome over a flat earth that flat-earthers promote. Several centuries after the translation of the Septuagint, Jerome translated both the Old Testament and the New Testament into Latin. Jerome selected the Latin word firmamentum to translate rāqîa‘, a word analogous to the Greek word stereoma. The hard, transparent celestial sphere model of the ancient Greeks was still the dominant cosmology in Jerome’s day. Therefore, he both accommodated that cosmology and endorsed the Septuagint’s reading on the matter. Much later, translators of early English versions of the Bible merely transliterated Jerome’s choice into English as firmament. This has caused problems ever since, because people recognize the word firm within that word and assume that the rāqîa‘ must be something hard. However, as we have already seen, rather than referring to something necessarily hard, the word rāqîa‘ probably refers to something that has been spread out. This is why many modern English translations render the rāqîa‘ as “expanse.” This is a good translation, because it gets to the heart of what the likely intended meaning of rāqîa‘ is. Some modern translations render rāqîa‘ as “sky.” This, too, is a good translation, because the sky that we see above us encompasses the likely meaning of the rāqîa‘, as discussed previously.

It is a common belief today that the cosmology presented in the Bible is that of a hard dome over the earth supported by pillars. Clearly, this is at odds with the facts. First, the Bible does not explicitly teach any cosmology. Rather, one may piece together certain passages to sort out what possible cosmology may be there, but one must be careful not to read into these passages interpretations coming from external sources.

Our approach ought to be exegesis, taking from Scripture what the likely meaning is, rather than eisegesis, reading a meaning into Scripture. As we shall see, an eisegetical approach is what led to the mistaken belief that the Bible teaches a solid dome over the earth. I recognize that I am not immune to this difficulty, but at least acknowledging the temptation to interpret Scripture through the lens of external factors makes it possible to be on guard. Let me emphasize again that the Bible does not explicitly endorse any cosmology. This is a good thing, and it is consistent with God’s wisdom. If God had endorsed in Scripture an ancient cosmology, those who believed some other ancient cosmology

would have dismissed the Bible on the basis that the Bible's cosmology was wrong. Certainly, modern man would make that argument, because modern cosmologies differ from all ancient cosmologies. But what if God had endorsed the modern cosmology? Then people up to relatively recent times would have dismissed the Bible, because, in their minds, it taught the wrong cosmology.

Second, while not an inspired source, Josephus does frequently reflect the thinking of Jews in the first century AD. Josephus lived in Israel, not Alexandria, but his writings show evidence of Hellenization. Since his sect was the only one to survive the persecution and destruction that came in AD 70, his work came to be recognized as representing the Jews of his time. However, Josephus misrepresented the ideas of the other sects and presented his own sect in the best possible light. This sort of misrepresentation extended even to his presentation of the religious beliefs of the other sects. Thus, we must be very careful in using Josephus. With that caveat, what do Josephus' writings reveal about cosmology among at least some of the ancient Jews? His account of the Day Two creation is consistent with the Greek cosmology of his day, but not the domed vault cosmology.

Third, the cosmology of the West throughout the Medieval period was that of the ancient Greeks, not a domed vault over a flat earth. It was within this cosmology that the second century AD astronomer Claudius Ptolemy developed his model to explain the motions of the planets. The Ptolemaic model was overturned (along with the other elements of ancient Greek cosmology) only four centuries ago in favour of more modern cosmologies, such as the heliocentric theory.

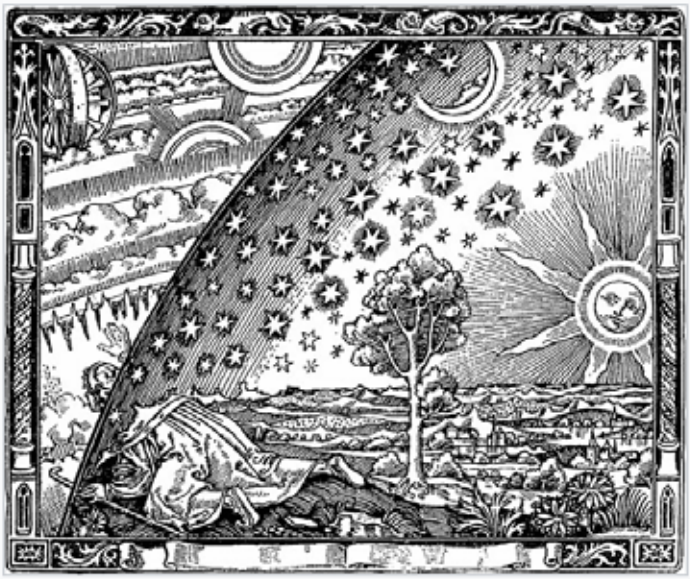
IF THE DOMED VAULT IS NOT THE COSMOLOGY OF THE BIBLE, HOW DID SO MANY PEOPLE COME TO THINK THAT IT WAS?

