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SOME IMPORTANT CHARACTERISTICS OF SURFACE ALBEDO OF CHINA IN RECENT YEARS

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ABSTRACT: Based on the radiation data from 14 representive stations from 1986 to 1990 and the distribution situations of vegetation and soil, some new characteristics of surface albedo in China are analysed. In different regions, surface albedo is different due to differences of surface features. Even though in the same region, surface albedo varies with seasonal variation. However, in the seasons and regions without snow cover, the long-term and interannual variation of surface albedo is not obvious. On the viewpoint of climate, the values of surface albedo mainly depend on whether there is snow cover or not. The interannual variation of surface albedo is greater to the north of 50°N, with a variation range of 5%. The influences of geographical conditions, such as latitude, elevation and air pollution, are also analysed.
KEY WORDS: surface albedo, time variation, influence factor

Surface albedo is defined as a ratio of reflective solar radiation to total solar radiation, which can indicate the absorption and reflective capability of the earth for solar radiation. It is an important factor to influence the surface radiation balance, especially for the formation and variation of local microclimate. Generally, the actual data from observational stations for radiation are used in the analysis of surface albedo. However, the representativeness of the data is limited due to the scarcity of observational station and uneven distribution of surface condition. After the 1960s, the analysis for surface albedo is evidently improved by means of satellite observation abroad (Preuss *et al.*, 1980). Of course, this method is highly advantageous to plateau and desert. Similar studies have been made by Chinese researchers in recent years, such as the study of surface albedo on Qinghai-Xizang (Tibet) Plateau by using satellite data(Zhong *et al.*, 1988). Meanwhile, it is noted that there are many problems in the use of satellite data, for example, the satellite observational data are insufficient in China up till now and used in a limited scope. In otherword, it is immature to transform satellite data to surface albedo. Therefore, it is still necessary to analyze surface albedo actual data from radiation observational

stations.

The space distribution and temporal variation of surface albedo of China was creatively studied by Chen(1964). However, in the past studies, the stations and years of surface albedo data are not enough. Specially in the recent 20 to 30 years, the environment problems, such as, forest and vegetation destruction, soil erosion, land desertification and abnormal climate variation become serious, the surface features have been changed on a larger extent in China, thus the corresponding changes of surface albedo have taken place. Therefore, it is necessary to study deeply the characteristics of surface albedo of China by using observational data in recent years. In this paper, the variation features of surface albedo are analyzed by observational data in 14 representative radiation stations from 1986 to 1990. This is a basic study to understand the change pattern of surface albedo, as well as characteristics of geographic and climatic variations in China.

I. REPRESENTATIVENESS OF SURFACE ALBEDO DATA

According to the conclusions given by Sun and Weng (1987), daily averaged surface albedo can be substituted by surface albedo at noon as first approximation, and the absolute error is below 1%. Thus the daily averaged surface albedo is represented by the surface albedo at noon of a local time in this paper, i.e.

$$A_g = R_{\max} / Q_{\max} = A_{gm} \tag{1}$$

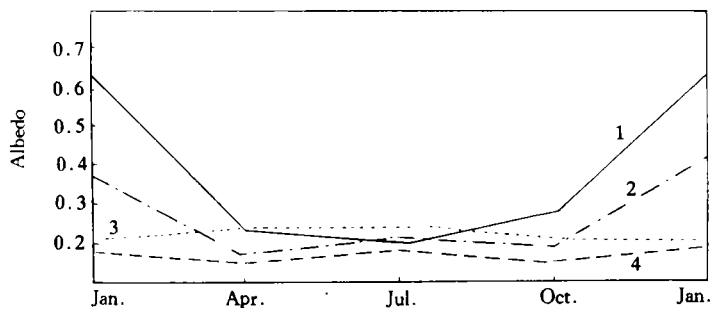
where A_g is daily averaged surface albedo, A_{gm} is surface albedo at noon, $R_{\max}$ and $Q_{\max}$ are maximum of reflective radiation and total radiation, respectively. Generally, they all appear at noon.

