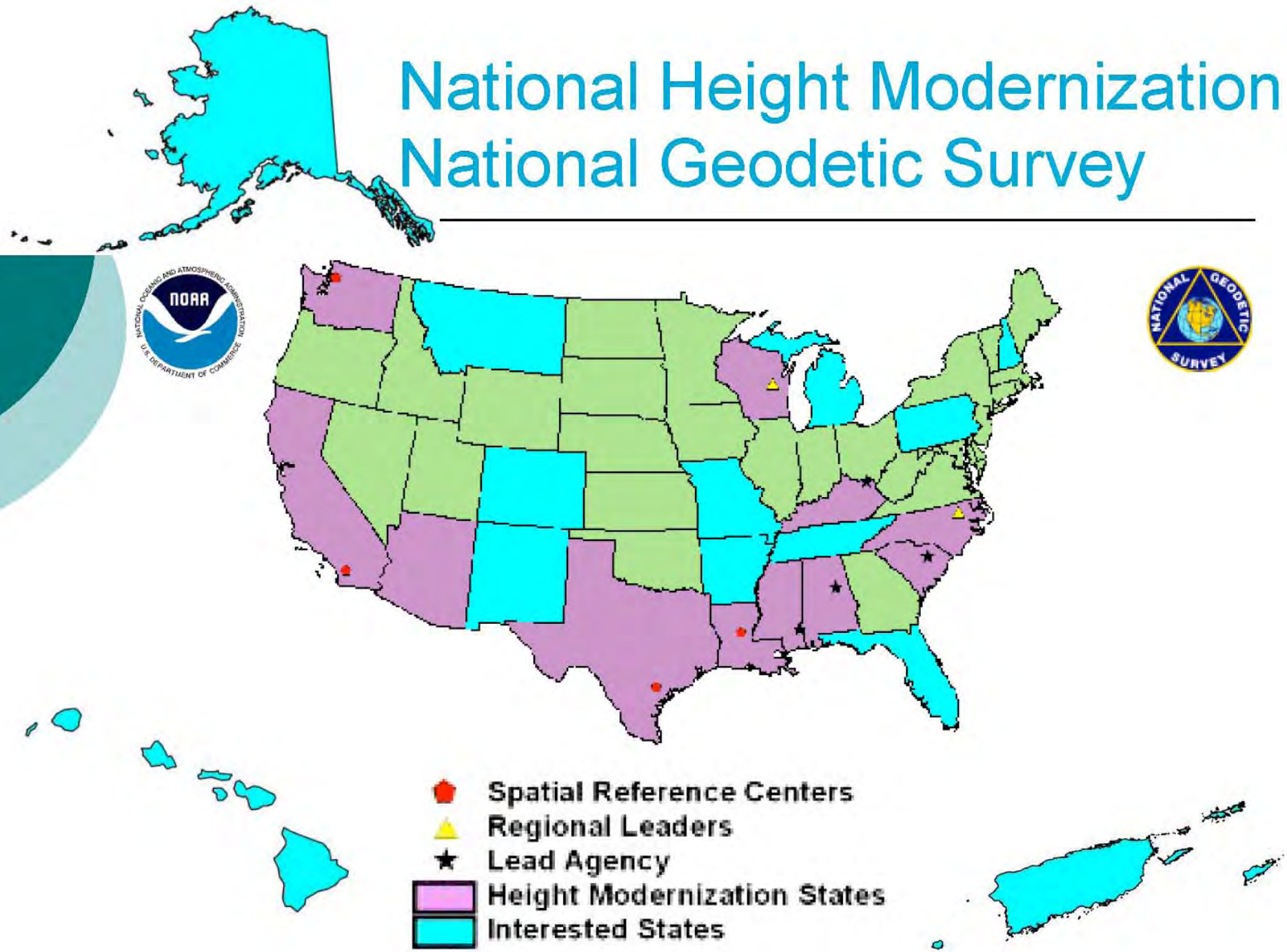
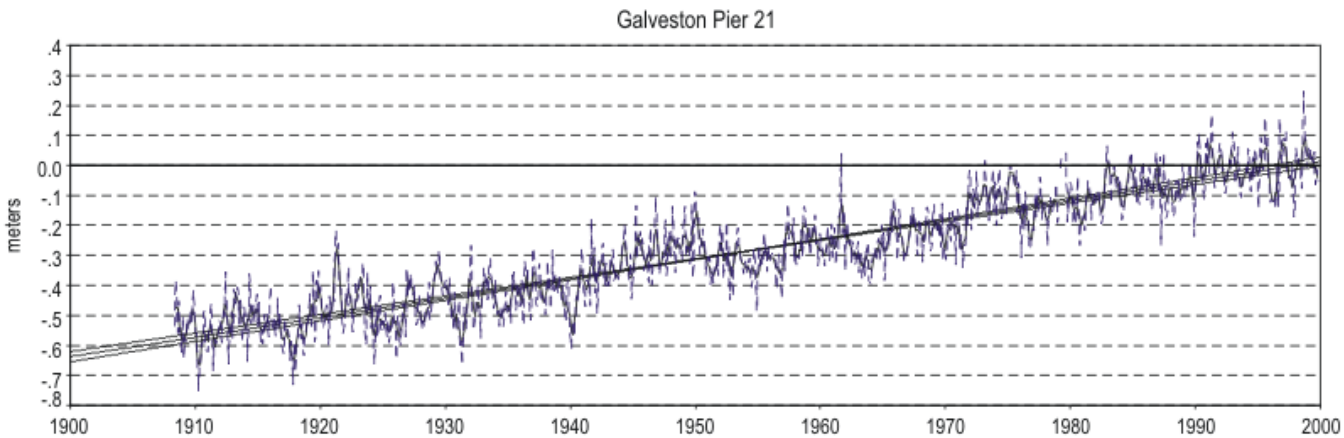
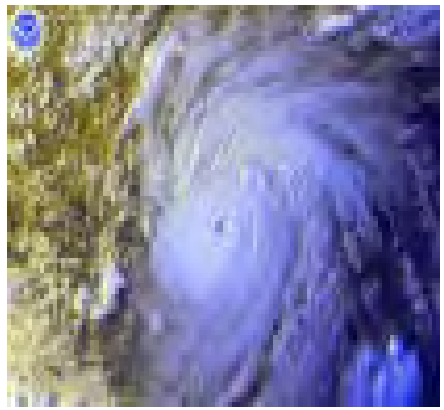
National Height Modernization
National Geodetic Survey



