

Relative Sea Level Trends in Alaska



AOOS
Alaska Ocean Observing System



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Karen Murphy and Joel Reynolds
Western Alaska LCC Coordinators

Western Alaska LCC



May 3, 2016

Sea-Level Rise Summit: Connected Futures from Alaska to Florida | Ft Lauderdale, FL

Alaska's Extensive Coastline



Shaktoolik, AK

(Kinsman 2011)

VS.



San Diego, CA

(www.oceanlight.com)

64% of Alaska residents live in coastal communities

Arctic coastal processes

Unique coastal cultures and socio-economic settings compared to the “lower 48”

Emerging infrastructure requirements

Alaska no longer participates in the Coastal Zone Management Program

12% of communities do not participate in the National Flood Insurance Program

Alaska's coastline is data-limited

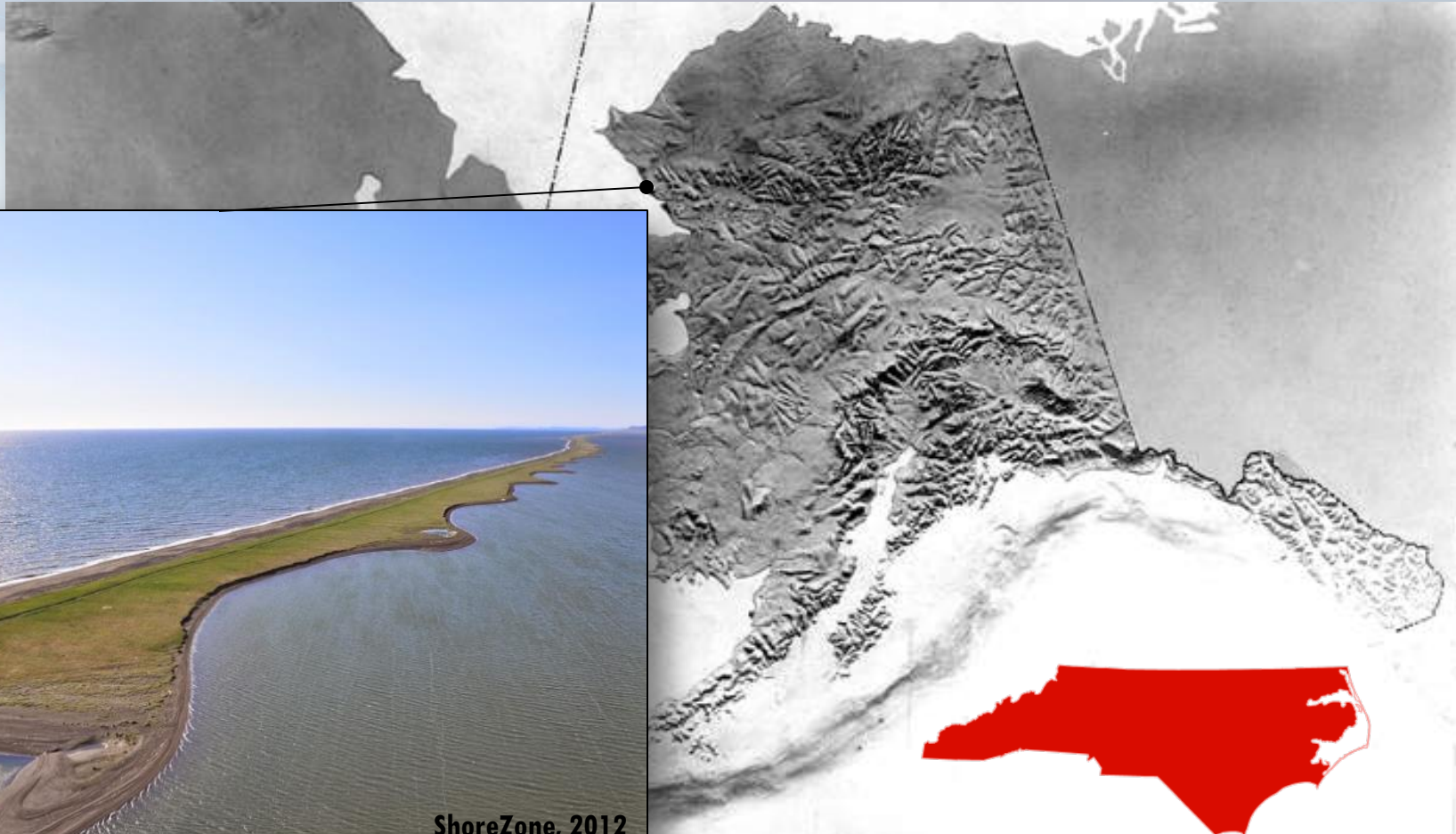


National Oceanic and Atmospheric Administration

Alaska's Coastal Environments



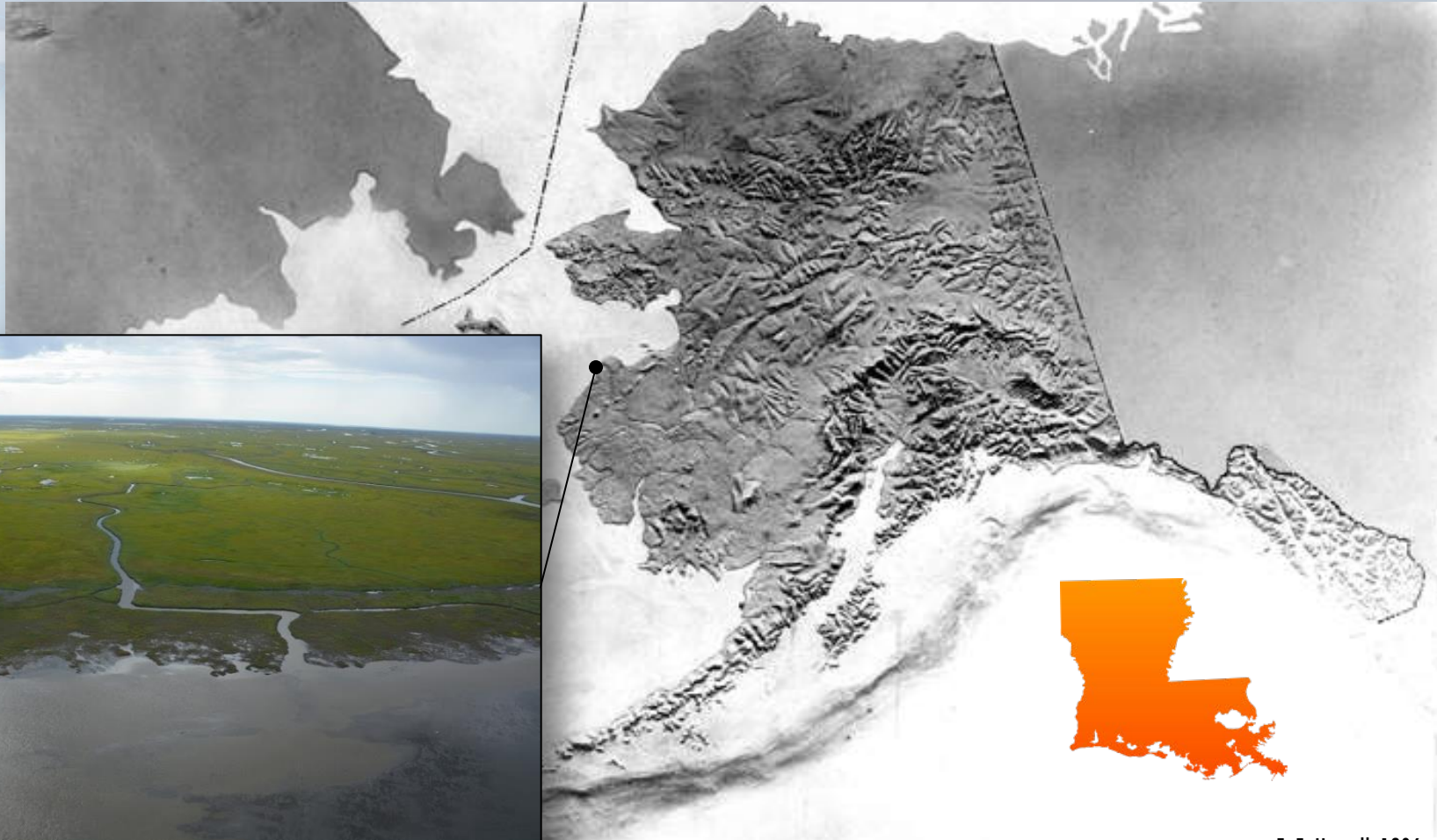
Alaska's Coastal Environments



ShoreZone, 2012

