Building and analyzing comprehensive Mars dust storm databases from 1 Martian Year of EMM observations

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Description

The generation of global and regional Mars dust storm databases is meticulous and systematic work. It is known that multiple local and regional dust storms may exist separately from each other at the same time and they are subject to strong variations from day-to-day. This has been demonstrated by precursor studies for both non-polar and polar latitudes [see e.g. the study of Cantor(2007), Cantor et al.(2010), Wang and Richardson(2015); details in the list of ''Recommended reading" below], using sequences of MDGMs (Mars Daily Global Maps). It is common practice to identify dust storms manually by the visual inspection of MDGMs. The latter may be based on different criteria such as dust clouds [Cantor et al.(2019)], dust storm texture/convective structures [Guzewich et al.(2015)], or atmospheric fronts [Wang and Richardson(2015)]. The planned PhD work may include further comparisons against the performance of automatic image classification methods (such as deep learning). In any case, practical applications of image processing and data analysis in the field of satellite remote sensing are mandatory. Moreover, personal scientific interest in Atmospheric Physics and Planetary Science is required.

The task of this PhD project is to build a dust storm database spanning at least 1 Martian Year (1 Martian Year is ca. 1.9 Earth Years) based on EMM (Emirates Mars Mission). The database construction will start with the beginning of the EMM Science phase, scheduled for early-to-mid 2021. The basis of this database will be images by the EMM instrument EXI (Emirates Exploration Imager). The combination with quantitative data on the dust optical depth, atmospheric temperature, etc. from the EMM instruments EXI and EMIRS (Emirates Mars Infrared Spectrometer) is possible. A particular challenge is the fact that EMM will map dust storms each few hours or, equivalently, several times per day. This implies that the database has to be updated on a sub-daily basis. Likewise, this makes the database unique from existing dust storm databases.

An integral part will be the subsequent statistical analysis of dust storm characteristics such as source region, storm track and size, timing and duration, etc.

Recommended reading

Cantor, B. A., Pickett, N. B., Malin, M. C., Lee, S. W., Wolff, M. J., and Caplinger, M. A.: Martian dust storm activity near the Mars 2020 candidate landing sites: MRO-MARCI observations from Mars years 28–34, Icarus, 321, 161-170, doi: 10.1016/j.icarus.2018.10.005, 2019.

Cantor, B. A., James, P. B., and Calvin, W. M.: MARCI and MOC Observations of the Atmosphere and Surface Cap in the North Polar Region of Mars, Icarus 208, 61-81, doi: 10.1016/j.icarus.2010.01.032, 2010.

Cantor, B. A.: MOC observations of the 2001 Mars planet-encircling dust storm, Icarus 186, 60-96, doi: 10.1016/j.icarus.2006.08.019, 2007.

Guzewich, S. D., Toigo, A. D., Kulowski, L., and Wang, H.: Mars Orbiter Camera climatology of textured dust storms, Icarus, 258, 1-13, doi: 10.1016/j.icarus.2015.06.023, 2015.

Wang, H. and Richardson, M. I.: The origin, evolution, and trajectory of large dust storms on Mars during Mars years 24–30 (1999–2011), Icarus, 251, 112-127, doi: 10.1016/j.icarus.2013.10.033, 2015.

Candidate Profile

Masters in Physics, Mathematics, or similar.