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The necessity of further ground based atmospheric observations on Mars

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Since the beginning of surface exploration with the Viking Landers in 1976 knowledge of the atmospheric dynamics on the planet Mars has greatly increased. However, the understanding of especially meso- and micro-scale meteorology on Mars is still limited. This is primarily due to the small number of ground based measurements. Only 8 missions have ever collected meteorological data from the Martian surface and only intermittently due to limited mission duration. These mission have given us an invaluable insight into the atmospheric conditions on Mars. However, the lack of continuous and comprehensive data from the ground is a problem that will have to be solved at some point going forward. The solution will naturally be to conduct further ground based atmospheric observations.

A system for ground based observations is needed for the proper verification, validation and data assimilation of satellite data and Martian atmospheric models. Missions with several small meteorological stations will at some point be needed on the Martian surface for this purpose. Several nations already have plans of manned Mars missions in the coming decades. Since Mars has seasonal local and sometimes even global dust storms, the weather conditions could severely effect the operation of a manned mission. Therefore, it will be necessary to have at least some numerical weather prediction capabilities in order to prepare future manned missions for the potential hazards of Martian weather.

Any implementation of a ground based atmospheric observation system on Mars will need to follow a very specific set of design requirements. The Martian atmosphere is mainly comprised of CO_2 and has a mean surface pressure of around 600 pascal. These factors along with a very strong diurnal temperature cycle, set some very strict demands and limitations on any instruments used. Furthermore, the nature of a Mars mission will demand for the stations to arrive on the surface from orbit, and to be able to commence operations independently and autonomously. To ensure continuous operations for as long as possible, the stations will require a long term power source, for this purpose in-situ energy resources could be used. They should also be durable enough to sustain operation for as long as possible while regularly transmitting data back to Earth. These requirements will impose significant constraints on what kinds of instruments can be utilized on such a mission.