E. E. Howell, 1906

Alaska's Coastal Environments



ShoreZone, 2014

E. E. Howell, 1906

Alaska's Coastal Environments



Alaska's Coastal Environments



Alaska's Coastal Environments



The Rising Sea Level Narrative

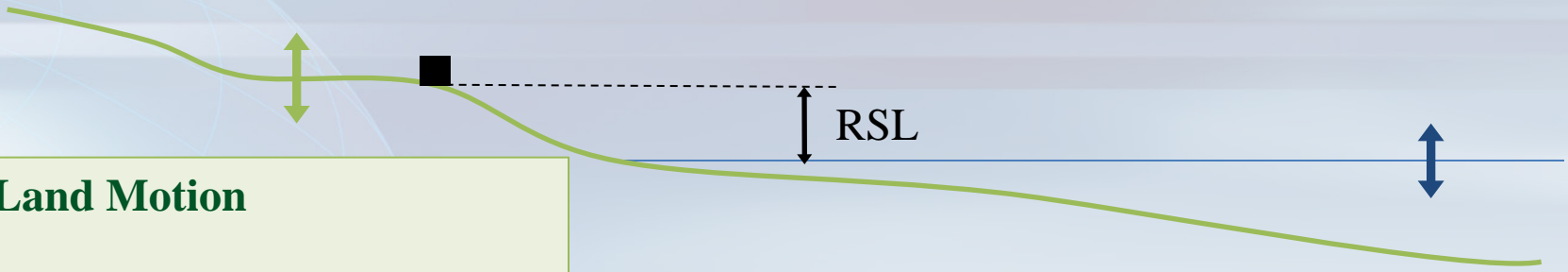


From Sallenger, 2012



National Oceanic and Atmospheric Administration

Land Motion + Ocean Surface Trend = Relative Sea Level



Vertical Land Motion

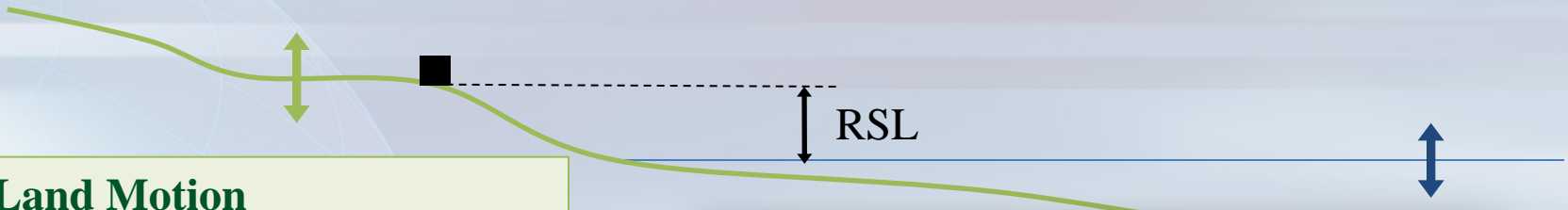
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Ocean Surface

