Figure II.1 shows the variation of the ambient dose equivalent rate as a function of flight altitude. The calculations were made for conditions close to solar maximum activity in January 1990 and close to the solar minimum activity in January 1998. The calculations were made with EPCARD and show results for both the equatorial and polar regions.

Solar energetic charged particles can contribute to the aircraft crew exposure through occasional so-called solar particle events (SPE's). These are produced by sudden, sporadic releases of energy in the solar atmosphere (solar flares), and by coronal mass ejections (CMEs). During such events a large number of mainly high-energy protons is produced and an increased fluence of particles at aviation altitudes may be observed. Only a small fraction of the SPEs, on average one per year, causes an increased dose rate at aviation altitudes. Those events can be observed with neutron monitors at ground level: ground level events (GLEs). The largest events often take place on either side of the period of maximum solar activity as measured by sunspot number. Any rise in dose rate associated with an event is quite rapid, usually taking place in minutes. The duration may be hours to several days. The prediction of which events will give rise to significant increases in dose rate at aircraft altitudes is not currently possible. Estimation of the doses to aircraft crew in the event of a GLE must be made retrospectively. Principally it is possible due to the existence of a number of geomagnetically dispersed, ground level neutron monitors, and because the observed neutron fluence at ground level is primarily caused by the cosmic radiation.

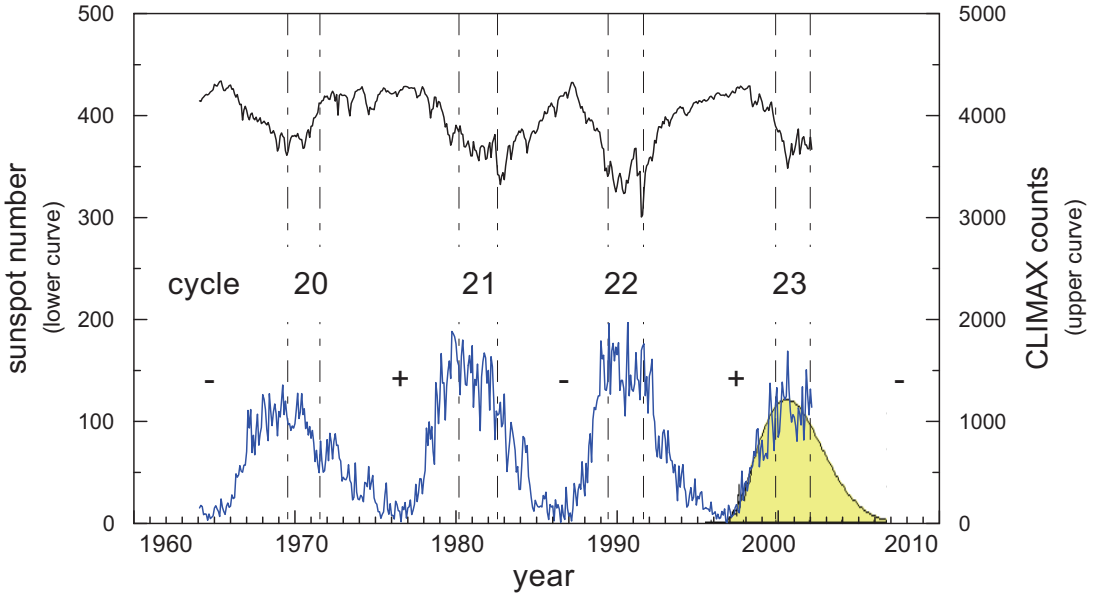

Figure II.2 Sunspot number (lower curve) and monthly averaged Climax neutron monitor count rate per hour (divided by 100) for solar cycles 20 through 23 (from 1964 to begin of 2002). Solar cycle 23 is expected to last until approximately the year 2008. The vertical dashed lines indicate the periods (around 2 years each) of solar reversal; +/- specifies the respective polarity of the field model of NASA Johnson Space Center (Badhwar, 1997). The shaded area is the solar activity predicted by the NASA Marshall Space Flight Center.

Figure II.2 shows how the neutron monitor count rate has varied with the number of sunspot during the time period from1960 to the present. The sunspot number reflects the actitiy of the sun and a smoothed curve is used to identify the maxima and minima of the sun activitity. The neutron fluence sometimes also decreases as an effect of increased solar wind and the increases in associated magnetic field. Those effects decrease the intensity of the GCR at the top of the atmosphere. Such events are called "Forbush decreases", they may occur a handful of times each year [FOR37], [CRR96] and [CAN00]. They may last for several days.