Flows of ice powders at very low temperature

Riccardo Artoni
Université Gustave Eiffel (France)

Several planetary surfaces in the solar system are covered by granular ices resulting from various processes. Anticipating the properties of the icy surfaces is important for both better understanding the evolution of surface morphologies and minimizing the technical issues that future missions may face when landing, sampling, or drilling.

In the past few years, we investigated the cohesive behavior of ice powders (relevant for bodies like Enceladus or Europa) as a function of temperature. Experiments were performed on ice powders differing by particle size and composition, on a wide range of temperatures (~80-250K) in a liquid-nitrogen cooled rotating drum where the flow was characterized through bed slope statistics. We observed a strong increase of the cohesion of pure ice with temperature, which was not present for other reference powders The presence of salts may reduce the effect of temperature. This intriguing phenomenon seems to be related to the balance between elastic and plastic effects at contacts.

In order to better understand the experimental result, we also performed discrete numerical simulations of rotating drum flows of cohesive grains. Different flow regimes were observed, and both the regime transitions and the angle statistics were shown to depend on particle size, cohesion and stiffness. A dimensional analysis based on the adhesive collision dynamics allows to explain the regime transitions.