Energy spectra of $<$200 MeV protons under quiet solar activity

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The energy spectra of protons in the 1-200 MeV range are studied under quiet solar activity periods during the 22^{nd} and 23^{rd} cycles using data sets from near-Earth spacecraft. A series of low-flux periods is approximated by the spectral form J(E)=AE$^{-\gamma}$+CE$^{\nu}$, where the two terms describe solar/heliospheric and galactic components, respectively. By determining the best fitting parameters to the energy spectra, correlations are made among them as well as with solar activity indices. In the majority of the cases, we obtain experimentally that ν has a value of 1.2 $\pm$ 0.15, which is significantly larger than the commonly expected ν = 1, predicted by the force-field approximation. In modulation theories $\nu >$1 corresponds to a negative Compton-Getting factor posing a challenge. Such an inversion may occur when if $\kappa_{rr} <$ rV (κ_{rr} denoting radial diffusion coefficient, r distance and V solar wind speed), then, most of the lower energy particles reaching 1 AU have been cooled down in the inner heliosphere (within 1 AU) and are subsequently convected outward by the solar wind. At the same time the value of the energy minimum of proton spectrum that divides the two populations is shifted towards higher values with increasing solar activity. Correlations made with solar activity indicate that the slope of solar/heliospheric spectrum slightly decreases with increasing solar activity whereas ν seems to exhibit a negative correlation with λ, the interplanetary mean free path of protons. Possible interpretations are discussed.