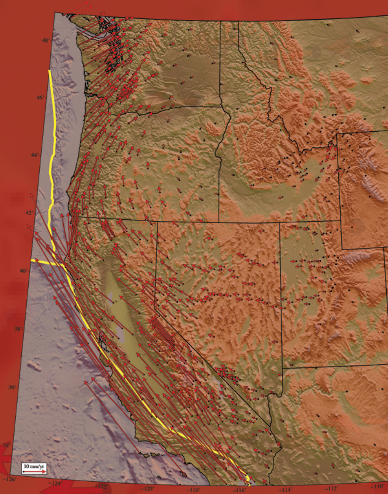
What's on the map?

The map shows the velocities of GPS stations in the Plate Boundary Observatory and other GPS networks in the Western US.



What is the Plate Boundary Observatory?

The Plate Boundary Observatory (PBO) precisely measures Earth deformation resulting from the constant motion of the Pacific, North American, and Juan de Fuca tectonic plates in the western United States.

These Earth movements can be very small and incremental and not felt by people, or very large and sudden such as those that occur during earthquakes and volcanic eruptions. PBO measures Earth deformation through its arrays of Global Positioning System (GPS) receivers, strainmeters, seismometers, and other geodetic instruments.

The Plate Boundary Observatory is operated by UNAVCO, is one of the major components of EarthScope, and is funded by the National Science Foundation.

For more: unavco.org/pbo

What is EarthScope?

EarthScope is a vast project for deep geoscientific exploration of the entire North American continent, as well as our entire Earth, to better understand the materials it is made of, how it was assembled, and how it works — including its recurring earthquakes and active volcanoes.

For more: earthscope.org

earthscope
www.earthscope.org

UNAVCO

UNAVCO is a non-profit university-governed consortium, facilitating geoscience research and education using geodesy.

We challenge ourselves to transform human understanding of the changing Earth by enabling the integration of innovative technologies, open geodetic observations, and research, from pole to pole.

Geodesy

Geodesy is the study of Earth's shape, gravity field, and rotation. Geodetic research defines the terrestrial reference frame and quantifies changes in the properties of Earth's surface and subsurface, ice sheets and glaciers, and oceans and atmosphere. Geodesy's broader benefits include help with preparedness and mitigation of hazards and foundational support for space-based operations, navigation, communications, surveying, resource management, and national security.

Community and Services

The UNAVCO consortium consists of more than 100 US academic Members and over 75 Associate Members (domestic and international). Through our Geodetic Infrastructure and Geodetic Data Services Programs, UNAVCO operates and supports geodetic networks, geophysical and meteorological instruments, a free and open data archive, software tools for data access and processing, cyberinfrastructure management, technological developments, technical support, and geophysical training. The UNAVCO Education and Community Engagement program provides educational materials, tools and resources for students, teachers, university faculty and the general public. We also provide summer internship experiences for undergraduate and graduate students interested in careers in geodesy and geosciences.

Offices and Staff

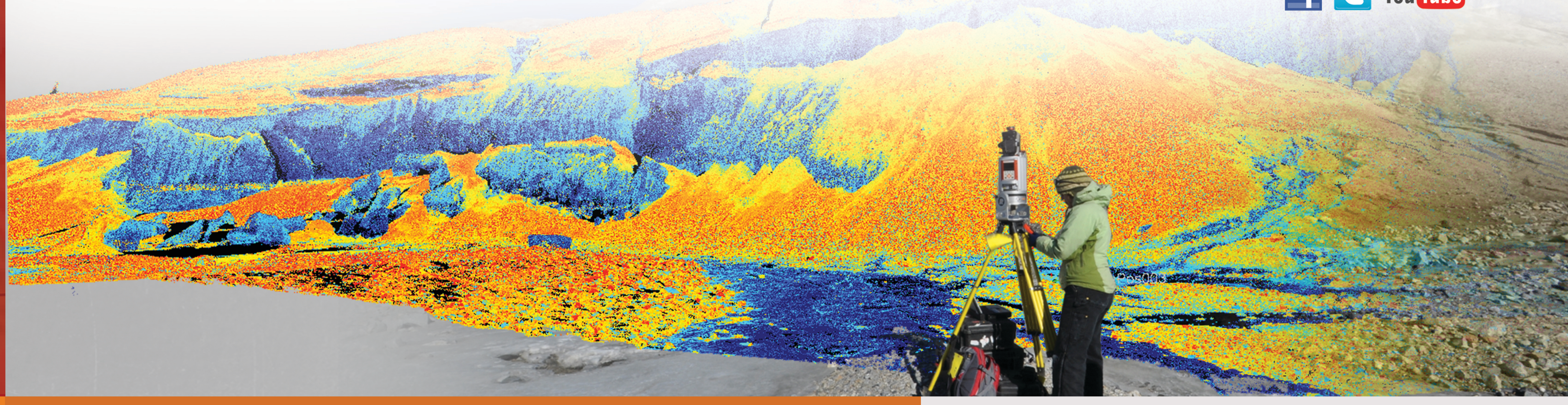
UNAVCO is headquartered in Boulder, Colorado with regional offices in San Clemente, California, Portland, Oregon, and Anchorage, Alaska. Geoscience and engineering staff are deployed on assignments throughout the United States and around the world with regular deployments in the Arctic and Antarctica. Core sponsorship for UNAVCO is provided by the National Science Foundation (NSF) and National Aeronautics and Space Administration (NASA).

