

Orthometric Heights from GPS and the GEOID99 high resolution geoid model for the United States

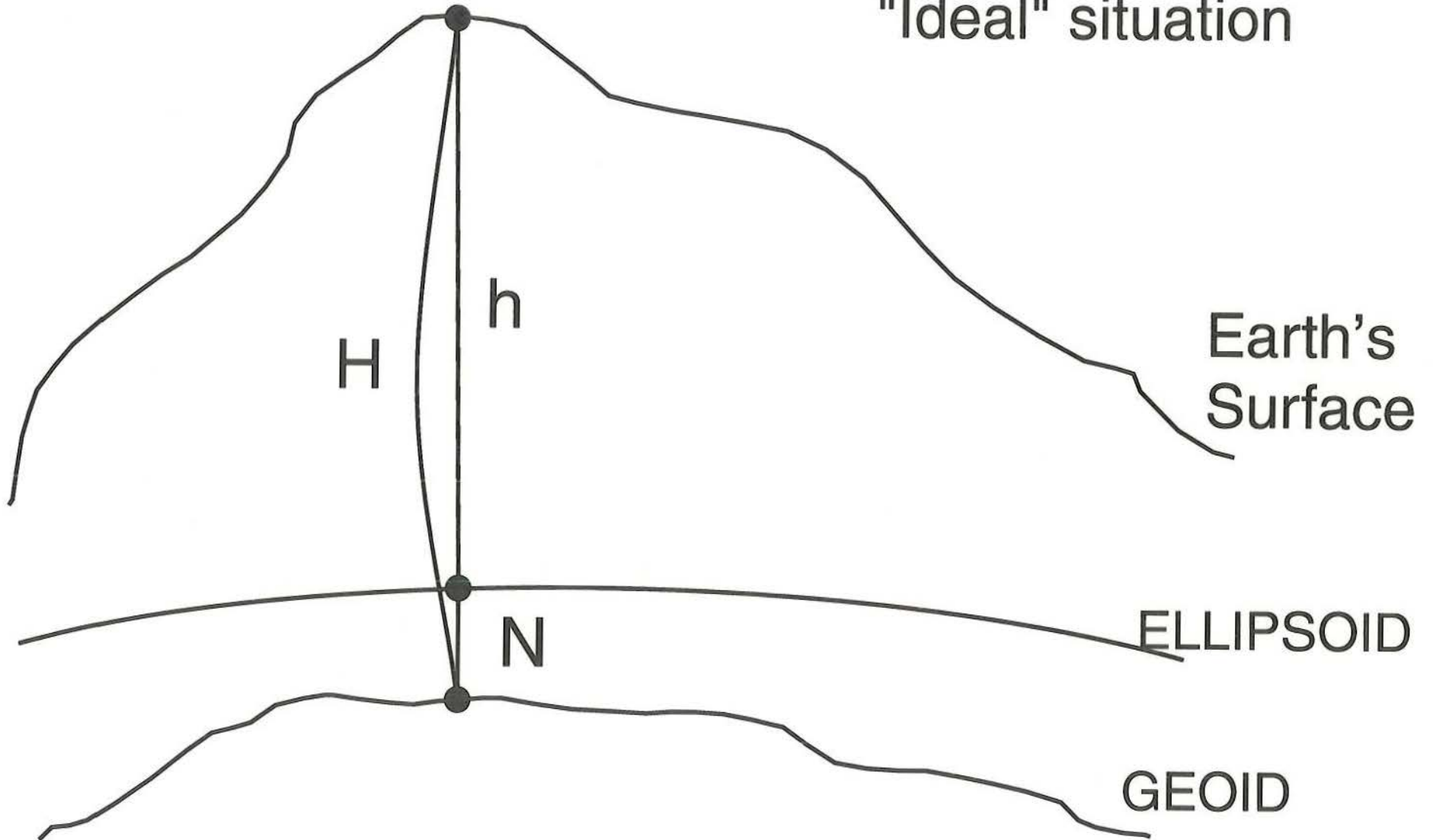
by

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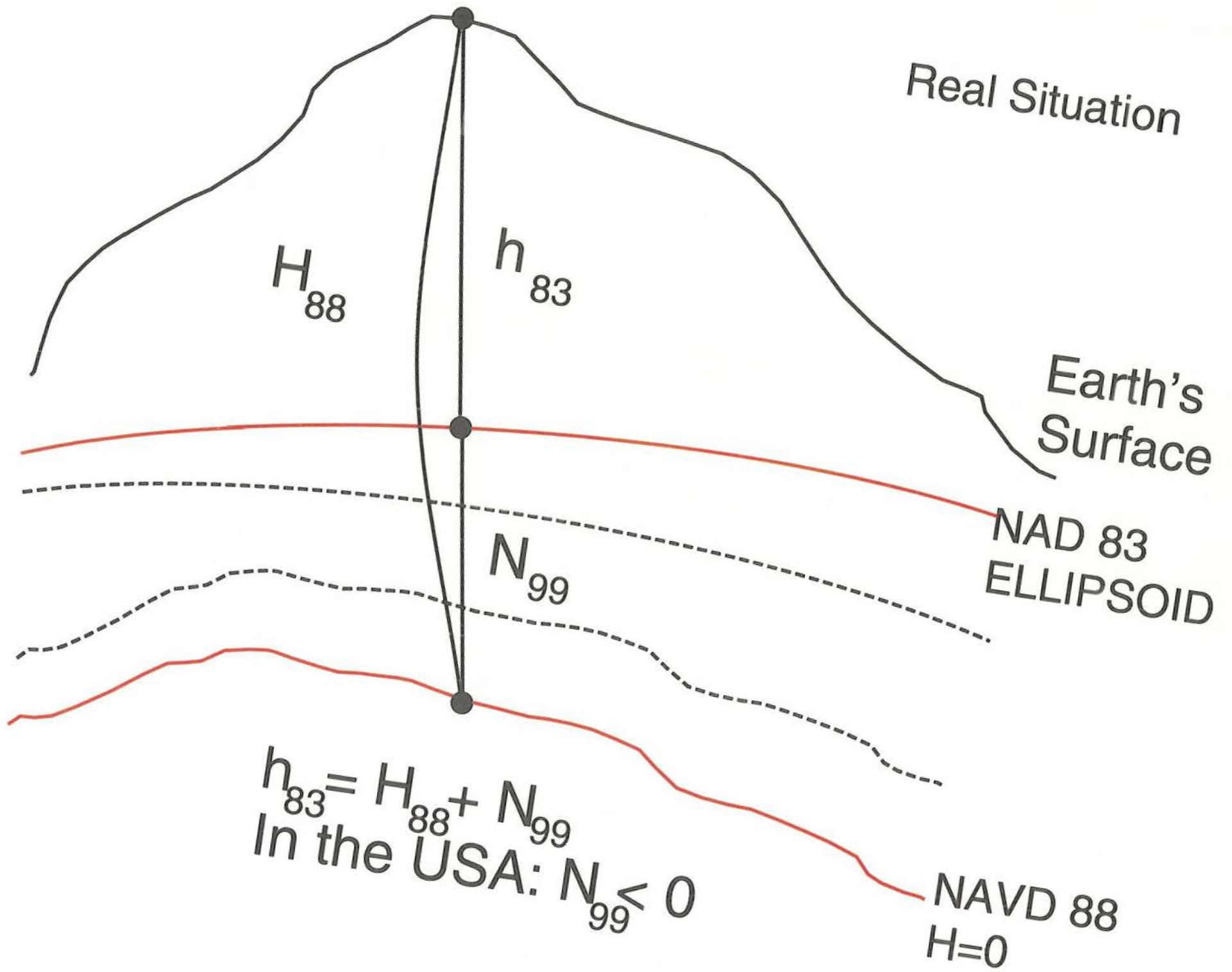
- Review of Height Systems**
- Creation of GEOID99 model**
- Comparison with GEOID96**
- Future Directions**

"Ideal" situation



$$h = H + N$$

In the USA: $N < 0$



GEOID99 basic information

Input data

- **2.0 Million gravity observations (1.6 from the NIMA evaluated gravity database)**
- **0.6 Million altimetric gravity anomalies**
- **EGM96 (NASA/NIMA)**
- **1 km DEM supplemented by 30 m DEM in Northwest USA**
- **6169 GPS heights on leveled benchmarks**

Theory

- **Faye anomalies \cong Helmert anomalies**
- **Remove/Compute/Restore using EGM96 and 1-D FFT**
- **Collocation to model h-H-N long wavelength systematic differences**

