Reading this week: Chapter 4, Sections 4.1, 4.2, 4.3
Homework #1: due in lecture **today**
Recitations: begin this Friday
Help Room: soon will be set - see course website

Last time: **Finding your way in the sky (and on Earth)**

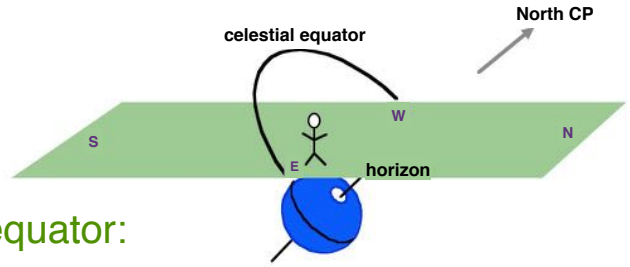
- The Celestial Sphere, link with terrestrial coordinates
- Horizon (local) System
  - altitude (horizon to zenith) and azimuth (East from due North)
- Celestial (Equatorial) coordinate system fixed to the stars

Today's themes: **Motions of the Sun & the Seasons**

- Finding the celestial pole and equator from anywhere
- Diurnal motions; the sidereal day and circumpolar regions
- The Motion of the Sun
  - the solar day (4 minutes longer than the sidereal day)
- The Ecliptic
  - inclination of the ecliptic = 23.5 degrees to celestial equator
- The Seasons

Finding the Celestial Pole and Equator in your sky

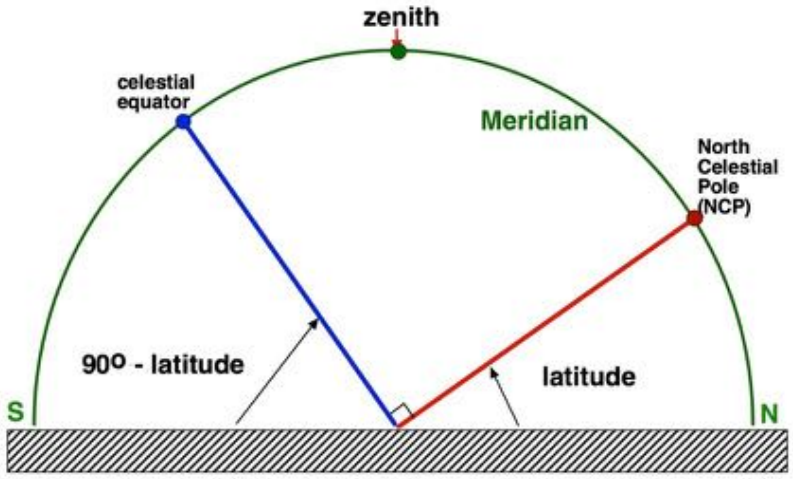
At other (middle) latitude:

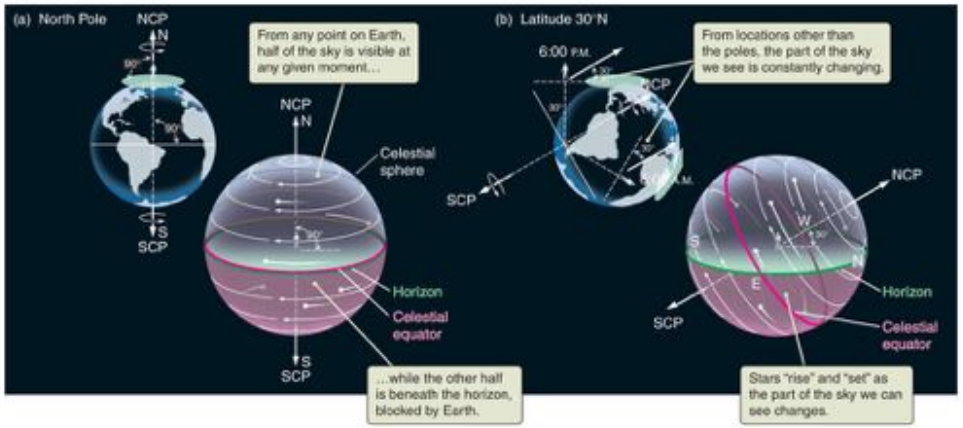


- Celestial equator:
  - tilted down from zenith by an angle equal to latitude
  - West through meridian to East
- Celestial poles:
  - due North (azimuth=0)
  - altitude equal to the latitude of the observer

