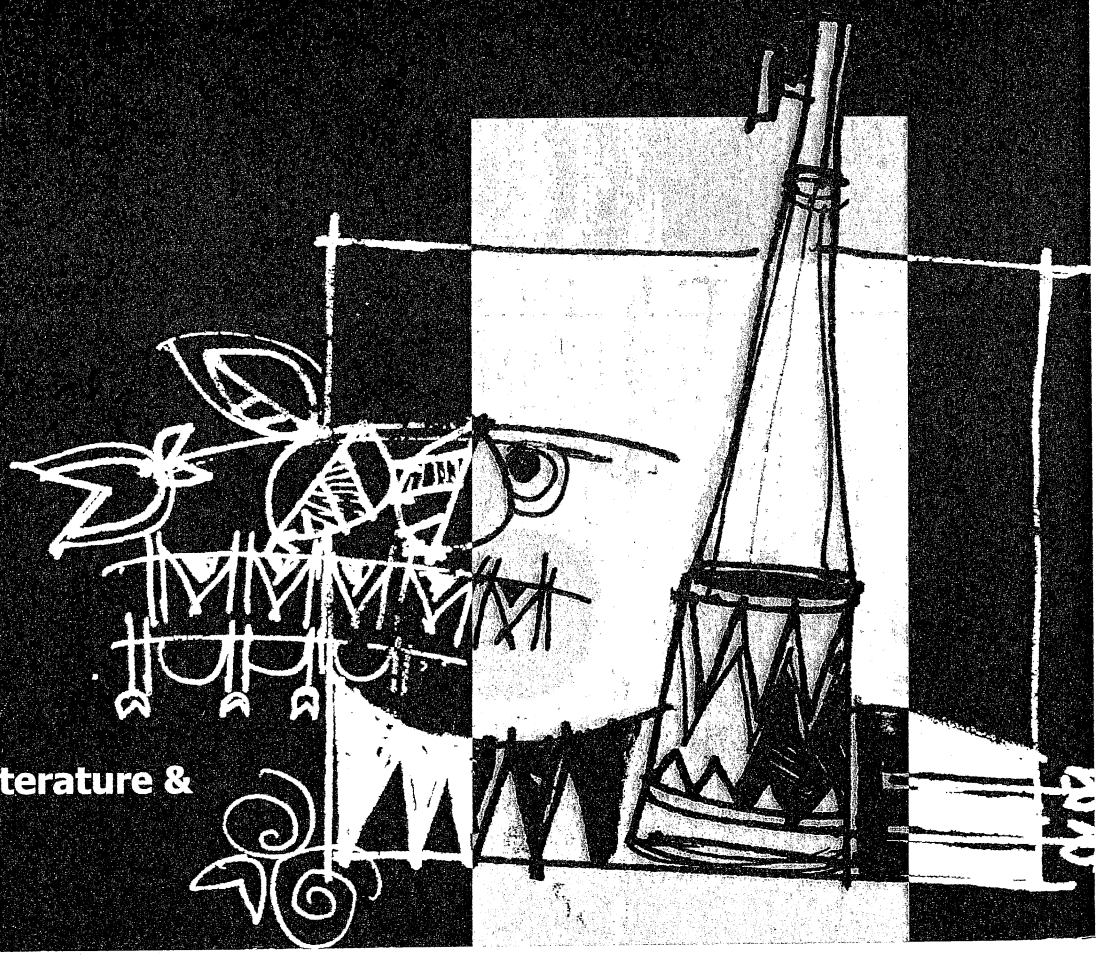
মিলন মেলা

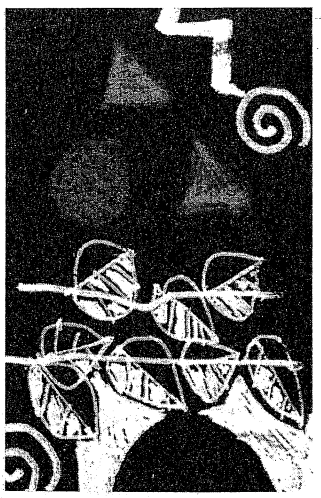


12th

North America Bangla Literature & Culture Convention
Columbus, OH 2010

EFFECT OF SOLAR RADIATION

Sultana N. Nahar



Connection between the Sun and the Earth The sun is our nearest star and is the primary energy source for the earth. It brightens and warms up the day as the earth spins around its own axis. It causes seasons as the earth moves along the orbit around it (left panel of Fig. 1). The earth is much smaller than the sun, its radius is about 110 times smaller than that of the sun. Only a small fraction of solar emission irradiates the earth.

