

Work Shop Outline

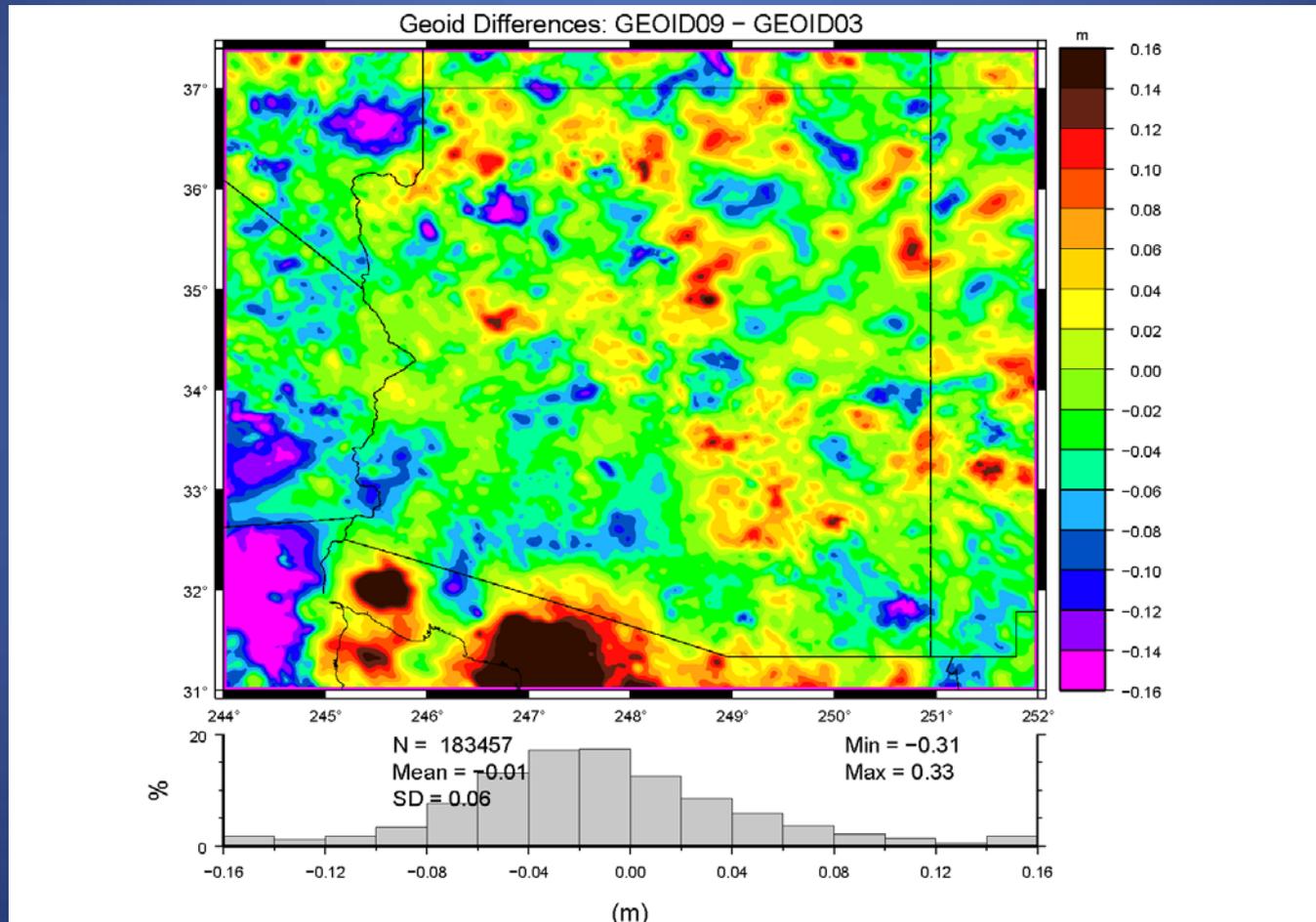
- Gravimetric Geoid Development
 - 60 minute presentation
 - 30 minute break and Q&A period
- Hybrid Geoid Development
 - 60 minute presentation
 - 30 minute break and Q&A period
- **Summary and Outlook**
 - 30 minute presentation
 - 30 minute break and Q&A period

