Jet Propulsion Laboratory
California Institute of Technology

π IN THE SKY 3

Peer through the haze on Saturn's cloaked moon, discover Mars from above, keep Earth's satellites powered, and put a spacraft into orbit around Jupiter. Just like NASA's science and engineering pros, you can do all that and more with pi!

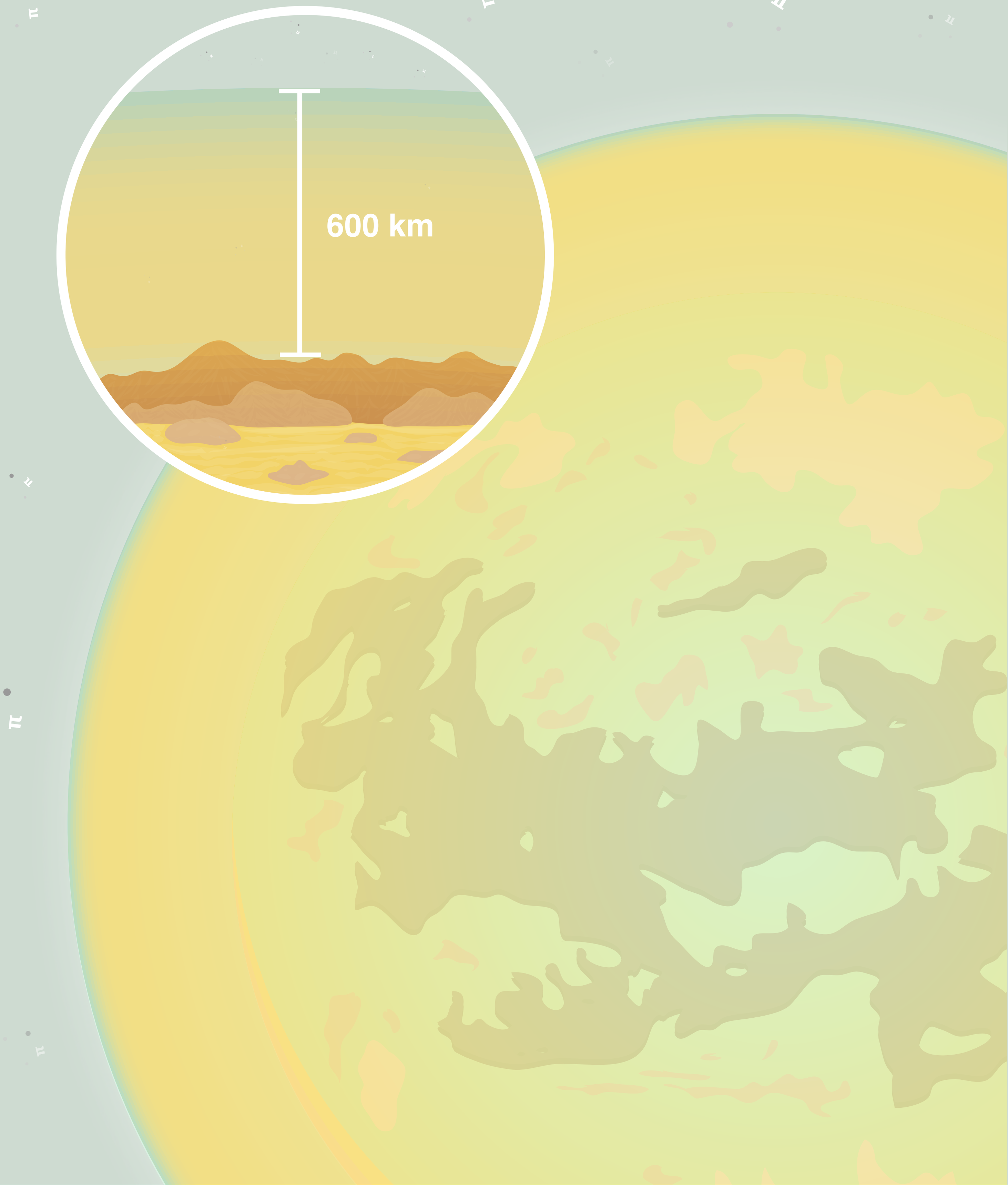
HAZY HALO

With its methane lakes and hazy atmosphere reminiscent of a primordial Earth, Saturn's moon Titan is an intriguing world – and one that scientists