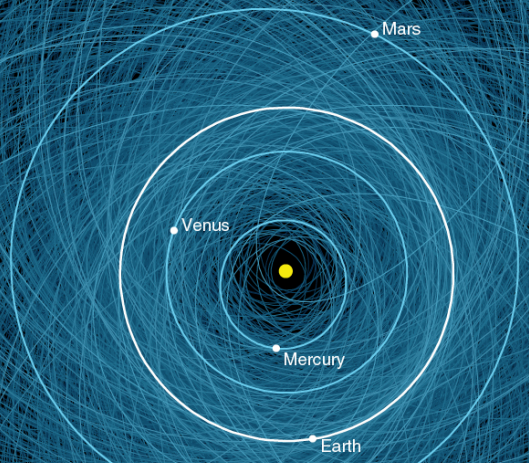
EXERCISE ONLY!!



Press Conference: April 29, 2019

Newly Discovered Asteroid Poses Small Threat of Earth Impact in 8 Years

Paul Chodas (Jet Propulsion Laboratory/California Institute of Technology)

2019 Planetary Defense Conference, College Park, Maryland

EXERCISE ONLY!!

Asteroid 2019 PDC: Initial Discovery & Tracking

EXERCISE

- Asteroid discovered on March 26, 2019 by Pan-STARRS at visual magnitude ~21.5
- Confirmed the following night; designated "**2019 PDC**" by the Minor Planet Center
- Initial orbit comes close to Earth's orbit: **Potentially Hazardous Asteroid (PHA)**
- After only 2-3 days of tracking, NASA CNEOS and ESA NEOCC both identified potential future impacts: the asteroid was placed on the **"Risk Page"**
  - Most likely possible impact is April 29, 2027, **over 8 years away**
- Asteroid has been approaching Earth and brightening; it has been tracked nightly
- As the tracking dataset has grown, the orbit has became better determined, and the impact probability has continued to rise
- Today, after 1 month of tracking, the impact probability has reached **1%**
- Size is roughly **100 to 300 meters (300 to 1000 feet)**, based on brightness
- 2019 PDC is rated a **2 on the Torino Scale**: "merits special attention"
- For more info: **https://cneos.jpl.nasa.gov/pd/cs/pdc19/day1.html**

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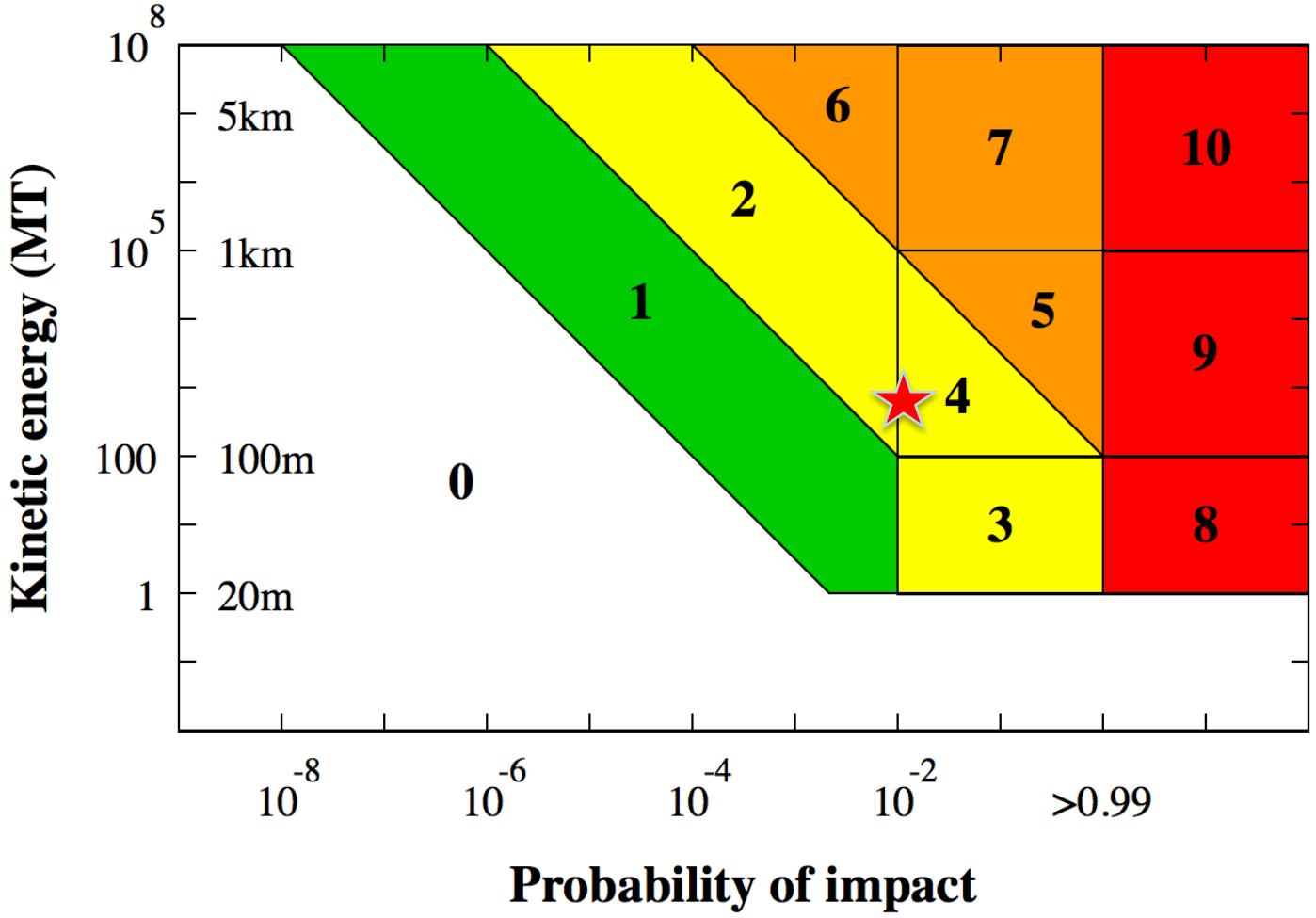
2019 PDC on the Torino Scale

Jet Propulsion Laboratory
California Institute of Technology



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2019 PDC: Possible Impact Effects

Jet Propulsion Laboratory
California Institute of Technology

Diameter of Impacting Asteroid	Type of Event	Approximate Impact Energy (MT)	Average Time Between Impacts (Years)
5 m (16 ft)	Bolide	0.01	1
10 m (33 ft)	Superbolide	0.1	10
25 m (80 ft)	Major Airburst	1	100
50 m (160 ft)	Local Scale Devastation	10	1000
140 m (460 ft)	Regional Scale Devastation	300	20,000
300 m (1000 ft)	Continent Scale Devastation	2,000	70,000
600 m (2000 ft)	Below Global Catastrophe Threshold	20,000	200,000
1 km (3300 ft)	Possible Global Catastrophe	100,000	700,000
5 km (3 mi)	Above Global Catastrophe Threshold	10,000,000	30 million
10 km (6 mi)	Mass Extinction	100,000,000	100 million

