

Alaska Local Tidal Datums

An introduction for non-experts

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What is a vertical datum?

A vertical datum is a reference surface that can be used to measure heights in a uniform way.



How much taller is Sally?

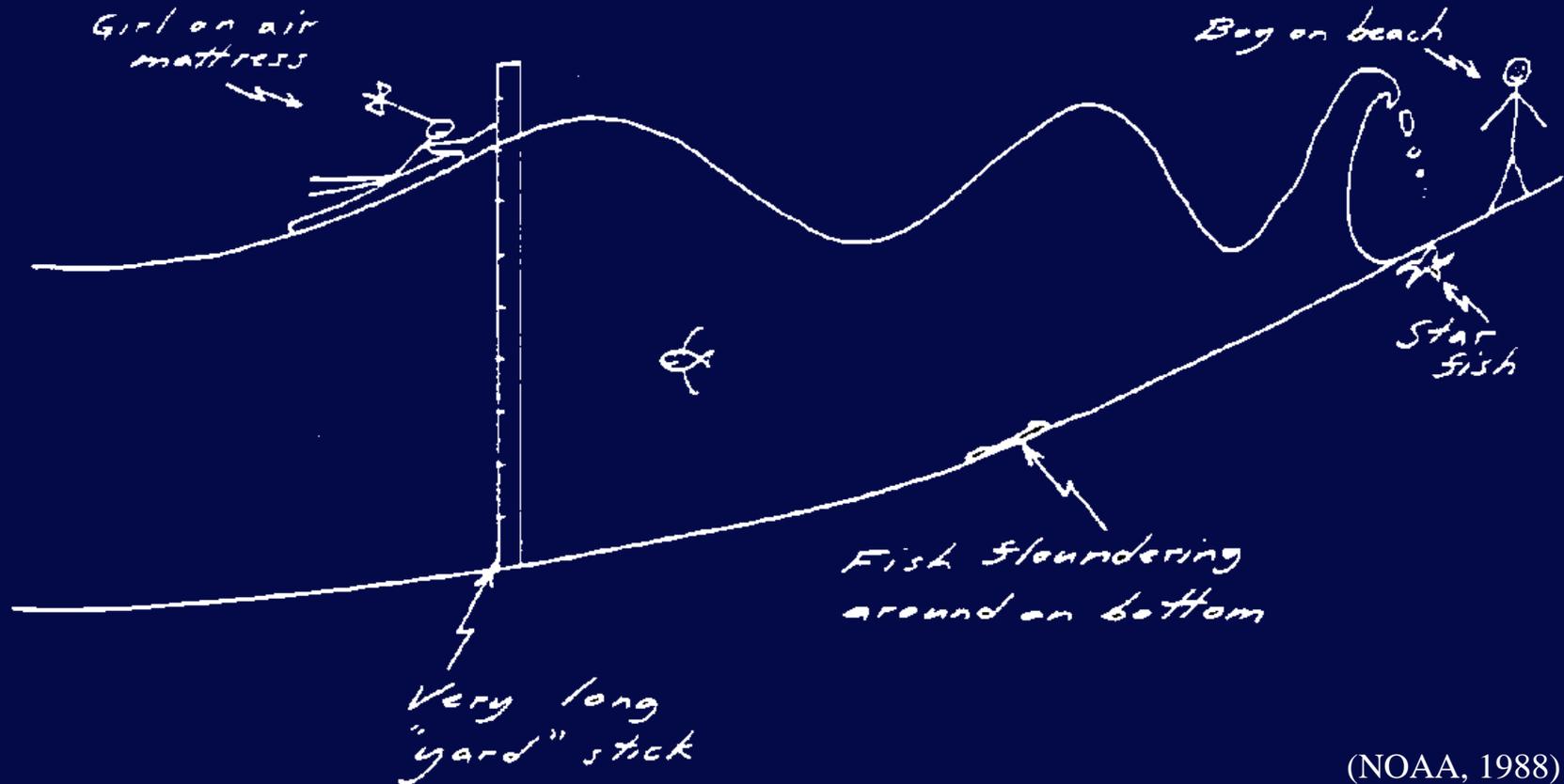
Need to know how tall the hill is!

... you cannot compare heights that are measured from different surfaces.

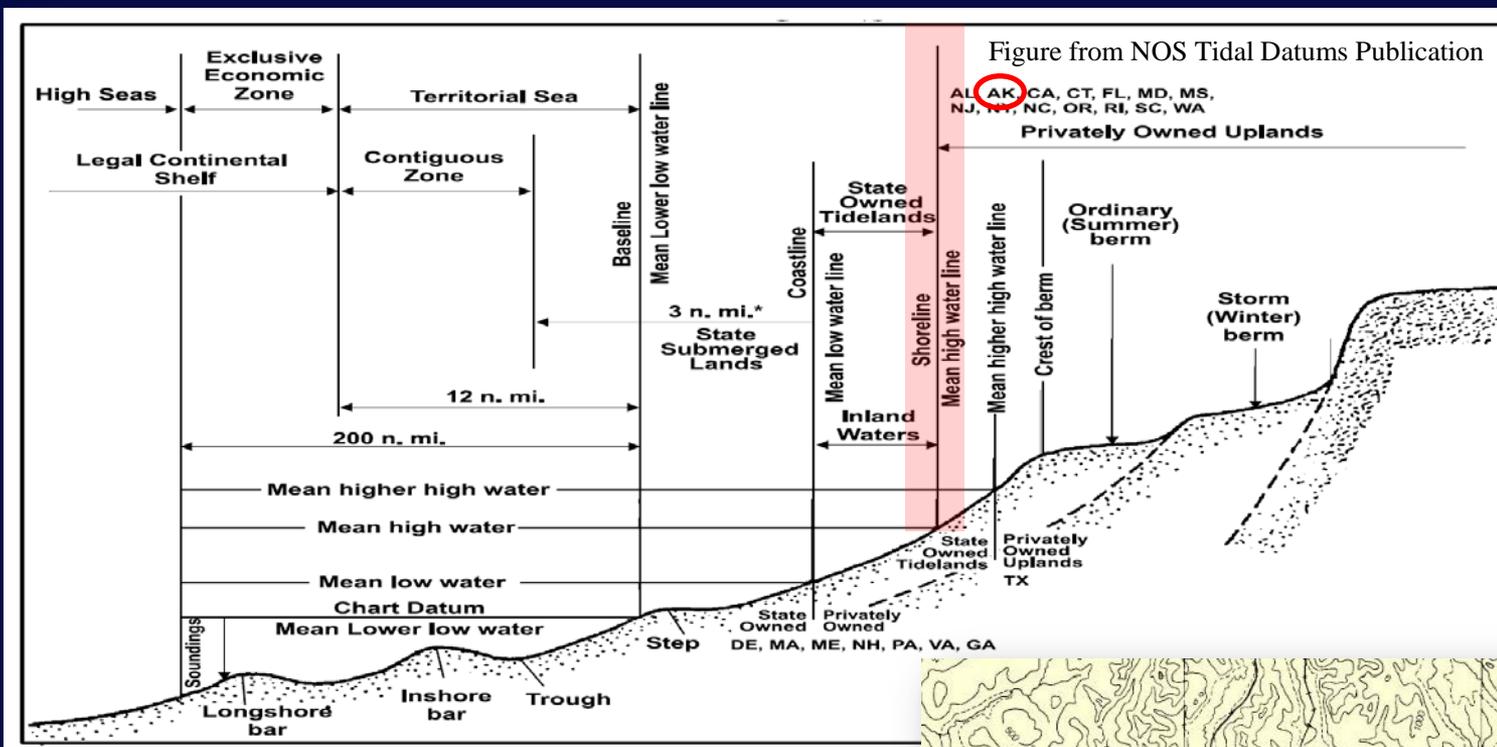
Common water level questions:

THE WATER KEEPS GOING UP AND DOWN. HOW WILL I TELL MY FRIENDS HOW DEEP IT WAS HERE?