If the domed vault is not the cosmology of the Bible, how did so many people come to think that it was? This idea came about as the result of three developments in the nineteenth century. First, modern archaeology began in earnest in the nineteenth century. Interpretations of early excavations in the Near East indicated a domed vault cosmology, from which archaeologists and historians erroneously concluded that this was the ancient Near Eastern cosmology.

Second, the documentary hypothesis proposed that the Pentateuch was written much later than the time of Moses (and many of its proponents doubt if Moses even existed!). According to the documentary hypothesis, four different documents arose in the first half of the first millennium BC, and those sources were redacted much later, during the intertestamental period. Supposedly, the Jews picked up much of their cosmology, cosmogony, and early history from ancient Near Eastern cultures, and these are reflected in both the creation and Flood accounts of Genesis. Therefore, it became fashionable to interpret biblical passages in terms of the supposed-dominant domed vault cosmology.

Third, the conflict thesis claimed that Christianity had held back development of thought throughout the Middle Ages, and it was not until man allegedly was freed from the strictures of the Bible during the Renaissance that man's reason enabled a renewal in learning. Part of the case made against Christianity as part of the conflict thesis was that the church and the Bible taught that the earth was flat and was surrounded by a domed vault. As demonstrated elsewhere, the church never taught that the earth is flat. Such a blatant lie ought to call into question the claim about the domed vault being the biblical cosmology as well. The Flammarion engraving is a very famous depiction of the domed vault over the flat earth. Most people think that this is a medieval piece of artwork, but it dates from the 1880s. One is hard-pressed to find any medieval depictions of the supposed vaulted dome/flat earth cosmology of the Bible, because this was not believed in the Middle Ages. The influence of the Flammarion engraving

as used by promoters of the conflict thesis cannot be overestimated. This one depiction appears to have done more than anything else to promote the false notion that medieval cosmology was a domed vault over a flat earth



A traveller puts his head under the edge of the firmament in the original (1888) printing of the Flammarion wood engraving.

The domed vault was not even the dominant cosmology in the ancient Near East. Later excavations and studies revealed a plethora of ancient Near Eastern cosmologies.[5] If one wishes to interpret the cosmology of the Bible in terms of the cosmology of the ancient Near East, then one first must decide which cosmology to use. Unfortunately, many Bible scholars today have been deceived by the conflict thesis into thinking that the Bible's cosmology is that of a domed vault over a flat earth, which has led to many twentieth- and twenty-first-century depictions of flat earth with a domed vault above supported by pillars.[6] However, such depictions began to appear in the nineteenth century, after the damage done by the conflict thesis. This line of thinking has gained much traction in recent years. For instance, the New International Version of the Bible, first released in 1984, originally translated the rāqîaʿ as "sky," but the updated edition published in 2011 translated it as "vault." Again, this false understanding of biblical cosmology by some Bible scholars, (scholars who, by and large, have been deceived by the conflict thesis) is relatively recent.

Compounding the problem, Christians who endorse the flat earth use depictions by contemporary theologians who wrongly portray biblical cosmology as a flat earth under a domed vault as evidence of what the Bible teaches. Therefore, they are victims of the conflict thesis twice, once in embracing a flat earth, and once again in accepting the false domed-vault cosmology. Again, this concept of biblical cosmology did not come from ancient sources, but rather arose in the late nineteenth century as an attempt to discredit the Bible. Those who support the flat earth believing that this is what the Bible teaches have fallen into a trap. Ironically, while apparently motivated to defend the Bible, they have been tricked into using the same false arguments that sceptics use.

Conclusion

CLEARLY, THE BIBLE DOES NOT TEACH THAT THE EARTH IS FLAT.

