Solar Radiation Weakening in the Earth's Atmosphere

Ulaanbaatar, T., Ts. Baatartsuluun

Earth Science Center, Physics and Electronics School,

National University of Mongolia

M. Legden

Renewable Energy Corporation, Mongolian

Academy of Sciences

(Received 20 March, 1998; accepted 15 May, 1998)

Абстракт

Энэ өгүүлэлд Дэлхийн агаармандал дахь нарны шулуун цацрагийн сулралыг тооцох онолын шинэ аргачлалыг боловсруулсан.

Introduction

What we understand under the term so-called atmospheric extinction or influence? In my opinion, it is a myriad of all physico-chemical, geographical, meteorological infinite factors, and man-made impacts, air pollution,

atmospheric content so on. However, we can determine it mathematically.

The insolation regime on the earth surface has written by Ulaanbaatar, T., [1997; 1998]. On the other hand, solar constant (I_0 =1.98 cal min^{-1} cm^{-2} by the international pirheliometerical scale) the solar flux measured at the exopause i.e. external boundary of Earth's atmosphere at the side of Sun at the average distance between the Earth and Sun. So, the atmospheric influence or solar radiation weakening in the earth atmosphere (K_φ^n) is described in the next form:

$$K_\varphi^n = I_0 - Q_\varphi^n$$

$$K_\varphi^n = I_0 - \frac{Q_0 C_\varphi^n}{2 \cdot 718^2} \cdot \cos[23^0 27^I \cos(0.98 \cdot n + \varphi)] \qquad (1)$$

Where I_0 denotes the familier solar constant, Q_0 is new etalon of insolation, n denotes the number of day from winter solstice, φ denotes geographical latitude, C_φ^n denotes the length of daylight, which equals:

$$C_\varphi^n = 718 - 7.977 \cdot \arcsin(tg\varphi \cdot tg(23.45 \cdot \cos(0.98 \cdot n)))$$

(Ulaanbaatar, T., [1994]; [1997]; [1998])

Looking to Figure 1. the solar radiation weakening in atmosphere equals 68%-100% which is in an enough coincidence with the results of other researchers.

The result of equation (1) is shown in Figure 2.

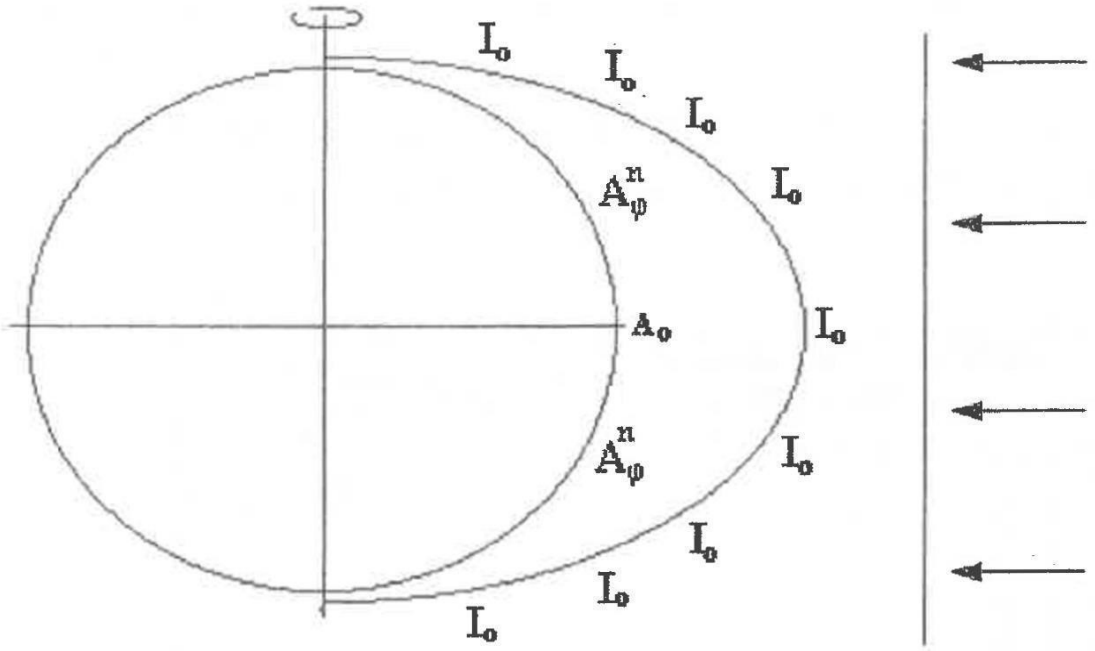

Figure 1. Atmospheric influence on the solar radiation

📖Pivobarova, Z.I., [1976] wrote: "As is known, the weakening of direct solar radiation flow on the way across atmosphere in conditions of absence of cloudiness fixes the molecular scattering ΔS_M, spending for water vapor absorption ΔS_b, and spending for aerosol absorption and scattering ΔS_a

$$\Delta S = \Delta S_M + \Delta S_b + \Delta S_a \qquad (2)$$

The value of global weakening of direct solar radiation ΔS may be determined as bias of intensities of direct solar radiation between the acting on the upper atmosphere (solar constant S_0), and measuring on the earth surface. ...Value of direct solar radiation weakening on the aerosol equals approximately 10% of solar constant. ...Comparing the three components of

direct solar radiation weakening in the atmosphere, may be conclude that in a year on the well the molecular scattering is 39-45%, water vapor absorption is 27-33%, aerosol weakening equals 23-33%".