AS THE WATER GOES UP AND DOWN, IT MOVES LANDWARD AND SEAWARD ON THIS SLOPING BEACH. WHERE DOES THE OCEAN REALLY END AND THE LAND REALLY BEGIN?

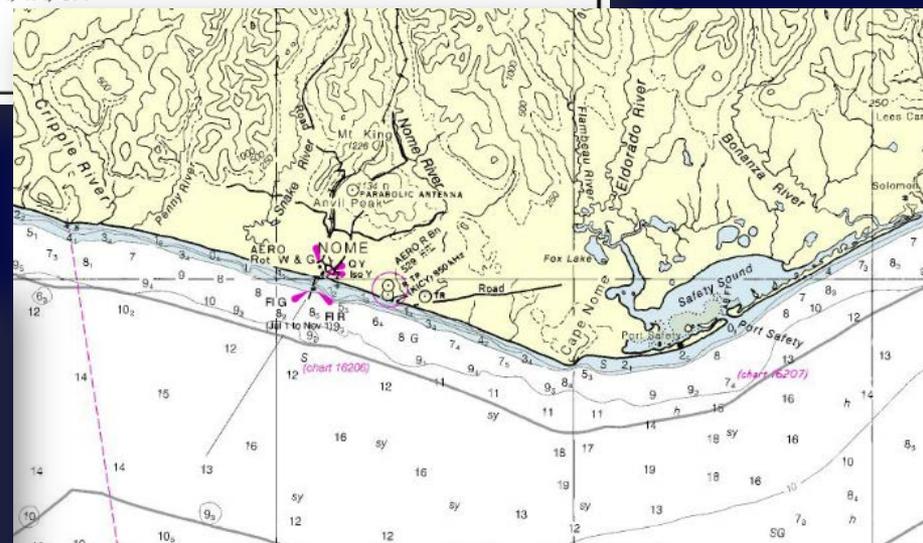


Examples of vertical datums

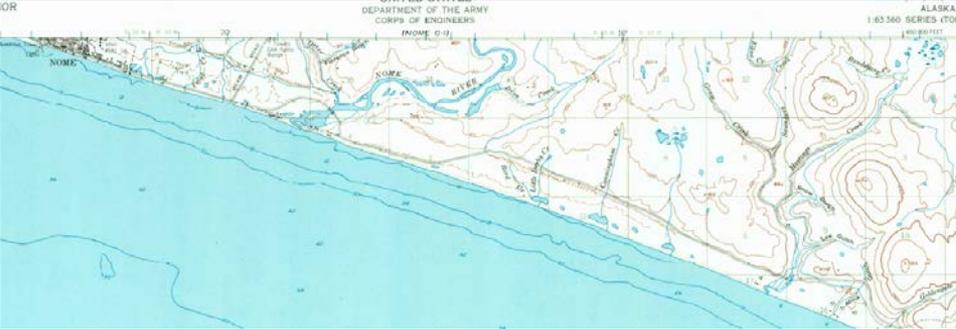


Land
Ownership

Topographic Maps (“NVGD29” or “NAVD88”)



Nautical Charts (MHW elevations, depths in MLLW)

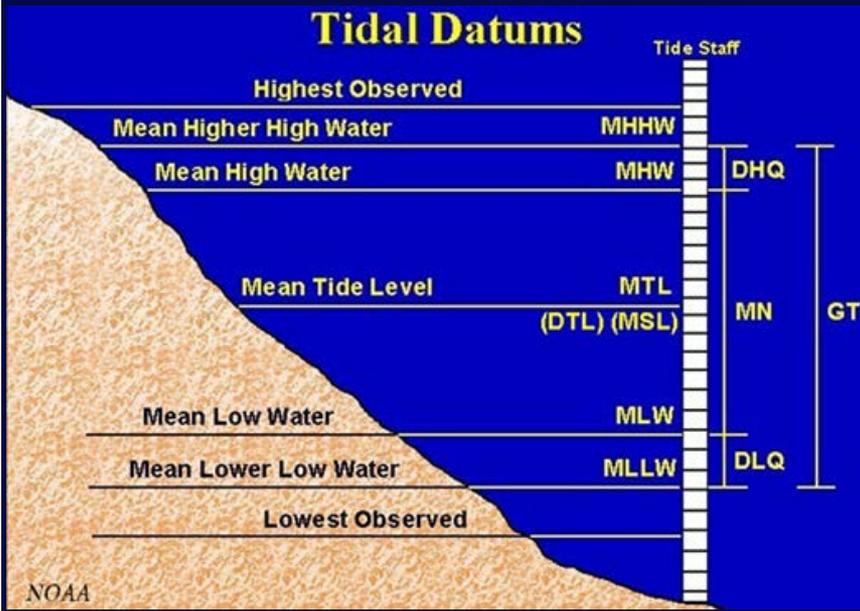


Vertical datums in the coastal zone

Tidal Datums

Standardized elevations of local sea level

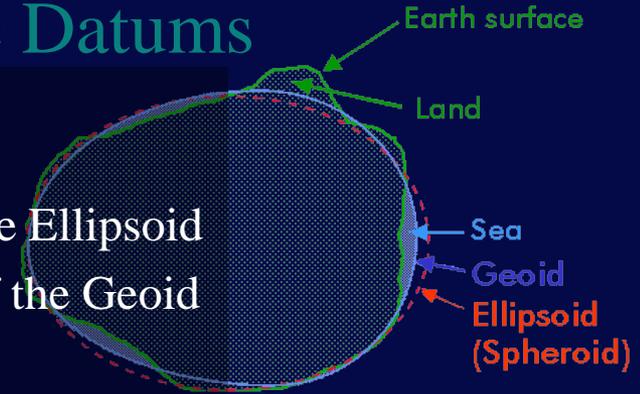
The basis for establishing coastal land ownership, marine boundaries, designing coastal infrastructure and quantifying coastal hazards.



Geodetic Datums

Combine:

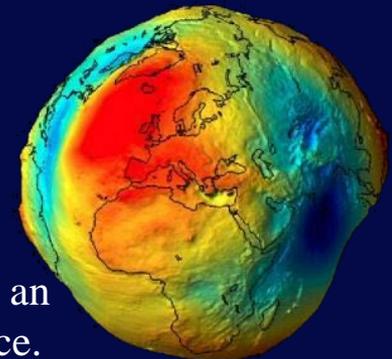
- Reference Ellipsoid
- Model of the Geoid



NAVD88 is the official geodetic vertical datum for the United States (orthometric height)

The geoid is an equipotential gravitational reference surface that approximates an *idealized* global sea surface.