Summary and Outlook

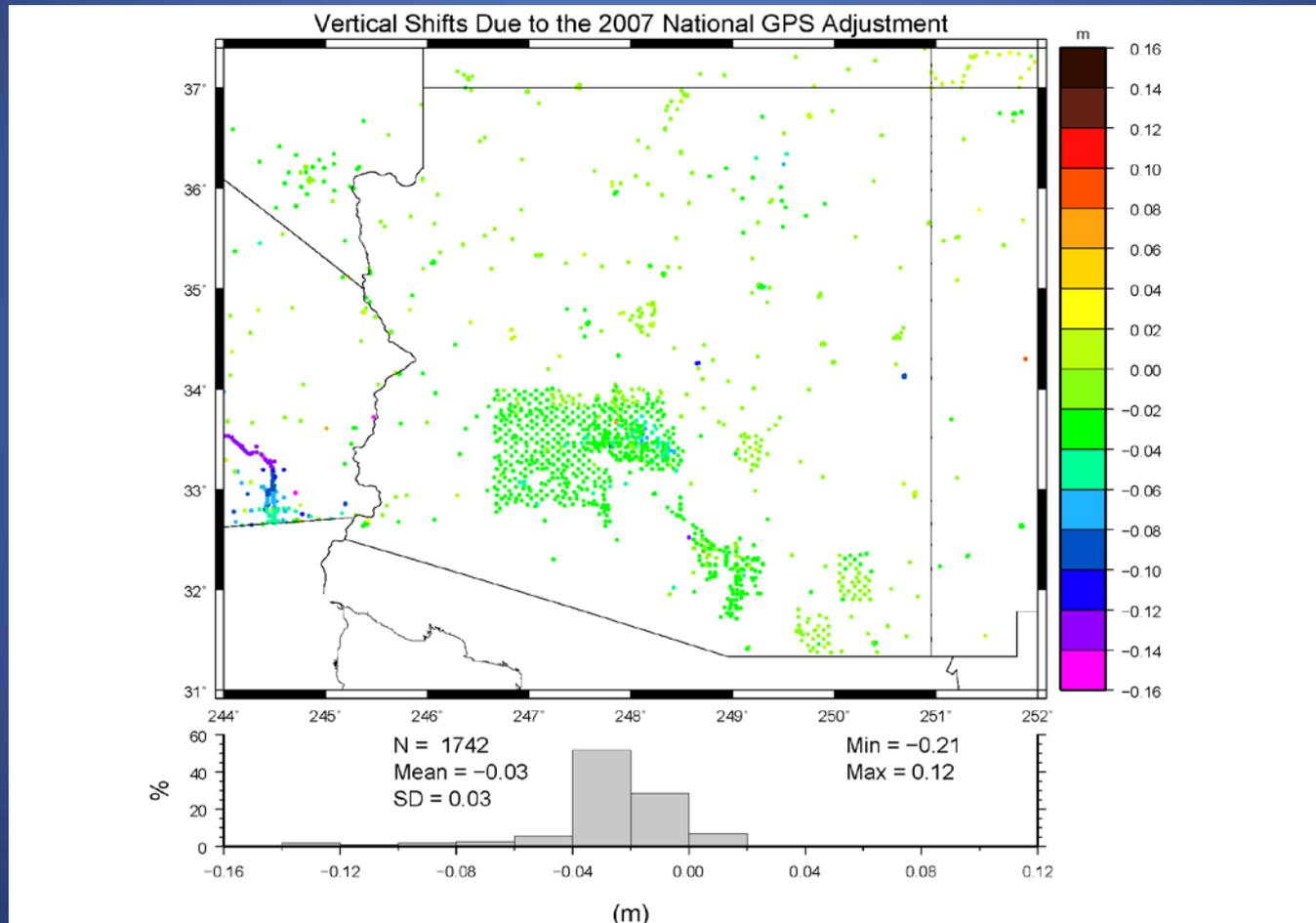
- Significant changes from GEOID03 to GEOID09
 - Example: Arizona
- Better fit to the data currently in the NGSIDB
- Future improvements: near- and far-term
- Why make a new vertical datum?
 - Accuracy versus Precision
 - Better ties to MSL
 - Better ties between all regions (HI to VI)