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-

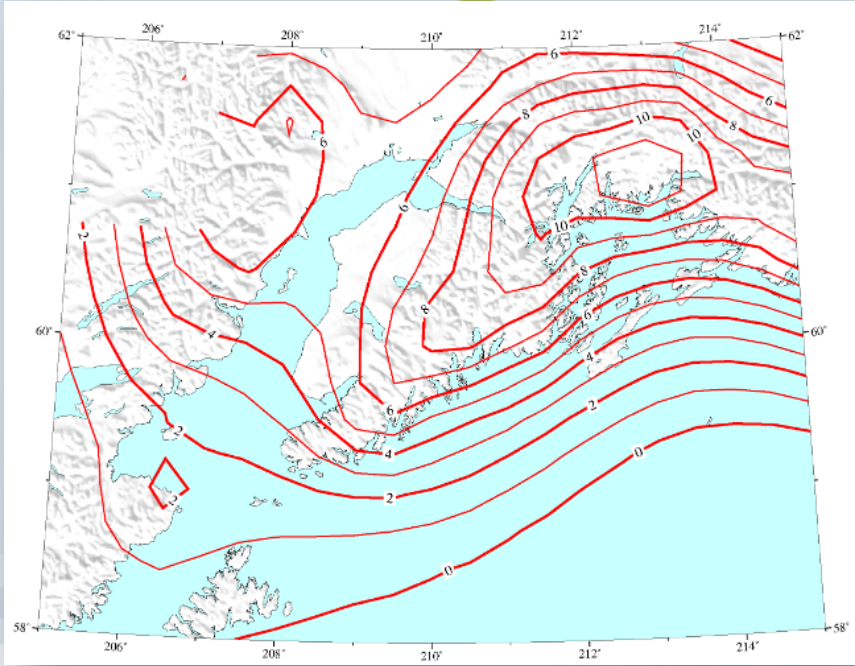


Land Motion + Ocean Surface Trend = Relative Sea Level



- ### Vertical Land Motion
- Gradual isostatic adjustment
 -
 -
 -
 -

- ### Ocean Surface
- -
 -

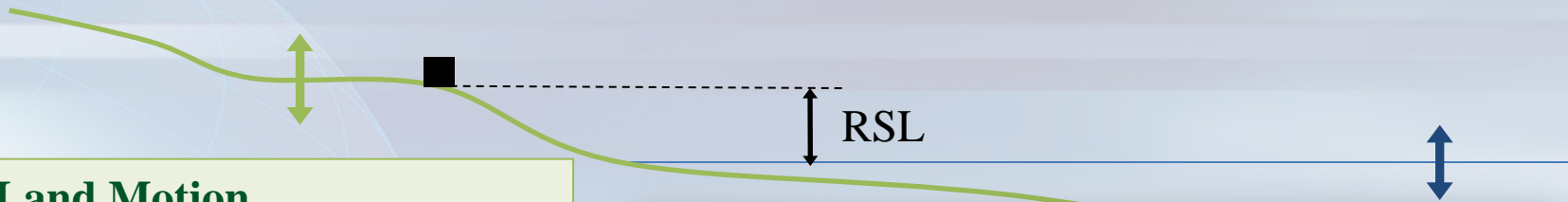


Predicted uplift rates (based on 1992-2012 averages; mm/yr) due to GIA around Columbia Glacier (Freymueller, 2013)



National Oceanic and Atmospheric Administration

Land Motion + Ocean Surface Trend = Relative Sea Level



Vertical Land Motion

- Gradual isostatic adjustment
- Rapid tectonic changes
-
-
-

Ocean Surface

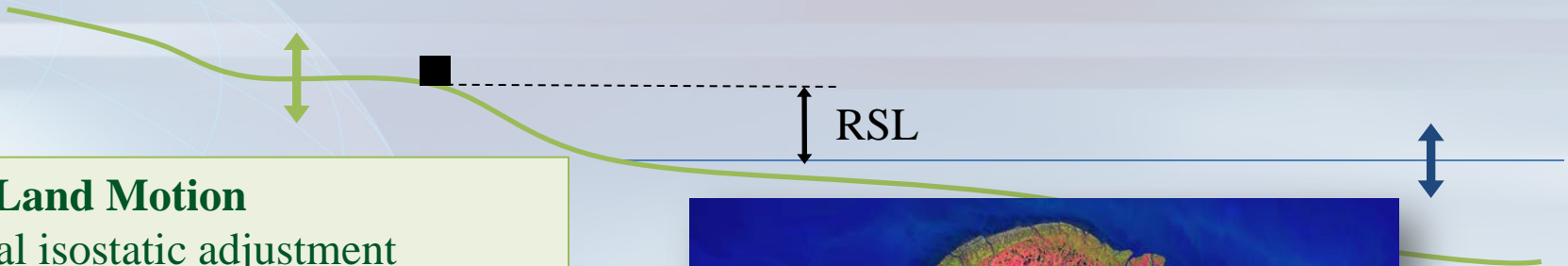
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National Oceanic and Atmospheric Administration

