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The terrestrial paleo-magnetosphere and its implications on the origin and evolution of the nitrogen-dominated atmosphere

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The present-day terrestrial atmosphere, as dominated by the volatile elements nitrogen and oxygen, is providing a habitable environment for a diverse range of life forms. However, simulations of the terrestrial paleo-magnetosphere as well as of the solar wind induced atmospheric ion-pickup escape $\sim$4 Gyr ago (see e.g. [1]) are indicating that during the harsh conditions of the Hadean and early Archean eons a nitrogen dominated atmosphere would not have been able to survive, but would have been eroded within a few million years due to the high EUV flux and the strong solar wind of the early Sun [2][3]. In addition, these results are suggesting that the present-day nitrogen-dominated atmosphere has its origin during later stages of the geological history of the Earth, whereas for the late Hadean and early Archean, CO_2 can be considered as the dominating atmospheric constituent. However, the small $^{14}N/^{15}N$ isotope disequilibrium between internal and surface reservoirs at the Earth [4] is indicating that some atmospheric escape of nitrogen should have taken place in the past. This escape, as well as the overall historical composition of the atmosphere are strongly coupled to the shape of the paleo-magnetosphere and to its interplay with the varying solar activity factors.

We will present simulations of the terrestrial paleo-magnetosphere during the late Hadean and Archean eons and its influence on the evolution of the terrestrial nitrogen atmosphere. This also includes an estimation of nitrogen lost to space based on the observed terrestrial $^{14}N/^{15}N$ fractionation. Our results support the idea that the nitrogen dominated atmosphere started to build up during the Archean eon and slowly evolved from a low-pressure atmosphere via outgassing of N_2 into the present-day habitable environment. Important environmental conditions for this evolution and its interconnections will be discussed within this presentation. This also includes a potential solution for the before mentioned $^{14}N/^{15}N$ disequilibrium.

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