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Short Wave Solar Radiation Features in Eastern Mongolia

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ABSTRACT

This study is conducted to examine the solar radiation features of landscape in Eastern Mongolia and their space and time distribution characteristics.

To many foreigners, the name Mongolia conjures up images of the vast steppes of Central Asia. And, indeed, the extensive grasslands of the steppe make up the heart of Mongolia-geographically and economically. Steppe covers nearly the entire far eastern part of Mongolia, extending west in a narrowing band just south of the Khangai and Khan Khokhii mountains all the way to the Depression of the Great lakes.

Eastern Mongolia is recognized as one of the last remaining untouched grassland steppes in the world. Landscape of Eastern Mongolia divided by 19 types that belongs to High Mountain, Middle Mountain and low mountain steppe. Only 5.6% of the total land area is covered by forest. Eastern Mongolian steppe is homeland of migratory rare and endangered birds and about 2.0million freely migrating gazelles.

According to Mongolian scientists, there is growing evidence of fundamental changes in the Eastern steppe ecosystems in terms of increasing aridity during the last 70 years. As estimated average annual temperature has increased by approximately 0.7oC, soil moisture, energy supply has been changing. These processes closely interrelated into water and energy cycle of steppe ecosystem.

Keywords : albedo, radiation, wave length, thermal and radiation balance

Introduction

Main features of the climate of Mongolia include great daily and annual temperature ranges, cool and long winter, low air humidity, little cloudness, low precipitation totals, as well as a great number of hours of sunshine throughout the year.

Total radiation amount in Eastern Mongolia lies between 4320-5400 Mj/m2. Despite of this annual distribution of total radiation in case of cloud free sky in order to latitude, ranges as shown in table 1 (Beresneva,1984)

For whole Mongolia the mean year total radiation amount is ranges between 5028-6285 mJ/m2, along with their latitudinal gradient in summer season is 8.4-12.6 mJ/m2 and in winter season reaches up to 25.1 mJ/m2. In the annual cycle the highest values recorded in June (626-712 mJ/m2) and lowest value has occurred in winter (128-210 mJ/m2).

In steppe station Maanit (N 47018', E107032', H=1427 m a.s.l.) insulation on in hill top, on it's northern side and year, and the monthly totals exceed 200 hrs in every month. Even in winter months, when the days are by a half shorter than in June

Table 1. Total radiation amount in cloud free sky (mJ/m2)

Lat.	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
52 o	155	318	532	742	880	964	901	759	595	398	197	126
50 o	193	348	562	767	905	9801	913	779	620	427	230	159
48 o	230	381	591	792	926	993	926	800	645	457	264	193
46 o	268	415	620	817	951	1006	939	821	670	486	298	226
44o	306	448	649	838	972	1014	947	838	691	515	331	260

and July, the duration of sunshine is almost as long as in summer because of scanty cloud cover. In the diurnal cycle insulation is greater in the forenoon. This is particularly visible in the warm season. In the afternoon the intense heating of the land surface and the increased vertical movement of the air cause convectional clouds to develop.

Since the air is clear, owing to low air vapor content and reduced cloud cover, direct sun's radiation is the basic component of the total solar radiation. The exemplary daily cycles of the individual components of radiation balance during clear weather indicate that direct radiation accounts for about 80% of the total radiation in the forenoon and afternoon and for about 65% only in the morning and late in the afternoon.

When sky is clear, all components of the radiation balance are most intense at noon. During the hours that the sun is in sky, the curves rise and fall symmetrically, for convectional weather the daily cycle of radiation is slightly different. In that case radiation reaches a maximum between 9 and 10 a.m.

