



2012

by Alice Enevoldsen (Pacific Science Center)

Perhaps the longest-standing prediction of the end of the world comes to its final reckoning in December of 2012. Are you ready? I'm stocking up on reality, logic, science, and rationality and am ready to teach my way through this non-apocalypse.

I truly hope 2012 brings less tragedy than previous end-of-the-world predictions like those of Heaven's Gate and other doomsday cults. Fear and panic are very real even if 2012 is not. Seek professional help for anyone you know who is truly afraid.

Actions: How to Talk About 2012

- **Validate:** Your students are intelligent people, so treat them as such. Validate their interest in the topic and acknowledge correct facts first.
- **Quash:** This hoax is causing too much panic, so you need to quash it as soon as possible, without being mean (anger will get you nowhere). Share facts from reliable sources and avoid getting stuck in arguments that have no hope of resolution.
- **Suggest:** Find some common ground. Suggest something real and related that you can enjoy together. Easy examples for 2012 are the solar eclipse visible from parts of the United States in May, the transit of Venus in June, safely viewing sunspots throughout the year, or going out to watch a meteor shower in August (Perseids), November (Leonids) or December (Orionids).

The 2012 Hoax: The Kitchen Sink of Doomsday Stories

2012 has become the kitchen sink of hoaxes. What with the non-existent planet Nibiru, the rollover of the Maya Long Count, a long-expected and non-existent conjunction of planets, some sunspots, a lack of reversal in the Earth's mag-



Maya Priest Tiburcio Can May greeting the rising Sun on the day of zenith passage at Chichen Itza, Mexico. (Image credit: Bryan Mendez, UC Berkeley Space Science Lab Calendar in the Sky Project)

netic field, and the continued alignment of the Earth, Sun, and galactic center, 2012 has a lot that has been sensationalized as part of its apocalypse story. This hoax rolls pretty much every astronomy-related doomsday thread into one.

Let's tackle the six biggest pieces one at a time. We'll do the quick ones first:

Nibiru, the Fictional Planet

- Is the Earth in danger from an unknown planet? **No.**

Nibiru is the name given to a non-existent planet supposedly discovered by the ancient Sumerians (2200 B.C.E. to 1600 B.C.E.). This discovery was entirely made up by Zecharia Sitchin in several fictional novels that he has written since 1970 about ancient Mesopotamian culture. Nancy Lieder, a "psychic," built upon these stories, saying the Earth was in danger from Nibiru in May 2003. Nothing happened in May 2003 so the "end" of the Mayan calendar was rolled into the hoax, giving the date December 21, 2012 as the "real" date

of the disaster.

There is no planet Nibiru. Planets are large enough that if there was a planet endangering the Earth in 2012, we'd be able to see it already.

Polar Shift: Tipping the Earth Upside Down

Magnetic Poles

- Will the Earth's magnetic poles flip in 2012? **No.**
- Will the magnetic pole reversal cause monster earthquakes or risk of extinction due to radiation? **No.**

Rotational Poles

- Will the Earth's rotational poles flip in 2012? **No.**

In the geologic record there is strong evidence that the Earth's geomagnetic field reverses polarity every several hundred thousand years with no regularity. There is nothing to suggest this poses a threat to life on Earth, and scientists can't predict when the next one will happen even to the nearest 100,000 years, let alone to the nearest decade.

"Polar Shift" refers to something different though—it refers to a physical change in the tilt of the Earth. This happened to Uranus in the past, and generally requires being slammed into by something very massive. There is nothing that massive on a collision course with Earth within your lifetime, and nothing that massive on a collision course with Earth at all as far as we know.