Arizona: An Example

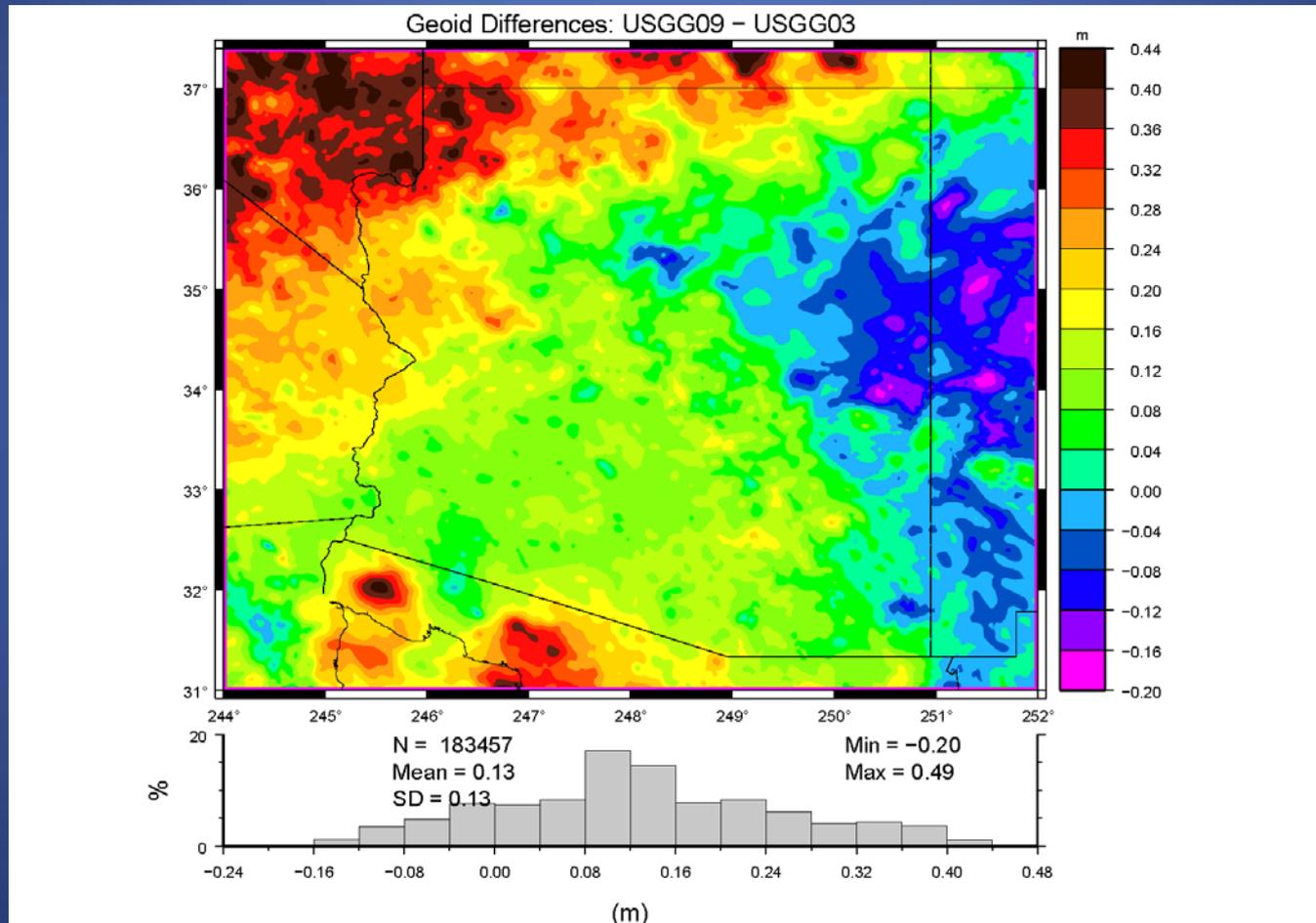
or, As Dave Minkel said, "... should I really expect to see a 5 decimeter range of difference from the previous NAD83 realization and/or Geoid03?"



