RISK ASSESSMENT FOR 2012 TC4 BASED HYPOTHETICAL IMPACT SCENARIOS. J. L. Dotson[1], L. F. Wheeler[2], D. L. Mathias[3], and D. Farnocchia[4], [1]NASA Ames Research Center (jessie.dotson@nasa.gov), [2]Affiliation for Lorien, [3]NASA Ames Research Center, [4]Jet Propulsion Laboratory.

Introduction: An asteroid impact with Earth is an unlikely event – though one which could have significant consequences. Quantifying the risk of low likelihood but high impact events requires careful modeling – ideally grounded regularly by activities which exercise different parts of the scenario. Here we discuss an effort to perform a risk assessment on two hypothetical impact scenarios based on the recent close approach of 2012 TC4.

Risk Assessment: Probabilistic impact risk assessments were performed for 2012 TC4 based hypothetical impact scenarios. The impact risk was assessed by using a Monte Carlo simulation framework, following the approach of Mathias [1]. A series of hypothetical impact locations were generated. For each hypothetical impact point, 1000 impact cases were simulated by sampling input parameters from uncertainty distributions to create the pre-impact characteristics of the asteroid. Atmospheric entry and breakup were modeled for each hypothetical impact case to calculate the energy deposited in the atmosphere, the airburst altitude, and any remaining energy striking the ground. Damage resulting from blast waves, thermal radiation, and tsunami was computed. The population affected was calculated based on the computed damage and the local population at the impact point.

The risk assessment was calculated at several epochs before and during the close approach of 2012 TC4, each time incorporating new information about 2012 TC4 as it became available due to new observations. For instance, the spread in the hypothetical impact locations was reduced as improved astrometry became available. The distributions developed by Stokes [2] for albedo, composition, density and strength were used until additional observational information became available. Improved distributions developed based on observations were used to generate pre-impact characteristics for the later epochs. At each epoch, two cases were run: one for an H = 26.7 object and one for an H = 21.9 object. The smaller size was chosen to match 2012 TC4's known parameters, while the larger size was chosen so that comparisons could be made with the virtual impact scenario executed at the 2017 Planetary Defense Conference.

Improving characterization: Over the course of the close approach, a coordinated ground campaign provided increasingly refined characterization measurements [3]. First came refinements in astrometry, then photometric colors and finally spectra and radar dimensions. A summary of the affected population for all epochs is shown in Figure 1 for the 2012 TC4-based hypothetical scenario and in Figure 2 for the H = 21.9 hypothetical scenario.

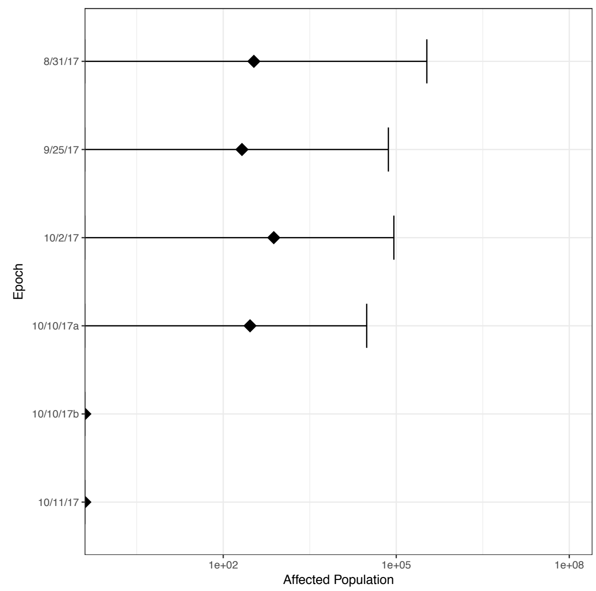

Figure 1. The affected population results from impact risk assessments of 6 epochs for a hypothetical 2012 TC4-based (H=26.7) object. The diamonds show the mean affected population and the bars show the minimum and maximum values across all simulations run for each epoch. In all epochs, there were instances where the affected population was zero.

Discussion: For both sizes considered in this particular scenario, the improvements in astrometry led to moderate reductions in the uncertainty in the range of possible outcomes. However, in all epochs impact with the Earth was assured and the hypothetical impact corridor always included (at least) moderately populated areas, so dependence on astrometry should be expected to be minimal. When considering a less controlled scenario, astrometry becomes critical in determining whether an impact occurs at all and whether it is coincident with a populated area. Across the epochs, only the irons caused significant damage for the smaller (H = 26.7) size. If a strong, non-fracturing iron was not a possibility, then no damage was predicted. For the larger (H = 21.9) size, irons always caused damage, hydrous stones sometimes caused damage, and anhydrous stones (because their lower albedos yielded a larger size) always caused damage. The different dependence on composition observed for the different sizes considered highlights that, after astrometry, in this regime, size is the most important physical property to determine for an incoming object.

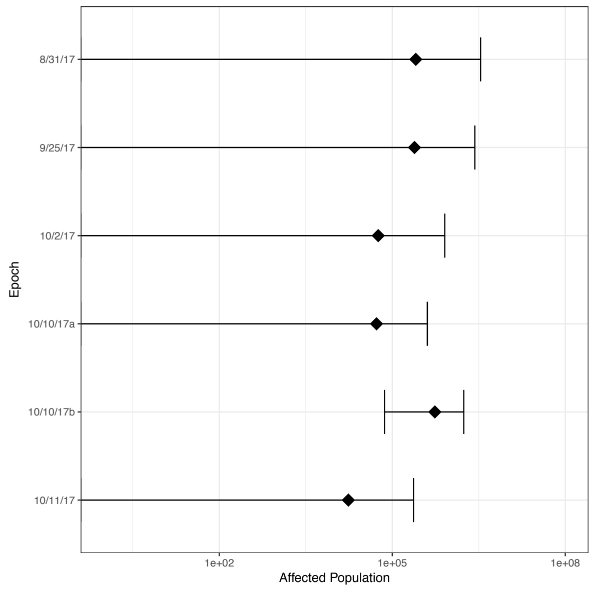

Figure 2. Affected population results from impact risk assessments of 6 epochs for a larger hypothetical object (H=21.9). The diamonds show the mean affected population and the bars show the minimum and maximum values across all simulations run for each epoch.

References: Use the brief numbered style common in many abstracts, e.g., [1], [2], etc. References should then appear in numerical order in the reference list, and should use the following abbreviated style:

[1] Mathias, D. L, Wheeler, L. F., and Dotson J. L. (2017) *Icarus, 289*, 106. [2] Stokes et al (2017) "Update to Determine the Feasibility of Enhancing the Search and Characterization of NEOs". [3] http://2012tc4.astro.umd.edu/index.shtml

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