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Analysis of Land Surface Energy Changes at Zhufeng Station in Qinghai Tibet Plateau in 2008

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Abstract

The surface radiation balance and partial meteorological elements in the Qomolangma region were analyzed by using the flux observation data of Qomolangma stations in 2008 in the High-Resolution Integrated Observation Dataset of Earth-Atmosphere Interaction Process of the National Tibetan Plateau Scientific Data Center. The main conclusions are as follows: 1) The influence of weather conditions on the total solar radiation is more significant at high altitudes. For 2008, radiation on average each component change after comparative analysis, not only from atmospheric radiation, upward curve comparison verified the surface temperature in the plateau area affected by the solar total radiation that largest at the same time from the curve of the downward shortwave radiation found in contrast, although the Everest region influenced by latitude and longitude and altitude. However, the maximum value of shortwave downward solar radiation at noon appears in spring and April, and the maximum value of summer radiation at noon is even lower than that in autumn. 2) In the analysis of the typical weather conditions of continuous sunny days and continuous rainstorm, it is found that the net radiation and the Upward short-wave radiation are affected by the underlying surface change, and the amplitude of the net radiation and Upward short-wave radiation are close to the original atmosphere because the atmospheric environment in the Qomolangma region is close to the original atmosphere, so the net radiation and Upward short-wave radiation are affected by the underlying surface change under any weather conditions. 3) Surface water content has obvious influence on radiation and reflectivity by changing the properties of underlying surface, and the response energy changes the fastest when the upward shortwave radiation has higher humidity.

Subject Areas

Atmospheric Science

Keywords

Mount Qomolangma, Radiation Budgets, Typical Weather Analysis

1. Introduction

1.1. Research Background and Significant

Nearly half a century after the industrial revolution, the overall global climate for heating trend, modern climatology think climate factors can be divided into four categories, three categories as the basic factors are respectively before the sun radiation, atmospheric circulation, surface condition, the fourth class factor it is difficult to explain in the above three basic factors over the past century issues such as climate warming, on the basis of introducing the concept of, including solar activity, solar and lunar tide-generating force, earth rotation speed, geomagnetic changes, gravitational field movement, human activities, etc. Research shows that the impact of climate change by human activities is more and more big, the human influence on climate change has also been more and more attention from scientists, because the vast majority of human activity is carried out on the land, and some scholars in the IPCC climate change and land special report highlights the land surface process's contribution to the global temperature rise [1] [2]. The study of land surface processes has become one of the hot topics in climate system and weather research in recent decades. It is known that land surface processes can be mainly divided into heat exchange process (radiation, heat exchange, etc.) and momentum exchange process (friction, etc.) on the surface, hydrological process (evaporation, precipitation, runoff, etc.), and heat exchange and water transport process in underground soil. Therefore, in the study of land surface processes in an area, human activities and underlying surface conditions in the fourth category of factors should be fully considered to determine which process is dominant in the region, and then start the analysis.

Located on the border between China and Nepal, the Qinghai-Tibet Plateau is the highest region in the world, and is known as the third pole after the North and South Poles. The Qinghai-Tibet Plateau affects monsoon and precipitation in China from dynamic and thermal effects respectively. Climate changes in this region not only directly drive climate changes in the east and southwest of China, but also have important and far-reaching impacts on climate changes in the northern hemisphere and even the whole world. As the region with the highest altitude on the Qinghai-Tibet Plateau, under the background of global warming trend change, the temperature in the Qomolangma region increases significantly compared with the global temperature trend [1] and is more sensitive to global climate change [3] [4] [5]. The range and thickness of permafrost decreases and glaciers melt and retreat. With its unique geographical location and sensitive and fragile environment, Mount Qomolangma has become a sensitive region in the plateau region to respond to climate change [4] [5]. As one of the sensitive and critical regions of global climate change, the Qomolangma region has been verified to be sensitive to the response of global climate change [6]. For the inaccessible Qomolangma, the impact of human activities is greatly reduced, and the land-air interaction is naturally the basic physical process affecting the local atmospheric circulation and climate change. Because the complex plateau climate and underlying surface of Mt. Qomolangma are different from the land-air interaction in most areas, the radiation budget and the change and distribution of surface energy flux are first considered when discussing the land surface energy in Mt. Qomolangma.

At present, resource and environment problems are becoming increasingly prominent. As the most important energy source on the earth, solar radiation energy plays a non-negligible role [7]. For example, our weather and climate depend on the distribution of solar radiation energy. Net radiation is equal to the difference between surface radiation and surface radiation. Net radiation is not only the most important radiation factor in the land-air process, but also the driving factor of water cycle, which affects the change of latent heat and sensible heat. It is also a determinant of surface temperature changes. [8] [9] Therefore, when discussing the radiation balance, it is of great significance to analyze the change of net radiation for climate change.