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Orbit of Asteroid 2019 PDC

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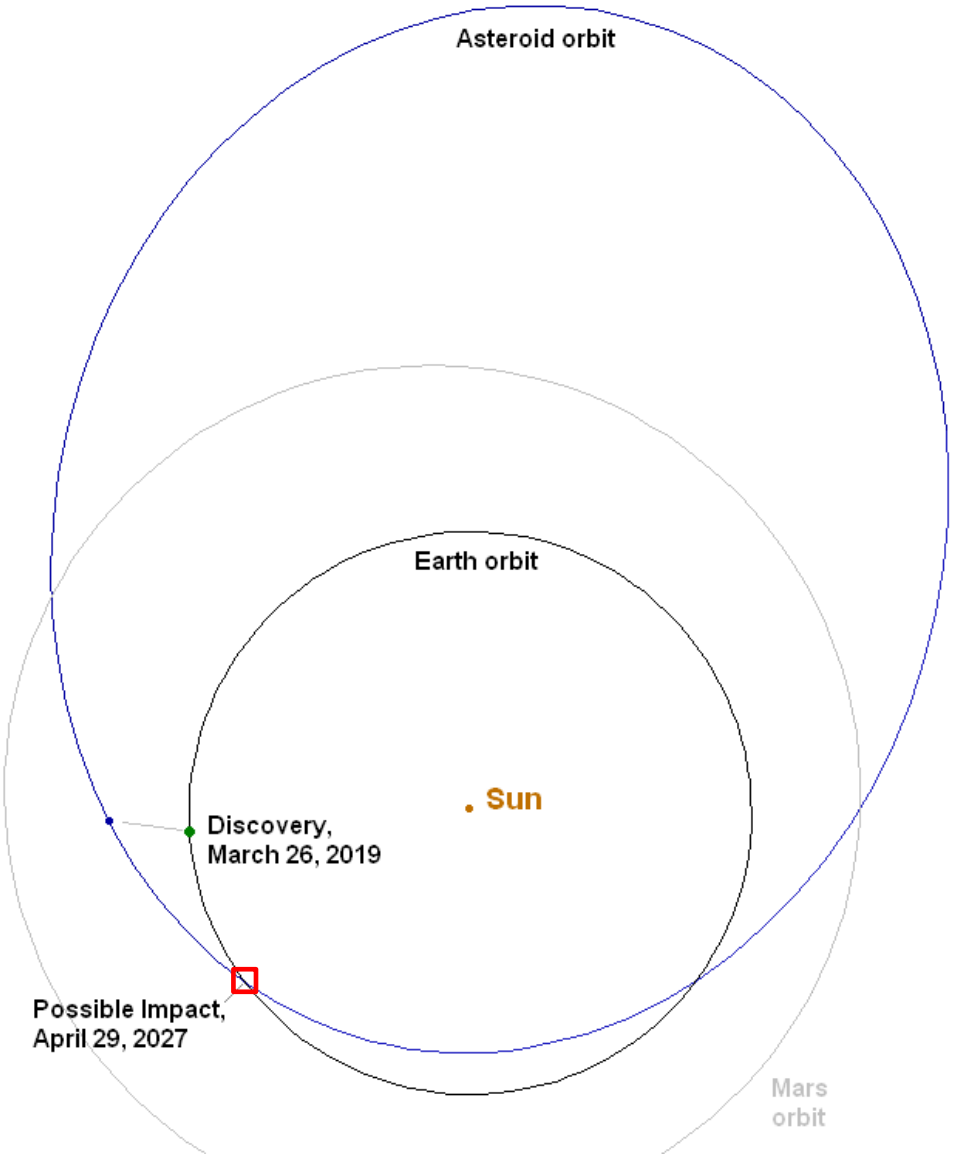
California Institute of Technology



Asteroid takes 2.66 years to orbit the Sun

Asteroid completes over 3 orbits between discovery and the possible impact

Earth completes 8 orbits of the Sun during this time

Asteroid orbit inclined 18 deg from the Earth's orbital plane

EXERCISE

EXERCISE

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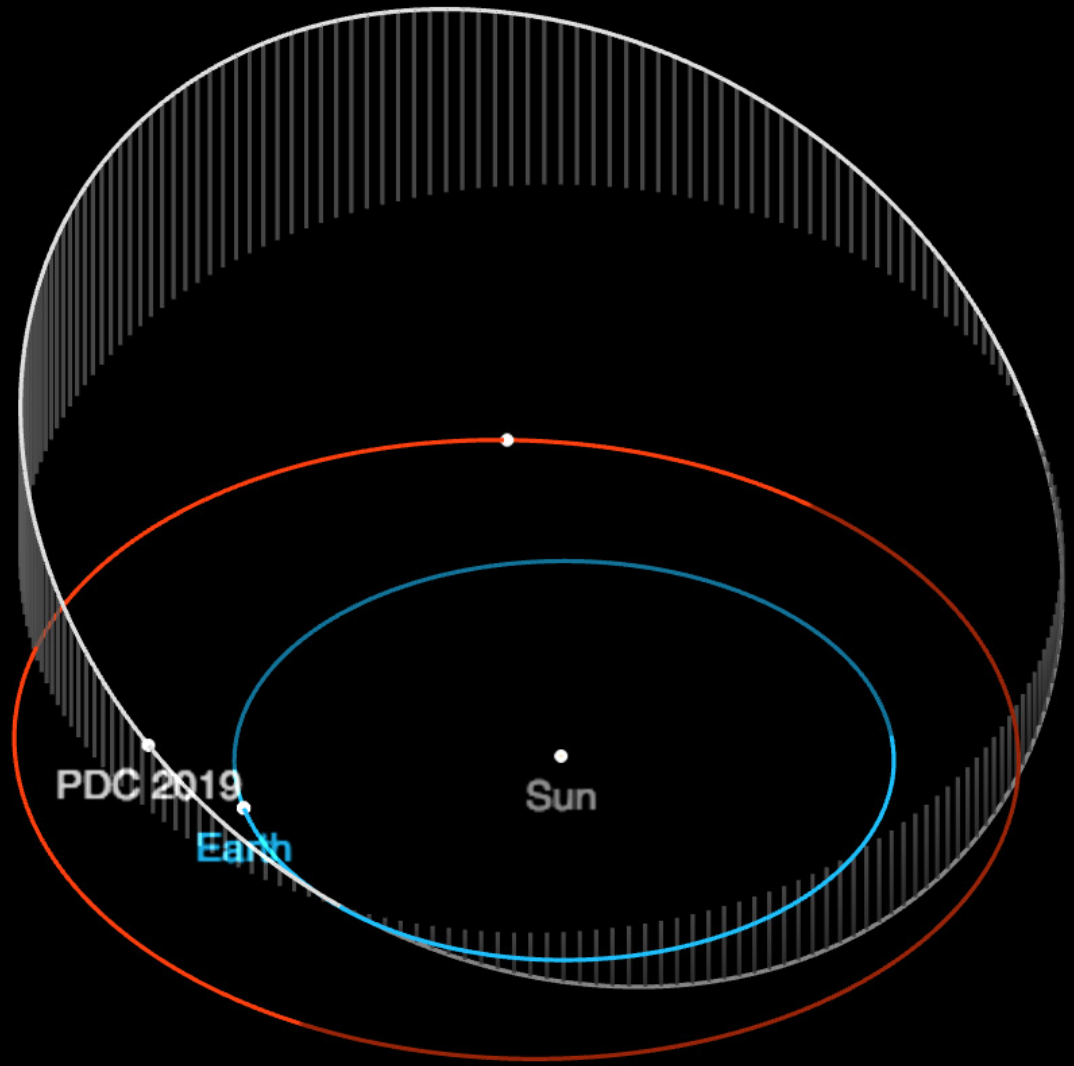
2019 PDC: Interactive 3D Orbit View

Jet Propulsion Laboratory
California Institute of Technology



https://cneos.jpl.nasa.gov/orbits/custom/pdc19.html

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Asteroid Orbits and Their Uncertainties

