

HYDROGRAPHIC SERVICES REVIEW PANEL

A federal advisory committee, advising the NOAA Administrator

All U.S. Latitudes, Longitudes, and Elevations to Change in 2022

ISSUE AND STATUS

The replacement of the North American Datum of 1983 (NAD83) and the North American Vertical Datum of 1988 (NAVD88) will dramatically impact everyone in the U.S., from professional applications and services to recreational users who use maps, charts and satellite positioning systems such as GPS (global positioning system). A study¹ conducted for the National Geodetic Survey estimates that an additional \$522 million in annual economic benefits could be generated by the implementation of a new vertical reference system, allowing users to determine more precise elevations using the GPS (global positioning system), with approximately \$240 million saved from improved floodplain management alone.

The National Geodetic Survey (NGS) defines and manages the National Spatial Reference System (NSRS), a consistent coordinate system that defines latitude, longitude, height (elevation), scale, gravity, and orientation throughout the United States. Today, various layers of the National Map are produced with centimeter-level absolute accuracy relative to NGS' official horizontal and vertical datums that establish the origin of horizontal coordinates and elevations above mean sea level. This ensures that orthophotos, elevation data, hydrography, transportation, administrative boundaries, and other mapped features fit together with centimeter-level precision when one mapping layer is registered to another.

However, in 2022, NAD83 and NAVD88 will be replaced with new interrelated reference frames (geometric and geopotential) which will rely on global navigation satellite systems (GNSS), such as GPS, as well as an updated and time-tracked geoid (gravity) model. The new geometric reference frame will change latitude, longitude, and ellipsoid heights approximately one to two meters from the current NAD83 (2011) values, and the new geopotential reference frame will change orthometric heights (elevations) on an average of -50 centimeters (from -1 meter in the Pacific Northwest to zero in south Florida).

The replacement of NAD 83 and NAVD88 with new reference frames (datums) will impact all maps, charts, geographic information systems, surveying and engineering operations that federal and state agencies produce and perform, to include hydrographic charts produced by NOAA; 3DEP elevation datasets and National Hydrography Datasets produced by USGS; and Flood Insurance Rate Maps produced by FEMA, for example. Furthermore, all State Plane Coordinate Systems will change. It is critical that federal, state, and local agencies along with the private sector are made aware of this change and develop plans for a transition to the new reference frames. The new 2022 geometric (horizontal) reference frame will be based on a Cartesian coordinate system with positions represented as sets of X/Y/Z coordinates with the origin of the coordinate system (0/0/0) at the center of the earth (the origin of the International GNSS Service (IGS) reference frame at a chosen epoch). It will be Earth Centered, Earth Fixed (ECEF), aligned with the International Terrestrial Reference Frame (ITRF) at a particular epoch (TBD). It is likely to contain aspects of some well-modeled velocities, e.g., plate rotations. Passive control will continue to be used as a secondary method to access the NSRS, such control will be 'tied to,' not a 'part of,' the NSRS."