So for Everest radiation budget analysis helps us build a more accurate specific gas interaction model framework, the development of accuracy is beneficial to our forecast for global climate change direction, especially the study area is less affected by human activities and is very close to the earth's environment the original status of Everest region. Because the winter and summer seasons also have important application value to the climate forecast and early warning in the east and southwest of China, at the same time, they have certain indicative effect on the direction of environmental policy. [10]

1.2. Research Status

Due to the complex topography of China, the climate environment of different regions is greatly affected by the underlying surface in this region, and the influencing factors are not the same. In order to study the impact of land-air interaction on climate change in China with different typical underlying surfaces, a series of field experiments on land-air processes have been organized in China in the past half century [11] [12]. In 1979, a series of experiments (QXPMEX, GAME-TIBET, TIPEX, and the Third Qinghai-Tibet Plateau Atmospheric Science Experiment, etc.) were launched on the Qinghai-Tibet Plateau, the largest plateau in the world, to carry out multi-factor comprehensive observations over several regions. Field observation experiments on soil-vegetation-atmosphere interaction (IMGRASS) in semi-arid steppe of Inner Mongolia were carried out from 1997 to 2001. To cope with the international coordination to strengthen observation program (CEOP) established the drying and orderly human activities in Jilintongyu long-term observation experiment stations, this is our country minority to enrage interaction process for long-term monitoring of field experiment stations, depending on the site data provides a number of studies of land surface process has a different degree of help; The Heihe Area Interaction Field Observation Experiment (HEIFE), sponsored by the Institute of Atmospheric Sciences of the Chinese Academy of Sciences and supported by the National Natural Science Foundation of China, systematically analyzed some basic land surface processes in the arid region. In the national key basic research development planning project, under the support of the Chinese Academy of Sciences atmosphere for the typical arid region of northwest China (double light Dunhuanggobi, Wudaoliang region of Qinghai-Tibet plateau, the Badainjaran desert Linze area) in the arid zone of northwest China gas field observation experiment of interaction, land-atmosphere interaction of typical arid study provided valuable experience. Field observation test over the land surface process study of arid region offers a lot of valuable experience, but at that time, including in the Qinghai-Tibet plateau, carry out a series of field observation experiment, on the one hand, restricted by the development of various aspects, on the other hand can get from the social and economic benefit consideration, inputs and know little of the Everest region. Until recent years, the climate warming trend obviously, high altitudes on climate response sensitivity validation by scholars, Everest climate change has caused climate scientists, research scholars, such as land surface process and the improvement of the Everest region traffic, our country science and technology and the development of social economy, the progress of the meteorological observation means such as a variety of conditions, In 2005, the first observatory was set up in the Qomolangma region, which has accumulated a large amount of valuable data for the study of the region, The monthly mean diurnal variation of radiation and land surface energy variation under different weather conditions in the Qomolangma region are analyzed by the obtained data, we can understand the basic atmospheric physical process under the unique geographical environment of Qomolangma, which is conducive to the construction of the third polar land surface model, the prediction of global climate change and the rational utilization of resources [13].

2. Data Summaries and Regional Profiles

2.1. Data Generalization

Since the establishment of the Institute of Qinghai-Tibet Plateau Research in 2003, the Chinese Academy of Sciences has successively set up the Namco Multi-Circle Integrated Observation and Research Station, the Qomolangma Comprehensive Observation and Research Station of Atmosphere and Environment, and the Alpine Environment Integrated Observation and Research Station in Southeast Tibet. The observation data in this paper are from the Qomolangma Station (86.56˚E, 28.31˚N, 4276 m above sea level), which began to set up the long-term boundary layer observation tower in 2005. It is about 30 km away from the base camp of Qomolangma, located in the Rongbu Valley of Basong Village, Zhaxizong Township, under Dingri County in the southern part of the plateau. This area is dominated by high mountains and gobi, and the terrain of Mount Qomolangma Station is relatively flat and the surrounding area is relatively empty. The underlying surface is mainly bare land, with sparse vegetation distribution including short grass, and a large amount of gravel in the surface to the deep soil [14].

