

Teacher Guide: Seasons Around the World



Learning Objectives

Students will ...

- Determine the areas of Earth that experience the most seasonal variations.
- Understand why the equator's temperatures remain relatively constant year-round.
- Explain why temperature differences between different latitudes are greater in winter than in summer.
- Discover how changing the tilt of Earth's axis would affect the seasons in a particular location.



Vocabulary

Arctic Circle, axis, equator, equinox, North Pole, solar energy, solar intensity, solstice, Tropic of Cancer



Lesson Overview

The North Pole remains completely dark during the winter. But during the summer there, the Sun never sets. What causes this extreme seasonal variation? Students can explore the answer to this question and many others using the *Seasons Around the World Gizmo*™.

This Gizmo was designed as a follow-up to the *Seasons in 3D Gizmo*. In this Gizmo, students explore in depth how seasons vary by latitude and how Earth's seasons would change if Earth's axial tilt changed.



The North Pole (marked by a red dot) during the summer

The Student Exploration sheet contains three activities:

- Activity A – Students compare seasonal changes in tropical and arctic regions.
- Activity B – Students discover why temperature differences between different latitudes are greater in winter than in summer.
- Activity C – Students explore how changing the tilt of Earth's axis affects climate.



Suggested Lesson Sequence

1. **Pre-Gizmo activities** (🧠 variable)

Do the *Seasons in 3D Gizmo* and Student Exploration sheet with your students. Check that students understand what causes Earth's seasons and why the length of the day varies from season to season in the Northern and Southern Hemispheres.

In addition to the *Seasons in 3D Gizmo*, you may want to have students explore the *Seasons: Why Do We Have Them?* and/or the *Seasons: Earth, Moon, and Sun Gizmos* before assigning the *Seasons Around the World Gizmo*.

2. **Prior to using the Gizmo** (🕒 10 – 15 minutes)
Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. Discuss student answers as a class, but do not provide correct answers at this point. Afterwards, if possible, use a projector to introduce the Gizmo and demonstrate its basic operations. Demonstrate how to take a screenshot and paste the image into a blank document.
3. **Gizmo activities** (🕒 15 – 20 minutes per activity)
Assign students to computers. Students can work individually or in small groups. Ask students to work through the activities in the Student Exploration using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity.
4. **Discussion questions** (🕒 15 – 30 minutes)
As students are working or just after they are done, discuss the following questions:
- Why doesn't the Sun set at the North Pole during the summer? Can the Sun be seen from the South Pole during this time?
 - Why do regions around the equator experience very little seasonal variation?
 - How does solar intensity relate to the angle of the Sun's rays?
 - What two factors determine the total amount of solar energy an area experiences every day?
 - Other than latitude, what other factors do you think would affect a region's climate? [Answers may include proximity to a large body of water, elevation, proximity to cold-water or warm-water currents, etc.]
 - How would changing the tilt of Earth's axis, even by just a few degrees, affect the amount of sunlight falling on Earth's poles?
5. **Follow-up activity: Travel plans** (🕒 variable)
Have students choose a far-away place they might like to visit one day such as Antarctica, South Africa, or Greenland. Ask students to use what they have learned about seasonal variations at different latitudes to determine which time of year would most likely be the best time to visit that location.

Students should put together a short presentation on the location of their choice. For example, students could do a slideshow or travel poster. In their presentations, students should give climate data about the seasonal variations experienced by the location, the season they think would be best to visit the location, and the reasons why that season would be ideal for travel.



Scientific Background

The further you live from the equator, the more pronounced are the seasons. This occurs because the intensity and amount of sunlight varies much more at higher latitudes than at the equator. Tropical regions do not experience winter, spring, summer, or fall because the intensity of sunlight, day length, and average temperatures do not vary much throughout the year. Instead, they typically experience wet and dry seasons. The tilt of Earth's axis causes seasons and also accounts for the differences in seasonal changes between the tropics and poles.

During winter on the North Pole, the Sun never rises above the horizon. This results in months of darkness and extremely cold temperatures. The Sun finally rises above the horizon on March 21, the spring equinox. The Sun remains above the horizon in a continuous day until the autumnal equinox around September 22.

On the equator, the Sun rises around 6:00 A.M. and sets around 6:00 P.M. every day. There is also relatively little variation in the altitude of the noon Sun, which ranges from 90 degrees on the equinoxes to 66.5 degrees on the solstices. This results in consistently warm temperatures throughout the year. As you travel north from the equator, summers tend to stay warm because the lower altitude of the Sun is offset by the increasing length of the day. Winters tend to get much colder because days are shorter and the Sun does not rise as high.

Currently, Earth's axis is tilted approximately 23.5°. However, this is not always the case. The tilt of Earth's axis changes by a small amount every year. Over a cycle lasting approximately 41,000 years, the axial tilt varies between 22.2° to 24.5°. In addition to changing its tilt, the axis also wobbles, a motion called *precession*. Because of precession, Earth's axis traces a full circle approximately every 25,700 years.



Astronomy Connection: Seasons on other planets

Like Earth, other planets in the solar system have seasons. The seasons experienced by each planet are determined by two factors: the planet's axial tilt and *orbital eccentricity* (how much the distance between the planet and the Sun changes as the planet moves in its orbit). Earth's orbit is nearly a perfect circle, so its orbital eccentricity has little effect on seasons. Mars has greater axial tilt than Earth and greater orbital eccentricity—its distance from the Sun varies between 1.64 and 1.36 AU. This causes Mars to experience dramatic seasonal changes.

Another planet with drastic seasonal changes is Uranus. These changes are caused by Uranus's extreme axial tilt (82°). Because of this tilt, the Sun shines directly on one of Uranus's poles for about 84 Earth years at a time (one-fourth of Uranus's year). Other parts of the planet remain in the dark during this time. When sunlight finally begins to fall on these areas, the sudden warming leads to gigantic, violent spring storms. Still other planets have seasons that defy definition. Mercury, for example, has an axis that is almost perfectly perpendicular to its orbit, but it has a high orbital eccentricity and Mercury only spins on its axis 1.5 times every time it orbits the Sun. These two factors work together to make Mercury's surface temperatures irregular and highly variable, ranging in some locations from -183° C to 427° C.



Selected Web Resources

Cause of seasons: <http://www.scienceu.com/observatory/articles/seasons/seasons.html>,
<http://www.usno.navy.mil/USNO/astronomical-applications/astronomical-information-center/seasons-orbit/>

Seasons and latitude: <http://geography.about.com/od/physicalgeography/a/fourseasons.htm>

Seasons on other planets:

http://www.nasa.gov/audience/foreducators/postsecondary/features/F_Planet_Seasons.html

Related Gizmos:

Seasons: *Why Do We Have Them?* <http://www.explorellearning.com/gizmo/id?407>

Seasons: *Earth, Moon, and Sun*: <http://www.explorellearning.com/gizmo/id?468>

Seasons in 3D: <http://www.explorellearning.com/gizmo/id?463>

Summer and Winter: <http://www.explorellearning.com/gizmo/id?656>