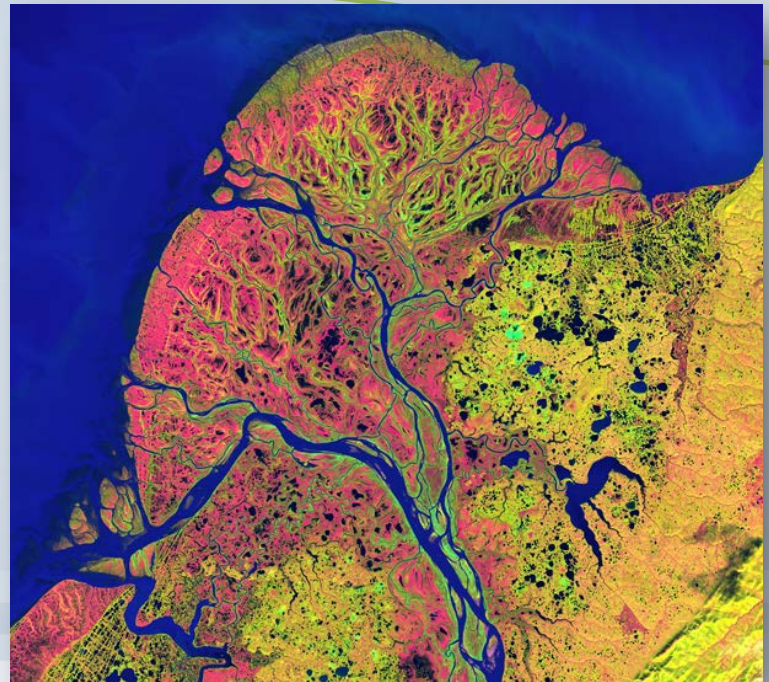
USGS Professional Paper 531-1

Land Motion + Ocean Surface Trend = Relative Sea Level



- ### Vertical Land Motion
- Gradual isostatic adjustment
 - Rapid tectonic changes
 - Loading subsidence (sedimentation)
 -
 -

- ### Ocean Surface
- -
 -

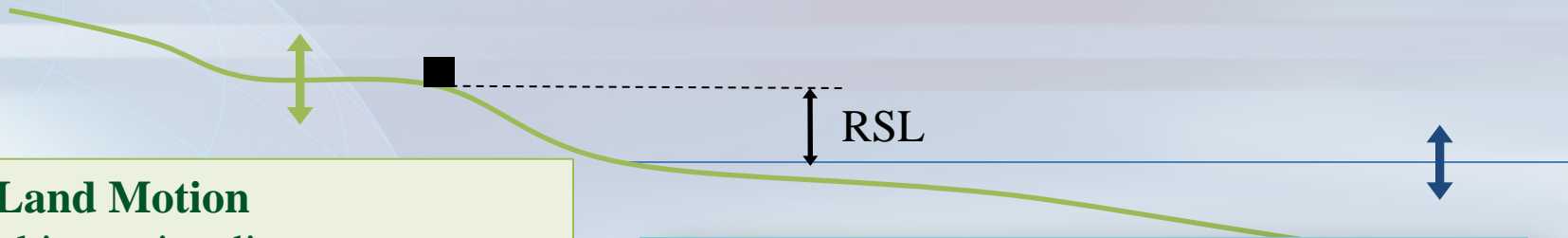


Yukon Delta (Landsat 7, 2002, NASA Goddard Space Flight Center/USGS)



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Land Motion + Ocean Surface Trend = Relative Sea Level



Vertical Land Motion

- Gradual isostatic adjustment
- Rapid tectonic changes
- Loading subsidence
- Sub-surface extraction (oil/water)
-

