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Advances in Modeling Impacts onto H_2O Ice[1]

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H_2O ice is a primary constituent of solid bodies in the outer solar system. Hence, understanding the response of H_2O ice to shock is particularly important in predicting and interpreting the outcome of natural collision events. The complex phase diagram and rheological properties of H_2O pose significant challenges to modeling shock processes in ice. We have developed a new multi-phase equation of state (EOS) and constitutive model for H_2O that are appropriate for the wide range of environmental conditions and impact parameters encountered in the solar system. The new tabular EOS includes 5 phases (vapor, liquid, ices Ih, VI, and VII) and allows for accurate predictions of peak and post-shock temperatures and the occurrence of phase changes. Unexpected phenomena are observed in simulations using the new EOS. For example, shock-induced formation and hysteretic unloading of dense, high-pressure phases leads to significant changes in the excavation flow field around impact craters compared to more homogeneous materials. The modified flow field results in observable differences in crater morphologies on ice-rich planetary surfaces compared to rock surfaces. With these improvements, we are able to model collisions onto H_2O ice with much better accuracy.

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