Topic # 12
HOW CLIMATE WORKS – PART I

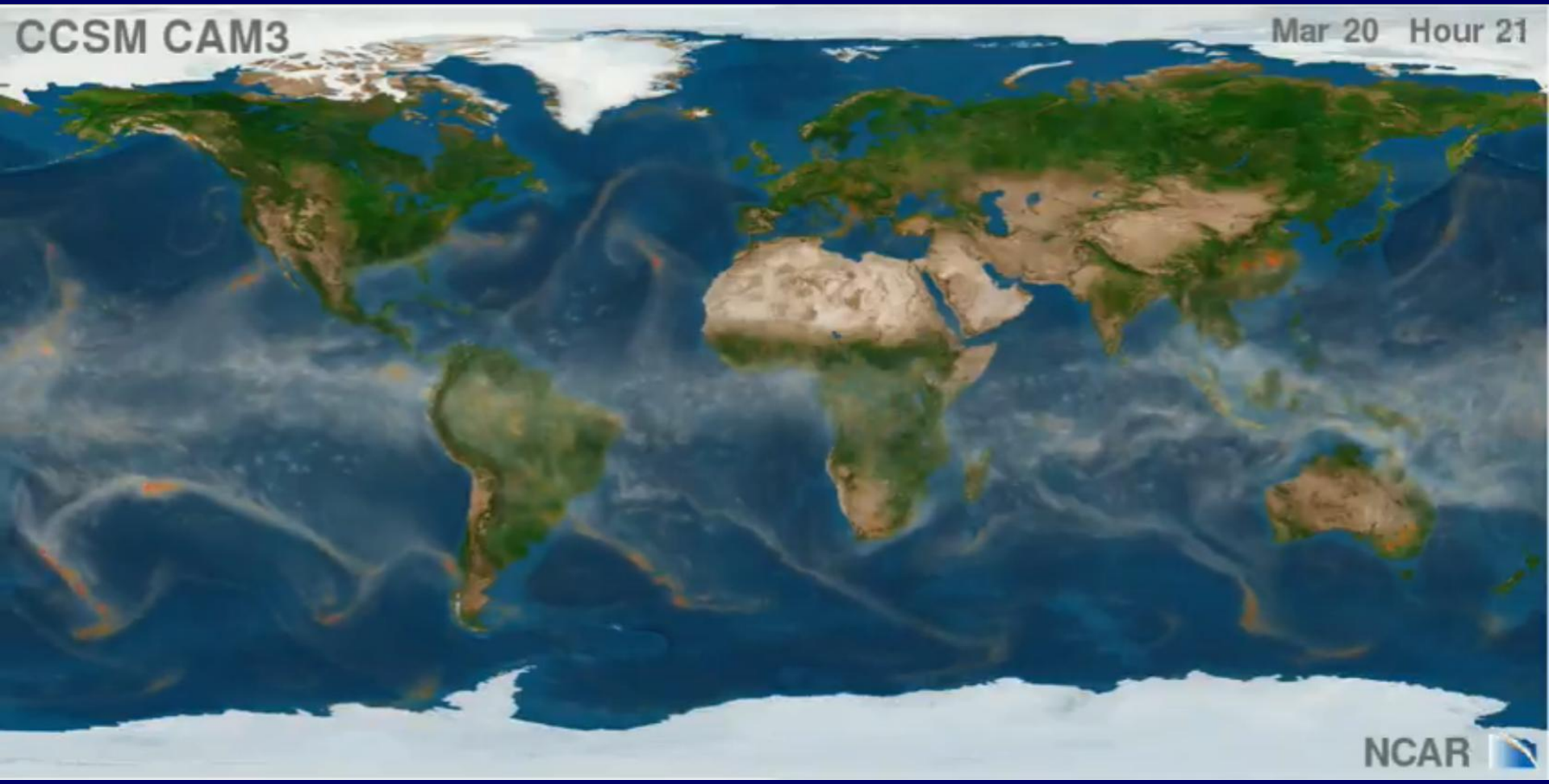
A "Primer" on
How the Energy Balance Drives
Atmospheric & Oceanic Circulation,
Natural Climatic Processes

Starts on p 63 in Class Notes

How do we get energy from this . . . .

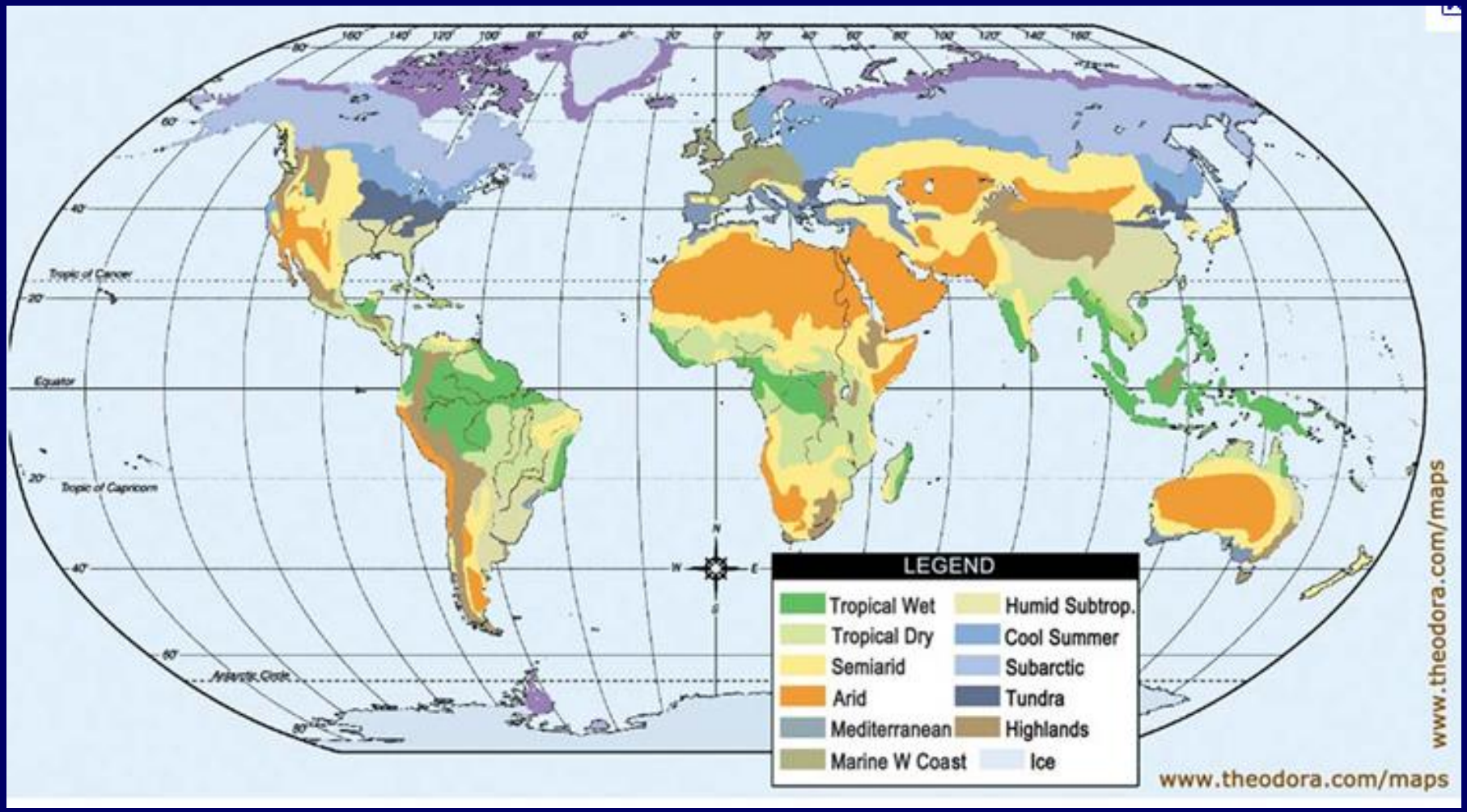
. . . . to drive this ?

. . . . or this ?