Jet Propulsion Laboratory
California Institute of Technology

- Although asteroids orbit the Sun on fairly predictable trajectories, predictions of future positions will always contain some uncertainty, since the measurements orbits are based on contain uncertainty
- We say a predicted position has an "**Uncertainty Region**" around it
- Since the most uncertain component of prediction is **along the orbit path**, the uncertainty region tends to align along the orbit path
- Sometimes the uncertainty region is millions of kilometers long, but it is also often very narrow
- If the Earth passes through an uncertainty region, an impact is possible
- Effectively, the uncertainty region slices through the Earth's surface, producing what we call a "**Risk Corridor**"
- If an impact occurs, it will happen at some point on the risk corridor

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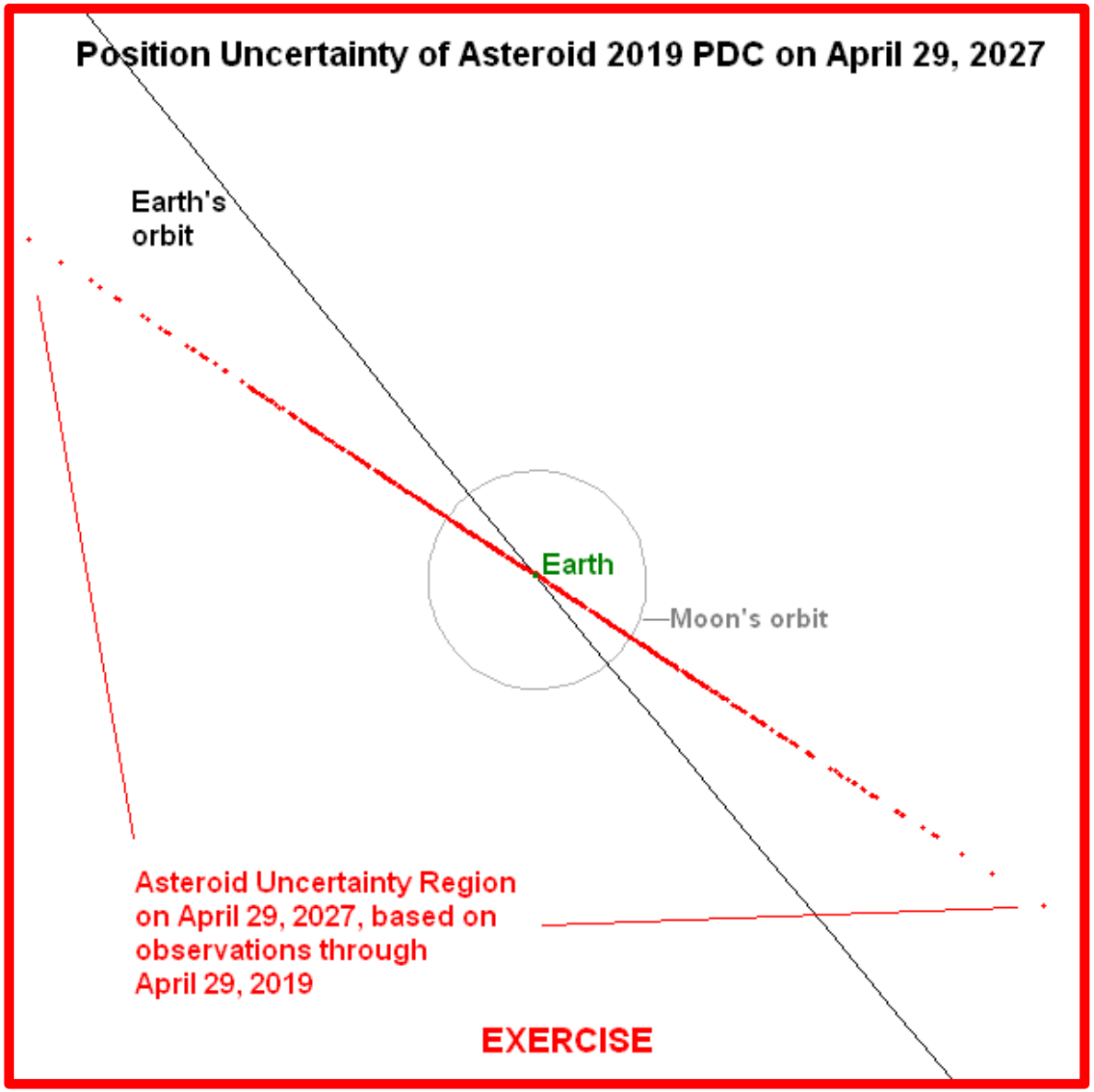
EXERCISE

2019 PDC Position Uncertainty at Potential Impact on April 29, 2027

Jet Propulsion Laboratory
California Institute of Technology



The red dots are the possible positions of the asteroid on April 29, 2027, computed using the 5 weeks of tracking data since discovery

1% of the red dots intersect with the Earth

As more observations are made, the uncertainty region will shorten, but we don't know exactly where

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2019 PDC: Uncertainty Region in 2027

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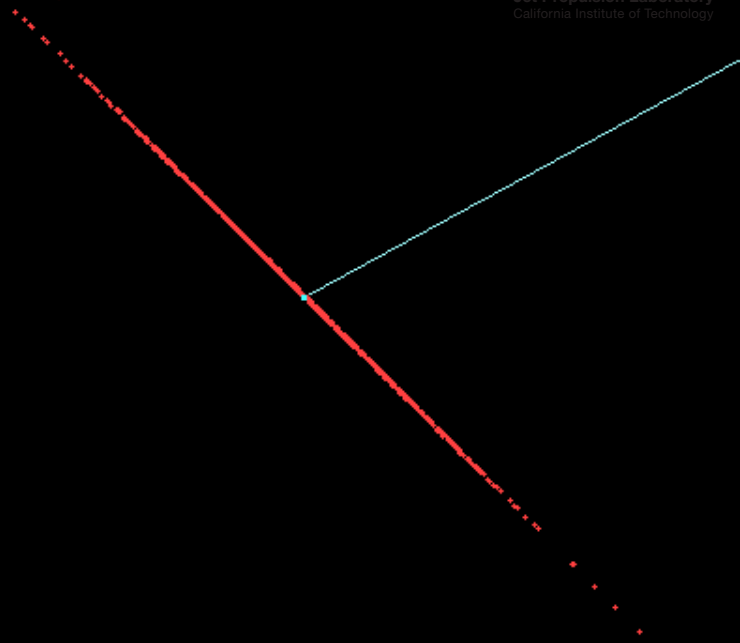
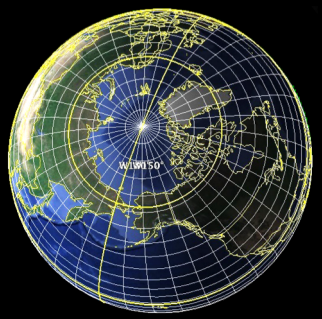
California Institute of Technology

