MODELING AMORPHIZATION OF CRYSTALLINE WATER ICE ON THE SURFACES OF GANYMEDE, CALLISTO, AND EUROPA. R. M. E. Mastrapa[1] and R. H. Brown[1], [1](University of Arizona Department of Planetary Sciences, 1629 E. University Blvd., Tucson, AZ 85721-0092 contact e-mail: mastrapa@lpl.arizona.edu).

Introduction: The Galileo spacecraft has returned interesting spectra revealing the composition of the Galilean satellites. There has been much debate about the exact composition of salts that are on the surface, but there is no argument that water ice is there [1]. The phase state of this ice may tell us a great deal about the dominant processes on the surface of these moons.

The Galilean Satellites: A distribution of crystalline and amorphous water ice has been detected on Europa, Ganymede, and Callisto [2], (Hansen, et al., this conference). The distribution appears to match the radiation and temperature environment. Europa has more amorphous water ice because it is cold and exposed to a higher fluence of radiation, while on Calllisto the opposite case is true.

Water Ice: The IR spectra of both crystalline and amorphous ice have been measured at a wide range of temperature conditions and the differences in stucture have been well documented [3], [4], [5]. In 1990, Kouchi and Kuroda showed that crystalline water ice exposed to uv radiation was indistinguishable from amorphous ice using electron diffraction [6]. It was later found that ion radiation also produced amorphous ice [7]. This study considered the 3.07 micron band (O-H stretch) of water ice and discovered that in ion radiated crystalline ice this band is indistinguishable from that of amorphous ice. However, there are no ion radiation studies that examine the change in the 1.65 micron band which is present in crystalline ice, but not in amorphous.

This work: MARLOWE is a collision cascade model designed by the Department of Energy to simulate the disruption of crystalline solids by ion radiation. We have used it in previous studies to simulate the amorphization of crystalline ice in the Kuiper Belt [8],[9].

Radiation Environment. The radiation environment used in this work has been taken from Galileo measurements [10]. This model energy spectra includes electrons, and H^{+}, O^{n+}, and S^{n+} ions.

Preliminary Results. Since MARLOWE only models collisions of ions, we did not include the electron energy input in our work. Also, we do not yet have a good model of inelastic energy loss behavior for S^{n+} ions. Therefore, we only use the model spectrum of H^{+} and O^{n+} ions. We used a global average spectrum for Ganymede.

Figure 1, is a plot of the ratio of amorphous water ice produced with column depth predicted by our model. The timescales of radiation are 100 s, 1,000 s, and 10,000 s for Europa, Ganymede, and Callisto, respectively. If this process would continue unconstrained, then crystalline ice would be converted to amorphous ice on very short timescale.

Re-crystallization. The amorphization process will have to compete with the process of re-crystallization. At the temperatures of the surfaces of the Galilean satellites amorphous ice can convert to crystalline ice on relatively short timescales. Thus, we plan to modify MARLOWE to include a re-crystallization process, to determine which might be the dominant process on the icy Galilean satellites.

Ion radiation may also cause the conversion of amorphous ice back to crystalline by depositing heat along the ion track. This would increase the reaction rate of the phase change and possibly produce crystalline ice along the tracks. We will be investigating the impact of this process. Another process that may be important is micrometeorite impacts. The relevance of this process is difficult to quantify since the equation of state of amorphous ice is unknown, and thus its behavior during impact is hard to predict. However, with an equation of state and reasonable knowledge of the meteorite flux, we may eventually be able to estimate the amount of energy this process contributes.

References:

[1] McCord, T.B., *et al.*, Journal of Geophysical Research, 1999. **104**(E11): p. 27157-27162. [2] Hansen, G.B. and T.B. McCord, DPS #32 #39.03, 2000. [3] Grundy, W.M. and B. Schmitt, Journal of Geophysical Research, 1998. **103**(E11): p. 25,809-25,822. [4] Hapke, B., *et al.*,. Icarus, 1981. **47**: p. 361-367. [5] Hagen, W., A.G.G.M. Tielens, and J.M. Greenberg,. Chemical Physics, 1981. **56**: p. 367-379. [6] Kouchi, A. and T. Kuroda, Nature, 1990. **344**: p. 134-135. [7] Strazzulla, G., *et al.*, Journal of Geophysical Research, 1991. **96**(E2): p. 17547-17552. [8] Mastrapa, R.M.E. and R.H. Brown, LPSC #32 #1381, 2001. [9] Mastrapa, R.M.E. and R.H. Brown, DPS #33 #08.07, 2001. [10] Cooper, J.F., *et al.*, *s.* Icarus, 2001. **149**: p. 133-159.