

Five arguments against the Flat Earth

The most popular Flat Earth idea today seems to be the assertion that the Earth is a flat disk, like the image shown here. The Sun hovers above this disk, moving in circles above it.

There are many ways to disprove this idea using astronomical observations. However, some of these concepts might not be very familiar to non-astronomers. So, in this document, I'll use straightforward arguments about the Earth that can be easily visualized.

A few notes: first, in the calculations below I'm using miles rather than kilometers, to be more familiar to readers in the U.S.

Second, for convenience I'm using 25,000 miles as a polar circumference of the Earth (which is close enough to the actual value of 24,860). This would mean that the "disk" model has 12,500 miles from pole to outer rim.

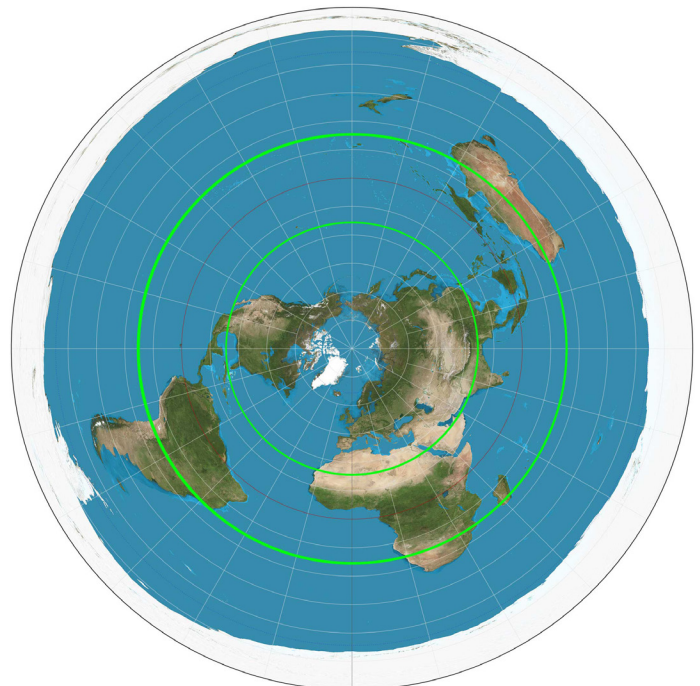
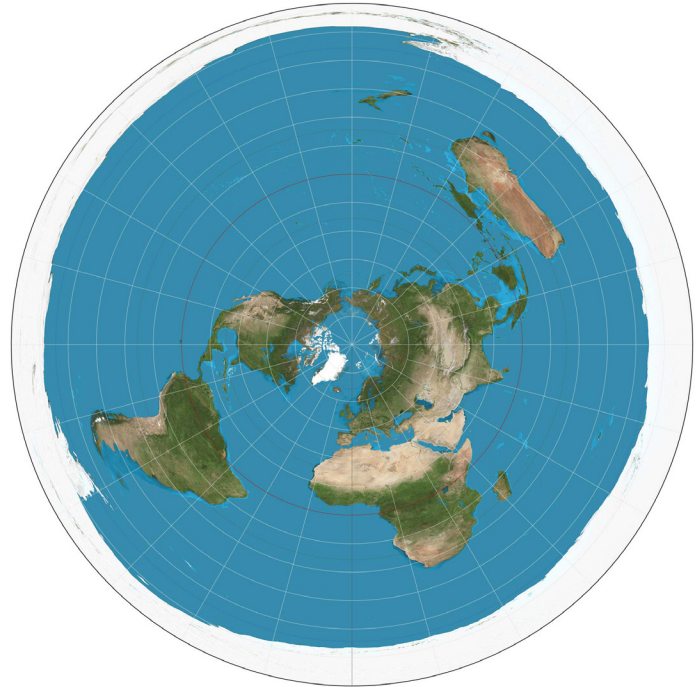
#1: The Sun's motion above the Earth

The Flat Earth model has the Sun being much smaller than is usually taught, and much closer to the Earth (merely a few thousand miles above the Earth's surface, as I'll discuss later).

Seasons are explained as being the result of changes in the Sun's motion. During the northern summer, the Sun is hovering above the disk, moving around in a path close to the middle of the disk. Conversely, during the northern winter, the Sun is moving around in a path that is farther away from the center.

The farthest north (or "inwards") the Sun ever gets occurs during the solstice in late June. On this day, the Sun moves above an imaginary circle known as the Tropic of Cancer (shown in the image to the right by the inner green circle). From that point on, it slowly spirals outwards.

Six months later, on the late December solstice, the Sun has reached the Tropic of Capricorn (the outer green circle). At that point, its motion changes again, and it slowly begins to spiral inwards until it reaches the Tropic of Cancer again. This inwards/outwards/inwards/outwards cycle repeats forever.