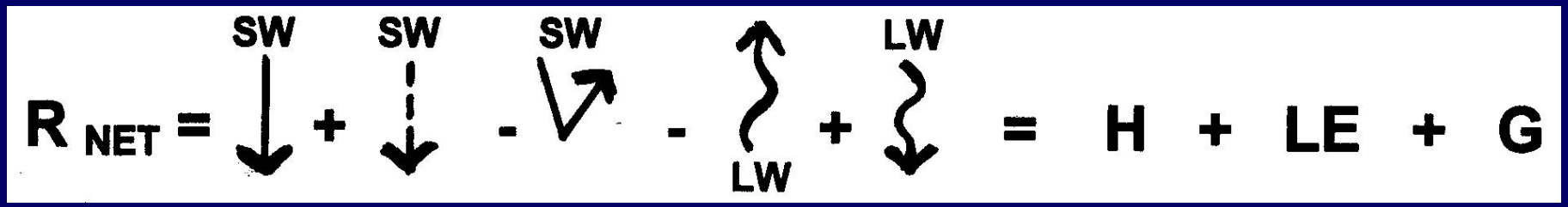
http://www.vets.ucar.edu/vg/T341/index.shtml

. . . .which leads to Global Climatic Regions:

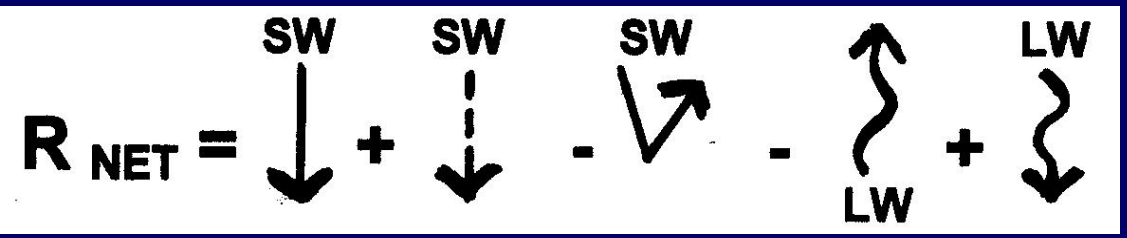


. . . .and CHANGES in these regions!

It all happens because of changes in the RADIATION / ENERGY BALANCE !



"Radiation Balance" part



All components are referring to electromagnetic radiation

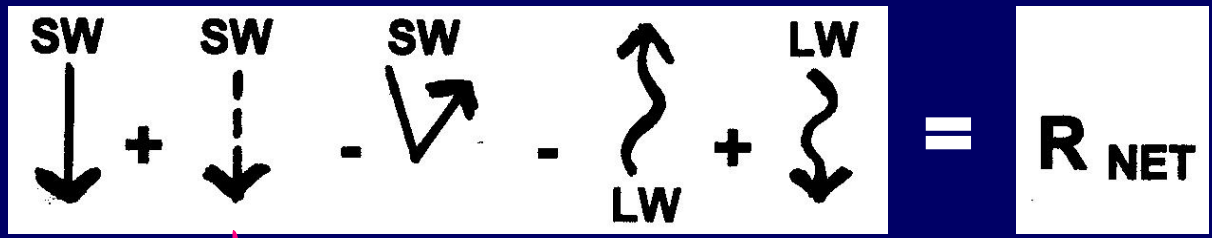
All components are referring to modes of heat energy transfer or heat energy storage involving matter

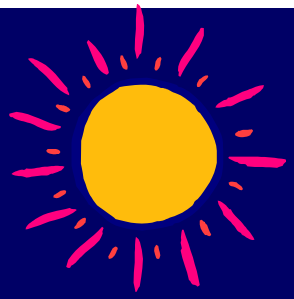
"Energy Balance" part

$$R_{NET} = H + LE + G$$

Start out here, with energy from the SUN radiated to Earth and so forth . . .

"Radiation Balance" part





The R_{NET} is then able to be used in thermal energy "heat transfer" processes which manifest themselves as weather & climate!

"Energy Balance" part

$$R_{NET} = H + LE + G$$

Thermal Energy Review

Heat **(def) = the thermal energy that is *transferred* from one body to another because of a temperature difference.**

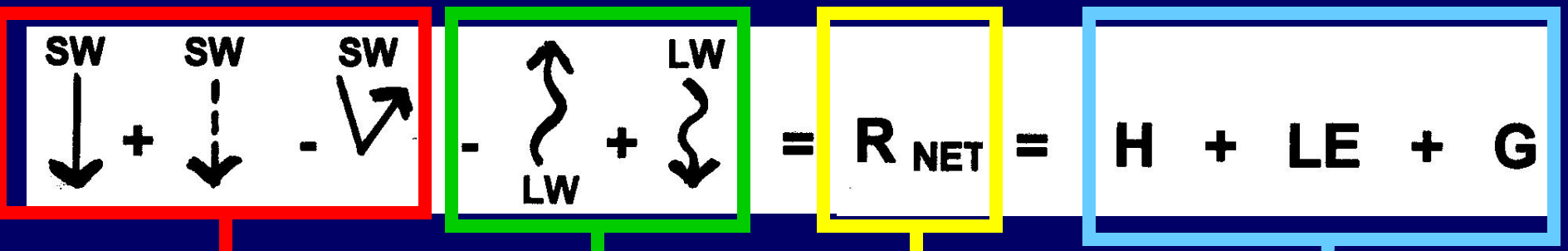
- **Sensible Heat transfer (H)**
- **Latent Heat transfer (LE)**

plus (after transfer) thermal energy can be STORED (G)

H + LE + G

Review

ENERGY IN THE EARTH-ATMOSPHERE SYSTEM



Ultimate source of energy is the SUN (SW)

After absorption of SW, LW energy is radiated in & out by EARTH & Atmosphere

Any NET (leftover) energy

Goes into the HEAT TRANSFER processes that drive **WEATHER & CLIMATE !**

The Earth [as viewed from space] . . .

has the organized,
self-contained look
of a live creature,
full of information,
marvelously skilled
in handling
the SUN.

- Lewis Thomas

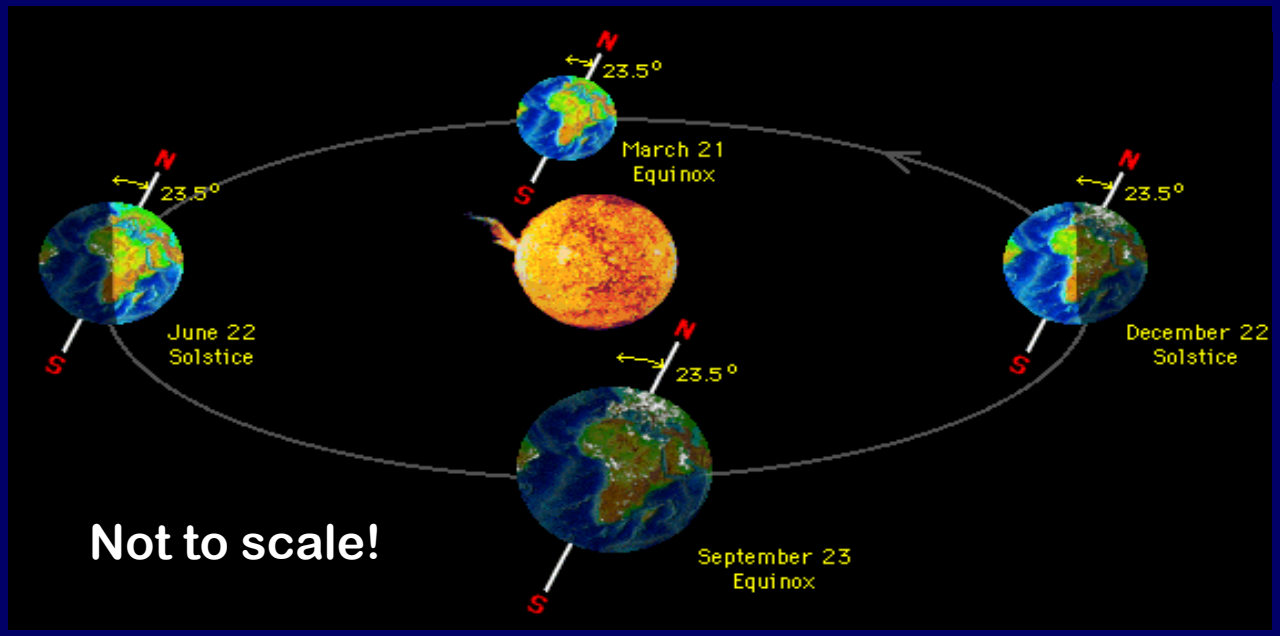
LINKING THE ENERGY BALANCE TO ATMOSPHERIC CIRCULATION . . .

