

# Datum Transformations

## *Ellipsoidal Survey to Tidal Referenced Products*

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24 Feb 2020



Office of Coast Survey  
National Oceanic and Atmospheric Administration

A detailed nautical chart of Buzzards Bay, Massachusetts, serves as the background for the top half of the slide. The chart shows various geographical features, including Buzzards Bay Entrance Light, Point Judith, and several islands like Chappaquiddick and Hantucket. Depth soundings and navigational markers are visible throughout the chart.

# Why Datum Transformations?

- Permits ellipsoidally referenced survey
  - Direct reference from ship to seafloor in universal frame
  - No need for reliance on tidal infrastructure during acquisition
  - **But...Chart Datum is tidal**
- Required for continuous coverage from ocean to land

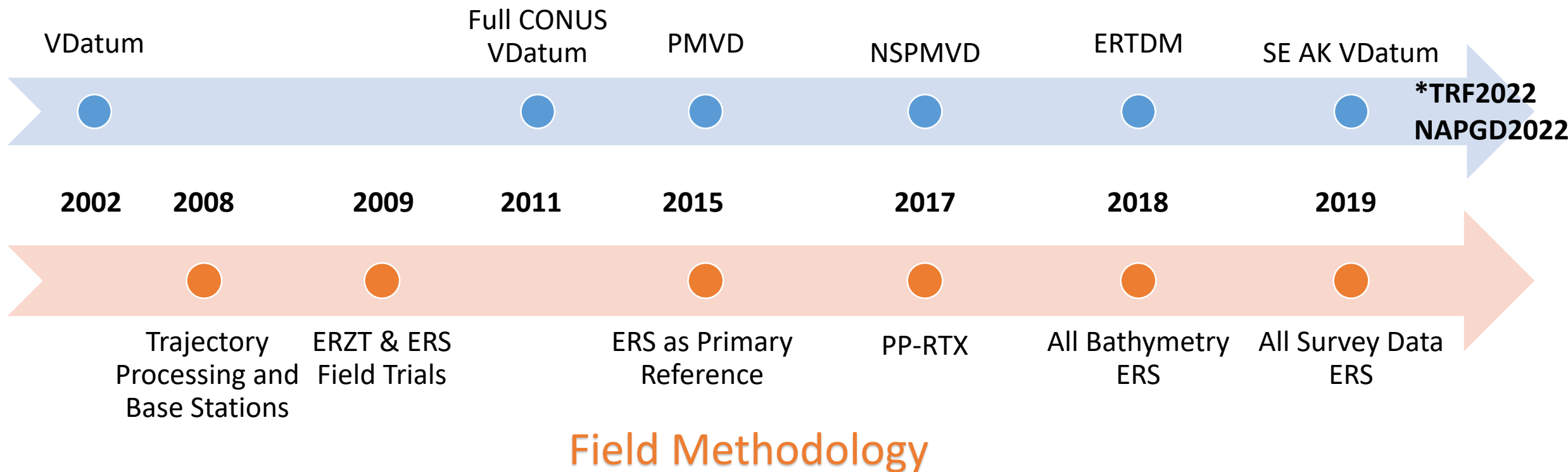
## Sticking points

- Datums defined by benchmarks
- Coverage of transformation models & measurements
- Uncertainty of transforms
- Accurate vertical GNSS based referencing for acquisition