Here I have examined the biblical passages flat-earthers generally use to claim the Bible teaches the earth is flat. There are other passages flat-earthers occasionally use. However, the frequency of use of those passages is far less than the verses I discussed here. Furthermore, those remaining verses generally require the assumption the earth is flat to begin with. Once these more important, frequently cited passages are dismissed as teaching a flat earth, the remaining few verses probably do not matter. Depending upon reaction to this article, I may take up those other passages later. Clearly, the Bible does not teach that the earth is flat. It was Bible sceptics who introduced this false claim in the 19th century. It is a shame that professed Bible-believers recently have embraced this false argument and have gone on to promote the flat earth. When combined with its many scientific and observational problems, the flat-earth theory is disproven.

The snow globe earth model requires that the earth be motionless. Therefore, flat-earthers are geocentrists, and many of them also support their position with biblical passages that supposedly teach that the earth is stationary. Before the recent rise of interest in the flat earth among conservative Christians, there was a geocentric movement already using many of the same arguments that flat-earthers do now. While the classical geocentrists and flat-earthers agree on the question of whether the earth moves, they strongly disagree on the earth's shape. I have written about geocentrism before, and have discussed some of the biblical passages that allegedly teach geocentrism. Perhaps in a future article I will revisit the topic of geocentrism and the supposed biblical passages that support it.

Footnotes

1. Geoffrey Burton Russell, Inventing the Flat Earth: Columbus and Modern Historians, New York, NY: Praeger, 1991.
2. J. Owen, "The Nature of the Neo-Darwinian Evangelicals' Criticism of Young-Earth Creationists: Personal Reflections on a Tale of Misadventures with History," Answers Research Journal 9 (2016): 299–316.
3. While I recognize the doctrine of biblical inerrancy, it is necessary to understand that the property of inerrancy extends only to the accuracy of Scripture's record, and not the accuracy of the things recorded. In other words, Scripture does, with relative frequency, faithfully record inaccuracies and lies contained in the speech of the individuals it quotes. Thus, while inerrancy ensures that the details of Nebuchadnezzar's dream are accurately represented in the biblical text, such does not guarantee (or even imply) that what Nebuchadnezzar saw in his dream was an accurate reflection of reality.
4. Danny R. Faulkner, The Created Cosmos: What the Bible Reveals about Astronomy (Green Forest, AR: Master Books, 2016), 39–43.
5. For instance, see Wayne Horowitz, Mesopotamian Cosmic Geography Warsaw, IN: Eisenbrauns, 1998.
6. If the earth were supported by pillars, it would contradict Job 26:7, which tells us that God hung the earth on nothing.

(This document was taken direct from Answers in Genesis website,
and the only change was to amend spelling to British English.)

YOUR HOMEWORK ASSIGNMENT TODAY is to calculate and predict the next lunar eclipse based on the Flat Earther's model of their flat Earth.

Flat Earth diagrams and your Flat Earth mathematical workings are to be included with your answer !

Failure to do so, which no Flat Earther has ever yet been able meet our challenge to do so, simply exposes their vacuity to be able to effectively comprehend both astrophysics and common sense, in order to correctly evaluate and process the abounding evidence that proves our Earth is a globe.

Here's an oxymoron for Flat Earthers: The Earth's surface can be both level and curved at the same time.

That's because the pull of Earth's gravity is radial, not parallel, and level is always at right-angles to the pull of gravity !

Technical Appendix

Flat Earth Proof — Just a Mirage

by Dr. Danny R. Faulkner

The flat earth movement began in the 19th century with the publications of Samuel Rowbotham. In the summer of 1838, Rowbotham conducted his Bedford level experiment. The Bedford level is a six-mile stretch of water that is very straight and level. Over the six miles, the earth ought to curve downward by 24 feet. Rowbotham stationed himself at one end of the Bedford level, and arranged for someone else in a small boat to row to the other end. A five-foot mast was attached to the boat, so certainly by the end of the level the mast would not be visible, because the top of the mast would have been 11 feet below Rowbotham's line of sight. Rowbotham observed the boat with a telescope mounted eight inches above the water. Rowbotham could see the small boat over the entire course of the Bedford level, whereupon he became convinced that the earth was flat. I've previously discussed the Bedford level experiment, in which I explained that atmospheric refraction bent the light of the boat along the surface of the earth, making the boat visible, even though the boat actually was below the direct line of sight. Here I wish to expand upon the phenomenon that caused Rowbotham's experiment to go awry. Rowbotham was a victim of a superior mirage. When flat-earthers hear this, they normally respond by dismissing this as impossible, because mirages supposedly are inverted images, but Rowbotham saw the boat right side up the entire time. However, this confuses superior and inferior mirages. What is the difference? First we must discuss the physics of light a bit.