What Height Modernization Brings to NOAA's Climate Goal

1) NSRS Supports GEOSS by providing positioning infrastructure for monitoring effects of climate change, like sea level rise, through the CORS program
2) GPS-Met Water vapor studies - fundamental to understanding the formation and propagation of weather; enhances capability for improved weather forecasting
3) Monitoring land velocities, effects of ground water extraction due to adverse affects of climate change; crustal motion (earthquakes, subsidence, uplift)
4) Accurate flood plain elevations to prepare for large rainfall events





What Height Modernization Brings to NOAA's Ecosystem Goal:

1) Ecosystem Restoration
   - Surface Elevation Tables (SETs) connection to NSRS
   - Blackwater National Wildlife Refuge – sea level rising at 3.5 mm per year
2) Emergency response
   - Forest fires – providing accurate 3D digital mapping
   - Flooding – hurricanes, tsunamis, tornadoes & heavy rainfall events
   - Earthquakes – crustal movement
3) Precision agriculture – CORS network provides geospatial information to allow for
   - More efficient effective application of fertilizers/pesticides, irrigation
   - Increased crop production; minimal negative Environmental impact
   - Soil nutrient management

What Height Modernization Brings to NOAA's Weather and Water Goal

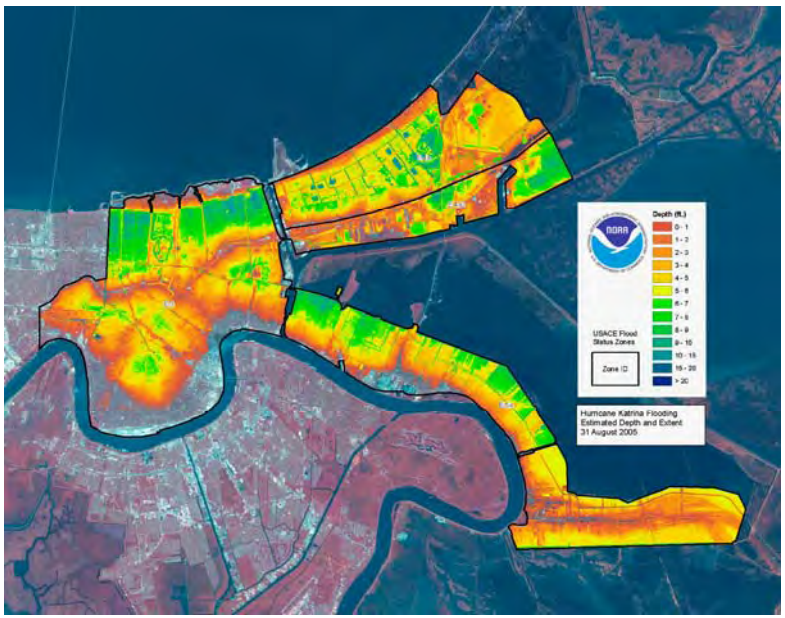
More accurate geospatial information for

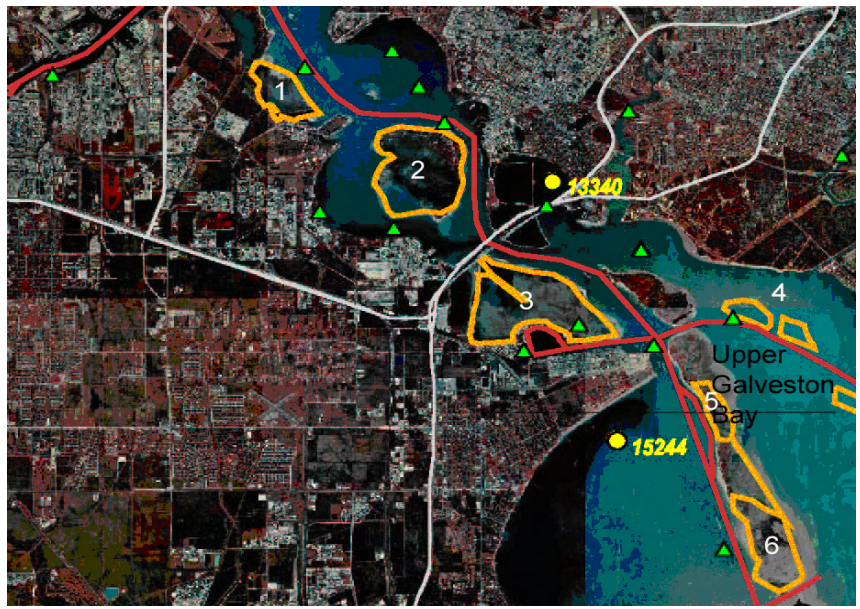
- Developing inundation and storm surge models for more accurate flood prediction
- Local forecasts and warnings for extreme weather events using tide gauge and CORS data
- Heights on levees/dunes/dams/streams
- Flood damage mitigation, reservoir management

What Height Modernization Brings to NOAA's Commerce & Transportation Goal

Common consistent geospatial data for

1) Accurate GIS Coastal Mapping
2) Emergency response information
3) Under keel and overhead clearance for ships/ GPS buoys
4) Accurate vertical datum for ship channel maintenance and dredging
5) Airport obstruction surveys
6) Hurricane Routes





Appropriations (2001-2008)

Fiscal Year	Appropriations	States
FY 2001	2.25 M	CA, NC
FY 2002	3.75 M	CA, NC, LA, WI
FY 2003	3.75 M	CA, NC, LA, WI, MS
FY 2004	9.0 M	CA, NC, LA, WI, MS, AL, WA, SC
FY 2005	9.6 M	CA, NC, LA, WI, MS, AL, WA, TX, KY
FY 2006	9.9 M	CA, NC, WI, MS, AL, SC, TX, KY, AZ
FY 2007	9.9 M	"without direction"
FY 2008	4.995 M + 1.152 M	Line + AL, KY, IL

It is about better measurement of heights or elevations in the US

How high above Mean Sea Level?