Some stars rise and set,
others circle the pole (circumpolar)
and others are never seen

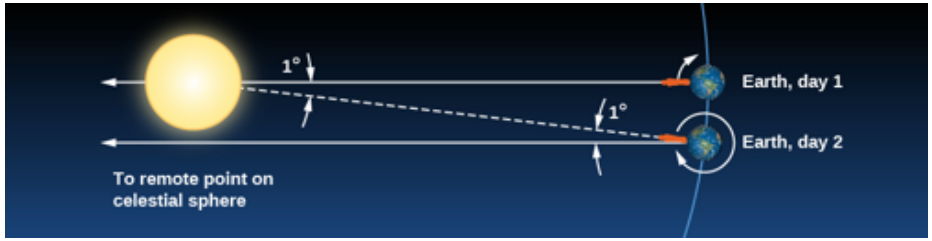
A simplified picture - the meridian diagram





The Motion(s) of the Sun

- follows westward motion of the sky, PLUS
- slower, eastward motion with respect to the stars
  - caused by the motion of the Earth around the Sun



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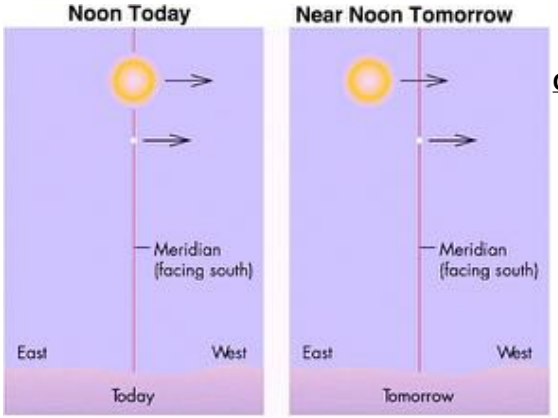


Complete circle in one YEAR

0.986^{o} per day (= $360^{o}/365.26$)

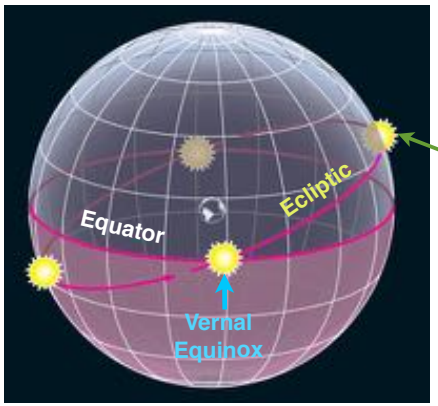
Solar day

4 minutes longer than sidereal day

Solar time = "ordinary" time

The Ecliptic

- apparent path of the Sun around the celestial sphere
- inclination: tilted 23.5 degrees to celestial equator
- Equinoxes: two crossing points (dec.= 0 degrees)
  - vernal equinox: RA= 0 h (Sun position ~ March 21)
  - autumnal " : RA=12 h (Sun on ~September 21)