II. YEARLY VARIATION OF SURFACE ALBEDO

Actual surface albedo depends on color, wetness and roughness of surface soil and so on. Thus in different regions, surface albedo is different due to differences of surface features. Even though in the same region, surface albedo varies with seasonal variation. However, in the seasons and regions without snow cover, the long-term and interannual variation of surface albedo is not obvious. Only in winter in China, because of the effect of snow cover, surface albedo would change as wave type every year, but this interannual variation is still not obvious. Therefore the average of surface albedo can be replaced by surface albedo five-year average, the absolute error is generally below 1%.

In Fig. 1, the maximum of surface albedo appears in winter and the difference between south and north regions in China is remarkable. Surface albedo rises with the increase of latitude. After October, surface albedo in the region increased abruptly with the beginning of snow, the maximum appears in November or January next year generally. After March, surface albedo drops below 0.2 with the rise of temperature and melting of snow cover. From

spring to autumn, surface albedo changed gently and characterized by transition season. In spring, temperature rises, snow cover dissolves, soil thaws, soil moisture and cover area of vegetation increase, and surface color become dark, thus surface albedo decrease gradually. In winter. The situation is just opposite. Therefore the yearly variation appears in U-shape, this is greatly related to snow cover and the slope of U dropped with decease of latitude. It should be pointed out that because of stable temperature, rich rainfall and damp soil, yearly variation of surface albedo in Chongqing is smaller than that in Kunming and Guangzhou even though the latter are to the north of the former.



1 Heihe 2 Changchun 3 Guangzhou 4 Chongqing

Fig. 1 The seasonal variation of surface albedo in different latitudes

In the northeast region of China, surface albedo in Heihe in January is above 0.6 due to stable snow cover in winter. However, it is only 0.18 in summer due to vegetation, thus the variation in a year is larger than 0.4. Surface albedo in Guangzhou almost does not change in whole year due to a dense vegetation except increase slightly in winter because of withered and yellow vegetation.

III. VARIATION OF SURFACE ALBEDO IN SOME TYPICAL CASES OF SURFACE

In the viewpoint of climate , the values of surface albedo mainly depend on whether there is snow cover or not. In addition. Surface albedo is above 0.25 in desert, frozen soil and grasslands in arid season. In middle and low latitude, surface albedo depends on the situation of lands and forests. According to the observational radiation data, the values of surface albedo in different zones and seasons in China are calculated in Table 1.

From Table 1, Fig. 2 and Fig. 3, larger interannual variation is to the north of 5°N, variation range is above 5% mainly due to snow variation resulting from interannual variation of climate. Surface albedo had random fluctuation every year, and no obvious climatic variation. In the areas without snow cover, interannual variation of surface albedo is small, variation range is

below 2%, i.e. the interannual and annual variation are not remarkable.

Table 1 The surface albedo in different zones of China

Station	Winter	Spring	Summer	Autumn	Annual average	Annual range	Interannual variation
Changchun	0.38	0.15	0.19	0.16	0.22	0.23	0.05
Beijing	0.21	0.17	0.17	0.18	0.18	0.04	0.01
Urumqi	0.51	0.13	0.15	0.16	0.24	0.38	0.01
Shanghai	0.17	0.15	0.17	0.18	0.17	0.03	0.02
Chongqing	0.11	0.15	0.17	0.14	0.14	0.06	0.02
Changsha	0.19	0.18	0.19	0.18	0.19	0.01	0.02
Kunming	0.20	0.19	0.22	0.19	0.20	0.03	0.01
Yushu	0.25	0.22	0.20	0.19	0.21	0.06	0.01