Is sea level rising?

Can I get flood insurance?

Why do we need accurate heights?

Austin, 1991

Houston, 2001

Many lives are lost and

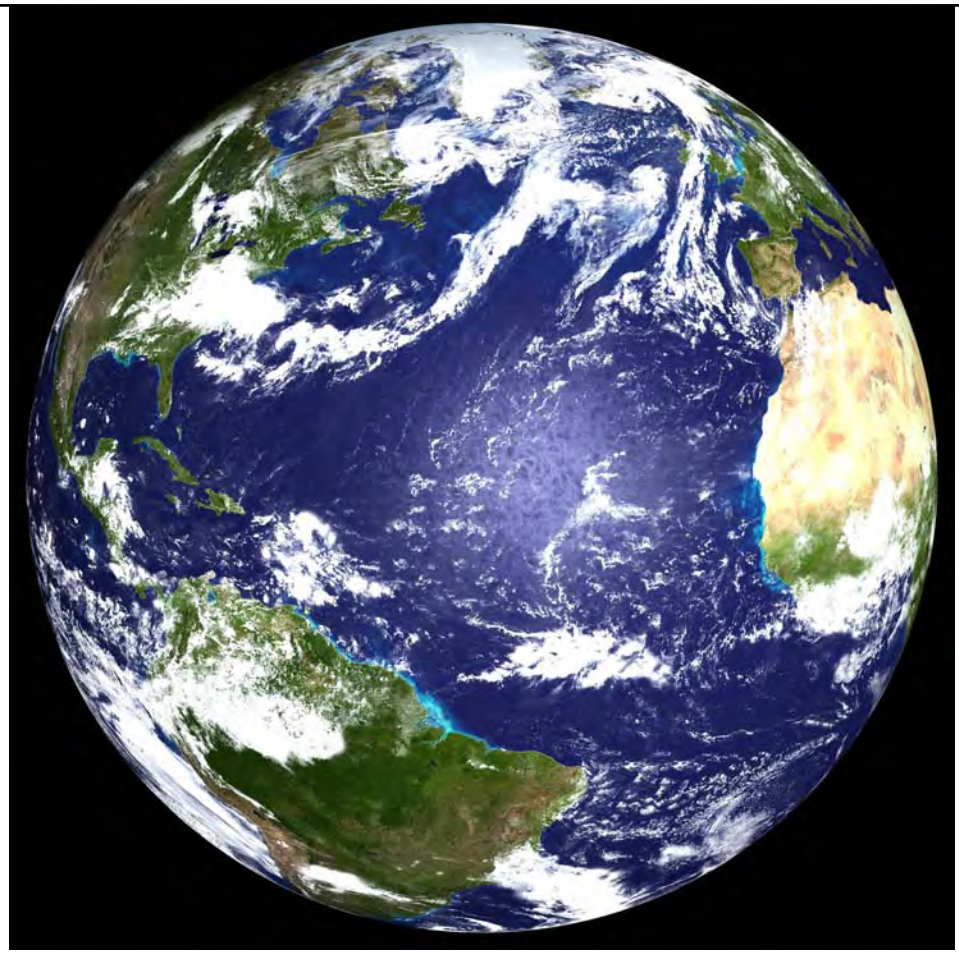
$Billions of property are lost.

Building local capacity/partnerships

HM Partners are helping NOAA with:

- State Geodetic Surveys
- State Geodetic Advisor Program
- Spatial Reference Centers
- Models, Tools: Gravity/geoid model; V-Datum; ionosphere; troposphere; Digital Elevation Models
- Education/outreach/technology transfer
- Enhance state and local partnerships

