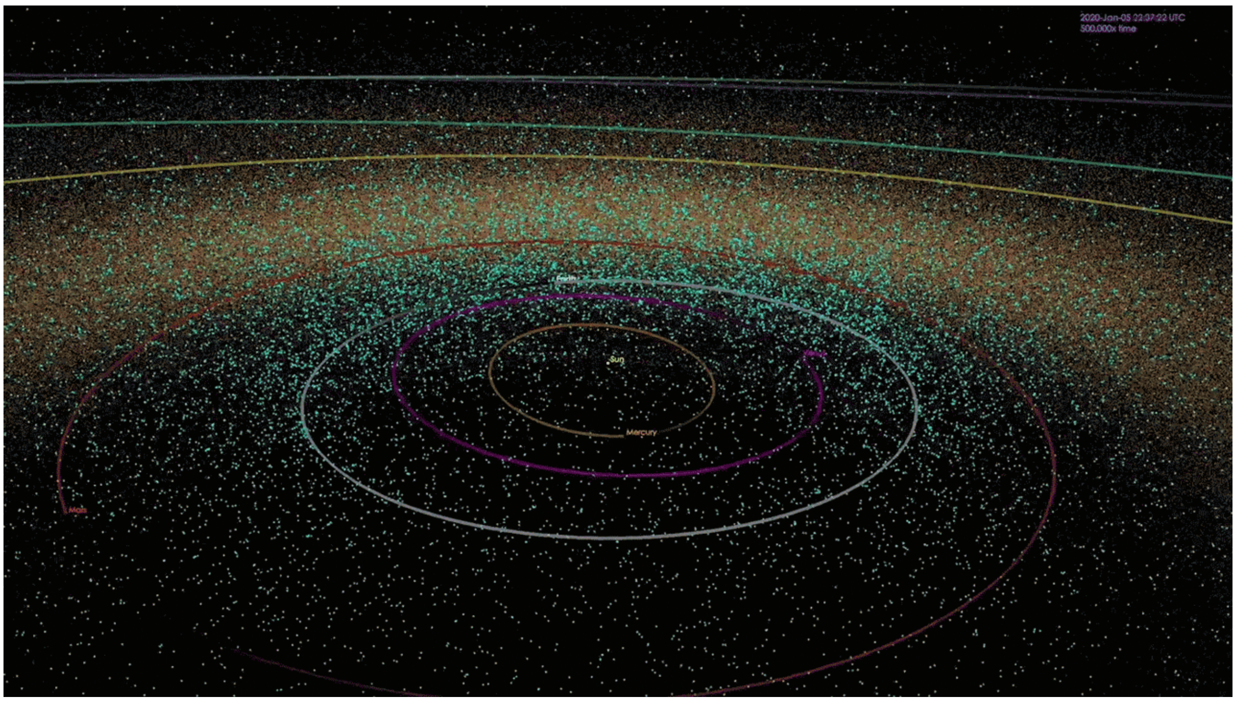
Twenty years of planetary defense

July 24 2018



The animation depicts a mapping of the positions of known near-Earth objects (NEOs) at points in time over the past 20 years, and finishes with a map of all known asteroids as of January 2018. Asteroid search teams supported by NASA's NEO Observations Program have found over 95 percent of near-Earth asteroids currently known. There are now over 18,000 known NEOs and the discovery rate averages about 40 per week. Credit: NASA/JPL-Caltech

On March 11, 1998, asteroid astronomers around the world received an ominous message: new observational data on the recently discovered asteroid 1997 XF11 suggested there was a chance that the half-milewide (nearly one kilometer) object could hit Earth in 2028.

The message came from the Minor Planet Center, in Cambridge, Massachusetts, the worldwide repository for such observations and initial determination of asteroid orbits. And although it was intended to alert only the very small astronomical community that hunts and tracks asteroids to call for more observations, the news spread quickly.

Most media outlets did not know what to make of the announcement, and mistakenly highlighted the prospect that Earth was doomed.

Fortunately, it turned out that Earth was never in danger from 1997 XF11. After performing a more thorough orbit analysis with the available asteroid observations, Don Yeomans, then the leader of the Solar System Dynamics group at NASA's Jet Propulsion Laboratory in Pasadena, California, along with his colleague Paul Chodas, concluded otherwise. "The 2028 impact was essentially impossible," said Chodas, who is now director of NASA's Center for Near-Earth Object Studies (CNEOS), located at JPL.

