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Characteristic of Solar Radiation and the Impact of Cloud at Yangbajing, Tibet

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Yangbajing (YBJ), 4,300 meters above sea level, is located 90 km west from Lhasa city of Tibet province, China. A famous international cosmic ray observatory (established by researcher from China, Italy, and Japan) is located there. We used surface solar radiation data during the period 2009-2010 to understand the characteristics of solar radiation and atmospheric status of this high-altitude region. Studying the changes of solar radiation reaching the ground, not only has direct climatic significance, but also is useful for understanding regional changes of atmospheric compositions, pollution particles and other atmospheric environmental conditions. The annual mean solar radiation was 478.4 W m-2 and annual mean transmittance was 0.713. The mean solar radiation of clear skies was 629.0 W m-2. 0.713Atmospheric mean transmittance of clear skies reaches 0.828 when solar elevation angle (SEA) is greater than 10 degree. We compared mean solar radiation of clear skies with the radiation of the U. S. Standard atmosphere simulated by model LibRadtran. Results show that they are very close and it can be inferred atmosphere of YBJ is very clean. It was also found atmospheric composition influencing solar radiation changes slightly during the year because standard deviation of transmittance of clear skies was less than 0.05 when the SEA was greater than 10 degree. It helps to understand the impact of cloud on solar radiation without considering other impact factors, such as aerosol.

Solar energy is now advocated and promoted by most countries over the world since it is the green and sustainable energy. Nowcasting of solar energy is a necessary work before application by traditional power system because surface solar radiation is variant and obviously mainly affected by cloud parameters, such as cloud type, cloud fraction and so on. Considering the nice atmospheric conditions of YBJ and using simultaneous cloud fraction data, we analyzed the impact of cloud on solar radiation and set up a preliminary quantitative relationship between the solar radiation and cloud fraction. It supports a reference for estimation of the ground solar energy. We hope it will be available for the parameterization of radiation in climate model and some other researches, for instance comparison with satellite observation, at Tibetan Plateau. In addition, 2.8% of the cases reported “abnormal” solar radiation (the solar radiation is greater than solar constant multiply cosine of SEA) due to the impact of cloud. Especially, some abnormal solar radiation occurred when sky was nearly overcast. Some 3-D numerical simulations were tested but not yet found the right ice-cloud that could redistribute and magnify the direct radiation.