Active Sun

The sun, however, is an "unQuiet" star. It is filled with hot charged particles in a state called plasma. These charged particles are formed mainly from hydrogen, then helium, carbon, nitrogen, oxygen, etc along the periodic table and ending to iron. The sun goes through a cycle of maximum and minimum activity in a period of 11 years. During active time, localized loops of magnetic fields are created and these trap the charged particles and form sun spots. They eventually explode in to solar flares. As the sun erupts with explosions, it ejects out large amount of particles and radiation in to the space. These events are called solar storms. A solar flare extends to a very large distance. Sun's picture in Fig. 1 (right panel), observed by the space observatory SOHO, shows white active regions and solar flares on the surface. The ejected materials are mainly charged particles, such electrons, protons, and heavy ions. They travel in space with extemely high energy. These are harmful to us since they can damage tissue, break strands of DNA, and lead to diseases like cancer. The emitted radiation has also a very wide electromagnetic band, such as harmful X-rays, ultraviolet and nonharmful optical, infrarad, low energy microwaves. These can affect satellites and communications and can even disrupt electrical service over long distances.

However, as we will below that we are protected from them by our atmosphere and earth's magnetic field. Protection by the Earth There are protective shields around the earth (left, Fig. 2). Earth's magnetic field captures charged particles and channels them around the earth. A fraction of them is accumulated in the atmosphere of north and south poles where they produce the most commonly noticed effect, the glowing auroras.

Various upper layers of atmosphere provide further protection for the earth habitants. The ozone, which is a molecule of three oxygen atoms (O3), in upper stratosphere deflect and block part of radiation, mostly ultraviolet, X-rays, and Gamma rays. The lower atmosphere scatters and burns part of the incoming

particles. However, the visible and near-infrared solar radiation penetrate through the earth's atmosphere. Solar Radiation in the Atmosphere and Grrenhouse Effect The solar radiation entering the earth causes various atmospheric phenomena. However, the earth has been maintaining a fine energy balance for thousands of years. It radiates back in to space the same amount of solar radiation entering its atmosphere through an energy cycle called the Greenhouse effect. Of the total solar radiation reaching the earth, 30% is reflected back to space, 19% is absorbed by atmosphere and 51% is absorption by the earth surface (right, Fig. 2). 51% energy absorbed by earth surface is reradiated to the atmosphere. The atmosphere absorbs this 51% of longwave infrared

1 Figure 1:Left:Change of position of the earth in its revolution around the Sun (www.physicalgeography.net/fundamentals/6h.html).Right: The solar eruption to flares observed by SOHO/NASA on July 1, 2002. The The active regions are the white spots, known as the sun spots, where loops of magnetic field trap the hot gas inside.

Figure 2: Left: The magnetic field lines (light blue) originating from the earth, the small object at the center, act as invisible shield to repel, capture, scatter out the dangerous emission accelerated by the solar explosions. Various layers of the atmosphere protect the earth from large number of particles and harmful radiation (NASA). Right: The distribution of solar energy reaching the earth (courtesy: Manitoba Energy, Science & Technology, Climate Change Branch). radiation plus the original 19% of shortwave radiation it absorbed directly from the sun, and then reradiates the total 70% back to space. Hence, a stable relation is maintained between atmospheric thermal strucutre and solar radiation. Direct sunlight reaching the surface heats it only to -18C. The atmosphere contains number of component gases: 78.08% nitrogen (N2), 20.95% oxygen (O2), 0.93% argon, 0.038% carbon dioxide (CO2) and some other traces.

About 1% could be water vapor varying with climate. Water vapor and some other gases, such as, carbon dioxide, methane, ozone are called the Greenhouse gases. They can absorb and trap the solar radiation and then release it. Part of the released radiation is reflected back to the earth's surface and warms it up to an average temerature of 14C. Global Warming For the last over a hundred years, the energy balance is earth's atmosphere has been perturbed, that is, the amount of solar radiation entering is not completely reflected back in to space. The reason being increment of Greenhouse gaes through our industrial revolutions and hence changed the concentrations of atmospheric compositions. More energy is being trapped than released leading to global warming and climate change. Industrially produced compounds are also breaking down ozone. Depletion of ozone has created holes for harmful radiation to reach earth's surface. We are now carryinng out research on how to bring back the energy.