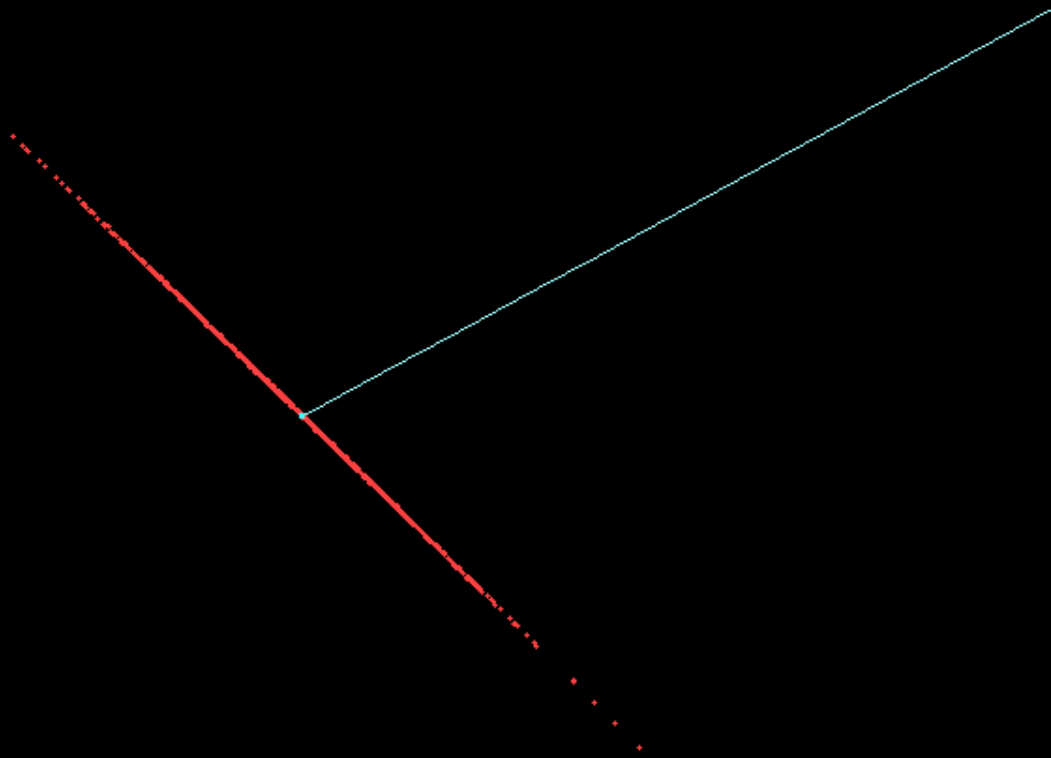


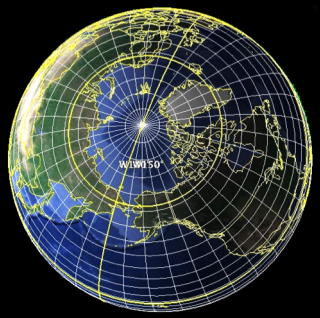


EXERCISE ONLY!!

2019 PDC: Uncertainty Region in 2027

EXERCISE





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2019 PDC: Uncertainty Region in 2027

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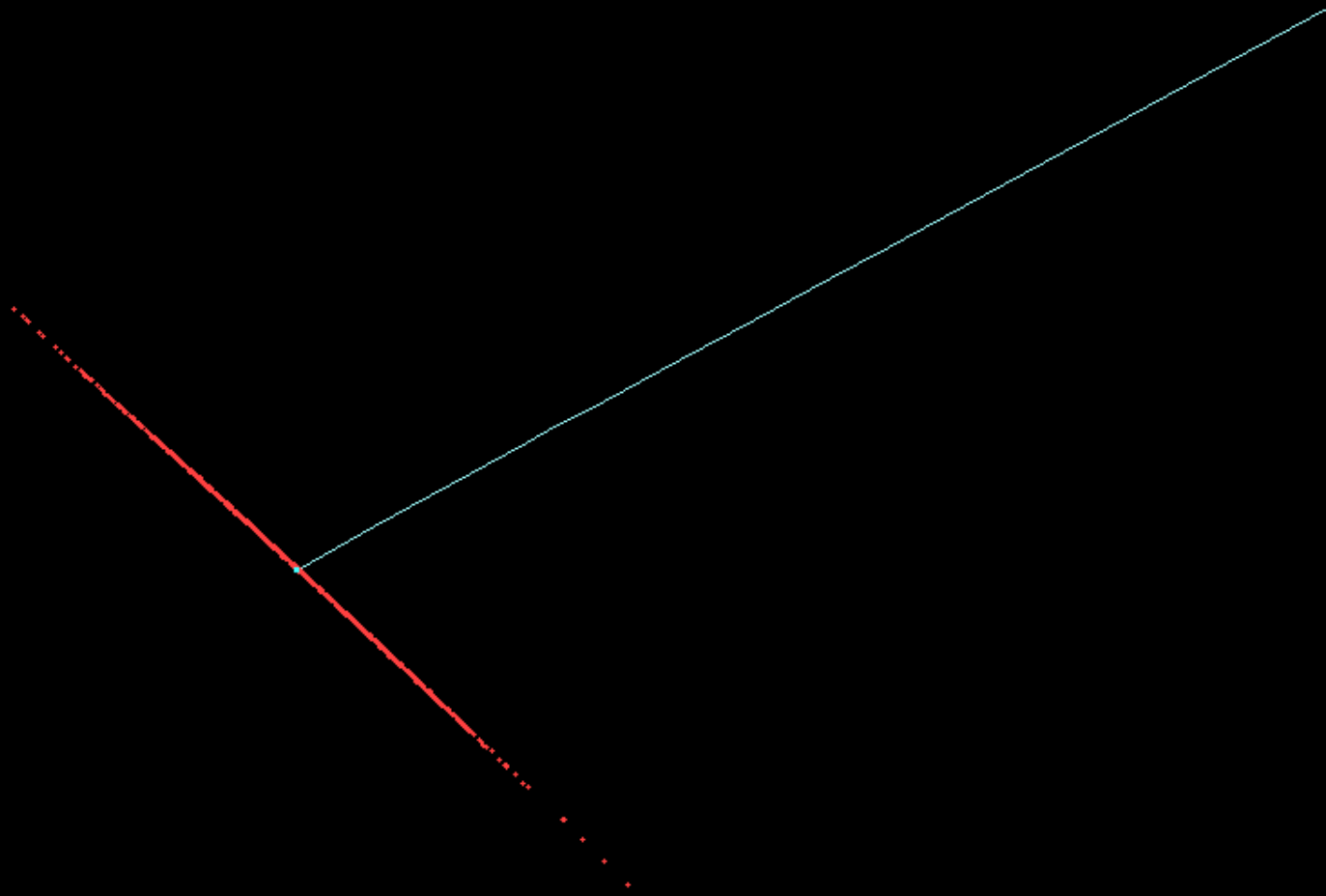

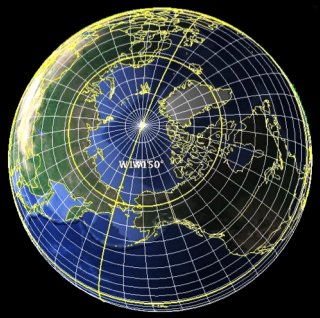

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2019 PDC: Uncertainty Region in 2027

EXERCISE

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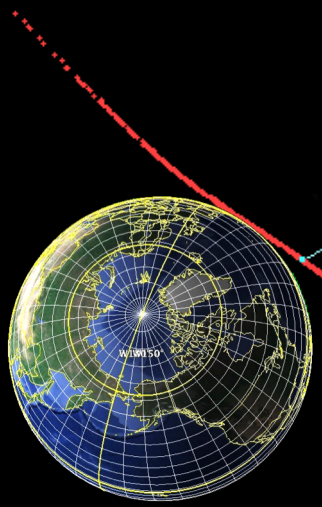

EXERCISE ONLY!!