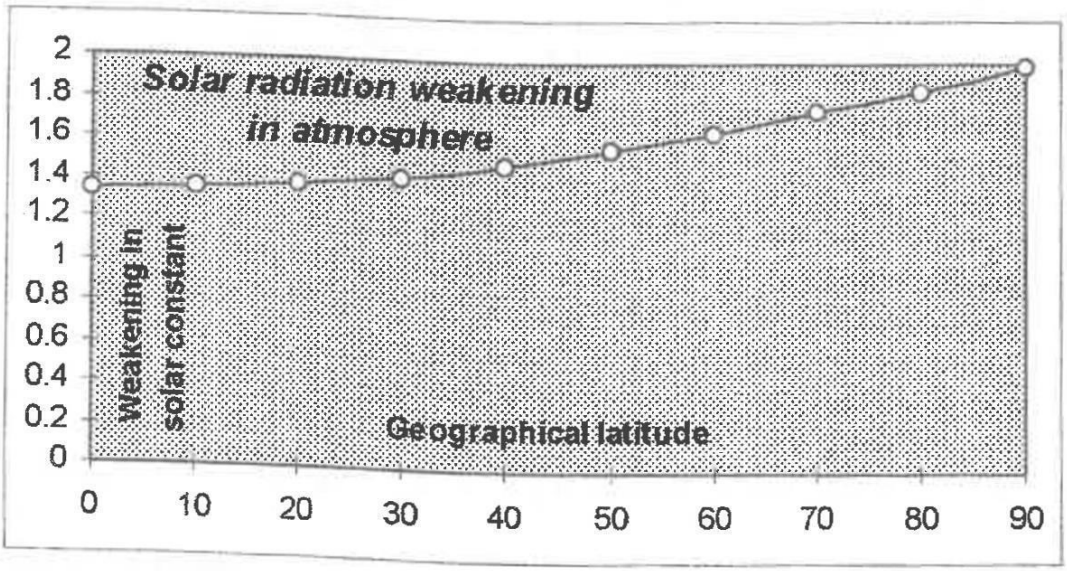

Figure 2. Solar radiation weakening in atmosphere at equinox

According to the result of calculation by equation (1) the weakening increases from 67% to 100% which is likely with the conclusion of Pivobarova."

Based on the equation (1) we can calculate the direct solar radiation in result of which the molecular scattering ΔS_M, spending for water vapor absorption ΔS_b, and spending for aerosol absorption and scattering ΔS_a. They may be determined, respectively, as ΔS_b by equation of Moller, F., [1932], $\Delta S_M = 0.36$ cal cm^{-2} min^{-1}

and ΔS_a by Pivabarova. In this paper we describe only the direct solar radiation.

Conclusion

1. The solar radiation weakening in atmosphere may be calculated by equation (1). The value of weakening increases from the equator to polewards.
2. The theoretical calculation of the solar radiation balance of the atmosphere is necessary to base on the equation (1).
3. The weakening of solar radiation in atmosphere varies between 67% -100%.

References

Mugge, R., Moller, F., Zur Berechnung von Strahlungsstromen und Temperatureanderungen in Atmospharen von beliebigen Aufbau, Z. f. Geophys., 1932, Bd 8, 1-2, S, 53-64

Pivobarova, Z.I., Estimation of the water vapor and aerosol in weakening of the direct solar radiation in atmosphere, Works of the Voeikov General Geophysical Observatory, Bull.365, 14-28, Gidrometeoizdat, L., 1976,

Ulaanbaatar, T., Mathematical modeling for the thermal regime of the Earth's surface and cryosphere, Ph.D Thesis, Mong. Univ.of Technology, Ministry of

Science and Education, Ulaanbaatar, 1994,

Ulaanbaatar, T., et al., Insolation regime on the Earth's surface, Rep. Sci.Con.on Renewable Energy Project Implementation in Mong. supported by UNESCO, Renewable Energy Corp., Mong. Acad. Sci., Ulaanbaatar, 1997

Ulaanbaatar, T., Climate Supercirculation of the Earth, Proc. Nat.Univ. Mong.1(126), National University of Mongolia, Ulaanbaatar, 1998,