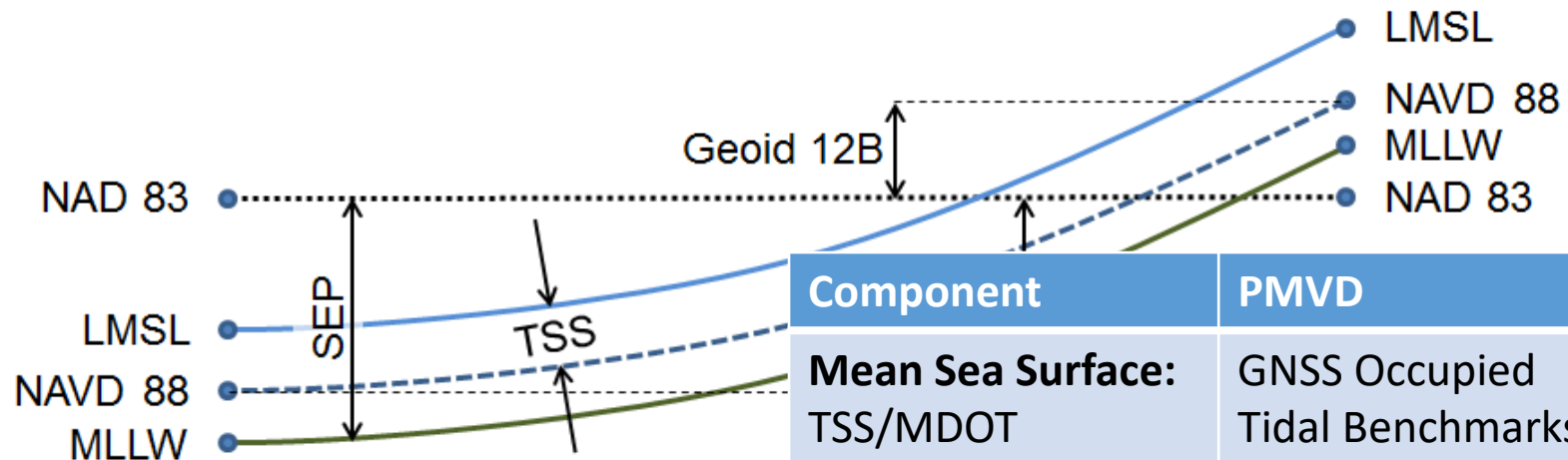


# NOAA Ellipsoidal Referencing Development

## Datum Transformation Development



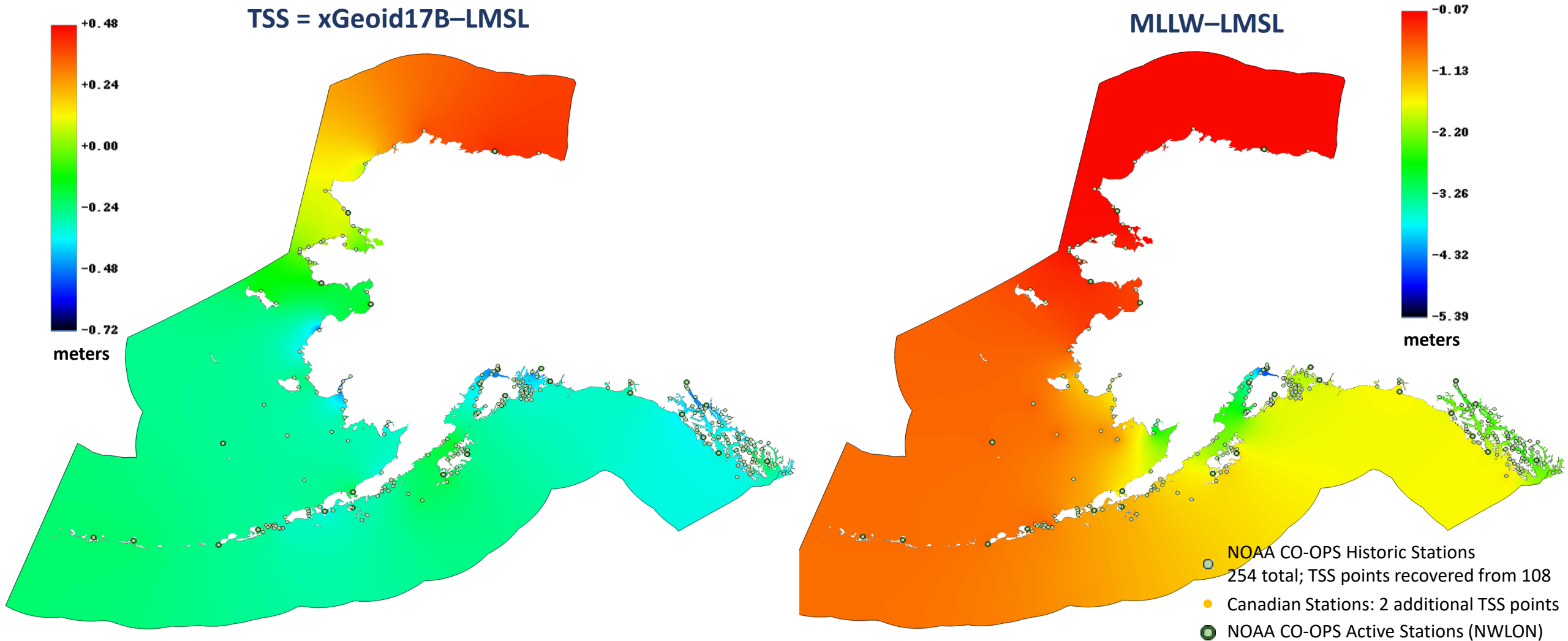
# Datum Model Methodology



Component	PMVD	ERTDM	VDatum
<b>Mean Sea Surface:</b> TSS/MDOT	GNSS Occupied Tidal Benchmarks – <i>Laplace Interpolation</i>	<b>Inshore:</b> Tidal Benchmark Elevations <b>Offshore:</b> Satellite Altimetry AVISO+	Benchmark Elevation Residuals re <b>Model</b> – <i>Minimum Curvature Interpolation</i>
<b>Tidal:</b> LMSL-MLLW	TCARI From Discrete Stations	<b>Inshore:</b> TCARI <b>Offshore:</b> Satellite Altimetry based Tidal Constituents	<b>FE Tidal Model</b>
Ellipse to Orthometric	Geoid12B	xGeoid19	GEOIDyy