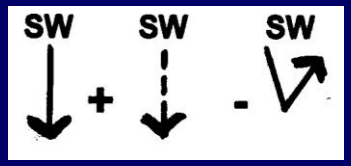
We'll start with the SUN (SOLAR INSOLATION)

IN – SOL- ATION =

Amount of incoming solar radiation received by a horizontal unit surface (at the top of atmosphere)

To drive the circulation, the initial source of energy is from the Sun:





EARTH-SUN Relationships

4 Things to Know about Earth-Sun Relationships:

1) Earth orbits Sun
2) Orbit not a perfect circle
3) Orbit traces "a plane"
4) Earth's axis tilts

Room for notes on p 62

4 Things to Know about Earth-Sun Relationships:

1) Earth orbits Sun in one year

2) Orbit is not a perfect circle = an ellipse: 

3) Earth's orbit around Sun can be "traced" on a plane ("Plane of the Ecliptic" – plane passes thru the center of Sun & Earth)

4) Earth's axis tilts 23.5° from a ⊥ to the "Plane of The Ecliptic"

These 4 Earth-Sun Properties lead to: the 2 factors that determine the **AMOUNT OF SOLAR INSOLATION** at any spot on Earth as the seasons progress:

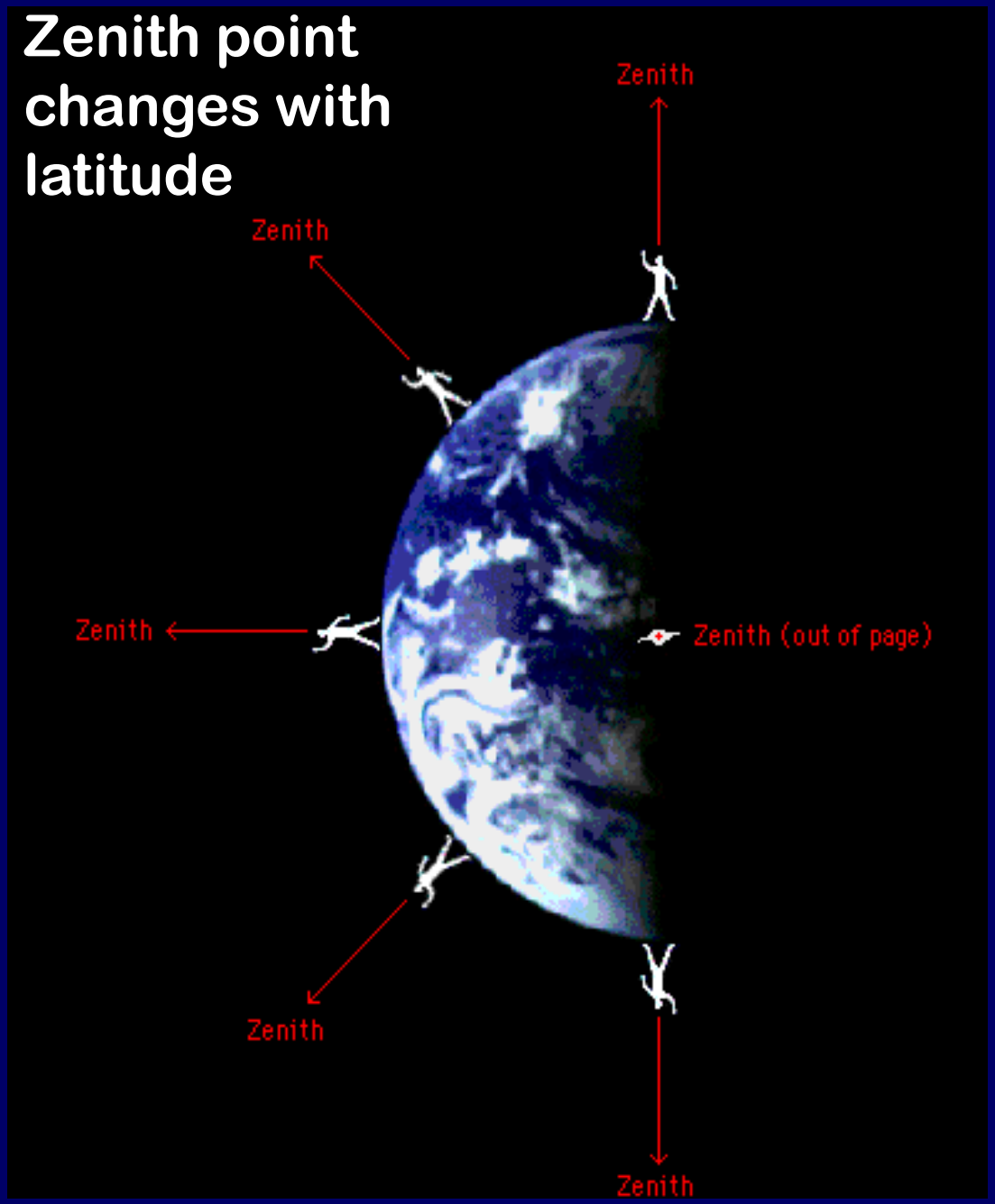
(1) **INTENSITY** of sun's rays

(perpendicular to surface = more intense)

(2) **DURATION** of daily insolation

(longer day length = more insolation)

Zenith point changes with latitude



The point **directly overhead** is important (called the **ZENITH**)

WHY?

INTENSITY is greatest at any spot on Earth when sun is closest to the ZENITH! ☺

INTENSITY + DURATION

The total daily insolation received at a given latitude is a factor of:

INTENSITY + DURATION

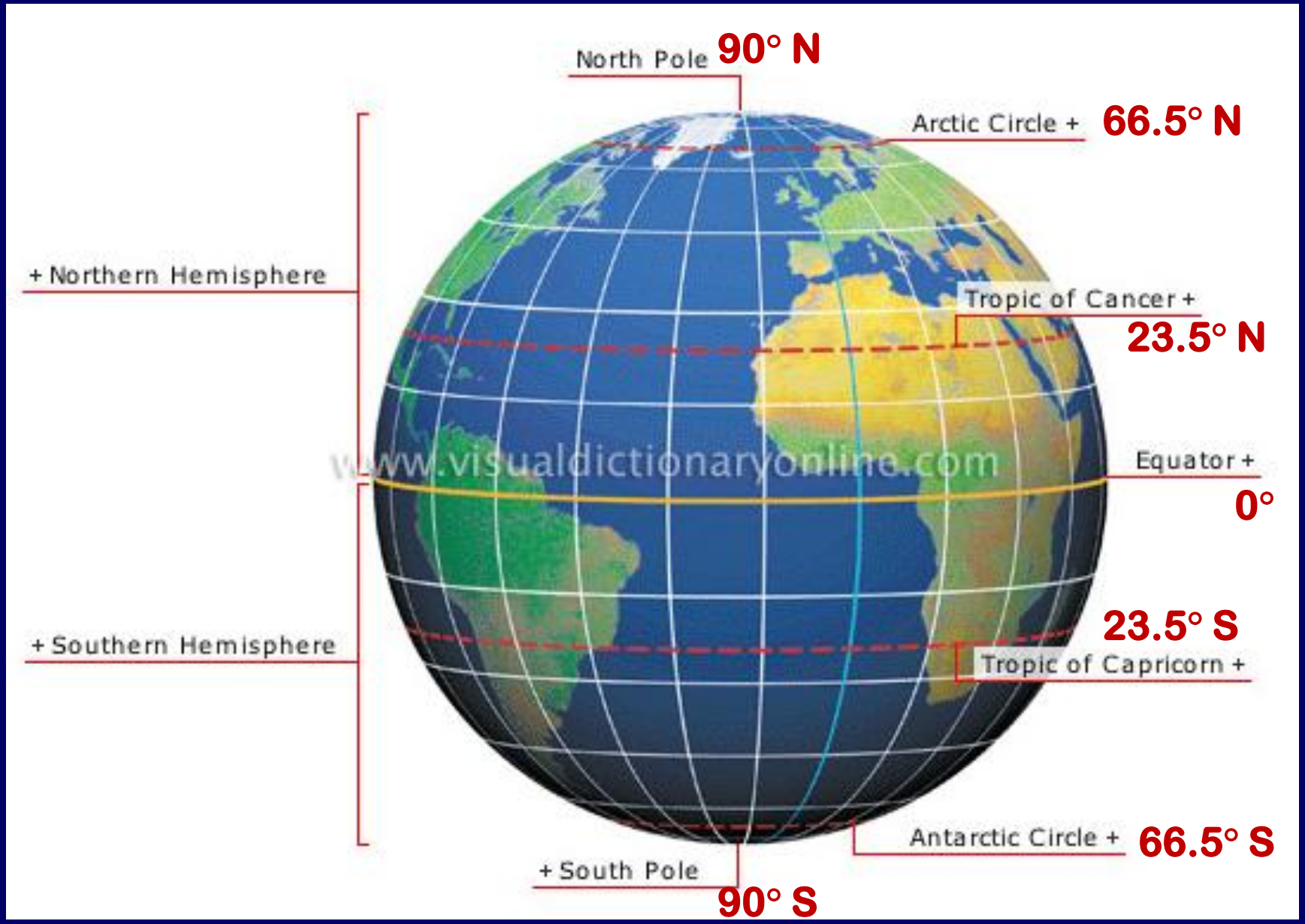
INTENSITY of sun's rays: depends on axis tilt and how earth intercepts sun's rays

DURATION of daily insolation (day length): depends on where circle of illumination intersects latitude band