The observation instruments set up in Mount Qomolangma Station (features of surface atmospheric turbulence and earth-atmosphere energy exchange in the north slope of Mount Qomolangma) include: a eddy covariance measurement system (CR5000 data collector—measurement, operation and data storage; Ultrasonic wind temperature instrument CSAT3—measurement of three-dimensional wind speed and ultrasonic virtual temperature; CO_2/H_2O infrared open-circuit analyzer LI-7500—measurement of CO_2 and water vapor flux; Water vapor analyzer), a set of instruments for measuring radiation (Kipp & Zonen CNR-1—consisting of two short and long wave radiation, including a daily radiometer and a ground radiometer), As well as other mobile observation instruments such as the Isotope Observation System, the Palynology Observation System, the Broadband Seismograph System and the Radiosonde produced by Vaisala (Finland) (MW21DigiCora III [13] [15].

In addition to the conventional meteorological elements (wind speed, wind direction, temperature, atmospheric pressure and humidity), the soil temperature and humidity observation data of Qomolangma Station include 0cm on the surface, 10, 20, 40, 80 and 160 cm underground [13] [16]. The dataset includes hourly soil, atmosphere, and eddy observation data from 2005 to 2016. Due to the problems of missing measurements and obvious errors of some data in the data set, this paper selects the hourly observation data of soil, atmosphere and eddy in 2008 with less missing measurements and more accurate data after comparing the data. The data specifically used are four components of radiation (downward shortwave, upward shortwave, downward long wave, and upward long wave) involved in the energy analysis of radiation budget, hourly observation data of net radiation data, soil water content data, temperature and relative humidity at 1.5 m were observed data.

2.2. Regional Overview

The Qinghai-Tibet Plateau is now located in the southwest of China, from the southern margin of the Himalayas in the south, to the northern margin of the Kunlun, Altun and Qilian Mountains in the north, to the Pamir Plateau and Karakoram Mountains in the west, and to the western Qinling Mountains and the Loess Plateau in the east and northeast. The mountain is tall, the mountains are uneven, the terrain is steep, the terrain is complex, the terrain is high in the west and low in the east. Most of the mountains are located in the middle of the troposphere, where the atmosphere is warmer and wetter than the atmosphere at the same altitude with lower wind speeds. But compared with the surrounding areas of the same latitude, it is cold and dry, with the strongest wind speed. The

Qinghai-Tibet Plateau has strong radiation, more sunshine, low temperature, less accumulated temperature, large diurnal range, distinct dry and wet, and no obvious seasonal change. It is rainy, warm and cool in summer and hailstorm in winter, and dry and cold and windy in winter.

Mount Qomolangma is located in the southern part of the Qinghai-Tibet Plateau and the middle part of the Himalayas. Compared with "China Water Tower" Naqu, which is located in the hinterland of the plateau and belongs to the hilly terrain of the plateau, and Qomolangma, which is located in the oceanic valley of Hengduan Mountains, has a huge mountain and high topography. At the same time, because the Qomolangma region is a high-altitude climate change area, compared with the plateau as a whole, the radiation in the daytime is stronger, the sunshine duration is longer, and the diurnal range is larger [17]. At the same time, because the high altitude area of Mount Qomolangma is more sensitive to climate change, the weather changes are more intense under the influence of monsoon in summer and winter. Heavy rain is frequent in summer and snow is wreak havoc, cooling is obvious in winter, and the weather is very harsh in summer and winter [18]. Therefore, the region of Mount Qomolangma is also one of the regions with the most rainfall in the world [19]. The temperature in the Qomolangma region showed an obvious rising trend from 1971 to 2004, and the increase was more significant in the winter non-growing season, and the increase was the highest in the fixed-day stations with higher elevations. Previous studies have shown that the higher the elevations were, the more significant the temperature rise was. To study the change of the mount Everest in nearly 60 years, the global warming significantly early Everest region, average warming and plateau phase, while the precipitation change is not obvious, but the recent Everest ice back significantly, lake area is rapidly increasing, Everest region ecosystem also have better growth trend, fully reflects the Everest region response to global climate change. Everest compared with other regions in the world is inaccessible, atmospheric environment and other remote areas, such as the north and south poles, is also the area where the original infinite close to the earth environment, currently Everest climate is affected by global climate and human activity is obviously, both of the ecosystem, and is in danger of melting glaciers, behind, The response of the Qomolangma region to climate change deserves the attention of global meteorologists and other scholars [17] [19] [20].

3. Analysis

3.1. Surface Radiation Analysis

Surface energy mainly comes from solar shortwave radiation, and the surface radiation budget can better reflect the surface energy situation. As can be seen from **Figure 1** the surface radiation budget is dominated by downward short-wave radiation (RSD) and upward long-wave radiation (RLU), and the interannual variation of each component is obvious, generally presenting a single peak curve, and the seasonal variation is also obvious.