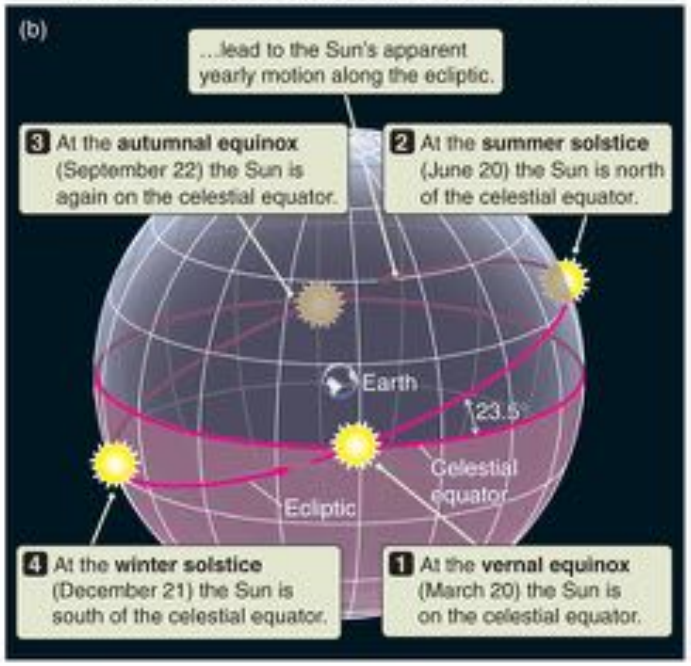


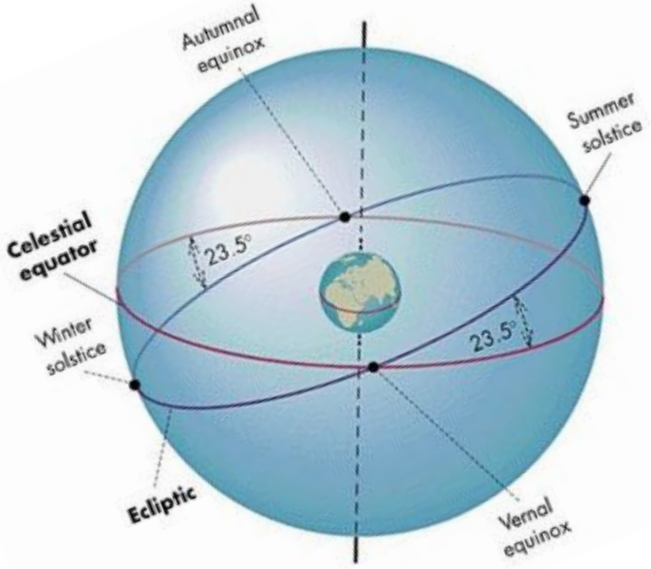
Solstices:
Extremes in solar declination

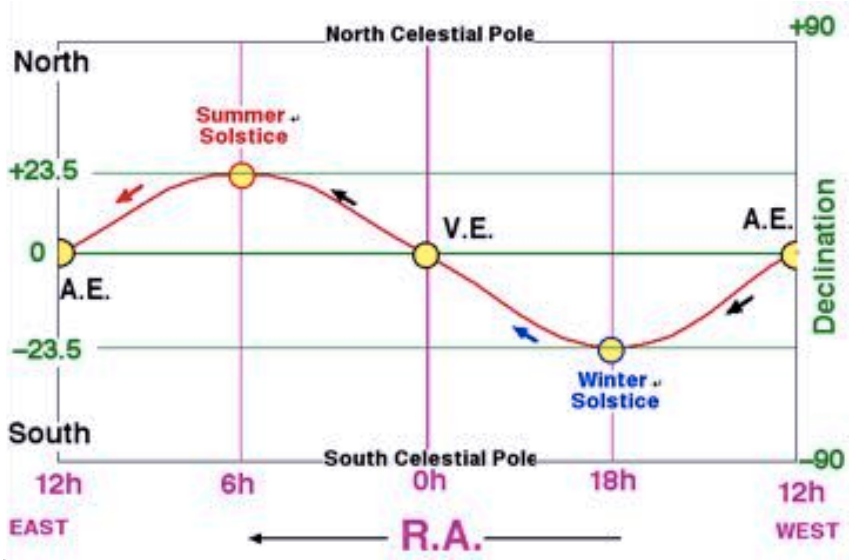
Summer Solstice (June 21)
R.A. = 6 h
dec. = + 23.5 (N)

Winter Solstice (Dec 21)
R.A. = 18 h
dec. = – 23.5 (S)

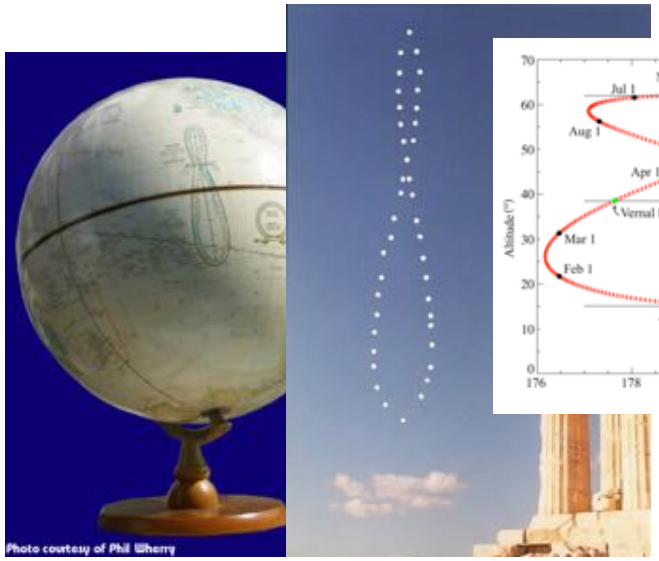
Apparent motion of the Sun seen from Earth