Total Internal Reflection

Light travels at a finite speed, with the speed depending upon the medium. With mirages, the medium is air. In air, the speed of light is only slightly less than it is in a vacuum, and the speed of light in air depends upon the temperature of the air. Simply put, the speed of light is slightly greater in warmer air than it is in cooler air. In physics, we usually express this behaviour reciprocally as the index of refraction, n:

$$n = c/v,$$

Where c is the speed of light in a vacuum, and v is the speed of light in any medium, in this case, air. Since the speed of light is greater in warmer air, warmer air has a lower index of refraction than cooler air. More specifically, the speed of light also depends upon air pressure, or expressing this conventionally as the index of refraction:

$$n(P,T) = 1 + 0.000293\ (P/P0)(T0/T),$$

Where P and T are the pressure and temperature of air, and P0 and T0 are the standard values of one atmosphere of pressure and 300K. Since with mirages there is no appreciable height difference, pressure differences are negligible, and so the temperature difference dominates differences in the index of refraction. When light travels from one medium to another, the path of the light is refracted, or bent. This is what causes the "bent stick" appearance of a long object partially inserted in water, such as a pole placed into the water of a pool. This behaviour is described by Snell's law:

$$\sin \theta 1/ \sin \theta 2 = n2/n1,$$

Where θ1 and θ2 are the angles that the light rays make with the perpendicular to the interface between the two media, and n1 and n2 are the indices of refraction of the two media (see Figure 1). Depending

upon which direction the light is travelling, one of the angles is the angle of incidence, and the other angle is the angle of refraction.

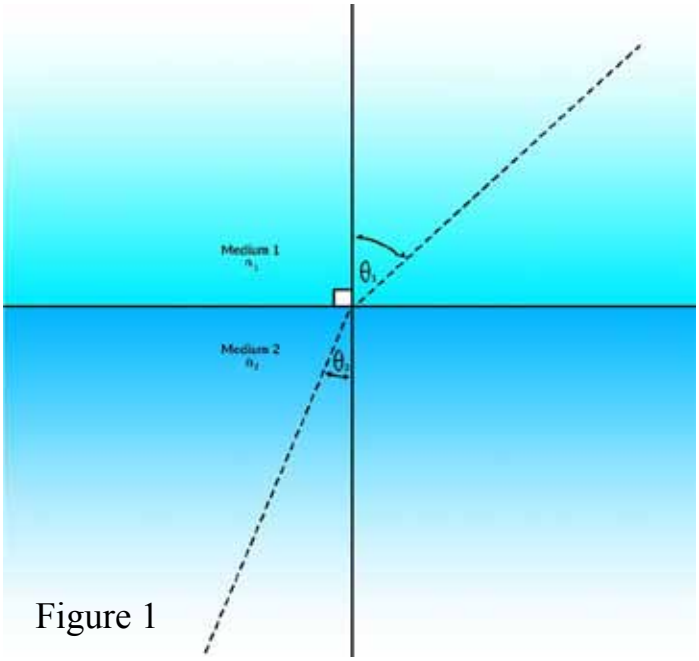


Figure 1

For most media and angles of incidence, the light transmits from one medium to the other. However, when passing from a medium of higher index of refraction into a medium of lower index of refraction at a sufficiently high angle of incidence, there may not be a real value for the angle of refraction. When this happens, the light cannot pass into the second medium. Instead, the light is reflected off the interface and back into the first medium. We call this phenomenon total internal reflection. Many devices make use of total internal reflection. Total internal reflection allows a prism with two 45-degree angles and one 90-degree angle to reflect light at a right angle. One could use a mirror mounted at a 45-degree angle to do the same thing, but total internal reflection is nearly 100% efficient, while the best mirrors are perhaps 85% efficient. Many optical devices, such as binoculars and periscopes, make use of this. Fibre optics are thin wires of glass. Being so thin, fibre optics are flexible and as easy to handle as any metal wire. Glass has a relatively high index of refraction, so light shining down a fibre optic is totally reflected internally by the walls of the fibre optic, if the fibre optic is not bent too sharply. We use fibre optics every day with telephone, cable TV, and internet connections.