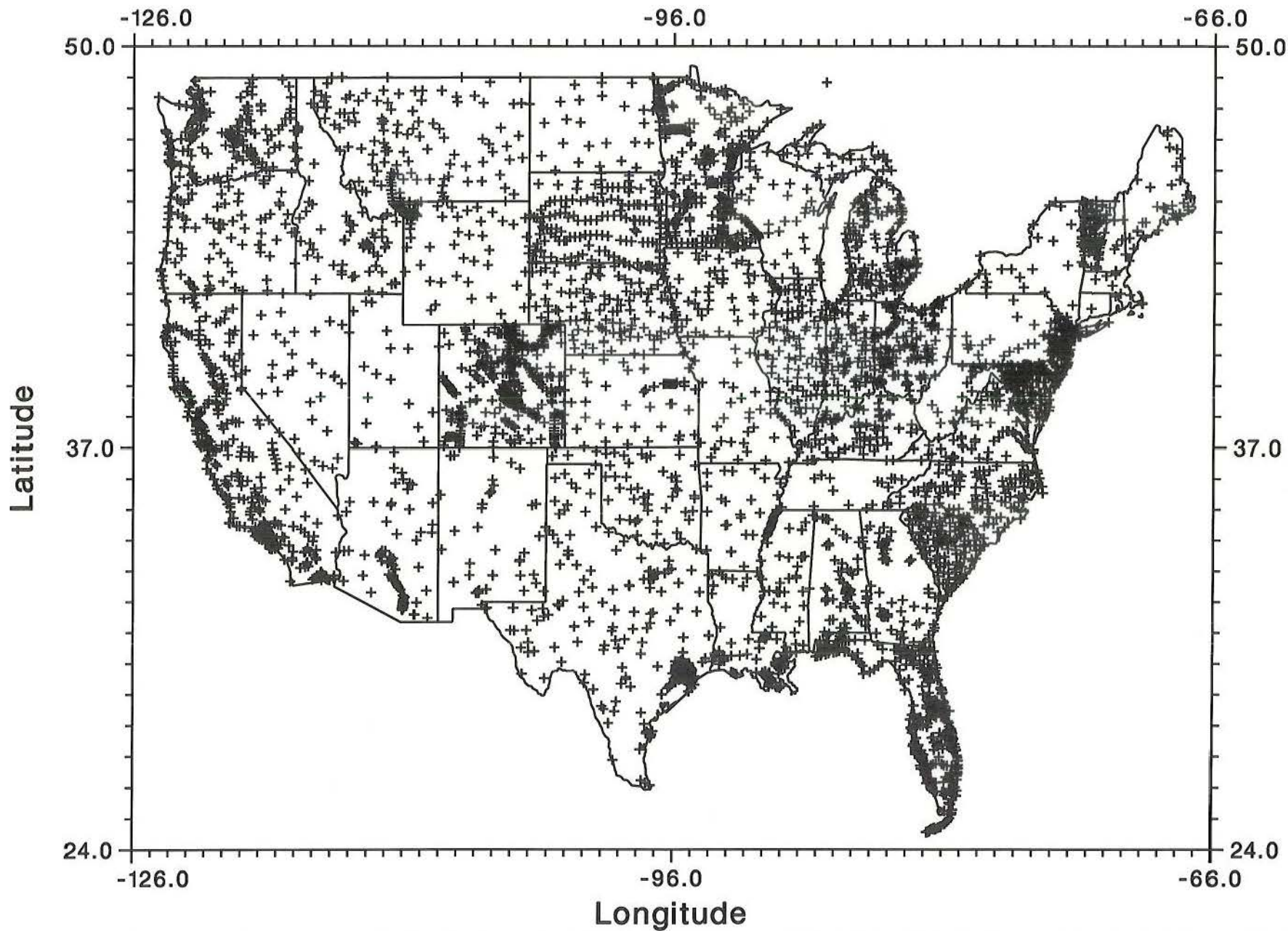
Output Grids

- **1 arc-minute grids**
- **CONUS: up to 58 degrees North**
- **Alaska, Hawaii, Puerto Rico/Virgin Islands**

GPS on Benchmarks

- 48 CONUS HARNs completed, including 6169 GPS measurements on leveled benchmarks.
- G99SSS gravimetric geoid vs. GPS/BMs
 - Bias: 52 cm
 - Tilt: 0.15 ppm, 327 degrees azimuth
 - RMS after bias/tilt removal: 18.2 cm
- Collocation used to model the residuals yields GEOID99
- GEOID99 vs. GPS/BMs
 - Bias: 0 cm
 - Tilt: 0.0 ppm
 - RMS: 4.6 cm

GPS/BMs for GEOID99 (6169 points)



30 meter DEM in Northwest USA

- **USGS makes 30 meter DEMs available in 7.5 minute quadrangular areas on UTM grid**
- **NGS acquired, cleaned, and regrided the data onto 1 arcsecond grid in the region 39/49 North and 231/256 East (NGSDEM99)**
- **Decimated 3 arcsecond DEM used for terrain corrections**
- **Geoid impact of new DEM in Northwest USA:**
 - ~14 cm (1 σ) locally (max +/- 40 cm)**
 - ~7 ppm tilts (1 σ) (max +/- 200 ppm)**

GEOID96 vs GEOID99

	<u>GEOID96</u>	<u>GEOID99</u>
Grid	2'x2'	1'x1'
North edge	54	58
DEM	TOPO30 (30")	corrected TOPO30 and 1" NGSDEM99
TCs	30"	3" and 30"
GPS/BMs	2951	6169
NAVD 88 bias	-31 cm	-52 cm
RMS wrt GPS/BMs	5.5 cm	4.6 cm

FUTURE GEOID ITEMS

- Rigorous Helmert anomaly computations
- 1" DEM for entire USA
- Incorporation of rock density models
- Future geoid model areas may include any of:
Canada, Greenland, Caribbean, Mexico, South America
- Annual models (?) to keep geoid current with latest GPS measured heights

GEOID99 Availability

WWW (Sept. 30):

<http://www.ngs.noaa.gov/GEOID/geoid99.html>

CD-ROM (Mid-October):

Information Services Branch

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