But this cycle poses several problems. As the Sun spirals outwards, what forces alter its motion, constraining it eventually to the Tropic of Capricorn? What forces then guide it inwards again? And once it's moving inwards, what stops it from moving past the Tropic of Cancer? Etc.

Also, notice that each trip around the Earth takes 24 hours (one day) — regardless of the time of year. But as the Sun moves towards the outer rim of the disk, its daily path gets longer, because the 'circles' get larger. What force accelerates the Sun as it moves outwards, so that it travels faster each day, *precisely* enough to compensate for the slightly larger circle (so that each trip still takes 24 hours)? Similarly, what slows it down precisely enough as it then moves inwards again?

Incidentally, notice that these motions are also the opposite of what one would expect if normal orbital processes were involved. (Kepler's third law shows that an orbiting object moves more quickly when its path is smaller.)

#2: Gravity

The flat earth idea requires the Sun to hover above the disk of the Earth. But gravity would obviously prevent this, by causing the Sun to fall onto the Earth.

In response, many flat-earthers claim that gravity is a hoax. They say that the phenomena that are usually explained by gravity are better explained by "Universal Acceleration"; the idea that when we see objects falling toward the Earth, they aren't really falling. Instead, the Earth's disk is perpetually accelerating upwards, and crashing into the objects from underneath.

But even if that were true, the Earth's disk would also crash into the Sun from underneath, which it obviously hasn't done.

Either way, gravity disproves the flat earth idea.

#3: The Sun's distance and position

In 240 B.C., the ancient Greek mathematician Eratosthenes measured the Sun's angle of elevation (about 7.2 degrees) on the summer solstice in Alexandria, Egypt.

With some simple geometry, he then calculated (fairly accurately) the Earth's circumference. This calculation was based on his belief that the Earth is a sphere. And so, this is good support for the Earth being (roughly) spherical, rather than a disk.

If you assume instead that the Earth is actually a flat disk, this changes the geometry that applies to this calculation. Eratosthenes' measurement would then prove that the Sun is *very* close to the Earth: roughly 3,958 miles above the Earth's surface. (And even the flat-earthers admit this.)

For perspective, that's less than the distance between Anchorage, Alaska and Miami, Florida. It's roughly the same distance as that between Paris and Washington, D.C.

There are obviously many problems associated with this idea.

#4: The Sun's light

If the flat earth idea is correct, no point on the Earth would ever experience darkness. If the disk is flat, and the Sun hovers above it, then *the Sun would always be visible from any point on its surface*.

It's straightforward to show geometrically that sunrises and sunsets would be impossible, if the disk idea is correct. But flat earthers tend to ignore all this.

Instead, they just assert that if the Sun were far enough away from an observer, the sky would be dark from that observer's perspective.

This would require that the Sun shines a 'spotlight' of some sort onto the Earth.

But sunlight doesn't arrive here as a spotlight. First of all, our atmosphere scatters and spreads sunlight onto the Earth. (This is called *Rayleigh scattering*—it's the reason why the daytime sky is blue.)

Second, consider what happens as the seasons progress. For example, during summer solstice in Greenwich in the U.K., the sun at its zenith will be directly south, right above the Tropic of Cancer. (This is Point A in the diagram.)

On this day, its light extends to the farthest point across the North Pole that it ever reaches: *just* to the far side of the Arctic Circle (but no farther). Thus, if the Sun actually shines a spotlight on the Earth, this is its maximum radius.