Planetary Alignment: Pretty Planets All in a Row

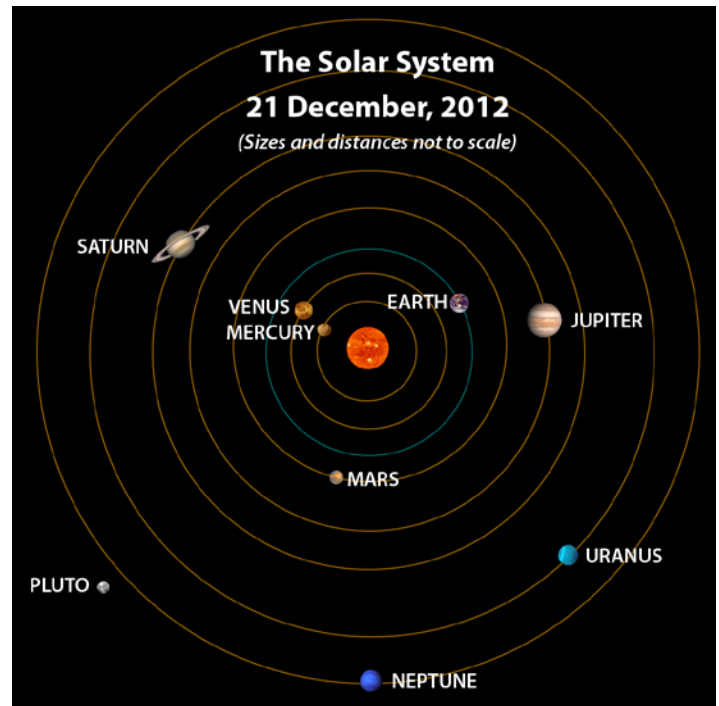
- Will the planets align in 2012? **No.**
- Will an alignment of the planets cause gravity to go crazy? **No.**

The planets will not be aligned on 12/12/2012 or any other day in 2012. Their positions on that date are shown top right.

If you look at another view of the same picture (see page 7), they do look aligned, but that line is the ecliptic—the line through the plane of our solar system. All planets are always aligned along this line: every moment of every day of every year. That is the definition of the ecliptic.

What is the ecliptic? All the planets in our solar system orbit in the same plane. It is also true that the students in your classroom are sitting in the same plane: they're all sitting in chairs at desks. You wouldn't, for instance, ever find a student on the ceiling or underneath your feet (hopefully).

If you sit among your students and you look for them you'll be looking around yourself in a line—not around the whole sphere around yourself. That line where the students are is a representation of the ecliptic.

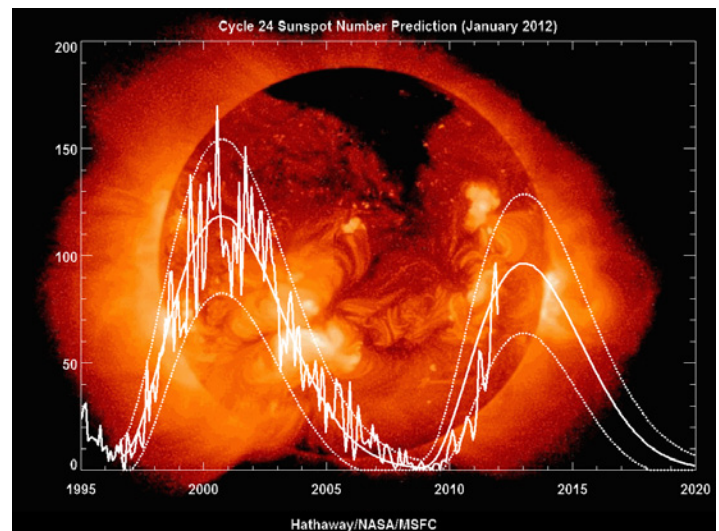


Planetary Positions on December 21, 2012.

Solar Maximum: the Sun Throws a Temper Tantrum

- Will the Sun be extra active in 2012? **Yes.**
- Will we be in danger from extra solar radiation during 2012? **No.**

The solar activity cycle lasts about 11 years, and the last maximum of activity was in 2001, which would imply a maximum in 2012. NASA is now predicting that this cycle's Solar maximum won't happen until May of 2013, and most of the biggest flares often occur just after the maximum. It's pretty neat, so get a trained astronomer to help you carefully



Solar activity will increase during 2012 as the Sun follows an 11 year activity cycle. Image credit: Hathaway/NASA/MSFC

