Study on the Characteristics of Long-wave Radiation over China Area

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Abstract— Long-wave radiation which escapes from Earth-atmosphere system often obviously changes before the occurrence of major natural hazards, therefore the research of OLR is necessary for the short-term forecast and early warning of disasters. This paper analyzed the long-wave radiation background field of Chinese mainland by using outgoing long-wave radiation (OIR) data from National Oceanic and Atmospheric Administration (NOAA), USA. The results showed that: the OLR value changed more obviously with the variation of latitude than that with longitude, and there are strongly seasonal and regional variations in outgoing long-wave radiation.

1. INTRODUCE

Long-wave radiation emitting from the earth-atmosphere system is observed from space by the Infrared channel of radiometer on Meteorological Satellite. It reflects convection strength of tropical regions and latent heat released by cloud cover, atmospheric vertical motion, divergence wind and convective condensation. Meanwhile, OLR contains information about sea surface temperature and air-sea interactions, which has a close relationship with rainfall of Tropical Ocean and continental monsoon. Before the outbreak of earthquakes, floods, volcanoes and other natural disasters, the radiation rises of OLR tend to be more obvious than that in the surrounding area, therefore, the research on OLR is becoming increasingly important. In the 1970s, people began to obtain OLR by satellite observations and apply it to atmospheric circulation, climate analysis and prediction [1–6]. Dongliang Li found the changes of OLR in El Niño years are quite different with those in Anti-El Niño years in mainland China, and investigated the connection between the OLR anomalies and the El Nino events [7]. Li Sun and others compared and analyzed the space-time distribution and the propagation characteristics of low-frequency oscillations of OLR field during the drought years in the Northeast, and the results showed that the drought of Northeast is closely related to the distribution and variation of OLR at low-latitude [8]. Since the significant meaning of studying OLR, the paper adopted global OLR data to investigate the spatial distribution and seasonal fluctuation characteristics of OLR.

2. DATA AND PROCESSING

2.1. Investigation Area

Higher west when compared to the East is one of the characteristics of China's terrain, and the mountains, plateaus are located in the west of Daxinganling — Taihang Mountains — Wushan — Xuefengshan line, while hills and plains are mainly in the east of the line. Yellow River, Yangtze River, Pearl River and other major rivers originate in the western highlands and mountains, tilting along terrain and flowing into the sea. Chinese climate has three characteristics: significant monsoon characteristics, distinct continental climate and various climate types.

2.2. Data

US National Oceanic and Atmospheric Administration (NOAA) provides $2.5^\circ \times 2.5^\circ$ and $1^\circ \times 1^\circ$ grid types of long-wave radiation data, where the data of $2.5^\circ \times 2.5^\circ$ grid type owns a long duration (from 1974 to date), which provides us with the data base to get more accurate spatial field characteristics of long-wave radiation. The study selected monthly average long-wave radiation data of $2.5^\circ \times 2.5^\circ$ grid type from January 1991 to December 2010 (20 years) as the original data of background field to analyze characteristics of OLR related to latitude and longitude, space and time.

2.3. Data Processing

First we combined monthly data from each year into quarterly data, and then synthesized the quarterly data into annual data; then we combined the 20 years' quarterly data into quarterly average data, and combined the 20 years' annual data into annual average data. Finally, based on the latitude, longitude, region and time, we analyzed the data.

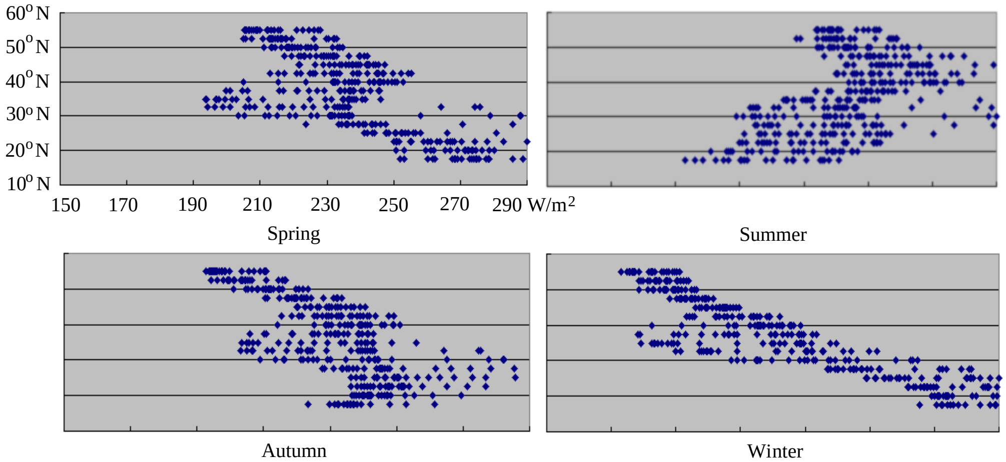

Figure 1: Characteristics of long-wave radiation along latitude.