Intensity & Duration vary with latitude and with the time of year

Box on p 63

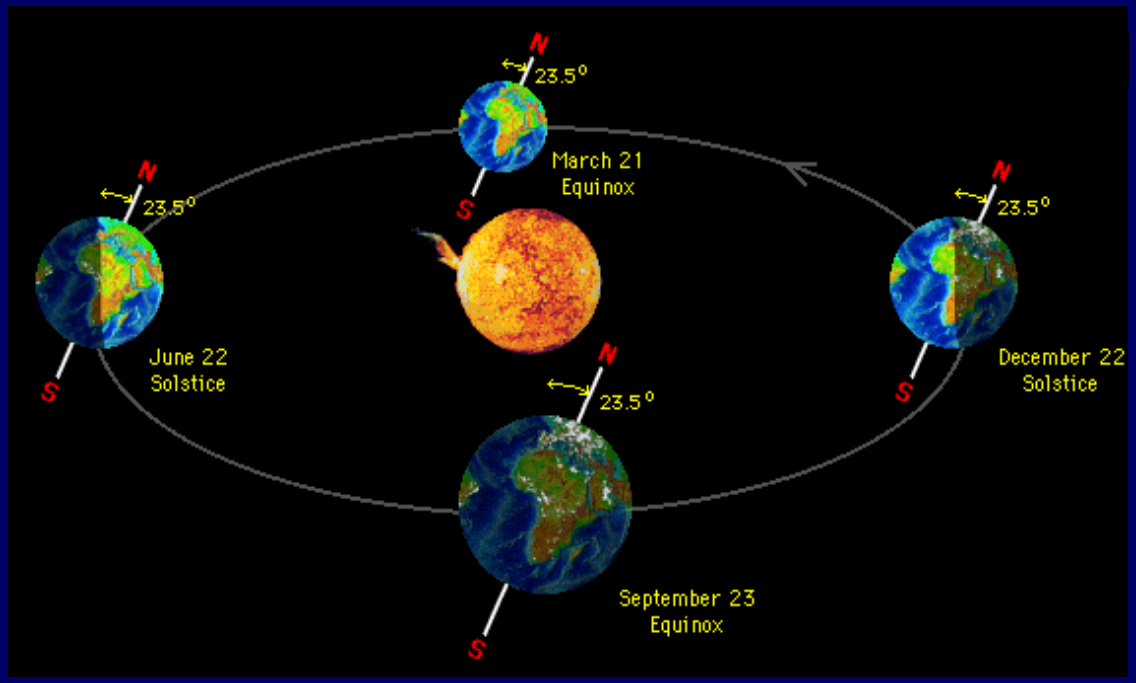
QUICKIE LATITUDE REVIEW:



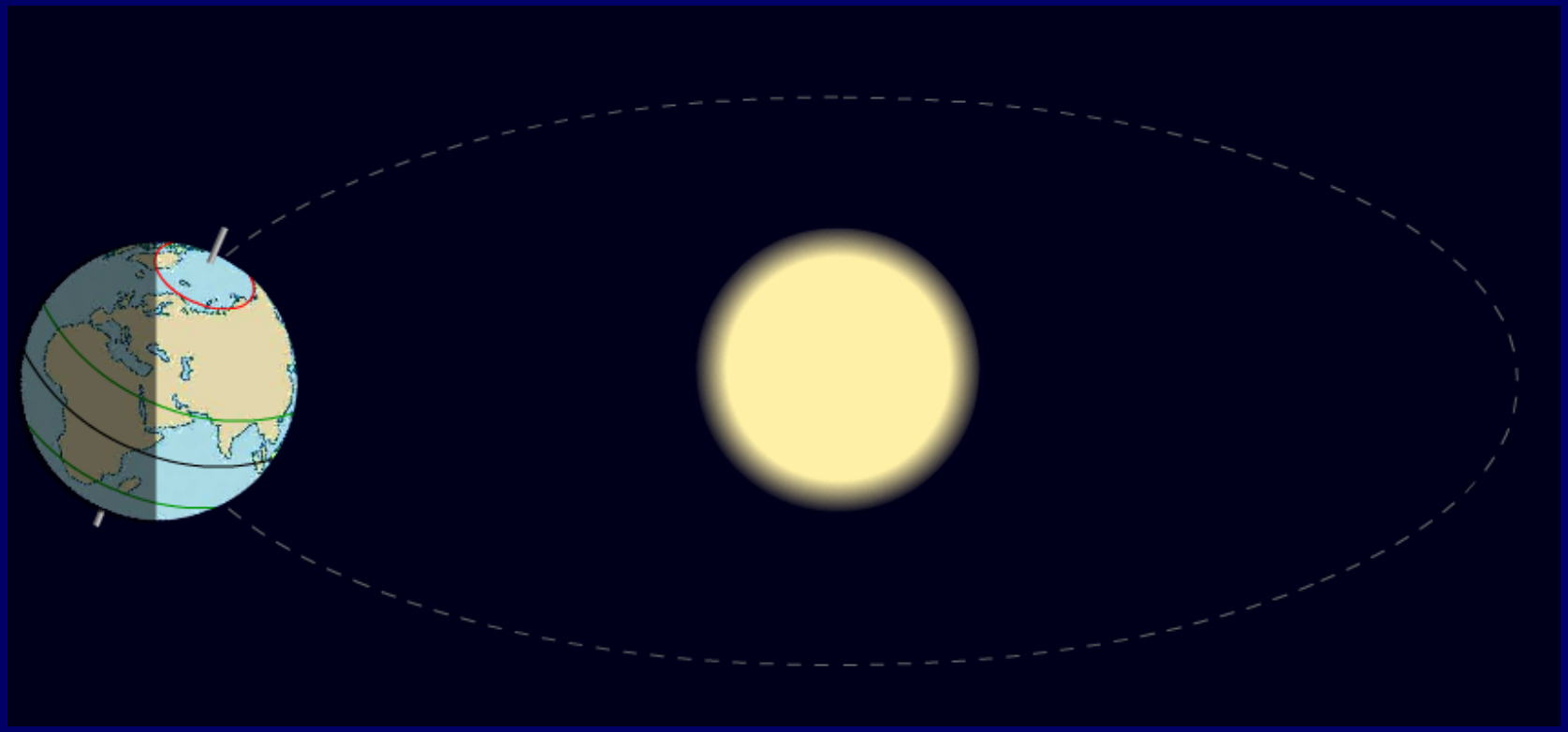
EARTH-SUN RELATIONSHIPS & The SEASONS:

VIEW THE ANIMATION:

http://mesoscale.agron.iastate.edu/agron206/animations/01_EarthSun.html

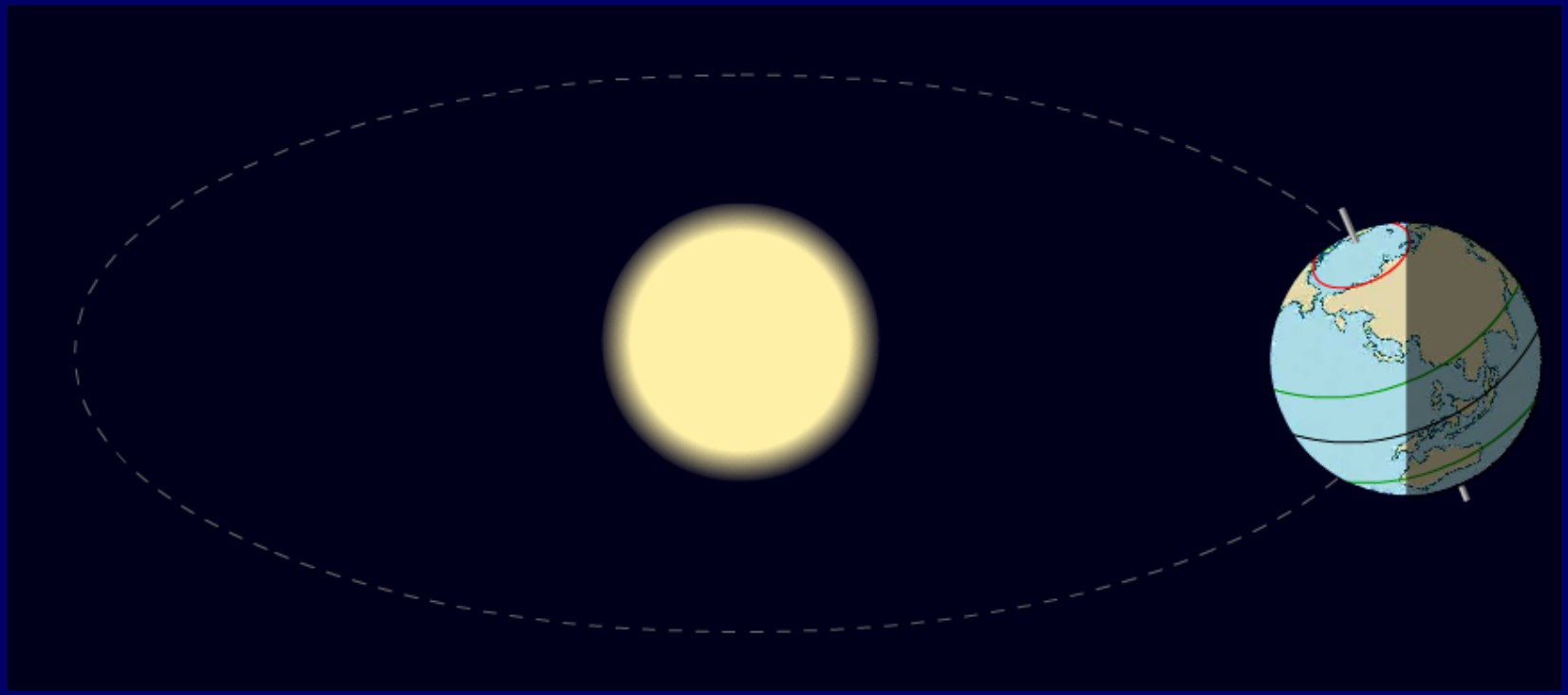


JUNE SOLSTICE



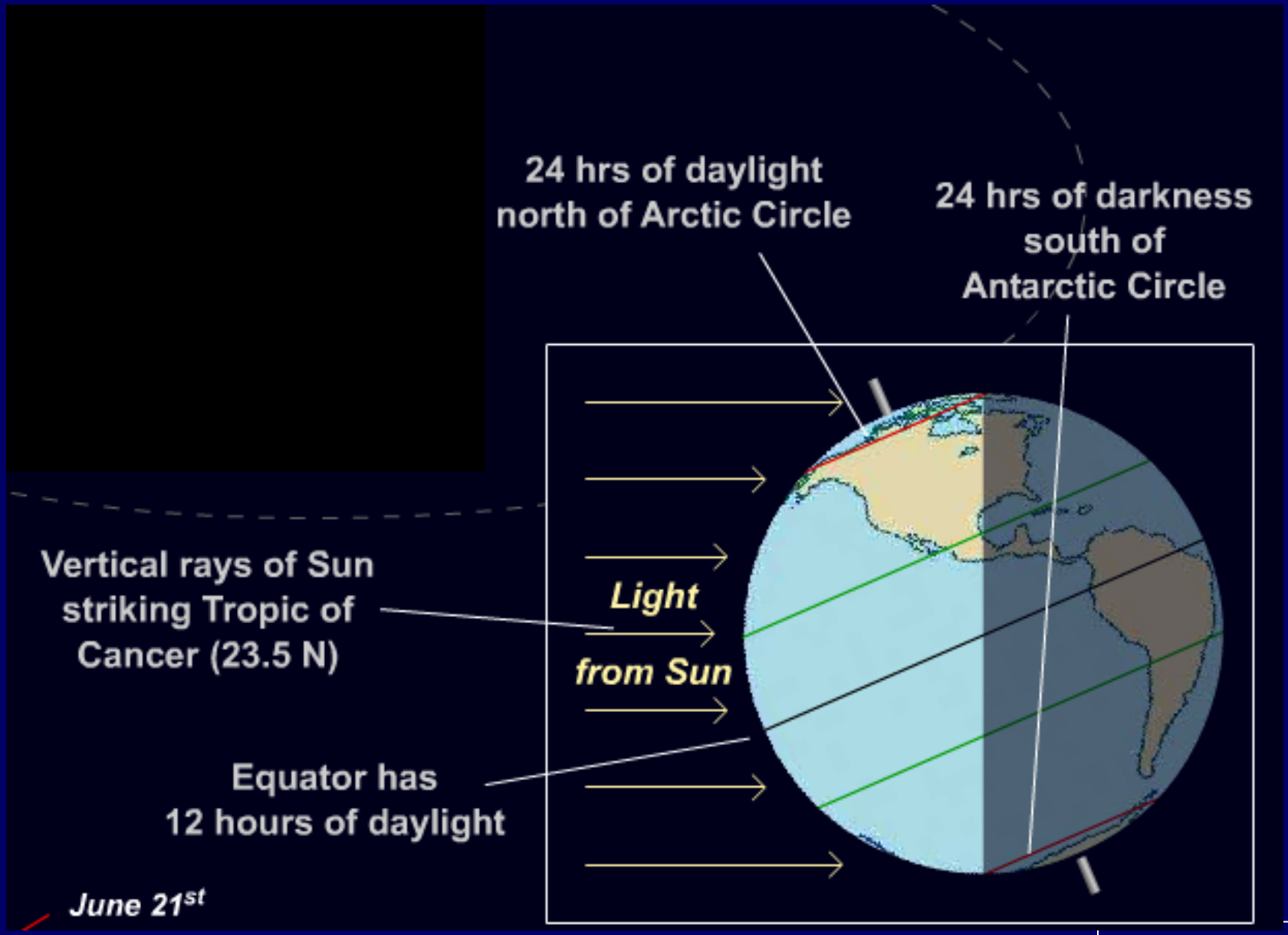
As viewed from one side of Sun

JUNE SOLSTICE



As viewed from the other side of the Sun

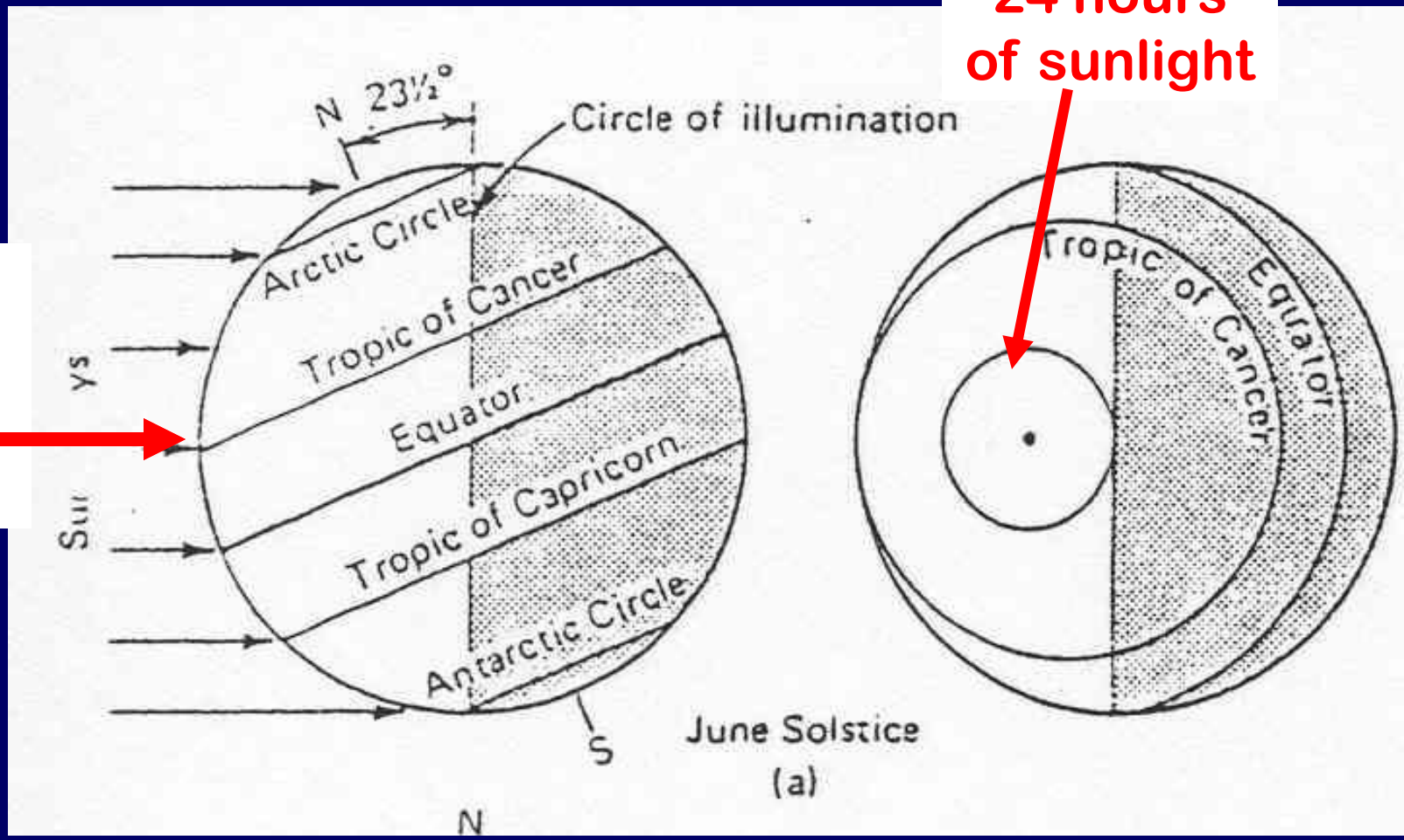