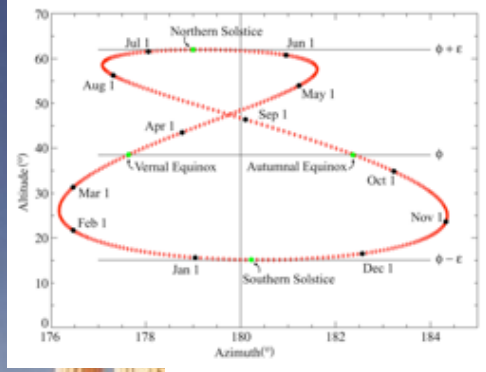






Seasonal change in solar declination: the **analemma**





Telltale Sun & Shadow

Astronomy & the

Sun and shadow have finally pinpointed a moment of history and ruled out the widely accepted scenario for an iconic photograph.

Donald W. Olson, Russell L. Doescher, & Steven D. Kawaler

VJ Day — Victory over Japan Day, August 14, 1945 — marked the end of World War II. As rumors of Japan's surrender spread, Americans poured into the streets. Amid the celebration in New York's Times Square, Alfred Eisenstaedt captured one of the iconic images of the 20th century when he shot four photographs in quick succession of a sailor kissing a woman in white. Victor Jorgensen, standing just a few feet away, photographed the same kissing pair at the moment of Eisenstaedt's second frame.

We have recently used astronomy to determine new information about these famous photographs.

The questions of identity — who is the sailor? who is the woman in white? — have been a source of much controversy over the decades, in part because their faces are largely hidden. Glenn McDuffie, George Mendonsa, and Carl Muscarello are among the dozens of men who have claimed to be the sailor. Candidates for the woman in the white dress include Edith Shain, Barbara Sokol, and Greta Friedman (Greta Zimmer in 1945).

We have used the position of the Sun to solve a related mystery — at what time were the Kiss photographs taken? — and thus to rule out some of the candidates for the real sailor and woman in white.

Kiss After 7:03 p.m.?

After rumors and false alarms throughout the day, radio networks carried a brief statement from the White House at 7:00 p.m., and by 7:03 p.m. the moving electric sign on the Times Building displayed the long-awaited words: "OFFICIAL *** TRUMAN ANNOUNCES JAPANESE SURRENDER ***." The current Wikipedia page assumes that the Kiss followed shortly thereafter: "Eisenstaedt was photographing a spontaneous event that occurred in Times Square as the announcement of the end of the war on Japan was made by U.S. President Harry S. Truman at seven o'clock."

Sixty-five years later in 2010, a front-page *New York Times* story on the VJ Day anniversary expressed the same opinion: "For decades, the world has believed that the photographs were taken after — perhaps just seconds after — President Truman's announcement at 7:03 p.m."

Kiss Near 6 p.m.?

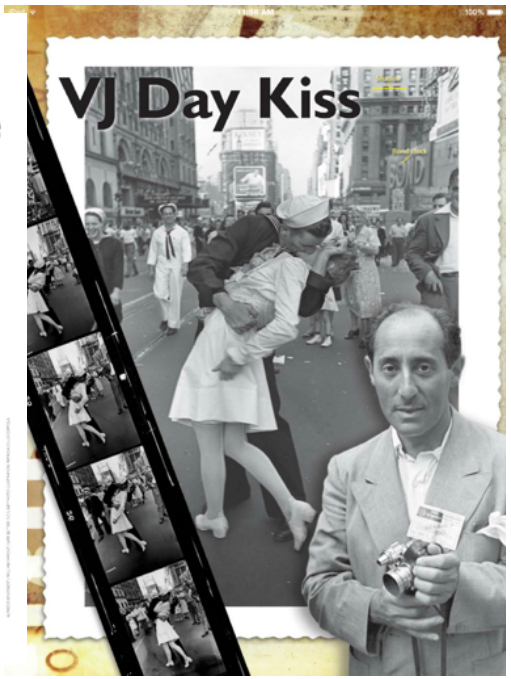
However, that same anniversary story went on to propose a scenario with an earlier time. The reporter interviewed Gloria Ballard, who identified herself as a figure in the background of the Jorgensen photograph. She gave an account of witnessing the famous Kiss and contradicted the conventional wisdom by implying that the event occurred not after 7:03 p.m. but instead "earlier — before the war was officially over."

