Radiation hazard at aircraft altitude and the correlation with solar activities

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Understanding the solar cycle variation of the radiation dose at aircraft altitude is one of the most important topics of space weather research. We applied Sato et al. (2013) air-shower model to calculate the radiation dose rate in the stratosphere and in the troposphere during solar cycle 23, using GOES energetic particle sensor data as the input. As a result, it is found that the seasonal variation of dose rate at the tropopause is relatively enhanced during the solar maximum, and longer-time trend of ~10 year shows monochromatic increase from the solar maximum to the solar minimum. The reason of increase of dose rate from the solar maximum to the solar minimum is considered that solar magnetic field decreases from the solar maximum to the solar minimum and particles of galactic cosmic rays (GCR) are relatively more come in atmosphere. Therefore, we tested that whether GCR energy spectrum calculated with force-field potential increases from the solar maximum to the solar minimum. As a result, it is found that GCR energy spectrum increases by 1.5 times - 2 times from 2000 to 2009.Similarly, the three months mean of GOES proton flux each energy channel increases by 1.5 times - 2 times from 2000 to 2009. We report further results of the radiation dose for the past 30 years, using GOES energetic particle sensor data as the input and research the variation of the radiation dose at aircraft altitude at longer-term distance. Also, we compare the increase in the radiation dose by solar activity decreasing, and GCR increasing with the decrease in the radiation dose by the number of the outbreak of solar flare relatively decreasing in comparison with solar maximum.