JUNE SOLSTICE



JUNE SOLSTICE

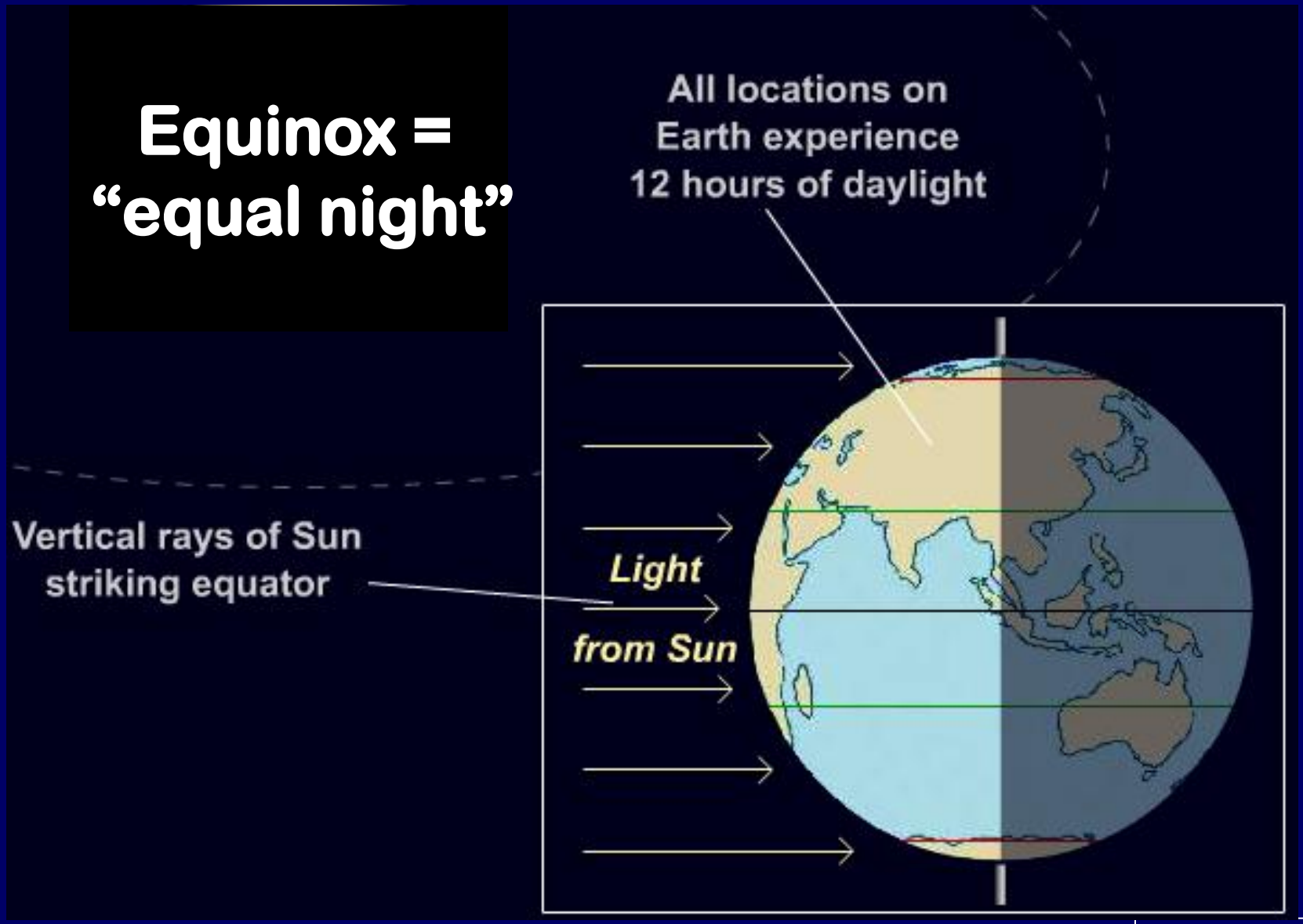
24 hours of sunlight

Most intense solar radiation



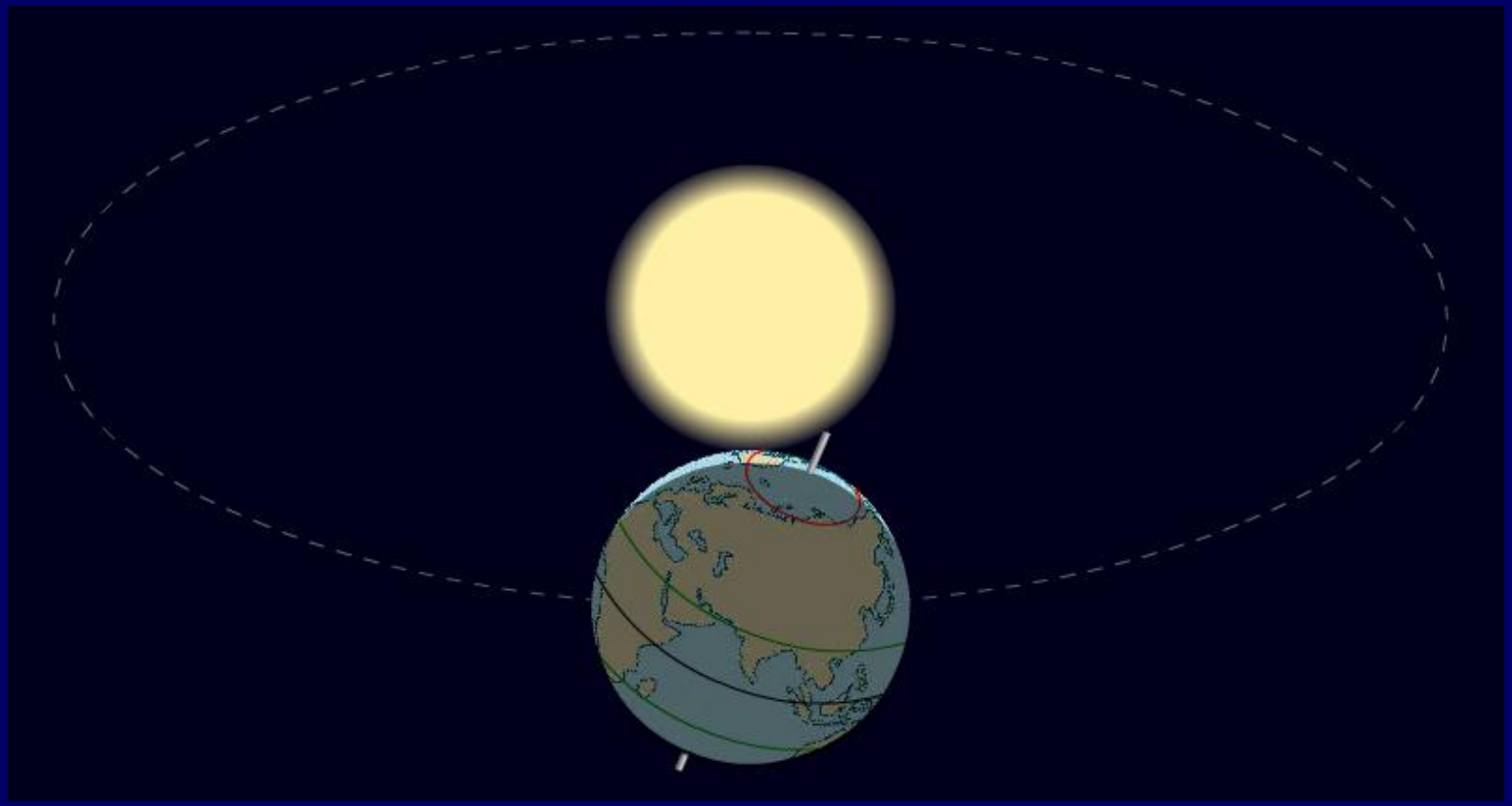
MARCH EQUINOX

Equinox = "equal night"



SEPTEMBER EQUINOX

different seasonal position in orbit . . .