2019 PDC Risk Corridor - West

EXERCISE

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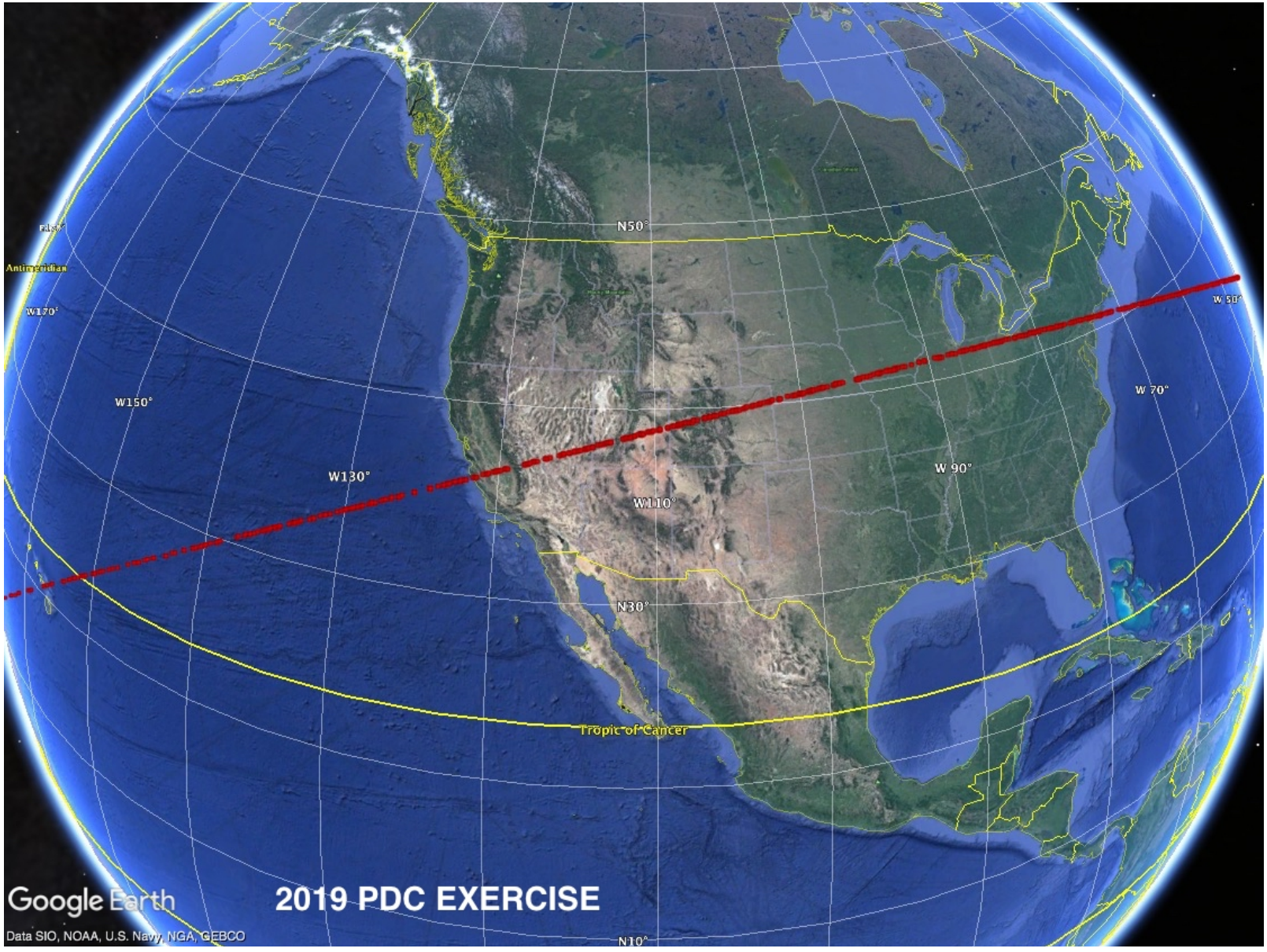

2019 PDC Risk Corridor - East

EXERCISE

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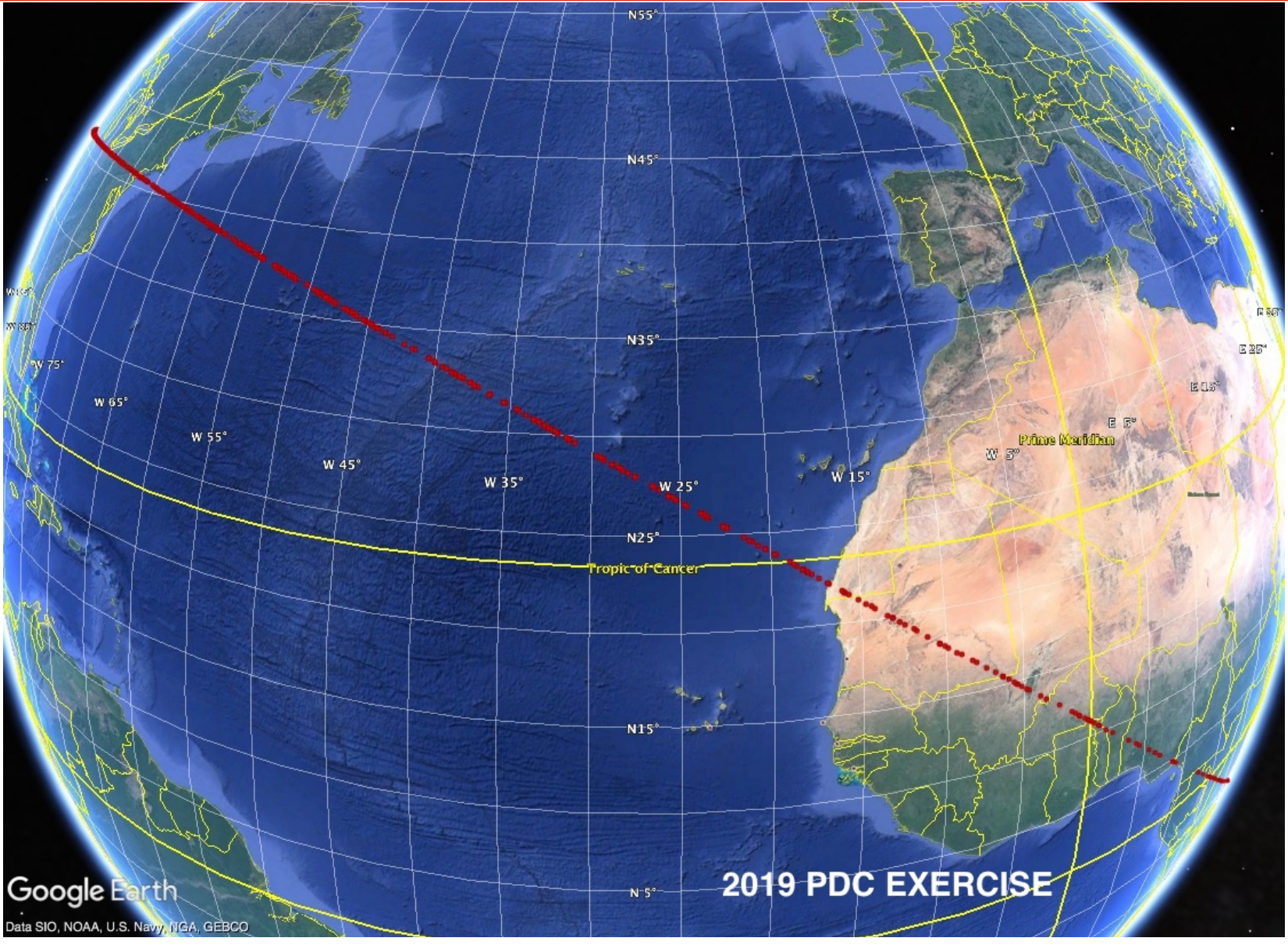
California Institute of Technology



