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Mars Mesoscale Modeling with MRAMS

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Introduction:

In an effort to better understand the atmospheric circulations of the Gale Crater, the Mars Regional Atmospheric Modeling System (MRAMS) [1] was applied to the landing site región of Curiosity rover (MSL) [2]. We provide a comparison of MRAMS predictions for pressure, air temperature, winds and ground temperature, to the Rover Environmental Monitoring Station (REMS) data available at the location of the Rover for solstices and equinoxes, in order to provide a baseline of model performance. Gale Crater is the most topographically complex area visited to date on Mars. The meteorology within the crater is one of the most dynamically complex meteorological environments, because topography drive the near-surface atmospheric circulations. The types of perturbations of pressure, air and ground temperature and wind measured at Gale have never been observed at other locations and these data provide a great opportunity to test the models at the most meteorological interesting area measured to date [3].

MRAMS was used also to predict meteorological conditions that are likely to be encountered by the Mars 2020 Rover at several proposed landing sites during entry, descent, and landing (EDL). The meteorology during the EDL window at most of the sites is dynamic. The intense heating of the lower atmos-phere drives intense thermals and mesoscale thermal circulations. Moderate mean winds, wind shear, turbulence, and vertical air currents associated with convection are present and potentially hazardous to EDL [4].

MRAMS is also being ideally suited for constraining the Curiosity-SAM methane detected source location. In order to characterize seasonal mixing changes throughout the Martian year, simulations were conducted at solstices and equinoxes. The rise in CH_4 concentration was reported to start around Ls336, peaked shortly after Ls82, and then dropped to background prior to Ls103. The aim of this work is to establish the amount of mixing during all seasons and to test whether CH_4 releases inside or outside of Gale crater are consistent with SAM observations. The experiments were designed injecting four tracers into the model to simulate the transport of methane and to understand the mixing of air inside and outside the crater. Timescale of mixing in MRAMS model is on the order of 1 sol regardless of season, much faster than previously estimated. Duration of CH_4 peak observed by SAM is ~100 sols. In an scenario with a puntual methane release outside Gale crater, methane arriving rover location from outside crater is diluted by approx. 6 orders of magnitude after just 12 hours. Therefore, either there is a continuous release inside the crater (more likely) to counteract mixing, or the methane is widely distributed so that mixing doesn't matter, or a local release outside the crater have to be continuous and very large magnitude (unlikely) [5]. In order to test that, new experiments are being performed with continuous methane releases both inside and outside the crater. The calculations of methane fluxes will be made for clathrates at different depths and formed from a gas phase containing 90%, 50% and 10% of CH_4 [6].

MRAMS is also suited looking for evidence of a direct transport connection of the Mars2020 Mawrth Vallis landing site to the northern polar regions. Mawrth, an ancient water outflow channel with light-colored clay-rich rocks, is the closest Mars2020 landing site to north polar cap. We are studying if moist air in northern spring/summer makes it to Mawrth at Ls90 and Ls180, two periods with high column abundance of water vapor at mid/high latitudes. The objective is to study if circulation (mean or regional) is favorable for transport water vapor from north polar cap to Mawrth Vallis to activate hygroscopic salts and/or chlorides. If affirmative, it should be a go-to site due to habitability implications [7].

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