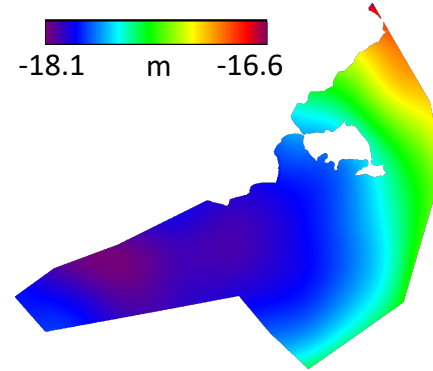
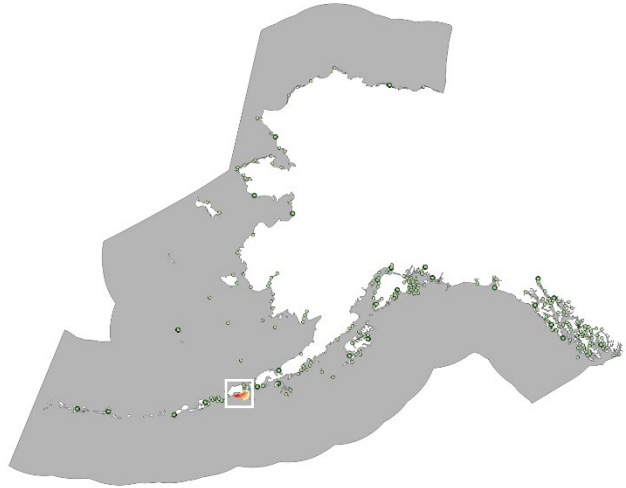


# Transformation Components

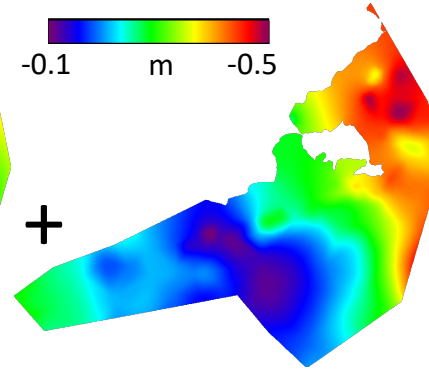




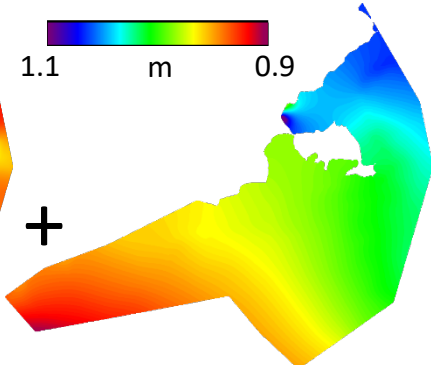
# Detailed Comparison



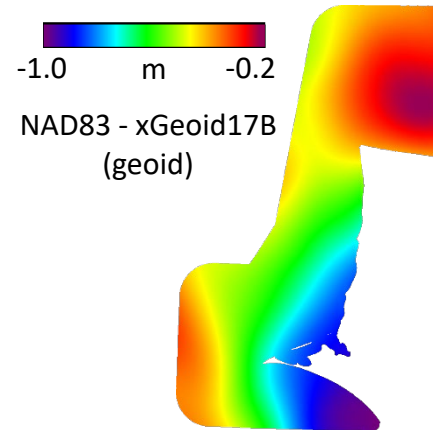
NAD83 – xGeoid17B  
(geoid)



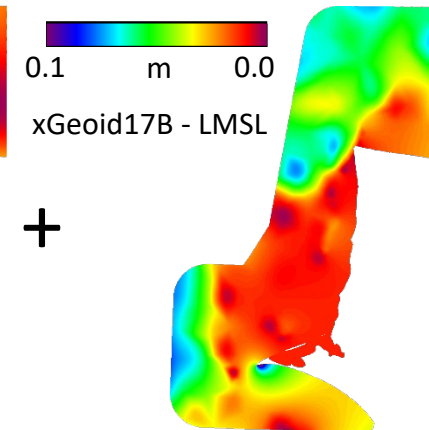
xGeoid17B – LMSL  
(hybrid inshore-interpolated ties  
& offshore-Aviso+ global MSS)



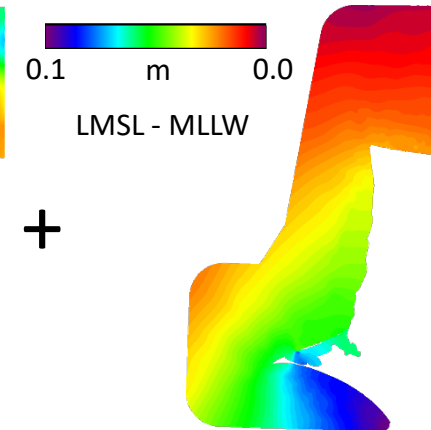
LMSL – MLLW  
(hybrid inshore-interpolated ties  
& offshore-FES2014 global tides)