believe may harbor ingredients for life. Though spacecraft have studied Titan up close, and the Cassini mission sent a probe to the surface, much of the moon remains a mystery because a dense, 600-km thick atmosphere masks its rocky surface. To study Titan in more detail, scientists have proposed developing a spacecraft to map the surface of this mysterious moon.

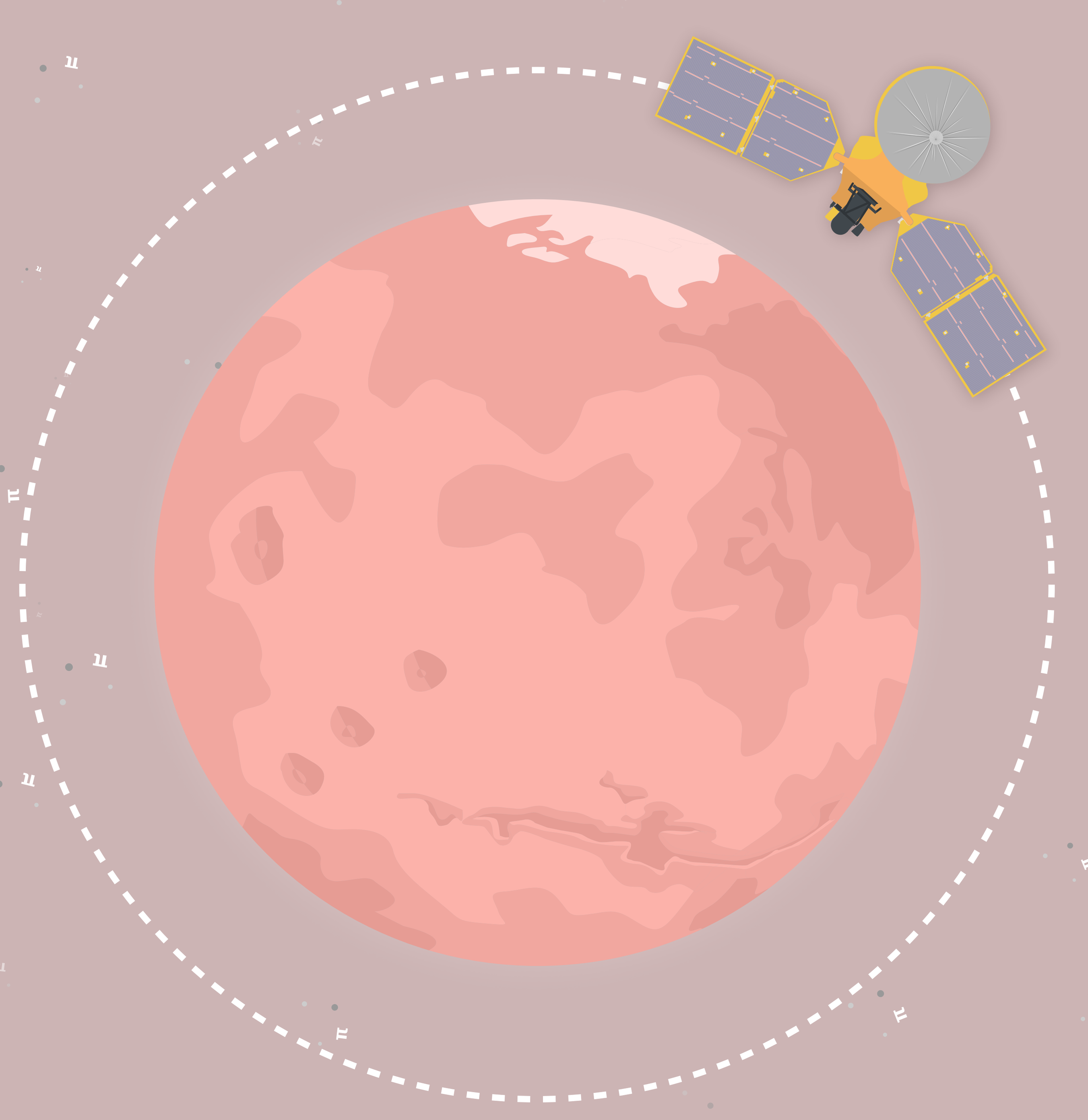
Given Titan's radius of 2,575 km, what percentage of the moon's makeup by volume is atmospheric haze?

