The Radiation Monitoring Network of Chinese Ecosystem Research: (CERN)

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Abstract:

Solar radiation is the original dynamical system of the earth. It is an essential parameter of Earth-climate physical process, and controls all courses of life-form on the earth. Energy from the sun sustains all life on the earth, and sustains all climate dynamic system. The differences of climate in the world are caused by different receivers of radiation energy on the surface of the earth. Ground-based radiation measurements are essential in forecasting the climatic change trends, evaluating the solar radiation transport theory in the atmosphere, assessing climate model computations, estimating retrial results by satellite, and surface radiation balance research. Radiations are also absolutely necessary parameters in environmental study.

Chinese ecosystem research network (CERN) was established in 1988. It consisted of 29 ecological research stations at beginning and expended to 36 stations in 2003, including 14 stations for agriculture, 9 for forest, 2 for grassland, 5 for desert, 1 for marsh, 2 for lake and 3 for marine ecosystems, representing diverse ecosystems. CERN has been placed as a base for ecological monitoring, research and demonstration in china. The CERN is engaged on monitoring the water, soil, atmosphere and biological elements of major ecosystems, the important ecological processes such as the energy and matter flow, and land use and land cover changes in the surrounding areas of the stations, by the standardized methods and organization. The goal of radiation monitoring is to obtain high quality dataset of radiation and ancillary measurements to develop climate model, adjust satellite retrieval, research on climate change and environment. The station map is showed in Fig 1. The routine observations of solar spectral radiation were carried out at 28 stations by the Chinese Academy of Sciences from 1 January 1989. The observational instruments are model TBQ-4-1 (Jinzhou ,china) and as follows. (1) There are three sensors with sensing wavelength ranges of 270–3200nm, 400–3200 nm, and 700–3200 nm, respectively. The main technical characteristics of the sensors are: sensitivity is 5–10 mV kW^{-1} m^2, response time is $\leqslant$1s(1/e), and stability is $\leqslant$2%.

The data on global irradiation on a horizontal surface in 28 stations of CERN during the 6-year period 1998–2003 are analyzed. The object of this study is obtained the global radiation time series and spatial variation characteristic in China.

In this topic, we want discuss distribution properties of global radiation in CERN. The main contents as fellow:

1, distribution properties of yearly global radiation

2, distribution properties of monthly global radiation

3, the global radiation extremum value

We rebuild radiation measurement system of CERN from August 2004.In the new observe

system Global radiation was measured using a Kipp&Zonen model CM-21, reflect radiation using CM6B, ultraviolet radiation using CUV3, Net radiation using QMN101, sunshine duration using CSD2, and soil heat flux using HFP01SC (Delft, The Netherlands). The Photosynthetically active radiation was measured with a Licro quantum sensor LI-190Sz (Lin-coln, Nebraska, USA). This station was completed with a data acquisition system (Vaisala M520 data-logger, and a storage module, Finland). The signals were conditioned with the respective instrument factors into units of W/m^2 and $\mu Em^{-2}s^{-1}$(quantum $mol^{-1}s^{-1}$ or $\mu molm^{-2}s^{-1}$). Global radiation measurements have an estimated experimental error of $\pm$ 2-3%, while the Photosynthetically active radiation sensor has a relative error of lees then 5%. All radiation values were measured by one-minute interval, and the hourly values were driven from minute value by integrating them. The global radiometers were calibrated against a reference pyranometer, which is calibrated a standard pyrheliomter, while the LI-190SA pyranometer is calibrated against calibration lamps at factory. All this calibrated work was done at the beginning and the end of data collected. In this observe system HMP45D used for temperature and humidity, WAA151 used for wind speed, WAV151 used for wind direction, DPA501 used for atmospheric pressure, 8 pieces of QMT110 used for profile of soil temperature (0cm, 5cm, 10cm, 15cm, 20cm, 40cm, 60cm, 100cm)(Vaisala, Finland), and RG13 used for precipitation (Casella, USA).