Brief History

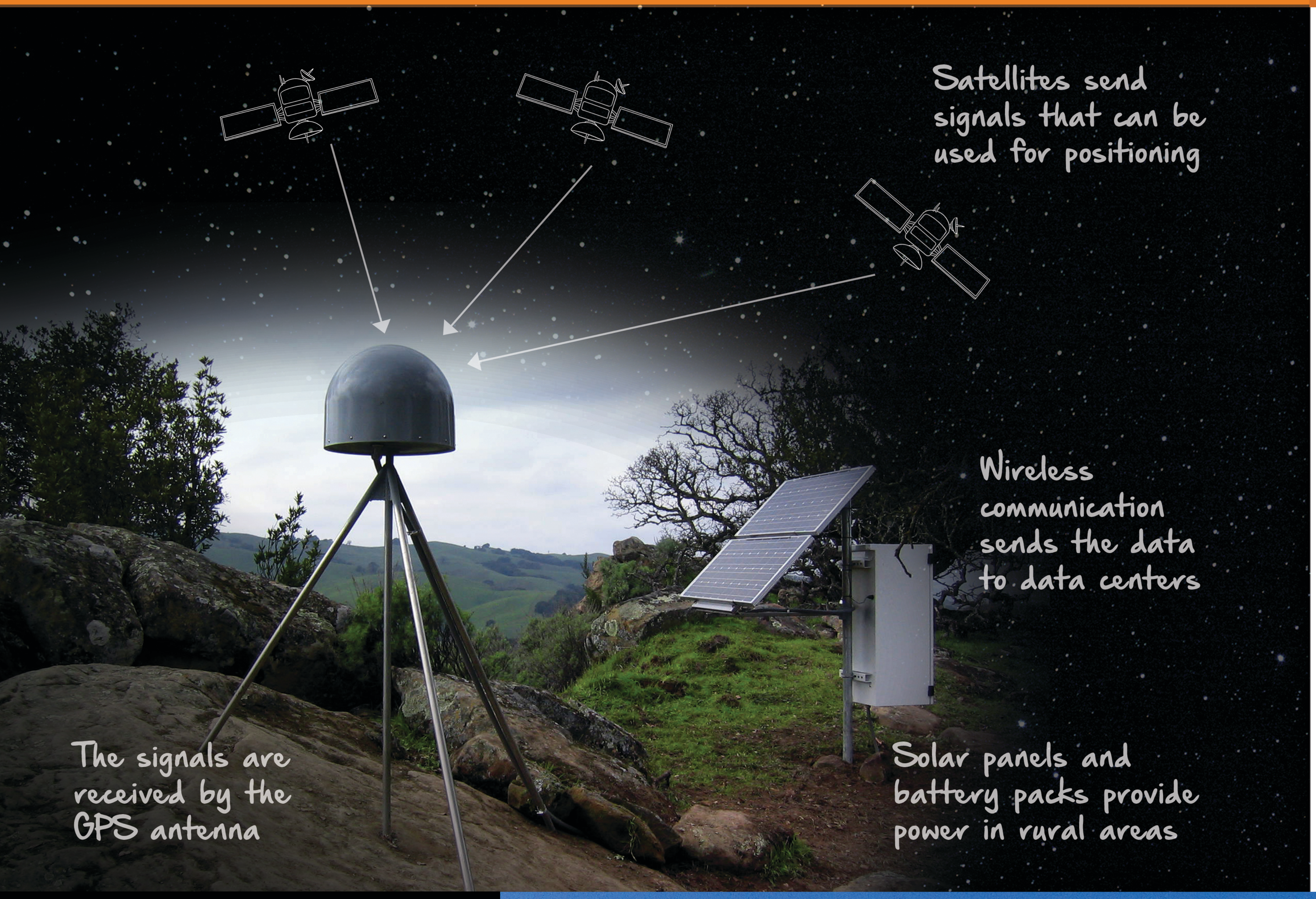
UNAVCO originated as the University NAVSTAR Consortium in 1984 within the Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado, Boulder. In 2001, UNAVCO, Inc, became an independent 501(c)(3) organization.

