Luego pienso en el título Va a estar chilero

Hernández, Giovanna[1*]

[1]Escuela de Ciencias Físicas y Matemáticas, Universidad de San Carlos de Guatemala

Abstract

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Introduction

Near-Earth Objects (NEOs) are comets and asteroids that have been nudged by the gravitational attraction of nearby planets into orbits that allow them to enter the Earth's neighborhood. Composed mostly of water ice with embedded dust particles, comets originally formed in the cold outer planetary system while most of the rocky asteroids formed in the warmer inner solar system between the orbits of Mars and Jupiter.[1]

A meteoroid is generally defined as an asteroid or comet fragment that orbits the Sun. Meteors, or "shooting stars", are the visible paths of meteoroids that have entered the Earth's atmosphere at high velocities. A fireball is an unusually bright meteor that reaches a visual magnitude of -3 or brighter when seen at the observer's zenith.[2]

Near-Earth Asteroids (NEAs) are small bodies of the Solar System with perihelion distance q 1.3 AU (Astronomical Units) and aphelion distances Q 0.983 AU, whose orbits approach or intersect Earth orbit.[3] Potentially Hazardous Asteroids (PHAs) are a special subset of NEAs that, according to The Center for Near-Earth Object Studies (CNEOS), have an absolute magnitude (H) of 22.0 or less that can come close to the Earth and are large enough to cause significant damage in the event of an impact.[4]

Sentry is a highly automated collision monitoring system that continually scans the most current asteroid catalog for possibilities of future impact with Earth over the next 100 years. Whenever a potential impact is detected it will be analyzed and the results immediately published, except in unusual cases.[5]

Data and Methods

The data about fireballs, NEOs, NEAs and impact probabilities have been collected from the database of The Center for Near-Earth Object Studies (CNEOS) and its monitoring system Sentry. The parameters studied include absolute visual magnitude (H), impact probability, impact energy (kt) and geographic location of fireball objects.

To determine if the impact energy (kt) of fireballs is consistent with some type of distribution it was decided to use the logarithm of the data and then a histogram was made with the counts of the impact energy ($log(kt)$) in intervals of 0.2. With these data, some distribution fit were applied to confirm wich one was more accurate.

At first, the covariance matrix was used to find the linear bond between NEOs' absolute magnitude (H) and impact probability, but due to the correlation not being linear, it was discarded. Then proceeded to use Pearson's and Spearman's correlation coefficients to analyze better the data and determine if a correlation existed and which type it was.

At last, using Gnuplot and Python with various libraries such as pandas, numpy, plotly, a graphic representation of geographic locations with their respective impact energy as the size of the reported events was made.

*Corresponding author: gioreneeha@gmail.com
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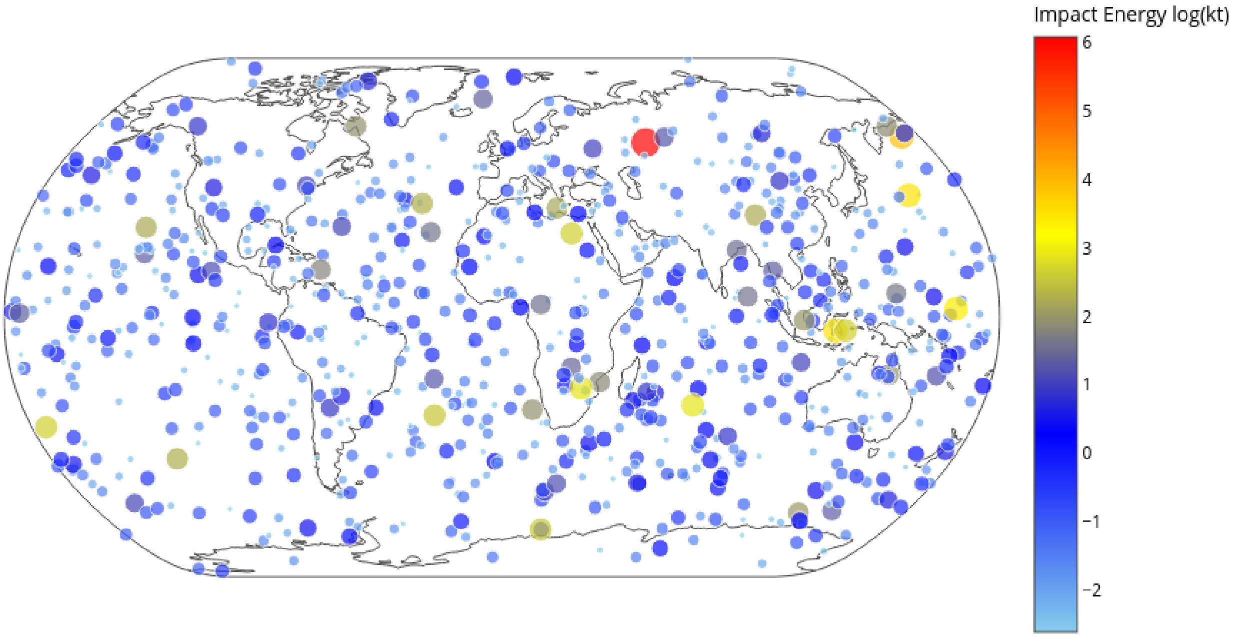