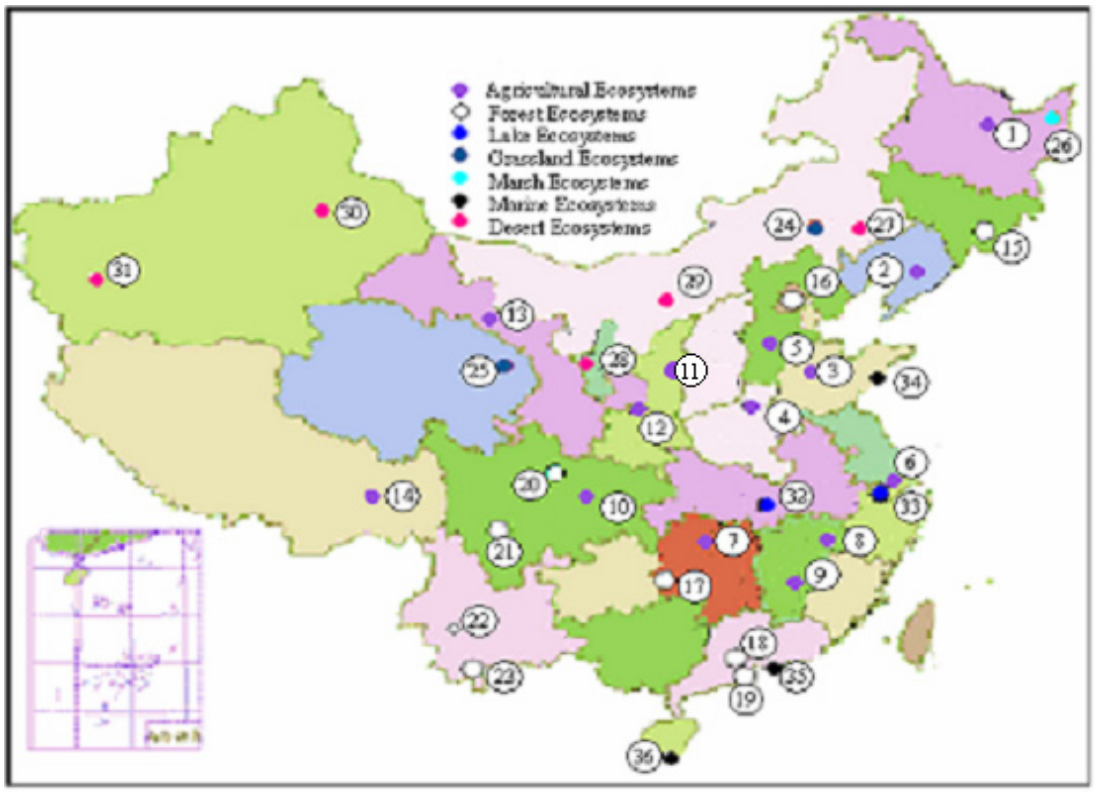

Fig.1 Distributions map of ecosystem research stations of CERN

1-14th Stations are Research stations for Agricultural Ecosystems; 15-23rd stations are Research Stations for Forest Ecosystems; 24-25th stations are Research Stations for Grassland Ecosystems; 26th station is Research Station for Marsh Ecosystem; 27-31st stations are Research Stations for Desert Ecosystems; 32-33rd stations are Research Stations for Lake Ecosystems; 34-36th stations are Research Stations for Marine Ecosystems

Introduction

CERN has been operating as a network of surface radiation monitoring observatories for over 10 years. The determination of a global climatology of the radiation budget at the surface of the Earth is fundamental to understanding the Earth's climate system, climate variability and climate change resulting from human influence. Estimation of the surface radiation budget from satellite observation can't be obtained without high accuracy surface-based measurements at various sites in contrasting climatic region for calibrating and validation. Long-term observations are essential for the study on climate variation trend and radiations transform theory.