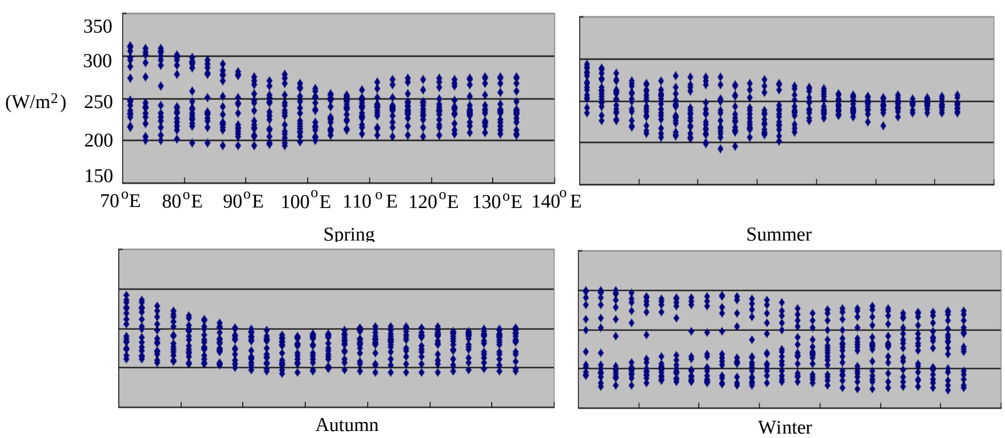

Figure 2: Characteristics of long-wave radiation along longitude.

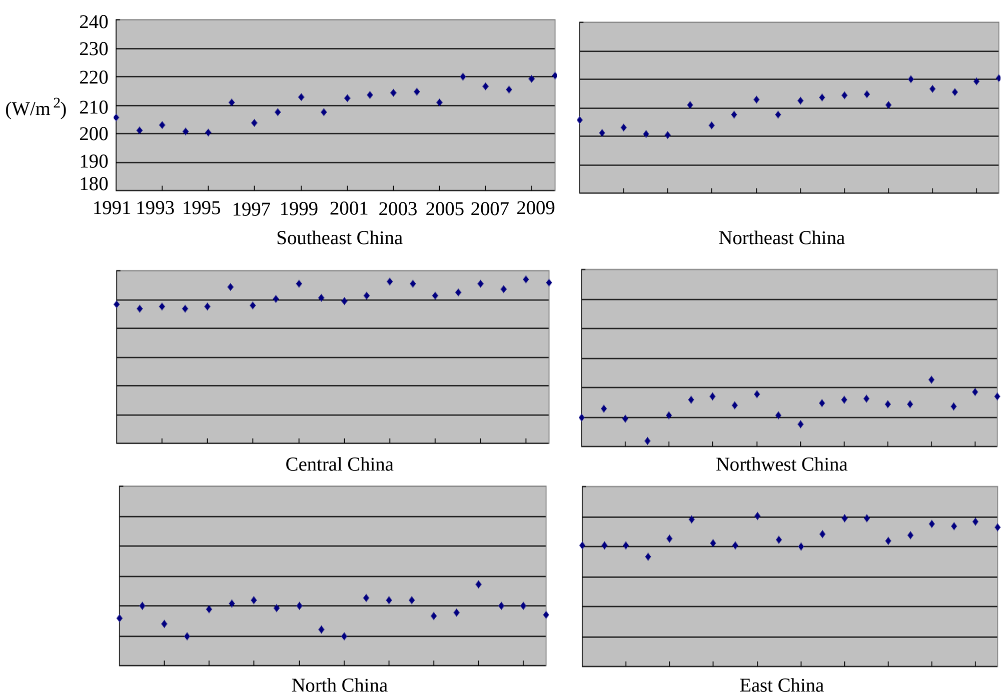

Figure 3: Characteristics of Chinese long-wave radiation data.

3. STUDY RESULTS

3.1. Characteristics of OLR along Latitude

The Figure 1 showed the variation of long-wave radiation data from 400 points in and around China where we could see that the OLR values with the variation of latitude had obvious seasonality. In spring, autumn and winter the long-wave radiation values had a decreasing trend with the increase of latitude, while the values had an increasing trend with the increase of latitude in summer. Generally speaking, the 35°N was feature latitude, where long-wave radiation changed obviously.

3.2. Characteristics of OLR along Longitude

Figure 2 showed the characteristics of long-wave radiation along longitude. Generally speaking, the changes of OLR along longitude were relatively gentle which were less obvious than those along latitude, and therefore it could be considered that the OLR values were mainly controlled by the latitude.

3.3. Spatial Distribution Characteristics of OLR

The Figure 4 showed that the OLR values were low in Northeast China and the Tibetan Plateau, and were high in Taiwan, Hainan, southern Yunnan province and northern Xinjiang province. The OLR values were higher relatively in Northwest China and East China than those in Tibetan plateau. The eastern of Xinjiang and the western of Inner Mongolia were two high value areas in Northwest China, especially in summer and autumn the values were abnormally obviously high.