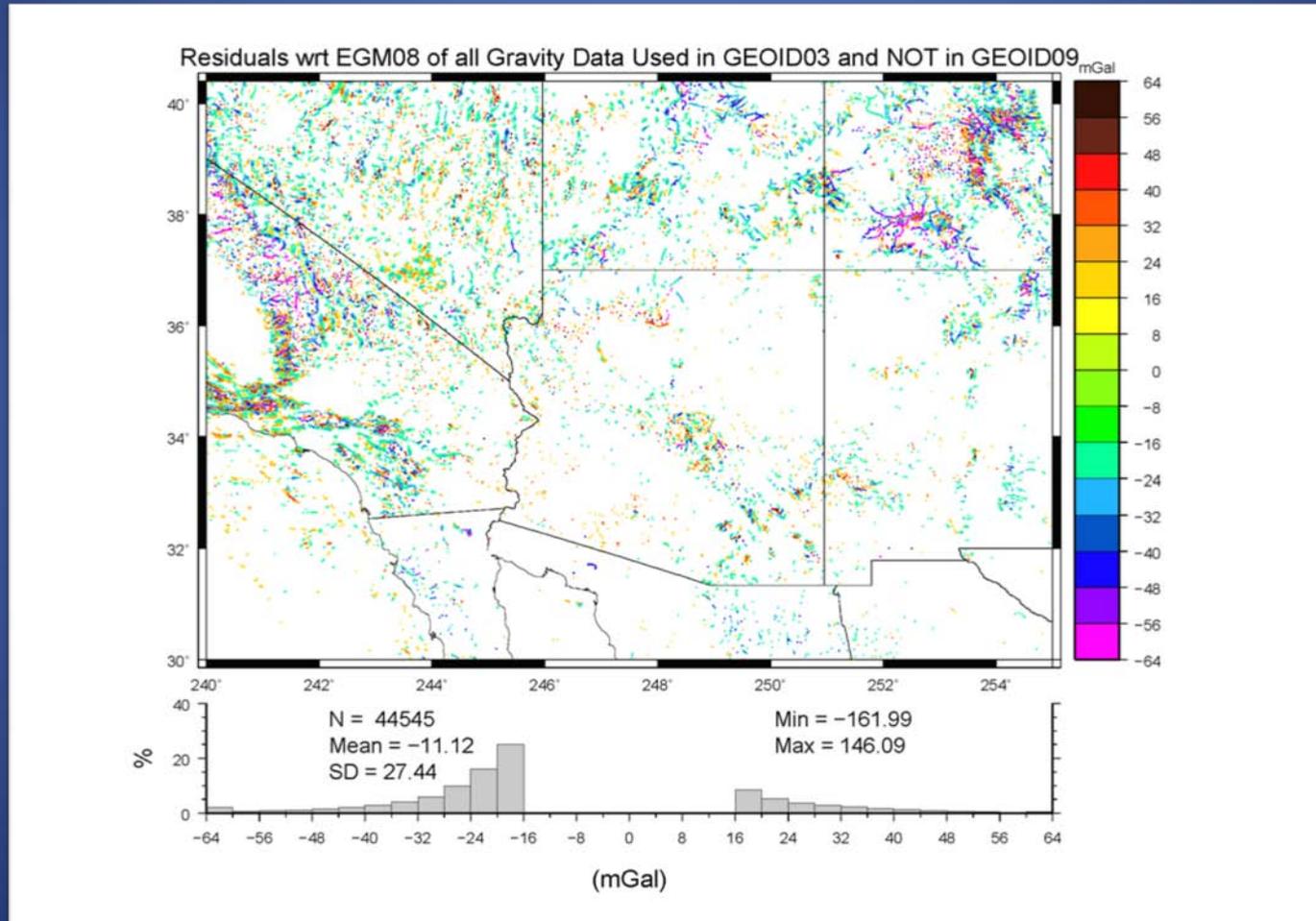
NRA2007 differences



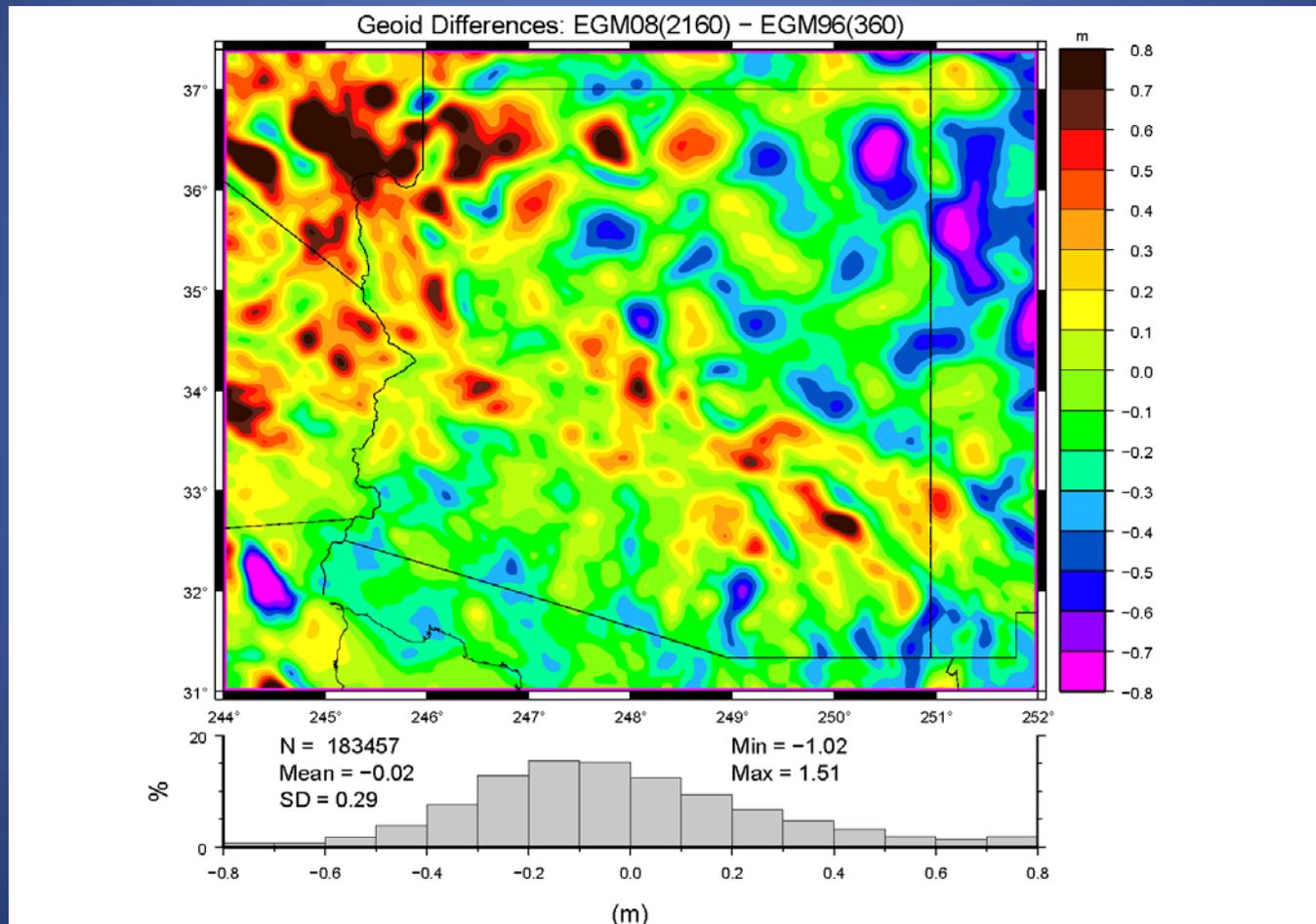
Differences in USGG Models



Surface Gravity Rejected in USGG2009



Differences in the Reference Models



GEOID09 – GEOID03 Differences

- Mainly due to shift in reference model
 - EGM96 => EGM08 (GRACE)
- Significant change in included surface gravity data that are already thin in the mountains
- Some change from readjusted ellipsoidal hts
- Net effect is a 5 dm difference
- GEOID09 better reflects the true geophysics and current ellipsoidal & orthometric heights

