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Assimilating martian atmospheric constituents using a global circulation model

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Introduction

The technique of data assimilation is employed in a novel way for a planetary atmosphere to perform a complete spatial and temporal assimilation of atmospheric constituent data over periods of several Mars years. Observations of martian atmospheric constituents, generally made from orbiting spacecraft, are often sparse and incomplete. A global circulation model can be used to predict the transport, phase changes, and chemical reactions that these species undergo. If constrained by observations, it can then provide a consistent interpolation to unobserved regions and, in principle, a useful a priori for future retrievals. Furthermore, any consistent mis-fit between the model predictions and new observations can be used to identify potentially important physical processes that are missing from the model, including inferring the presence and location of sources and sinks.

Data Assimilation

Data assimilation is the combination of observations and models, which provide physical constraints and propagate the observational information that is introduced. This offers some significant potential advantages for the analysis of atmospheric data from other planets [4]. Thermal and dust opacity observations have been successfully assimilated over a period of about eight Mars Years (MY), including data from the Thermal Emission Spectrometer (TES) aboard NASA Mars Global Surveyor (MGS) in MY24–27 and Mars Climate Sounder (MCS) data from NASA Mars Reconnaissance Orbiter (MRO) in MY28–31.

Previous work has focused on assimilation of temperature and total column dust opacity into a Mars global circulation model (MGC), which includes the option of a coupled photochemical model [2, 3]. We now add assimilation of water vapour, water cloud aerosol and chemical species. Results shown in this paper for water vapour are for MY24–25 and for water ice and ozone are for MY30.

Below: dust absorption optical depth at 9.3 μm, normalised to 810 Pa and averaged over longitude. This should be multiplied by about 2.6 to get a broadband visible dust total extinction. The data here are from [7]; assimilation gives similar zonally- and diurnally-averaged results.

References


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Background Image: Mars Exploration Rover Mission, Cornell, JPL, NASA.