

*Geodesy is a science that covers the Earth itself. It's the reason we know where we are, and how we can make maps of where we are and where we want to go. In this episode, learn how this science with an unfamiliar name shapes much of what we do every day.*

## 📷 Earth from Space

While we often think of the Earth as a sphere, our planet is actually very bumpy and irregular. Geodesy is the science of accurately measuring and understanding the Earth's geometric shape, orientation in space, and gravity field. This composite color full-disk visible image was captured on January 15, 2017, by GOES-16, the first spacecraft in NOAA's next-generation of geostationary satellites.

0:00 / 0:00

## Transcript

HOST: You're listening to the NOAA Ocean podcast... I'm Megan Forbes. In this episode we're going to talk about a science that affects our everyday lives, but that you might not be familiar with. In fact, I would venture to guess that most people have never heard of it. I'm talking about geodesy. Geodesy is the science that accurately measures and understands our planet's geometric shape, its orientation in space, and its field of gravity. All of these things have an important effect on our lives, but are always working the background where most of us don't notice. Geodesy is so important that NOAA has an entire program offices dedicated to geodetic information. I wanted to learn more about geodesy, so I sat down with Galen Scott with the Geosciences Research Division of the National Geodetic Survey, and we talked about the basics of this science and why it is such a fascinating subject.

HOST: Thanks, Galen, for meeting me here today at the Collaboration Center in the NOAA Campus in Silver Spring. So why don't you walk us through a little bit about geodesy. I have to say, before I came to NOAA, I had never heard the word *geodesy*, although I understood time and space and gravity separately, I certainly didn't know of the science that puts that all together. Even after working here, I still had to do some research on it – so I thought, “why not talk to somebody who knows a lot about it” so you can explain it to me and hopefully to any of our other listeners out there.

GALEN SCOTT: Great! Well, thanks for having me, I'm really glad to be talking to you today. Geodesy is the study of the size and shape of the Earth and how we position ourselves upon it. It also has to do with the study of gravity and the variations of gravity across the planet...because that has implications for the instruments that we use to do surveying, it has implications for which way water flows. It's a science that covers the Earth itself, how we know where we are, and how we can make maps of where we are and where we want to go. If a person is considering just the town or the village where they are, [they] can essentially think of the Earth as a flat surface, because they're only going relatively small distances. Once you start going farther and farther away, you need to start accounting for the fact that the Earth is curved. The Earth curves at about 8 inches per mile.

HOST: So how would you describe the shape of the Earth...because that's really important to understanding geodesy, right?

GALEN SCOTT: Right. So the Earth is what we call an oblate spheroid. It's a sphere, but it's kind of squished and it is fatter in the middle at the equator than it is at the poles. It's actually rather “lumpy and bumpy”...it's not a perfect sphere. Being able to measure that and monitor that requires being able to basically see it from out in space. If you think about navigation – what this really started with was navigation and the questions of “how do I get there?”, “which direction do I need to go to get from one place to another?” and “how far is it?”- all of those questions require some geodesy. We have to account for that curvature of the Earth, so making a map of a large area gets to be a little more complex than making a map of a small town. Geodesy is about measuring angles and distances. We started off looking at astronomic angles and distances to the stars to support navigation. Historically, we used the stars for navigation, and the



addressing system for those places. So that concept of having a consistent national coordinate system is what my office is responsible for. The National Geodetic Survey is responsible for what is called the National Spatial Reference System. That Reference system provides that foundational reference frame for all kinds of geospatial activity, to make sure we're all starting at the same zero point, at the same coordinates, and we can do this building and this construction and be confident that things will meet in the middle where they are supposed to.

HOST: So you talked about the National Spatial Reference System...how does geodesy translate between countries?

GALEN SCOTT: The National Spatial Reference System takes part of what is called the International Terrestrial Reference Frame, that works on a global scale and is a best-fit for the globe as a whole, and we kind of massage that and move it and change it around a little so that it is more accurate for the U.S. The mapping system in the U.S. is defined by our Federal agency, but other agencies and other countries around the world create their own reference systems for better maps for their particular places. Think about...your cell phone and wanting to use Google Maps on your cell phone. That map is putting together data from many, many different sources. You have data about the buildings, and the restaurants, and the office buildings and your home, and where those buildings are in relation to each other...and then you've got the road networks and the metro system and other layers of information that you need to be able to navigate and to do the things that you do every day.

HOST: So, really, if you are planning to move yourself anywhere – whether it's walking or driving, going cross-town or within states, you are really using geodesy whether you know it or not!

GALEN SCOTT: Right! Geodesy – you can think of it as “the infrastructure of infrastructure”. It is that invisible backbone of science and technology behind all of this data that your phone is putting together that enables it all to line up and work well together. It's one of those things that is pretty much invisible to you...until it doesn't work.

HOST: Right.

GALEN SCOTT: So one of the things that we are doing right now is we are creating a new reference frame. Coming up in 2022 we will be replacing all of the datums, the pieces of the National Spatial Reference System, to create a new set of reference frames for the country.

HOST: Wow!

GALEN SCOTT: Yeah, and it's one of my favorite acronyms! The big project that is pushing us toward that goal is called GRAV-D, or Gravity for the Redefinition of the American Vertical Datum. GRAV-D is going to create a new model of gravity, a new geoid model...a much more accurate and precise geoid model. We're going to be able to use that geoid model with the information that comes from your GPS receivers to get a much more precise and accurate position and height on the Earth's surface. The really big benefit of this is to be able to much better map and model which way water flows, particularly in flat areas.

HOST: I'd like to know what personally makes geodesy such a cool subject for you – someone who thinks about it a lot more often than I do.

GALEN SCOTT: What I really love about geodesy is that it's so interdisciplinary! There are so many different types of science that go into it and it can answer so many different questions. There are so many different applications to it and it is important in so many different ways that people just really don't understand. So this idea of using different pieces of science, different bits of science from different disciplines and putting them all together is really what interests me most about it. The basic questions of “where are we?”, “where do we want to go?”, and “how do we get there?” are fundamental questions we've asked for eons and we're even asking today...and geodesy gives us a way to answer those questions.

HOST: That's it for this episode of the NOAA Ocean Podcast. Thanks to Galen Scott for helping us understand the science of geodesy and its importance in our lives. To learn more about this science, or any ocean-related topic, visit our website at [oceanservice.noaa.gov](http://oceanservice.noaa.gov). We appreciate you taking the time to learn with us, and hope you'll join us again soon. Until then...thanks for listening.