The original motivation for the CERN is provide data for climatic change, ecology system study and the relationship between these two fields. The goals and objectives were prescribed as fellow:

Monitor regional radiation fluxes at the surface

Get the radiation variation trend

Provide data for ecology system study

Provide data for calibrating satellite estimates of the surface radiation budget.

Instruments and database

The routine observations of solar spectral radiation were carried out at 28 stations by the Chinese Academy of Sciences from 1 January 1989(Donghu station no data). The observational instruments are model TBQ-4-1 (Jinzhou, china) and as follows. (1) There are three sensors with sensing wavelength ranges of 270–3200nm, 400–3200 nm, and 700–3200 nm, respectively. The main technical characteristics of the sensors are: sensitivity is 5–10 mV kW^{-1} m^2, response time is $\leqslant$1s(1/e), and stability is $\leqslant$2%.These instruments are fixed in the old observation system.

The instrument fixed in new observation system is showed as fellow.

Global radiation was measured using a Kipp&Zonen model CM-11 (wavelength ranges of 300–3200nm) (Delft, The Netherlands). The PAR photon flux was measured with a Licro quantum sensor LI-190Sz(wavelength ranges of 400–700nm) (Lin-coln,Nebraska,USA).Reflect radiation is measured by a Kipp&Zonen model CM-6B.Ultraviolet radiation is measured by a Kipp&Zonen model CUV3(wavelength ranges of 290–400nm).Net radiation is measured by a Kipp&Zonen model QMN101(wavelength ranges of 300–10000nm).This station complete with data acquisition system(Vaisala M520 data-logger, and a storage module, Finland). Global radiation measurements have an estimated experimental error of 2-3%, while the PAR sensor has a relative error of lees then 5%. All radiation values were measured by one-minute interval, and the hourly values were driven from minute value by integrating them.

A metrology observation system is also fixed in this system. (Vaisala automatic weather station with wind speed, wind direction, temperature, humiditity, rainfall, atmospheric pressure, and soil temperature)

The data used in this topical is get from the old observation system in 28 station from 2001 to 2003.

