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Nebula Winter

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Encounters with nebulae, such as supernova remnants and dark clouds in the galaxy, can lead to an environmental catastrophe on the Earth through the negative climate forcings and destruction of the ozone layer by enhanced fluxes of cosmic rays and cosmic dust particles. A resultant reduction in primary productivity leads to mass extinctions through depletion of oxygen and food starvation as well as anoxia in the ocean. The model shows three levels of hierarchical time variations, caused by supernova encounters (1-10 kyrs), dark cloud encounters (0.1-10 Myrs), and starbursts (˜100 Myrs), respectively.

This Nebula Winter model can explain the catastrophic phenomena such as snowball Earth events, repeated mass extinctions, and Cambrian explosion of biodiversities which are happened in the late Proterozoic era through the Cambrian period. Late Neoproterozoic snowball Earth event covers a time range of ca. 200 Myrs long spanning from 770 Ma to the end of Cambrian period (488 Ma) with two snowball states called Sturtian and Marinoan events. Mass extinctions occurred at least eight times in this period, synchronised with large fluctuations in delta13C of carbonates in the sediment. Each event is likely to correspond to each nebula encounter. In other words, the late Neoproterozoic snowball Earth and Cambrian explosion are possibly driven by a starburst, which took place around 0.6 Ga in the Milky Way Galaxy. The evidences for Nebula Winter can be obtained from geological records in sediment in the deep oceans at those times.

Keywords: Dark Cloud, Supernova Remnant, Snowball Earth, Mass Extinction, Cosmic Dust, Cosmic Rays