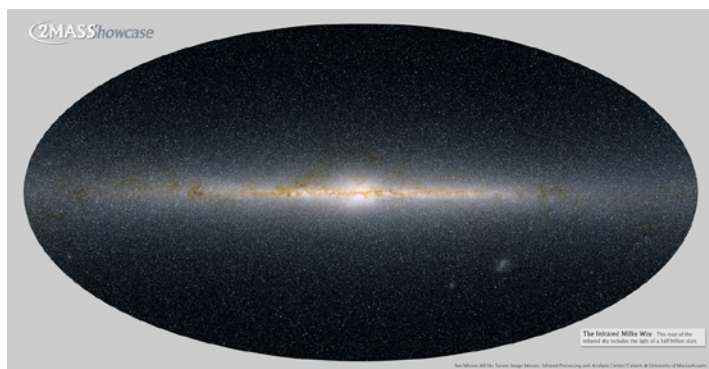
observe sunspots (always use approved filters to observe the Sun, never look directly at it!).

Solar maximum is of more concern to satellites and people working in space than it is for us with our feet on the ground. Down here we're protected by both the atmosphere and the Earth's magnetic field. We'll get some extra auroras, and you might hear more static on overseas calls than you usually do.

Galactic Alignment: Fried Eggs and Blueberry Pancakes

- Will the Sun, the Earth, and the center of the Galaxy be aligned on December 21, 2012? **Yes, as much as they ever are.**
- Will this alignment cause anything on Earth? **No.**

The Sun, the Earth, and the center of the galaxy will be sort-of aligned on December 21, 2012. Actually, they're aligned the same way every winter solstice and have been for decades. We also know that the three won't exactly align—they stay about 5.5 degrees apart—but the closest they'll be in your lifetime was back in 1998, not in 2012.

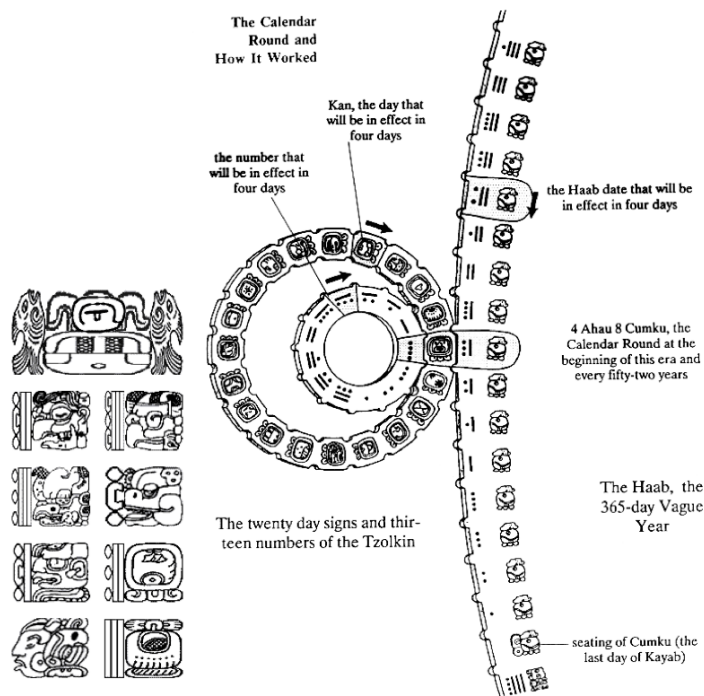


The Milky Way Galaxy in infrared, showing the bright central bulge and dust clouds in the galactic plane. Image Credit: Atlas Image courtesy of 2MASS/UMass/IPAC-Caltech/NASA/NSF

A related argument states that the solar system will pass through or out of the galactic plane. Setting aside the fact that we'd have to define what we mean by "galactic plane" it is worthwhile to note that the galaxy has thickness like a pancake or a fried egg, and the solar system is in the middle of that thickness. Think of us as a blueberry seed in a blueberry pancake. It will take us a while to pass fully through the galactic plane. We'll be in the middle for several million more years.

