TRACE GAS ASSIMILATION IN PREPARATION FOR FUTURE SATELLITE MISSIONS.
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Introduction: This work aims to set up a framework for assimilation of trace gas species into a Martian Global Circulation Model (MGCM). The launch of the ISRO Mars Orbiter and NASA Mars Atmosphere and Volatile EvolutioN mission will add to our knowledge of trace gases and atmospheric chemistry. In addition, the Exomars Trace Gas Orbiter (TGO) launches in 2016 and will obtain observations of trace gas species using the Nadir and Occultation for MArs Discovery (NOMAD) instrument amongst others. These missions will lead to a wealth of trace gas observations to compare to an MGCM.

To make optimal use of information, observations and an MGCM are combined by the process of data assimilation. The outcome of this process is a dynamical global reconstruction of the observations (See Figure 1). Using this methodology, observations of short-lived (and long-lived) species can be supplemented by knowledge of the transport and atmospheric chemistry from an MGCM. The satellites currently orbiting Mars (Mars Reconnaissance Orbiter, MRO, and Mars Express), combined with the future planned satellite missions, create a great opportunity for the development of a data assimilation technique for trace gases on Mars.

Ozone assimilation: Data assimilation is fast becoming a common technique for input of observations into an MGCM to study a variety of topics [1,2,3]. We are currenly using total column ozone observations combined with the LMD/UK MGCM by data assimilation to study the annual ozone cycle. Ozone data has never before been assimilated for Mars, but the use of this technique is widespread for Earth [4].

The Mars Color Imager (MARCI) [5] on MRO provides near-daily global mapping of ozone column concentration extending the currently available ozone dataset [6]. Alongside Mars Climate Sounder temperature and dust opacity observations, a fully comprehensive analysis of the ozone cycle is possible.

There are a multitude of current issues which can be investigated including the chemical stability of the atmosphere, the polar vortices and habitability. OH (part of the odd hydrogen family HO_x and produced from the photolysis of water vapour) is known to play a key role in the stability of the atmosphere and is also a major catalytic destructor of ozone. This chemical species was recently observed by [7] and for further studies a possible option is to use ozone as a tracer for OH.

Ozone has also been found to be quasi-passive in the polar night [8] due primarily to the lack of daylight hours and a negligible amount of HO_x radicals present at this time of the year. The dynamics associated with the northern polar vortex can therefore be traced using the ozone abundance. The UV flux reaching the ground, an important parameter for the habitability of Mars, is controlled by the atmospheric ozone. A more realistic ozone cycle reduces the uncertainties of the amount of UV radiation reaching the surface of Mars. Further analysis of the ozone cycle can also provide a broader understanding of the Martian atmospheric chemistry.

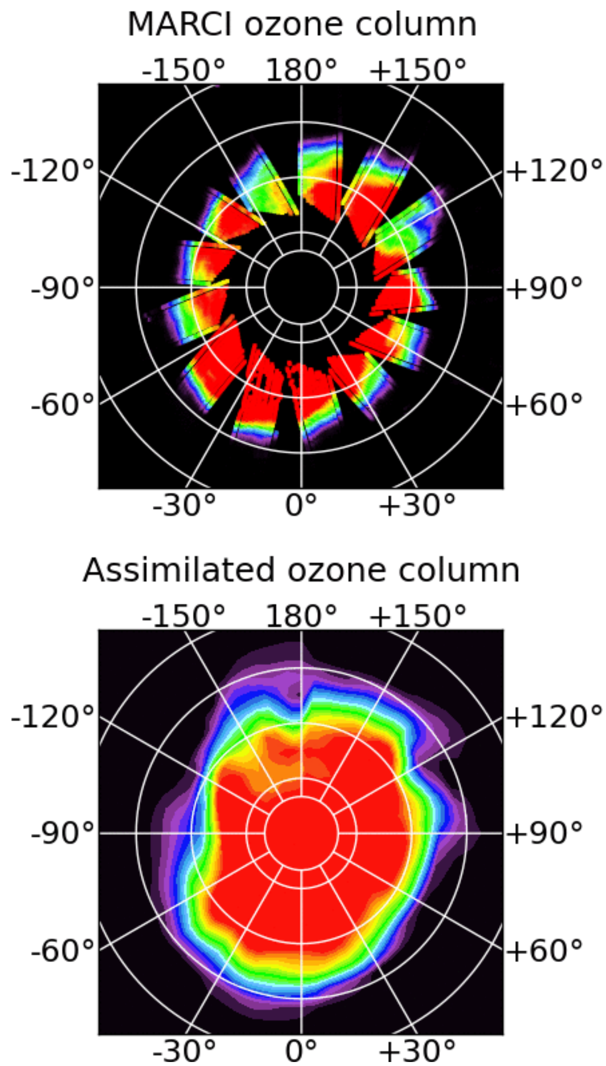

Figure 1. Northern polar stereographic comparison of MARCI observations (top) and assimilated output from the LMD/UK MGCM (bottom) at L_S = 343° MY30.

Trace gas assimilation: Assimilating trace gas observations allows for investigations into interactions between chemical species and subsequently improving our understanding of the Martian chemical environment. Chemical rate coefficients imposed by reconciling observational datasets and theoretical models would add to our current estimates which come primarily from laboratory experiments only. Sources and sinks of species can potentially be inferred by this method. The NOMAD instrument on the TGO is set to measure water vapour and ozone abundance using the same instrument which would allow for a direct look at their apparent anti-correlation and deviations from this.

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