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Wind risk assessment for the Mars 2020 helicopter at Jerezo crater, Mars: implication for wind retrievals.

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Abstract

We develop a simple point-mass model to estimate the deflection due to the winds of Mars 2020 helicopter for a set of simplified flight profiles.

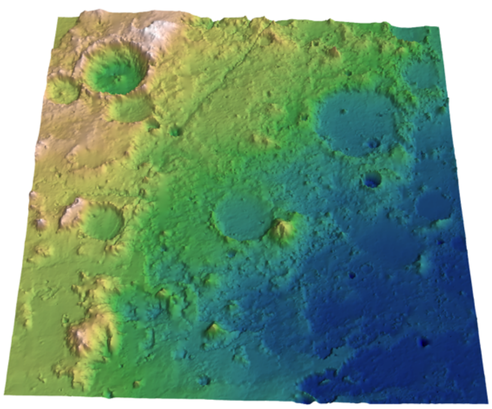

Figure 1: Jerezo crater (at the center of the figure). Shades show the local elevation above the aeroid.

1. Introduction

NASA Mars 2020 rover will bring along a scouting helicopter as a technology demonstrator to the surface of Mars. On Earth, lightweight Unmanned Air Vehicles (UAV) are particularly sensitive to side slip and likewise, the Mars helicopter will also be subjected to deflection by the winds. Fortunately, the thin air that makes flying so challenging on Mars also results in generally low dynamic pressures which makes wind drift less of a concern for near-surface, autonomous operations. Our primary motivation to study the dynamics of the Mars helicopter (beside obstacle avoidance of large rocks or un-even terrain) is to retrieve the near surface winds from future observed trajectories.

2. Method

The commanded trajectories, time of day, and flight strategies for the Mars 2020 are expected to vary during the surface operations. Therefore, we propose to use a fairly generic, semi-analytical point-mass model for the helicopter applicable to different phases for the flights, coupled with our best estimate for the winds at the season of landing retrieved from Mars climate models. Jerezo crater has a diameter of ~ 50km, which is in the order of the minimal grid spacing obtainable with Mars Global Climate Models (~ ¼ degree). Such resolution would only allow for a single grid point within the crater and is not sufficient to resolve the influence of the topography and the local atmospheric circulation. Atmospheric conditions at the landing site of Mars 2020 are therefore derived using the Mars Regional Atmospheric Modeling System and a set of 6 nested grids to obtain km-scale resolution at the landing site. Predictions for the winds in the first atmospheric layer (Figure 2) are adjusted to potential flight altitudes using a logarithmic profile in order to derive the direction, magnitude, and induced wind speed at the end of the flight for different flight profiles and time of day.

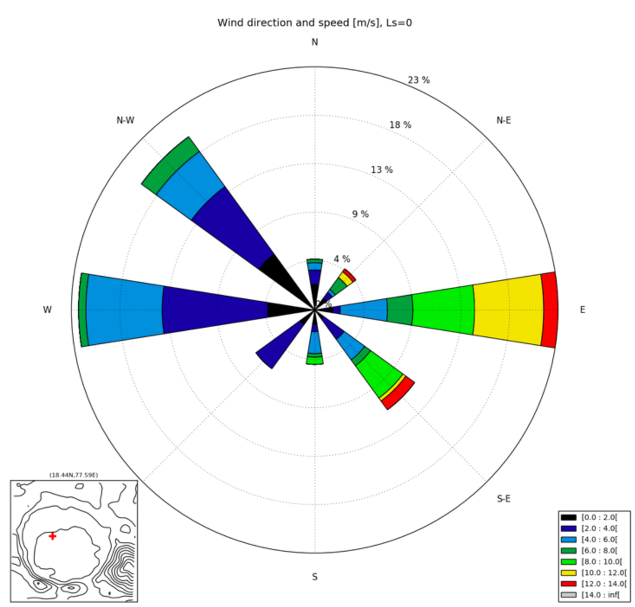

Figure 2: Windrose for the dominant directions and magnitudes of the winds in Jerezo crater at the season and location of landing (red marker on the map)