ABOUT THE AUTHOR:

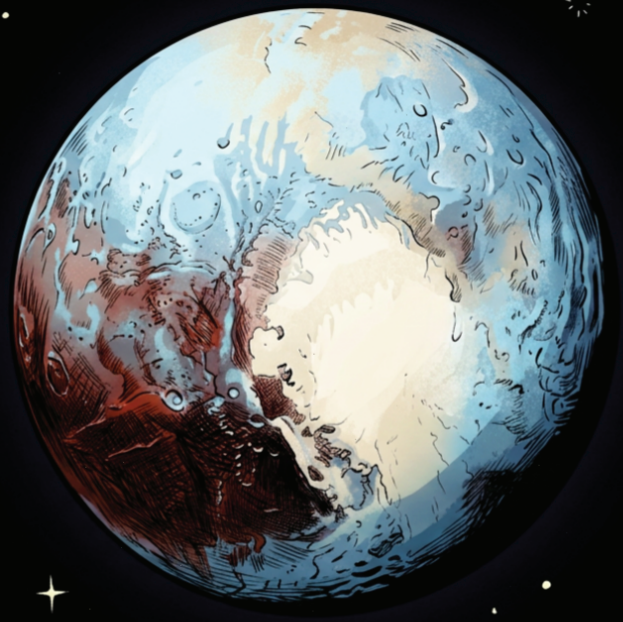


BP Blakley is a PhD student in Planetary Science at Johns Hopkins University. Their research focuses on questions like, how does the atmosphere of Titan affect its surface? And how does the surface of Pluto affect its atmosphere? And, How do atmospheric and surface conditions affect the formation of Pre-life compounds?

LEARN MORE ABOUT THE NEW HORIZONS MISSION:

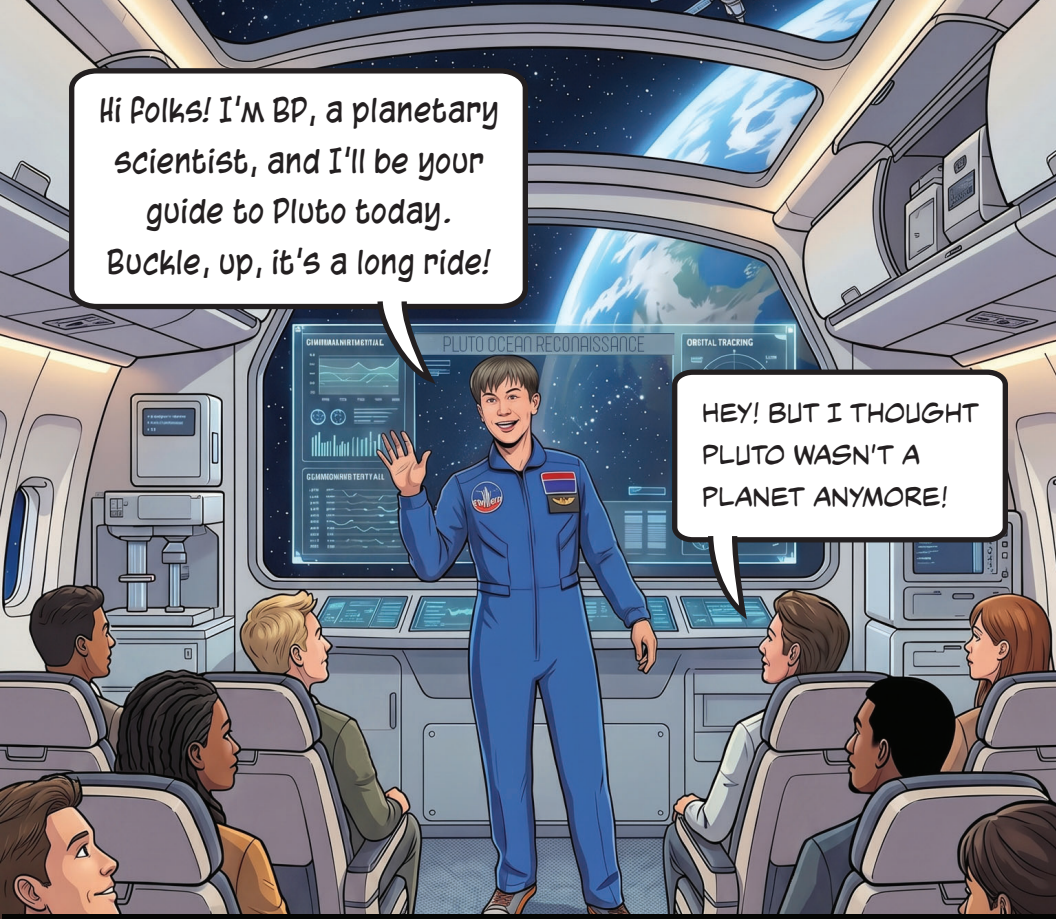
ADVOCATE FOR NASA AND NSF SCIENCE FUNDING:

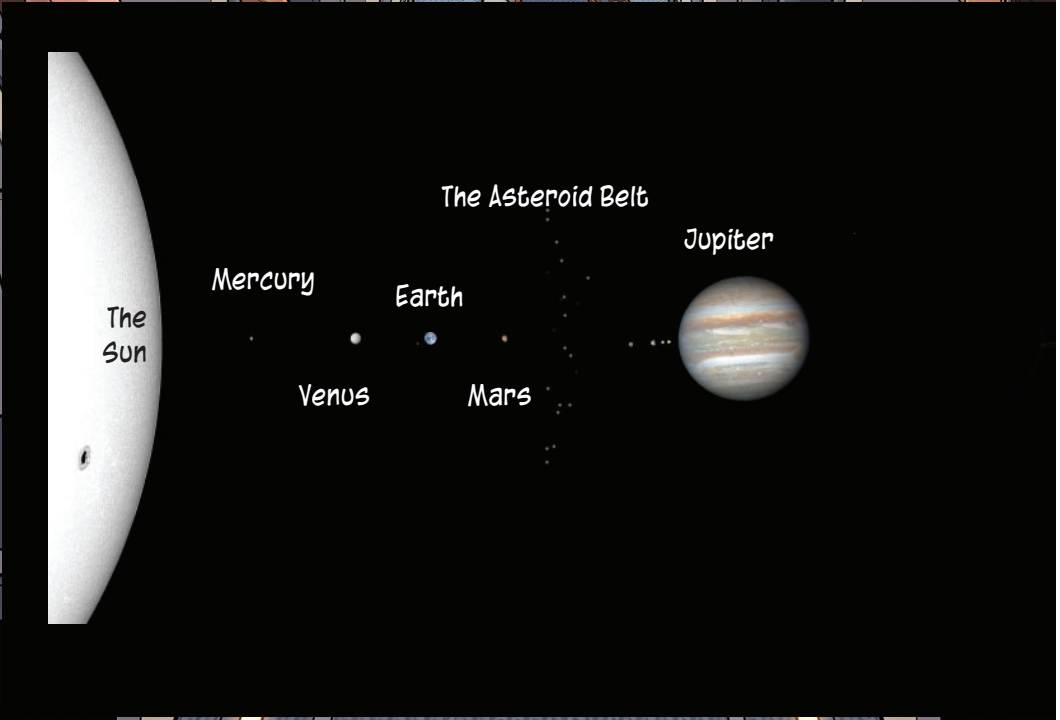
All photographs of Pluto are genuine, from NASA data, and used under Public Domain and/or applicable Fair Use laws. Illustrations not otherwise credited were created using generative AI.