Ballard, after leaving Times Square on VJ Day, spent a few minutes walking to 8th Avenue. She estimated that it then took two more hours to reach her home town of New Canaan, Connecticut, by bus and train. She noticed that dusk was settling and the streetlights were just coming on as she walked the final blocks near her home.

Here astronomy first enters. For New Canaan, we calculate that sunset fell at 7:54 p.m. that day and the end of civil twilight followed at 8:24 p.m., expressed in Eastern War Time, equivalent to modern daylight saving time. We can be certain that this is the correct time system in use because the *New York Times* that day listed Manhattan sunset at 7:56 p.m.

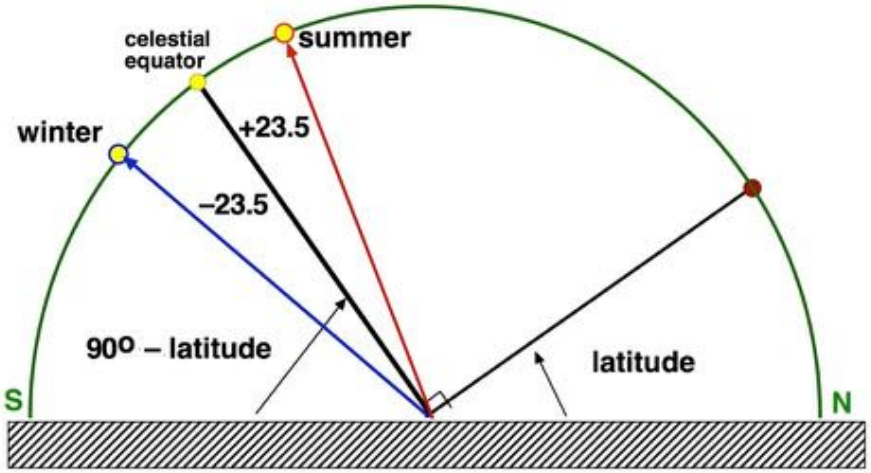
THE KISS Any collection of the 20th century's iconic images is likely to include this 5¢ magazine photo taken by Alfred Eisenstaedt in New York's Times Square on the day World War II ended. The shadow on the Loew's Building (labeled) allows us to determine that he clicked the shutter at 7:51 p.m. An archived contact sheet from Eisenstaedt's roll of film shows the four Kiss shots to be negatives #24–27. The numbers are another smoking gun; the roll's earlier #10 and #11 are Eisenstaedt's Peace At Last images, which shadows reveal to have been taken around 5 p.m. — long after the 2 p.m. claim for the Kiss.

THE PHOTOGRAPHER This on-the-spot snapshot of Alfred Eisenstaedt was taken by William Shrout, another *Life* photographer assigned to cover the VJ Day celebration in Times Square.