What must be the angle of incidence for total internal reflection to occur? Let medium 1 be the medium with the higher index of refraction. As θ1 increases, θ2 also increases, albeit at a faster rate. When θ2 reaches 90 degrees, there is total internal reflection, and there is no transmission of light. The corresponding angle of incidence, θ1, is the critical angle where total internal reflection occurs. Let the critical angle be θc. Substituting into Snell's law:

$$\sin \theta c = n2/n1$$

From the second equation above, the index of refraction at one atmosphere of pressure and a temperature of 310 K (50 degrees F) is 1.000284, while the index of refraction at one atmosphere of pressure and a temperature of 320 K (68 degrees F) is 1.000275. These values yield a critical angle of 89.76 degrees. Hence, when air attempts to pass from 310 K to 320 K air at one atmosphere of pressure, the light will be totally internally reflected if the angle of incidence is greater than 89.76 degrees, or less than about a quarter of a degree from grazing incidence. If the temperature difference is greater, the critical angle will be less; hence the angle from grazing incidence will be greater.

Inferior Mirages

Inferior mirages are the most commonly noticed type of mirage; therefore, in the minds of most people, it is the only type of mirage. An inferior mirage occurs when there is a layer of warm air in contact with the ground, with layers of much cooler air just above. This condition exists nearly every sunny day. As the sun's radiation is absorbed by the ground, the air in contact with the ground heats. Air a short distance above the ground remains cooler, so a large temperature difference can exist between these two layers. Because this temperature difference is most pronounced when the sun is as high in the sky as possible, this condition is most likely to occur in the early afternoon in late spring and into

summer. The type of surface exposed to sunlight is very important too, because dark, flat surfaces, such as pavement, rock, and sand are most efficient at heating air this way. Surfaces with much vegetation, such as grass, are far less efficient in doing this. Because of its high specific heat and great optical depth, water generally is very poor at producing conditions conducive to an inferior mirage. The above example of a 10-degree difference in air temperature is rather modest—much greater temperature differences occur under ideal conditions of early summer, decreasing the critical angle, and increasing the angle above grazing where an inferior mirage can happen.

With these conditions, light from a distant object near but above the horizon reflects off the warmer air (see Figure 2).