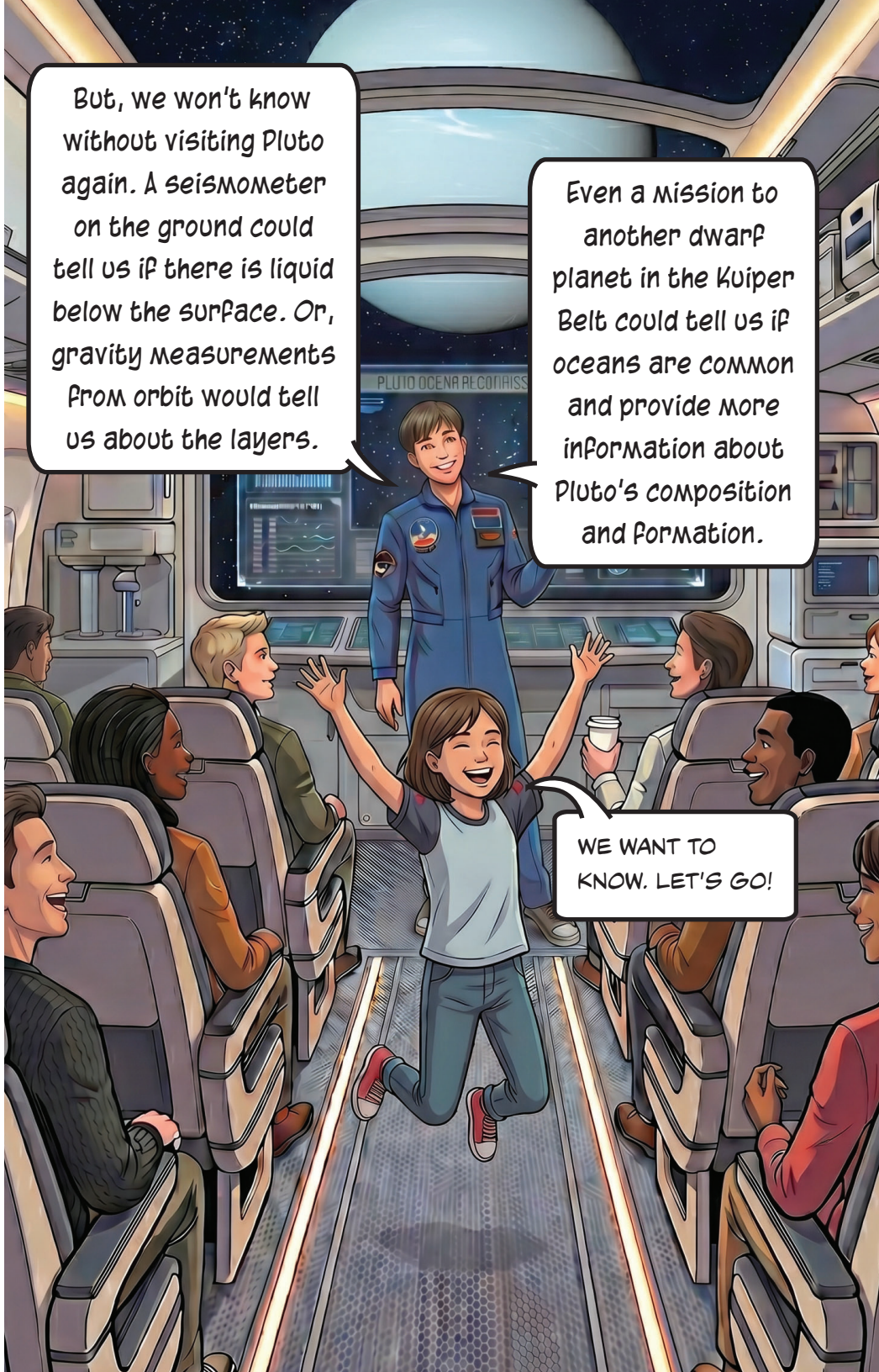


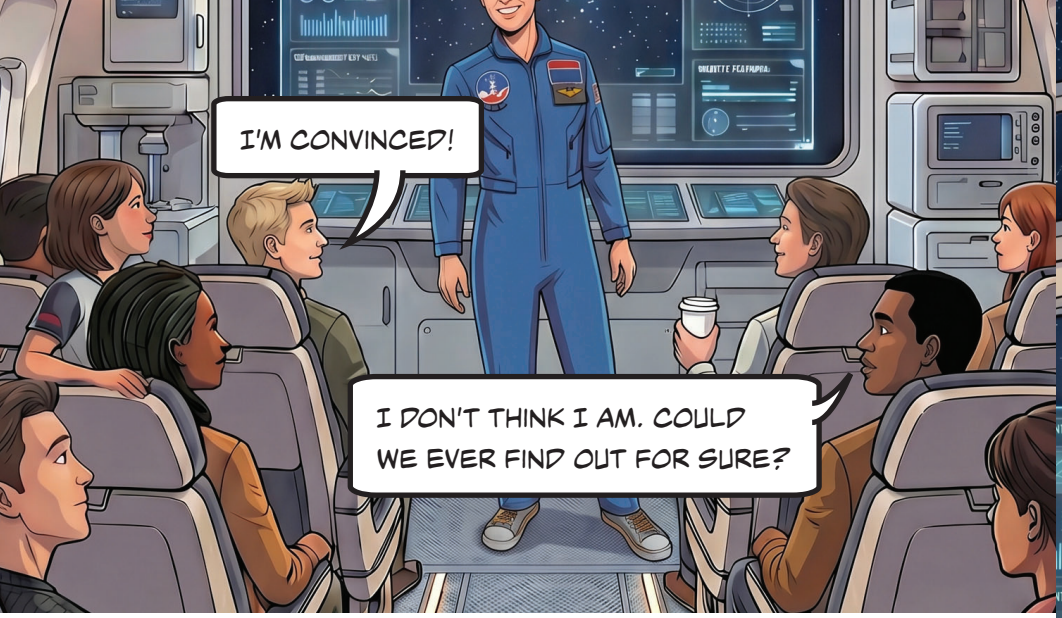
PLUTO AND THE *OTHER* HABITABLE ZONE

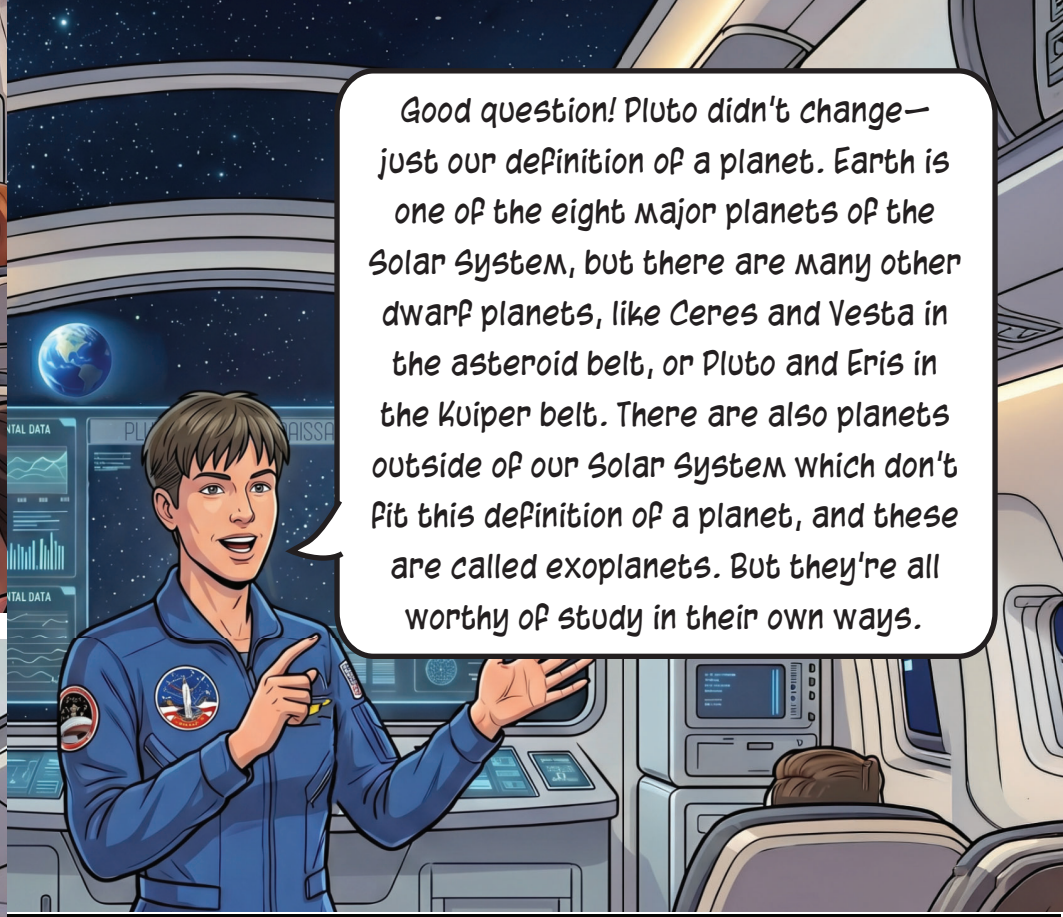
By B.P Blakley

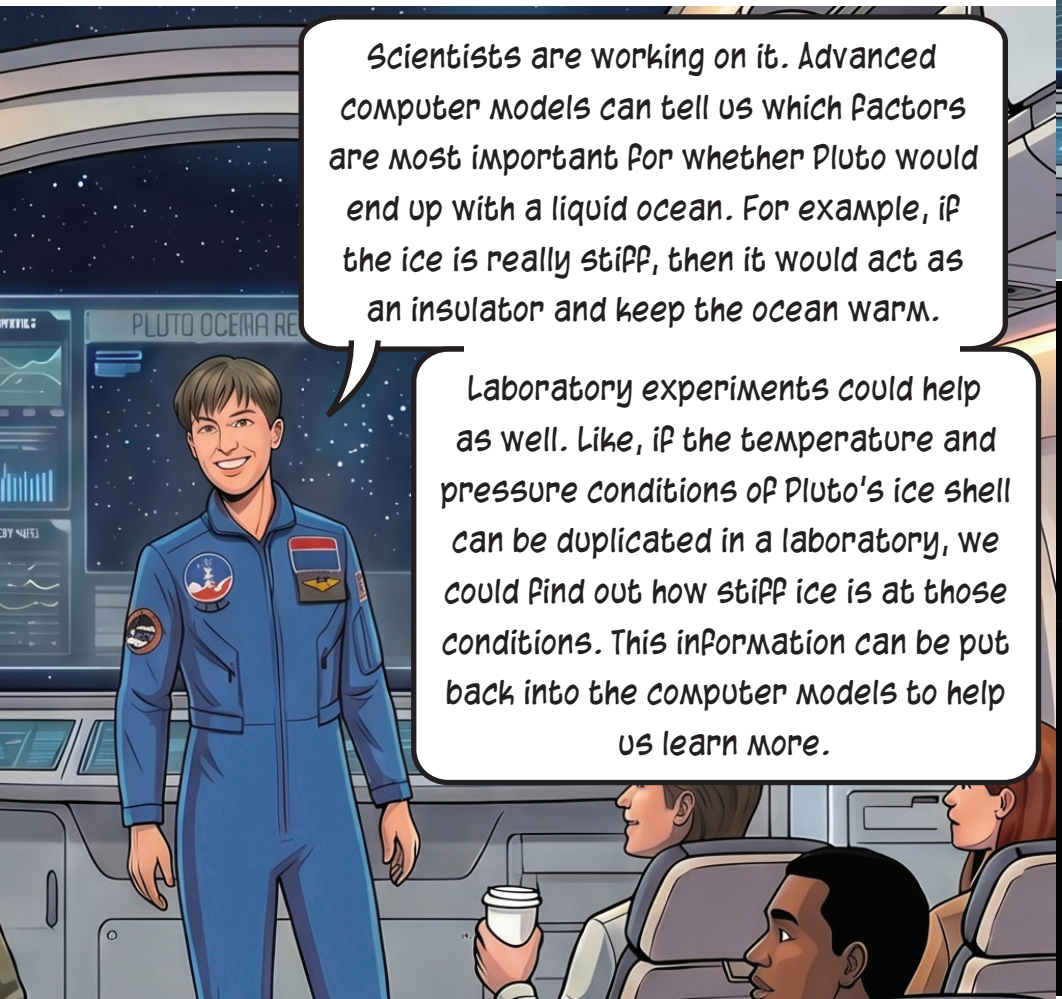

Hi folks! I'm BP, a planetary scientist, and I'll be your guide to Pluto today. Buckle, up, it's a long ride!
HEY! BUT I THOUGHT PLUTO WASN'T A PLANET ANYMORE!
PLUTO OCEAN RECONAISSANCE
ORBITAL TRACKING

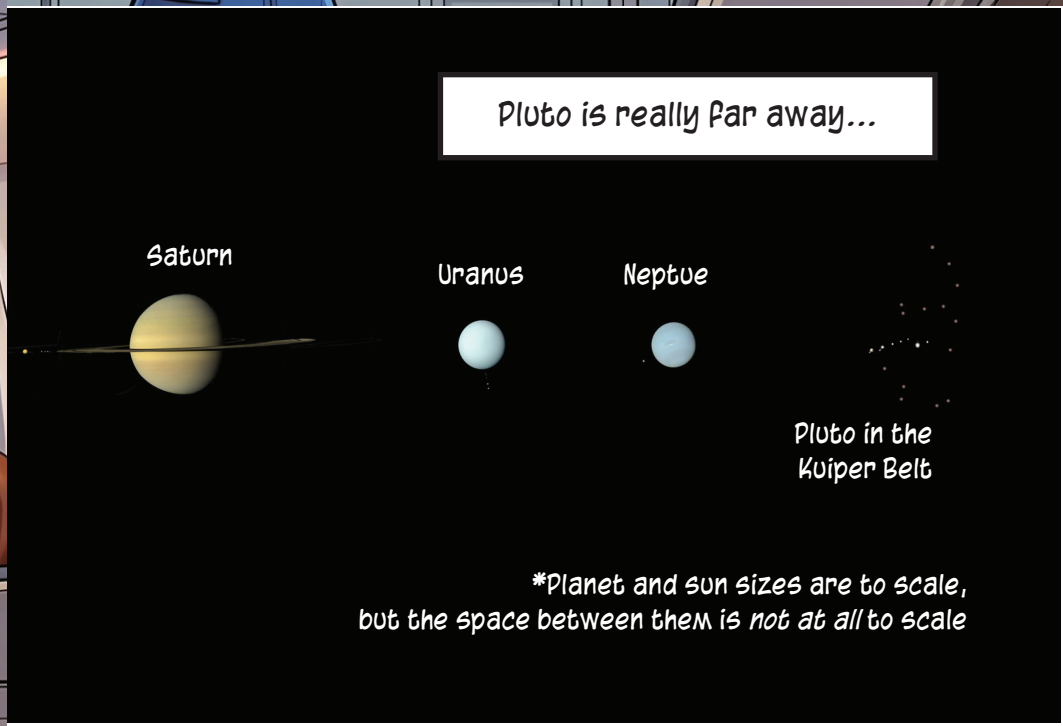

The Sun
Mercury
Venus
Earth
Mars
The Asteroid Belt
Jupiter


But, we won't know without visiting Pluto again. A seismometer on the ground could tell us if there is liquid below the surface. Or, gravity measurements from orbit would tell us about the layers.
Even a mission to another dwarf planet in the Kuiper Belt could tell us if oceans are common and provide more information about Pluto's composition and formation.
WE WANT TO KNOW. LET'S GO!


