The relationship of satellite anomalies and launch failures to the space weather

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A statistical evaluation of the impact of space weather on space missions has been made using a large database containing geostationary and low-Earth orbit satellite anomalies. The database covers the period 1971-94, comprising the growth, maximum, and decline phases of solar activity. It includes reported anomalies onboard international and former SU satellites. Various types of anomalies, mainly caused by internal and external charging of spacecraft, but also those with undetermined origin, are considered. It is found that the way space radiation impacts satellites is a function of particle environment, location of satellite and phase of solar cycle. During solar maximum, solar protons are the main cause of geostationary satellite anomalies, whereas during the growth, and especially - decline of solar activity, the magnetospheric relativistic electrons are the main menace to satellite systems. There are periods when solar proton and relativistic electron fluxes are low, and satellite anomalies are related to energetic (˜100 keV) electrons. Critical ranges of proton and electron fluxes constituting a threat for satellites have been determined for various energies. We verified the efficiency of ULF turbulence as a possible source of the "killer" electron acceleration. For that, we examined the statistical relationships between the ULF power indices (characterizing the wave activity on the Earth's surface, in the magnetosphere, and in the solar wind) and magnetospheric electron fluxes with energies from hundred keV to several MeV in the outer radiation belt. The relationship "solar wind velocity - ULF pulsations - "killer" electrons" was studied for different time scales (from hours to days) to estimate the specific role of each factor. The cumulative effect in the electron response to the ULF activity was revealed. Since 1966, all spacecraft failures at the Russian launch site Plecetsk have been statistically analysed. Most of them occurred during high geomagnetic activity and the failure distribution shows a seasonal variation with peaks during summer and winter. These findings - "regularities" in satellite anomalies and launch failures - should be taken into account when considering which measures to take for the mitigation of potential radiation hazards for planned satellite missions.