The Maya Calendar "Ends"—Just Like Ours Did

- Will the Maya Calendar end in 2012? **No.**
- Will the Maya Calendar roll over in 2012? **Yes.**



Mayan calendar glyphs and how the calendar round works. Images courtesy of Alice Enevoldsen

Maya Long Count Cheat Sheet

- 1 kin = 1 day
- 1 uinal = 20 kin = 20 days
- 1 tun = 18 uinal = 360 days
- 1 katun = 20 tun = 7200 days (about 20 years)
- 1 baktun = 20 katun = 144000 days (about 400 years)
- 1 may = 13 katun = 93600 days (about 255 years)
- 20 may = 13 baktun = 260 katun = 1872000 days (about 5000 years)
- 13 baktun (or 20 may) is when the Long Count rolls over

- 1 pictun = 20 baktun = 2880000 days (about 8000 years)
- 1 calabtun = 20 pictun = 57600000 days (about 150000 years)
- 1 kinchiltun = 20 calabtun = 1152000000 days (about 3 million years)
- 1 alautun = 20 kinchiltuns = 23 040 000 000 days (about 63 million years)

The 13th Maya *baktun* rolls over on December 21, 2012 — this is often referred to as “the end of the Maya Long Count.” As with many cultures’ calendars, the Maya calendar uses different periods of time than the calendar stuck to your fridge right now. They use 5 numbers to represent a given date, called the Long Count. A *baktun* = 20 *katun*, a *katun* = 20 *tun*, 1 *tun* = 18 *uinal*, 1 *uinal* = 1 *kin* (which is one day). Americans usually use only three numbers: year, month, and day.

Both cultures have designations for larger periods of time as well, we just don't track them as closely. For instance the Maya have a *calabtun* which is over 3 million years, and Americans have millenniums—1000 years each. Like an odometer, when one of the dials reaches “9” the next numeral to show up in its place is “0”, when the *baktun* counter of the Long Count reaches “12” it rolls over to “0.”

The end of the long count is like buying a new year's calendar, or when the mileage on your beater car finally rolls so high that it reads 000000. We were all very excited when we got to turn over all the numbers in our calendar on New Year's 2000—so I'd be just as excited about 12/21/2012 if I used the ancient Maya calendar in my daily life.

When working with students on this concept, it could be fun to make a physical calendar with a different number of days in a week, weeks in a month, (etc) and check off the days as time passes. (See activity below) If you do this at the beginning of the year, you can track how the class moves through different students' calendars throughout the term.

If you use the actual Maya lengths above, be careful to point out whether you have aligned the calendar correctly with the everyday calendar you use in your classroom or not, otherwise you'll get to “the end of the world” and your calendar may say it is simply the 4th kin of the 2nd uinal of the 1st tun. If you make everything up from scratch, as if we lived on an alien world, you won't accidentally offend an existing culture by mis-using their calendar.

On Language — Hoax

A bit about the word hoax. Hoax implies that someone is doing this on purpose, trying to pull one over on other people. For some parts of the 2012 story, “hoax” applies. For other parts of the story “misunderstanding” is more accurate. I will continue to use the word hoax, because it carries more weight—and this misunderstanding has the potential to take people's lives.

Featured Activity and Resources

Activity – DIY Calendar

Materials:

- Graph paper or a ruler
- Pencil
- Art Supplies
- Calculator—optional

We know there are 365 days in a year. Have students choose new lengths of time and new names for weeks and months. To make your own calendar follow these steps.

1. Pick a new number of days to have in a week: ____
 - a. Pick a new name for a “week”: _____
2. Pick a new number of days to have in a month: ____
 - a. Pick a name for this “month”: _____

Direct them to draw out their calendars (or a few months of their calendars), labeling each day with its new date and decorating the top with a themed picture.

1. How many days across does one month of your calendar need to be? ____
 - a. Hint: this is the same as the number of days in a week.
2. How many days tall does one month of your calendar need to be? ____
 - a. Hint: divide the number of days in the month by the number of days in a week. If you have a remainder, the last week of your month will be shorter than the others. It will be as many days long as you have leftover.
3. Draw a table that is that many boxes tall and that many boxes across. If you use graph paper you can just trace out the right number of boxes.
4. Number the days. You can write the names as well if you like.
5. When you have completed one month, draw the next month.
 - a. Hint: Start numbering the next month on the next day of the week from when the last month ended.

You can complete a whole year of your calendar if you like, or just do a couple months.

Have students calculate how many months are in their year. What will happen if they don't have an exact number of months in the year? Will they add the leftover days to other months? Have a celebration week at the end of the year that isn't part of any other month?