I'M CONVINCED!
I DON'T THINK I AM. COULD WE EVER FIND OUT FOR SURE?

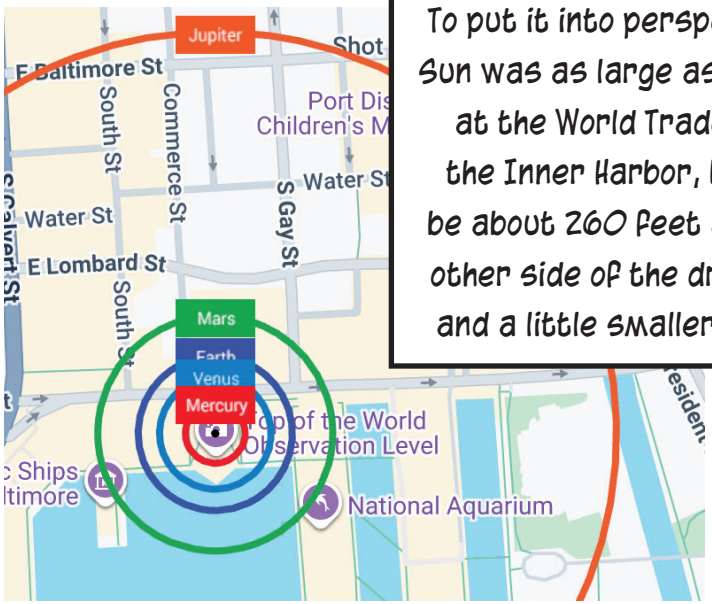

Good question! Pluto didn't change—just our definition of a planet. Earth is one of the eight major planets of the Solar System, but there are many other dwarf planets, like Ceres and Vesta in the asteroid belt, or Pluto and Eris in the Kuiper belt. There are also planets outside of our Solar System which don't fit this definition of a planet, and these are called exoplanets. But they're all worthy of study in their own ways.

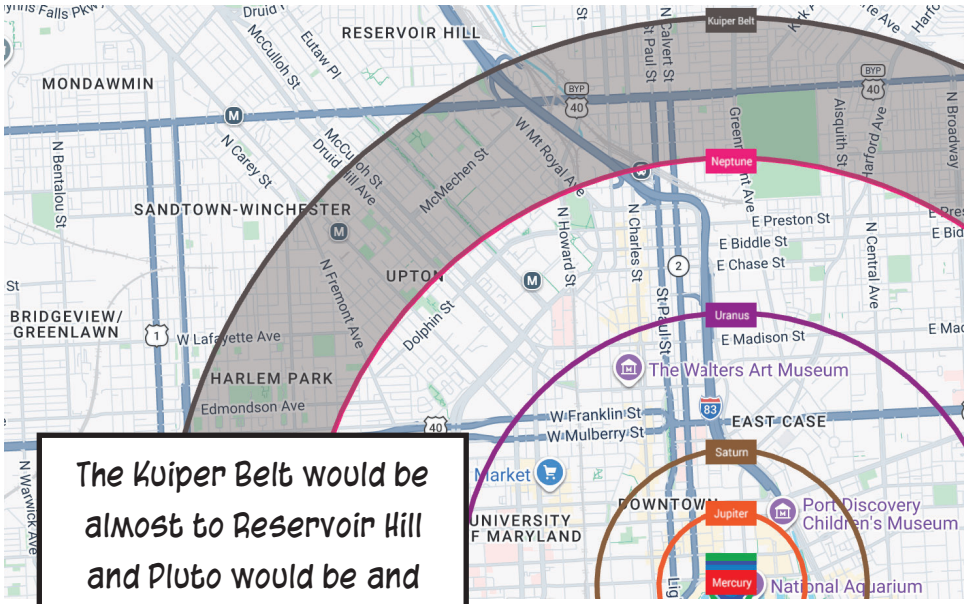

Scientists are working on it. Advanced computer models can tell us which factors are most important for whether Pluto would end up with a liquid ocean. For example, if the ice is really stiff, then it would act as an insulator and keep the ocean warm.
Laboratory experiments could help as well. Like, if the temperature and pressure conditions of Pluto's ice shell can be duplicated in a laboratory, we could find out how stiff ice is at those conditions. This information can be put back into the computer models to help us learn more.


Pluto is really far away...
Saturn
Uranus
Neptue
Pluto in the Kuiper Belt
*Planet and sun sizes are to scale, but the space between them is *not at all* to scale

...40 times further from the Sun than Earth!

To put it into perspective, if the Sun was as large as a basketball at the World Trade Center in the Inner Harbor, Earth would be about 260 feet away (on the other side of the dragon boats) and a little smaller than a pea.