Results and discussion

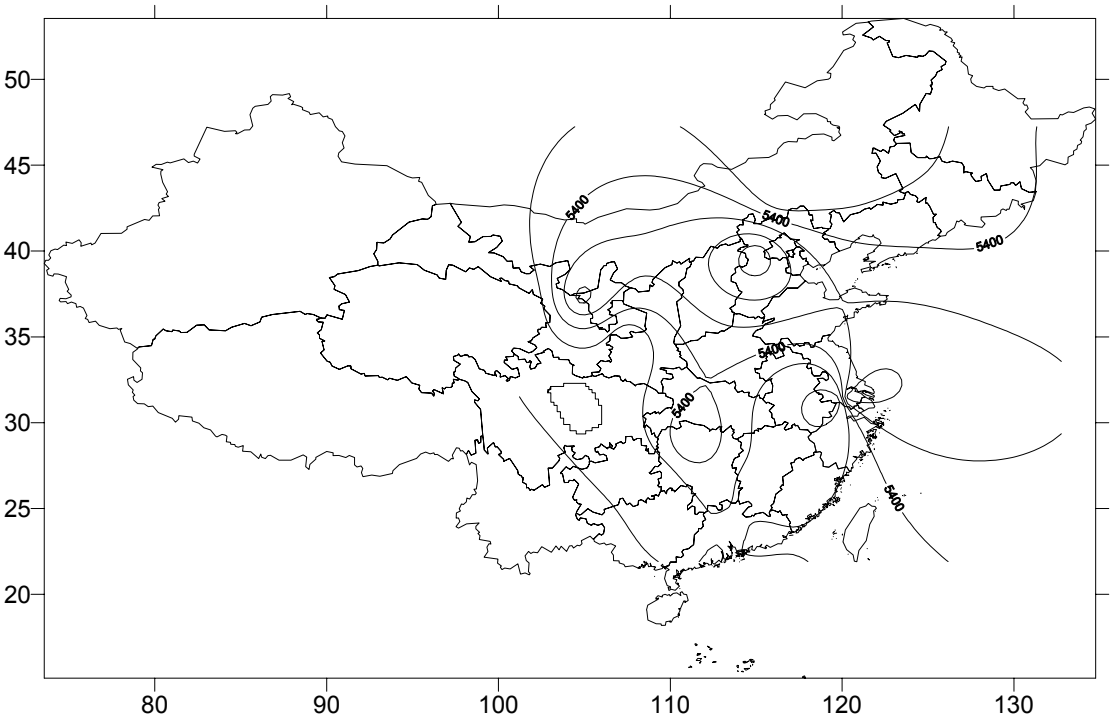

Fig.2 The distribution of annual global radiation in 2003(CERN)

The figure of global radiation annual variation characteristic show that there are four low center, namely, Yanting of Sichuang,Huitong of Hunan,Changshu of Jiangsu ,and Beijing. There is a high central of global radiation in Inner Mongolia. The global values of inner land are higher than that of inshore province, and dry area values of global radiation is higher than global radiation in humidification circumscription. There is a lower values appears in Sichuang,this phenomena is caused by there are many rainy and more cloudy day in this area, at the same time pollution concentration is higher in this area.

