ENVIRONMENTAL EFFECTS ON DUST AROUND EUROPA. K. Miljković[1,2], N. J. Mason[1] and J. C. Zarnecki[1], [1]Centre for Earth, Planetary, Space and Astronomical Research, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK, [2]Department of Earth Sciences, University College London, Gower Street, London, WC1E 6BT, UK. (k.miljkovic@open.ac.uk).

Introduction: A dust model has been developed in order to explore the dust environment around Europa. The dust is composed of five different dust populations: (i) asteroidal and (ii) halo dust populations as part of the interplanetary dust particle (IDP) population [1]; (iii) interstellar dust (ISD) [2]; (iv) the Io stream and [3] (v) ring dust that originate from inside Jupiter's system itself [4-5]. Critically for this study, we have also modelled the dust ejected from the surface of Europa by micrometeoroids impact. Should the ejected dust be a significant proportion of the total dust environment around Europa, a dust analyzer in orbit around Europa could collect some of this dust and hence provide data on the surface composition of Europa.

Method: The impacting dust flux (influx) causes the ejection of a certain amount of surface material (outflux) and the relation between the influx and outflux is determined through the mass yield [6]. In impact experiments and impact modelling in Autodyn hydrocode, the size and velocity distributions of ejected fragments were determined [7]. Assuming that these distributions are independent of the impactor size and velocity, they can be used to model Europa ejecta, allowing the outflux dust to be analysed in detail. The outflux populates the space around Europa, where a small part of the ejecta escapes and the rest eventually falls back to the surface. The model predicts the dust densities of the ejecta outflux at any altitude within Europa's Hill sphere and the dust densities at any altitude can be presented as a size distribution of dust. The results of the present model match the Galileo data (Fig.1-2) collected during several Europa flybys [8].

Environmental effects. Physical properties at Europa: The uncertainties of the following dust model input parameters were considered: the density of the impacting micrometeoroids [9], the micrometeoroid impact velocity, the hydrated salt content in the surface ice [10], the largest ejecta fragment, the slope of the cumulative size distribution of the ejected fragments, the slope of the ejecta fragment size-velocity distribution, the strength of Europa's surface material and the maximum ejecta velocity. Variations in each parameter were tested in the dust model and their influence on the spatial density of the ejected dust determined. In selecting the input parameters, the surface strength introduces the largest uncertainties [11-13] (Fig.3). Harder surfaces provide ejecta with faster speeds and vice versa [14]. This directly affects the spatial density of dust around Europa as well as the fractionation between bound and escaping dust. The other input parameters affect the spatial dust density for up to an order of magnitude.

Environmental effects. Non-gravitational forces present inside the Europa's Hill sphere are: atmospheric drag [15-17] and ablation [18-20], ion induced sputtering [21-23], grain charging [24-26] and potential (cryo)geyser-like activity. It was found that none of these processes can effect the motion, population and destruction of dust ejecta fragments because the ejected fragments only spend a little time in flight, regardless of whether they are bound (and fall back to the surface) or escape (and leave Europa's Hill sphere upon ejection) by overcoming the gravitational force. The largest effect has the Lorentz force on the smallest ejecta fragments, providing the grains become sufficiently charged and ejected at high speeds.

Conclusions: Europa, as a representative of an atmosphereless body with a low gravity, suffers a constant micrometeoroid bombardment and ejection of the surface material into the surrounding space. The fastest ejected fragments (up to a few % of the total ejected mass) should be capable of leaving the satellite's surface (and contribute to the Jovian dust ring population), while the rest (~97 %) falls back to the surface after reaching no higher than a few thousand km above the surface. The time the micron size ejecta fragments spend in flight is not sufficient for the environment to substantially alter the dust fragments. This can be used to support the installation of a dust detector on board of the proposed EJSM mission in orbit around Europa [27]. It is likely that dust, collected at predicted 100 – 200 km altitudes [28], could contain compositional information about the surface. It is also calculated that over the three-month orbital campaign period [28] the dust detector (with 5 cm^2 sensor area) should be exposed to about 10^4 dust fragments ejected from the surface of Europa [7].

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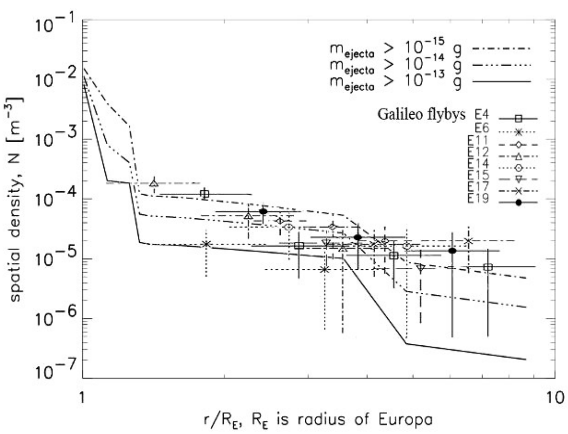

Fig. 1. Radial spatial density of ejecta from Europa, for different mass thresholds compared with Galileo data.

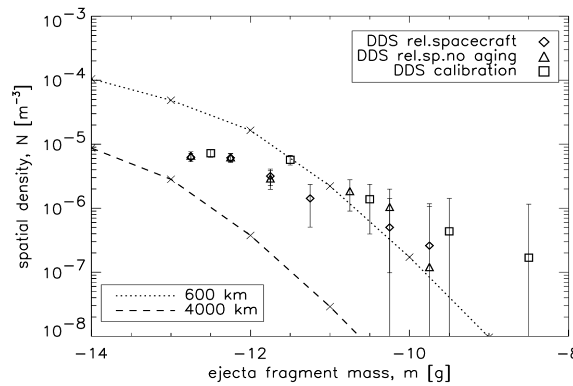

Fig 2. Cumulative spatial density of dust at Europa, for dust masses larger than m.

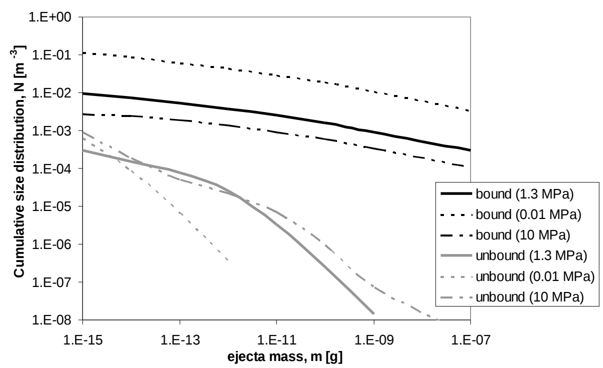

Fig. 3. The change in bound and unbound fragments around Europa due to change in surface tensile strength.