Ground-based infrared mapping of H$_2$O$_2$ on Mars near opposition

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We have carried out ground-based seasonal monitoring of hydrogen peroxide on Mars since 2003. This presentation is on the latest set of observations using thermal imaging spectroscopy, with two observations of the planet near opposition, in May 2016 (Ls = 148.5°, diameter = 17”) and July 2018 (Ls = 209°, diameter = 23”). Data have been recorded in the 1232 - 1242 cm$^{-1}$ range (8.1 micron) with the Texas Echelon Cross Echelle Spectrograph (TEXES) mounted at the 3-m Infrared Telescope Facility (IRTF) at Maunakea Observatory in Hawaii. As in the case of our previous analyses, maps of H$_2$O$_2$ have been obtained using line depth ratios of weak transitions of H$_2$O$_2$ divided by a weak CO$_2$ line. The H$_2$O$_2$ map of April 2016 shows a strong dichotomy between the Northern and Southern hemispheres, as predicted by the photochemical model developed in the Mars Climate Database (Forget et al. 1999) and in the Global Environmental Multiscale model (Daerden et al. 2019). The second measurement in July 2018 was taken in the middle of the MY 34 global dust storm. H$_2$O$_2$ was not detected, with a disk-integrated 2-sigma upper limit of 10 ppbv, while both the MCD and the LEM models predicted a value above 20 ppbv that was actually observed by TEXES in 2003 in the absence of dust storm (Encrenaz et al., 2004). This July 2018 depletion is probably the result of the high dust content in the atmosphere at the time of our observations, which led to a decrease of the water vapor column density in the relevant altitude range, as observed by PFS on Mars Express during this period (Giuranna and Wolkenberg, 2019). GCM simulations using the GEM model show that the H$_2$O depletion leads to a drop of H$_2$O$_2$ due to the depletion of HO$_2$ radicals whose self-recombination gives rise to H$_2$O$_2$. Our data provide new constraints to the photochemical modelling of H$_2$O$_2$ in the presence of a high dust content. In parallel, we have reprocessed the whole TEXES dataset of H$_2$O$_2$ measurements using the latest version of the GEISA database (2015). We have recently found that there is a significant difference in the H$_2$O$_2$ line strengths between the 2003 and 2015 versions of GEISA. Therefore, all H$_2$O$_2$ mixing ratios up to 2014 from TEXES measurements have been reduced by a factor of about 1.75. As a consequence, in four cases (Ls around 80°, 100°, 150° and 209°), H$_2$O$_2$ abundances show contradictory values between different Martian years, while, at Ls = 209°, the cause seems to be the increased dust content associated with the global dust storm. The inter-annual variability in the three other cases remains unexplained at this time.