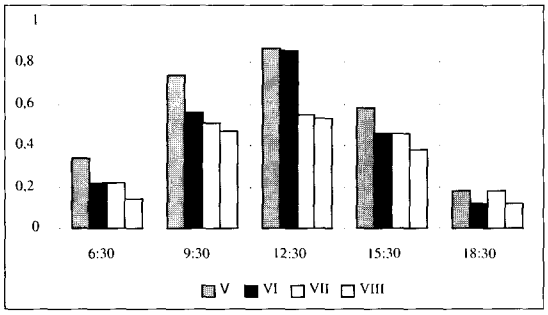

Fig 1. Total solar radiation amount in Ugii lake, steppe station (E 1020° 43′, N 470° 48′)

As shows a stationary investigation the albedo in steppe region, particularly in dry steppe is 0.20-0.30, in desert steppe is 0.25 and in grassland is 0.23. According to these the values the penetrated radiation in forest steppe zone, per year reaches 3143 mJ/m2. Despite of this longwave radiation in steppe zone for year ranges 1590-2000mJ/m2.

Power potential of the region is estimated by radiation index of aridity by Budyko (R/Lx). It is most informative index in comparison with other characteristics of radiation regime. Some important values of water and energy characteristics given in Table 2 in below.

Where: Q- total radiation, Q(1-Ak)- penetrated radiation in active soil layer, R- radiation balance, LE- latent heat of evaporation, P- heat turbulance between atmosphere and active soil layer, Lr- precipitation heat., (mJ/m2), E0- (mm/year) potential evaporation, St>100C- sum of mean diurnal air temperature which exceed 100C.

In the steppe zone of Mongolia potential evaporation varies between 700 mm and 800 mm Per year. Annually, its highest values recorded from May to September (80% of the annual total), with a maximum in June. During observing period potential evaporation reached 373 mm, 191 mm of which was noted in May. On the average, the diurnal potential evaporation rate was 6.8 mm. The maximum diurnal potential evaporation rate exceeded 16 mm, while its minimum value was 1.0 mm.

Table 2. Water and thermal characteristics of steppe zone of Mongolia

Veg. zone	Q	Q(1-Ak)	R	St>100C	LE	P	E0	Lr	R/Lr
forest step.	4610-5240	3350-3770	1260-1470	1000-2200	630-840	630-840	500-800	630-840	1.3-2.0
Step.	5240-5660	3770-4190	1470-2300	2200-2800	250-630	1260-1680	800-1100	250-630	2.5-8.0

Table 3. Thermal balance components of steppe zone (mJ/m2)

Station	R	LE	P	LE/R %	P/R %
Binder	1504.2	683.0	821.2	45	55
Kherlen	1638.3	611.7	1026.6	37	63
Choibalsan	1634.1	703.9	930.2	43	57
Undurkhan	1684.4	666.2	1018.2	40	60
Bashint	1919.0	460.9	1458.1	24	76
Arvaikheer	2203.9	293.3	1910.6	13	87

Its interesting now to see the thermal balance components and their variance in the steppe zone of Mongolia.

The greatest differences in the thermal stratification of the air layer near the ground and in the upper part of the soil are observed during clear weather, when ground surface becomes extremely heated because of intense solar radiation. These features well reflected in structure of thermal balance components (Table 3).

In structure of thermal balance components a dominant role played the P value, due to low humidity source and high values of wind in steppe zone. Despite of this soil moisture amount is limited the evaporation process.

Discussion

Climate of steppe region is extremely sensitive due to low amount of precipitation and high values of total solar radiation and thermal balance structure.

In past years, useful mineral exploitation activities have increased in Eastern Mongolia. In addition, many important natural habitats have been or are being destroyed, degraded and depleted in pursuit of land for crop production. In some parts of region desertification rate had activated because of climate change.

The precious landscapes and biological diversity of Mongolia, specially Eastern region are not only the life source and matter of pride for Mongolians but also they have regional and global importance because they contribute to Central Asia's ecological balance and provide the homeland for numerous globally threatened and endangered species.

Protecting Mongolia's pristine landscapes provide not only a reference point against which to measure and study global change and harmful environmental impacts but also are an important regional step toward standing up to the Earth's global environmental crisis, and preserving an important biological resource.

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