Some basic Geodesy* and Leveling



* The study of the size and shape of the earth

Vertical Datums

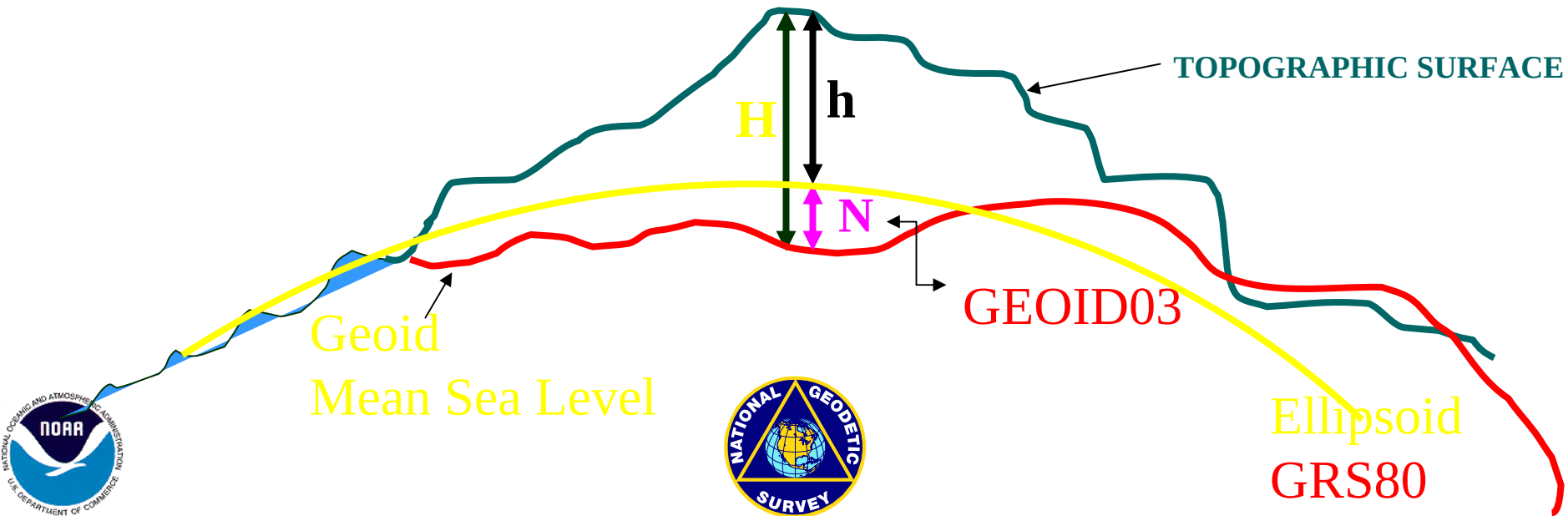
A set of fundamental elevations to which other elevations are referred.

H = Orthometric Height (NAVD 88 - Spirit Leveling)

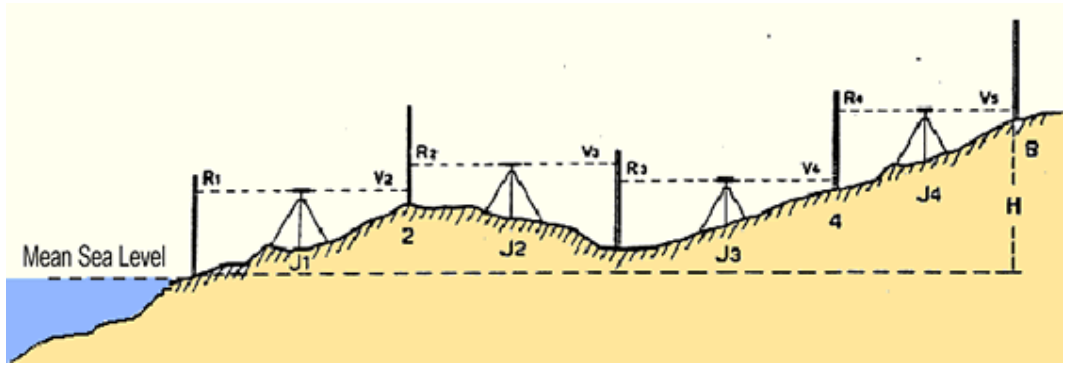
h = Ellipsoidal Height (NAD 83 - GPS)

N = Geoid Height (GEOID 03-Sea Level)

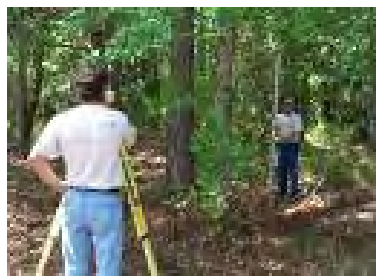
$$H = h - N$$



How elevations are observed.