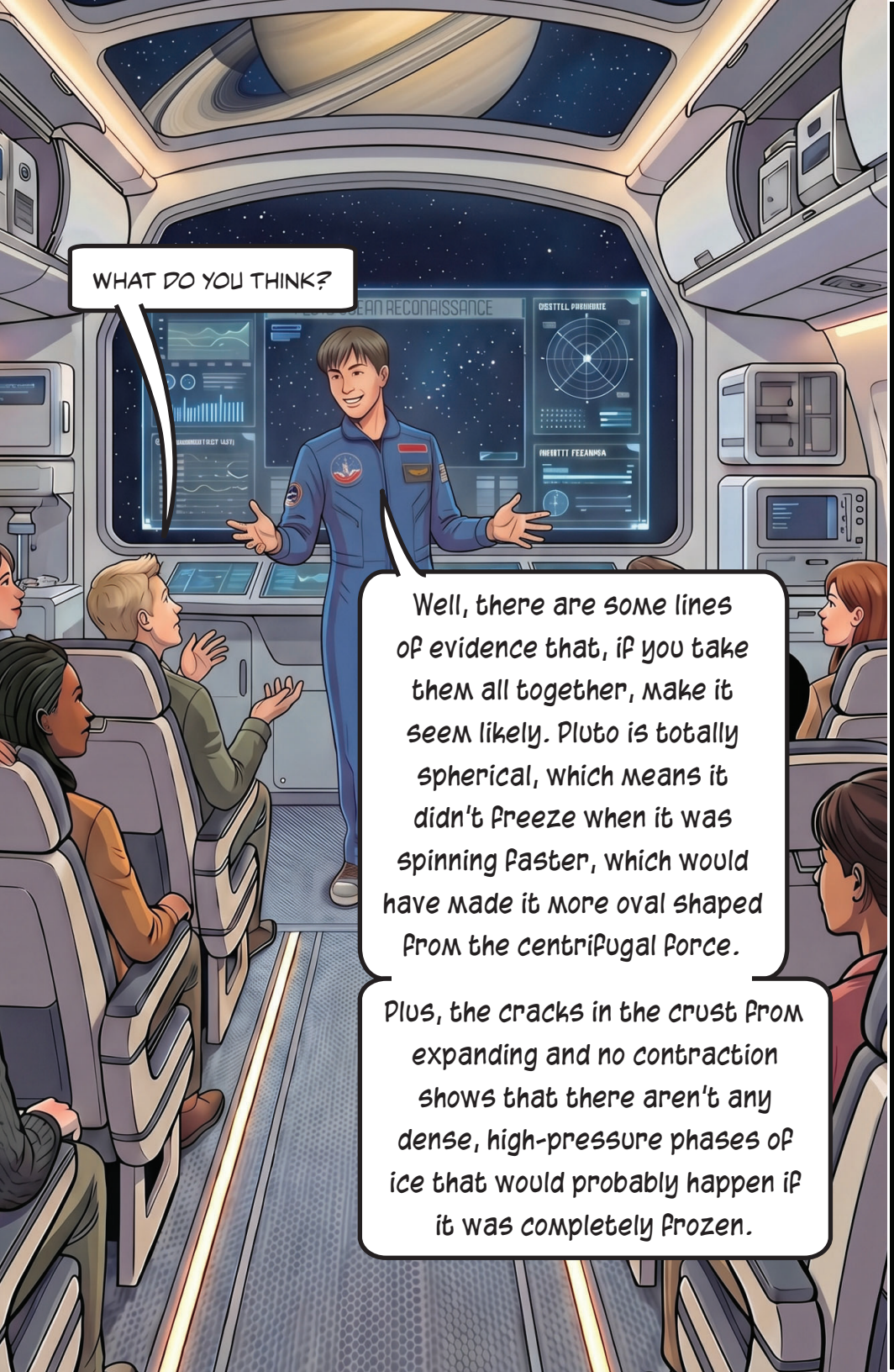




The Kuiper Belt would be almost to Reservoir Hill and Pluto would be and as wide (but not as long) as a grain of rice.

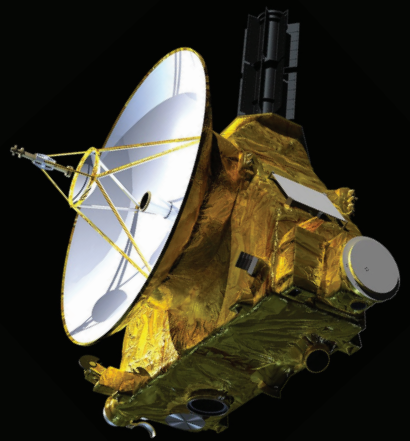
And, there are some features that look like cryovolcanoes, which are like volcanoes on Earth, but liquid water comes out instead of liquid rock. The liquid would have to come from below the surface.

Wright Mons: a potential cryovolcano, south of Sputnik Planita on Pluto. Image from New Horizons, credit NASA / Johns Hopkins University Applied Physics Laboratory / Southwest Research Institute



...but we sent a spacecraft to it!

New Horizons launched in 2006—the fastest traveling spacecraft ever launched by humans, and it took almost ten years to get to Pluto.

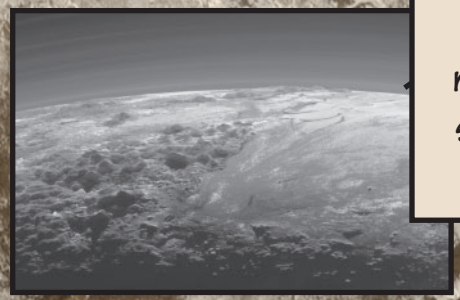


Pluto receives **1600 times less** sunlight than Earth, so many people expected it to just be a frozen rock, but New Horizons found beautiful landscapes and a thin atmosphere



Composite stretched color image of Pluto and Charon taken by New Horizons. Credit: NASA / Johns Hopkins University Applied Physics Laboratory / Southwest Research Institute

And we learned a lot from New Horizons:



Pluto has a thin and hazy atmosphere mostly made of nitrogen from the sublimation of its ice caps.