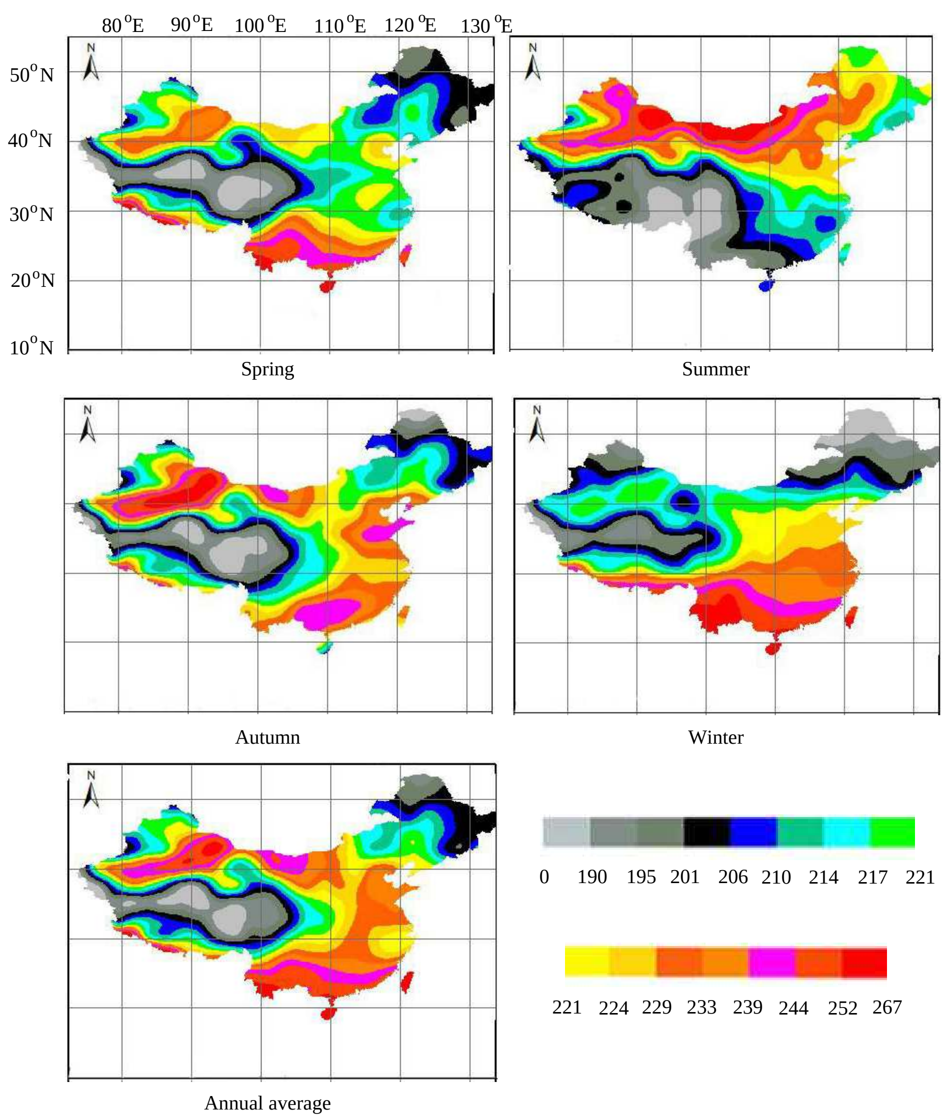

Figure 4: Characteristics of Chinese long-wave radiation data.

Similar to the Qinghai-Tibet Plateau blocks, the changes of OLR in the two high value areas were dramatic in spring and autumn and relatively slow in the summer and winter.

3.4. Time Distribution Characteristics of OLR

As could be seen from Figure 3, the OLR values had a overall increasing trend and were generally low in Northeast China and Northwest China, and were highest in Central China.

4. CONCLUSIONS

1. Long-wave radiation values changed significantly along latitude, and 35°N was feature latitude, where the long-wave radiation values changed significantly along latitude, but did not change significantly along longitude in the Chinese region.
2. The changes of long-wave radiation had seasonal and regional pattern. Being affected by topography, long-wave radiation of China's Qinghai-Tibet Plateau, Northwest, Southeast coastal region, Northeast and other had different characteristics. The regional characteristics were manifested as the low value of OLR in area of Qinghai-Tibet Plateau and northeast at all seasons, the relatively high value of OLR in Taiwan, Hainan, southern Yunnan and north Xinjiang in spring and winter, and the relatively high value of OLR in eastern Xinjiang and western part of Inner Mongolia in summer and autumn.
3. The time characteristics showed that in most parts of Chinese region the value of OLR advanced while in other regions, the value of OLR unchanged.

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