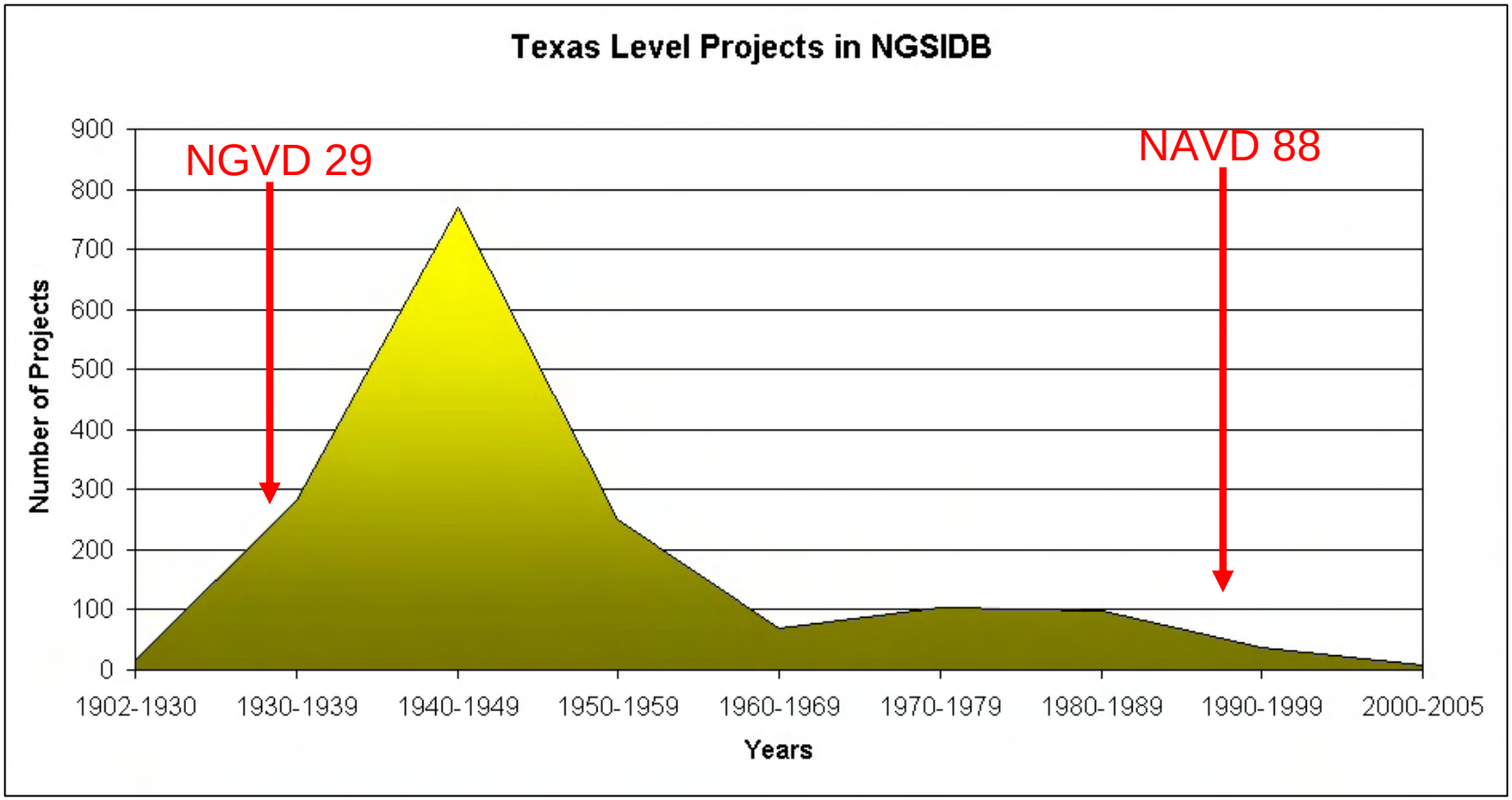
Using a level instrument and Rods graduated in feet.



