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Measurements of dielectric properties of ices in support to future radar measurements of Jovian Icy moons

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The JUpiter ICy moons Explorer (JUICE) (ESA) and Europa Clipper (NASA) missions will be launched in the next decade in order to spend a number of years making detailed observations of the giant gaseous planet Jupiter and three of its largest moons, Ganymede, Callisto, and Europa.

The focus of both missions is to scrutinize the nature of these icy moons and characterize the conditions that may have led to the emergence of habitable environment for life. A particular aspect of both JUICE and Europa Clipper missions is the exploration of the icy crusts, which comprises a new and very focused objective for outer solar system missions. A good example however of such investigations has been presented by Cassini's RADAR instrument. One of JUICE's tasks is to characterize the structure and properties of the ice shell by probing the subsurface of Ganymede down to a depth of a few kilometers. An additional task of JUICE's ice penetrating RIME and Clipper's radar REASON is to obtain profiles of subsurface thermal, compositional, and structural horizons down to a maximum depth of 1 to 9 km depending on the crust's properties. However, the interpretation of radar sounding experiments relies on the ability to decipher the backscattering patterns.

The icy moons of Jupiter have been reported to be efficient backscatters of cm-wavelength radiations, showing polarization effects that must be due to factors other than the only single scattering process at the space-body surface interface. The identification of the characteristics of the backscattering radiation results from the superposition of backscattering layers with different electrical properties as a function of depth. Amongst the properties likely to modify the backscattering efficiency are: the amount of silicate (partial absorbers), the ice salinity, and the distribution of cracks present in the layer (inhomogeneity of the medium at size scales comparable to the radar wavelengths). Consequently, direct measurements of the dielectric values (electrical conductivity and permittivity) of an icy layer with properties controlled in the lab could unveil the backscattering efficiency of the sample.

We provide here the first version of a database of measurements, following a number of laboratory experiments made at CAB-CSIC-INTA, in collaboration with UCM and CSIC-ITEFI (Please see abstracts EPSC Muñoz-Iglesias et al. and EPSC Gonzalez-Díaz et al.), collected and classified based on the parameters and properties of the different ice samples, which are manufactured to resemble the Jovian moon ice compositions. During the experiments, different conditions of T and P were applied and the recorded measurements of electrical properties were collected in this database of 'ice behavior'.

Since the next remote sensing data are not expected anytime before the arrival of JUICE and Europa Clipper (around 2030), the database provides us with the opportunity to compare with the current literature and the data available for the Jovian icy moons from previous missions, but also add information that is currently missing and relate that information to relative surface processes. The ice database would facilitate the interpretation of future radar sounding measurements, providing a better constrain on the true nature of ices of the surfaces of JUICE's and Europa Clipper's future targets.