EXERCISE

Observation Plans for 2019 PDC

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California Institute of Technology

- The International Asteroid Warning Network (IAWN) is coordinating international observation efforts for 2019 PDC
- The asteroid is approaching Earth and getting brighter; it will soon peak in brightness, at an expected magnitude of 20.3
- Closest approach will occur on May 13 at 0.13 AU (19 million km or 12 million miles), too distant for radar observations
- The asteroid will continue to be observable throughout 2019, but as it recedes from Earth it will become fainter, and larger telescopes will be required to detect it
- The asteroid will be too far away and therefore too faint to be detected for most of 2020

EXERCISE

2019 PDC: Observability Periods

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Telescope:

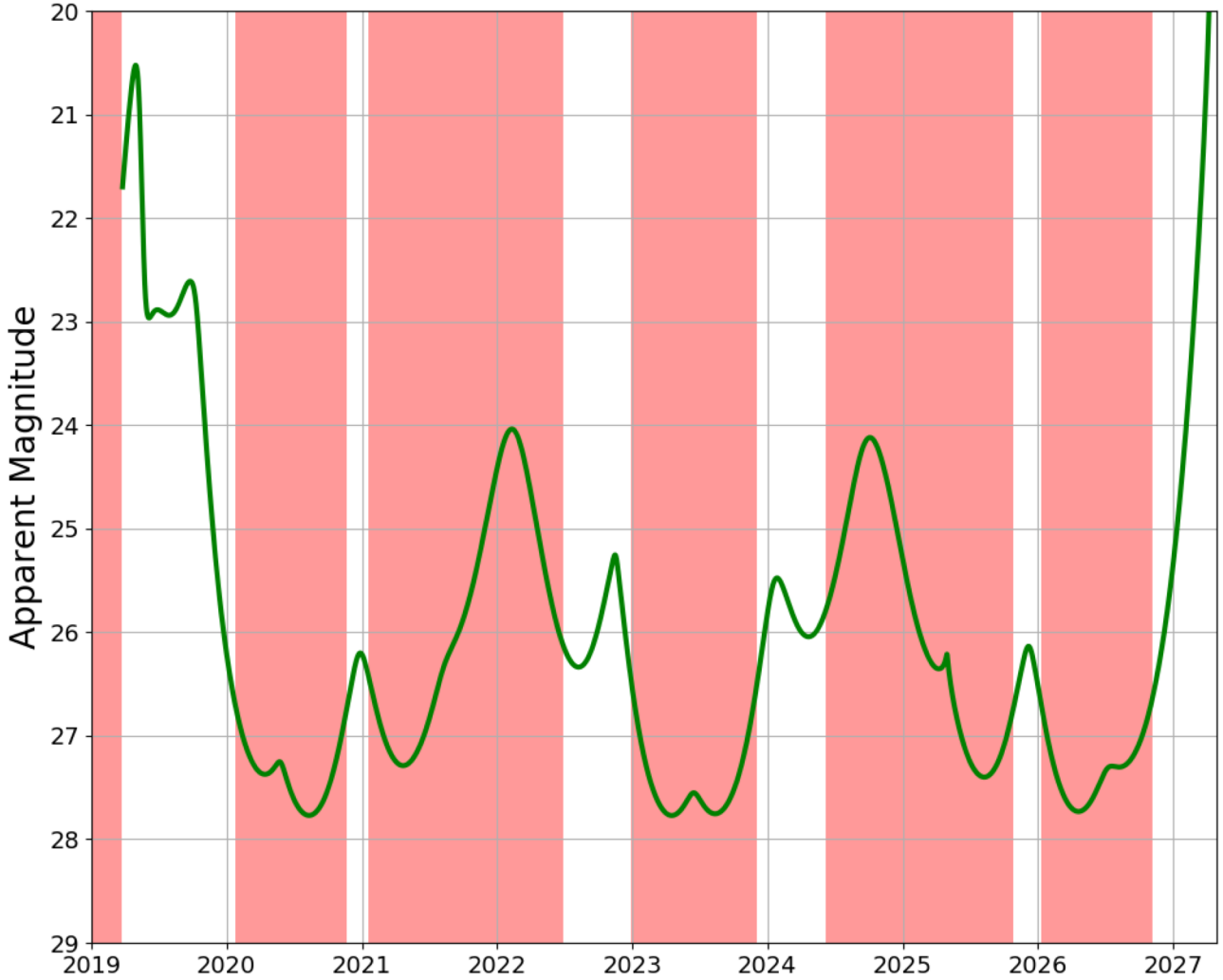
1 m

2 m

4 m

8 m

HST



Asteroid observable only during the un-shaded periods, when:

Vmag < 26.5

Solar Elongation > 50 deg

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EXERCISE

Will Impact Probability Increase or Decrease?

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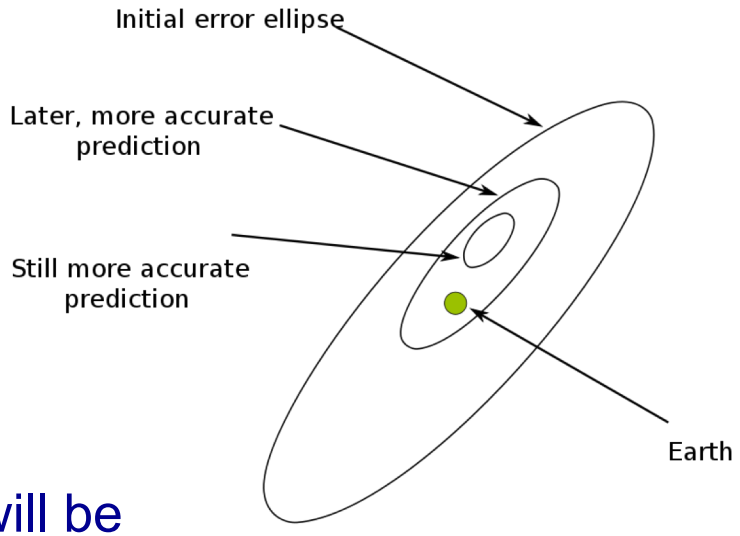
California Institute of Technology

- As 2019 PDC is tracked, it orbit will become more accurate and the uncertainty region for 2027 will shrink
  - If the region shrinks away from the Earth, impact probability goes down
  - If the region shrinks and Earth remains inside, the impact probability will grow



- Since we can predict when the asteroid will be observed, we can predict how much the uncertainty region will shrink, but we can't predict whether or not the Earth will remain inside
- The most likely outcome is that the region will shrink entirely away from the Earth, and the impact probability will then drop to zero
- But if the asteroid really is headed for impact, we won't be 100% certain of that until the uncertainty region becomes small enough, and that won't happen until observations are made in **late 2020**

EXERCISE ONLY!!

