

Web Resources for the Seasons

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A few years ago, in the Annenburg/CPB video "Private Universe," students (and faculty) revealed significant misconceptions regarding the cause of the seasons. Rather than citing the correct cause - the Earth's axial tilt in relation to the orbital plane of the Sun and Earth - the majority of those interviewed incorrectly believed that seasonal change was due to Earth-Sun distance. That is, when the Earth is closest to the Sun (perihelion) there is summer and when farthest away (aphelion), winter. This entrenched misconception might be explained by any number of factors including the following:

- focus on the Earth's slightly elliptical orbit which students inadvertently translate into the cause of seasonal variations;
- logic based on an understanding that closer to a heat source is warmer; the true reason for the seasons thus seems counter intuitive to people's experiences with heat; and
- lack of understanding of how oblique and direct insolation heat the Earth's surface.

Fortunately, there are many interactive databases, animations and images, lesson plans, and content resources to assist in teaching about the cause of the seasons and to address misconceptions.

The sites reviewed should not be viewed as a "best of the best" list. Many worthy resources do not appear because of space limitations. The sites reviewed are archived at "Resources For Earth Science And Geography Instruction" (<http://webs.cmich.edu/resgi/>) and were featured on the weekly "Earth Science Sites of the Week Listserv." To suggest useful sites for listing in future installments or to be added to the listserv please contact Mark.Francek@cmich.edu

Site Name	Author	URL	Description
Interactive Databases			
Sun or Moon Rise/Set Table for One Year	US Naval Observatory	http://aa.usno.navy.mil/data/	Tables of sunrise and sunset can be generated for any place in the world. Students can calculate the length of days by using this data and then graph this data, making for an excellent spreadsheet activity. This site is also useful for seasonal change discussions and is especially important for students with very limited direct outdoor experience with day length or students living between the Tropic of Cancer and the Tropic of Capricorn
Sunshine Applet	Juergen Giesen's	http://www.jgiesen.de/sunshine/index.htm	With this Java applet, students can set the any date and any location in order to view on a pie chart hours of daylight and darkness. Also depicted is the position of the sun at two hour intervals for the day selected. Below this window is a map of the Earth showing the circle of illumination (the divider between the sunlight and shaded portion of Earth). Be sure to scroll down to see a pie graph showing the time the Sun will be above 45°. When the Sun rises above this level, the probability of sunburn increases
Sun's Path	Australian National University	http://solar.anu.edu.au/Sun/SunPath/index.html	The site allows students to simulate the Sun's position and path during an hour, a day, a month and a year at different latitudes. The path of the Sun is traced from sunrise to sunset on the day and yearly views, helping students to see that the Sun does not always rise due east, a difficult concept for many students. Since the noon shadow is shown students can observe that those areas north of the Tropic of Cancer will always have a solar noon shadow that points to true north
Animations and Images			
Cause of Seasons	Prentice Hall	http://esminfo.prenhall.com/science/geoanimations/animations/01_EarthSun_E2.html	This is a premier animation from Prentice Hall for showing the cause of the seasons. A special strength of the animation is the 'Show Earth Profile' inset that, when clicked, provides a close up of annual changes in the circle of illumination. The inset also points out where the direct rays of the Sun are striking (subsolar point) for equinox and solstice conditions.
Seasonal Sunlight Orbit, Declination and Sunlight on Ground	U. of Illinois	http://www.astro.uiuc.edu/projects/data/Seasons/seasons.html	Two things make this Flash animation unique. First, one inset pictures the Sun's seasonal variation in declination above the equator. Second, there is a rendering of seasonal variation in the amount of sunlight that would actually reach the ground. Superimposed on a gridded surface, this latter inset shows more concentrated sunlight reaching the northern hemisphere in summer months and gradually more diffuse sunlight as winter approaches.
Sunlight and the Seasons	Charles Burrows	http://www.eram.k12.ny.us/education/components/docmgr/default.php?sectiondetailid=17500&fileitem=635&catfilter=333	This Flash animation allows the user to view where the direct rays of the Sun are striking during solstice and the equinox. Note how the circle of illumination, the lit portion of the animation, changes for each date. The yellow line located on the right of the animation represents the subsolar point. Upper and lower arrows depict the Sun's oblique rays.