Sponsored by: NSF NASA

unavco.org



ANATOMY OF A GPS STATION



READING GPS DATA

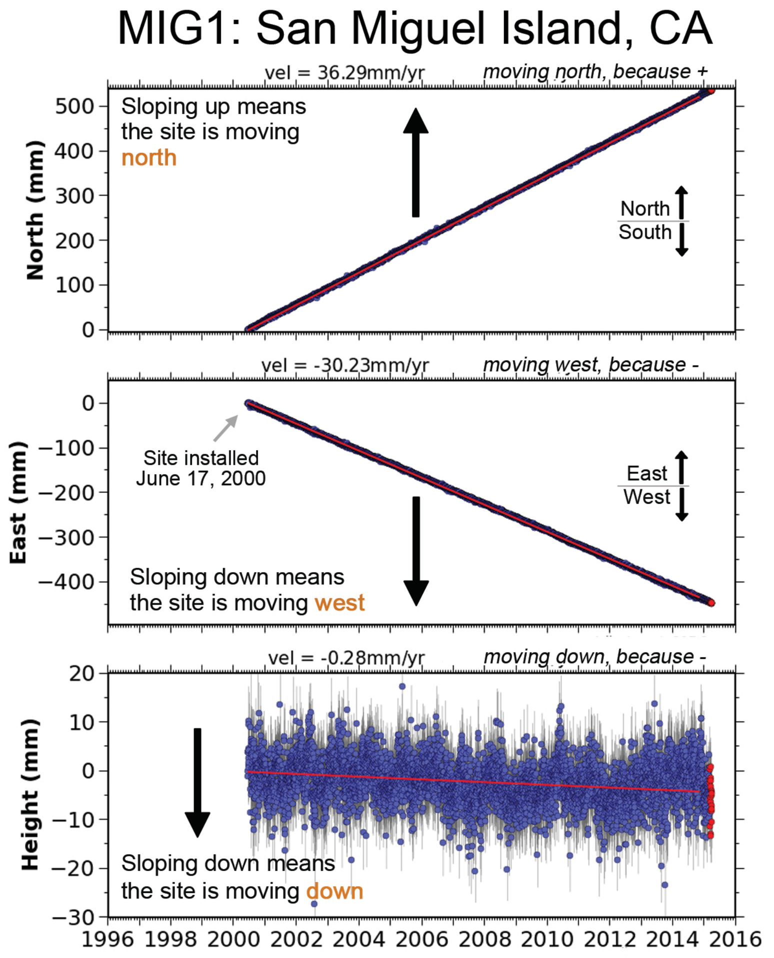
HOW POSITION CHANGES OVER TIME

How do we get the arrows on the map? We start with a position time series. These graphs show how a GPS station's position has changed since the day it was installed.

This example is from station MIG1, on San Miguel Island, California. Each blue dot represents one day. The red dots are new positions that still need to be refined. Because GPS measures 3D position, the changes are shown in north-south (top), east-west (middle), and up-down (height, bottom). The station's velocity, or speed, is calculated by fitting a line (the red line) to the dots and measuring its slope. (There's more to it than this, but this is roughly what we do.) Note the velocities above each graph.

Not all time series are this tidy. Some have breaks in data from problems with instruments. Others have jumps in position from earthquakes. Many stations move up and down seasonally because of changes in rainfall or nearby groundwater withdrawal.

POSITION TIME SERIES



Also, stations appear to jump up and down from day to day because GPS positioning is less precise in the vertical than the horizontal—and, here, because the scale on the vertical position is different than the scale on the north and east positions.

All PBO GPS data are freely available online.
To explore more time series, go to unavco.org/instrumentation/networks/status/pbo/

VELOCITY

WHAT ARE THE ARROWS?

Each arrow originates at a GPS station, and points in the direction the station is moving. Its length is proportional to the station's speed, or velocity. The faster the station is moving, the longer the arrow. The scale for the arrows is given at the bottom of the map. Station motions are given in millimeters per year. That's tiny—but even small motions can tell us a lot about the Earth.

HOW DO WE KNOW?

We calculate a GPS station's velocity from its position time series. To get the horizontal velocity and direction, we add the east-west velocity and the north-south velocity together, as shown above, making a vector.

MIG1 is the fastest station in California. The fastest station in the Plate Boundary Observatory is on Montague Island, Alaska (AC79).

WHAT DOES THIS TELL US?

Every arrow on the map shows us how the Earth is moving. The GPS stations are anchored into rock or deep into soil so we can see how the whole area is moving, not just the surface.

Why is western North America moving so much? The main players are the Cascadia subduction zone in the Pacific Northwest pushing stations landward and the San Andreas fault sliding stations past each other in California. The Plate Boundaries are shown in yellow. Regions with the highest seismic hazard often coincide with the greatest contrast in motion, e.g. long arrows near short ones.

Check out unavco.org

- Geodesy lesson plans for grades 6-12 and undergraduate
- A global interactive Velocity Viewer
- GPS, LiDAR and InSAR data
- The latest information about earthquakes around the world

Photo by Jacob Sklar