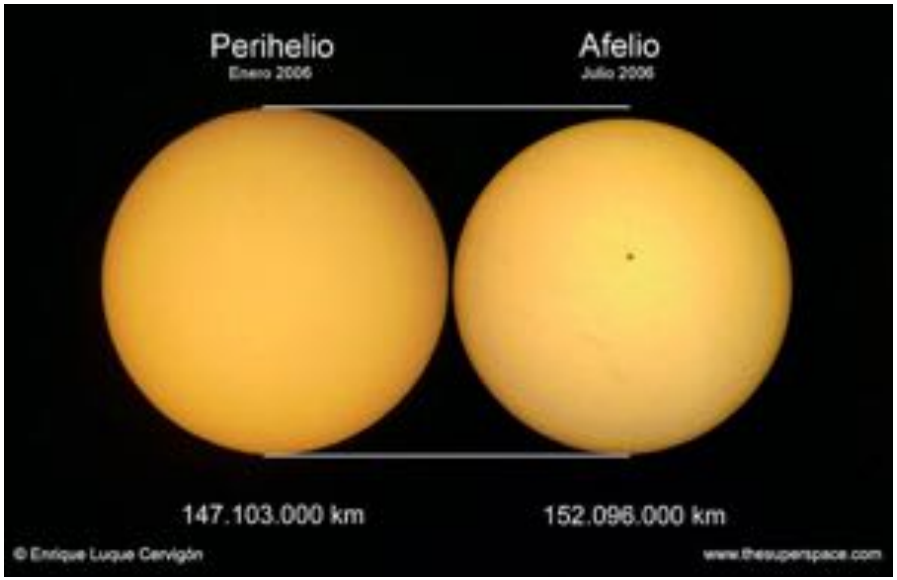


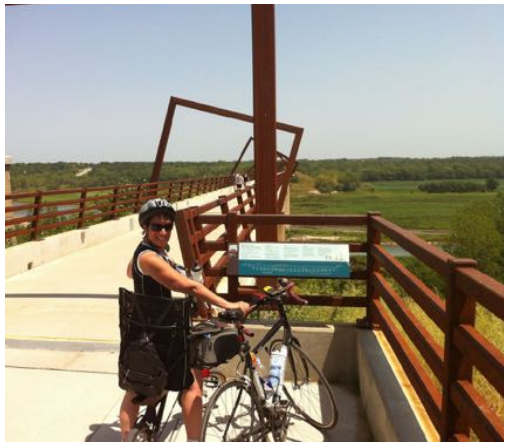
The Seasons

The Sun at local noon: altitude via meridian diagram



http://antwrp.gsfc.nasa.gov/apod/ap070709.html



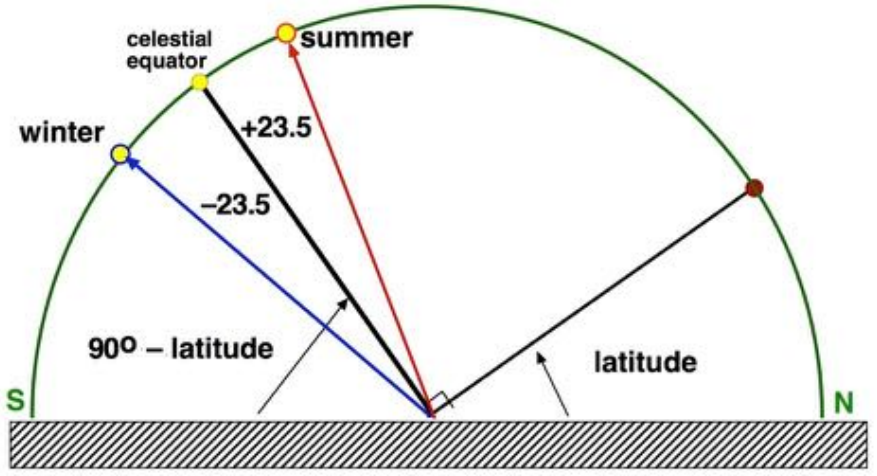


near Madrid, Iowa
Latitude 42:00 North
July 4, 2012
Summer

Christchurch, New Zealand
Latitude 43:32 South
July 5, 2003
Winter

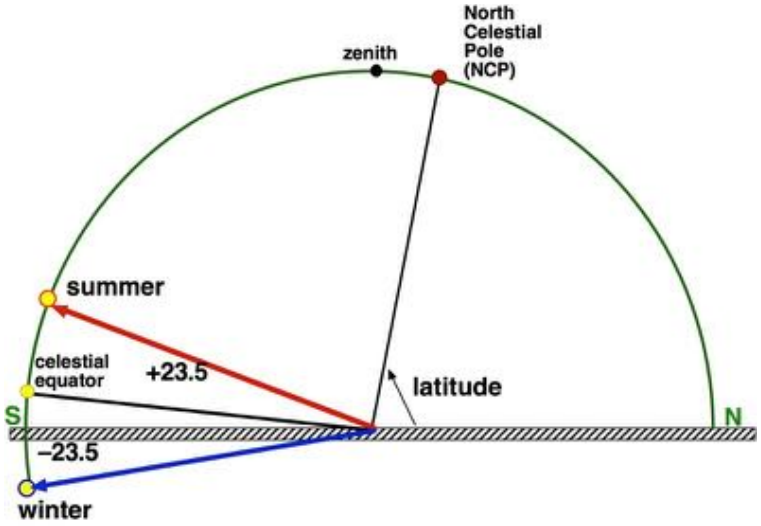
The Seasons

The Sun at local noon: altitude via meridian diagram



The Seasons

The Sun at local noon: altitude via meridian diagram
far-northern latitude

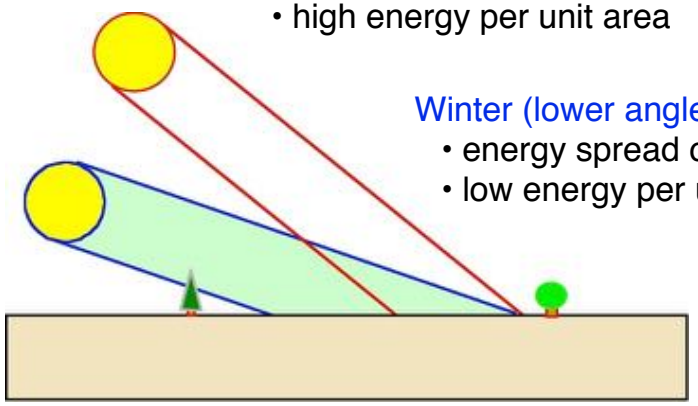


The Angle of sunlight and the temperature of the Earth:

Constant flux of solar energy comes from the Sun

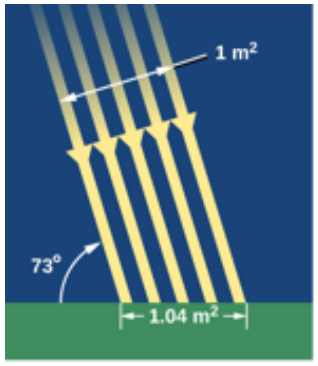
Summer (higher angle):
- energy concentrated on small area
- high energy per unit area

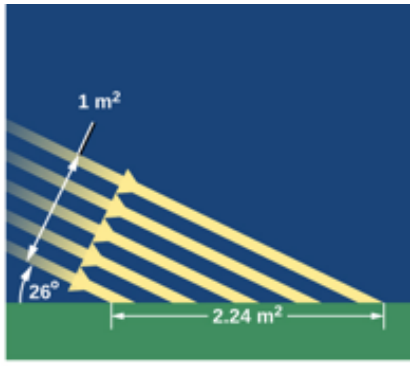
Winter (lower angle):
- energy spread over large area
- low energy per unit area



First day of summer

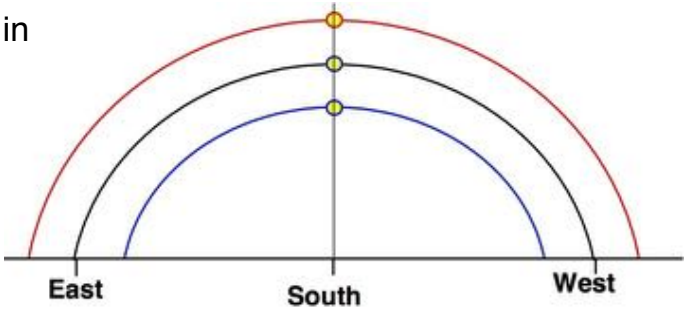
First day of winter

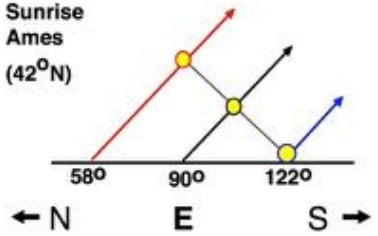




... in the Northern hemisphere ...

Arc of the Sun in
summer
spring/fall
winter





- **Sun rises in**
  - **NE in summer**
  - **due E in spring/fall**
  - **SE in Winter**
- **Sun rises 3 hours earlier in the summer than winter**