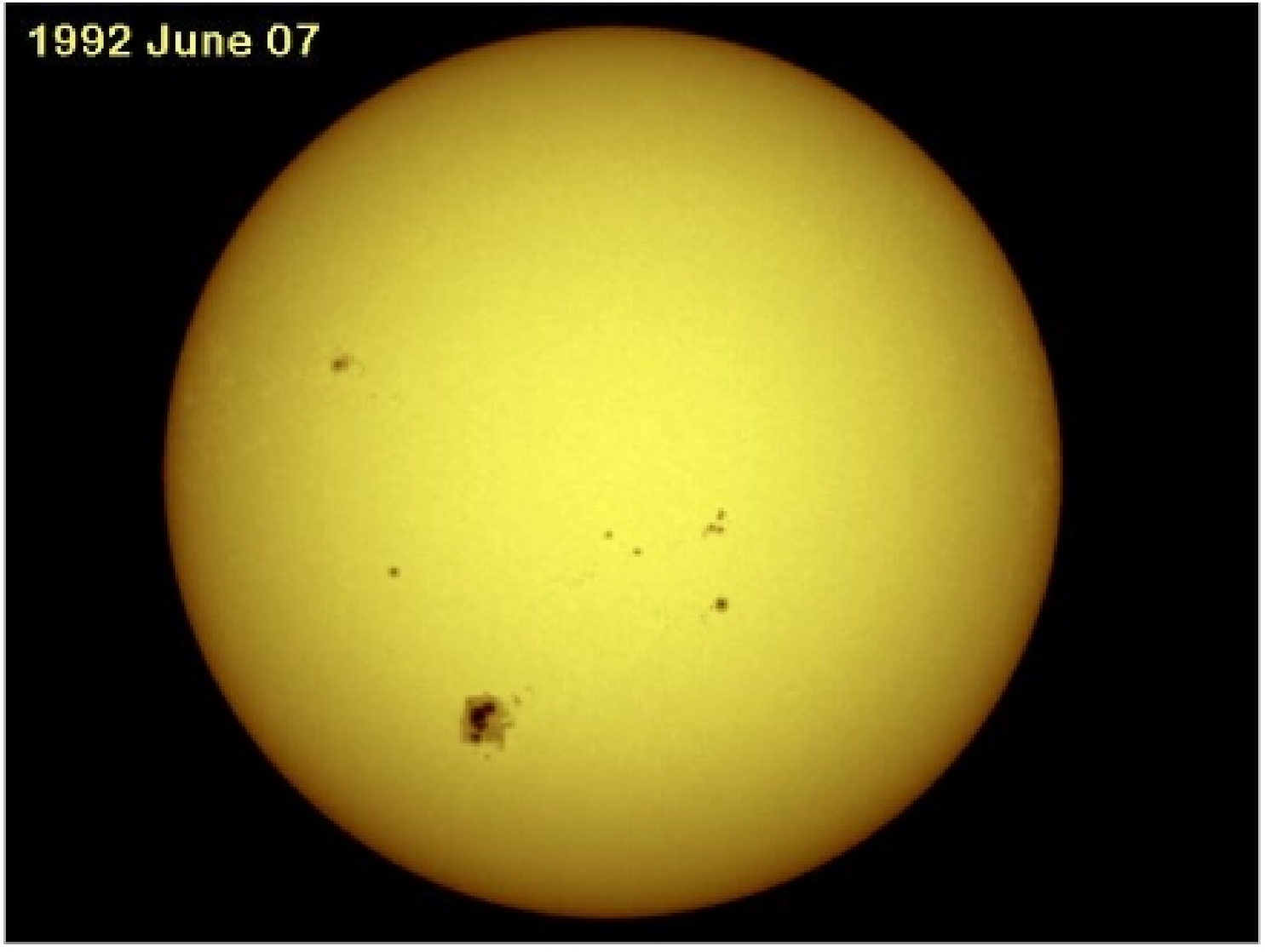
Lectures 2-3 week 1-2 2009:
HAS222d
Solar radiation, the greenhouse, global heat engine



http://en.wikipedia.org/

The 4 streams of this course (see syllabus)

1.Energy

forms of energy
  concetrated, diluted

conservation

transmission/movement
transformation
    efficiency of transformation
    heat engines
degradation (and entropy)
storage
'utilization' by plants and animals
carbon cycle, photosynthesis

3.Humans and energy

history of energy demand
and development
….fossil fuels

connections with evolution

alternative energies

2.Global Environment

physical, chemical, biological
atmosphere, ocean, land surface
energy, air, water, ice, carbon

the sun-atmosphere-ocean heat engine

fluid circulations in which protective
'niches' of life develop

4.Arctic populations

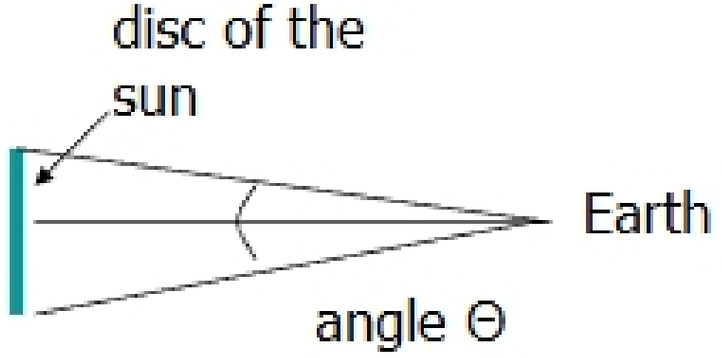
natives: settlement
Europeans: exploration
assimilation, exploitation

shaping of their lives
by energy and food
resources in a harsh
environment

amplified global
warming in the Arctic

Let's start with the sun

diameter: 1.38 million km
distance from Earth (mean): 149.6 million km (93 million miles)*



tilt of Earth's rotation axis relative to its orbit round the sun:
23.5^0
the orbit is an ellipse, but only about 2% different from a circle: the oribital eccentriciy**= 0.017
rotation period: 23.9 hours
length of day: 24 hours
On July 4 this year the Earth is farthest from the sun (aphelion);
on Jan 4 it was closest (perihelion); about 7% more sunlight (rate of energy falling on Earth) in Jan than in July. As Northern Hemisphere goes, so goes climate!

The eccentricity shifts with 100,000 year period from 0.05 to nearly zero.
perihelion shifts with 21,000 year period
obliquity (tilt of axis) shifts with 41,000 year period …..all these slight changes alter the amount of sunshine and its distribution at the Earth's surface, somehow leading to ice ages….cycles of cold and warm climate.

Averaged over the globe, sunlight falling on Earth in July (aphelion) is indeed about 7% less intense than it is in January (perihelion)." That's the good news. The bad news is it's still hot. "In fact," says Spencer, "the average temperature of Earth at aphelion is about 4o F (2.3o C) higher than it is at perihelion." Earth is actually warmer when we're farther from the Sun!

www.cwru.edu/
http://science.nasa.gov/headlines/y2001/ast03jul_1.htm

*[these two numbers together tell us how big the disc of the sun appears in the sky...the relationship is tan ½Θ = ½ diameter/distance (see diagram above)
For small angles tanΘ us approximately Θ, measured in radians.
So, Θ = 1.39/149.6 = 0.00932 radians or .00932 x 360/2π degrees. This is 0.53 degrees...roughly ½ degree,almost the same angular size as the moon, which is why we have such perfect eclipses)*

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**the eccentricity of an ellipse is defined as the ratio $\sqrt{(1-b^2/a^2)}$ where a is the largest diameter (the major axis) and b is perpendicular to it, the smallest diameter