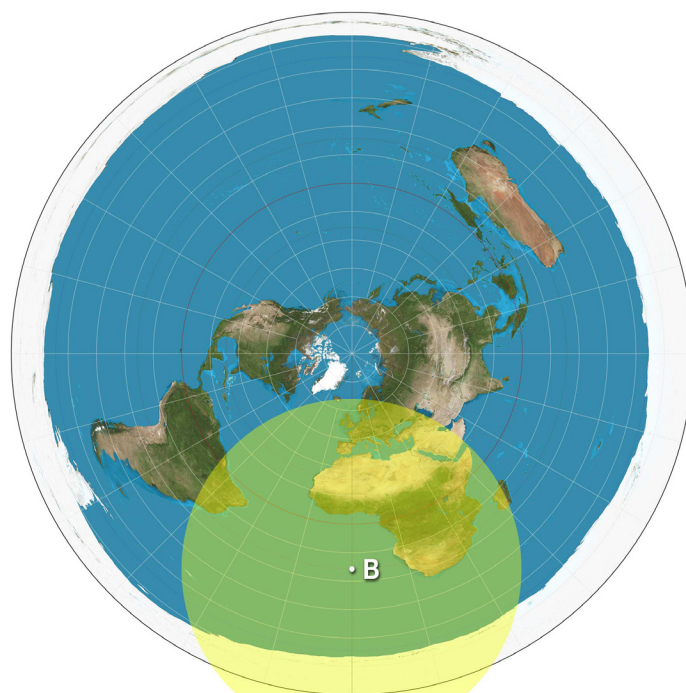
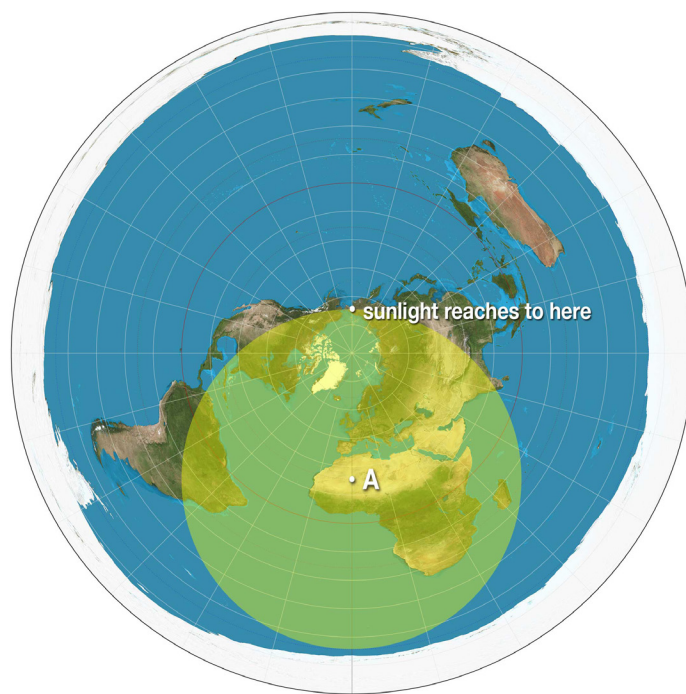
Now consider the situation six months later. It's now winter solstice at Greenwich, and the sun at its zenith will be directly south, but this time it will be above the Tropic of Capricorn (Point B in the next diagram).

If you draw the same spotlight again, but centered on this new location, you again see the maximum extent of the sunlight/spotlight. Notice that at this particular moment, part of Madagascar and most of South America are both in darkness.

If the flat-earth model is correct, Madagascar and the bulk of South America could never be in daylight at the same time. Obviously, this is incorrect.

Also notice that for this specific example, this is the *longest* day of the year for people in the Southern Hemisphere. Yet in the flat earth hypothesis, folks in Madagascar would be watching the sun set at about 3 PM, while over in São Paulo in Brazil, it's 9 AM and the sun hasn't risen yet! Obviously, this is wrong.

Of course, I've assumed here that the Sun stays at roughly the same distance from Earth throughout its annual "cycle". So, a potential rebuttal would be that the Sun moves significantly closer to the Earth during the southern summer. But that's obviously *ad hoc*. Furthermore, if it were true, it would be observable to us. But we don't observe it.



#5: Grotesque geographic distortions

The disk idea has other testable consequences, which it likewise fails. For example, let's look at two cities in Australia: Perth and Sydney.

Using their latitudes and longitudes, we can calculate their distance according to the disk model. Sydney would be 8,602 miles from the North Pole, and Perth 8,469 miles. They are separated by 35.35 degrees of longitude.

As shown here, this means that according to the flat earth idea, the distance between the two cities is 5,185 miles.

But in the real world, a flight from Perth to Sydney travels only 2,038 miles (see for example www.airmilescalculator.com/distance/per-to-syd/).

This can also be verified using Google Maps, which shows that you can drive this distance (in a longer, non-direct route) in only 3,938 km, which is 2,447 miles.

So here's a challenge to the flat earthers. They could prove their idea is correct, just by driving directly across Australia and showing that the *real* distance is more than twice as long as what everybody else thinks it is.

Similar arguments could be made for other trips, e.g. a sea voyage between Australia and Chile. The disk idea would again be off by many thousands of miles here.

Overall, the flat earth has massive implications for travel and navigation. A flat-earther has to believe that not only is NASA a giant conspiracy, but the conspiracy also includes all the world's airlines, shipping companies, map makers, Google, Bing, Yahoo, etc. etc. etc. — all of whom are covering up the true distances that travel requires.

And, as mentioned at the beginning of this document, there are many observations in astronomy that disprove the flat earth. For many, many reasons, the flat earth idea fails.

Spike Psarris
www.CreationAstronomy.com