Seasons and Alignment	Exploratorium	http://www.exploratorium.edu/chaco/HTML/canyon.html	This animation shows the Sun's progression across the horizon throughout the year (note that the depiction of the Sun rising perpendicular to the horizon is not quite accurate; in reality, the Sun would rise at an angle for this latitude). The animation is part of the Chaco Canyon Observation site which provides resources about historical observations on seasons by Native Americans. To access the animation, click the "seasons and alignment" link at the top of the page.
Explaining Daylength	Montana Earth Science Picture of the Week	http://formontana.net/solstice.html	This satellite Arctic image, taken in January helps explain why day length is so short in the northern hemisphere winter. By looking at the location of two plotted points, Helena, Montana, and Anchorage, Alaska in relation to the circle of illumination, it is easy to see why winter days are short.
Lesson Plans			
Seasons of the Year	David Stern	http://www.phy6.org/stargaze/Sseason.htm	This lesson is part of a high school course on Physics, written by a retired NASA engineer. The lesson plan explores how the tilt of the Earth's axis to the ecliptic causes the seasons of the year. It covers length of day, effectiveness of sunlight, polar day and night, and seasons south and north of the equator.
Seasons: Why it's Essential	National Geographic	http://www.nationalgeographic.com/xpeditions/lessons/07/g912/seasons.html	This site provides a lesson plan about the causes for seasons for the middle or high school teachers incorporating standards. It links to activities for students to perform using minimal equipment. Possible assessments are provided.
The Cause of Earth's Seasons	Glenn Simonelli PUMAS	http://pumas.jpl.nasa.gov/examples/layout.asp?Document_ID=03_10_04_3	This is a hands-on activity explaining the cause of seasons for upper elementary level students (grades 3-5). The lesson begins with an instructor-led discussion, then proceeds to an experiment using globes and lamps
The Sun Times: Global Sun Temperature Project	Stevens Institute of Technology	http://k12science.ati.stevens-tech.edu/curriculum/tempproj3/en/index.shtml	An authentic research opportunity is provided for classes signed up for this project. Students from around the world collect data correlating latitude with temperature and hours of sunlight and submit the data online. Sunrise and sunset data from the U.S. Naval Observatory site are also recorded. Datasheets, reference materials, and temperature conversion tools are included. Since data is collected world-wide, students get the chance to compare data with data from other latitudes. The project is recommended for upper elementary through high school students.
To Every Season There is a Reason	Astronomical Society of the Pacific (ASP)	http://www.astrosociety.org/education/publications/tnl/29/29.html	This lesson is part of ASP's "Universe in the Classroom" program. It is suitable for middle or high school students. In addition to presenting the causes of the seasons, this lesson provides graphs and data charts for students to interpret.
The Reason for the Seasons	Aviation Now	http://www.aviationnow.com/content/ncof/lo_ewc01.htm	Using minimal equipment, in this case, "flashlight tag," this lesson teaches students of every level about how the Earth's tilt affects the intensity of the sunlight reaching the Earth's surface.
Content Resources			
Inter-planetary Fall	NASA	http://science.nasa.gov/headlines/y2000/ast22sep_1.htm?list110076	Information on seasons on different planets is given including a table showing the date of solstices and equinoxes on different planets.
Earth's Seasons	NOAA	http://kids.msfc.nasa.gov/earth/seasons/EarthSeasons.asp	Although better classified as an animation, this resource provides accompanying background audio defining equinoxes, solstices, and the causes of varying day length. An accompanying quiz (http://kids.msfc.nasa.gov/Puzzles/Fill-in/AutumnalEquinox.asp) allows students to check their understanding of key concepts related to the seasons.
Global Climate Maps	FAO	http://www.fao.org/WAICENT/FAOINFO/SUSTDEV/EIdirect/climate/EIsp0002.htm	Global climate data including temperature, rainfall amounts, sunshine fraction (percentage of time the Sun shines during a day,) climate classification, etc. provide material for teachers to use to structure student research projects involving the seasons. The data would be suitable for high school students.
The Seasons and Axis Tilt	Enchanted Learning	http://www.enchantedlearning.com/subjects/astronomy/planets/earth/Seasons.shtml	Find an easily understood explanation of the cause of the seasons. This site begins by pointing out that the cause is not the distance from the Sun. The site targets younger students and is jargon-free.
For Every Season: Tilt, Tilt, Tilt.	Virginia Commonwealth University	http://www.courses.vcu.edu/PHYS-aab/PHYZ103/CourseFiles/For%20Every%20Season.ppt#1	This PowerPoint presentation provides details about the cause of seasons. Unlike most sites it includes a combination of mathematics and analogy to explain why there are differences in the seasons.
Sun Control	Square One	http://www.squ1.com/index.php?http://www.squ1.com/solar/shading-design.html	The practicality of knowing the about seasons is stressed with this commercial site about home building. With proper design, homes can be built to take advantage of the Sun for heating in the winter and for cooling using shadows during the summer.