Figure 1: *Fireballs reported by US government sensors from April 15, 1988, to May 15, 2024. The size and color of each circle were determined by the logarithm of the impact energy (kt), and the location was determined by the altitude and longitude. All this data was obtained from the database published by NASA's CNEOS at JPL.*

Results

As it can be observed in figure 1 and figure 2, the most frequent impact energy is of -2.4 to -2.2 $log(kt)$ which is equivalent to 0.09 and 0.11 kt. Little data varies from 2 to 4 $log(kt)$, or its equivalent range 7 to 55 kt And even more impressive, only one data was far from the rest, it was of 440 kt. That piece of information was unique among the rest, to the point where it's easy to tell from where the data is. It was the Chelyabinsk meteor of February 15, 2013. It generated infrasound returns, after circling the globe, at distances up to $\sim$ 85000 km, and was detected at 20 infrasonic stations of the global International Monitoring System (IMS).[6] It was surely a unique occurence.

In figure 2 it can be seen that the fit of a Gaussian distribution was the best fit, it has a χ^2 value of $6.37E+03$, which means that the fit had a large variation with respect to the original data. With this it can be said that the fit wasn't precise. On other hand the Poisson distribution was also used, but in that case a fit was not even generated. Same case with Log-normal distribution. That was the reason because the Gaussian distribution was selected as the best fitting one, despite its high variation with the presented data.

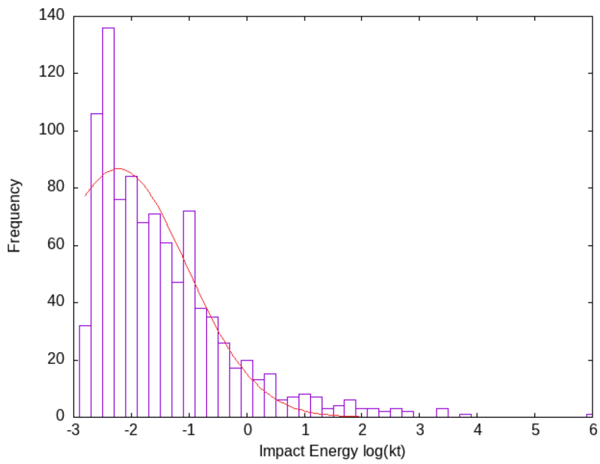

Figure 2: *Histogram of the logarithm of fireballs' impact energy (kt) reported by US government sensors from April 15, 1988, to May 15, 2024. The red line indicates the fit of a Gaussian distribution that was applied to the data. The larger impact energy was of* $6\,log(kt)$.

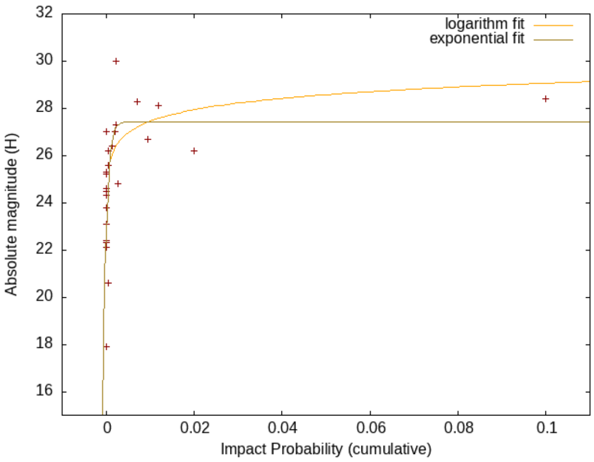

Figure 3: *Plot between NEOs' impact probability and absolute magnitude (H) obtained from the database published by NASA's CNEOS at JPL. The olive line indicates an exponential fit and the yellow one indicates a logarithmic fit, both were applied to the data.*

Conclusions

References

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