"To this day we still get queries on the chances of XF11 impacting in 2028," Chodas said. "There is simply no chance of XF11 impacting our planet that year, or for the next 200 years."

Chodas knows this thanks to CNEOS' precise orbit calculations using observation data submitted to the Minor Planet Center by observatories all over the world that detect and track the motion of asteroids and comets. For the past two decades, CNEOS calculations have enabled NASA to become the world leader in these efforts, keeping close watch on all nearby asteroids and comets—especially those that can cross Earth's orbit.

"We compute high-precision orbits for all asteroids and comets and map their positions in the Solar System, both forward in time to detect potential impacts, and backward to see where they've been in the sky," Chodas said. "We provide the best map of orbits for all known small bodies in the Solar System."

Mapping the Celestial Hazard

Near-Earth Objects (NEOs) are asteroids and comets in orbits that bring them into the inner solar system, within 121 million miles (195 million kilometers) of the Sun, and also within roughly 30 million miles (50 million kilometers) of Earth's orbit around the Sun.

The media frenzy around NEO 1997 XF11 demonstrated the need for clarity and precision in communicating with the public about the close passes by Earth of these objects, as well as "the importance of peer review before public statements like these are made," Chodas said.

NASA's original intent was to fulfill a 1998 Congressional request to detect and catalogue at least 90 percent of all NEOs larger than one kilometer in size (roughly two-thirds of a mile) within 10 years. To help reach the Congressional goal, NASA Headquarters requested that JPL establish a new office to work with the data provided by the International Astronomical Union-sanctioned Minor Planet Center for submission of all observations of asteroids and comets, and to coordinate with observatories operated by academic institutions around the United States, as well as U.S. Air Force space surveillance assets.

In the summer of 1998, NASA established the Near-Earth Object Observations Program and JPL became the home for the agency's research data and analysis on NEOs, the "Near-Earth Object Program Office." (To view the announcement regarding the creation of the Near-Earth Object Program Office, see: www.jpl.nasa.gov/news/news.php?feature=5134)

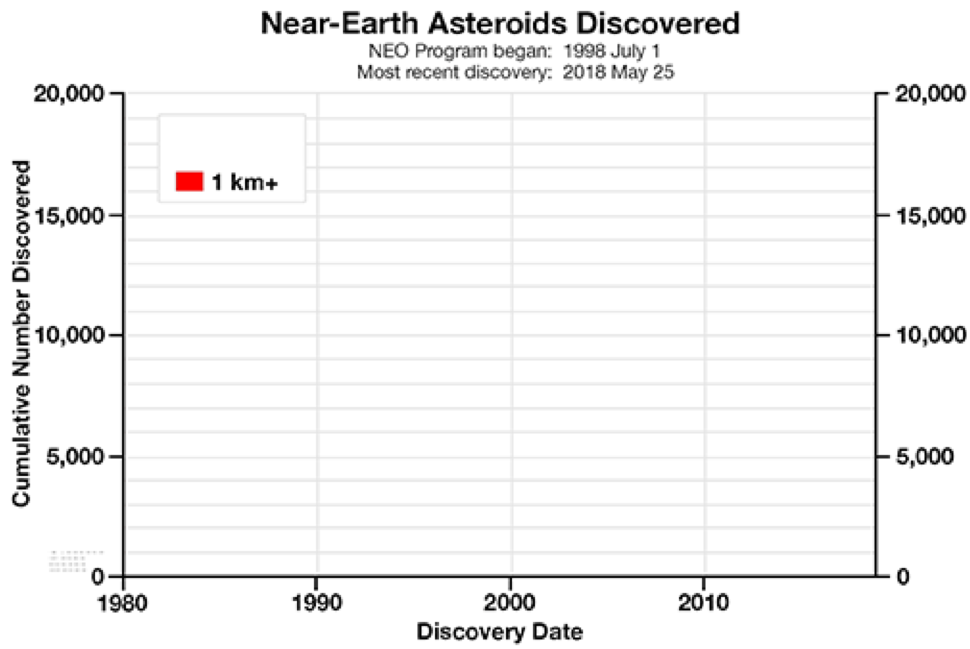
In 2016, the office was renamed the Center for Near-Earth Object Studies (CNEOS) in conjunction with the establishment of the Planetary Defense Coordination Office (PDCO) at NASA Headquarters in Washington.