NAD83 - xGeoid17B  
(geoid)



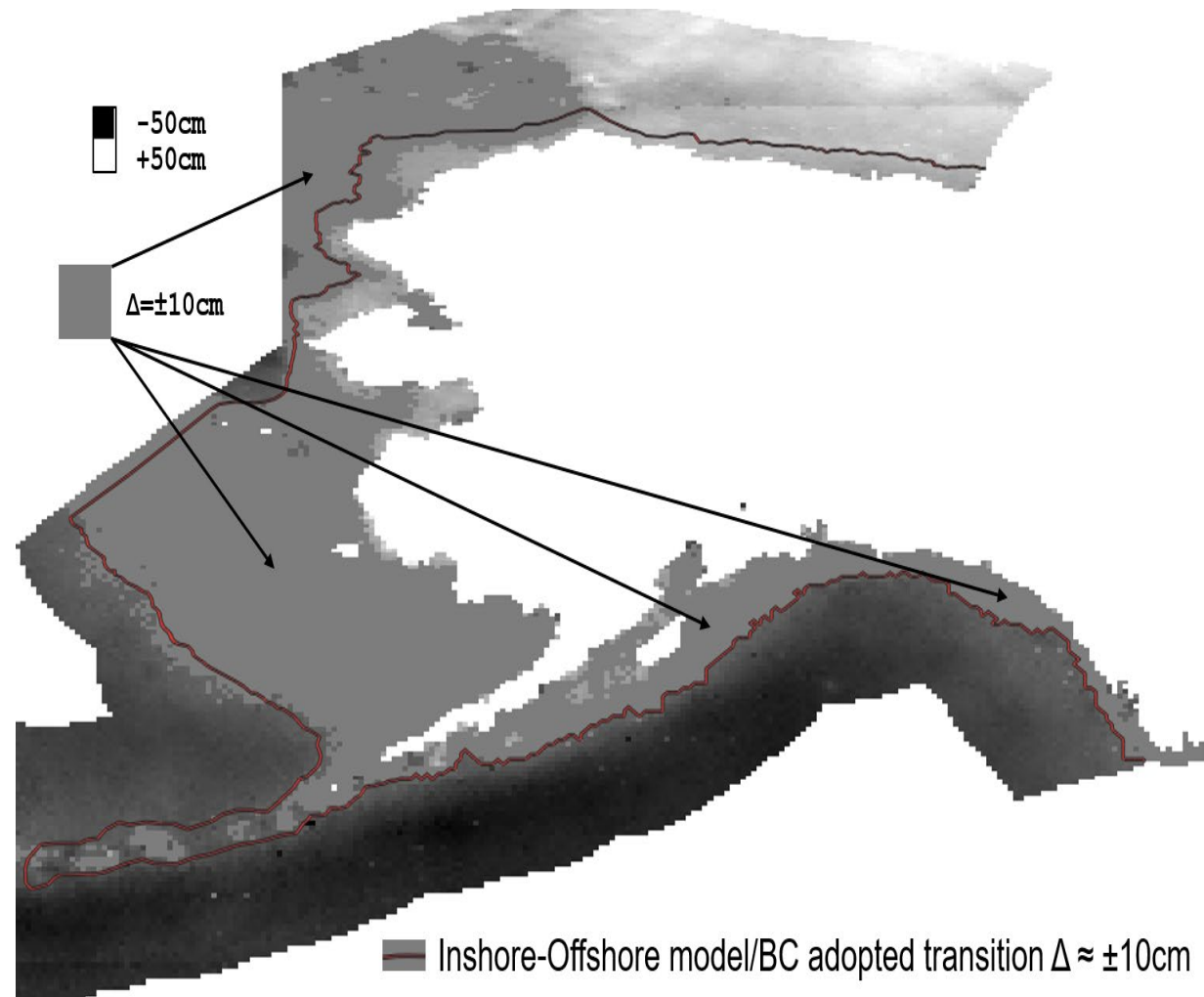
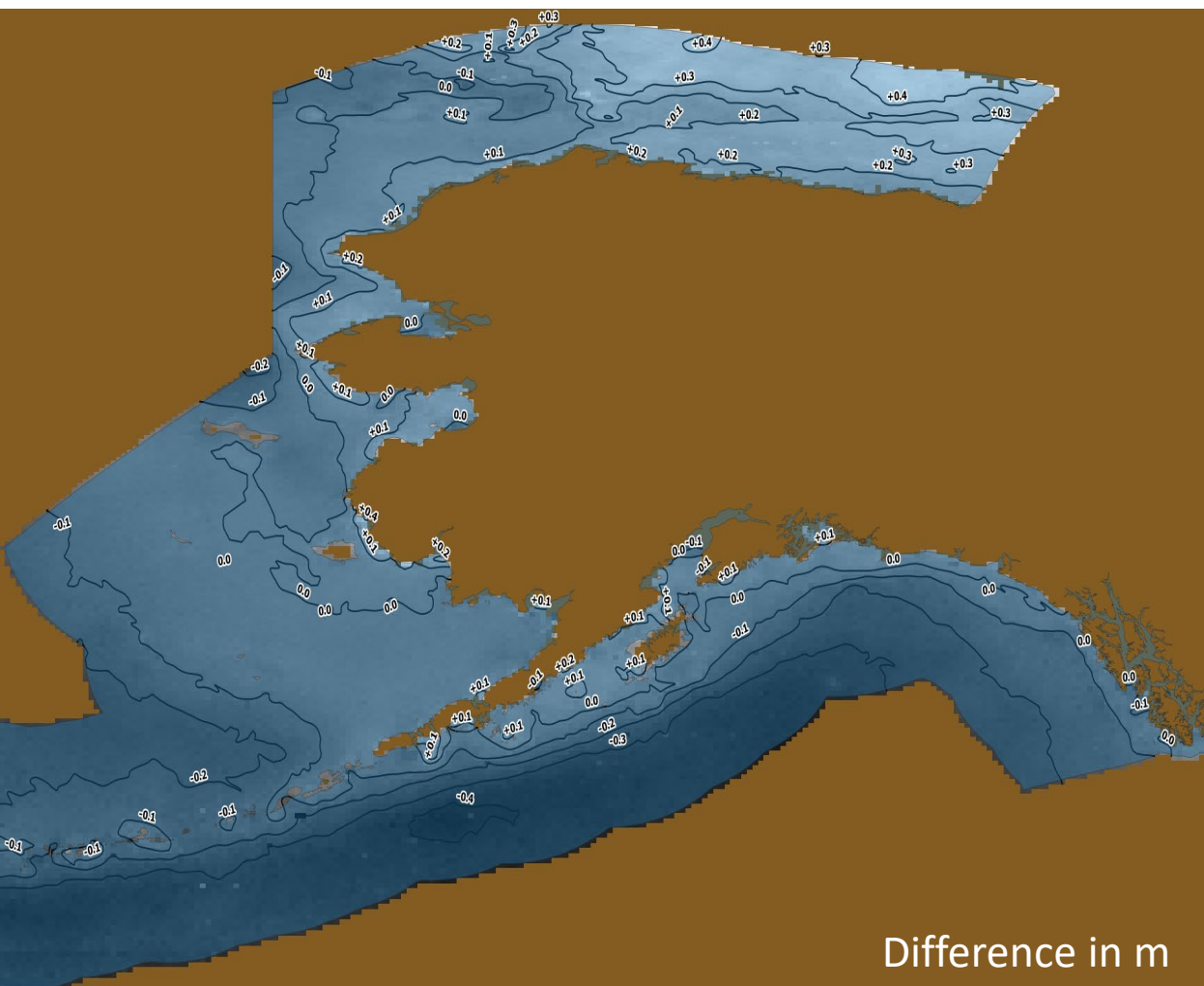