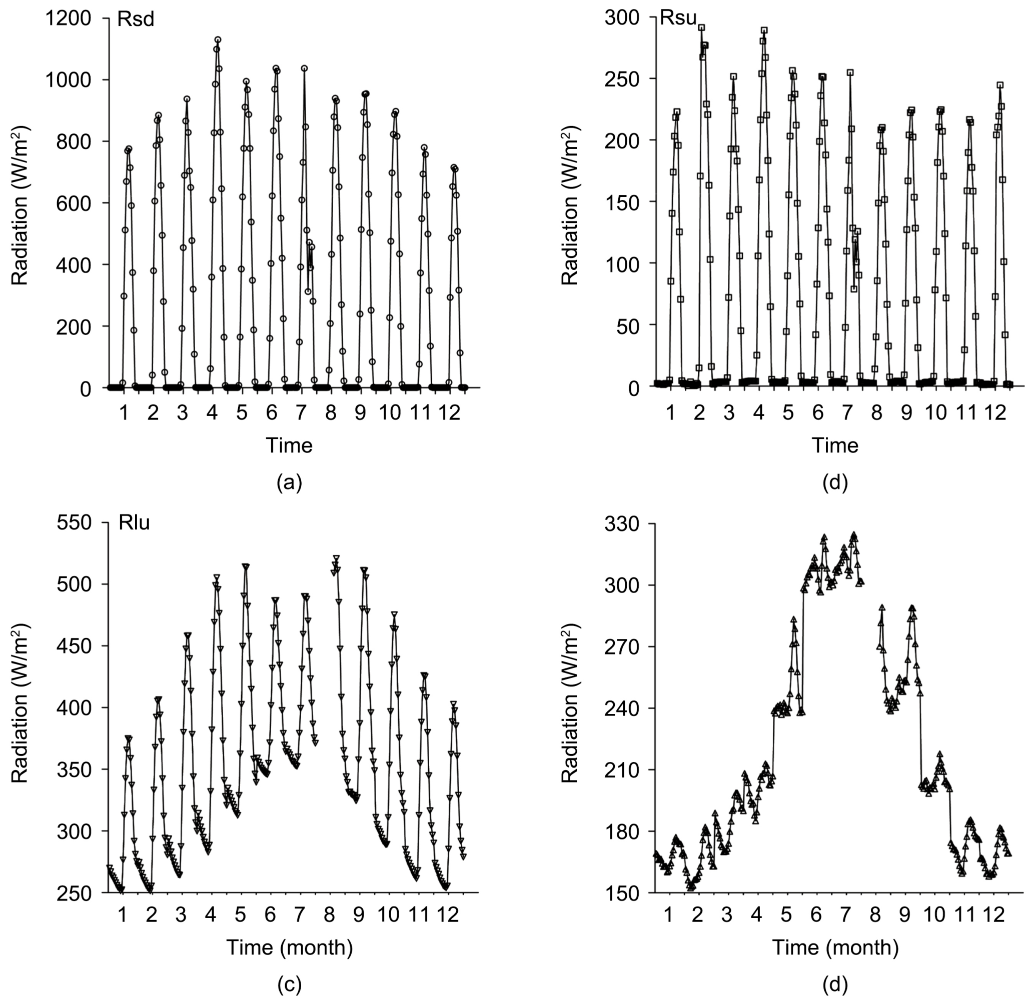

Figure 1. Monthly Mean Annual Variations of Surface Radiation Components in 2008 (Missed in August). (Rsd: downward shortwave radiation; Rsu: Upward shortwave radiation; Rlu: Upward long wave radiation; Rld: Downward long wave radiation). (a) Rsd Monthly mean daily change in 2008; (b) Rsl Monthly mean daily change in 2008; (c) Rlu Monthly mean daily change in 2008; (d) Rld Monthly mean daily change in 2008.

Figure 1(a) shows the monthly mean diurnal variation of the downward shortwave radiation RSD, also known as the total solar radiation. The RSD is affected by many factors, such as latitude and longitude, altitude, weather conditions, underlying surface conditions and so on. In the figure, the RSD curve showed obvious unimodal change, that is, it rose from night to day, reached the peak at about 12:00 noon, and then began to decline. The mean value is arranged as follows: spring > in autumn ≥ (slightly greater than) summer > in winter; the maximum noon value of 1100 W/m^2 appears in spring April noon; the minimum noon value of 750 W/m^2 appears in winter December; the maximum monthly average value of spring is over 1000 W/m^2; and the maximum monthly average value of winter is about 800 W/m^2. The phenomenon is strongly influenced by the Angle of the sun and weather conditions, because the cause of the maximum value appeared in April is as the earth's orbit, gradually increase the solar altitude angles to spring, Rsd, although because of lack of measurement cannot be observed in August a complete graph, but actually the Angle of the sun may higher, and the maximum value is declined, The reason is that the weather conditions in the study area in summer and winter are complicated and changeable due to the effect of monsoon. Under the influence of cloudy and rainy weather, the RSD of the study area is not as large as that in spring. The weather conditions in spring and March are better, and the radiation value is higher than that in summer. In the case of increasing solar altitude Angle, summer June and July still decreased by about 100 W/m^2 compared with May. It can be seen that the influence of weather conditions is relatively greater in high altitude regions than other factors.

