

Increase of global radiation and cloud cover in the northern part of Japan

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Solar irradiance at the surface is a source of energy that drives climate system. This variation affects climate. Cloud cover variation does not only link with solar irradiance at the surface, but also affects global warming through greenhouse gas effect. It is well known that global solar irradiance at the surface changed from dimming to brightening around 1990 (e.g. Wild, 2009) including Japan (Norris and Wild, 2009). On the other hand, long-term trend of cloud depends on regions, and cloud cover (cloud amount) trend around Japan is uncertain due to limited researches. We analyzed long-term trends of daily global radiation with daily mean cloud cover from 1974 through 2006 at 53 pyranometer sites in 6 regions (Hokkaido, Tohoku, Kanto-Chubu, Kansai, Nishinippon, Kyushu, Okinawa) in the Japan Meteorological Agency (JMA). The JMA regularly calibrates pyranometers according to the WMO reference standards in the World Radiation Center (JMA, 2009). The daily mean cloud cover was from synoptic cloud reports 8 times per day (some stations are 4 times) at the same sites as global solar radiation observation. Cloud cover (max 10) was classified to 6 categories (CC0: 0-1.9, CC2: 2-3.9, CC4: 4-5.9, CC6: 6-7.9, CC8: 8-9.9, CC10: 10) for analyses. It is well known that diurnal temperature range (DTR) has a close relationship with cloud cover variation (Dai, et al., 1999). To make certain reliability of the cloud reports, we plotted the annual variations of the daily mean cloud cover and the DTR in the 6 regions. The averaged correlation coefficient was -0.66, which indicates the cloud reports are consistent with temperature measurement and reliable.

The regional relative trends of cloud cover are positive and large in Hokkaido and Tohoku (~2.5% per decade), and decreasing to southward to Okinawa where the trend shows almost zero. The increasing trends in Hokkaido, Tohoku, and Kanto-Chubu are significant at 95% level. The regional relative trends of global solar radiation are positive (increasing) in all regions, but the trends in Hokkaido and Tohoku are much smaller than other regions. They are significant at 95% level except in Tohoku (but it is significant at 90% level).

It is unexpected that both trends show positive except in Okinawa. Furthermore, we analyzed global solar radiation trends in the cloud cover categories. Generally, global solar radiation trends (relative) are larger in larger cloud cover except in Okinawa. Particularly, the trends in large cloud cover (ex. CC10) are by far larger than that in CC0 in Hokkaido, Tohoku, and Kanto-Chubu. This result suggests that the cause of the global radiation increasing in northern part of Japan may not be caused only by global brightening, but may be related with change of cloud physical property, such as cloud optical depth.

Reference

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