



Summary

We compare eight long-term monuments and mounts currently in use in UNAVCO-supported projects. The designs range in height from 0 to 3 meters; substrates into which they are installed include soil, bedrock, and concrete; and costs range from approximately \$30 to \$15000. The more expensive options may be considered more stable, but in many places outside the US, logistical, economical, and material constraints make installation of deep- and shallow-drilled braced monuments at best difficult and at worst impossible. Simpler single-mast or concrete monuments offer less expensive, more portable installation options with acceptable stability.

When choosing a monument and mount, consider:

- Stability needed (precision needed)
- Funds available
- Time available for installation
- Site security
- Materials available (esp. international work)
- Site accessibility
- Site substrate

Requesting support from UNAVCO

UNAVCO is a non-profit, membership-governed consortium that supports and promotes Earth science by advancing high-precision techniques for the measurement and understanding of deformation.

UNAVCO can provide assistance with design, purchasing, and construction of geodetic monumentation to NSF- and NASA-funded scientists.

To request support from UNAVCO, fill out a support request form at: <http://www.unavco.org>. For questions, contact support@unavco.org. For more information on monuments and mounts, check out <http://facility.unavco.org/kb>.

Monument	Deep drilled braced	Shallow braced	Concrete pillar	Thermopile	Polar mast	Shallow foundation mast	Stainless steel pin w/ mast	5/8" all-thread	Custom
Description	4-5 stainless steel legs in a tripod configuration cemented into the substrate up to depths of about 40 feet; welded together at the top.	4-5 1" diameter stainless steel legs in a tripod configuration epoxied or pounded into the substrate up to depths of about 5-6 feet; welded together at the top.	Of variable design, but typically consisting of reinforced concrete set within a tubular concrete form. The leveling mount and GPS antenna are secured to a stainless steel pin which is anchored within the top of the pillar.	A single 4"-diameter, 20'-long pillar containing pressurized, two-phase carbon dioxide to prevent thawing at the monument's base. Set ~16' deep into the ground; coupled to the permafrost with a slurry of sand and water.	Lightweight aluminum mast bolted onto bedrock. Can be produced at heights of 0.5m, 1m, and 2m (1m shown here).	1.25" diameter threaded stainless steel mast cemented into bedrock. Throughout the Rio Grande network, masts used are ~5' long set into holes 16-24" deep.	Threaded pin cemented or epoxied into the ground with a removable mast screwed onto it. Throughout the Afar network, masts used are 1" diameter, 0.5m-long stainless steel screwed onto a 10"-long threaded stainless steel pin cemented into bedrock.	5/8" stainless steel all-thread cut to custom height, cemented or epoxied into bedrock or cement.	UNAVCO works with scientists to design custom monumentation when needed. Solutions are often simple and cost-effective, like the mount used here to fix a GPS antenna to a sawed-off tree to measure methane release in a Minnesota bog.
Substrate	Bedrock, unconsolidated	Bedrock (drilled), unconsolidated (pounded)	Bedrock, unconsolidated	Permafrost	Bedrock, concrete	Bedrock	Bedrock, concrete	Bedrock, concrete	
Stability	high	high	medium	medium-high	medium-high	medium-high	medium-high	medium-high	
Install Time	2-4 days	1-3 days	1-3 days	1-4 days	1 hour	1-2 days	1 hour	1 hour	
Labor	2-3 people + drill crew	2-3 people	2-3 people	1 person + drill crew	1 person	1-2 people	1 person	1 person	
Cost	\$7,500-15,000 incl. drilling	\$800	\$500-2000	\$6,700-16,000 incl. drilling	\$500	\$150	\$130	\$30	
Site Impact	high	medium	medium	high	low	low	low	low	
Drilling Requirements									
Where Used	Plate Boundary Observatory, BARGEN, PANGA, Costa Rica	Plate Boundary Observatory, BARGEN, PANGA, Iceland, Saudi Arabia, etc.	Numerous incl. GGN	Plate Boundary Observatory	TAMDEF, POLENET, Mauna Loa	Rio Grande, GGN	Afar, Ethiopia; RETREAT, Italy; Iceland	Calabria, Italy; Bangladesh; Caribbean; Santorini	

Antenna Mounts



SCIGN mount

Expensive but precise. Only needed if using a SCIGN dome.

\$600, available through John McRaney of SCEC/University of Southern California.



SECO 2072-series stainless steel adapter

Less expensive and also precise. Used in the US National Geodetic Survey's CORS network.

\$225, available from www.surveying.com.



Cup and brass adapter

Inexpensive but no leveling ability. Allows for antenna to be aligned to north.

\$50, custom machined.

