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Effect of cosmic ray on global high cloud from MODIS

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The Earth's climate is affected by not only internal forcings but also external forcings related with solar activities. The energetic particles called "cosmic rays" from outer space have been considered as a potentially important external climate forcing since the first report by Svensemark and Friis-Christensen (1997) which showed a significant correlation between cloudiness and cosmic ray. This correlation is a basis of a couple of hypotheses in microphysical processes: ion-aerosol clear-air mechanism and ion-aerosol near-cloud mechanism. These mechanisms have been either supported or objected by many successive studies, most of which correlated long-term trends of cloud and cosmic ray. However, it is most likely that such methodology is not suitable to find actual connection, because long-term trends of clouds may invite affection by many factors other than cosmic ray. It is therefore necessary to find the relation at shorter time scale, since cosmic ray affect the process of cloud formation in a moment. Here we show spatial distributions of correlation between global high cloud fraction data from MODIS and cosmic ray of neutron monitor data from McMurdo, Antarctic. We removed 3-month running means from the original data in order to get high frequency fluctuations. As results, positive correlations are dominant in the spatial distribution, especially over lands on the northern hemisphere and oceans on the Southern hemisphere. On the other hand, negative correlations exist over limited area including the Indian Ocean. According to the cross-correlation (with time lags), the areas with positive correlation is widely distributed at zero lag. At ± 1 month lags, the signs of correlations become the opposite of that at zero lag. Furthermore, the correlation between relative high cloud amount to total cloud and cosmic ray shows similar distribution to the correlation between absolute high cloud amount and cosmic ray, implying stronger high cloud response to cosmic ray than low and middle clouds. Considering the correlations with dependence on regions, a physical cloud process regarding to cosmic ray may not be universal perhaps due to anonymous factors affecting the cloud amount. However, our synthetic conclusion is that the amount of global high cloud increases with increased cosmic ray. This implies that infrared warming effect due to increased high cloud may be intensified when more cosmic ray comes in.