Geophysical Research Abstracts
Vol. 16, EGU2014-2178, 2014
EGU General Assembly 2014

The time-variable spatial distribution of the O_2 environment around Europa

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Europa's exosphere is a mixture of different species among which sputtered H_2O and H_2 dominate in the highest altitudes and O_2, formed mainly by radiolysis of ice and subsequent release of the produced molecules, prevails at lower altitudes. Europa's O_2 exosphere has been demonstrated through both observation and simulation-based techniques to be spatially non-uniform.

In the present study we investigate Europa's exospheric O_2 characteristics under the external conditions that are likely in the Jupiter's magnetospheric environment, applying the Europa Global model of Exospheric Outgoing Neutrals (EGEON, Plainaki et al., 2012) for different configurations between the positions of Europa, Jupiter and the Sun. After performing a study of the structure of Europa's exosphere as function of the moon's position in orbit around Jupiter, we demonstrate for the first time that Europa's exosphere is explicitly time-variable due to the time-varying relative orientations of solar illumination and the incident plasma direction. Our main results are summarized as follows: the density of the released O_2 becomes maximum when trailing hemisphere coincides with sunlit hemisphere and is equal to 3.2•10^{14} m^{-3} above the subsolar point, whereas in all other configurations the density above the subsolar point is smaller by a factor up to $\sim$5; the EGEON results on the O_2 column densities are consistent with the surplus of OI emission at the 90^0 west longitude (leading hemisphere) observed by HST and, therefore, solar illumination prevails over the more intense bombardment of the trailing hemisphere by energetic ions in determining the efficiency of the O_2 release; although the O_2 column density calculated with EGEON is consistent with the observations of the OI emission from the trailing hemisphere of Europa, the longitudinal asymmetry (at 230^0-250^0 west longitude) is not reproduced by the model and hence further modeling including simulations of the Jupiter's plasma conditions at those locations and or other possible sources (e.g. plumes), is intended; the escape rate from the moon of O-atoms produced by the dissociation of exospheric O_2molecules becomes maximum when trailing hemisphere coincides with sunlit hemisphere. In this case, the rate of supply of O-atoms to the torus is estimated to be 6.5•10^{25}/s.

Plainaki, C., Milillo, A., Mura, A., Orsini, S., Massetti, S., Cassidy, T., (2012). The role of sputtering and radiolysis in the generation of Europa exosphere, Icarus, Volume 218, Issue 2, p.956–966, doi: 10.1016/j.icarus.2012.01.023