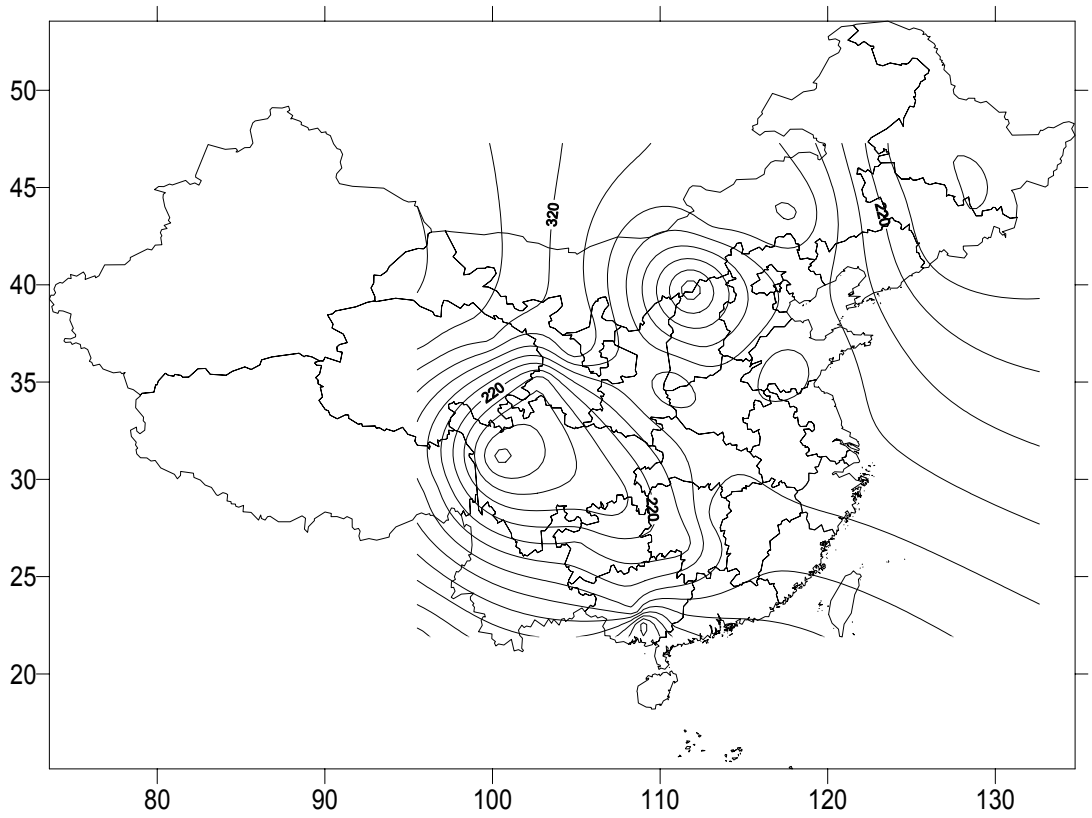

Fig.3 The distribution global radiation in January 2003

In winter the distribution characteristic of global radiation is similitude as that in annual global variation characters. In the eastern area, the value of south area is bigger than the north area. The distribute properties is depend on the law of sun revolution. The lower values in Sichuang is caused by cloudy and pollution concentration.

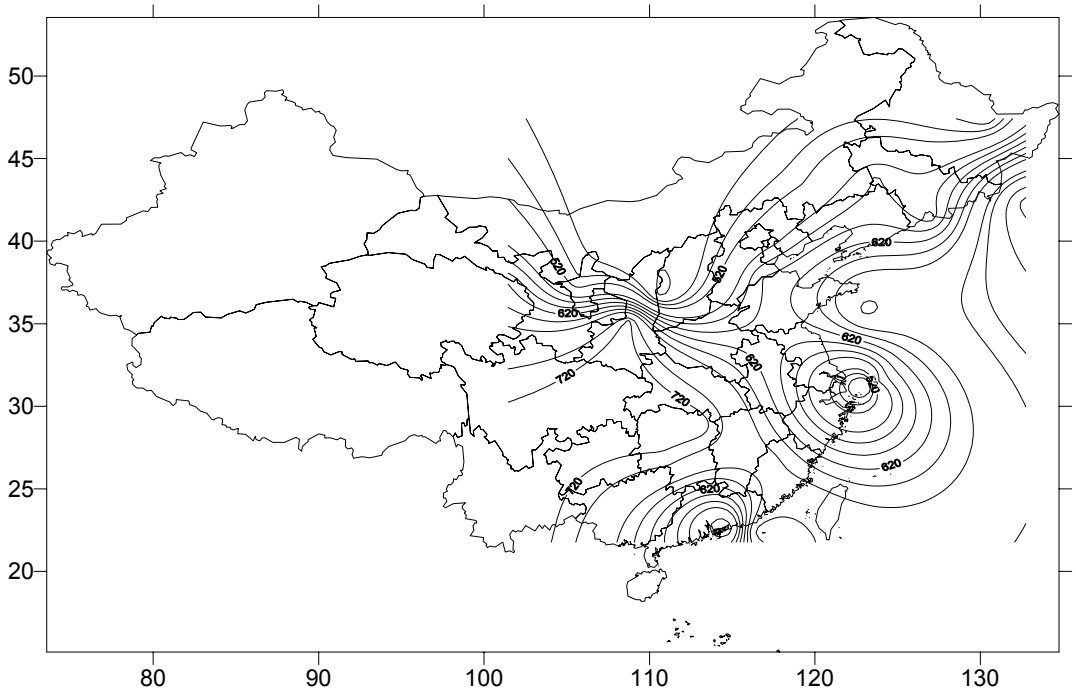

Fig.4 The distribution of global radiation in July 2003

The isoclines of global radiation, which stretch from northeast to southwest, are higher in northwest hinterland than that in coastland except Sichuan province.

Conclusions

The global radiation on ground of Inner Mongolia and Xinjiang is higher than other area of China. Contrariwise, it is very low in Sichuan province, which is decided by the climate of local area. The global radiation measured by CERN radiation observation system is consistent with the observation results from ninety-eight radiation-observing stations distributed over our country. Thus, the observation stations we have established are so representative that the results can reflect the characteristics of global radiation on the mainland of China.