xGeoid17B - LMSL  
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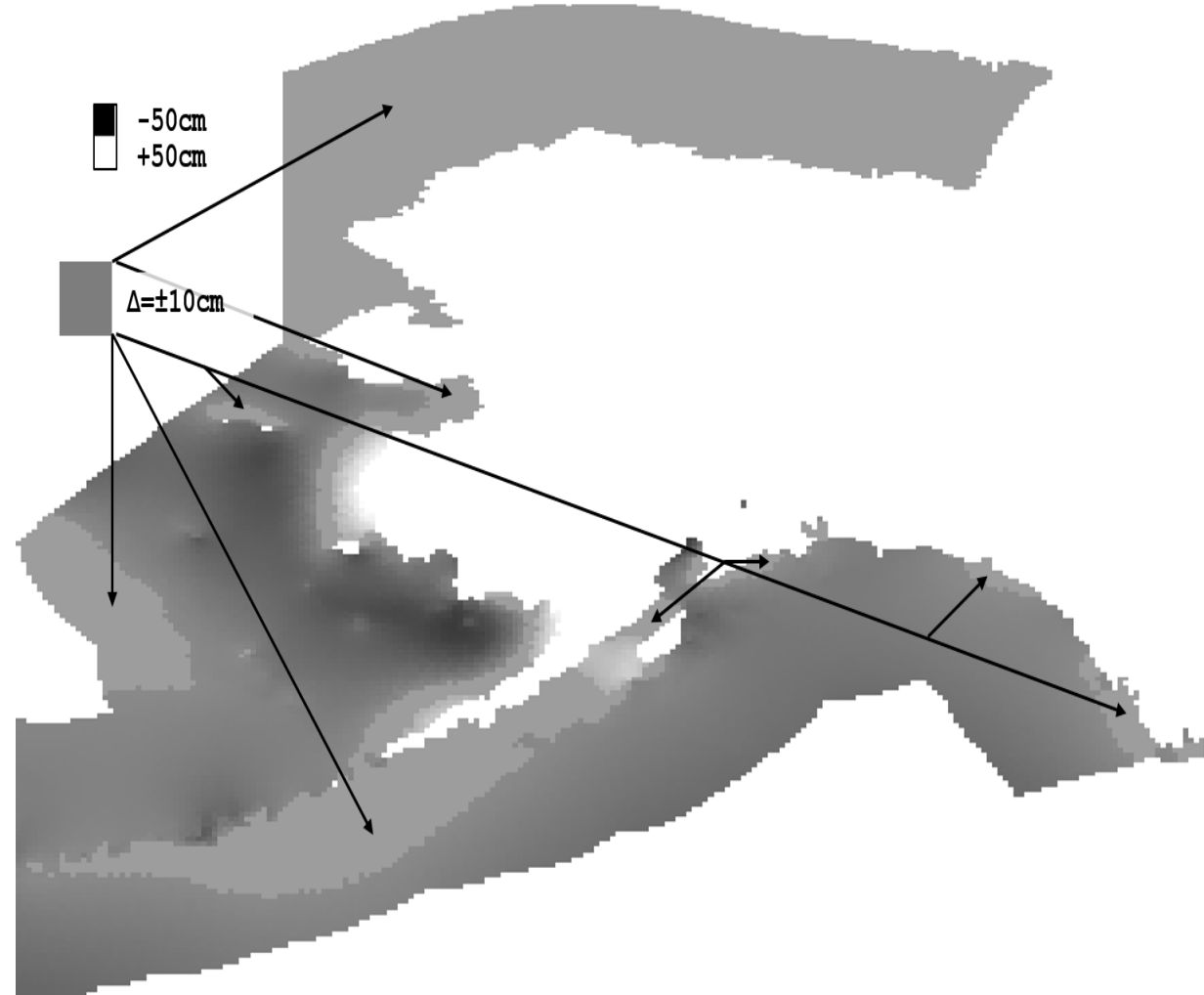
