Impact erosion and delivery of planetary atmospheres: the net effect on the atmospheric amount during heavy bombardment

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Impact events of asteroids and comets have many consequences to the evolution of planetary atmospheres and surface environments. One of the most important effects is to change an amount of the planetary atmosphere through impact erosion and impact degassing.

Impact event vaporizes the impactor and a part of the target, and produces a vapor cloud. The vapor cloud, which generally has very high pressure against the ambient atmosphere, can accelerate the planetary atmosphere and cause the loss of atmosphere. It is called impact erosion. Vickery and Melosh (1990) proposed a simple atmospheric blow-off model and estimated an amount of atmospheric loss. In their model, it is assumed that the vapor cloud expands spherically in a stratified atmosphere. Newman et al. (1999) employed a computational fluid dynamics code (the Los Alamos' CAVEAT) and examined the validity of the Vickery and Melosh model. They showed that the strong shock wave was produced and propagated vertically, and that the behavior of the vapor cloud and the accelerated atmosphere was quite different from the one assumed in Vickery and Melosh model. However, they don't study the dependence of the atmospheric loss on various parameters (e.g. an impactor mass, impact velocity and atmospheric pressure).

On the other hand, impacts also have a role in adding impact-induced gasses to the planetary atmosphere. If a part of the impact-induced vapor cloud is retained, volatile components in the retained vapor cloud is supplied to the atmosphere (impact degassing). To estimate the amount of gasses gained by impact degassing, it is required to know how much the vapor cloud is retained. However, it hasn't been fully studied in any previous study.

We developed a two-dimensional cylindrical hydrodynamic code and investigated the dynamical interaction of the vapor cloud with the planetary atmosphere. And the amount of atmosphere lost and vapor retained was calculated for various parameters, respectively. In this presentation, we will discuss the net effect of impacts for the change of atmospheric amount and its parameter dependence.