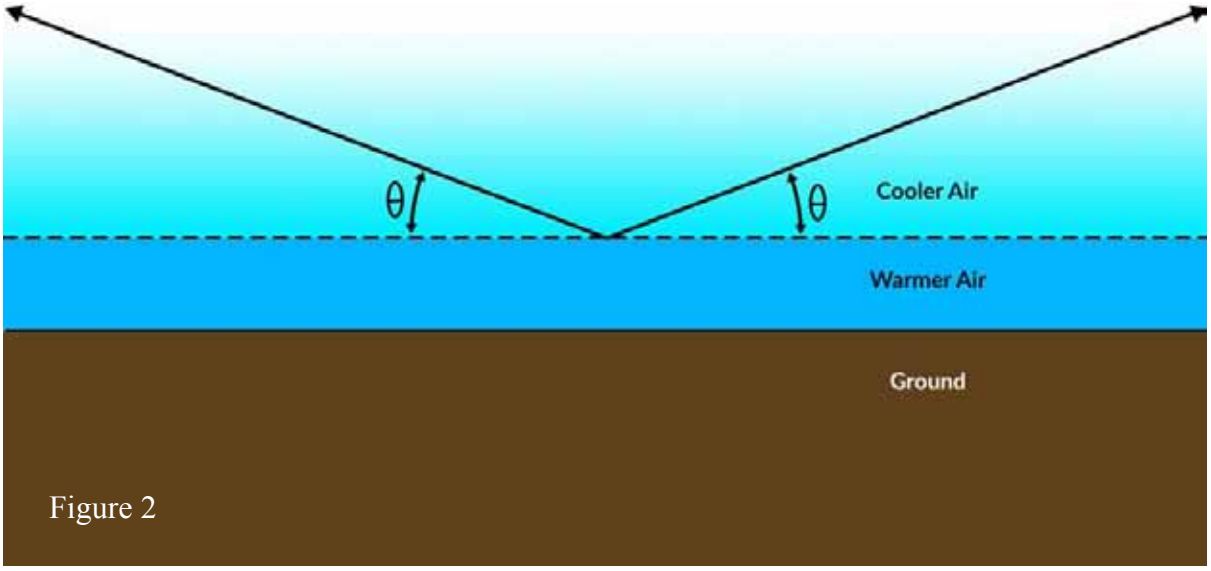


Figure 2

One of the most common objects reflected in this way is blue sky, which our brains interpret as light reflecting off a body of water. The reflected image appears below the object, which is why we call this an inferior mirage. The layer of warm air near the surface acts much like an ordinary mirror. As a mirror reverses direction left to right, an inferior mirage reverses direction from top to bottom (you see the same thing with a mirror if you tilt your head 90 degrees and look at reflections in the mirror.) The reversal happens because light from the top of a distant object will reflect closer to the observer than light from the bottom of the object. Therefore, inferior mirages usually appear inverted. Early in the morning or late in the afternoon, solar heating of the ground is not nearly as great, so inferior mirages are less likely to happen then. The same is true during autumn and winter when the sun is much lower in the sky.

The warm surface air that causes inferior mirages tends to expand. As air expands, it becomes less dense, producing buoyancy. Buoyant force causes the warm air to rise, and the air must be replaced somehow. This unstable condition leads to upward and downward motion of air (turbulence). Light passing through turbulent air is blurred. The constantly changing turbulence causes the images to shimmer. It is unusual for an inferior mirage to be steady.

Superior Mirages

As previously mentioned, the reaction of bodies of water with sunlight is very different from that of land. Being largely transparent, light penetrates deeply into water, so that the sun's light is absorbed throughout a thick layer from the surface to some depth rather than just on the surface, as with land. Additionally, water has a high specific heat, which means that its temperature increases very slowly

as heat is added. Consequently, water exposed to sunlight does not change temperature appreciably throughout the day, so there is no heating of air in contact with the water. If anything, during summer afternoons, when land is rapidly heating, bodies of water frequently are cooler than air temperature. The cooler water chills the air in direct contact with it, so the air lying just above water often is cooler than air higher up. Since air temperature normally decreases with height, this temperature reversal from the norm is called a temperature inversion. Temperature inversions are common over bodies of water during late spring and into summer. Since this temperature structure is the reverse of what causes inferior mirages, inferior mirages are far less commonly noticed over water. This happens particularly during the summer, when inferior mirages are common over land.

Consider light from a distant object that is emitted horizontally, parallel to the water's surface at the location of the object (see Figure 3).

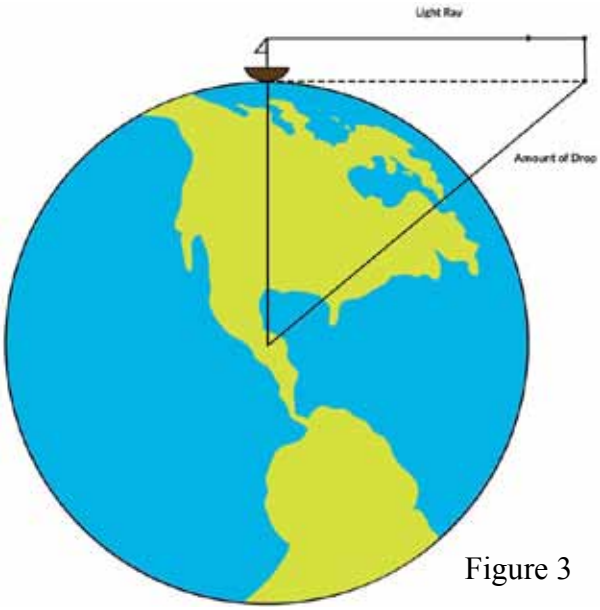


Figure 3

With increasing distance from the object, the earth's curvature causes the surface of the water to fall away from the beam of light. Over one mile, the amount of drop is eight inches, but the drop increases quadratically with distance. Consequently, after three miles the drop is six feet, and after six miles the drop is 24 feet. This is the point of the Bedford level experiment—the curvature of the earth ought to intervene to prevent the mast of the boat being visible from much more than three miles, let alone six miles. However, for the light from the distant object not to be visible, it would have to travel in a straight line. But with a temperature inversion, straight-line motion would carry the light from a cooler layer of air into a warmer layer of air at nearly a grazing angle. The light cannot do this, so it continually is internally reflected, causing the light to bend around the edge of the earth. Therefore, with a temperature inversion, one can see objects that lie well beyond the edge of the earth's curvature when viewing close to the surface of water.

