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Two years with comet 67P/C-G: H_2O, CO_2, CO as seen by ROSINA/RTOF and comet nucleus modeling

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Comet 67P/Churyumov-Gerasimenko (hereafter 67P) has been investigated by the Rosetta space mission over two years from August 2014 to September 2016. Onboard the spacecraft, the ROSINA experiment included two mass spectrometers to measure the composition of neutrals and ions, and the Comet Pressure Sensor (COPS) to monitor the density and velocity of neutrals in the coma. Here we will here analyse and discuss the data from the Reflectron-type Time-Of-Flight (RTOF) instrument during the comet escort phase. The RTOF mass spectrometer possesses a wide mass range and a high temporal resolution (Scherer et al., 2006; Balsiger et al., 2007).
The analysis of 67P's major molecules in the coma over the mission showed strong variability of the environment in terms of the main volatiles concentrations (H_2O, CO_2, CO) and their ratios. The 2 years long Rosetta mission allowed us to observe the seasonal evolution in the atmosphere of 67P, in particular the change occurring during the equinoxes and at perihelion. In this work, we analyze the asymmetry in the outgassing rate with respect to perihelion (13/08/2015), the evolution of the major volatiles' relative abundances through the whole mission, and in particular the behaviour of the very volatile CO molecules. Density maps projected on the surface of 67P demonstrate the evolution of the three main volatiles after the 2nd equinox.
We also present results of comet nucleus thermal modelling used to simulate the internal structure and temperature evolution of 67P at characteristic surface areas. The comparison with the coma composition measurements by ROSINA and VIRTIS helps to characterize the distribution of volatiles at the surface and set constraints to the sub-surface distribution of these species.