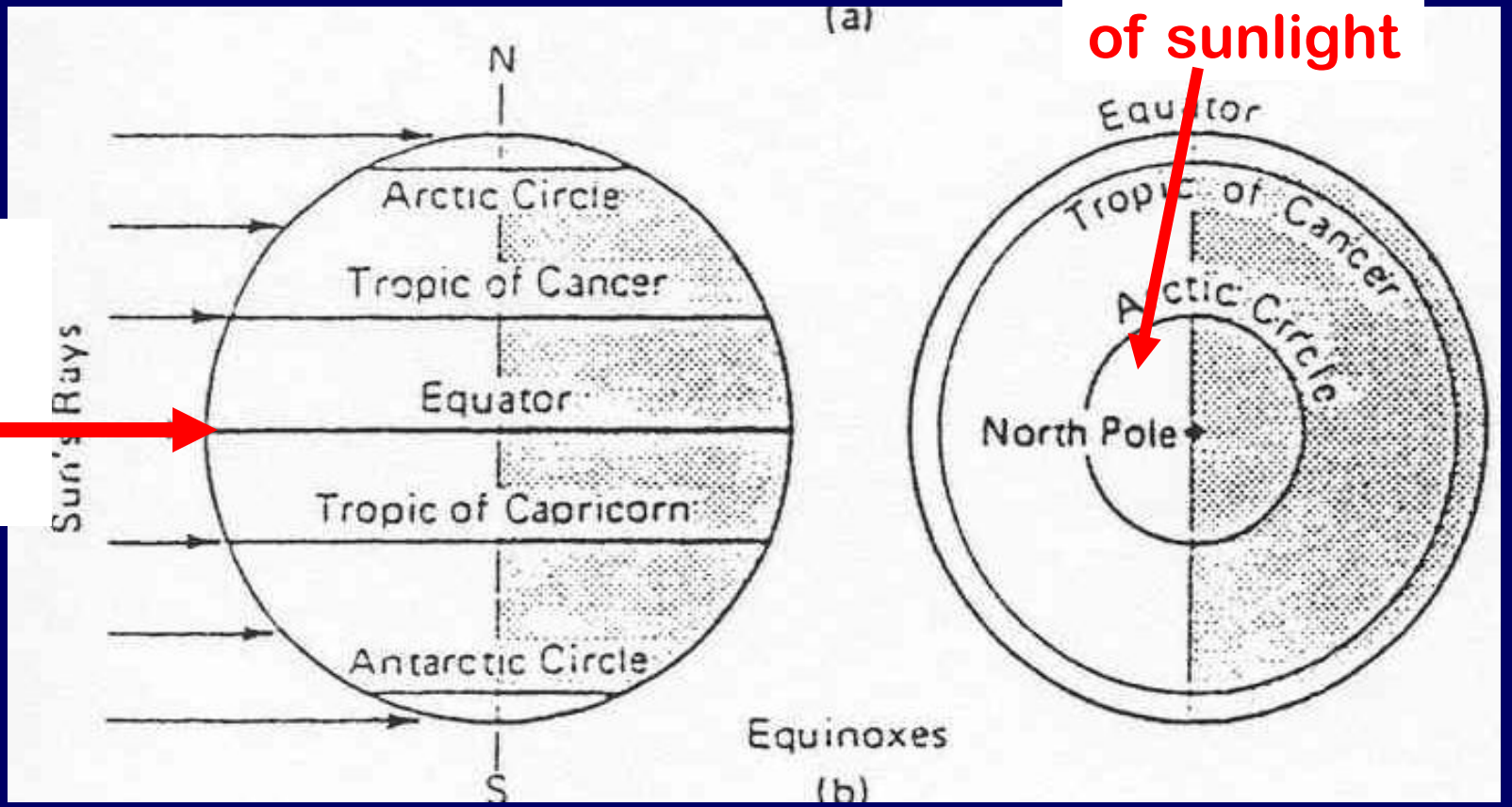


. . . but same latitudinal insolation as March Equinox

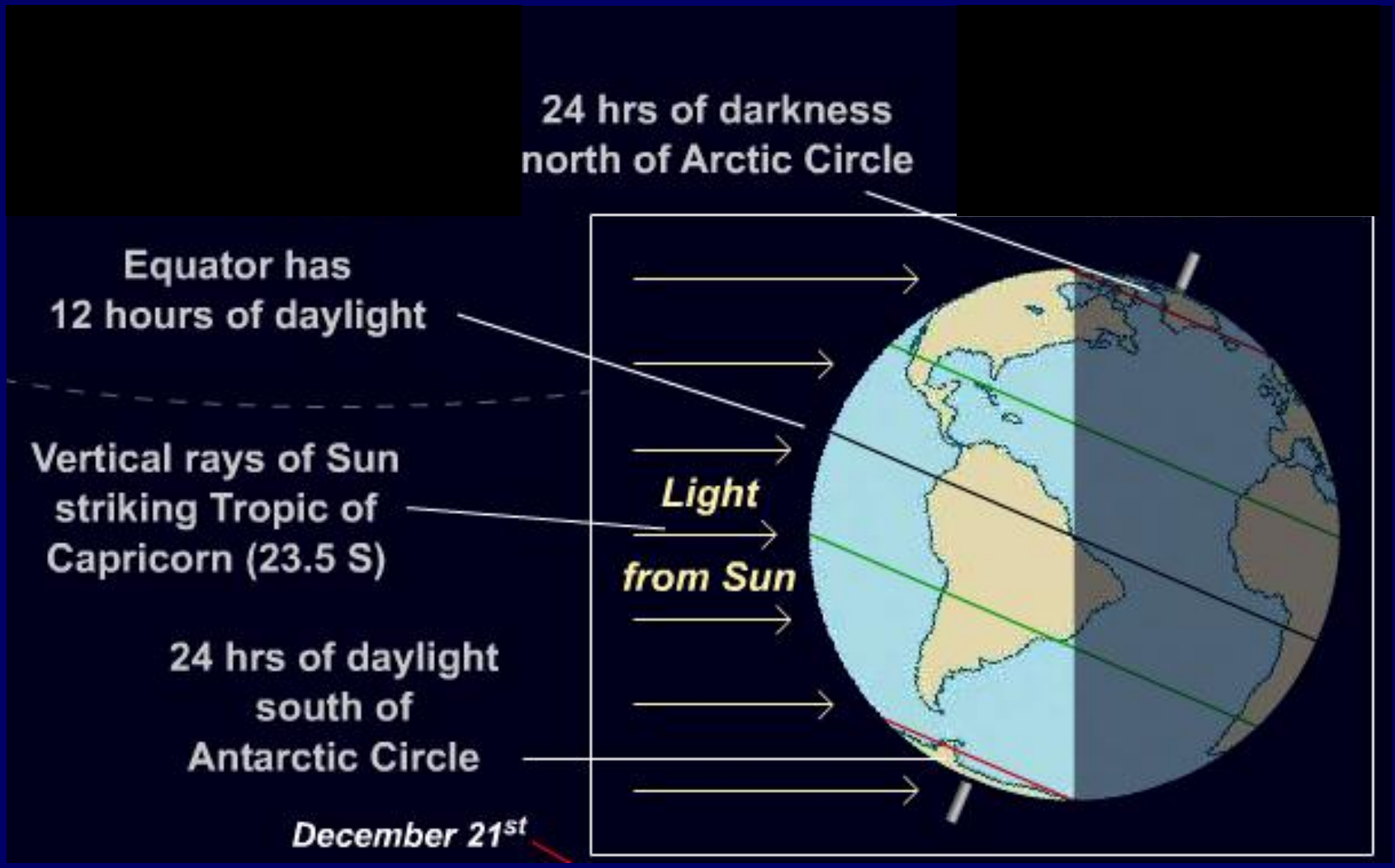
MARCH & SEPTEMBER EQUINOXES

12 hours of sunlight

Most intense solar radiation



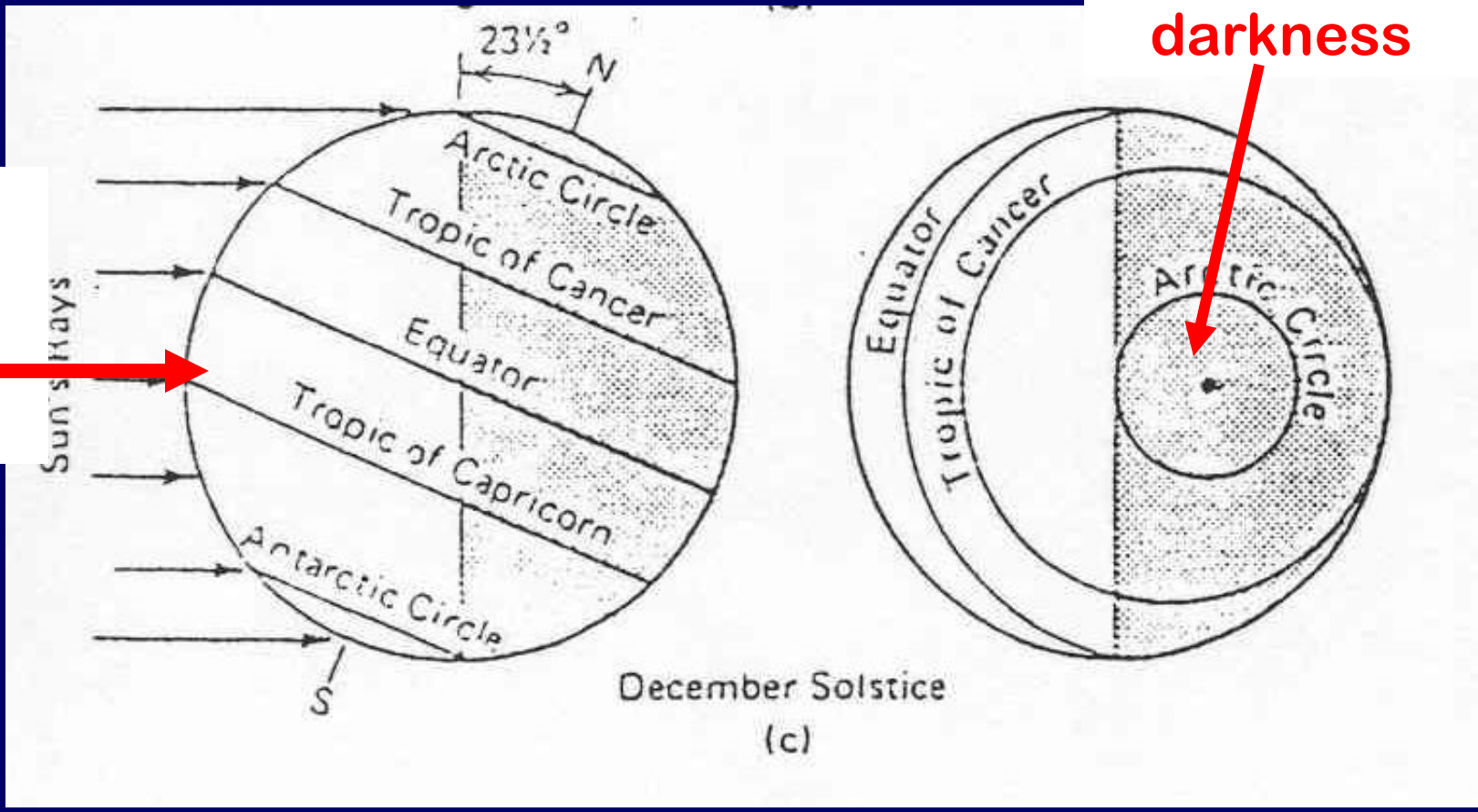
DECEMBER SOLSTICE