Figure 1(b) shows the monthly mean diurnal variation of the near-ground upward short-wave radiation RSU, also known as reflected solar radiation, that is, the short-wave radiation reflected back to the atmosphere by the solar radiation received from the ground, which is mainly affected by the albedo of the underlying surface and RSD. In the figure, the RSU curve showed obvious unimodal change. Seasonality is also obvious, and the mean value is arranged as follows: spring >, autumn >, summer >, winter. The maximum value of 280 W/m^2 at noon appears in April in spring, and the minimum value of 200 W/m^2 at noon appears in December in winter. The monthly average value of spring is about 260 W/m^2, and the monthly average value of winter is about 230 W/m^2. Under the condition of relatively low in January-February Rsd, Rsu is surging up to 40 W/m^2, December are the main reasons why the Everest region affected by cold snow, underlying surface is covered by the new snow result in higher albedo, continuously affected by cold in January, February to maintaining high albedo, until February affected by cold, surface albedo decreases, However, as the sun's altitude Angle continued to increase until spring, the RSD increased, and the new snow could still maintain the snow surface in the early spring, so the RSU remained at a high level in March and April. After April, when the temperature warms up, the ecosystem recovers, the dry snow surface is difficult to maintain, the ground albedo drops significantly, and the RSU drops in May. However, in summer, the RSU is affected less by the underlying surface due to the frequent rainstorm and the complex and changeable weather in the Qomolangma region. The RSU picked up in the autumn when weather conditions improved. The underlying surface condition is still the main influencing factor of RSU in the Qomolangma region.

Figure 1(c) shows the monthly mean diurnal variation of upward long-wave radiation RLU, also known as surface long-wave radiation. As the name suggests, long-wave radiation emitted even near the Earth toward the upper atmosphere. According to Stefan-Boltzmann's law, RLU is determined by the surface temperature, and the higher the surface temperature, the greater the upward long-wave radiation. In the figure, the unimodal change of RLU curve is obvious. Seasonality is also obvious, the mean value of spring ≥ (slightly greater than) autumn > summer > winter. The maximum noon time is close to September in May, but the minimum noon time appears in January. Compared with (a) in **Figure 1**, the monthly maximum and minimum values of RLU are generally consistent with the RSD trend, and the RLU trend lags behind that of RSD, which can verify the statement that some current studies show that the surface temperature in the plateau region is most affected by RSD.

Figure 1(d) shows the monthly mean diurnal variation of downward atmospheric long-wave radiation RLD, also known as atmospheric inversion radiation. Greenhouse gases, such as clouds, water vapor and aerosols in the atmosphere, are influenced by atmospheric temperature. Since clouds and water vapor have weak absorption of short-wave radiation, the rise of atmospheric temperature mainly depends on RLU, so RLD should have similar change characteristics with RLU. In the figure, the RLD curve still showed unimodal variation, but the difference of variation range was large. Seasonality is not obvious. The maximum value and the seasonal average maximum value both appear in summer. The reason should be that there are more cloudy and precipitation days in summer, the total amount of long wave absorption by cloud body and water vapor in the atmosphere increases, and the atmospheric temperature rise is larger, so the summer RLD is higher. The lowest value and the seasonal average lowest value also appeared in winter, which should be caused by the cold current, water vapor condensation and snowfall, and the dry and cold atmospheric environment. Weather is still the main influencing factor of RLD in the Qomolangma region.

3.2. Comparative Analysis under Different Weather Conditions

Net radiation: The difference between the radiant energy obtained by the surface absorbing solar radiation and atmospheric inversion radiation and the radiant energy emitted upward by the surface.

In the study of radiation balance, the most critical is the net radiation Rn. Net radiation is a parameter to calculate the energy budget of the surface through the radiation process, and it is also the decisive factor and the main energy source of the radiation process to drive the earth-atmosphere interaction. When Rn is greater than zero, the radiation absorbed by the surface is greater than the radiation emitted by the surface, so it can be considered that solar radiation plays a leading role in the radiation process. When Rn is less than zero, the amount of long-wave radiation emitted from the surface is greater than the inverse radiation, that is, the long-wave radiation from the surface plays a leading role in the radiation process.