If scientists hope to create a global map of Titan, what is the surface area that a future spacecraft would need to map?

LEARN MORE ABOUT TITAN
solarsystem.nasa.gov/planets/titan



ROUND RECON



The Mars Reconnaissance Orbiter (MRO) has been zipping around Mars since 2006, collecting data and images that have led to exciting discoveries about the Red Planet. So scientists can get the data and images they need from MRO, they must know when the spacecraft (traveling in a near-circular, near-polar orbit at an average speed of 3.42 km per second) will reach certain locations around Mars.

Given that Mars has a polar diameter of 6,752 km and MRO comes as close to the planet as 255 km at the south pole and 320 km at the north pole, how far does MRO travel in one orbit*?

How long does it take MRO to complete one orbit?

How many orbits does MRO complete in one Earth day?

*MRO's orbit is near enough to circular that the formulas for circles can be used.

LEARN MORE ABOUT THE ORBITER
mars.nasa.gov/mro

SUN SCREEN

A transit occurs when a planet passes in front of the disk of a star. As seen from Earth, only Mercury and Venus transit our star, the sun. During a transit, there is a slight dip in the amount of solar energy reaching Earth, which can be found using this equation:

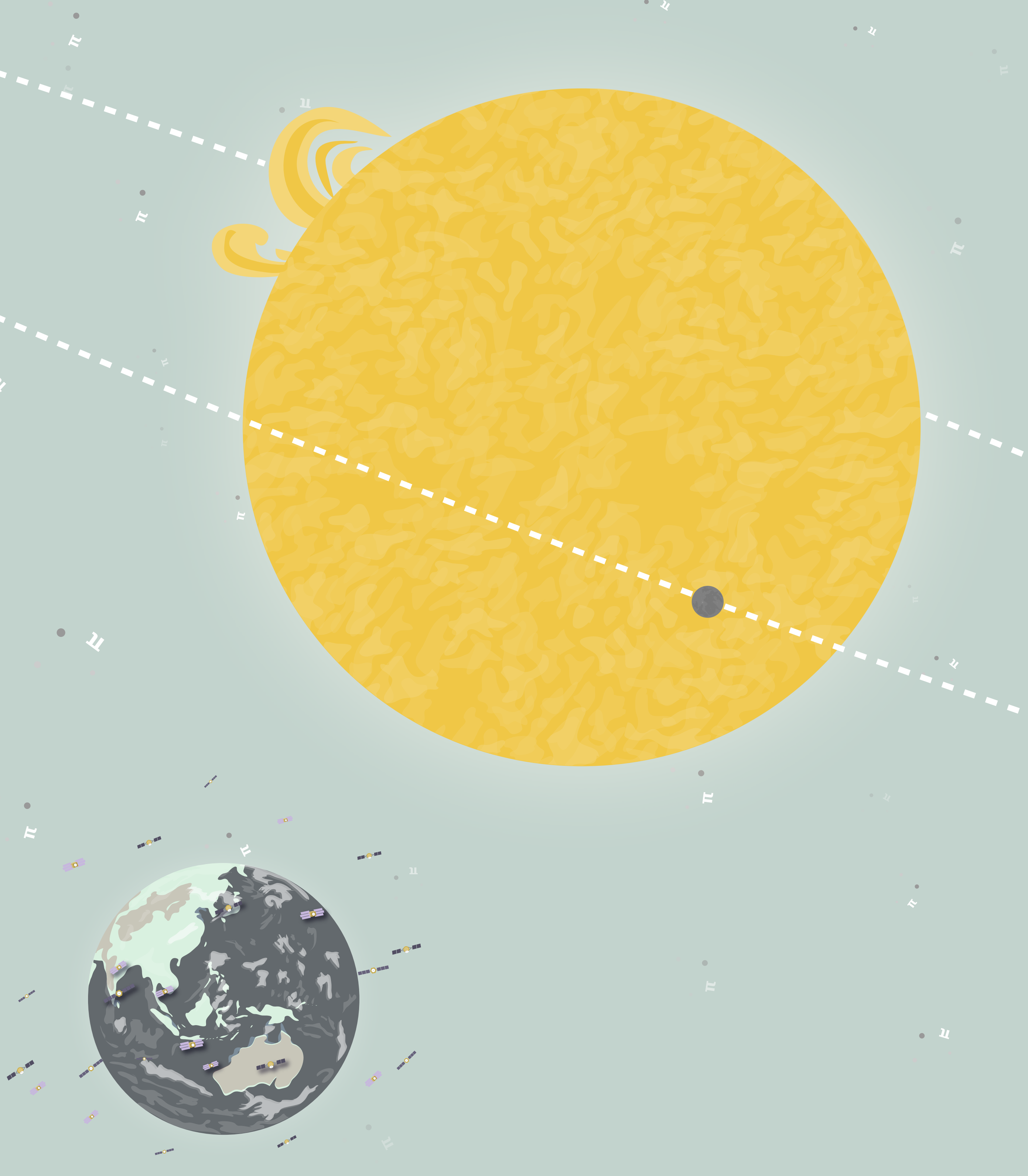
$$B\% = 100\left(\frac{\pi r^2}{\pi R^2}\right)$$

B = percentage drop in the brightness of the sun
r = the radius of the planet as it appears from Earth (in arcseconds)
