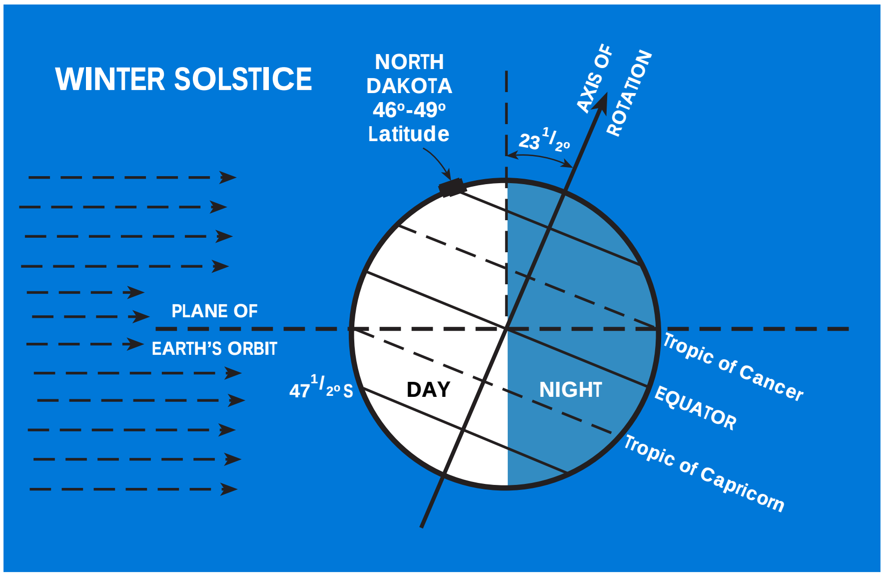
THE
ATMOSPHERIC RESERVOIR
Examining the Atmosphere and Atmospheric Resource Management

Our Changing Seasons

by Bruce Boe



The earth orbits the sun once every $365\frac{1}{4}$ days—the period we know as a year. As we orbit the sun, the earth is spinning on its axis, making one revolution every 24 hours. If the earth's axis of rotation was exactly vertical with respect to the plane of its orbit, every day and night would be the same length all over the planet, and the sun would always rise and set in the same place in the sky (at each latitude). We would not have seasons as we know them, for the sun would be at the same angle at noon on Dec. 21 as it would at noon on June 21.

However, this is not the case. The earth's axis is tipped from the vertical by $23\frac{1}{2}°$, and stays tipped at that angle throughout each orbit. Because of this inclination, the northern hemisphere leans toward the sun part of the year, and away from the sun some 182 days later. We know these periods of maximum "leaning" as the *summer and winter solstices*, respectively. In between these times, the amount of the lean is less as the earth moves from winter into spring, toward summer, and then from summer into autumn, back toward winter.

The times (twice a year) when the earth is leaning neither toward nor away from the sun are called the *equinoxes* (from the Latin meaning *equal night*). [Note that the earth is still tilted on its axis at these times, but the tilt is in the same direction as the earth's orbital path, not toward or away from the sun.] The *vernal equinox* marks the first day of spring, and the *autumnal equinox* the first day of autumn.

The earth's orientation at the first day of winter, the winter solstice, is illustrated above. On this date, the northern hemisphere is tilted away from the sun as far as it gets, and at noon, is directly above $23\frac{1}{2}°$ south latitude, the Tropic of Capricorn. Though the true latitude of North Dakota is about $47\frac{1}{2}°$ north, the northern hemisphere is tilted away from the sun by $23\frac{1}{2}°$ at this time, so the effective latitude of North Dakota at the winter solstice is $47\frac{1}{2}° + 23\frac{1}{2}° = 71°$. The solar angle is very low indeed. As a result, the sun stays low to the horizon even at noon. Look again at the illustration. Note how much of North Dakota's latitude lies in darkness at the winter solstice. No wonder our days are so short, and the nights so long!

There is good news in all this as well. To imagine North Dakota's circumstances at the summer solstice, all you need to do is look at the southern hemisphere in the illustration. The same latitude line is shown for your convenience. At that time, our days are very long, and because the extreme tilt is toward the sun, our effective latitude is $47\frac{1}{2}° - 23\frac{1}{2}° = 24°$, almost tropical!

Thus we now see why we have seasons, and why they are pronounced. This year, the winter solstice falls on Dec. 21. While officially the first day of winter, this date actually marks the time when the northern hemisphere begins to tilt back toward the sun, the days begin to get longer, and the sun climbs higher. Keep this in mind, and rest assured that the return of spring is inevitable. We'll see the first evidence, as lengthening days, on Dec. 22. ■

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