Pluto's crust is made of water ice, which peaks through in these deep troughs. **It's so cold on Pluto that the ice is as hard as granite.**

Pluto only has the type fault lines from Plutoquakes caused by the stretching of its crust, but no signs of the opposite. On Earth we find both types.

And, if Pluto's ocean has ammonia in it—which is very common in the Solar System—it would act like antifreeze and allow the ocean to stay liquid at lower temperatures.

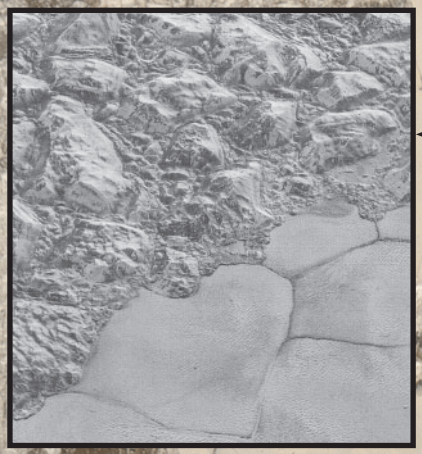
Yep! But, just because it's possible that Pluto still has liquid water below its surface, it doesn't necessarily mean that it does.

THAT'S WHY WE PUT SALT ON THE SIDEWALK BEFORE A SNOWSTORM IN THE WINTER!

And, depending on how much heat Pluto started with, and how well insulated it is, it's *possible* that the ocean hasn't completely frozen yet.

LIKE HOW MY PAPER CUP OF COFFEE ALREADY GOT COLD, BUT IF I HAD BROUGHT MY INSULATED MUG, IT WOULD STILL BE HOT?

Exactly!



The mountains on Pluto are made of water ice, and the **glaciers are made of nitrogen ice!**

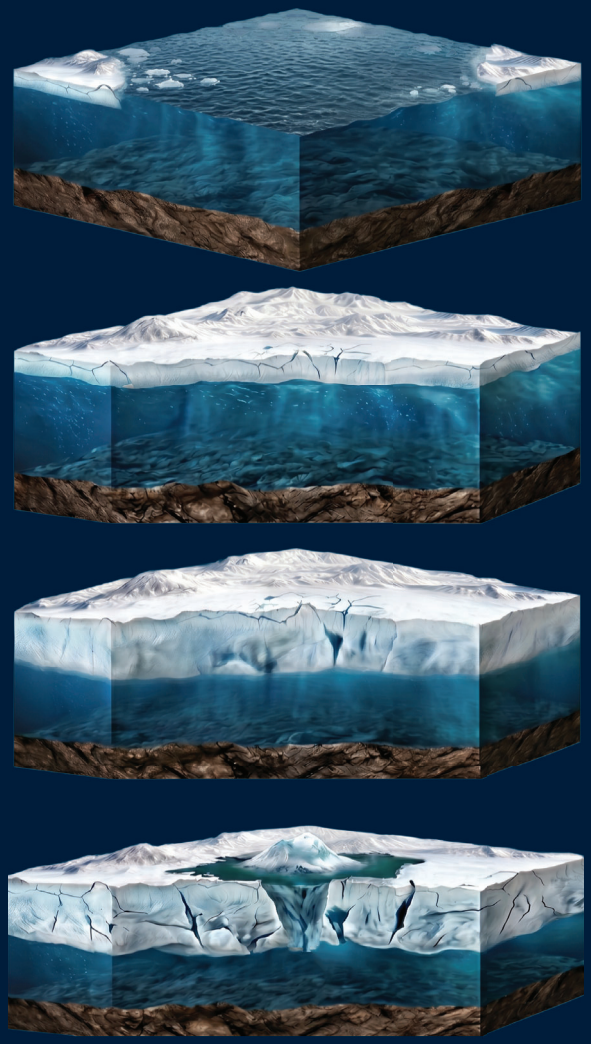
A large, light-colored plain on Pluto called Sputnik Planitia, which forms the western half of Pluto's "heart", is a huge basin formed by a giant impact, and filled by **convecting solid nitrogen**—like boiling water in a pot! It has almost no craters on it, which means it's a very young surface.

Older terrains are pitted by lots of craters and covered by a reddish substance that seems to be made of **complex organic molecules** that are created by Pluto's atmosphere reacting with sunlight.

But we still have a lot of questions.



Also, water expands when it freezes—which is why if you leave a can of soda in the freezer, the top and bottom get pushed out. Pluto shows signs of expanding from freezing. Which means there must have been at least some liquid to freeze.



A global ocean freezes from the top down

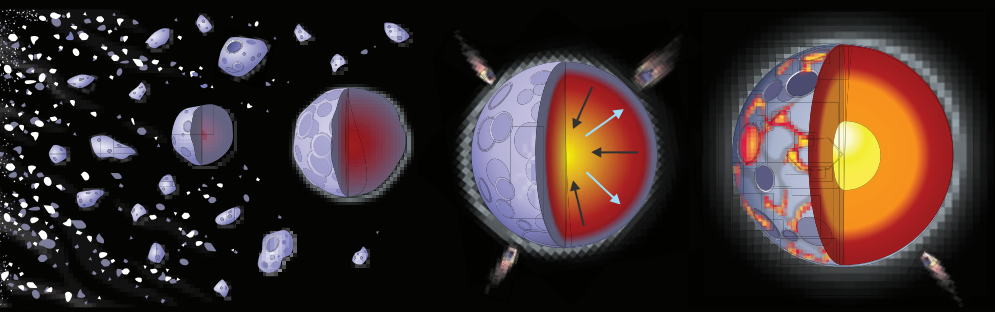
The ice forms a global layer and expands as it freezes

As the water at the bottom of the ice layer freezes, it builds pressure on the ocean below it.

