

HYDROGRAPHIC SERVICES REVIEW PANEL

A federal advisory committee, advising the NOAA administrator

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NSRS: All U.S. Latitudes, Longitudes, and Elevations to Change

The replacement of the North American Datum of 1983 (NAD 83) and the North American Vertical Datum of 1988 (NAVD 88) 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). Implementation of the new datum will have an estimated socio-economic benefit of \$4.8 billion.

The National Geodetic Survey (NGS) defines and manages the **National Spatial Reference System (NSRS)**, a consistent coordinate system that defines latitude, longitude, height (elevation), gravity, and more throughout the United States. Today, various layers of the National Map are produced with centimeter-level 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 related to another.

However, in 2022, NAD 83 and NAVD 88 will be replaced with four new plate-fixed geometric reference frames and a geopotential datum which will rely on global navigation satellite systems (GNSS), such as GPS, as well as an updated and time-tracked geoid model. The new geometric reference frames will change latitude, longitude, and ellipsoid heights up to four meters from the current NAD83 (2011/PA11/MA11) values, and the new geopotential datum will change orthometric heights (elevations) on an average of -50 centimeters (from -1 meter in the Pacific Northwest to zero in south Florida) in CONUS, with decimeter to meter level changes in other parts of the United States.

The replacement of NAD 83 and NAVD 88 with four new reference frames and a new geopotential datum 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, the State Plane Coordinate System will change in all states and territories. 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 reference frames 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 Terrestrial Reference Frame of 2020). They will be Earth Centered and Earth Fixed (ECEF), affixed to one tectonic plate per frame (North American, Pacific, Caribbean and Mariana).

The new 2022 geopotential datum 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

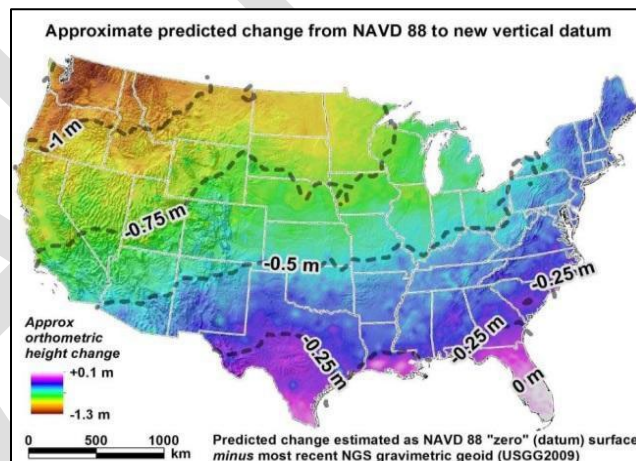


Image source: National Geodetic Survey

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.

COMPLEX TECHNICAL CHALLENGES and CRITICAL NEEDS

- Conversion of existing tide and reference frame information to the modernized NSRS
- Development of user-friendly transformation tools;
- Education of users on the modernized NSRS 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 modernized NSRS;
- Requirement of complete metadata for all mapping products;
- 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; and
- Surveying in regions of local crustal deformation not modeled by a plate rotation model.

RECOMMENDATIONS FOR NOAA ACTION:

- 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 modernized NSRS.
- In collaboration with the user community, develop and implement user friendly tools to easily transform positional information to the modernized NSRS.
- 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 modernized NSRS.
- Provide status reports on the new reference frames and datum 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 geopotential datum.
- Develop regional partnerships to collaborate with partners (governmental, commercial, and academic) to support the GRAV-D project.
- Involve partners and all federal agencies with a geospatial data role such as: 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; and others.

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In October 2003, Secretary of Commerce Don Evans established the HSRP as directed by the Hydrographic Services Improvement Act of 2002, Public Law 107-372. Panel members, appointed by the NOAA Administrator, include a diverse field of experts.

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