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Space weather hazards and planetary habitability

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Space weather related responses of planetary atmospheres include: thermospheric and ionospheric density variations, changes in atmospheric composition including ozone depletion, changes in heating/cooling, temperature and wind perturbations, photochemistry, collisional excitation, deactivation and cooling due to IR-, optical and UV-emissions, magnetospheric compression, enhancement of secondary particles, etc. That these atmospheric effects related to extreme solar events have an influence on satellites (drag, anomalous behaviour / failure), navigation and tracking difficulties, spacecraft/mission design, radiation hazard issues for future manned missions (e.g., Moon, Mars) etc., is only one aspect. Another important aspect is directly related to the evolution of planetary atmospheres and their water inventories. For understanding the principles that generate long-time habitable environments like on Earth or terrestrial type exoplanets such as the recent discovered Gliese 581 inside the habitable zones of lower mass stars, one has to understand the evolutionary influence of the solar/stellar radiation and particle environment to the atmosphere and surface. The need for a coordinated study of the behaviour of the upper atmosphere, ionosphere, magnetospheric environment and thermal and non-thermal atmospheric loss processes of Venus, Earth, and Mars during “extreme solar events” will be discussed. Such events can serve as a proxy for the influence of the active young Sun with implications for the evolution of planetary atmospheres (solar system and exoplanets), water inventories and habitability. Studies of the evolution of the spectral irradiances (X-ray, EUV, UV) of solar-type stars of different ages are used as a proxy for reconstructing the history of the Sun/stars radiation output. Complementary information concerning solar mass loss (solar/stellar winds) can be derived from studies of the energy distributions of flare related CMEs during low and high solar activity by extrapolating CME related solar mass loss to the early stage of the solar system using solar proxies. The presentation

will also discuss why the understanding of space weather related effects are important within the investigation on how different planetary systems and their individual planets - and particularly Earth-like ones - evolve, how they may evolve in their radiation and particle interaction with their host stars under different circumstances, and how often they give rise to conditions that could in principle be benevolent enough for the origin of life, even if such a planet orbits within a climatologically defined habitable zone.