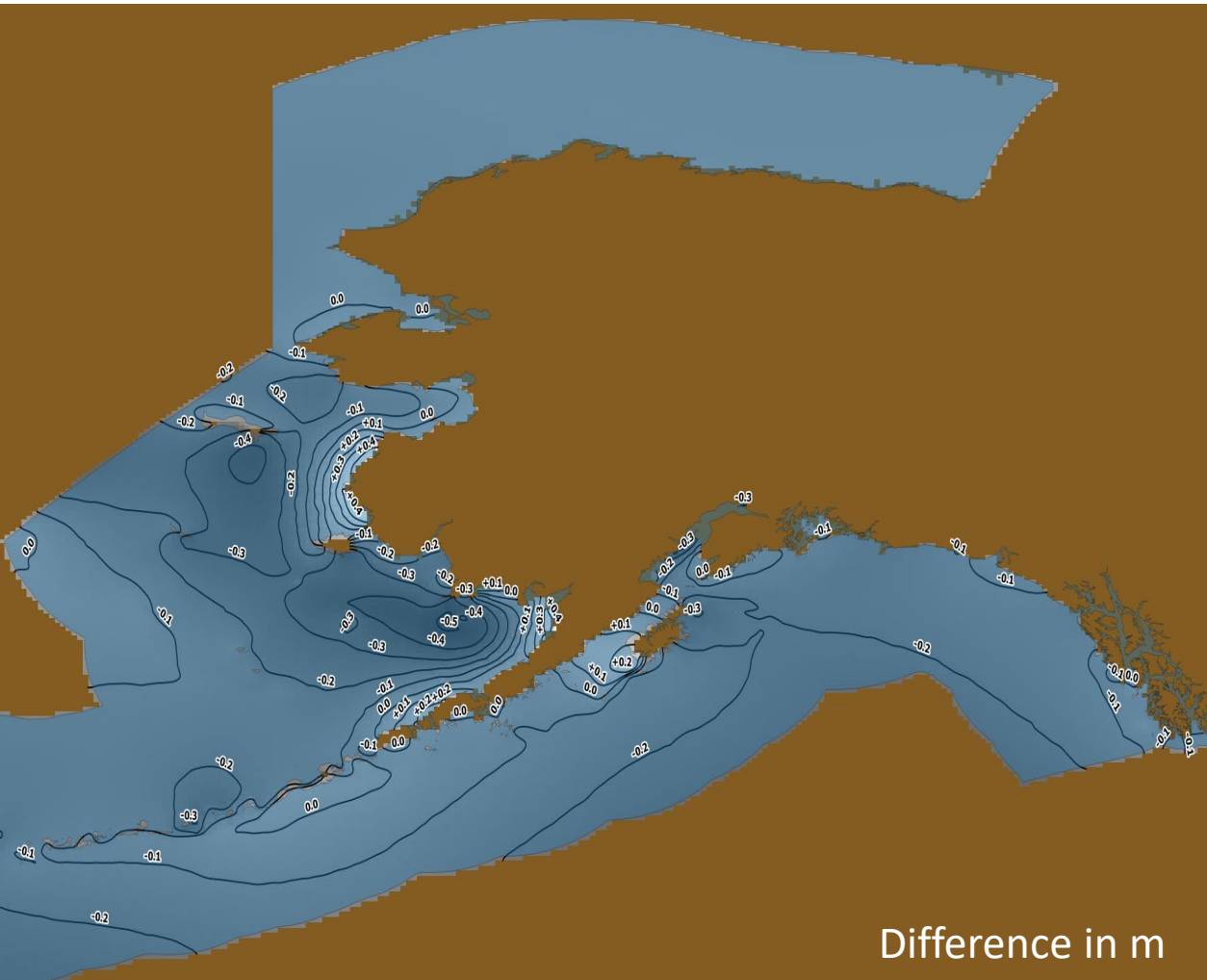
LMSL - MLLW  
(hybrid inshore-interpolated ties  
& offshore-FES2014 global tides)



