Evolution of Pluto's surface albedo due to sublimation and condensation of ice

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Observation of the spacecraft New Horizons approached Pluto in 2015 revealed that H_2O, N_2, CH_4, CO ice coexists on the surface of Pluto and that the surface has a strong contrast of bright and dark due to a difference in the amount of ice. However, it is not cleared an origin of the bright and dark color distribution on the surface.
In previous researches about a temporal changing of albedo on the Jovian and Saturnian moons, it has been shown that sublimation of ice due to an insolation affects albedo changing on their surfaces. In addition, condensation of sublimated ice in the atmosphere also should affect Pluto’ s surface albedo. Through these processes, ice behavior like sublimation and condensation possibly affects a change of albedo on Pluto’ s surface. However, it has been not considered quantitatively so far.
In this study, we evaluate relationship between behavior such as sublimation and condensation of various ices and change of albedo with a numerical simulation, and investigate the origin of the albedo variation on Pluto.
In our model, we assume that bright ice and dark non-ice material exist uniformly mixed and the surface albedo can be modeled by the volume ratio. Subsequently, calculate the surface temperature with a change of insolation on each latitude and thermal inertia and then estimate the sublimation amount of ices from the difference between the vapor pressure at the temperature and the atmospheric pressure. Sublimated ices exist as the atmospheric gas, and these gas should be segregated and deposited on the surface if the surface temperature falls below the segregation temperature. We calculate albedo at the next time step from the volume ratio of ice and non-ice material contained in depth considered to be mixed by micrometeorite bombardment. Finally we examine temporal change of the Pluto’ s surface albedo by repeating these cycle.
As a result, using the difference of insolation amount for each latitude caused by the large inclination of the obliquity, we found that a possibility to explain the overall trend of the albedo on current Pluto without special events like a giant impact.

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