New Zealand Science Curriculum:
Astronomy Year 8

Part 1: What Causes the Seasons?

The Earth takes a single year (365 days) to orbit around the Sun. As the Earth travels around the Sun, its axis of rotation is tilted in relation to its orbit (i.e. to the plane of its orbit). This tilt of the Earth's rotation axis away or toward the Sun causes the seasons.

We call the plane of the Earth's orbit around the Sun the 'Ecliptic Plane'. The Earth's axis of rotation (the axis of Earth's rotation about itself) is tilted at approximately 23.5° to the Ecliptic Plane and remains tilted in the same direction throughout its orbit. However, at different times in the year, the Earth's rotation axis is tilted towards or away from the Sun and sometimes is not tilted towards or away from the Sun). The axis is tilted towards the Sun in summer, away from the Sun in winter, and neither toward nor away from the Sun in spring and autumn.

When we say that the axis is tilted towards the Sun in summer, away from the Sun in winter, and neither toward or away from the Sun in spring and autumn, we mean that the Earth is tilted towards the Sun in summer, away from the Sun in winter, and neither toward or away from the Sun in spring and autumn. Figure 1 (sourced from Quora.com) shows the tilt of the Earth, always pointing in the same direction throughout the Earth's orbit.

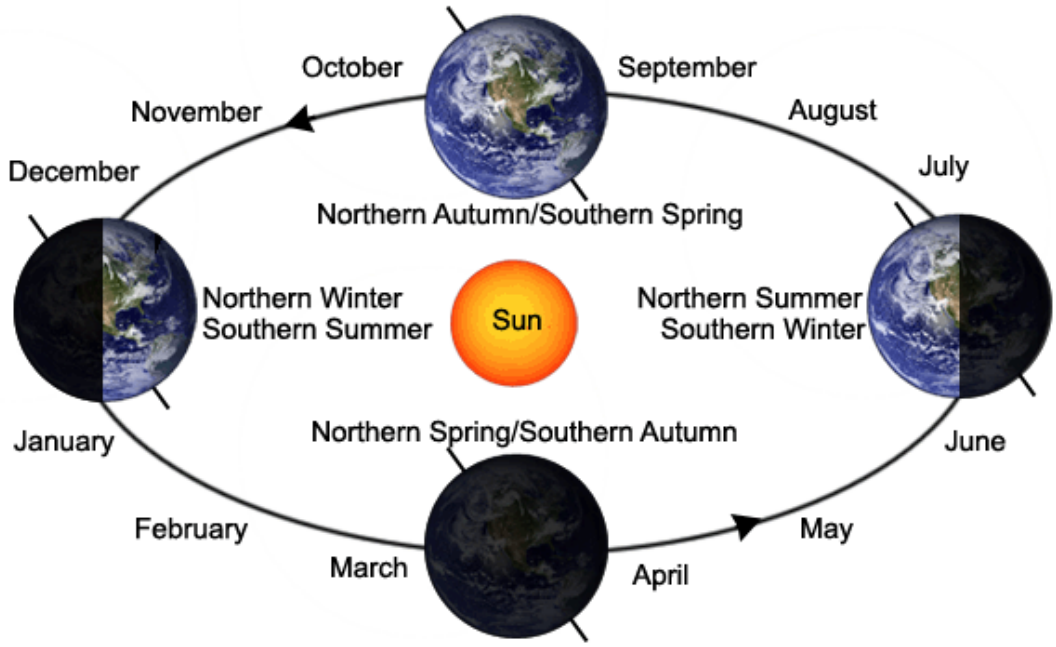

Figure 1: The Earth throughout its Orbit around the Sun

Summer and Winter

On the right of Figure 1, we see the northern hemisphere tilted towards the Sun. The Earth's axis of rotation is tilted towards the Sun and the whole of the northern hemisphere is tilted towards the Sun too. The whole of the southern hemisphere is tilted away from the Sun.

The short lines you see at each end of the Earth show its axis of rotation. At this time of the year (in the month of June - around the time of the northern hemisphere summer - the northern hemisphere Summer Solstice), when the northern hemisphere is tilted towards the Sun, a larger area of the northern hemisphere is also tilted towards the Sun than at other times. Therefore, the northern hemisphere receives more sunlight than at any other time of the year. This is the time of the northern hemisphere summer.

At the same time, the southern hemisphere is tilted away from the Sun and receives less sunlight than at any other time of the year. This is the southern hemisphere winter (the southern hemisphere Winter Solstice).

Six months later (in December - the Winter Solstice for the northern hemisphere and the Summer Solstice for the Southern Hemisphere), the northern hemisphere is now tilted away from the Sun. At this time, a much smaller area of the northern hemisphere receives sunlight than it did in summer. This is the northern hemisphere winter and the southern hemisphere summer.

In addition to the larger area of a hemisphere receiving sunlight in summer (and the smaller area receiving sunlight in winter), another factor leads to warm summers and cold winters - the different intensity of sunlight in summer, winter and the other seasons. Figure 2 (sourced from Wikipedia) shows how the tilt of the Earth leads to high density (high intensity) sunlight in the southern summer and low density (low intensity) sunlight in the northern winter.