# Inshore – Offshore Difference TSS



# Inshore – Offshore Difference Tidal





# VDatum Coverage 2020



NOAA's Vertical Datum Transformation - v4.0.1

\* Region : **Alaska**

Horizontal Information

Source	Target
Reference Frame: <b>NAD83(2011)</b>	<b>IGS08 - use ITRF2008</b>
Coord. System: <b>Geographic (Longitude, Latitude)</b>	<b>Geographic (Longitude, Latitude)</b>
Unit: <b></b>	<b></b>
Zone: <b></b>	<b></b>

☒ Vertical Information

Source	Target
Reference Frame: <b>NAD83(2011)</b>	<b>MLLW</b>
Unit: <b>meter (m)</b>	<b>meter (m)</b>

ONLINE VERTICAL DATUM TRANSFORMATION  
INTEGRATING AMERICA'S ELEVATION DATA

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Point Conversion

\* Region :

Horizontal Information

Source	Target
Reference Frame: <b>NAD83(2011)</b>	<b>NAD83(2011)</b>
Coord. System: <b>Geographic (Longitude, Latitude)</b>	<b>Geographic (Longitude, Latitude)</b>
Unit: <b>meter (m)</b>	<b>meter (m)</b>
Zone: <b></b>	<b></b>

☒ Vertical Information

Source	Target
Reference Frame: <b>NAVD 88</b>	<b>NAVD 88</b>
Unit: <b>meter (m)</b>	<b>meter (m)</b>
<input checked="" type="radio"/> Height <input type="radio"/> Sounding	<input checked="" type="radio"/> Height <input type="radio"/> Sounding
<input type="checkbox"/> GEOID model: <b></b>	<input type="checkbox"/> GEOID model: <b></b>

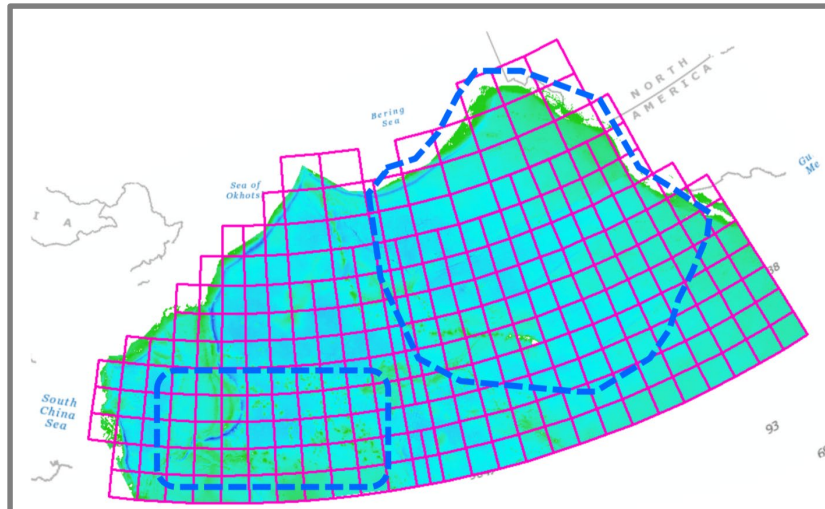
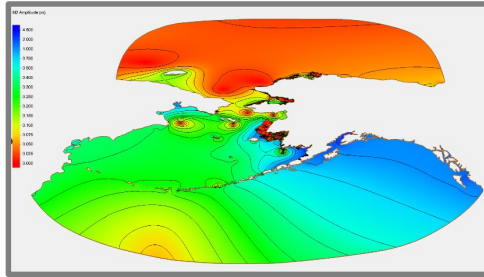
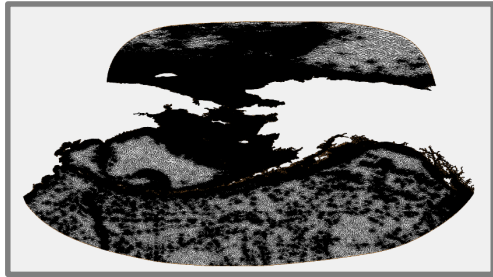
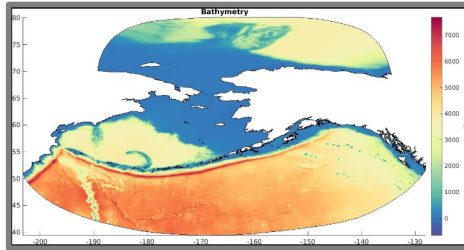
Point Conversion | [ASCII File Conversion](#)