Modern levels are digital +/- 0.0001m*

* though expensive at ±$2000 per mile

Elevations observed in Texas



Many benchmarks have been destroyed, or worse, are unreliable.

Comparison of US Vertical Datums

	NGVD 29	NAVD 88
DATUM DEFINITION	26 TIDE GAUGES IN THE U.S. & CANADA	FATHER'S POINT/RIMOUSKI QUEBEC, CANADA
BENCH MARKS	100,000	450,000
LEVELING (Km)	102,724	1,001,500
GEOID FITTING	Distorted to Fit MSL Gauges	Best Continental Model

Mean Sea Level vs. NAVD 88

centimeters

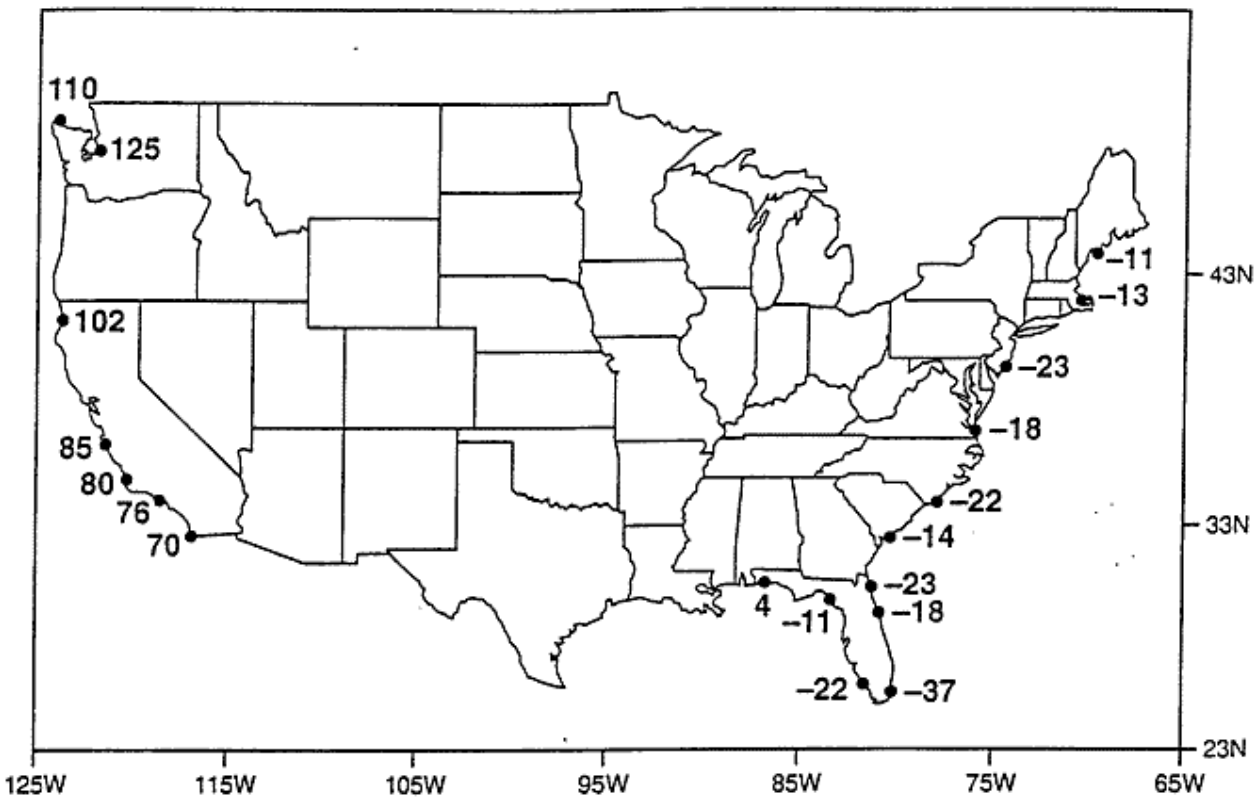
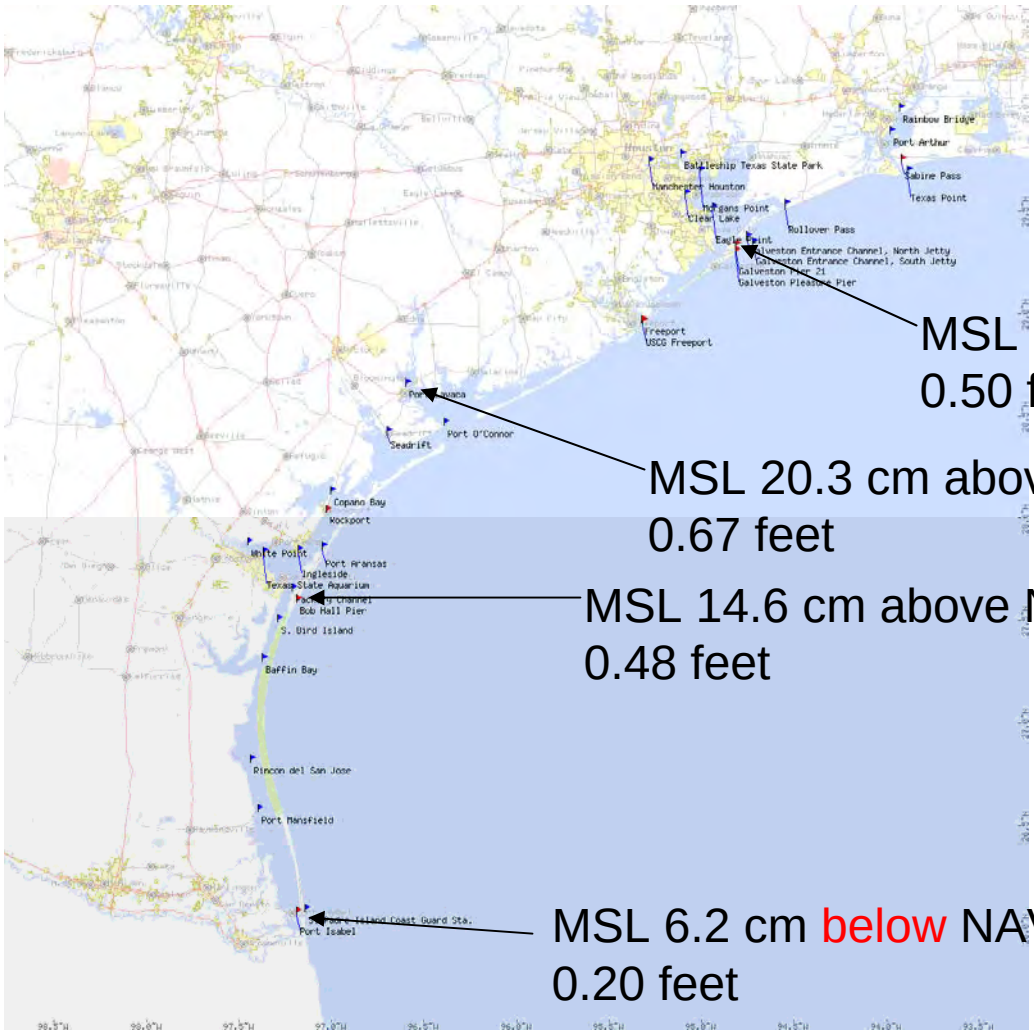


Figure 9. Height differences between NAVD 88 and heights of tidal benchmarks above LMSL (epoch 1960-78) (units = cm).

Modern MSL Texas vs. NAVD 88



MSL 15.2 cm above NAVD88
0.50 feet

MSL 20.3 cm above NAVD88
0.67 feet

MSL 14.6 cm above NAVD88
0.48 feet

MSL 6.2 cm below NAVD88
0.20 feet

Integrating GPS with Tide Gauges

VDatum

VDatum is designed to transform coastal elevations between 28 different vertical datums consisting of tidal, orthometric, and ellipsoidal (3-D, three dimensional) datums.

The future of elevations…

GRAV-D

Gravity for the Re-definition of the American Vertical Datum

Q: What is GRAV-D?

A: A Plan (released Dec 2007)

- *Official NGS policy as of Nov 14, 2007*
  - *$38.5M over 10 years*
- *Airborne Gravity Snapshot*
- *Absolute Gravity Tracking*
- *Re-define the Vertical Datum of the USA by 2017*