EXERCISE

2019 PDC: Initial Physical Properties

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- Measurements of an asteroid's brightness are used to estimate its "absolute magnitude", which is a proxy for its size
- An absolute magnitude corresponds to a wide range of possible sizes because the asteroid's albedo (reflectivity) is generally not known
  - For 2019 PDC, the absolute magnitude implies a size of 100 to 300 meters
- Radar is often used to provide much more accurate size estimates, but this asteroid will not approach within radar range
- Space-based infrared measurements provide a direct measurement of size.
  - NEOWISE is still active and the asteroid just passed through its field of view; that data comes down to the ground tomorrow
- The albedo and spectral class of an asteroid provide insights into its likely composition and density; these are important to know for planning possible mitigation

Deflection Options Being Considered

- The Space Missions Planning Advisory Group (SMPAG) has started to assess options for potential space missions to prevent a possible impact
  - SMPAG is composed of space agencies and assesses mitigation options and mitigation plans for consideration by its member states

EXERCISE

Apophis in 2004 vs. 2019 PDC Today

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California Institute of Technology

	Apophis	2019 PDC
Impact Probability	As high as 2.7%	1%
Size	300 - 700 meters	100 - 300 meters
Time to potential impact	25 years	8 years
Orbit	Mostly inside Earth's	Mostly outside Earth's
Number of close approaches before potential impact	6 within 0.25 AU 3 within 0.20 AU	1 within 0.15 AU

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CNEOS NEO Deflection App (NDA)

https://cneos.jpl.nasa.gov/nda/nda.html

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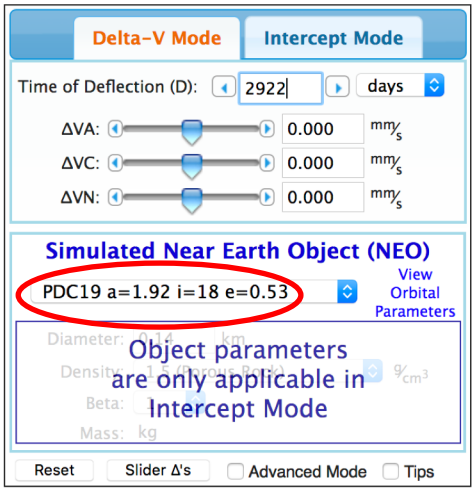
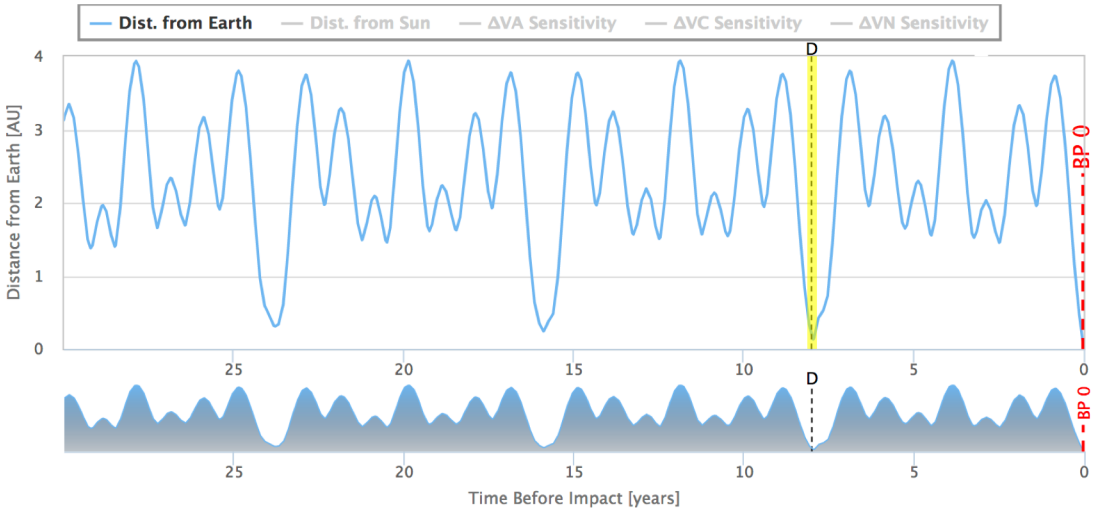
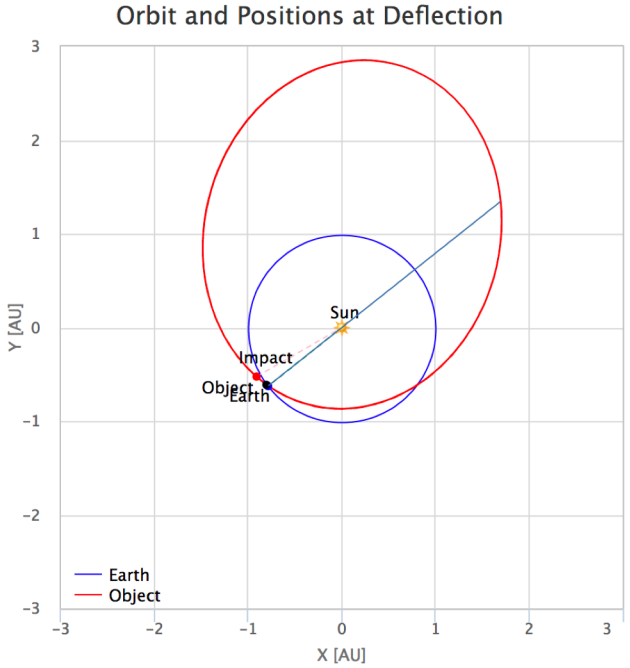




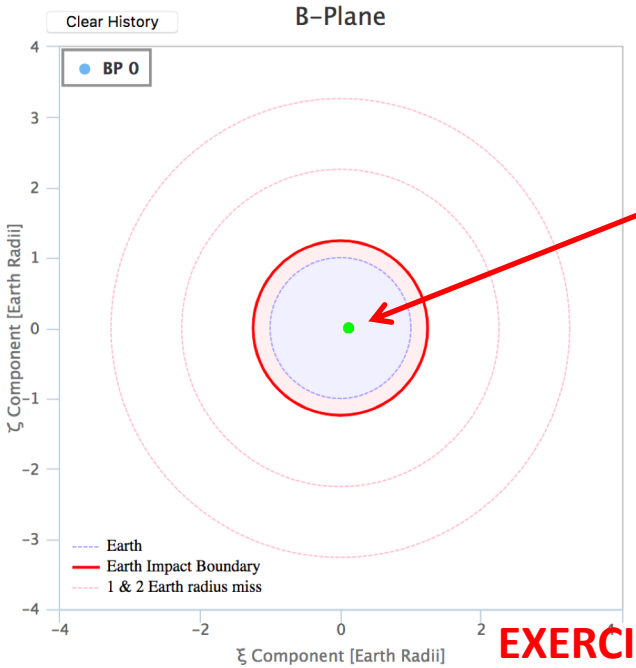


Orbit Changes
ΔVA: 0.000 mm/s
ΔVC: 0.000 mm/s
ΔVN: 0.000 mm/s
Total ΔV: 0.000 mm/s
Period at D: 971.041 d
Δ Period: 0.0000 s

B-Plane Values
ζ (zeta): 0.001 R_e
ξ (xi): 0.109 R_e
B magnitude: 0.109 R_e
Capture Rad.: 1.239 R_e
Perigee Dist.: 0.021 R_e
IMPACT
V_∞: 15.271 km/s

