Geophysical Research Abstracts
Vol. 16, EGU2014-6332, 2014
EGU General Assembly 2014

Chemical pathway analysis of the Martian atmosphere: The formation and destruction of ozone

Joachim Stock (1), Christopher Boxe (2), Ralph Lehmann (3), Lee Grenfell (4), Beate Patzer (5), Heike Rauer (4,5), and Yuk Yung (6)

(1) IAA-CSIC, Solar System, Granada, Spain (jstock@iaa.csic.es), (2) Department of Physical, Environmental and Computer Science, MEC-CUNY, New York, New York, United States, (3) AWI, Potsdam, Germany, (4) DLR, Institut für Planetenforschung, Berlin, Germany, (5) ZAA, TU Berlin, Berlin, Germany, (6) Division of Geological and Planetary Sciences, Caltech, Pasadena, California, United States

Ozone is a species of major importance in the Martian atmosphere e.g. since it is involved in the stabilization of Mars' major atmospheric constituent carbon dioxide. Below approximately 40 km altitude, ozone acts as an atomic oxygen source which is produced by photolysis and oxidizes carbon monoxide via catalytic cycles involving odd hydrogen (HO_x=H+OH+HO_2). Originating mainly from H_2O photolysis, odd hydrogen destroys ozone resulting in the observed anti-correlation between water vapor and ozone. Compared with species from the HO_x-family, ozone is relatively easy to detect by e.g. UV spectroscopy or IR heterodyne spectroscopy. Similar to carbon dioxide, the concentration of ozone can be critically influenced by chemical trace species acting as catalysts in chemical pathways. The identification of such chemical pathways in complex reaction networks and the quantification of their contribution are in general challenging. Therefore, we use an automated computer algorithm (PAP - Pathway Analysis Program), which is specifically designed to address such problems.

In this work, we apply the PAP-algorithm to the results of the newly updated JPL/Caltech photochemical column model of the Martian atmosphere in order to investigate Mars' atmospheric ozone photochemistry. The efficiencies of individual ozone formation and destruction pathways are calculated for different atmospheric heights, by applying the algorithm to each vertical layer of the column model in turn.

The results of our investigations suggest that ozone is primarily produced by a Chapman-like mechanism, whereby atomic oxygen is produced by carbon dioxide photolysis instead of molecular oxygen photolysis. In the ozone layer at approximately 40 km altitude, ozone formation is chiefly dominated by a chemical pathway where atomic oxygen is supplied by vertical transport. Ozone consumption pathways involving ozone photolysis are most efficient except for a layer around 40 km altitude where the reaction between ozone and atomic hydrogen become more important. These findings are of particular importance to understand the dominating processes in Martian chemistry also in view of more complex modelling approaches.