Descend isochrones in Martian atmosphere

Miljan Kolcic[1]
[1]*Department of Astronomy Faculty of Mathematics, University of Belgrade;*
miljan@kolcic.space

Keyword : Mars, atmosphere, trajectory, optimisation

Martian atmosphere is probably the most hostile environment in the Solar system to perform entry, descend and landing (EDL) because it is thick enough to create substantial heating of the entry vehicle but not thick enough to reduce its velocity to the one necessary for safe landing. This specifically holds for landing on the southern hemisphere of Mars where the surface elevation is much higher than in the northern lowlands due to Martian dichotomy [1], the most prominent feature of its topography. Landing in these regions requires a special attention to trajectory optimization in order to achieve maximum descend time which is necessary for performing number of complex EDL events. While the landing on the southern hemisphere is extremely difficult from engineering point of view, there is a tremendous scientific motivation for its exploration, because this part of Martian surface is almost entirely covered with the ancient terrain which originates from the Noachian eon of planetary evolution (4.6 - 3.5 Ga) [2]. This is greatly enhanced by the fact that the majority of locations of confirmed recurring slope lineae (seasonal flows of briny water on today's Martian surface) is in the southern highlands [3].

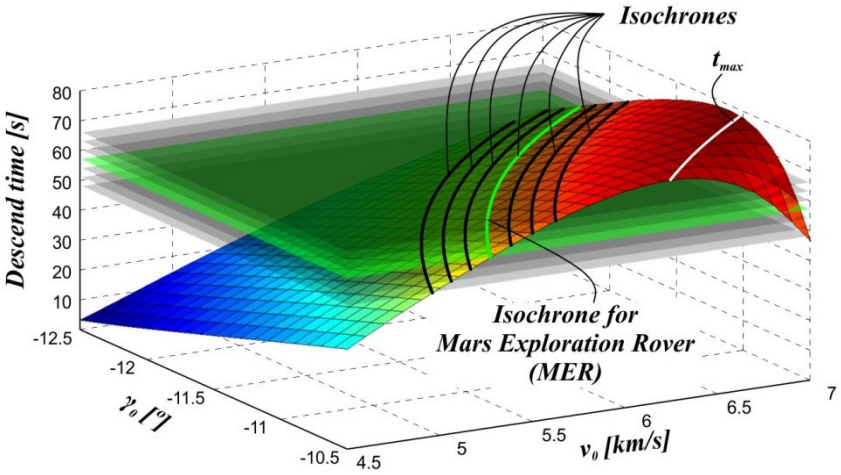

Fig. 1. Descend isochrones

In this paper is presented the analysis of the descent time for ballistic EDL on Mars and very simple method for optimization of the initial entry parameters, velocity (v_0) and flight path angle (γ_0). Analysis is done using Mars-Gram atmospheric model [4]. The results which are presented in Fig.1 show that the initial conditions (v_0 and γ_0) on descent isochrones have quadratic relationship which enables their optimization by simple solving of the quadratic equation. The specific analysis was performed for EDL of Mars Exploration Rover on several sites on the southern highlands and the results indicate that the landing is possible on the locations with high elevations (~ 2 km MOLA) by targeting the optimal entry parameters, season and the time of day of EDL.

References

[1] Smith, D. E. *et al*., The gravity field of Mars: Results from Mars Global Surveyor, *Science*, **286** (1999), 94-97.
[2] Scott, D. H. *et al*., Geologic Map of Mars, *Misc. Invest. Ser. Map I-1083, U.S. Geol. Surv., Reston,* (1978).
[3] McEwen *et al*., Recurring slope lineae in equatorial regions of Mars, *Nature Geoscience*, **7** (2014), 53-58.
[4] Justus, C. G. *et al*., Mars-GRAM 2000: A Mars atmospheric model for engineering applications, *Advances in Space Research*, **29** (2002), 193-202.