Ocean Surface

-
-
-

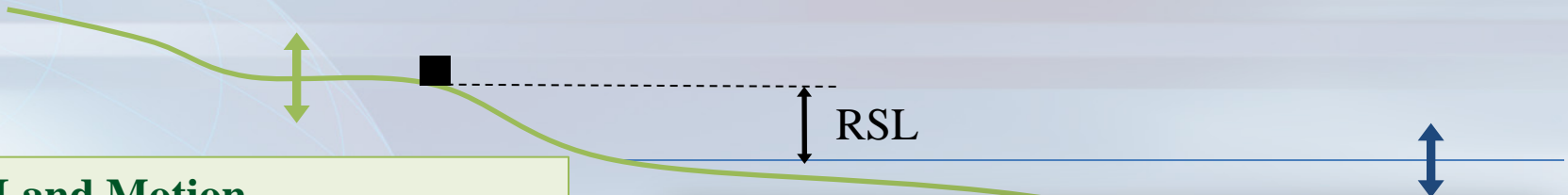


*Jack-up rig in Cook Inlet, Alaska
(Photo by Loren Holmes, Alaska Daily News)*



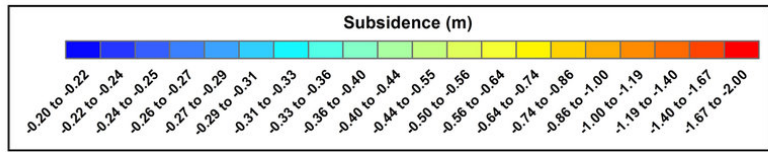
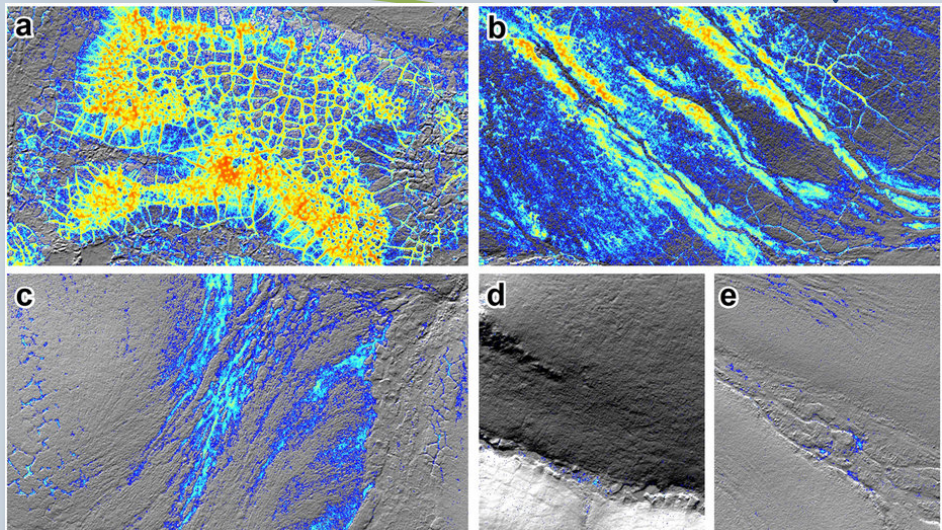
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Land Motion + Ocean Surface Trend = Relative Sea Level



- ### Vertical Land Motion
- Gradual isostatic adjustment
 - Rapid tectonic changes
 - Loading subsidence
 - Sub-surface extraction
 - Permafrost degradation

- ### Ocean Surface
- -
 -



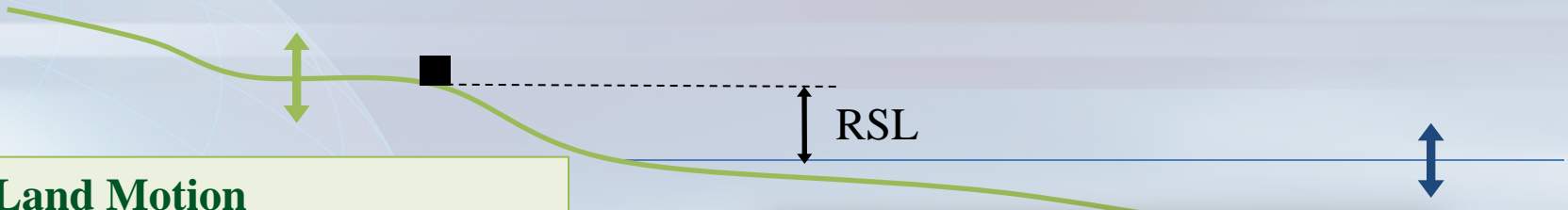
100 m



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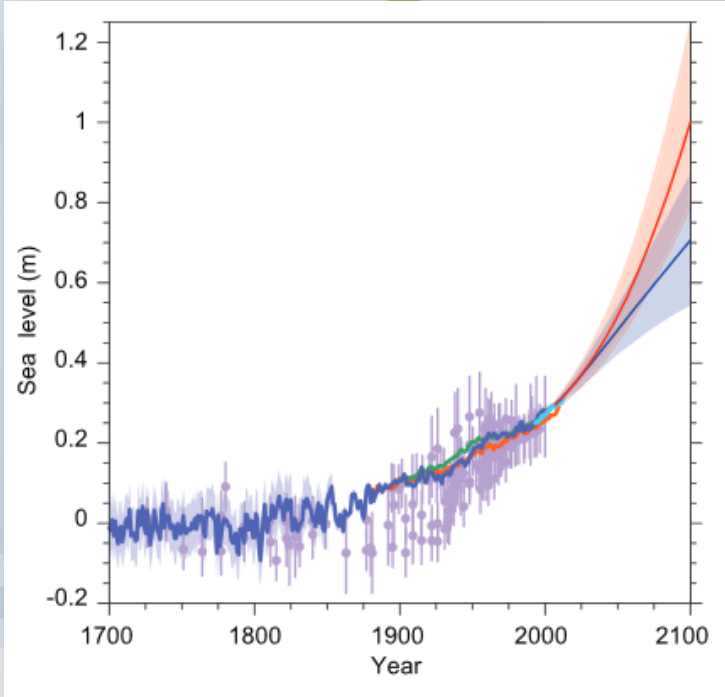
Thermokarst development on North Slope of Alaska following tundra wildfires (Jones et al., Nature, 2015)