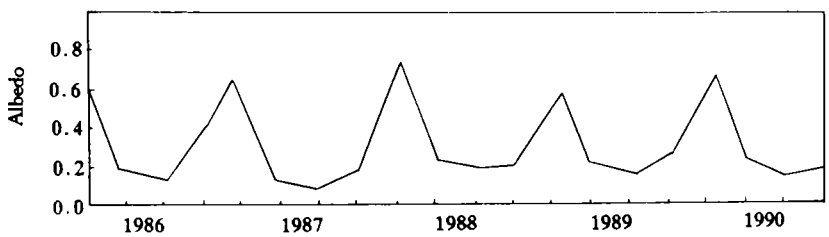


Fig. 2 The interannual variation of surface albedo in Heihe

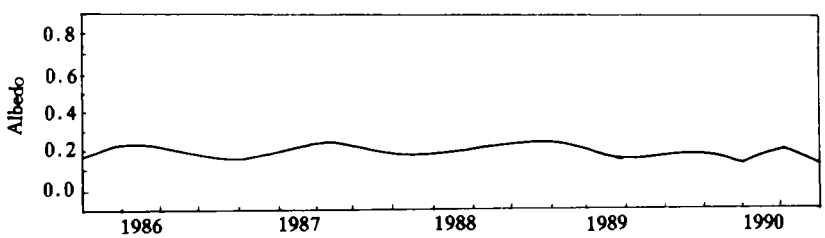


Fig. 3 The interannual variation of surface albedo in Guangzhou

IV. EFFECT OF GEOGRAPHIC DIFFERENCE ON SURFACE ALBEDO

1. Effect of Latitude

If not including the effect of longitude and arranging the stations in latitude order, we can obtain the distribution curves of surface albedo in January, April , July and October(as shown in Fig. 4). It shows that the effect of latitude on surface albedo in cold season is larger than that in warm season. In cold season, surface albedo drop from north to south because snow cov-

er decrease in the same direction. Surface albedo in winter increases remarkably with latitude from 36°N, but variation of surface albedo with latitude is not remarkable in other seasons. This shows that there are stable snow cover to the north of 36°N. In warm season, the influence of geographic conditions on surface albedo is smaller. When rainfall and vegetation cover and soil moisture are large, surface albedo is small; in an arid region, the situation is just opposite. Thus, the relationship between surface albedo and latitude is exponential in winter season, linear in transition season and not obvious in summer season.

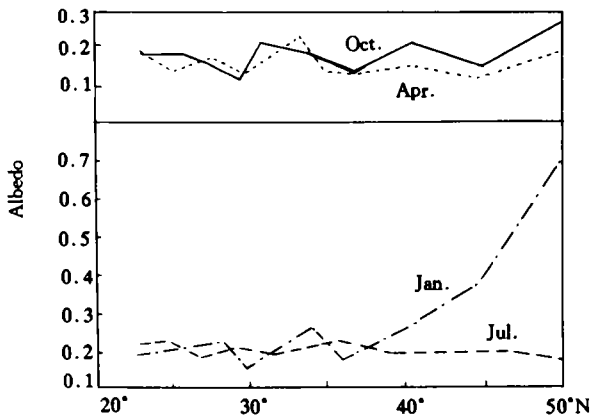


Fig. 4 The seasonal surface albedo with latitude in China

2. The Effect of Elevation and Topography

As shown in Table 2, the surface albedo at the same latitude increases with the rise of elevation. With the rise of elevation, temperature drops, the period of cold season becomes long, snow amount increases, the period of snow cover becomes long and there is snow cover above the snow line in mountain region throughout the year, therefore, the surface albedo increases.

The topographic effect on surface albedo is also remarkable, general regulations are as follows: the effect in mountain area is larger than that in plain, river valley and basin (Table 3). Because in mountain area, snow amount is larger and surface of snow is not easy to be polluted, surface albedo can remain higher values in a longer period. In addition, surface albedo deceases with the rise of surface roughness.

Table 2 The relationship between the mean annual surface albedo and the elevation at the same latitude

	Erlian	Urumqi	Changchun
Elevation(m)	964.7	917.9	236.8
Mean albedo in 5 years	0.30	0.24	0.22

Table 3 The topographic effect on the surface albedo

	Yushu (plateau)	Changsha (hill)	Shanghai (plain)	Chongqing (basin)
Elevation(m)	3681.2	44.9	2.8	351.1
Mean albedo in 5 years	0.21	0.19	0.17	0.14

3. Influence of Air Pollution

According the observational data , surface albedo of new snow is 0.7—0.9, old snow is 0.4—0.6, seriously polluted snow is only 0.2—0.3. Thus under the same snow days and because of polluted snow, surface albedo is smaller in the region where the industrial pollution is more serious.

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