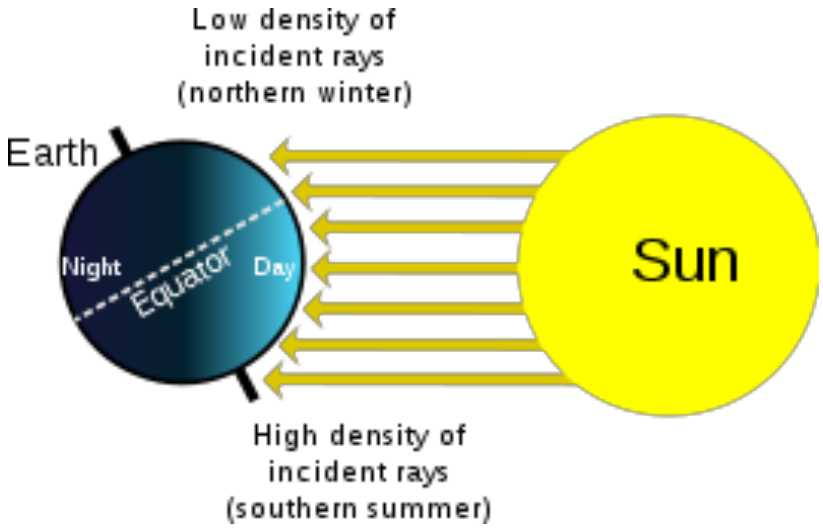

Figure 2: The Earth's Tilt - showing high intensity sunlight in the southern summer and low intensity sunlight in the northern winter

Sunlight is both more intense in summer than at other times and also covers a greater area of the hemisphere than at other times. That's why summer is warmer than winter.

Spring and Autumn
During the Northern Autumn/Southern Spring and the Southern Autumn/Northern Spring (the Spring and Autumn Equinoxes), the Earth is not tilted either toward or away from the Sun. At these times, the Earth's axis of rotation is roughly parallel with Earth's path around the Sun. During the equinoxes, the northern hemisphere and southern hemisphere receive roughly the same amount of sunlight. At this time, day and night are about equal in length (i.e. are about the same number of total hours in duration).

It is an interesting fact that the Sun and Earth are closer during the northern hemisphere winter than at any other time of the year. Being closer at this time does not affect the weather because of the very large distance between the Sun and Earth. It's really the amount of area exposed to sunlight and the intensity of the sunlight that causes the weather to be warmer in summer, colder in winter and in-between during spring and autumn.

More about the Solstices and Equinoxes

Part 2: Solstices

The solstice is the time during the Earth's orbit around the Sun when the Sun is highest in the sky and therefore at its greatest distance from the equator. During an equinox, the Sun is at its lowest in the sky during the year and farthest from the equator.

In the northern hemisphere the summer solstice takes place in June, and in the southern hemisphere, the solstice takes place in December. So, the northern hemisphere winter solstice (on 21 December) is the shortest day of the year, while the northern hemisphere summer solstice (21 June) is the longest day of the year.

The winter solstice (midwinter), is the day of the year with the shortest time of daylight and the longest night. It happens twice each year, once in each hemisphere. In the northern hemisphere, this is the December solstice (on 21 December) and in the southern hemisphere (the June solstice on 21 June). So, the winter solstice is the shortest day of the year while the summer solstice is the longest day of the year.

Figures 3 (sourced from the EpochTimes) gives another picture of the solstices and equinoxes, with dates for both hemispheres.

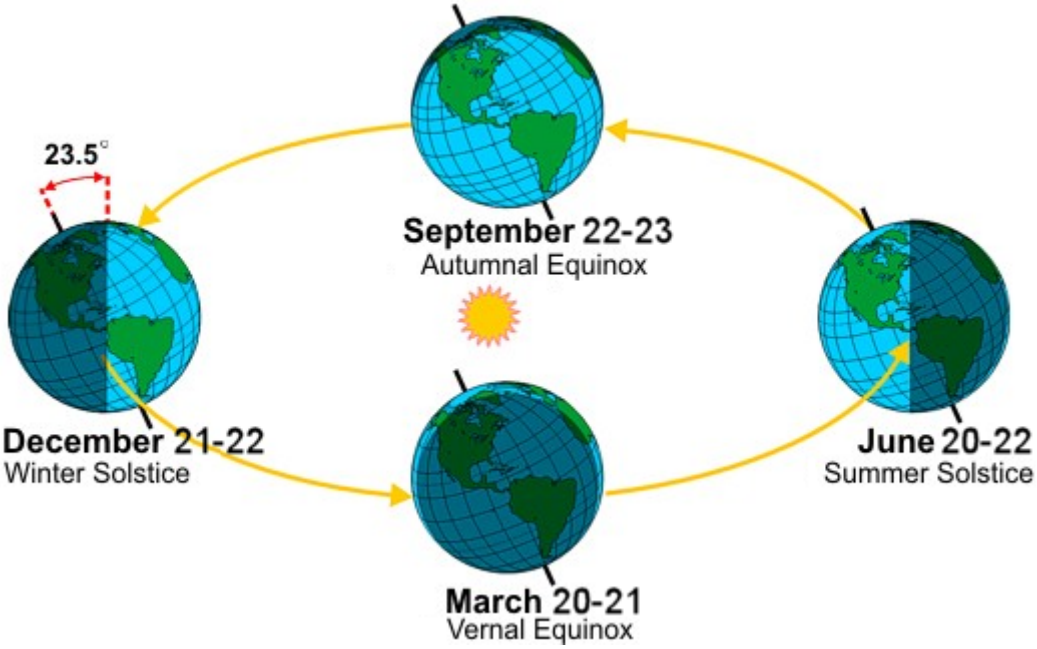

Figure 3: The Solstices and Equinoxes, with dates for both hemispheres

At a solstice, the Sun reaches its most northerly or most southerly point in the sky and the Sun looks farthest from the Earth's equator.

Part 3: Equinoxes

We can think of an equinox as the time when the Sun lies directly above the Earth's equator. During an equinox, the length of day and night are roughly the same over the Earth. So, during the the vernal equinox (21 March) and the autumnal equinox (22 September), night and day are roughly equally long.

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