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MODELING THERMAL RADIATION FROM ASTEROID AIRBUSTS

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ABSTRACT

Large meteoroids, when they enter the atmosphere, produce large quantities of radiation due to shock heating of the air and ablation products. For typical large bolide events (~1-3m diameter objects) this takes the form of visible luminosity, while for large superbolide-class events (e.g. Chelyabinsk and Tunguska), this can result in sufficient thermal radiation causing damage on the ground.

A model for thermal radiation to the ground from large airburst events is developed [1]. This model is based on detailed fully coupled calculations of the flowfield around a meteoroid, including ablation, radiation, chemical reactions, and ionization [2]. Line-by-line computed radiation spectra from the flowfield are propagated to the ground and integrated heat flux computed. The analytical model is implemented in a simple meteoroid trajectory solver to assess ground damage footprints for representative impactors.

Expeditions to the Tunguska impact site measure directional burn patterns on trees near the epicenter [3]. In the current study, this data is used to assess the validity of the model for predicting burn from thermal radiation. Comparisons with burn area

from Tunguska show that the model, when a 17.5 km/s, 72m diameter meteoroid is considered, reproduces the size and shape of the area for assumed charring threshold of 40 J/cm^2 (Fig.1). Therefore, this modeling approach has the potential to provide additional constraints on the nature of the Tunguska impactor, as well as more accurate models for thermal radiation for asteroid risk assessments.

Additionally, the application of this modeling approach to prediction of bolide luminosity will be discussed. In particular, the recent discovery of bolide signatures in data from the Geostationary Lightning Mapper (GLM) [4] provides a compelling source of data for use with this model. Progress on developing a luminosity model for use with GLM light curves will be provided.

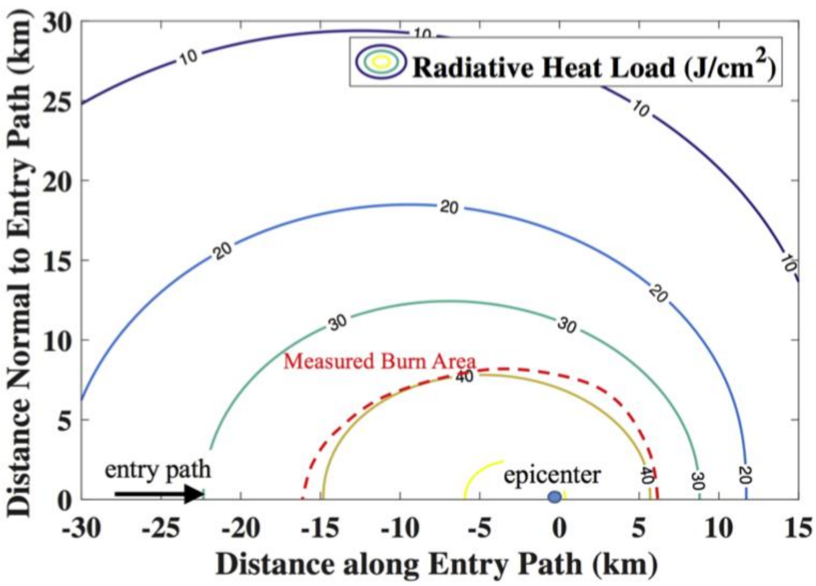

Figure 1: Predicted contours of heat load for a 17.5 km/s, 72m diameter meteoroid, with entry angle of 30 degrees. 40 J/cm^2 is a typically assumed threshold for charring of wood. Measured burn area for Tunguska shown in red.

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