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# Warmings in the polar middle atmosphere of Mars: requirements on the validation of MAOAM general circulation model simulations

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Observations of the atmospheric temperature on Mars during the solstices reveal the reversal of the temperature gradient over the winter pole and the corresponding warming above approximately 30-40 km. This feature was explained by the increase of the solar radiation absorption by the dust, as dust storms usually occur during the Northern hemisphere winter. However, this mechanism cannot be relevant for the low dust Southern hemisphere winter, when a similar (although weaker) warming occurs.

Numerical experiments with the General Circulation Model of the Martian atmosphere (MAOAM) suggest an alternative pure dynamical explanation. The strength and the shape of the polar night jet is controlled by the eddies propagating up and pole-ward. The temperature field is related to the wind, and the warming corresponds to the weakening and pole-ward displacement of the polar vortex. The MAOAM simulations show that a cooling appears above the area of warming. Similar phenomena have been observed in the polar regions of the Earth atmosphere. For Mars there are unfortunately no observations available which could confirm or disprove the MAOAM results, since the orbiting IR sounders (TES, PSF) provide temperatures just up to 60 km and according to our knowledge there is no other Mars satellite temperature data with sufficient spatial and temporal resolution available. Ground-based mm – and submm observations may extend the altitude up to 80 km, however they do not resolve the Martian disk highly enough in order to constrain the model results. The situation may change with new submm-interferometers like ALMA and SMA.

To validate this mechanism and to study the details (what type of waves is involved, and what causes their enhancement in winter), wind (not available from any IR sounder) and temperature observations are needed. They must have a global (or at least a hemispheric) coverage with a horizontal resolution of about 100x100 $km^2$ and include heights up to at least 100 km. It would be advantageous to have these measurements taken during both low and high dust periods. According to our current knowledge the only instrument being capable to provide the required data would be a submm-wave orbiting instrument like for instance MIME or instruments investigated in follow-up studies (latest study: SWI). Retrieval simulations show that winds and temperature can be determined to above 100 km with 5 m/s respectively 2 K accuracy.

Keywords: submm wave sounder; Mars middle atmosphere; MAOAM; validation