Eventually, the pressure becomes too high, and the ice cracks open to release the pressure and/or cryovolcanoes form where liquid seeps onto the surface.

Scientists have asked each other these questions too! We've reached agreement on one thing at least— **Pluto *did* have an ocean.**

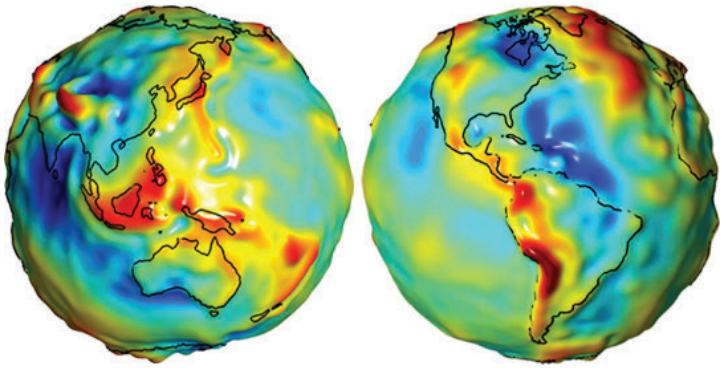
We can tell from the way Pluto spins (what's called it's Moment of Inertia) that it is *differentiated*, meaning that the planet is layered so that the densest material is in the middle, and the lightest material is on the outside. In order for that to happen, it had to have melted in the past.



A planet forms as small pieces clump together. Eventually it becomes large enough that heavier, denser materials fall to the middle and lighter material floats to the outside. Illustration by Woudloper - Own work, CC BY-SA 4.0 (Wikimedia)

On Earth, gravity feels constant, but it actually changes by tiny amounts depending on how much stuff (mass) is below your feet. With gravity measurements, we can tell how dense and how thick the planet's crust is and how it varies, and that can help us understand what's below the surface.

3d Gravity Map of Earth with topography subtracted from NASA Science

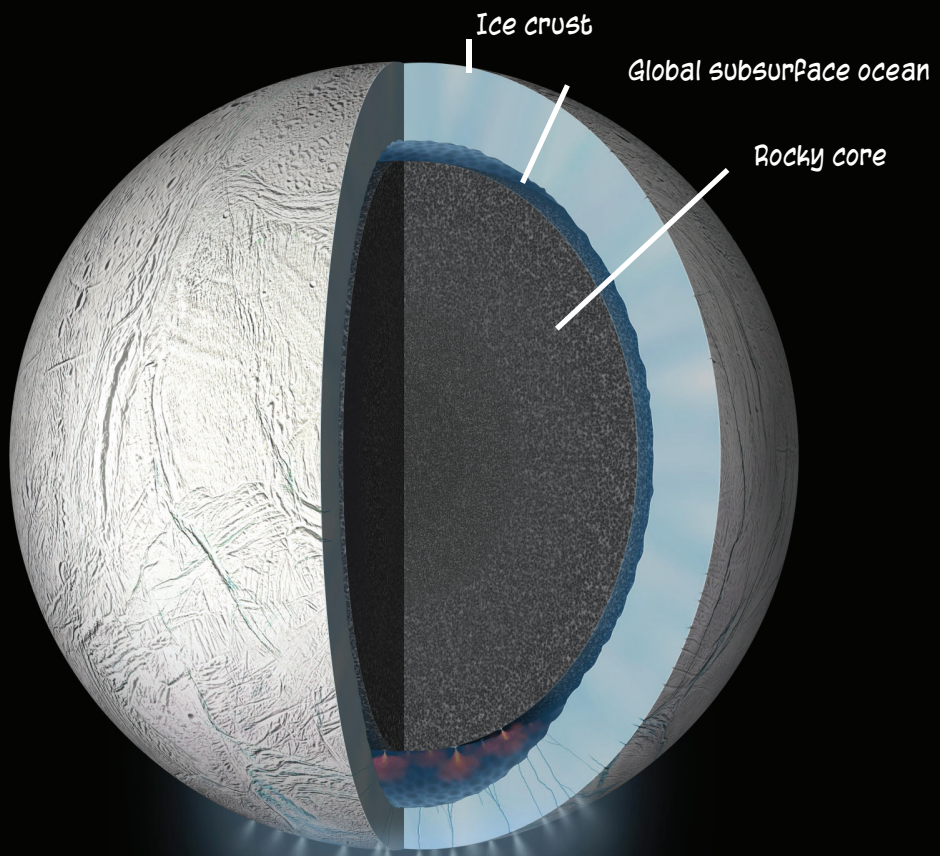


New Horizons couldn't take gravity measurements, so a big question left unanswered is: **is Pluto an ocean world**, or just a frozen ball of ice and rock?

UM, WHAT'S AN OCEAN WORLD?

Good question!...

An ocean world is a planet or moon like Jupiter's moon Europa, or Saturn's moon Enceladus* that has an ice crust covering a global liquid water ocean.



Artist's rendition of Enceladus, courtesy NASA/JPL-Caltech

*prounounced En-SELL-uh-dis

THAT DOES SOUND COOL... BUT, WHY DOES IT MATTER IF PLUTO IS AN OCEAN WORLD, IF IT'S SO FAR AWAY?

On Earth, where we find water, we find life. So far, **we haven't found life anywhere outside of Earth**—in the entire Universe! Are we all alone? One way that scientists are trying to start to answer that question is by looking for planets with liquid water. And if cold, distant Pluto can have an ocean, that might expand the number of possible worlds to look for life.

I'M ON BOARD WITH THAT-- BUT ***CAN*** PLUTO HAVE AN OCEAN? I MEAN, IF IT'S SO COLD AND DISTANT, WHY DO WE THINK THERE MIGHT BE AN OCEAN ANYWAY?