Current best model is GEOID12A



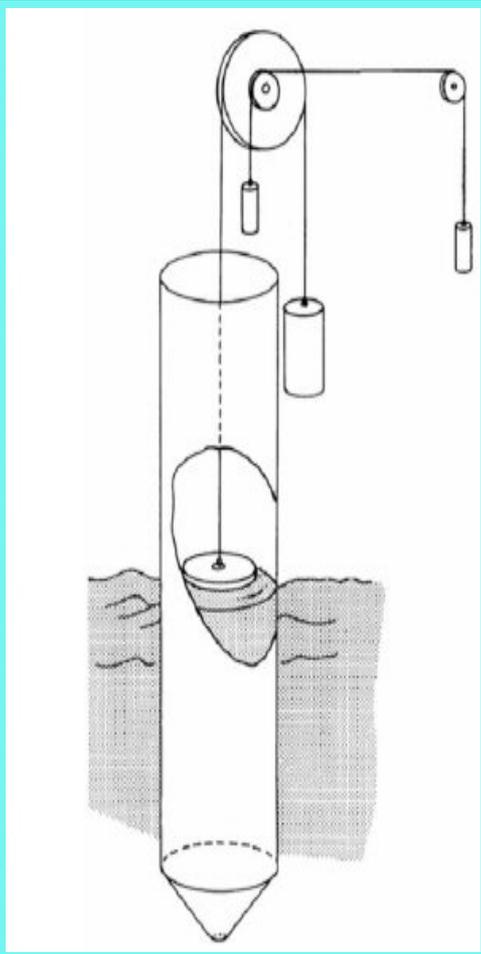
How are water levels measured?

Tide Stations

Older methods:



Tide Staff



Float and stilling well

Modern Methods:

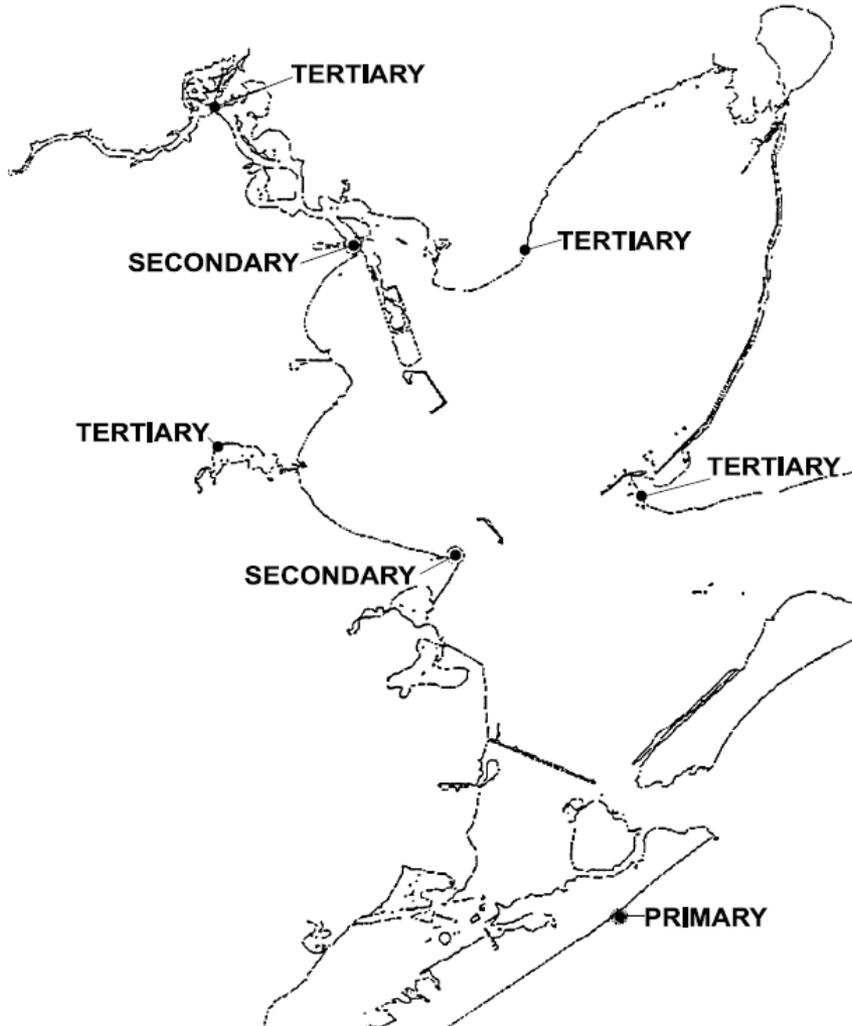
- Bubbler Gauge
- Pressure Transducer
- Acoustic Gauge
- Radar Gauge

Tide stations use two independent sensors to collect primary and backup water level data

Network of tide stations for the United States is maintained by NOAA's Center for Operational Oceanographic Products and Services (CO-OPS)

Are all tide stations the same?

TIDE STATION HIERARCHY



Tertiary Water Level Stations

- 1-12 months of operation
- provide control for hydrographic surveys
- short-term/seasonal installations
- Alaska examples:

Secondary Water Level Stations

- 1-19 years of operation
- provide control for local effects
- installations typically have finite lifetimes
- Alaska examples:

Primary Tide Stations (Control)

- 19+ years of operation
- continuous records
- permanent installations
- Alaska examples:

Tide stations in Alaska

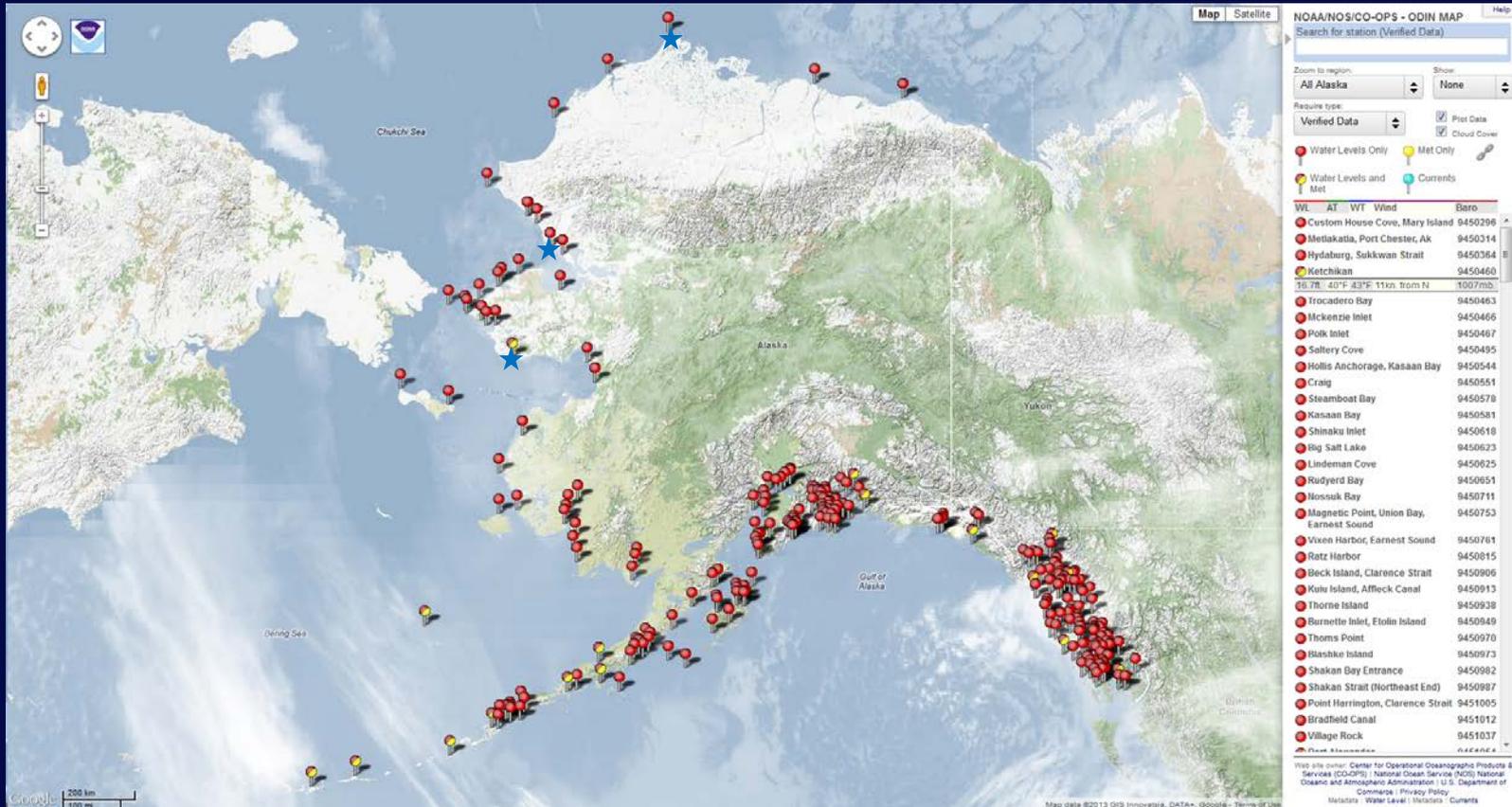
26 active stations

Delaware has 3 gauges along 30 miles of coastline

Northwest Alaska has 3 gauges along 2,000+ miles of coastline

~140 harmonic stations (& declining)

987 total tide gauge locations on record – earliest is July 1900

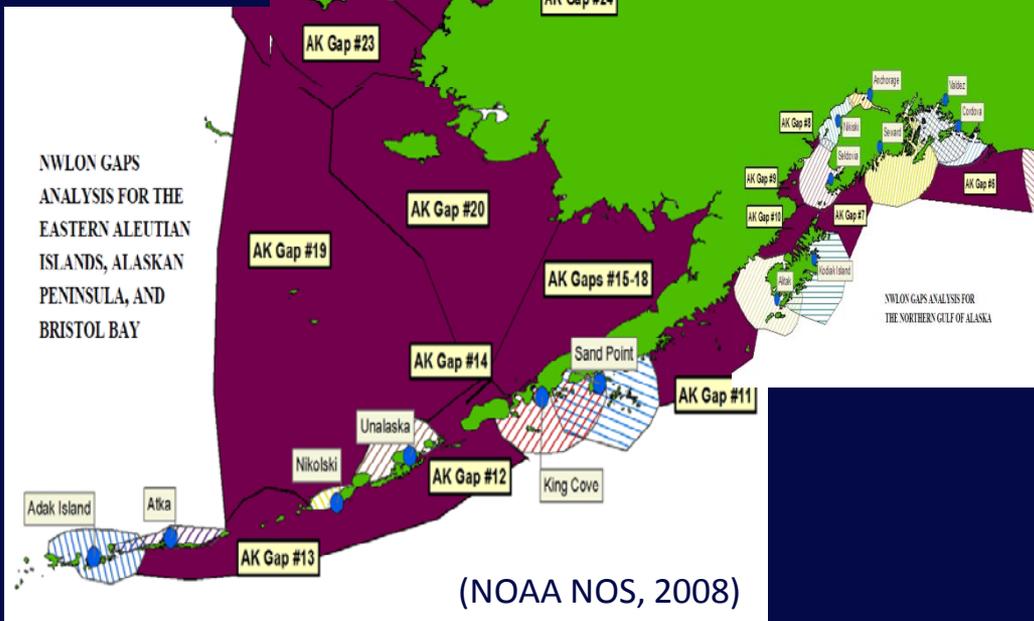


Tidal analysis of harmonic constituents by NOAA = Tide Predictions

Available at: <http://www.tidesandcurrents.noaa.gov>

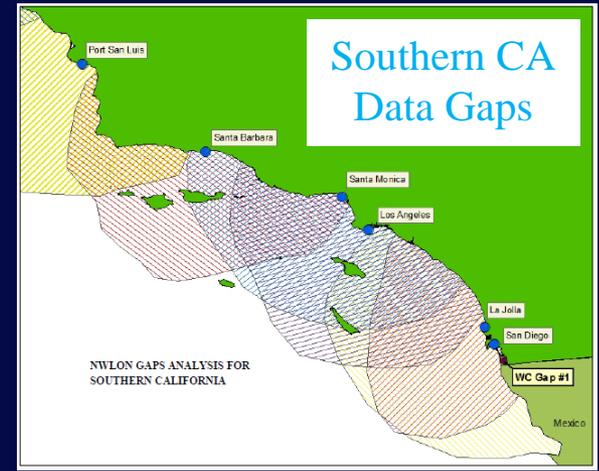
National Water Level Observation Network (NWLON)

Alaska Data Gaps



(NOAA NOS, 2008)