For about 20 years, CNEOS has been NASA's central hub for accurately mapping the orbits of all the known NEOs, predicting their upcoming close approaches, reliably assessing their chances of impact to our planet, and delivering that information to both astronomers worldwide and the general public.

Predicting Close Approaches and Impacts: Sentry and Scout

The first and most important step in assessing the impact risk of an asteroid or comet is to determine whether any given object's orbit will cross Earth's orbit—and then how close it will actually get to our planet. JPL was determining high-precision orbits for a few NEOs even before NASA launched its NEO Observations Program, and has since upgraded its orbit models to provide the most accurate assessment available for asteroid positions and orbits.

Observatories around the world take digital images of the sky to detect moving points of light (the asteroid or comet) over days, weeks, months (and even decades!), and then report the positions of these moving objects relative to the static background of stars to the Minor Planet Center. See "How a Speck of Light Becomes an Asteroid". The CNEOS scientists then use all this observation data to more precisely calculate an NEO's orbit and predict its motion forward in time for many years, looking for close approaches and potential impacts to the Earth, its Moon, and other planets.



The chart depicts the cumulative number of known Near-Earth asteroids (NEAs) versus time. The area in red depicts the number of known NEAs larger than 0.6 miles (1 kilometer). The area in orange depicts the quantity of known NEAs larger than 460 feet (140 meters). The area in blue depicts the number of known NEAs in all sizes. Credit: NASA/JPL-Caltech

A CNEOS system called "Sentry" searches ahead for all potential future Earth impact possibilities over the next hundred years—for every known NEO. Sentry's impact monitoring runs continually using the latest CNEOS generated orbit models, and the results are stored online. In most cases so far, the probabilities of any potential impacts are extremely small, and in other cases, the objects themselves are so small—less than 20 meters in size, or nearly 66 feet—that they would almost certainly disintegrate even if they did enter Earth's atmosphere.

"If Sentry finds potential impacts for an object, we add it to our online 'impact risk' table, and asteroid observers can then prioritize that object for further observation," said Steve Chesley of JPL, a member of the CNEOS team who was the main developer of the Sentry system. "The more measurementsmade of the object's position over time, the better we can predict its future path."

"In most cases, the new measurements mean the object can be removed from the risk list because the uncertainties in the orbital path are reduced and the possibility of impact is ruled out," Chesley said.

More recently, CNEOS also developed a system called Scout to provide more immediate and automatic trajectory analyses for the most recently discovered objects, even before independent observatories confirm their discovery. Operating around the clock, the Scout system not only notifies observers of the highest priority objects to observe at any given time, it also immediately alerts the Planetary Defense Coordination Office of any possible imminent impacts within the next few hours or days. A recent example is the Scout-predicted impact of the small asteroid 2018 LA over Botswana, Africa.

More Hunting to Do

With the addition of more capable NASA-funded asteroid surveys over the years, NASA's NEO Observations Program is responsible for over 90 percent of near-Earth asteroid and comet discoveries. There are now over 18,000 known NEOs and the discovery rate averages about 40 per week.

Although the original Congressional goal from 1998 has been exceeded and much progress has been made in asteroid discovery and tracking over the past two decades, the work isn't over. In 2005, Congress established a new, much more ambitious goal for the NEO Observations

Program—to discover 90 percent of the NEOs down to the much smaller size of 450 feet (140 meters), and to do so by the year 2020 (www.congress.gov/congressional … s/house-report/158/1).

These smaller asteroids may not present a threat of global catastrophe if they impact Earth, but they could still cause massive regional devastation and loss of life, especially if they occur near a metropolitan area. CNEOS continues to make improvements to its orbital analysis tools, image and graphic presentation capabilities, and updates of its websites to quickly and accurately provide the very latest information on NEOs to PDCO, the astronomical community and the public.

More information: More information about CNEOS, asteroids and near-Earth objects can be found at: cneos.jpl.nasa.gov , www.jpl.nasa.gov/asteroidwatch

Provided by Jet Propulsion Laboratory

Citation: Twenty years of planetary defense (2018, July 24) retrieved 26 April 2024 from https://phys.org/news/2018-07-twenty-years-planetary-defense.html