A STUDY ON SUNLIGHT

Kalahari Desert sunrise. Source: C.Michael Hogan

Sunlight filtering through Ceiba pentandra

Tikal, Guatamala. Source: C.Michael Hogan

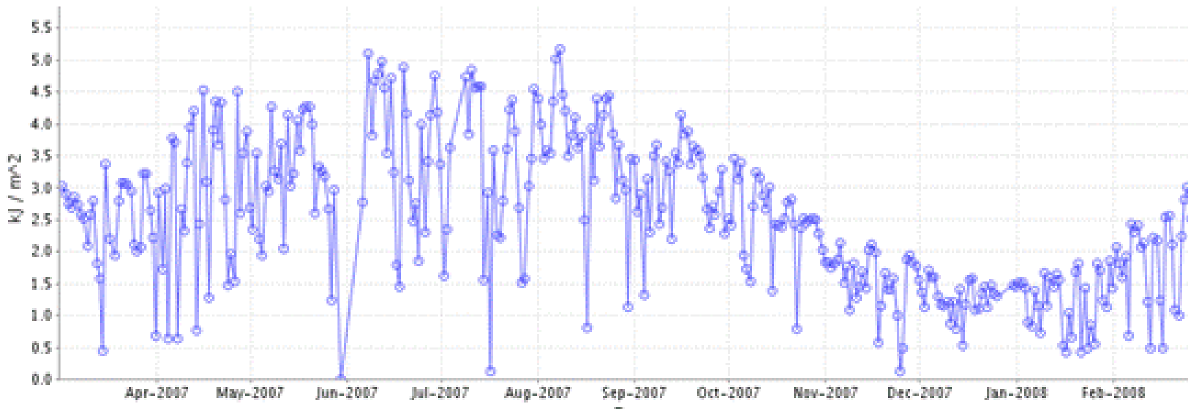
Sunlight is the electromagnetic radiation arriving at the Earth's surface due to direct illumination by thesun; this radiation includes ultraviolet, visible and infrared components of radiation. Sunlight intensity varies by season and time of day due to the orbit of the Earth around the sun and the Earth's rotation. Characterization of sunlight at the Earth's surface is further complicated by the presence of clouds, concentration of atmospheric particulate matter and integrity of

the ozone layer. Sunlight can theoretically be defined as the illumination of a sun in any galaxy impinging upon any arbitrary point in the universe; however, the present treatment will concentrate on the sun in our solar system reaching the Earth surface.
Also called **solar insolation**, sunlight is responsible for maintaining thetemperature of the Earth Crust at levels hospitable to life on Earth as we know it. Sunlight is also the energy source for almost all life on planet Earth. Although it has certain salutory effects on human health, excessive exposure can elevate the risk of skin cancer. Sunlight has obvious variations in diurnal and seasonal intensity at any given point on the Earth surface.

Spectral composition

Longer wavelengths than 1000 micrometers are considered microwaves and will not be addressed in this treatment of sunlight. Thus the sunlight spectrum can be classified into seven bands by wavelength:

Name	**Wavelength (micrometers)**	**Note**
Ultraviolet-C	0.1 to 0.28	This radiation manifests lower wavelengths than visible violet light (and, hence undetectable by the unaided eye). Since the atmosphere absorbs this wavelength strongly, little reaches the Earth's surface. This ultraviolet band has mutagenic, carcinogenic and germicidal characteristics.
Ultraviolet-B	0.28 to 0.315	It is also greatly absorbed by the atmosphere, and along with is responsible for the photochemical reaction leading to the production of the ozone layer.
Ultraviolet-A	0.315 to 0.4	This band has been traditionally held as less damaging to the DNA, and hence used in sun tanning and therapy for psoriasis.
Visible Light	0.4 to 0.7	This band is detectable to the human eye
Infrared-A	0.7 to 1.400	
Infrared-B	1.4 to 3.0	
Infrared-C	3.0 to 1000	



UV energy flux (kilojoules per sq m) Houston, Texas. Source: NOAA

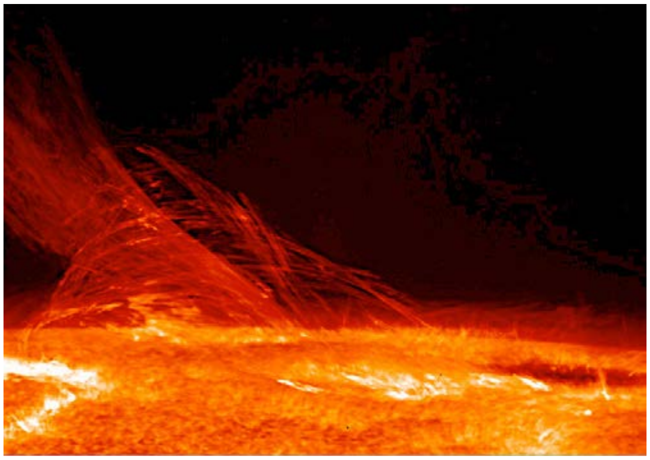
Atmospheric physics and chemistry

Sundog display over the Kluane Range, Alaska. Source: Joseph N.Hall

On its inbound journey to the Earth surface, sunlight has a number of important interactions with the atmosphere, including ionizing effects that result in photochemical smog. The journey of sunlight form its source to the Earth takes about 500 seconds. Re-radiated infrared energy from the Earth's crust has significant interaction with greenhouse gases (chiefly methane and carbon dioxide) resulting in the retention of significant heat within the lower atmospheric layers. There are also significant optical phenomena such as the formation of rainbows, sundogs and ecclipses.