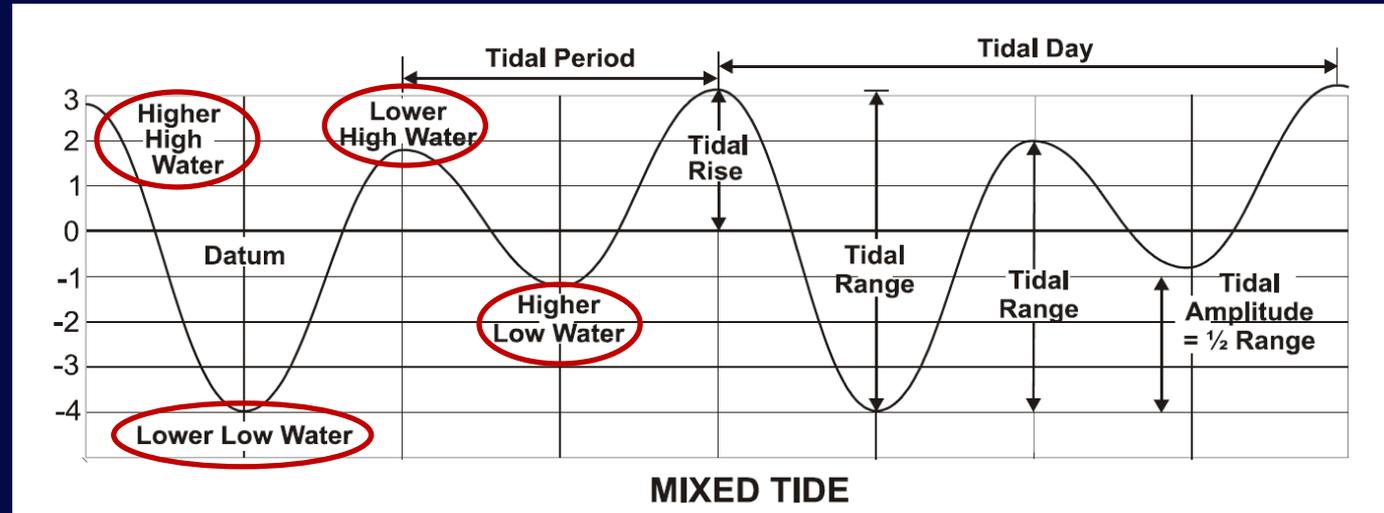
210 stations total in US



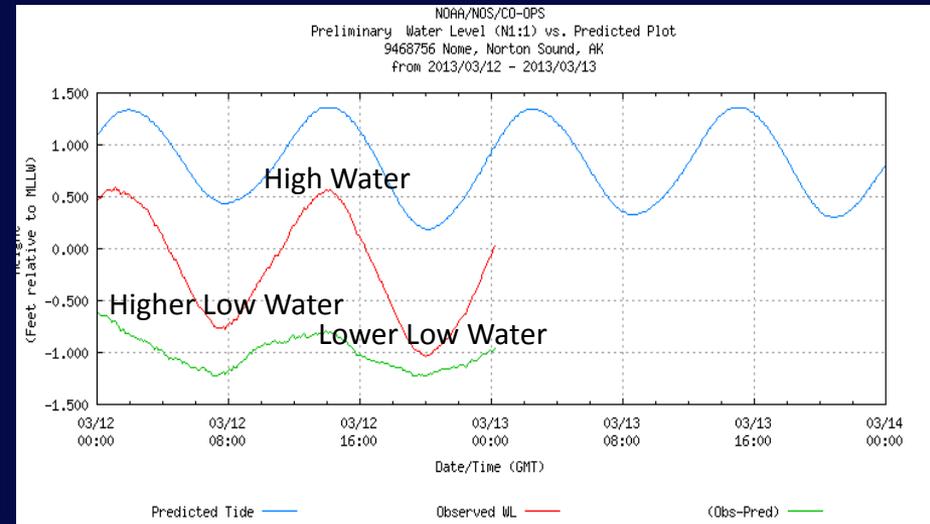
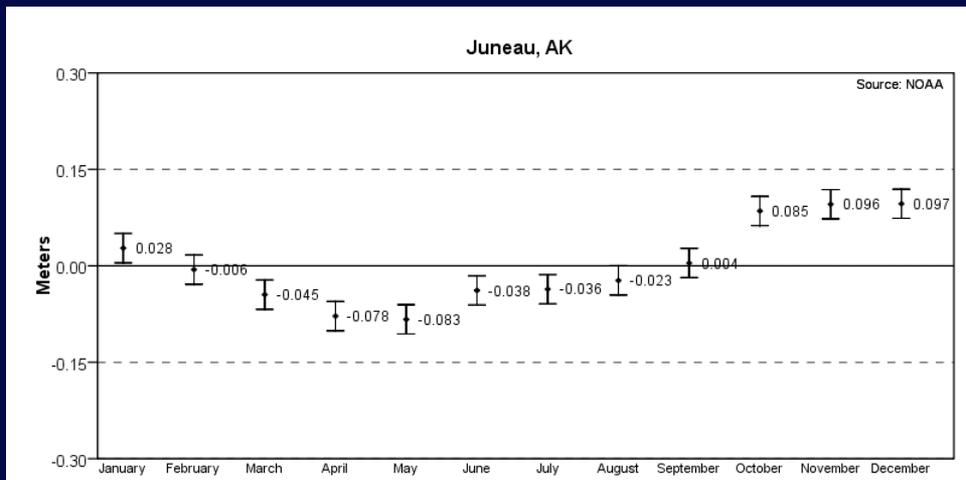
NWLON GAPS ANALYSIS FOR SOUTHEAST ALASKA

Tide station records

Idealized:



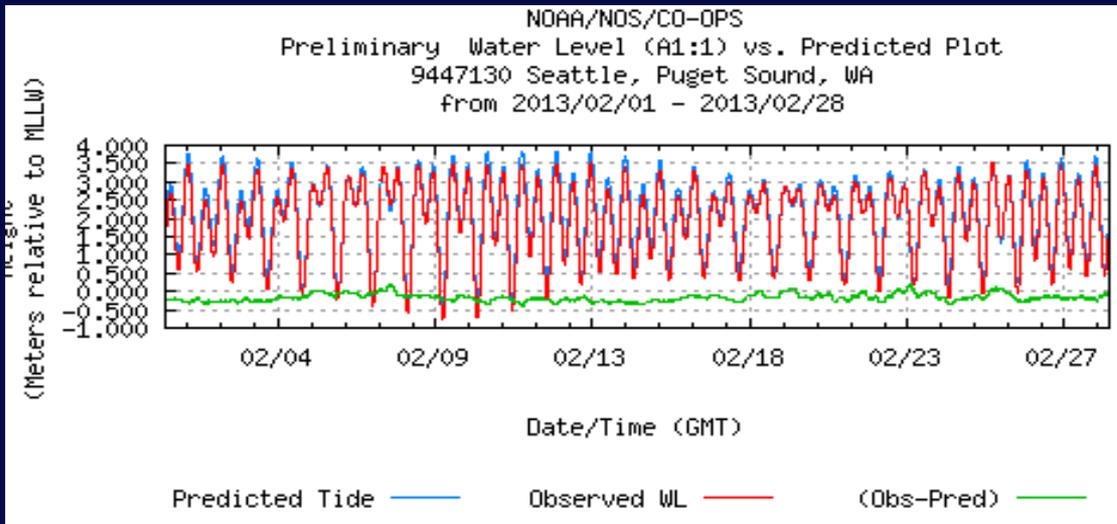
Real:



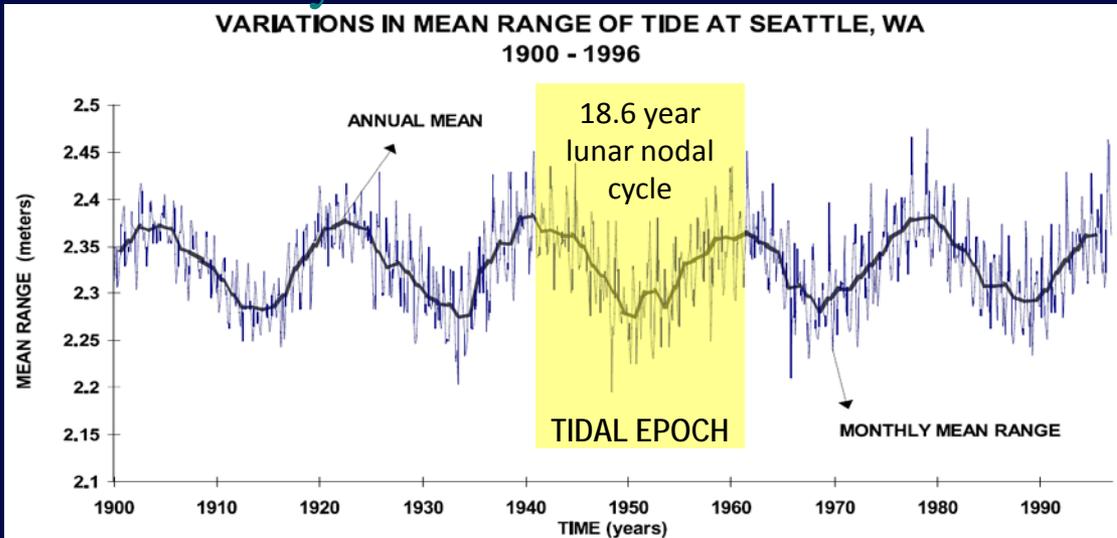
Tides - Wave & wind setup - Ocean & river currents - Temperature and salinity - Wind waves - Ocean eddies
- Barometric pressure - Seiches

How do we define the local sea level?

One month of water level measurements



One century of water level measurements



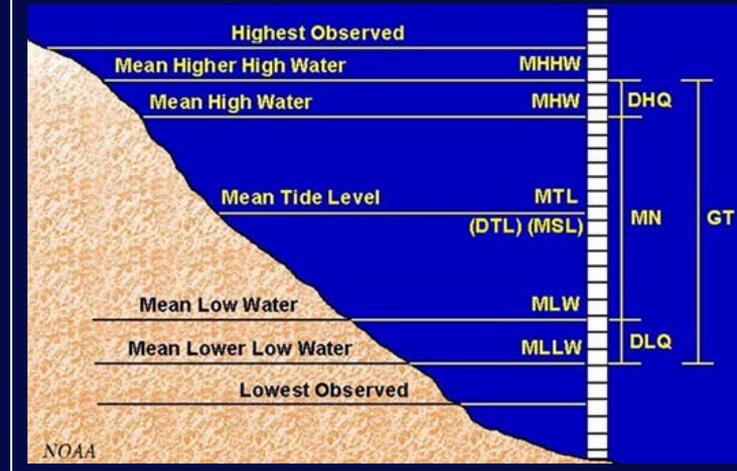
Tidal Datums

Examples:

Local MHW - Average of the high water levels at a station over a 19-year period (1983-2001)

Local MTL - Average of all high water and low water levels at a station over a 19-year period

Local MSL - Average of hourly water level measurements over a 19-year period



Geodetic Elevations and ‘Mean Sea Level’

First standardized vertical datum in US was NGVD29

“Sea Level Datum of 1929”

26 tide stations in US and Canada

NAVD88 (1988)

ONE tide station is used as the reference MSL →

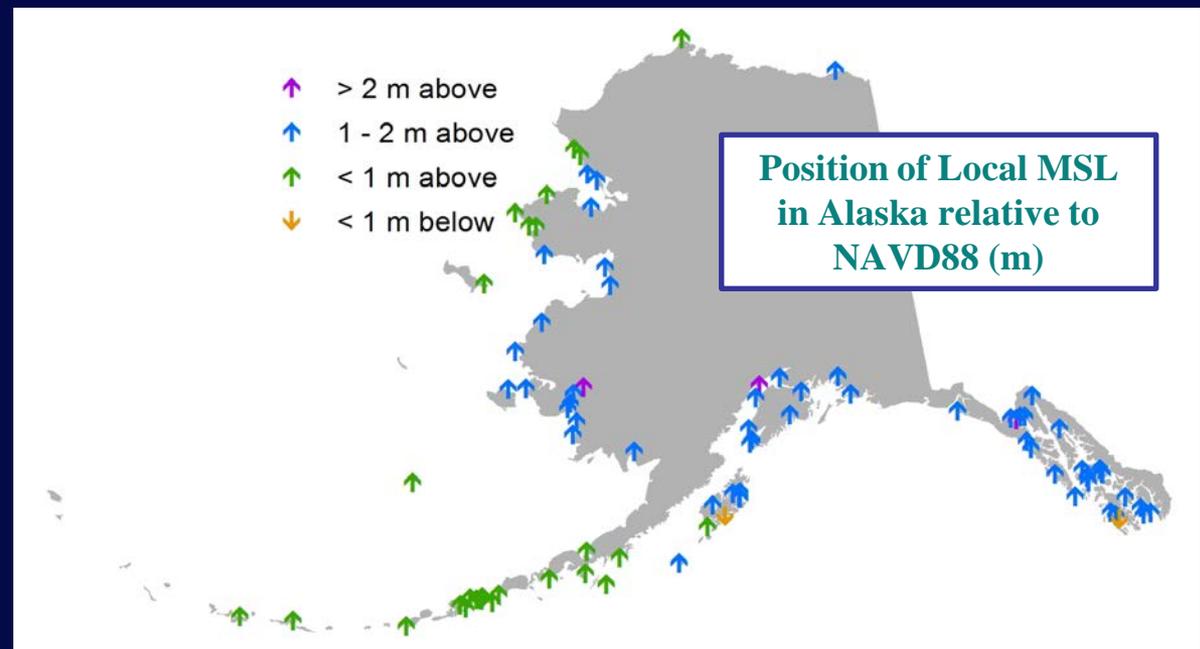
NAVD88 "MSL" ≠ Local MSL

Please spread the word!



Why does local MSL differ?

- Incomplete map of earth’s gravity field = GEOID12A
- Sea surface topography is driven by oceanographic and atmospheric effects as well



Datum Conversion

In most of USA

NOAA's VDatum tool

Uses a continuous sea surface grid (TSS)
to make transformations

Available in all contiguous states, Puerto
Rico and the US Virgin Islands

The screenshot shows the NOAA's Vertical Datum Transformation - v3.1 software interface. It is divided into several sections:

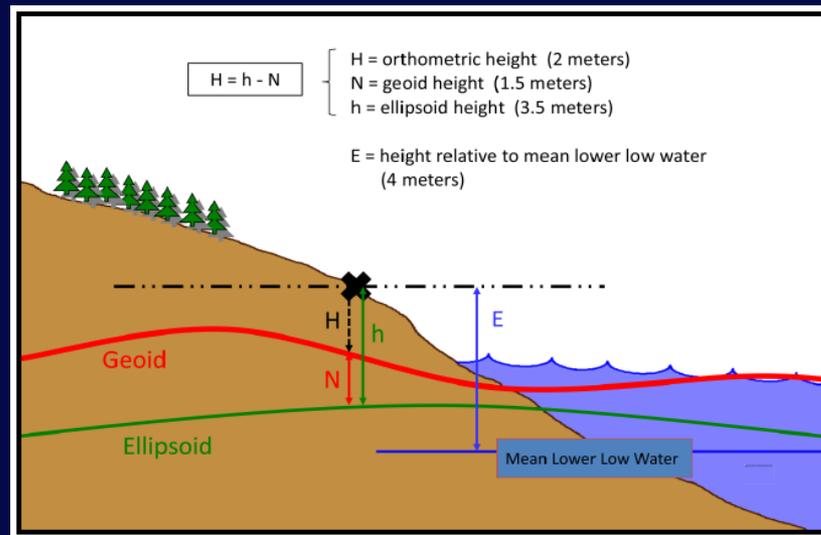
- Horizontal Information:** Contains dropdown menus for Source and Target Datum (both set to NAD83(2011/2007/CORS96/HARN) - North Am...), Source and Target Coord. System (both set to 0 - Geographic (latitude, longitude)), and Unit (both set to meter (m)).
- Vertical Information:** Includes checkboxes for Height and Sounding (Sounding is selected), and checkboxes for GEOID model.
- Point Conversion:** Features input fields for Longitude, Latitude, and Height, and corresponding output fields. A 'Convert' button is located between the input and output fields, and a 'Reset' button is below it.

In Alaska

Sole-station offset transformations

Require:

- Tidal Datums (19-year averages)
- Tidal Benchmarks w/ published geodetic heights



NOTE: elevations obtained using this method are
only valid in the immediate vicinity of the
original tide station



Alaska Department of Natural Resources Division of Geological & Geophysical Surveys

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Alaska Tidal Datum Portal

The Alaska Division of Geological & Geophysical Surveys (DGGs) has a coastal community geohazards evaluation and geologic mapping program that is funded through the federal Coastal Impact Assistance Program (CIAP). Since this program was launched in 2010, fieldwork has been conducted in seven coastal communities and includes field efforts to rapidly document the impacts of severe storms on Alaska's coastline. Accurate vertical datums in the coastal environment are critical to the evaluation of natural hazard vulnerability in support of local and regional planning. Appropriate tidal data must be considered in the siting, design, construction, and operations of development projects to ensure protection of human life, property, and the coastal environment.

- [About the Alaska Tidal Datum Portal](#)
- [Frequently Asked Questions \(FAQ\)](#)
- [The Alaska Tidal Datum Calculator](#)
- [Recommended External Resources](#)

The values in this conversion calculator were last updated January 2013.

Location: Adak Island

Geodetic Elevation: (meters) NAVD88(GEOID12A), Orthometric

Local Tidal Elevation: (meters) MLLW

A summary of relevant information, including links to all of the published values included in this calculator, can be found in the [reference table document](#). The table includes all Alaska tide stations with published local datums as of January 2013, however, tidal benchmarks or NAVD88(GEOID2012) tidal benchmark elevations are not available for all locations.

The development of this site was partially funded with qualified outer continental shelf oil and gas revenues by the Coastal Impact Assistance Program, Fish & Wildlife Service, and U.S. Department of the Interior. The views and conclusions contained herein are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. government. Mention of trade names or commercial products does not constitute their endorsement by the U.S. government.

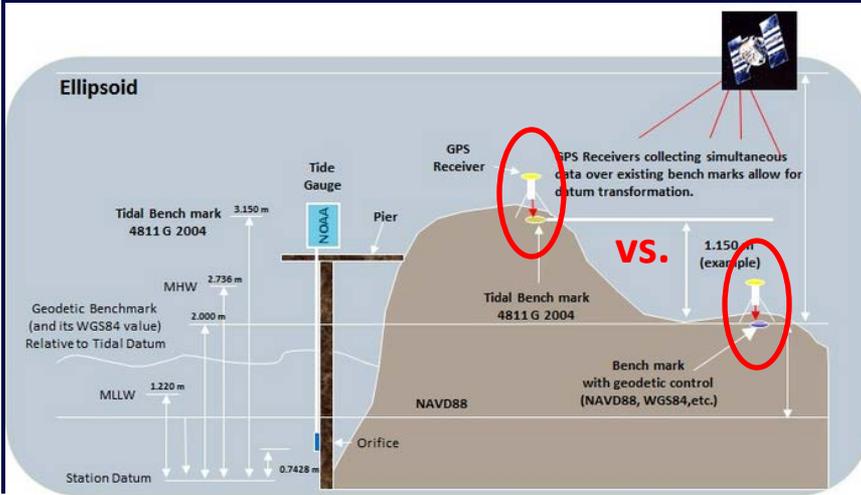
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http://dggg.alaska.gov/sections/engineering/ak_tidal_datum_portal

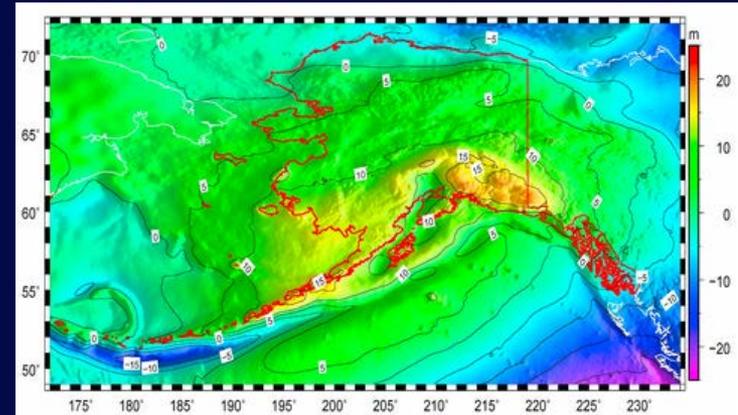
Causes of Variation

Different Tidal Benchmarks



Orthometric Height Computation

Example: GEOID09 → GEOID12A



GRAV-D for eastern Alaska coming soon.

Re-establishment of Tide Station

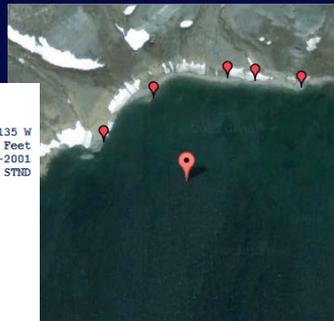
Mar 13 2013 18:12 GMT ELEVATIONS ON STATION DATUM
National Ocean Service (NOAA)

Station: 9469439
Name: Tin City, Bering Sea, AK
Status: Accepted (Dec 11 2007)

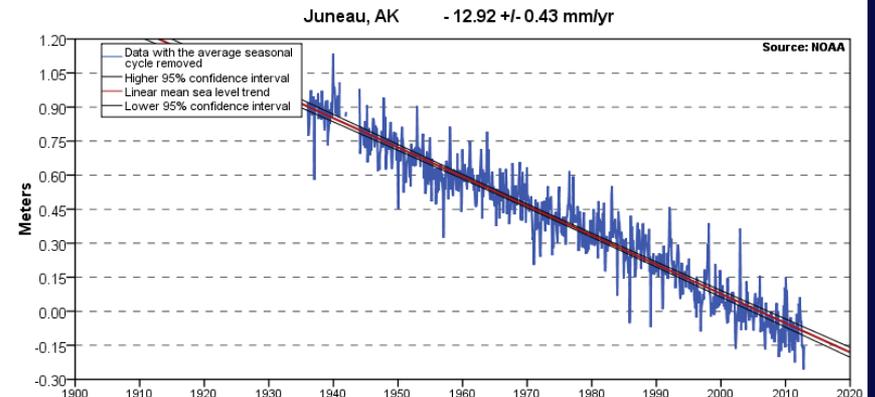
T.M.: 135 W
Units: Feet
Epoch: 1983-2001
Datum: STND