Surface reflectance is defined as the ratio of upward long-wave radiation to downward long-wave radiation, and is a parameter to measure the reflectance ability of the surface to solar short-wave radiation, with a value range of 0 - 1. The reflectivity is mainly affected by the underlying surface, such as the material condition of the underlying surface, the roughness of the underlying surface, the humidity and the color of the underlying surface [20] [21] [22].

Surface water content SWC is the ratio of surface water content to dry weight under natural conditions, which is mainly affected by soil physical properties, such as surface soil pore size, number and soil density. This parameter can not only be ignored in the analysis of land surface energy balance, but also has a very important guiding significance in the direction of agricultural production.

Figure 2(a) shows the diurnal variation of the radiation component in sunny days on June 21, 2008 in summer. The variation trend of RSD and net radiation RN in sunny days is basically the same. From 00 to 09, RSD and RSU maintained at 0 W/m^2, indicating that although RSU was mainly affected by underlying surface, whether or not RSD was the decisive factor. In this case, the change trend of Rn is basically the same as that of RLD. In this case, Rn is negative, which verifies the statement that surface long-wave radiation plays a leading role in the radiation process when Rn is negative. The RLU curve changed gently and maintained at about 370 W/m^2. From 09:00 to 23:00, the RSD curve was the first to change, rising continuously from 09:00 to 15:00, reaching the maximum value close to 1200 W/m^2, and then decreasing slightly at 16:00. After rising up to the maximum value at 17:00, it dropped sharply to 200 W/m^2 at 18:00, and rose to around 400 W/m^2 at 20:00, two hours later. Then it gradually decreases and tends to 0 W/m^2. The curve variation characteristics of net radiation RN and upward short-wave radiation RSU were consistent with those of RSD, but the variation range of RSD >, RN > RSU was consistent with the radiation process: After sunrise, the downward solar shortwave radiation reaches the ground. One part of the net radiation is absorbed by the surface and the other part is reflected and emitted by the surface shortwave radiation. Therefore, the variation characteristics of the three are relatively consistent, and the difference of net radiation variation and the difference of upward shortwave radiation are approximately equal to the difference of RSD variation. After the net radiation increases, the surface begins to warm up, and at the same time, it emits long-wave radiation upward, part of which is absorbed by the surface atmosphere, and atmospheric adverse radiation is emitted as the atmosphere warms up. Therefore, the variation curve of long-wave radiation RLU is consistent with that of long-wave radiation downward, and the value of RLD is always lower than that of RLU. However, the drop at 18:00 was due to the fact that it was a single day, so it was considered that it was cloudy at that time. Therefore, under sunny conditions, downward-shortwave radiation RSD plays a leading role in the radiation process, affecting net radiation RN and upward-shortwave radiation RSU. The net radiation RN affects the upward long-wave radiation RLU by affecting the surface temperature, and the upward long-wave radiation RLU affects the atmospheric inverse radiation RLD.

Figure 2(b) shows the diurnal variation of the radiation component in the rainy day on July 17 during the frequent rainstorm period in summer. Compared with sunny days, there are obvious changes from 00 to 09: The curves of each radiation component are very smooth, in which RSD, RN and RSU are maintained