R = the radius of the sun as it appears from Earth (in arcseconds)

With many solar-powered satellites orbiting Earth, it's important to know what impact a dip in solar energy might have.

If 1,360.8 w/m² of solar energy reaches the top of Earth's atmosphere, how many fewer watts reach Earth when Mercury (diameter = 12 arcseconds) transits the sun (diameter = 1,909 arcseconds)?

LEARN MORE ABOUT MERCURY
solarsystem.nasa.gov/planets/mercury



GRAVITY GRAB

The Juno spacecraft is hurtling toward Jupiter. At closest approach, it will reach a velocity of 57.98 km per second relative to the planet.To get into orbit around Jupiter, Juno will have to brake at just the right time to be pulled in by Jupiter's gravity or miss its target completely.

By how much does Juno need to change its velocity relative to Jupiter to get into a 53.5-day orbit around the planet?

Use these equations to approximate a solution assuming Juno could instantaneously decelerate at perijove:

$$T = 2\pi\sqrt{\left(\frac{a^3}{\mu}\right)}$$

$$E = \frac{-\mu}{2a} = \frac{v^2}{2} - \frac{\mu}{r}$$

T = orbital period (in seconds)
E = total orbital energy
a = semi-major axis of the orbit (in km)
μ = gravitational parameter for Jupiter $\left(126{,}686{,}536\ \frac{km^3}{sec^2}\right)$
v = velocity of Juno relative to Jupiter after deceleration
r = radius of Juno at perijove (76,006 km)

LEARN MORE ABOUT THE MISSION
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