The Galilean moons reveal large albedo variations on their surfaces, in particular between their leading and trailing hemispheres. The differences observed are likely the result of a balance between various weathering processes of the surface, determined by the moons' local environment. Chemical and physical alterations occur at the surface, triggered by multiple exogenic energy deposit processes (radiolysis, plasma sputtering, micro-meteoroids impacts, ...). The observed variations are probably due to anisotropy in the energy fluxes received on each hemisphere and to a different relative contribution of the weathering agents (plasma, dust...) as a function of the distance to Jupiter. We will be testing this hypothesis by estimating quantitatively the kinetic energy flux impacting different part of the surfaces of the Galilean moons using the latest environment models available at the European Space Agency. This work is essential in the context of the future observations performed by the Juice mission, as a proper understanding of the moons' surface history can be achieved only if one is able to constrain the balance between exogenic and endogenic alteration processes. Impacts of dust particles coming from the Galilean moons and evolving dynamically in the Jovian system will be simulated using the Jovian Micrometeoroid Environment Model (JMEM). Primary interplanetary dust impacts are simulated using the prediction of the Interplanetary Micrometeoroid Environment Model (IMEM) computed at Jupiter’s Hill radius, taking into account gravitational focusing by the planet while electrons, protons and ions fluxes hitting the moons’ surfaces can be estimated using the Jovian Specification Environment model (JOSE). Finally, an ESA-led research proposal has been selected this year to perform laboratory studies of the space weathering effects on icy moons’ surfaces: the experiment will consist of bombardment of icy targets (which characteristics are as representative as possible of what we currently know of the various icy moons’ surfaces) by micrometeorites and electrons/ions in order to try and better understand how the satellite material in the Jovian environment react to micrometeorites bombardment and charged particles irradiation.

### References

[1] Liu et al., Dynamics and distribution of jovian dust ejected from the Galilean satellites, JGR, 2016
[4] Spahn et al, JOVIAN METEOROID ENVIRONMENT MODEL (JMEM)

#### Computing the kinetic energy flux of primary Interplanetary Dust (IDP) impactors at the surface of the icy moons

Using the IMEM model, we computed the flux of interplanetary impactors for all mass ranges above 1e-12 kg, expected at the Hill’s radius of Jupiter. The Hill’s radius defines the region of influence of Jupiter’s gravity field – inside the Hill’s radius, we applied a formulation of gravitational focusing as described in [4] in order to estimate the increase in volume number density and speed (resulting in an increase of the flux) of the interplanetary grains as a function of the radial distance to Jupiter (top left panel). The injection velocity (top right panel) of the grains refer to the velocity that the grains possess when they reach the Hill’s sphere, before the gravitational focusing. On the bottom left plot, we convert the mass distribution, grain speed and the particle flux to infer the kinetic energy flux entering the Jovian system from the interplanetary space. This kinetic energy flux is distributed isotropically on the moons surface, once corrected for the gravitational focusing, and is the primary energy source for producing secondary ejecta.

#### Computing relative jovian dust impactor (from ejecta) flux anisotropy on the moons surface

The Galileo NIMS data have been re-analysed using the data as provided in the Planetary Data System (PDS) archive. The plot above shows the normalized flux of dust on the surface of Ganymede superposed to the Galileo NIMS spectral map at 1.65 μm indicative of crystalline water. How dust impacts alter the phase (crystalline or amorphous) of the surface ice is poorly understood and new laboratory work is needed (see below)

#### Study icy moons’ exosphere formation by sputtering (next steps)

**Study the contribution from jovian dust (ejectas) to the exosphere formation:**

→ For different longitude-latitude elements on the surface of the icy moons and for different impactors mass ranges, we can estimate the mean velocity of the dust hitting the different parts of the moons surface (using JMEM).

→ For each mass and velocity range, we can adapt the formula used in [5] (numerical modeling of impact processes) to the Jupiter icy moons to get an estimate of the total mass of an impact induced vapor cloud for a single impact as a function of its mass and velocity.

→ The estimated flux of (jovian dust) impactors will be estimated by JMEM to get the total vapor production rate at the moons’ surface.

→ We can then analyze the anisotropy on the moons’ surface and identify the main contributors (in terms of mass range) to the vapor cloud formation.

**Study the contribution from the interplanetary dust population to the exosphere formation:**

→ Same analysis using IMEM (with estimated flux of interplanetary dust population also taking into account the gravitational focusing) to compare the contributions of both populations to vapor cloud formation.

**Study the effect of plasma sputtering (and the surface anisotropy) at the surface using JOSE.**

### Space Weathering of the Jovian Icy Moons

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