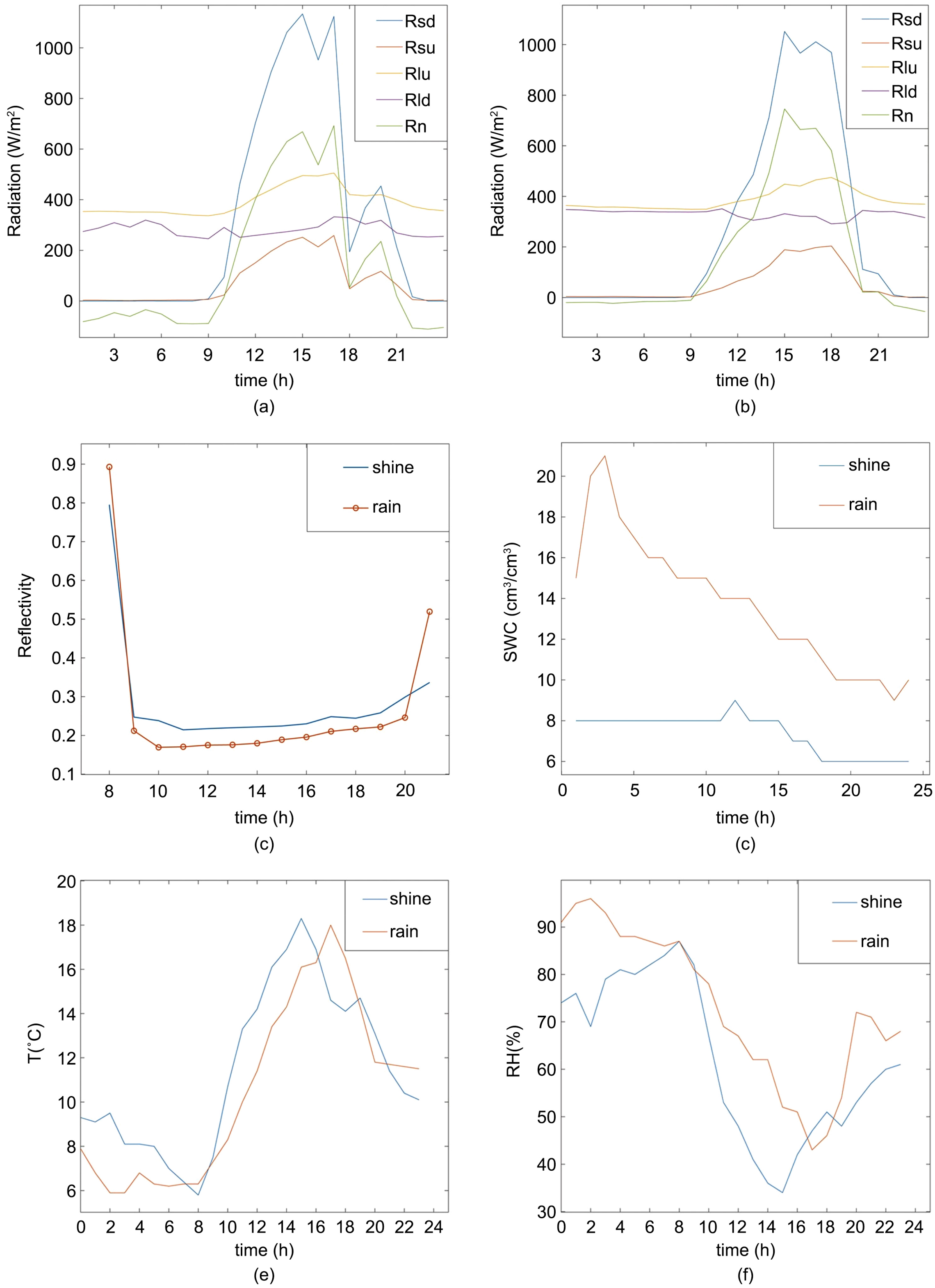

Figure 2. Comparative analysis of meteorological elements under different weather conditions. (Rn: Net radiation). (a) Diurnal variation of radiation components in sunny days in summer; (b) Diurnal variation of radiation components in summer rainy days; (c) Diurnal variation of reflectivity under different weather conditions; (d) Diurnal variation of surface water content under different weather conditions; (e) Diurnal variation of temperature under different weather conditions; (f) Diurnal variation of relative humidity under different conditions.

around 0 W/m^2, RN is slightly lower and negative than RSD and RSU, while RLD and RLU are maintained around 380 W/m^2. Although RLD is still lower than RLU, the difference between them is greatly reduced. The numerical results of the five radiation quantities confirm that when Rn is negative, RLU is the leading factor in the radiation process. The smooth curves from 00 to 09 should be due to the influence of continuous rainy season, and the humidity temperature in the surface and atmospheric environment is close, while the moisture is abundant and the temperature is low, and the humidity and temperature in the surface and atmospheric environment are close. From 09 to 23, the change characteristics of RN and RSU curves were consistent with those of RSD curves. The difference was that when the peak value of RSD decreased about 200 W/m^2 at 15, the corresponding peak value of RN increased and the peak value of RSU decreased, while the curves of RLU and RLD showed opposite changes from 09 to 18. RLD curve showed a downward trend while RLU curve showed an upward trend. Rsd less because rain clouds on the radiation transmission of the atmospheric environment has weakened effect, the surface humidity and lower Rsu is rainy day high latent heat storage and not conducive to reflection and Rn peak value at the same time increase is also one of the reasons, but the heat capacity of the water a lot larger than the earth's surface, ground temperature relatively sunny is reduced, so the Rlu, upward longwave radiation emitted by reduction, Although the atmospheric environment is conducive to the increase of RLD, the reduction of RLU sources plays a major role in the process, which leads to the decrease of RLD. After 18:00, solar radiation approaching sunset is difficult to reach the ground under the obstruction of numerous and complex cloud bodies, which affects the surface energy balance. In rainy conditions, the atmospheric environment and the change of the underlying surface conditions make solar shortwave radiation Rsd lower down, but still down solar shortwave radiation is the dominant factor in the process of radiation, the change of the atmospheric environment, especially the humidity bigger influence on the radiation Rld big reversed flow of qi, and the change of the underlying surface conditions affect the change of net radiation Rn and upward shortwave radiation Rsu, And the changes are often opposite.

