4D HCL TRANSPORT IN THE MARTIAN ATMOSPHERE WITH COMPARISONS TO TGO OBSERVATIONS.

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The recent discovery of hydrogen chloride (HCl) in the martian atmosphere [1, 2] has renewed interest in the martian chlorine cycle and its potential impact on martian atmospheric chemistry. Here we present the results of a numerical modelling study of the transport and chemical interactions of chlorine species in the martian atmosphere, in order to better constrain the rates of creation and destruction of HCl.

Korablev et al. [1] used the Atmospheric Chemistry Suite (ACS) aboard the ExoMars Trace Gas Orbiter (TGO) and detected HCl in the 1–4 ppbv range in both hemispheres before and during the Mars Year (MY) 34 global dust storm. Subsequent measurements in MY 35 [2] have confirmed the seasonal nature of observed HCl, with almost all detections occurring during the dusty second half of the martian year (L_S=180 − 360°). HCl abundances were found to decrease rapidly at the end of the dusty season. The seasonal nature of the observed HCl, with near-simultaneous onset in both hemispheres, and the non-detection of any sulfur species in the martian atmosphere [3] suggest that transient volcanic activity is unlikely to be the source of the observed HCl.

In addition to the correlation with dust, a correlation between HCl and water vapour has also been observed [4]. Olsen et al. [2] found that HCl spectral lines were never found without the presence of water vapour lines, and reported a Pearson correlation coefficient of 0.73 between vertical profiles of HCl and water vapour over MYs 34 and 35. These correlations have raised the possibility of a direct coupling between surface minerals and atmospheric gases, with heterogeneous processes likely playing a key role [1, 2, 5].

Studies of martian chlorine chemistry thus far have focused on studying chemical reactions using simplified 1-dimensional column models of the martian atmosphere. Whilst these models have advantages, they cannot evaluate the crucial impact of atmospheric dynamics on the chlorine cycle. In this work we present results of an investigation of the chlorine cycle on Mars using a full Global Climate Model (GCM). The GCM used for this study is the Open University Mars GCM, which shares physics packages with the Laboratoire de Météorologie Dynamique (LMD) Mars GCM [6] but utilises a spectral dynamical core [7] and a semi-Lagrangian scheme to advect aerosols and chemical species [8]. The model uses a modified version of the LMD photochemistry scheme [9] that has been augmented with a chlorine sub-model

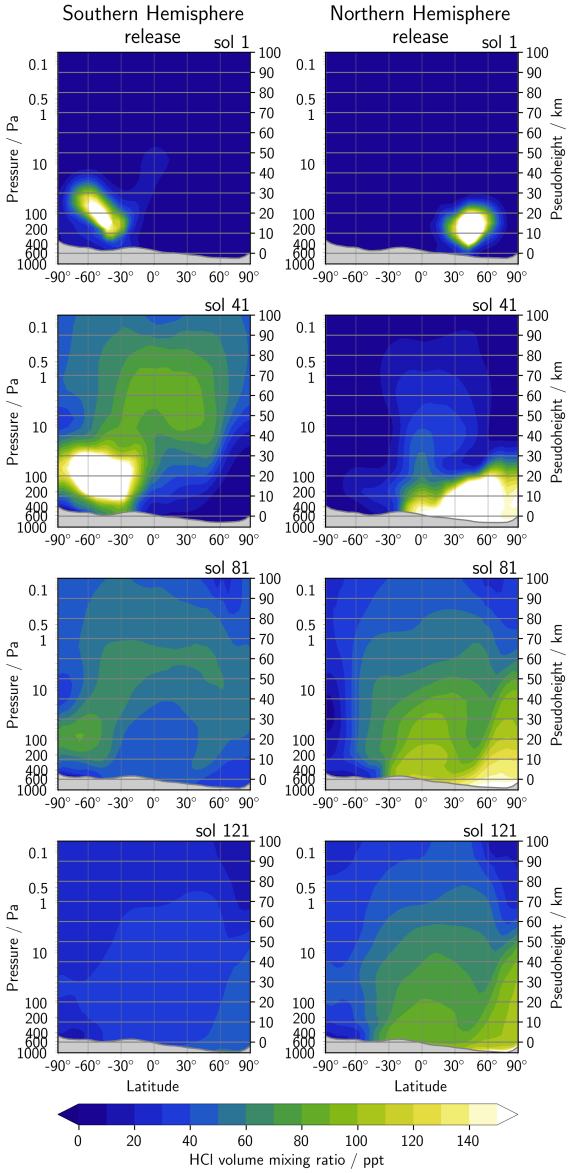

Figure 1: The evolution of HCl released from 15 km above the surface at 45°S (left column) and 45°N (right column) respectively. HCl is first introduced at L_S=180° and is continuously injected for 60 sols. Panels show the zonal mean HCl volume mixing ratio at multiples of 40 sols (+1) after initial release.

with 11 new gas species, 47 gas-phase reactions and 5 photolysis reactions in order to simulate the major chemical pathways of atmospheric chlorine [10, 11]. By varying the locations, times and rates at which HCl is introduced and removed from the model (e.g. Figure 1), we quantify the impact of both chemical and transport processes on the subsequent horizontal and vertical distribution of HCl. These results are then compared to the reported observations of chlorine, allowing us to derive constraints on the creation and destruction rates of HCl.

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