An Investigation of the Ranges of Validity of Asteroid Thermal Models for Near-Earth Asteroid Observations

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The majority of known asteroid diameters are derived from thermal-infrared observations. Diameters are derived using asteroid thermal models that approximate their surface temperature distributions and compare the measured thermal-infrared flux with model-dependent predictions. The most commonly used thermal model is the Near-Earth Asteroid Thermal Model (NEATM), which is usually perceived as superior to other models like the Fast-Rotating Model (FRM). We investigate the applicability of the NEATM and the FRM to thermal-infrared observations of Near-Earth Objects using synthetic asteroids with properties based on the real Near-Earth Asteroid (NEA) population. We find the NEATM to provide more accurate diameters and albedos than the FRM in most cases, with a few exceptions. The modeling results are barely affected by the physical properties of the objects, but we find a large impact of the solar phase angle on the modeling results. We conclude that the NEATM provides statistically more robust diameter estimates for NEAs observed at solar phase angles less than 65 degrees, while the FRM provides more robust diameter estimates for solar phase angles greater than 65 degrees. We estimate that less than 5% of all NEA diameters and albedos derived up to date are affected by systematic effects that are of the same order of magnitude as the typical thermal model uncertainties. We provide statistical correction functions for diameters and albedos derived using the NEATM and FRM as a function of solar phase angle.