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Compositional Profiles of the Enceladus Dust Plume from CDA measurements at flybys E5 and E17

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Abstract

The plume of gas and dust particles emerging from the region around the south pole of Enceladus is one of the most spectacular discoveries of the Cassini mission [1, 4, 7]. Compositional analysis of the dust particles from Enceladus provided evidence for liquid water [5], ongoing hydro-thermal processes inside the icy moon [Hsu et al 2015] and macromolecular organics [6]. The Enceladus plume has a complex structure which is noticeable in images and in-situ observations. Along the South Polar Terrain there is also a strong correlation between intensity of gas and dust flux with the intensity of the heat emitted from the surface [3, 8]. Furthermore, spacial variations have been inferred also in the dust to gas ratio and the composition of the plume from remote sensing Cassini instruments [2].

Based on the modelling approach from Schmidt et al, 2008, and Postberg et al, 2011, we develop in this work an improved model for the dust plume. The new model allows us to study compositional variations in the dust emission across the south polar terrain. Specifically, the model allows for a non-uniform emission of particles from the tiger stripes on the south polar terrain and it uses a new parameterization of the grain size distribution of grains of different composition. We constrain the model with the profiles of dust composition obtained by the Cosmic Dust Analyzer (CDA) [9] during the 5th and the 17th flybys of Cassini at Enceladus, E5 and E17, but also with CDA data obtained in the E ring. Differences in the compositional profiles of the E5 and E17 flybys can be partly attributed to the differences in the flyby velocity, which affects the sensitivity range of the CDA in terms of particle size. But the trajectories of E5 and E17 also sampled different parts of the plume, for which we see differences in grain composition. Overall, we find that the tiger stripe Alexandria emits a higher fraction of salt rich grains (CDA compositional type III, Postberg et al 2009) while grains with traces of organics (type II) are more abundantly ejected from Baghdad and Damascus, which are also the warmest parts of the south polar terrain [3] where the plume is densest.

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