Figure 2(c) shows the diurnal variation of albedo under different weather conditions. Before 9 o'clock, the albedo curve is relatively close. After 9 o'clock, the albedo in sunny days is higher than that in rainy days, and the maximum value of the albedo is about 0.2 at 10 o'clock. The value of RN increases slightly in sunny days with high albedo, while the value of RSU increases greatly, and is opposite in rainy days. After 10 o'clock, the overall trend of albedo is upward. And after 20 o'clock, the albedo of rainy days will greatly increase than that of sunny days at the same time.

Figure 2(d) shows the diurnal variation of surface water content under different weather conditions. On sunny days, the maximum surface water content appears at 12:00, and from 00 to 11, the surface water content curve is smooth and basically unchanged. The change of surface water content lags RSD and RN for about three hours, and RSU, RLD and RLU for about four hours. When the surface water content drops to 8 at 15:00, the surface water content decreases and the reflectance shows a reverse change. On rainy days, the maximum surface water content appears at 03:00 and gradually decreases after reaching the maximum. When the surface water content drops to 15 when the surface water content drops to 10, the surface water content continues to decrease and the reflectance continues to increase in rainy days. The reflectance lags RSD, RN and RSU to change one hour later, and changes at the same time as RLD and RLU. It can be concluded that the response radiation energy of RSU changes rapidly under the condition of high humidity.

Figure 2(e) shows the diurnal variation of temperature at 1.5 m under different weather conditions. Temperature is mainly affected by atmospheric environment and RLU. As can be seen from the curve in the figure, there is little difference between the peak temperature of sunny and rainy days, but the temperature of rainy days lags behind by 2 hours. At night, the temperature at 1.5 m in continuous sunny days is higher, and the temperature generally decreases from 0 to 08, and the minimum temperature in sunny days is lower than that in rainy days, that is, the clear sky radiation effect. On sunny days, the temperature rise is faster and larger, which is in line with the process of radiation action. On rainy days, the temperature rise is slightly smaller because it is rainy in summer. Even on sunny days, there are many cloud bodies, which reduce the RSD radiation to some extent.

Figure 2(f) shows the diurnal variation of relative humidity under different weather conditions. Relative humidity is the percentage of the water vapor pressure in the air and the saturated water vapor pressure at the current temperature. It represents the actual water vapor content in the wet air, namely the degree of humidity. From 0 to 08, the relative humidity in both sunny and rainy days continued to rise, contrary to the temperature curve change, so the temperature change played a leading role in this process. 08 up to 20, the relative humidity increase after lower first, relative humidity and temperature trends have obvious contrary trend, but on the curve amplitude variations in relative humidity is bigger, sunny or rainy days the temperature difference is not big, the rain precipitation in atmospheric environmental moisture increase in relative humidity decrease the rate of the sunny day is slow, and the rise of temperature, wet environment rich water vapor, The relative humidity increases at a faster rate than that of sunny days.

4. Conclusions and Prospect

4.1. Main Conclusions

This paper mainly analyzes the radiation status of Qomolangma region and some meteorological elements on the land surface in 2008, and draws the following conclusions:

1) The influence of weather conditions on the total solar radiation is more significant at high altitudes.

2) Since the atmospheric environment in the Qomolangma region is close to the original atmosphere, net and upper shortwave radiation are mainly affected by the underlying surface under any weather conditions

3) Surface water content has obvious influence on radiation and reflectivity by changing the properties of underlying surface, and the response energy changes the fastest when the upward shortwave radiation has higher humidity

4.2. Prospects and Existing Problems

As the only meteorological observation station with a long-term boundary layer observation tower in the Qomolangma region in China and in the world, the Qomolangma station is of great significance to the study of the climate in the high active area and the plateau. More importantly, the environmental conditions that are as close to the primordial atmosphere as the other poles are invaluable to the study of climate change. This paper only made a superficial and crude analysis on the basis of surface energy balance in the land-gas process, which could not make good use of the hard-won and precious data of the Everest Station. In order to make the study more accurate, we will try to correct many problems existing in the analysis in the future, such as:

1) There was a large lack of data, and no sensitivity analysis was conducted on the results under both use and non-use conditions. There is no better way to handle data.

2) Lack of programming ability and time-consuming data drawing and analysis, so I should strengthen my ability to use auxiliary tools such as mathematics and computers.

3) I do not know enough about 24 h weather change in Mount Qomolangma.

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Conflicts of Interest

The authors declare no conflicts of interest.

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