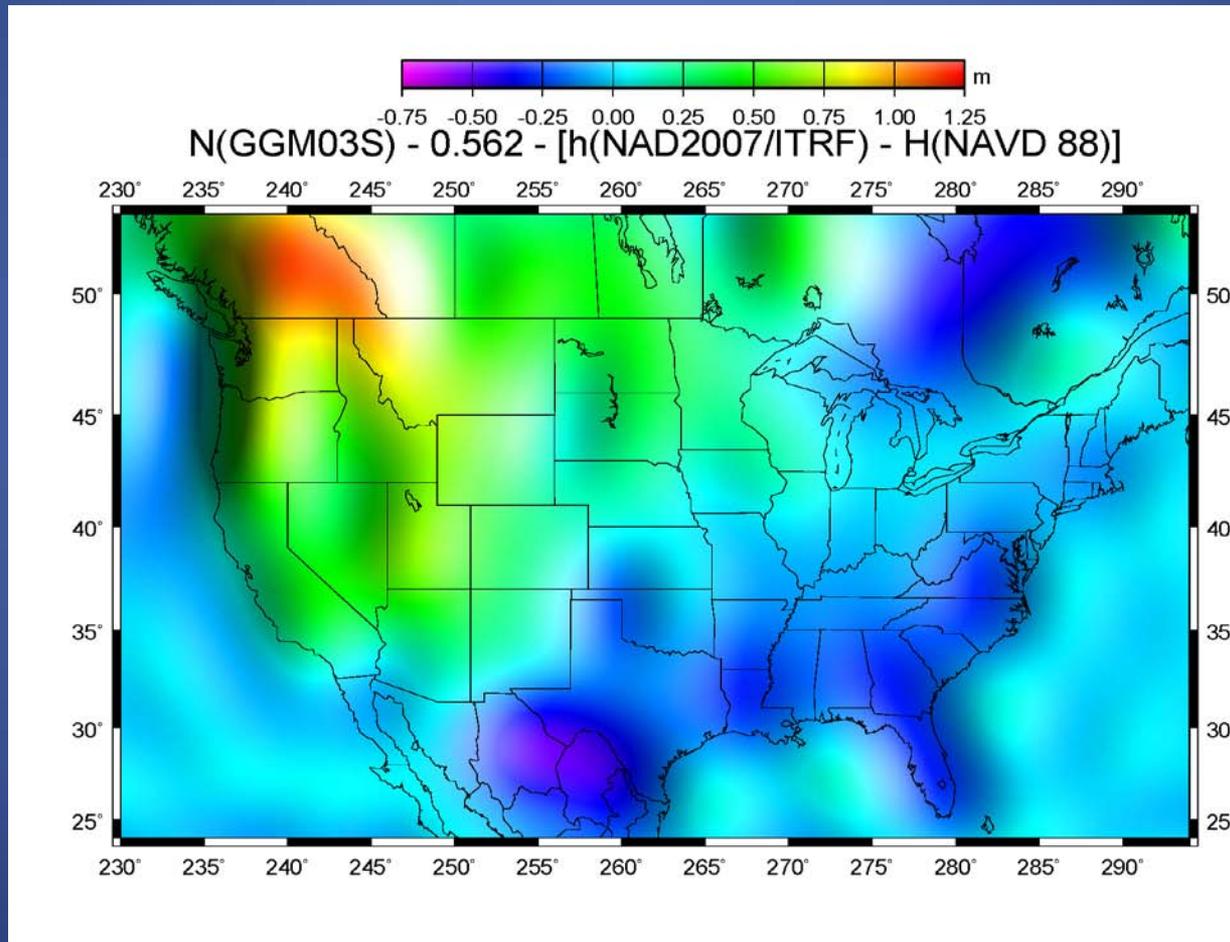
Future Improvements

- Near Term
 - GOCE data to further solidify reference field
 - Less reliance on EGM08 and more on GRACE/GOCE satellite only field
 - GRAV-D to improve surface gravity and fill voids
 - Refined geoid modeling techniques
 - Evaluate incorporation of OPUS-DB GPS values for select locations (i.e., supplement sparse coverage)

Future Improvements

- Far Term
 - Continued evaluation of GRAV-D enhanced geoids
 - Check against TBM's
 - Check against unconstrained GPSBM's
 - Comparison with other North American countries
 - Integration of vertical datums for all U.S. states and territories
 - Replacement of existing vertical datum (NAVD 88)

Why make a new vertical datum?



Courtesy of Dr. Dennis Milbert

GRAV-D: Gravity for the Redefinition of the American Vertical Datum

- Airborne gravity data provide an internally consistent backbone
 - Satellite-only EGM's (GRACE/GOCE) provide long
 - Airborne data are tied to that and yield to 20 km
 - Spot surface gravity and terrain models yield short
- Refined modeling to reduce commission error
- One arc-minute resolution already tested as sufficient to capture a cm-level accurate geoid

