TERRAFORMING MARS – WHY NUKING MARS WOULD NOT WORK

John K. Strickland[1,2,3,4]
[1]National Space Society; [2]Space Frontier Found.; [3]Mars Soc.; [4]Amer. Inst. of Aeronautics & Astronautics.
E-mail: jkstrickl@sbcglobal.net

Summary: Terraforming Mars, the only planet in our solar system that can be terraformed with technology we can anticipate, is important to provide a backup location for Life itself: humans, animals, plants, fungi, eukaryotic protists and selected bacteria. Different methods of terraforming Mars have been proposed. This article compares them, their practicality and effectiveness.

Introduction: Even though terraforming is decades away, we need to start a more realistic discussion about which methods to use and in what order to be effective. These include warming Mars, temporarily warming Mars, adding volatiles to the atmosphere, and combination of methods. For people, animals and plants to live outdoors on Mars, we need enough air pressure for warm liquid water to exist on the surface (about 1.0 psi), at least 2.5-3 psi of oxygen for breathing and plant respiration, about 2.5 psi to block cosmic radiation and for plant growth, and allow a high enough air and ground temperature to keep most of the liquid water from permanently freezing. The air must have about 2 parts nitrogen (N_2) for 1 part oxygen (O_2), so we need ~6 psi of N_2 and ~3 psi of O_2.

Approaches: *Permanent Warming.* Two methods can permanently warm Mars: (1) *large space mirrors* redirecting sunlight onto the surface; (2) *adding a mixture of perfluorocarbon gases to the atmosphere.* Even if fluorine is imported, method #2 is easier with no maintenance.

Temporary Warming. Nuking Mars (tens of thousands of H bombs detonated just above the atmosphere) is the only semi-practical way to temporarily raise temperatures. Using multiple asteroid impacts is impractical as the resulting non-nuclear winter could cool Mars for centuries. Both temporary methods require "ultra-violence"!

*Increase Pressure***.** N_2 on Earth acts as a buffer gas and contributes bulk air pressure; plants need N_2. N_2 and O_2 help to stabilize day-night temperature swings and block most Galactic Cosmic Radiation. N_2 can be imported from multiple outer solar system locations. Pluto is the best, as its solid N_2 deposits are large, and on a low gravity world. With fusion propulsion, tugs can move huge N_2 loads from Pluto orbit to Mars **(Fig. 1)**. The chunks hit the upper Mars atmosphere *horizontally*, vaporizing with no new craters. O_2 can be hydrolyzed from a relatively small portion of the millions of km^3 of Mars H_2O ice, using nuclear power, fission or fusion.

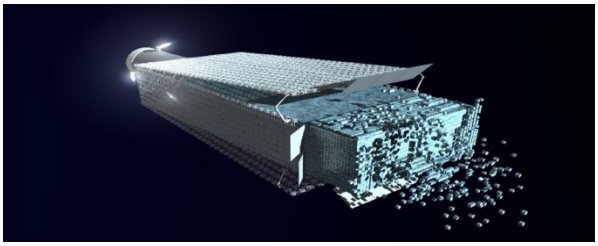


Figure 1. Fusion Tug Delivering 100 MT of N_2.

Discussion:

Drawbacks of Permanent Warming. (1) Giant space mirrors would be hard to build and keep in position. (2) Fluorine to make super greenhouse gases may be hard to find and mine on Mars.

Drawbacks of Temporary Warming. I am a strong supporter of nuclear energy, but temporary warming methods like nuking Mars *cannot work.* Even if all H_2O ice on Mars was melted, within a year or two after the bombing onslaught, the melted water would all freeze solid again, only in a different location. Mars terraforming requires *augmenting the atmosphere*. The cost of the H bombs would be enormous. There is not enough fissile material on Earth to even make that many triggers. Some radiation would reach the surface. Existing Mars settlers would strongly object.

Drawbacks of Combination Methods After Warming. (A) Outgassing – Academic view: Wait for gases like CO_2 to be released from the crust and regolith where they could be adsorbed. *This would not happen* in any substantial amount, as 2 billion years of near-vacuum would have already done this. *(B) Volatile Imports:* We would need to hydrolyze about 800 trillion tons of O_2 from Mars H_2O ice. Thousands of fusion tugs are needed to move 1600+ trillion tons of N_2 to Mars.

Possible Solutions. Atmospheric terraforming operations can be completed over a roughly 200 year period, using fusion heat and power. Huge N_2 cargo vehicles can be mass-produced. N_2 ice is soft and easy to mine. Settlers would be very supportive of terraforming operations.

Conclusion: Methods for permanent Mars warming in conjunction with volatile imports of N_2 and generation of O_2 and greenhouse gases are practical, effective, measurable and rapid.

Future Work: Setting up Mars climate models to know how warm Mars can be made and which order the steps should be done in is important.