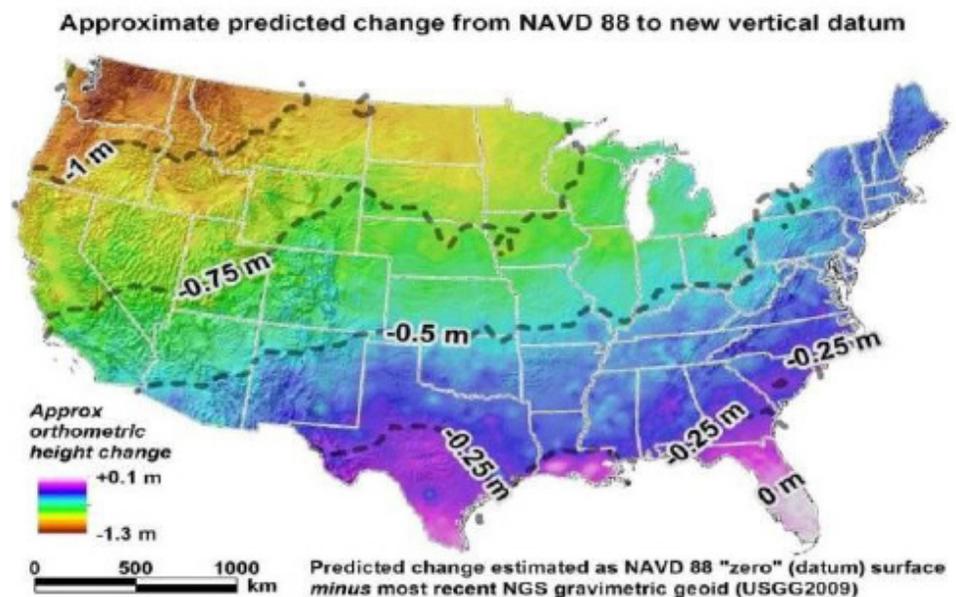


Image source: National Geodetic Survey

¹ http://www.geodesy.noaa.gov/PUBS_LIB/Socio-EconomicBenefitsOfCORSandGRAV-D.pdf

The new 2022 geopotential (vertical) reference frame will be accessed with GNSS technology, and a gravimetric geoid model and passive monuments will continue to be used as a secondary method to access the NSRS. It will be based on a spherical harmonic model (SHM) of Earth's external gravity potential. This will be partly derived from airborne gravity data collected as part of the Gravity for the Redefinition of the American Vertical Datum (GRAV-D) and likely build upon the planned "EGM2020" model from the National Geospatial-Intelligence Agency (NGA). This SHM will be used to derive various quantities, such as dynamic heights, surface gravity, and a gravimetric geoid serving as the zero height surface of orthometric heights (commonly known as "elevations"). The target accuracy is 2-centimeter in both absolute and relative (over all distances) orthometric heights using GNSS and a geoid model. It will monitor time-varying nature of gravity field, including the geoid. "What's Next for Geodetic Datums" video explains current plans, the expected benefits and impacts, and the importance of preparing now to adopt these new datums at http://www.ngs.noaa.gov/corbin/class_description/NGS_Datums_video_2c/

GRAV-D is an NGS project being performed to: (a) complete an airborne campaign to develop a high-resolution snapshot of gravity in the U.S., supporting gravimetric geoid accuracy; and (b) monitor changes to the gravity field at decadal scales, including changes to the geoid.

CHALLENGES

Complex technical challenges lie ahead:

- Conversion of existing tide and reference frame information to the new 2022 reference frame
- Development of user-friendly transformation tools
- Education of users on the new 2022 reference frame and tide information, and how users can incorporate passive control into the new NSRS
- Impact on hydrographic surveys
- Conversion of reference frame and tide software to support the 4D reference frame in 2022
- Requirement of complete metadata for all mapping products
- Conversion from NGVD29 to NAVD88 before transition to the 2022 vertical reference frame;
- Modernization of tools that will provide an efficient and consistent method to submit GNSS, leveling, gravity, and traverse data to the NGS for inclusion in the NSRS
- Surveying in regions of local crustal deformation not modeled by a plate rotation model

FUTURE FEDERAL ACTION RECOMMENDATIONS

- Require (to the extent practicable and legally allowed) all federal agencies using or producing geodetic coordinates of any type to prepare and develop an orderly transition to the new geometric and geopotential reference frames.
- In collaboration with the user community, develop and implement user friendly tools to easily transform positional information to the 2022 reference frames.
- Establish an ad hoc group to include datum and tide information users to ensure they are included in the decision making process for transition to the 2022 reference frame.
- Provide status reports on the new reference frames and obtain feedback from users by participating in National and State surveying and mapping conferences.
- Develop and document guidelines, algorithms, and user-friendly tools for incorporating geodetic leveling data into the new 2022 geopotential reference frame.
- Develop regional partnerships to collaborate with partners (governmental, commercial, and academic) to support the GRAV-D project.

PARTNERS

National Geodetic Survey, U.S. Coast Guard, U.S. Geological Survey, U.S. Army Corps of Engineers, Naval Oceanographic Office, commercial tug and barge operators, others (all federal agencies with a geospatial data role)

The Hydrographic Services Review Panel was established as directed by the Hydrographic Services Improvement Act of 2002, Public Law 107-372.

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