A future mars environment for science and exploration

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Today, Mars is arid and cold with a very thin atmosphere that has significant frozen and underground water resources. The thin atmosphere prevents liquid water from residing permanently on its surface and makes it difficult to land missions since it is not thick enough to completely facilitate a soft landing. In its past, under the influence of a significant greenhouse effect, Mars must have had a significant water ocean covering perhaps 30% of the northern hemisphere. Mars lost its protective magnetosphere and therefore much of its atmosphere around 3 Ga ago, due to the solar wind. The atmospheric loss into the solar wind is somewhat balanced by the outgassing of the Mars interior and crust that contributes to the existing atmosphere leading to a global-mean surface atmosphere of ~6 mbar pressure currently.

By using our extensive simulation tools and physics capabilities in Space Weather and Mars global climate modeling, we have started to explore the effects on Mars of placing an artificial magnetic dipole field at the Mars L1 Lagrange point putting Mars in a magnetotail. This situation then eliminates many of the solar-wind erosion processes that occur with the planet's ionosphere and upper atmosphere allowing the Martian atmosphere to grow in pressure and bulk temperature over time. Under thicker atmospheres, the global circulation patterns and seasonal changes are much different than at present. An enhanced atmosphere would: allow larger landed mass of equipment to the surface, shield against some cosmic and solar particle radiation, extend the ability for oxygen extraction, and provide "open air" greenhouses to exist for plant production, just to name a few. These new conditions on Mars would allow human explorers and researchers to study the planet in much greater detail and enable a truly profound new understanding of the habitability of this planet.