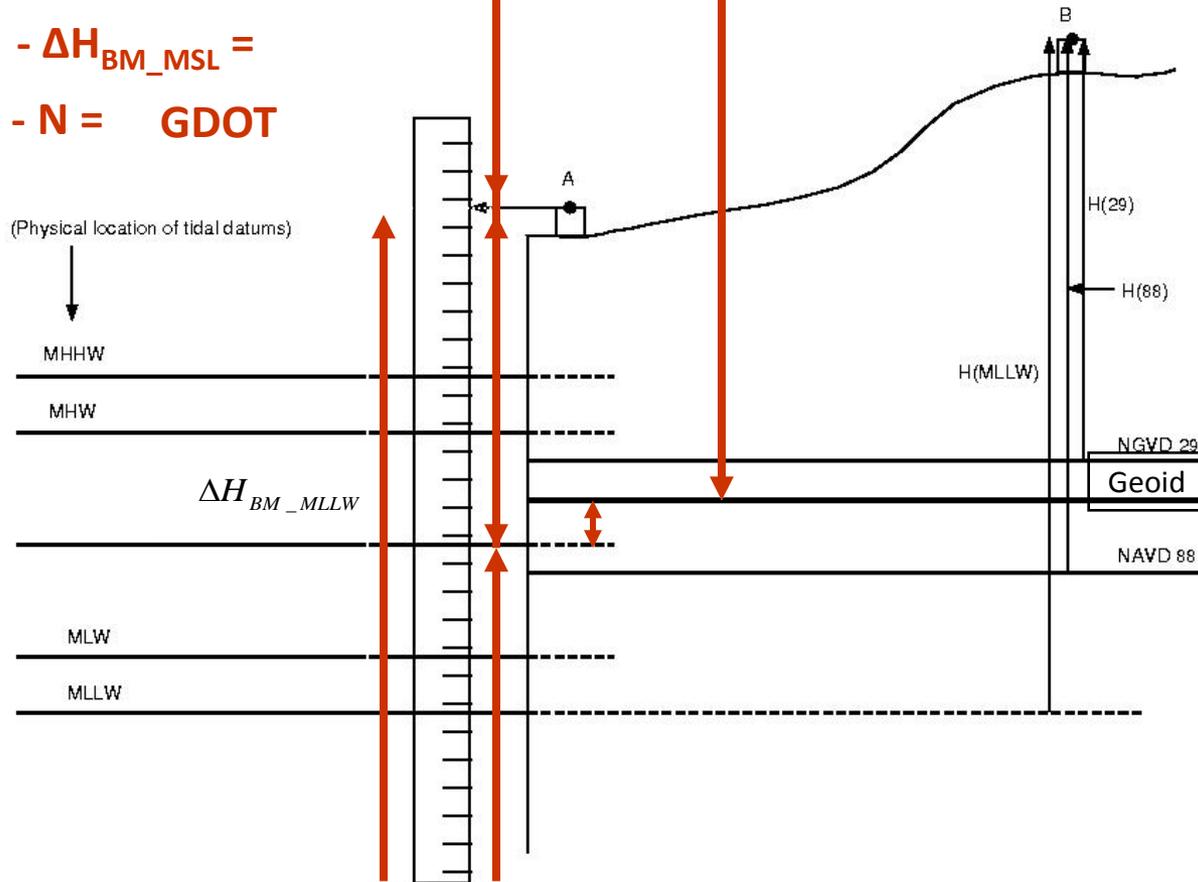
NOAA's National Geodetic Survey

Ellipsoid

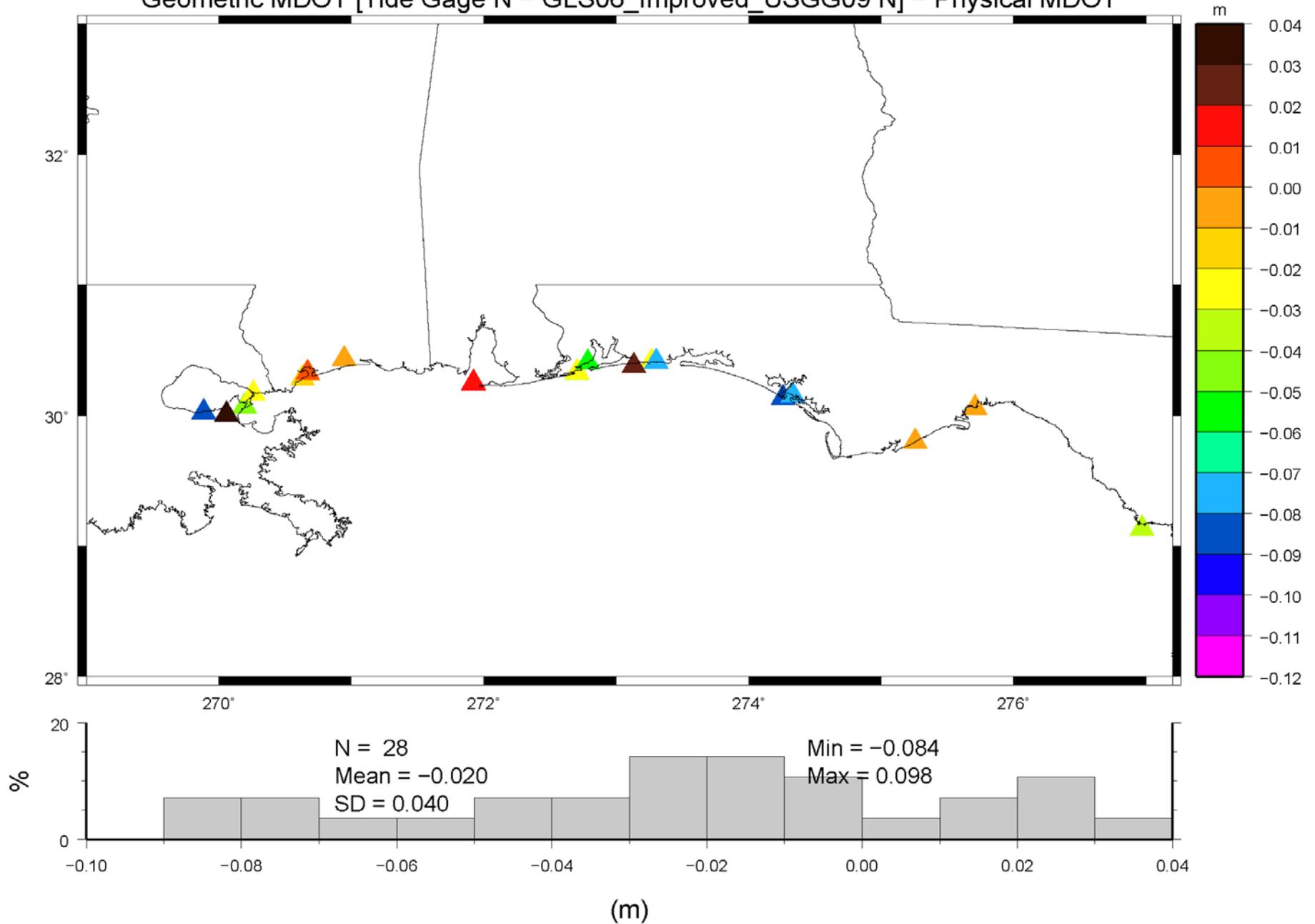
$$H_{BM_0} - H_{MSL_0} = \Delta H_{BM_MSL}$$