Since this image is visible above where the object is, it is called a superior mirage. Because cooler air has no physical reason to rise, a temperature inversion is a stable situation, with little convection as with the condition that produces an inferior mirage. Therefore, superior mirages can be very steady, much steadier than inferior mirages. Furthermore, since the refraction acts almost continually rather than at one point, superior mirages normally are erect rather than inverted. If one gains a little altitude, one can get out of the inversion layer, and thus avoid seeing a superior mirage. In my earlier article, I pointed out that this is what Alfred Russell Wallace did when he repeated the Bedford level experiment. Russell did not see the distant object that was his target, which is consistent with a spherical earth. Russell correctly accounted for this effect, but Rowbotham did not.

My Own Experiment

Since temperature inversions are common over water, it is relatively easy to devise experiments in which distant objects beyond the curvature of the earth are visible. Perhaps the most famous are the photographs of the Chicago skyline taken across Lake Michigan, about 60 miles away. The photographer, Joshua Nowicki, does not promote the flat earth, but flat-earthers have used his photographs many times, such as here, as supposed proof that the earth is flat. Flat-earthers do not seem to be aware of just how rare these photographs are. If the earth were flat, then the Chicago skyline would be visible

across Lake Michigan nearly every clear day, but it is not. If the earth is spherical, then the hulls of ships ought to disappear as the ships move away from the observer. Since the ship must move many miles away for this to become noticeable, it is difficult to see this with the naked eye.

As with the Chicago skyline, there are many images on the internet, usually videos, of ships some distance away in which their hulls are visible. Many of these are taken during warm weather, such as late spring and summer, when the water is likely to be much cooler than the air, producing a temperature inversion. However, what would happen if one were to repeat this experiment over water that is warmer than the air temperature? Since there is no temperature inversion, the hulls of ships ought to disappear. This condition is likely to prevail on cool days in late autumn and early winter, when water temperatures are higher than air temperatures. These conditions also can produce inferior mirages, though not nearly as pronounced as over land on sunny summer days.

On November 12, 2016, I had the opportunity to conduct this experiment. I was near the water's edge, just beyond the surf, at Virginia Beach from middle to late afternoon. When I began, the air temperature was 50 degrees F, and the temperature dropped a degree or two by the time that I was done, near sunset. The water temperature was 62–64 degrees F, so the air immediately above the water was at least ten degrees warmer than the air temperature a short distance above the water. I photographed two cargo ships as they made their way out to sea from the port at Hampton Roads. I mounted a digital SLR camera on a 3.5-inch Questar telescope, having a 1,200-mm focal length. The ISO setting on the camera was 100 for all photographs.


Figure 4

The first photograph (Figure 4) is of a cargo ship bearing the name of the company on its hull. The company is the NYK line, a major Japanese shipping company. Notice that the bottoms of the letters are not visible. The letters on the hulls of cargo ships do not extend to the water line, even when fully loaded, so clearly the bottom of the hull is not visible. This is consistent with what we would expect on a spherical earth, but not on a flat earth. Notice the white bridge castle to the left. The shipping containers are multicoloured, and they are stacked at least seven high above the hull directly in front of the bridge castle. Below the visible tiers of the multicoloured containers there is a level of what appears to be gray containers. It is not clear why the containers in this layer are the same colour. Finally, notice that the image is a bit blurry. This is because of turbulence in the air between the ship and shore. With increasing distance, the turbulence will get worse, and the images will get blurrier.


Figure 5

In the next photograph and succeeding photographs, the ship is farther away, as indicated by the decreasing apparent size of the ship. In Figure 5, an inferior mirage is starting to show up. At the edge of the water, you can see a gray line, which is an inferior mirage of the row of gray containers right above the hull. On the right side of the ship, you can see the inferior mirage of the bow. The hull protrudes forward there, and the small white patch just above is a small portion of the forecastle. Notice that the inferior mirage of the bow is inverted, as one would expect. It is difficult to see here, but the lettering on the hull also is undergoing an inferior mirage too.

