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A numerical simulation on diurnal thermal waves of an asteroid surface with detailed topographical model

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The numerical-shape model of asteroid Itokawa is available to perform the combined calculation of thermo physical state of a planetary surface in surface topography and thermal inertia. The spatial resolution of numerical shape model for a thermal observation in a future exploration will require the appropriate scale of the surface topography to explain the observed data in physically meaningful manner, which will determine the issue of understanding of the thermo physical state of asteroids. The thermo physical modelings for spherical planet including lunar and mercury are successful for explaining observational results with spatial resolutions. However the classical thermal models for ground based observation to explain the light curve of point of light asteroid fails to explain the spatially-resolved monitoring images that contains the distribution of surface temperature in thermal infrared wave length. The new thermo physical modeling style needs constructing to adequately simulate the thermal state of a planet with specially resolved none-spherical topographical perspective. The thermal state of NEA is explained in black body approximation in terms of albedo and thermal emissivity. The additional features will be expected when we consider the topographical effect in thermo physical modeling of an asteroid, which contains self-shadowing effect, thermal re-radiation heating and scattering of direct solar flux of the surface. When we take the black body approximation into account, the former two effects becomes more important to calculate the temperature of an asteroid with spatially-resolved numerical shape models which will be different from spherical models with no such secondary effects.

The thermo physical state of an asteoroid surface is well described in thermal inertia of surface materials of the planet. The degree of thermal inertia can be estimated by reproducing diurnal thermal profiles of surface temperature, whose difference from spherical thermal models is necessary to be evaluated as well as the accuracy and feasibility of the estimation. The accuracy depends upon imaging frequency of an on-board imaging device, which in turn is supposed to be used for the purpose of deciding the imaging operation for investigating the accuracies of thermal inertia, conversely. The effect of local topography (several m) as well as the global shape (several hundred m) is considered at the same time in this study.

Keywords: asteroid, surface temperature, spatial resolution, thermal modeling, topography, thermal inertia