In the 1970s earnest efforts began in the understanding of formation of photochemical smog, addressing California valleys such as the Los Angeles Basin and Livermore Amador Valley. The driving chemical reaction is a photon of UV radiation colliding with the NO_2 molecule, producing NO and a dissociated oxygen atom, which in turn reacts with a variety of reactive hydrocarbons to produce the various chemicals of photochemical smog. .

Energy flux



Surface of the sun, generating an energy flux, which will reach the Earth surface. Source: NASA/Hinode mission

The sun provides the driving force for most biological processes in the Earth's biosphere through a massive energy flux delivered by its radiation. Averaged over all locations and twenty four hours per day, the mean energy flux delivered at the surface is approximately 342 watts per square meter. Not only is this energy sufficient to power all of the Earth's biological systems, but it has some reserve capacity to provide useful energy to humans using solar power technologies. A cautionary note is needed here, since placement of massive solar arrays would not only deprive most terrestrial ecosystems of needed energy, but deployment of large arrays in many desert environments is causing irreversible damage to sensitive desert crust soils, often termed cryptobiotic soils. Consequently solar power must be pursued either as integrated building installation or in carefully chosen low latitude regions like the Sahara Desert, where biological resources are extremely low. Conversely, deserts such as the Mojave, Sonora and Namib are unusually rich in endemic species and high in cryptobiotic soils. If the Earth did not re-radiate an equal amount of energy, there would be a strong systematic warming of the Earth itself. Consequently, infrared radiation from the Earth occurs continuously to balance the incident sunlight. One can calculate that the stable mean Earth temperature to achieve the needed blackbody radiation is -18 degrees Celsius; however, the actual mean Earth surface temperature is about +15 degrees Celsius. The reconciliation of these numbers is the existence of the greenhouse gas content in the atmosphere. Were it not for this protective layer of greenhouse gas, most of the Earth would be inhospitable to life as we know it.

Power supply of the biosphere

Meercats sunning at daybreak to achieve warming.
Kalahari Desert, Botswana. Source: C.Michael HoganSunlight is the source of most biological energy needed to sustain life on the planet Earth. The chief mechanism for conversion of solar power to biological energy is autotrophism, or the process of organisms to manufacture biological resources using sunlight.Photosynthetic activity in vegetation is the most well known autotrophic mechanism. Approximately 10^{14} watts of solar radiation are converted to photosynthetic processes including sunlight incident on the shallower waters, or epipelagic zone, less than 200 meters in depth; this primary production results in about 10^{11} tons per annum ofbiomass production.

Naturally, the primary production fuels growth of heterotrophs, or higher organisms, who consume the autotrophs. Besides the production of biological resources from photochemistry and faunal metabloic function, there is an important direct thermal heating effect essential to most lifeforms. This phenomenon is most apparent in species such as butterflies and meercats, who have a daily sunning cycle intrinsic to achieving necessary body temperature to engage in routine daily locomotion. This effect is observable on a global scale, in that colors of butterfly wings in cooler climates are generally darker, allowing the absorption of greater heat.

Other abiotic effects of incident sunlight are the powering of ocean and atmospheric currents, which are intrinsic to the dynamic equilibria that characterize the ecoregions of the world as we know them. Beyond the powering effects of sunlight, there are important temporal and spatial biotic cues given by sunlight, including circadian rhythm impulses that govern many diurnal biological processes; cues to fauna that perform seasonal migration; and direction finding capabilities for bees and other fauna that use the sun location as a means of navigation.

Albedo and illuminance

Sunlight coming over Picacho Peak, Arizona. @ C.Michael Hogan

The reflectance of sunlight at the Earth surface is termed *albedo*. The reflective coefficient of snow cover is typically about 85 percent; in contrast, the albedo of freshly poured asphalt is approximately five percent. Alteration of land cover has a significant influence on reflectivity and hence, thermal balance at the surface of the Earth. When the albedo is high, such as snow cover, there is a local reduction in surface temperature and a corresponding diminution of re-radiated infrared energy.

Relatively bright mid-day sunlight in a low latitude region yields illuminance of approximately 100,000 lumens per square meter at the Earth's surface. Sunlight illuminance even at higher latitudes is quite high during the daylight hours; there is vast unutilized potential to design buildings to take advantage of natural light through perimeter fenestration, skylights and light tubes. Some estimates indicate that better building design could supplant more than ten percent of electrical lighting demand of current buildings.

Human health

Besides providing food and warmth, sunlight has both beneficial and deleterious impacts upon humans. Benefits include manufacture of vitamin D, while harmful effects include sunburn and the possibility of carcinoma or other genetic mutation; these adverse effects are enhanced at extreme latitudes of the Southern Hemisphere, where a hole in the protective ozone layer has been puctured.

The UVB band of ultraviolet spectrum induces the body to produce vitamin D; furthemore, prolonged absence of sunlight exposure will result in vitamin D deficiency, if dietary intake of this vitamin is not compensated. This common syndrome is known to increase cancer risk. Correspondingly deprivation of sunlight exposure at higher latitudes is a causes of seasonal affective disorder. In addition research has shown that sunlight exposure in childhood reduces incidence of multiple sclerosis.

Source : http://www.eoearth.org/view/article/51cbf00a7896bb431f6a0015/?topic=51cbfc78f702fc2ba8129ea9