Input	Convert	Output
Longitude: <b></b>	<b>Convert</b>	Longitude: <b></b>
Latitude: <b></b>	<b>Reset</b>	Latitude: <b></b>
Height: <b></b>	<b>DMS</b>	Height: <b></b>
<input type="checkbox"/> to DMS		<input type="checkbox"/> to DMS

Vertical Uncertainty (+/-):



# VDatum Development



## Upcoming Developments:

West Coast Update - FY2021 Q4  
Pacific Basin R&D – FY2021  
Exploratory Full Alaska Model

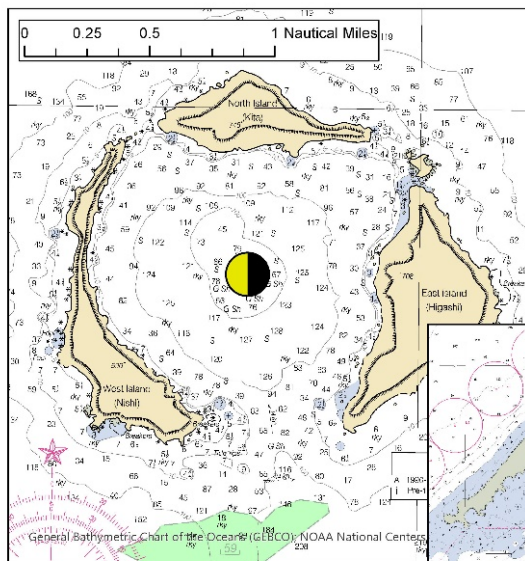
Expansion of spatially varying  
uncertainty

Continued updates to VDatum  
software and web interface



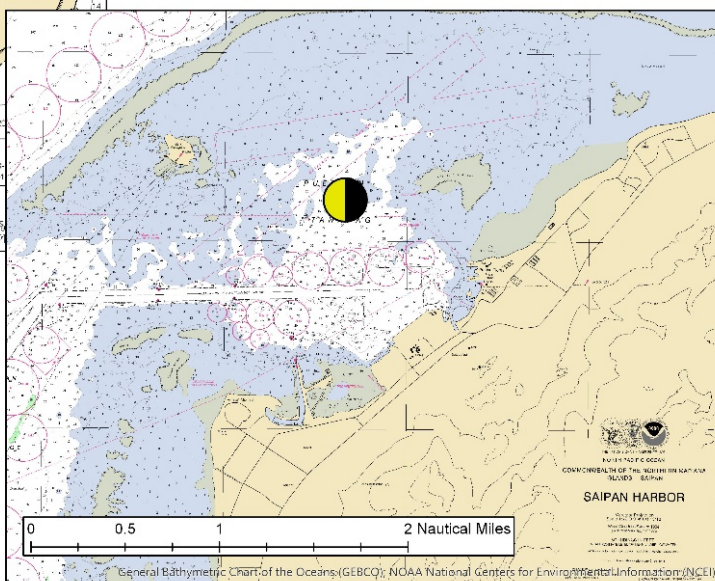


# Tide Buoy



**OPR-T381-RA-20**  
Mariana Islands Hydrographic Survey Water Level Data  
Proposed Locations for >30 Day Tide Buoy Deployments

Maug Islands Near 145.221E, 20.022N, ~20 - 60m Water Depth  
Saipan Harbor Near 145.726E, 15.237N, ~7m Water Depth



~0.6 meter  
diameter tide  
buoy



## 2020 Planned Deployments – Mariana Islands



Office of Coast Survey  
National Oceanic and Atmospheric Administration



# Future of Datums & ERS

- NGS 2022 Datums – [NA|CA|PA|MA]TRF2022, NAPGD2022
  - Changing definition of TSS
- Streamlined access to benchmark databases
  - Ellipsoid ties to benchmarks directly available
- Full US Tide Zoning web map, TCARI tools
- Additional tide buoys