$$h_{BM} - \Delta H_{BM_MSL} =$$

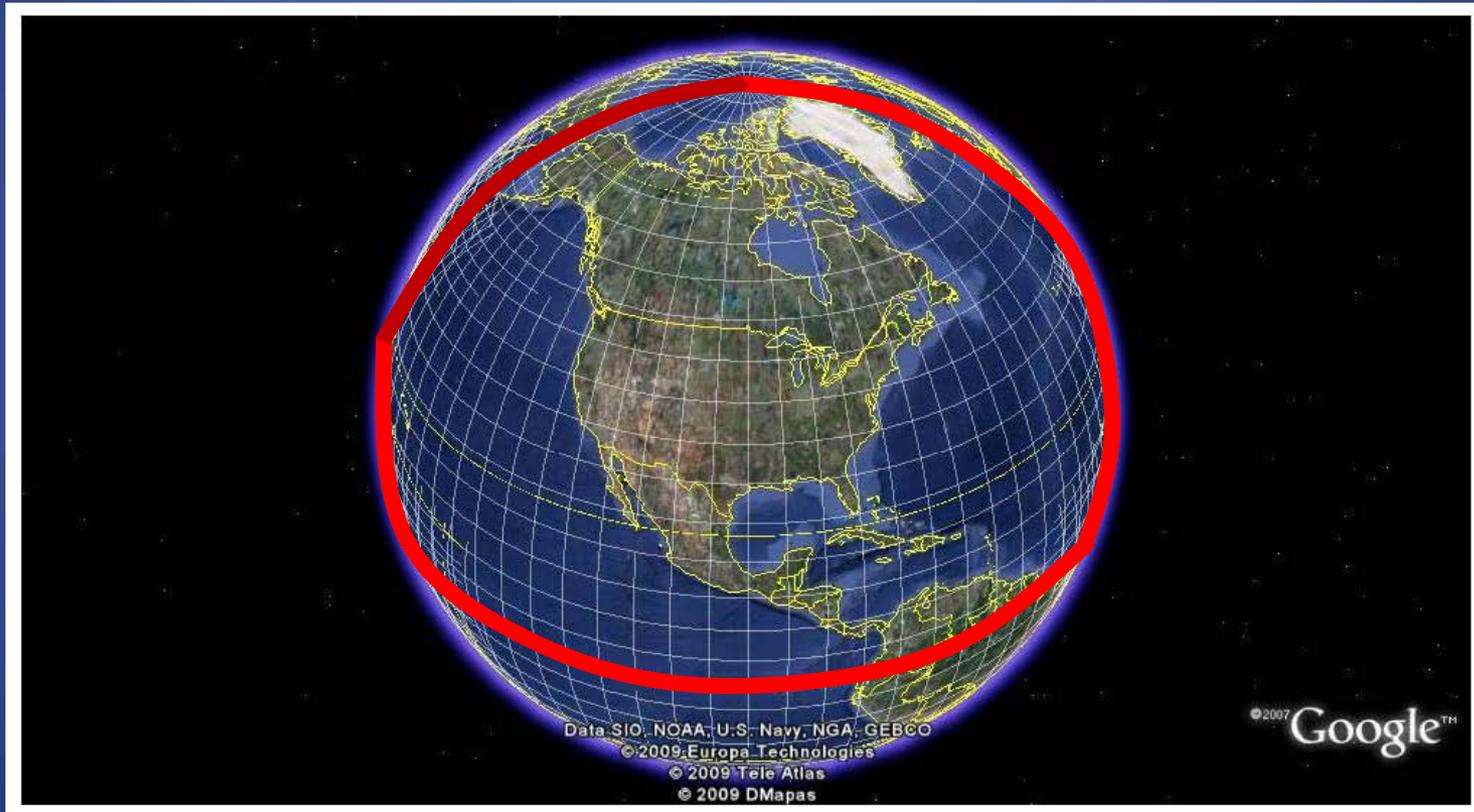
$$h_{MSL} - N = \text{GDOT}$$



Geometric MDOT [Tide Gage N - GLS06_Improved_USGG09 N] - Physical MDOT



A North American Geoid



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- <http://www.ngs.noaa.gov/GEOID/>