Effects of Solar Wind Fluctuations on the Earth's Atmosphere and Climate

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EXTENDED ABSTRACT

The Sun, as a star, emits wide range energies of photon and plasma particles or Solar Energetic Particles (SEPs). Solar energetic particles constitute a flock of energetic plasma particles, which can be often observed in the near Earth space. They bear information about processes of energy enhancement and turbulence propagation of charged particles in the solar and heliospheric magnetic fields. Many studies concentrated on high energetic solar events related to flare, coronal mass ejection (CME), solar proton events (SPEs), shock, etc. which may abruptly cause relativistic events. Interplanetary SEP observations have already directed to study of high-energy particles, plasma physics or space weather. In powerful events, the particle fluxes occupy more than eight orders of magnitude and the energy range extends over more than four orders of magnitude, from MeV to tens of GeV. After more than half a century years, observations results have still remained unknown acceleration processes in the interplanetary space. Charged protons and electrons with high energies originating from the Sun or the Earth's magnetosphere enter the atmosphere in the polar regions, where they are guided by the Earth's magnetic field. Once in the atmosphere, they increase the ionisation levels, providing a major source of ionisation in the mesosphere and upper stratosphere. The typical energies of energetic particle precipitation (EPP) particles range from 1 MeV to a few hundred MeV for protons, and from tens of keV to a few MeV for electrons, energies above these are usually regarded to be in the cosmic ray energy range. In the atmosphere, the enhanced ionisation from EPP leads to production of HO*x* and NO*x*, reactive gases which have an important role in middle atmosphere ozone balance, thus providing a potential link to dynamics and regional climate. It is important to note that the questions included under the theme 'What is the solar influence on climate?' cover an extremely wide range of subjects, which for long have been the focus of scientific communities that were relatively separated from each other.

We characterized solar energetic particle power-law spectra from selected two sunspotless events with more than 30 consecutive day's length on July 21 to August 20, 2008 (31 days) and July 31 to August 31, 2009 (32 days) in the solar cycle 24. Their spectral of energetic interplanetary multielements of seven charge particles (H, He, C, O, Ne, Si, and Fe) from 15 keV to 0.5 GeV have been compiled from instruments onboard several satellites (GOES, ACE, STEREO, and Voyager) with different distance from the Sun. The spectral energetic particles also compared with appearances of AR12192 owing very large sunspot area (>2000 millionth of solar hemisphere) without foreshortening effect on October 19-27, 2014. Our results from six charge elements show that there were intrinsic differences among those events on aspects of enhancement flux particles and changing of double power law or V-shape. Flux enhancements occurred after 10 MeV for sunspotless days and 20-30 MeV for AR 12192 passage, which the latter less increased than former. It is suggested that very strong magnetic field in AR 12192 showed two roles, flux enrichment in lower energy and inhibited streaming of energetic particles in high energy. Interactions of multielements of solar energetic particles with interplanetary magnetic fields and plasma speed play an important role, as seen from the variations of rollover power law of spectral energy. Production of neutral and charge atomic gases as function with atmospheric height were clearly affected by interplanetary conditions, e.g. during sunspotless days periods or the largest sunspot area passages, as obtained by MSIE-1990 and IRI-2007 atmospheric models.