* R_e = Earth Radii

Save Current Session
Restore Session
Deflection Map



Initial Impact Location

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EXERCISE

2019 PDC in the B-Plane

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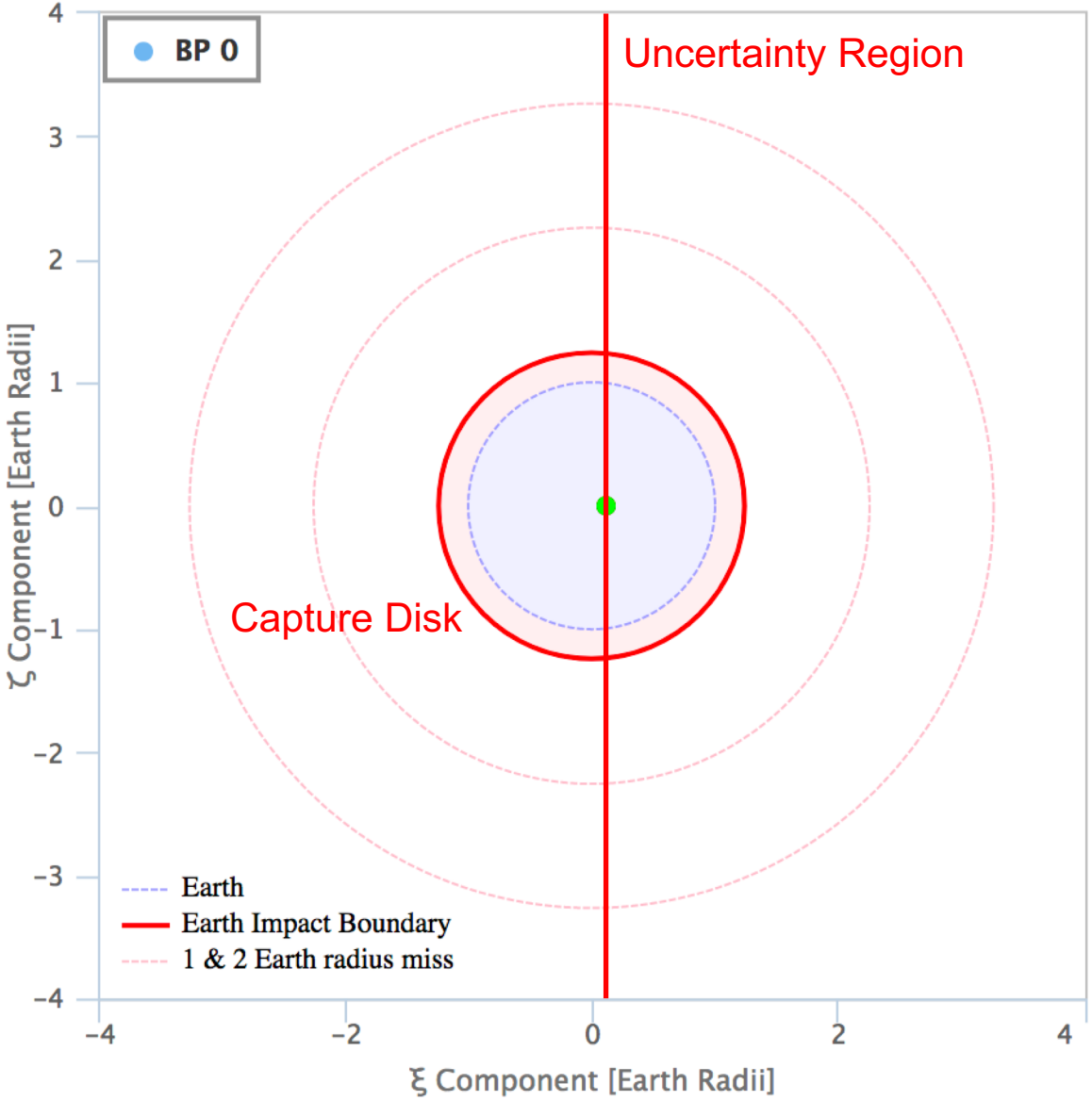

The B-plane shows where the asteroid is headed when it encounters Earth, with gravitational focusing removed

The region where trajectories will impact is the Capture Disk, and has radius > 1 Re

Axes oriented so that the heliocentric velocity of Earth projects vertically

EXERCISE ONLY!!

EXERCISE

2019 PDC in the B-Plane

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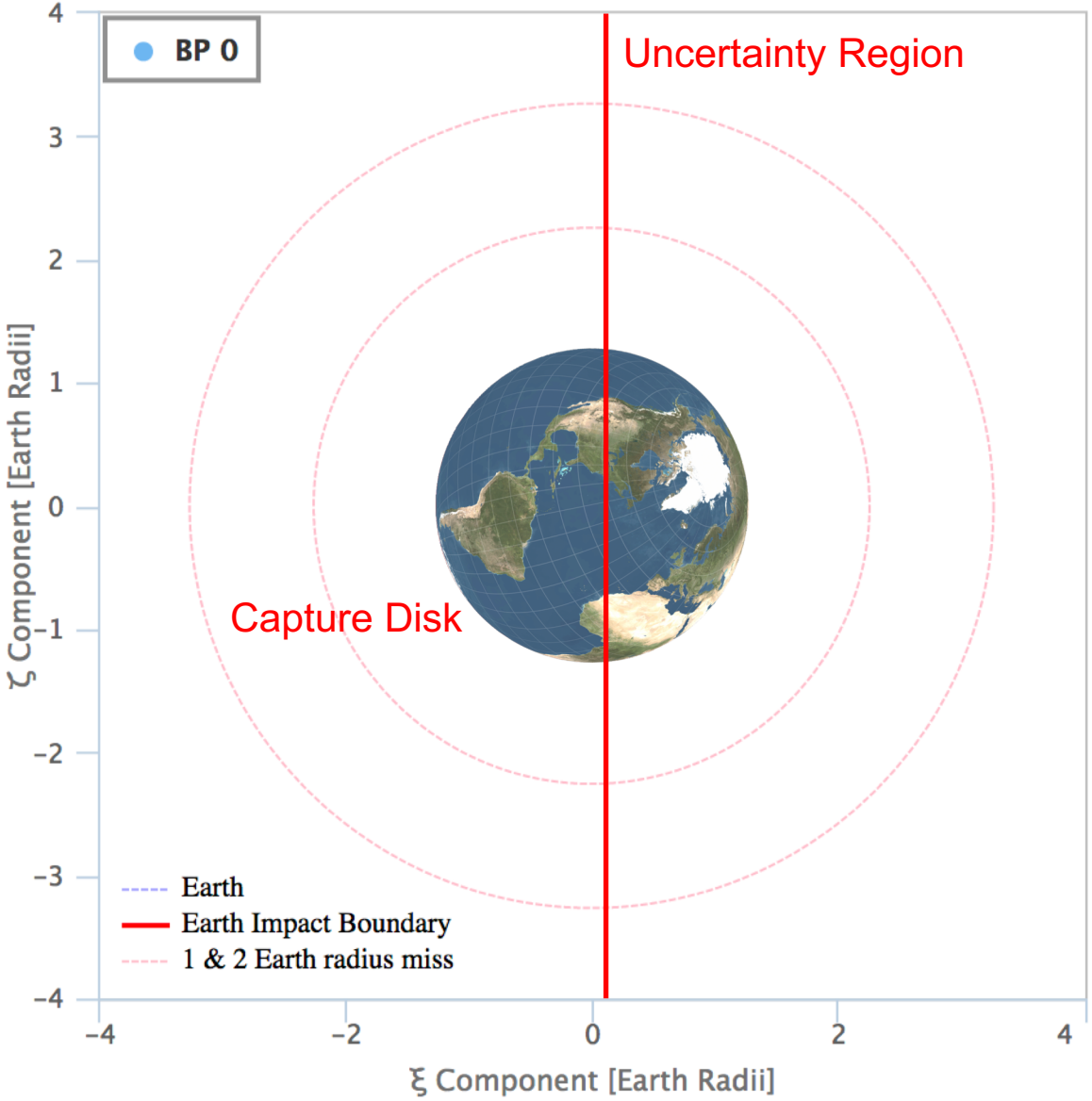

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