Don't forget to decorate your calendar!

Example

Heather chooses:

- 1 day will be called 1 Sun and will be the same as a regular day.
- 1 week will be called 1 Teen and will be 10 Suns long
- 1 month will be called 1 Urn and will be 36 Suns long.

Urn 1

Teen1	Teen2	Teen3	Teen4	Teen5	Teen6	Teen7	Teen8	Teen9	Teen10
1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36				

Urn 2

Teen1	Teen2	Teen3	Teen4	Teen5	Teen6	Teen7	Teen8	Teen9	Teen10
						1	2	3	4
5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32	33	34
35	36								

After 10 Urns we'll get almost to the end of a year—but what should Heather do with the leftover 5 days to make a complete year?

Alternatives for elementary school classrooms:

- Work together to make one classroom calendar.
- Have the teacher do the math as a demonstration, or choose numbers that make for easy division.
- Ask the students to invent holidays on dates that look interesting to them.
- Assign a real date to each date on your new calendar.

Expansions for high school or astronomy classes:

- Choose a known planet. Calculate the length of a day and the length of a year. Choose your “week” and “month” lengths to make sense with those periods. Also map out “Earth days” on your calendar so you can check them off as time passes. (Warning, choosing Venus or Mercury will be extra-difficult)
- Figure out how to deal with the fact that the Earth's year is 365.24 days long, not 365.

Resources

Doomsday 2012, the Planet Nibiru, and Cosmophobia by David Morrison (NASA Astrobiology Institute), an article from the Astronomical Society of the Pacific: <http://astrosociety.org/2012/>

An archive of 2012 articles from Universe Today, an online newsletter on space science:

<http://www.universetoday.com/category/2012/>

Articles from Sky and Telescope Magazine:

The Great 2012 Scare – and What You Need to Know:

<http://www.skyandtelescope.com/about/pressreleases/64679127.html>

December 21, 2012: <http://www.skyandtelescope.com/community/skyblog/newsblog/64430612.html>

Questions and Answers from NASA's Ask an Astrobiologist, including a video clip with David Morrison:

<http://astrobiology.nasa.gov/ask-an-astrobiologist/intro/nibiru-and-doomsday-2012-questions-and-answers>

Alice's AstroInfo: <http://www.alicesastroinfo.com/2008/08/planetary-alignment/>

Astronomy Answers: 21 December 2012:

<http://aa.quae.nl/en/2012.html>

Information on a variety of historical calendars, including those from Central America:

http://aa.quae.nl/en/antwoorden/historische_kalenders.html

The Mayan Calendar and the 2012 Hoax, an article from NASA's Sun-Earth Day:

http://sunearthday.nasa.gov/2011/articles/2012_hoax.php

Calendar in the Sky, a NASA funded project of the UC Berkeley Center for Science Education at the Space

Sciences Laboratory connecting the knowledge of the Maya to NASA science: <http://www.calendarinthesky.org/>

Tales of the Maya Skies, a planetarium show about the Maya calendar: <http://www.mayaskies.org/>

Ancient Observatories, a website including Maya astronomy from The Exploratorium:

<http://www.exploratorium.edu/ancientobs/index.html>

Counting Time Through the Ages, a primer on the Mayan Calendar from FAMSI, the Foundation for the Advancement of MesoAmerican Studies at the Los Angeles County Museum of Art:

<http://www.famsi.org/research/pitts/MayaGlyphsBook2Sect2.pdf>

It's Not the End of the World: What the Ancient Maya Tell Us About 2012. An article by Mark Van Stone for

FAMSI: <http://www.famsi.org/research/vanstone/2012/index.html>

Awesome links for teachers:

Create your own diagrams of planetary positions using Solar System Live:

<http://www.fourmilab.ch/solar/>

Stellarium:

<http://www.stellarium.org/>

A simple animation of the progression of days in the Maya Tzolkin calendar:

http://www.getflashy.com/stuff/cal_round.html

The Maya Cycles of Time:

<http://mathdl.maa.org/mathDL/46/?pa=content&sa=viewDocument&nodeId=1459>



The position of several planets viewed from Earth at noon on December 21, 2012. Image created with Stellarium