Chap. 2 Solar energy, seasons, & atmosphere

Key concepts in Chap. 2

• Distinguish among galaxies, stars, and planets, and locate Earth.
• Describe the Sun’s operation and explain the characteristics of the solar wind and the electromagnetic spectrum of radiant energy.
• Define solar altitude, solar declination, and daylength, and describe the annual variability of each—Earth’s seasonality.
• Construct a general model of the atmosphere based on composition, temperature, and function and diagram this model in a simple sketch.
• Describe conditions within the stratosphere; specifically, review the function and status of the ozonosphere (ozone layer).
• Distinguish between natural and anthropogenic variable gases and materials in the lower atmosphere and describe the sources and effects of air pollution and acid deposition.

Chapter 2. The Energy-Atmosphere system

Our home—Milky Way Galaxy, 100,000 light yrs across; Nebular theory.

Solar System: 11 light hrs wide (~7.4 bill mi)
The stony planets; Sun ~ 870,000 mi diam
Earth ~ 8,000 mi diam; Jupiter ~ 88,865 mi diam

Sun – thermonuclear fusion of hydrogen, sunspots are magnetic storms

Coronal mass ejections => solar wind

Auroras from space (a) and from the ground (b)

Radiant energy and the electromagnetic spectrum

Objects radiate energy in wavelengths related to their surface temperature
Hotter objects emit greater energy per unit area than cooler ones.
**Solar and terrestrial energy distribution by wavelength**

**Earth’s energy budget simplified**

**Insolation** = incoming solar energy

**Solar constant** = 1372 W/m² = avr at thermopause

**Uneven distribution of insolation**

**Daily radiation patterns at the top of the atmosphere 1979-1987**

**Author’s photo of pen w/ sun directly overhead at 22° N**

**Revolution and rotation**
Earthrise

Viewed from the distance of the Moon, the astonishing thing about Earth, exalting the breath, is that it is alive. The photographs show the dry, frozen surface of the Moon is the background, dead as an old bone. A drift, floating free beneath the mist, glowing on white as a bright white day, is the rising Earth, the only exuberant thing in this part of the cosmos. It has the organized, carefully plaited makeup of the sun... When the Earth came alive it began constructing its own atmosphere, for the general purpose of adapting the sun... Where God is all, the way is a successful achievement. It works, and for what it is designed to accomplish it is as infallible as anything in nature.
Lewis Thomas

Profile of the atmosphere based on composition, temperature, and function
The highest skydive, p. 56.
Wow! Capt. Kittinger, 1961, 31.3 km (19.5 mi)

Density of air decreases exponentially w/ altitude. Air pressure is weight of air above a certain point, so there is less air pressure at higher altitudes.

Composition of the atmosphere, variable vs non-variable gases

CO2 at Mauna Loa from 1958 - 2008
Lapse rate or temperature change with elevation.

Atmosphere protects Earth's surface

Ozone is O₃, an isotope naturally produced.

Thinning of natural ozone layer is due to human and natural factors.

Chlorofluorocarbons, CFSs = consume natural ozone.

The ozone hole—see sidebar on p. 59-61.

CFS extremely effective, 100,000 O₃ molecules can be destroyed / 100k CFCs!

Why South Pole—polar vortex?

Politics of: Montreal protocol

Regulated to some extent, from 1987 on but in stages...

CA wildfires, Oct 23, 2007. > 500k acres

Sierra Nevada fires July 2008
Natural dust

Nevada

Africa

Table 2.4 p. 65 shows anthropogenic gases and materials found in the lower atmosphere

Autos >60% us
In 2008- >50% or world in metro areas

SMOG – sun + NO₂ + VOCs

Coal – SO₂, H₂SO₄ - Sulf. acid

Particulate matter (PM) < 10 microns (10 µm)

Table 2.3 Sources of Natural Variable Gases and Materials

<table>
<thead>
<tr>
<th>Sources</th>
<th>Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volcanoes</td>
<td>Sulfur oxides, particulates</td>
</tr>
<tr>
<td>Forest fires</td>
<td>Carbon monoxide and dioxide, nitrogen oxides, particulates</td>
</tr>
<tr>
<td>Plants</td>
<td>Hydrocarbons, pollens</td>
</tr>
<tr>
<td>Decaying plants</td>
<td>Methane, hydrogen sulfides</td>
</tr>
<tr>
<td>Soil</td>
<td>Dust and viruses</td>
</tr>
<tr>
<td>Ocean</td>
<td>Salt spray and particulates</td>
</tr>
</tbody>
</table>

Industrial pollution – coal-fired power plant in Norway w/ no scrubbers
Table 2.1 Five Reasons for Seasons

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revolution</td>
<td>Orbit around the Sun; requires 365.25 days to complete at 107,280 kmph (66,600 mph)</td>
</tr>
<tr>
<td>Rotation</td>
<td>Earth turning on its axis; takes approximately 24 hours to complete at 1675 kmph (1041 mph) at the equator</td>
</tr>
<tr>
<td>Tilt</td>
<td>Axis is aligned at a 23.5° angle from a perpendicular to the plane of the ecliptic (the plane of Earth's orbit)</td>
</tr>
<tr>
<td>Axial</td>
<td>Remains in a fixed alignment, with Polaris parallelism directly overhead at the North Pole throughout the year</td>
</tr>
<tr>
<td>Sphericity</td>
<td>Appears as an oblate spheroid to the Sun's parallel rays; the geoid</td>
</tr>
</tbody>
</table>

Table 2.1.1 UV Index (EPA, NWS, WHO, WMO)

<table>
<thead>
<tr>
<th>Exposure Risk Category</th>
<th>UVI Range</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>less than 2</td>
<td>Low danger for average persons. Wear sunglasses on bright days. Watch out for reflection off snow.</td>
</tr>
<tr>
<td>Moderate</td>
<td>3-5</td>
<td>Take covering precautions, such as sunglasses, sunscreen, hat, protective clothing, and stay in shade during midday hours.</td>
</tr>
<tr>
<td>High</td>
<td>6-7</td>
<td>Use sunscreens with SPF of 15 or higher. Reduce time in the sun between 11 A.M. and 4 P.M. Use protections mentioned above.</td>
</tr>
<tr>
<td>Very High</td>
<td>8-10</td>
<td>Minimize sun exposure 10 A.M. to 4 P.M. Use sunscreens with SPF ratings of over 15. Use protections mentioned above.</td>
</tr>
<tr>
<td>Extreme</td>
<td>11+</td>
<td>Unprotected skin is at risk of burn. Sunscreen application every 2 hours if sun-exposed. Avoid direct sun exposure during midday hours. Use protections mentioned above.</td>
</tr>
</tbody>
</table>

See: https://www.epa.gov/sunsafety/uvindex.html for a UV Index for your location.