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WAVE GENERATION, WAVE PROPAGATION, AND ONSHORE CONSEQUENCES OF THE 2015 PDC ASTEROID-IMPACT SCENARIO

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ABSTRACT

A hypothetical asteroid-impact scenario (Chodas 2014) will be used as the basis for discussion and analyses during the PDC 2015 table-top exercise. The asteroid is discovered on 13 April 2015, at magnitude 20.9, declination -39^{o}, and is classified as a potentially hazardous asteroid. The asteroid size is initially estimated between 100-500 meters. The large size uncertainty is due to uncertainties in both albedo and absolute-magnitude values. As the object is tracked over subsequent weeks, the probability of impact in September 2022 continues to rise, but the asteroid's impact-risk region is much longer than the diameter of the Earth, with a narrow width. The risk corridor wraps more than halfway around the globe from the Caspian Sea to the Pacific Ocean. Roughly two thirds of the corridor is over water while the other third is on land.

Based on this script and because there is a high probability of water impact, we simulate water impacts at several locations along the risk corridor: in the South China Sea, the Sulu Sea, and the Pacific Ocean. We have simulated the problem from source (asteroid entry) to ocean impact (splash) to long wave generation, propagation, and interaction with the shoreline. The effects of the asteroid on the ocean surface are simulated using the hydrocode GEODYN to create the wave source for the shallow water wave propagation code, SWWP. The GEODYN-SWWP coupling is based on the structured adaptive mesh refinement infrastructure, SAMRAI, and has been used in FEMA table-top exercises conducted in 2013 and 2014. Results from the wave-propagation simulations can be used to estimate onshore effects or can inform more sophisticated inundation (flooding) models, not included in this discussion.

We describe previous results of this methodology, including models of impacts off the East Coast of the United States, in the Gulf of Mexico, and near San Francisco.

Figure 1 displays an example of the wave pattern resulting from an impact in the Gulf of Mexico, resulting in 2-3 m waves reaching surrounding shorelines.

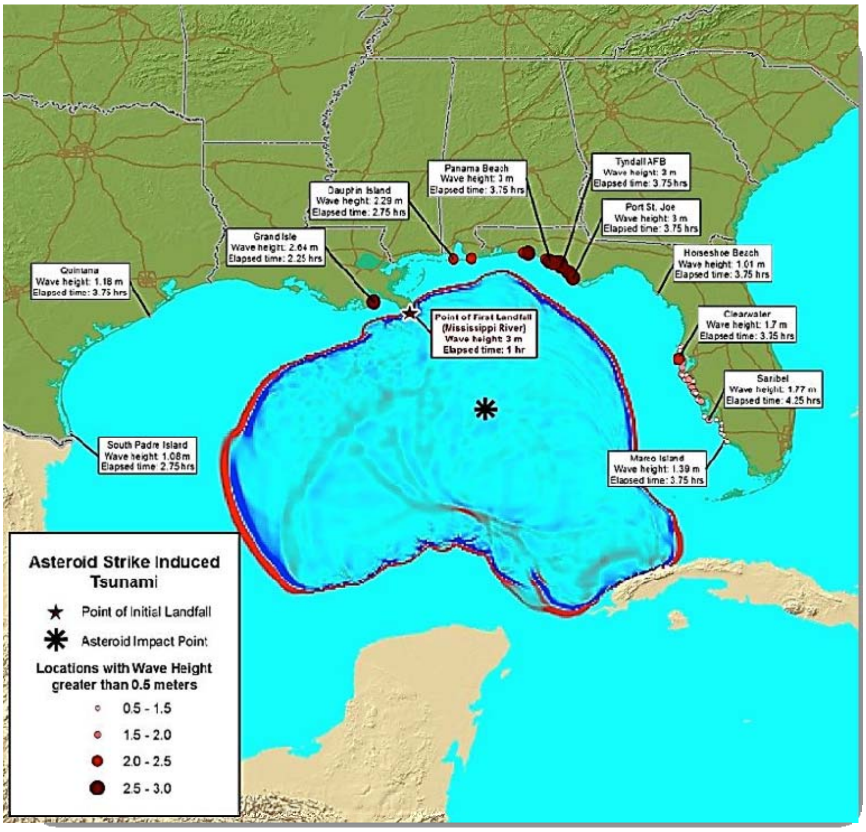

Fig. 1 — Wave patterns resulting from the hypothetical impact of a fifty-meter object in the Gulf of Mexico, two hours after impact. Graphic generated in collaboration with NISAC, Sandia National Laboratories.

For the PDC 2015 exercise object, because the size of the asteroid is not deterministically known, we explore the effect of asteroid size on the landfall waves at several shoreline cities of interest near the potential impact area. We construct a probability of wave height given the size of the asteroid and the location of the impact along the risk corridor. Such probability profiles can inform emergency response and disaster-mitigation efforts, and may be used for design of maritime protection (e.g. jetties, breakwaters walls) or assessment of risk to shoreline structures of interest (e.g. bridges, power plants).

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References:

Chodas (2014) http://neo.jpl.nasa.gov/pdc15/, downloaded on 5 Dec 2014.

Comments:

Alternative session: Consequence Management & Education. Oral presentation requested.