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COMPARISON OF DAMAGE FROM HYDROCODE SIMULATIONS OF AN ASTEROID AIRBURST OR IMPACT ON LAND, IN DEEP, OR IN SHALLOW WATER

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ABSTRACT

This paper follows the 2017 IAA Planetary Defense Conference hypothetical scenario where a 100 – 250 m diameter asteroid is on a potential impact course with Earth. This paper examines the scenario where there is insufficient time for a deflection effort to redirect an impactor so that it will miss Earth completely, but sufficient time does exist to allow the choice between redirecting it to a land or an ocean impact. While distance from densely populated areas should obviously be maximized, the differing ability of blast, ground shock waves, and tsunami waves to cause damage at distance does not make the choice between land and ocean impacts an immediately obvious one.

Following the PDC scenario, impacts will be simulated in the Pacific Ocean, specifically in the deep waters of the Japan Trench, in the shallow water of the Sea of Japan, and in the Gobi Desert, which are the lowest population density areas along the Eastern end of the potential impact corridor. Any impact will create damaging blast waves in the air that will destroy structures close to the impact. Impacts onto land will also create ground shock waves that are potentially damaging further from the impact than the blast wave. Similarly tsunami waves can travel long distances over the open ocean and create damage further from the source than blast waves alone.

Impacts onto continental shelves will create shallow water waves that propagate efficiently, but may be shallow enough to cause impact tsunami waves to break, and dissipate their energy. Impacts over ocean basins will create deep water waves that do not propagate as efficiently but may still be hazardous at significant distance. They may also break when encountering shallow water on the continental shelf before reaching shore. It is intended that damage from tsunami waves will be calculated by including shoaling and run-up on the shore in the hydrocode simulations. This will then be compared to analytical models such as by Van Dorn. The hydrocode simulations can also be passed off the analytical models at an earlier time.

At the lower end of the size range the asteroid may also airburst, especially if it enters the atmosphere at a low angle. An airburst depositing most of the energy into the air may result in stronger blast waves than created by evaporation of material in a ground impact.

The hydrocode simulations, such as shown in figures 1 and 2, will examine the land, shallow, and deep water impacts, and airburst, and the propagation of resulting shock and tsunami waves to address the question of which would be the preferred impact location.

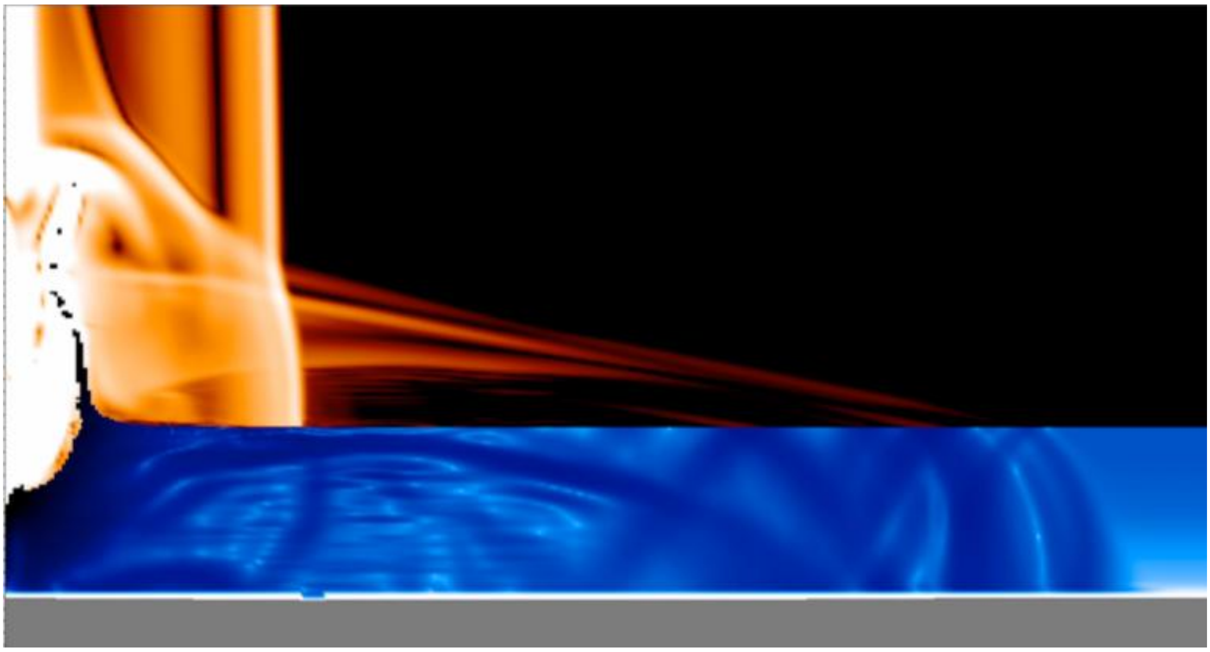

Fig. 1: Simulation of 3km deep water impact by 100MT iron asteroid from NASA-NOAA workshop on Asteroid generated tsunami, August 2016.

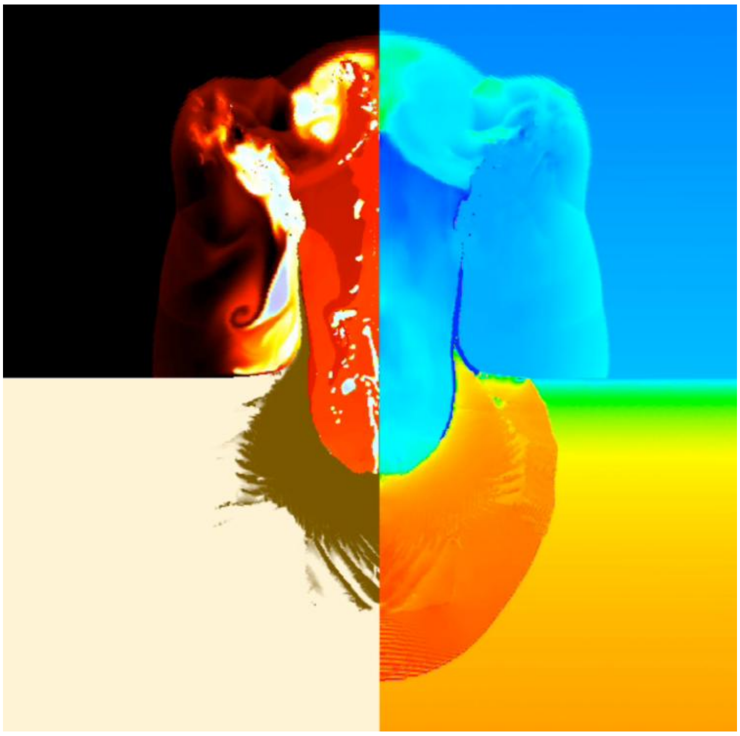

Fig. 2: Preliminary simulation of land impact showing shock waves and fracturing of rock.

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