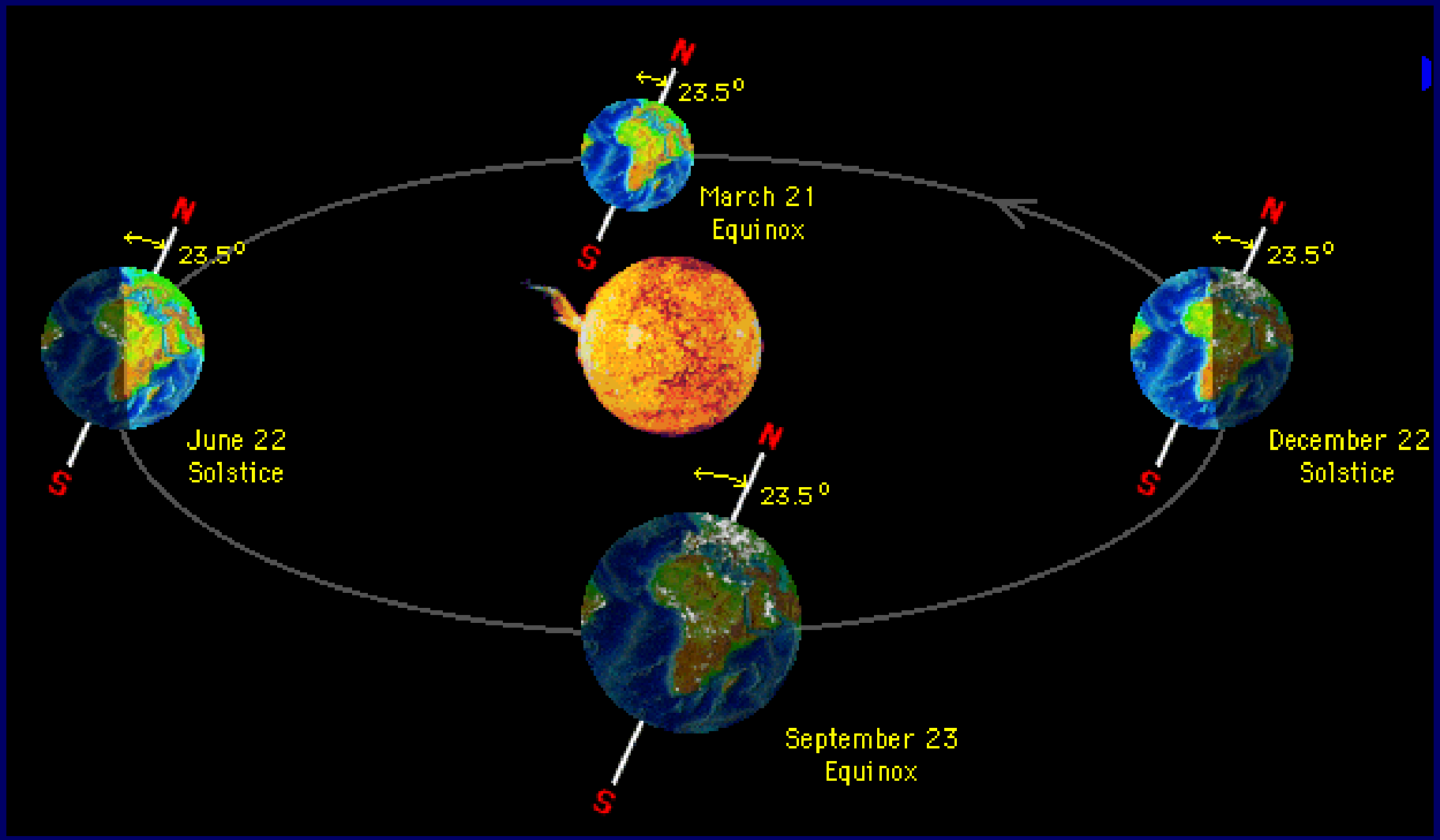
DECEMBER SOLSTICE

24 hours of darkness

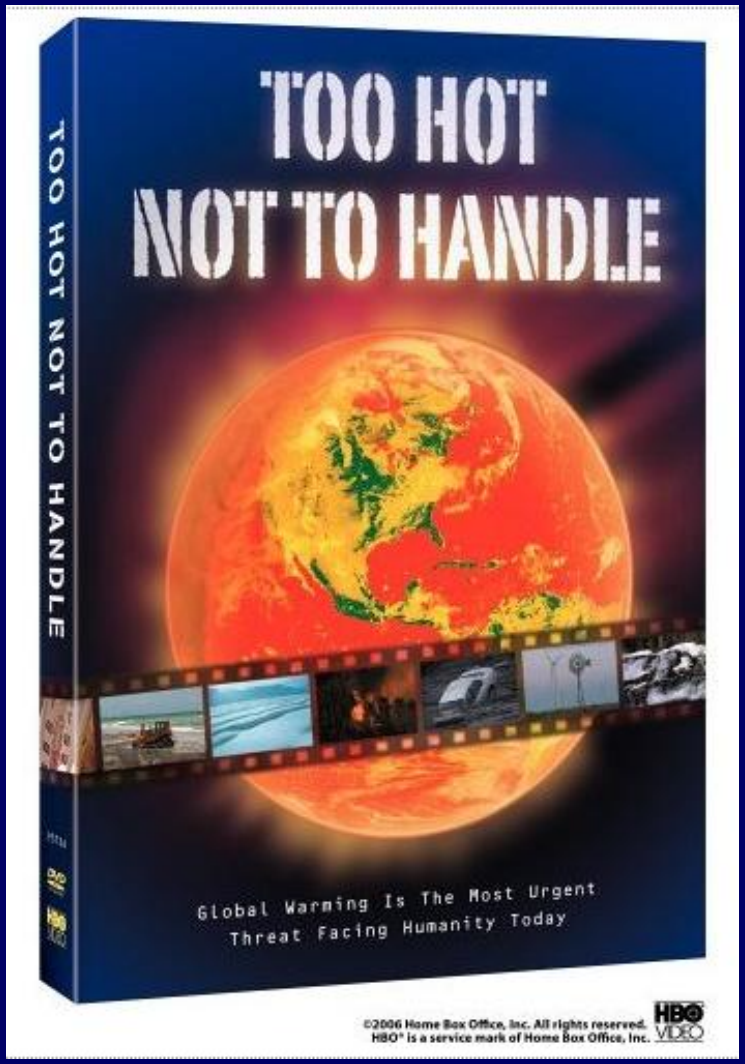
Most intense solar radiation



http://mesoscale.agron.iastate.edu/agron206/animations/01_EarthSun.html



Recap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