GAS AND DUST REDEPOSITION ON THE SURFACE OF COMET 67P/CHURYUMOV-GERASIMENKO. M. Rubin[1], N. Fougere[2], K. Altwegg[1,3], M. R. Combi[2], L. Le Roy[3], V. M. Tenishev[2] and N. Thomas[1,3], [1]Physikalisches Institut, University of Bern, Sidlerstrasse 5, 3012 Bern, Switzerland (martin.rubin@space.unibe.ch), [2]Atmospheric, Oceanic and Space Sciences, University of Michigan, 2455 Hayward Street, Ann Arbor, MI 48109, USA, [3]Center for Space and Habitability, University of Bern, Sidlerstrasse 5, 3012 Bern, Switzerland

Introduction: The coma of a comet is composed of a thin expanding atmosphere made up of dust and gas. Even though the gravity is small dust grains can get transported around the nucleus and are then redeposited in different locations. This effect is believed to be responsible for the rather smooth waist composed of mostly water grains observed at comet Hartley 2 [1]. Also gas can be scattered around the comet if collisions in the near nucleus coma are abundant. In case the surface is cold enough it is even possible that a small layer of trapped volatiles can accumulate, e.g. in regions of permanent shadow during the inbound part of the orbit. Here we investigate the redeposition rate of gas and dust on comet 67P/Churyumov-Gerasimenko based on Monte Carlo modeling and discuss how such trapped and redeposited material could enhance the activity of the comet once it passes its perihelion when previously shadowed regions come into sunlight. Several comets have been observed to exhibit seasonal behavior and in case of comet 67P/Churyumov-Gerasimenko the neutral gas production rate remains elevated on the outbound compared to the inbound portion of the orbit [4]. While there are several explanations for this behavior, such as the comet's geometry, the distribution of active areas, and the thermal lag generated by the heat wave penetrating into the comet, here we investigate the contribution by transport of volatile material around the comet and subsequent thermal trapping in cold areas.

Model: Our investigation is based on the works by [2] and [3]. Neutral gas originates from active patches on the surface. Depending on the local neutral gas density and velocity grains are lifted from the surface. In case the gas production is not symmetric there is a lateral component in the drag force the neutral gas exerts on the dust which leads to tangential transport of material around the comet. Our first test case is based on [2] assuming a non-rotating comet. Such a setup would put half the comet's surface in permanent shadow which then acts as a cold trap for returning gas and grains containing volatile species. The second case is similar but based on the work by [3]. Here the much active but smaller spot is located adjacent to the collecting area and thus this case represents an upper limit on the redeposition of cometary material.

Results: Over the last few hundred days as the comet approaches perihelion a small layer of up to a few millimeters of volatiles and dust grains can accumulate. Based on the specific geometry and orientation of the spin axis this area comes into sunlight only after perihelion passage. Our estimation shows that this effect could make up the first few days of the seasonal asymmetry observed at several comets ([4]).

Acknowledgements: This work has been supported by the Swiss National Science Foundation and NASA Planetary Atmospheres program grant NNX09AB59G.

References:

[1] A'Hearn, M. F. et al., (2011) Science, 1396-1400. [2] Tenishev, V. M. et al., (2008) ApJ, 104-+. [3] Combi, M. R., et al. (2012), ApJ, 29-+. [4] de Alameida, A. A. et al. (2009), Adv. Sp. Sci., 1993-2000.