Land Motion + Ocean Surface Trend = Relative Sea Level



- ### Vertical Land Motion
- Gradual isostatic adjustment
 - Rapid tectonic changes
 - Loading subsidence
 - Sub-surface extraction
 - Permafrost degradation

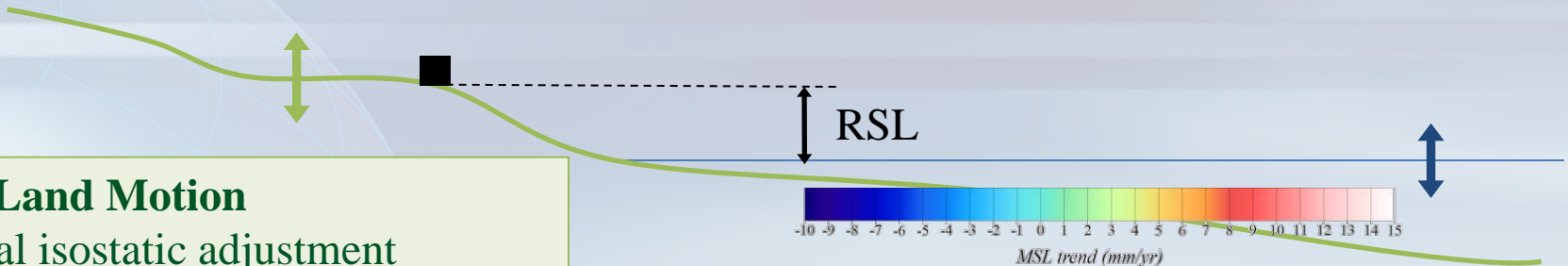
- ### Ocean Surface
- Glacier/ice sheet melting
 - Thermal expansion
 -



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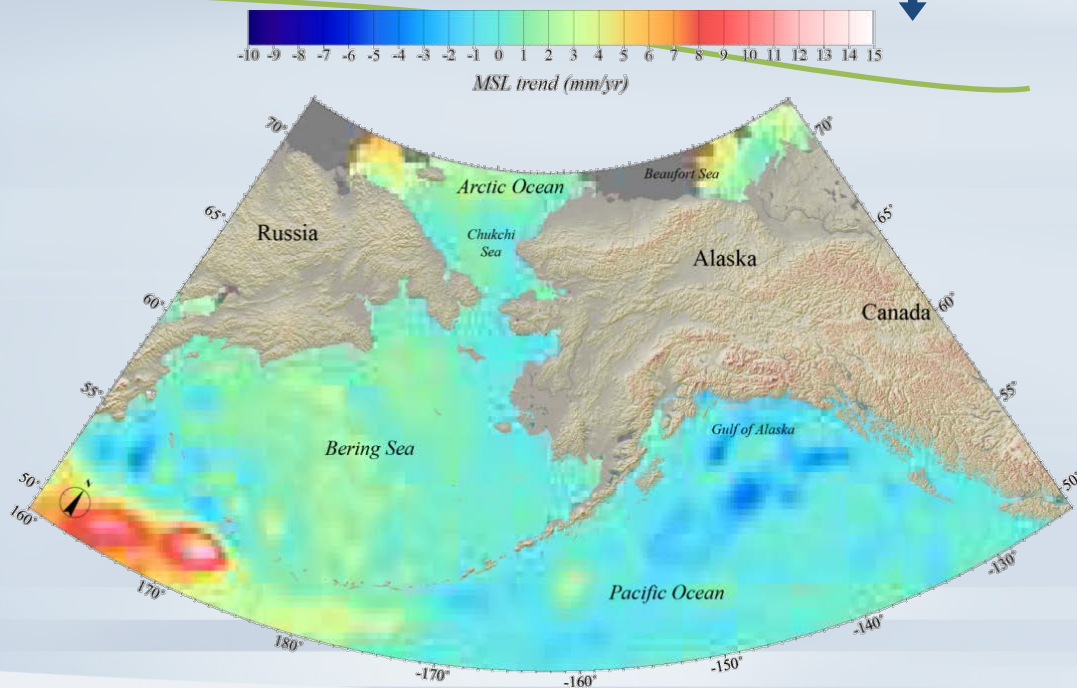
Global mean sea level rise projections (IPCC AR5, 2013)