In the next photograph (Figure 6), the lettering on the hull is no longer visible. The layer of gray containers is even more visible in the inferior mirage, and the first layer of multicoloured containers is now beginning to appear in the inferior mirage. In the next photograph (Figure 7), the light from the gray layer of containers and its inferior mirage are beginning to merge. The first layer of the multicoloured containers above it is clearly visible in the inferior mirage. The white of the bridge castle is starting to show up in the inferior mirage. In Figure 8, the layer of gray containers no longer is visible. The bottom of the bridge castle and its inferior mirage have merged. None of the hull is visible. In the next photograph (Figure 9), the ship has turned, so we see the back of the bridge castle and containers on the stern. Much of the bottom of what appears to be the ship is an inferior mirage of the upper containers. At any rate, the hull is clearly not visible. Finally, in Figure 10 none of the containers are visible. All that we can see is the back of the bridge castle, merged with the upside-down inferior mirage. Notice the symmetry between the two.


Figure 6


Figure 7


Figure 8


Figure 9


Figure 10

Another container ship made its way outward, as shown in Figure 11, a photograph taken through the supports of the pier at Virginia Beach. You can clearly read the name of the shipping company, Maersk Line, on the turquoise hull. What appears to be stains under the letters are the beginnings of an inferior mirage of the letters. Instead of a level of gray containers immediately above the hull, the layer of containers right above the hull on this ship appear a deep red. As with the other ship, in each succeeding photograph this ship is farther away, as evidenced by the decreasing apparent sizes of the containers and the ship.

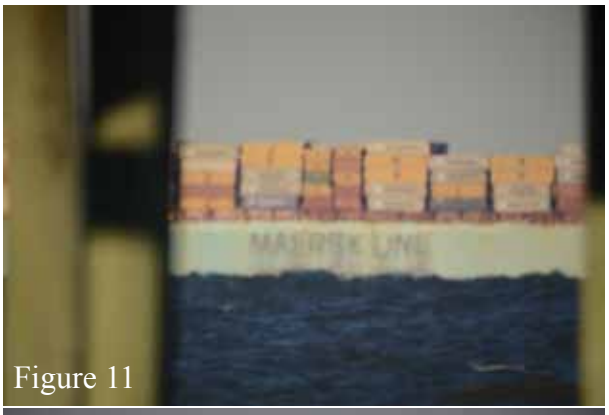


Figure 11

In Figure 12, the ship now appears beyond the pier. Notice that the inferior mirage of the lettering on the hull is much more obvious now. In Figure 13, the lettering and its inferior mirage have not merged. In Figure 14, the lettering is difficult to see. This probably is because most of the lettering is below the horizon, and what appears to be the bottom of the hull is an inferior mirage of the top of the hull. This is clearly seen by the inferior mirage of the first layer of red containers below the turquoise. In Figure 15, the inferior mirage of the bottom layer of containers is more obvious, and the inferior mirage of the bottom of the bridge castle is beginning to show up. Clearly, at least half of the turquoise visible here is an inferior mirage. Most of the hull is below the curvature of the earth. Unfortunately, at this point the sun was about to set, so light levels were dropping quickly, forcing me to use longer exposures. At that point, I stopped taking photographs.

Figure 12


Figure 13


Figure 14


Figure 15

Conclusion

These photographs clearly reveal that the hulls of these two ships progressively disappeared as the ships moved farther away. This is consistent with what we would expect if the earth is spherical, but this cannot be explained if the earth is flat. Therefore, this is good evidence that the earth is spherical. The results presented here contradict the many photos on the internet of objects beyond the horizon that supposedly prove that the earth is flat. Those alleged proofs are flawed because they failed to take account of atmospheric refraction due to a temperature inversion. By conducting this experiment when there was no possibility of a temperature inversion, I avoided that complication. The fact that inferior mirages consistently showed up in the photographs prove that there was no temperature inversion, indicating instead that there was a slightly warmer layer of air in contact with the water, with slightly cooler air above.

(This document was taken direct from Answers in Genesis website,
and the only change was to amend spelling to British English.)