Datum	Value	Description
MHHW	4.64	Mean Higher-High Water
MHW	4.45	Mean High Water
DTL	4.13	Mean Diurnal Tide Level
MSL	4.09	Mean Sea Level
MTL	4.08	Mean Tide Level
MLW	3.72	Mean Low Water
MLLW	3.62	Mean Lower-Low Water
STND	0.00	Station Datum
GT	1.02	Great Diurnal Range
MR	0.73	Mean Range of Tide
DHC	0.19	Mean Diurnal High Water Inequality
DLC	0.10	Mean Diurnal Low Water Inequality
HAT	4.80	Highest Astronomical Tide
HAT Date	19981107	Highest Astronomical Tide Date
HAT Time	21:12	Highest Astronomical Tide Time
LAT	3.25	Lowest Astronomical Tide
LAT Date	19920124	Lowest Astronomical Tide Date
LAT Time	04:00	Lowest Astronomical Tide Time

Tidal Datum Analysis Period: 09/01/2007 - 09/30/2007



Tidal Epoch



Surrogate Tidal Datum Estimates

Temporary Tide Gauge



Measurement of Foreshore Features

For example:

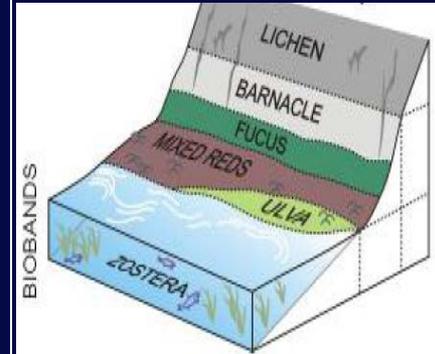
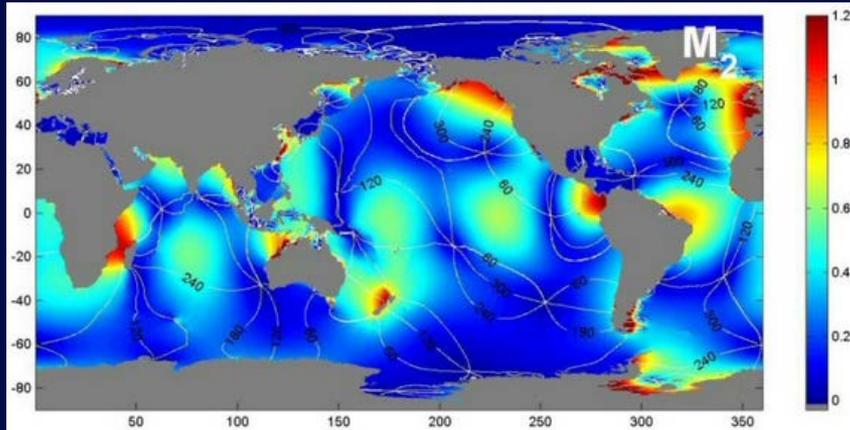
Strandlines



Biobands



Modeled Value

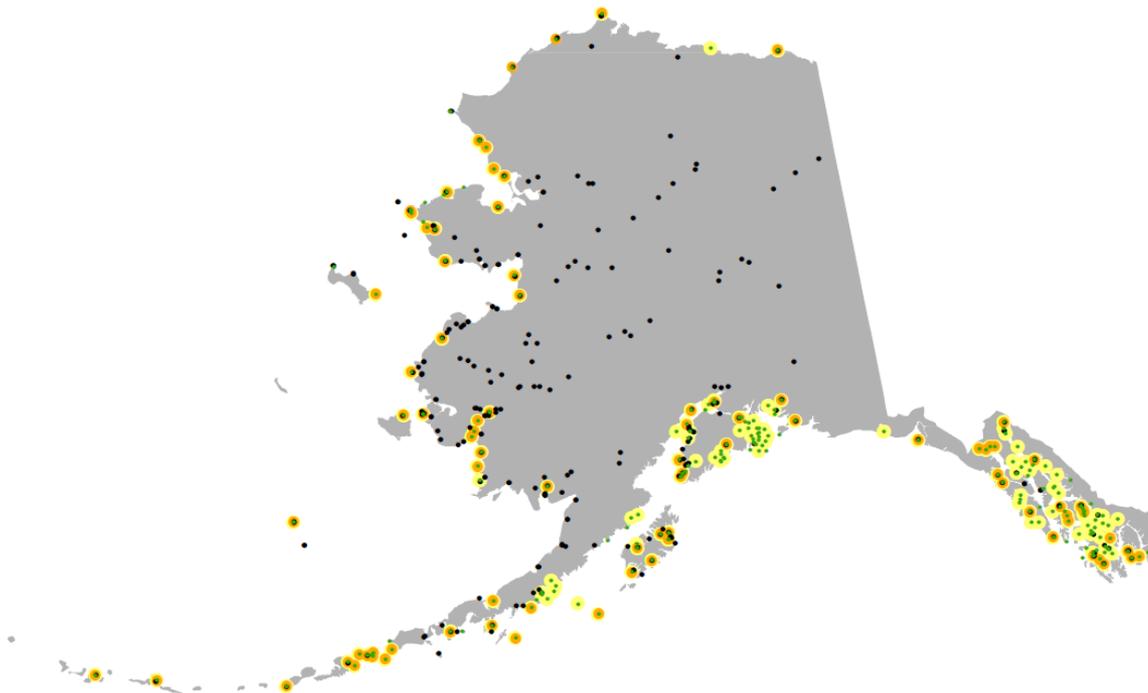


**For more information or to make conversions visit:
www.dggs.alaska.gov/sections/engineering/ak-tidal-datum-portal/**

January 2013 Status of Tidal Datums in AK

- Populated Places
- Established Tidal Datums (n=209)
- Published Geodetic Elevations (n=89)
- Published Tidal Benchmark Sheets (n=172)

**Only areas that can
be included in online
conversion tool**



**For more information or to make conversions visit:
www.dggs.alaska.gov/sections/engineering/ak-tidal-datum-portal/**

In conclusion:

- **Any time you encounter an elevation or height (3 feet for example) be sure to ask “3 feet above *WHAT?*”**

If the answer is height above ‘Mean Sea Level’, is it:

- 1. The National Standard Sea Level (NAVD88)**
- 2. Local Mean Sea Level (based on tide gauge)**
- 3. Local Mean Sea Level (based on something else)**

→ If it is Local Mean Sea Level, when was it calculated?

- **Different ‘types’ of Mean Sea level can vary by up to 7 feet in Alaska.**

Thank You!