Land Motion + Ocean Surface Trend = Relative Sea Level



- ### Vertical Land Motion
- Gradual isostatic adjustment
 - Rapid tectonic changes
 - Loading subsidence
 - Sub-surface extraction
 - Permafrost degradation

- ### Ocean Surface
- Glacier/ice sheet melting
 - Thermal expansion
 - Regional variability

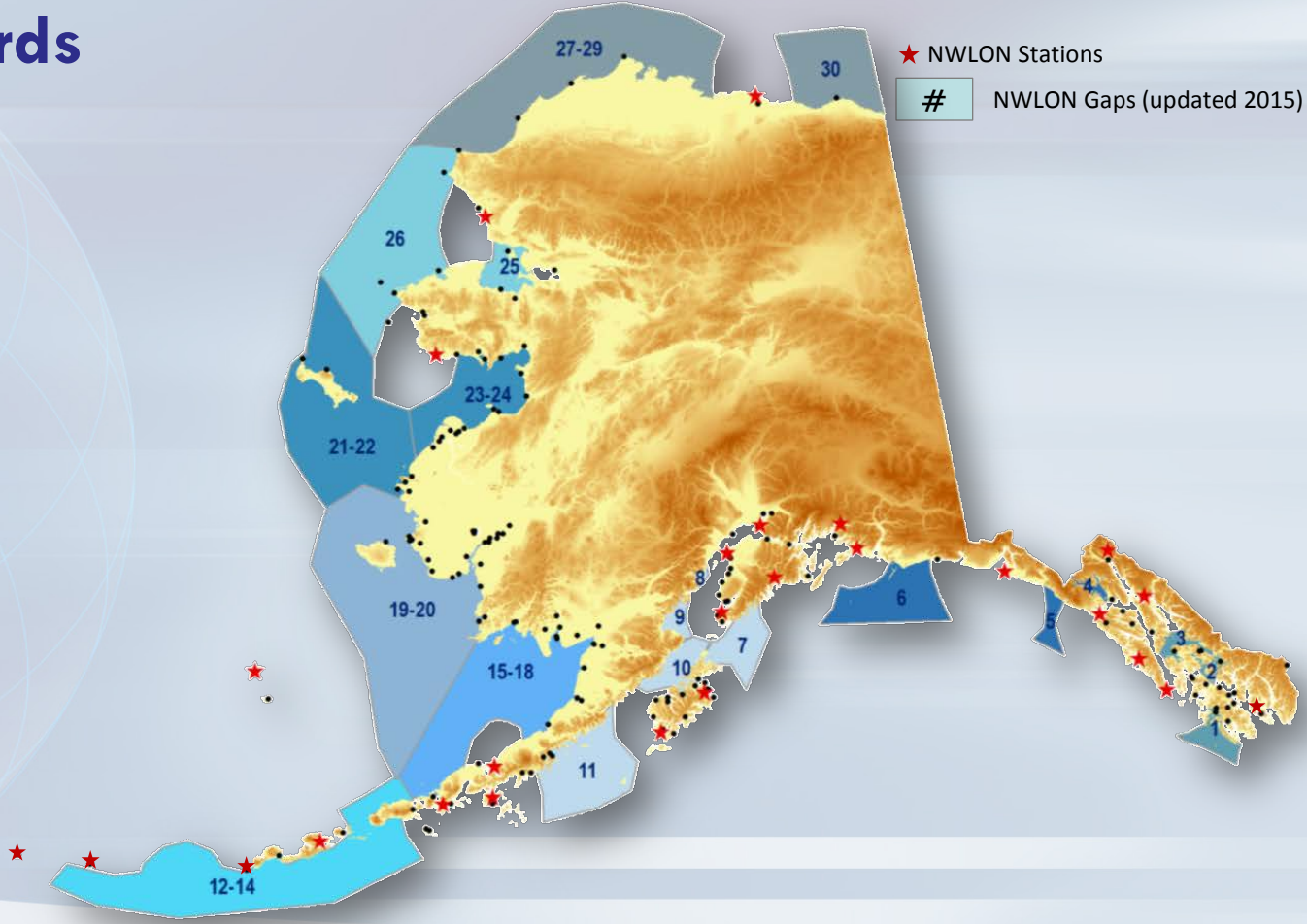


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1992-2014 sea surface trends (AVISO gridded [0.25°x0.25°] and merged satellite altimetry data)

Alaska Tide Records

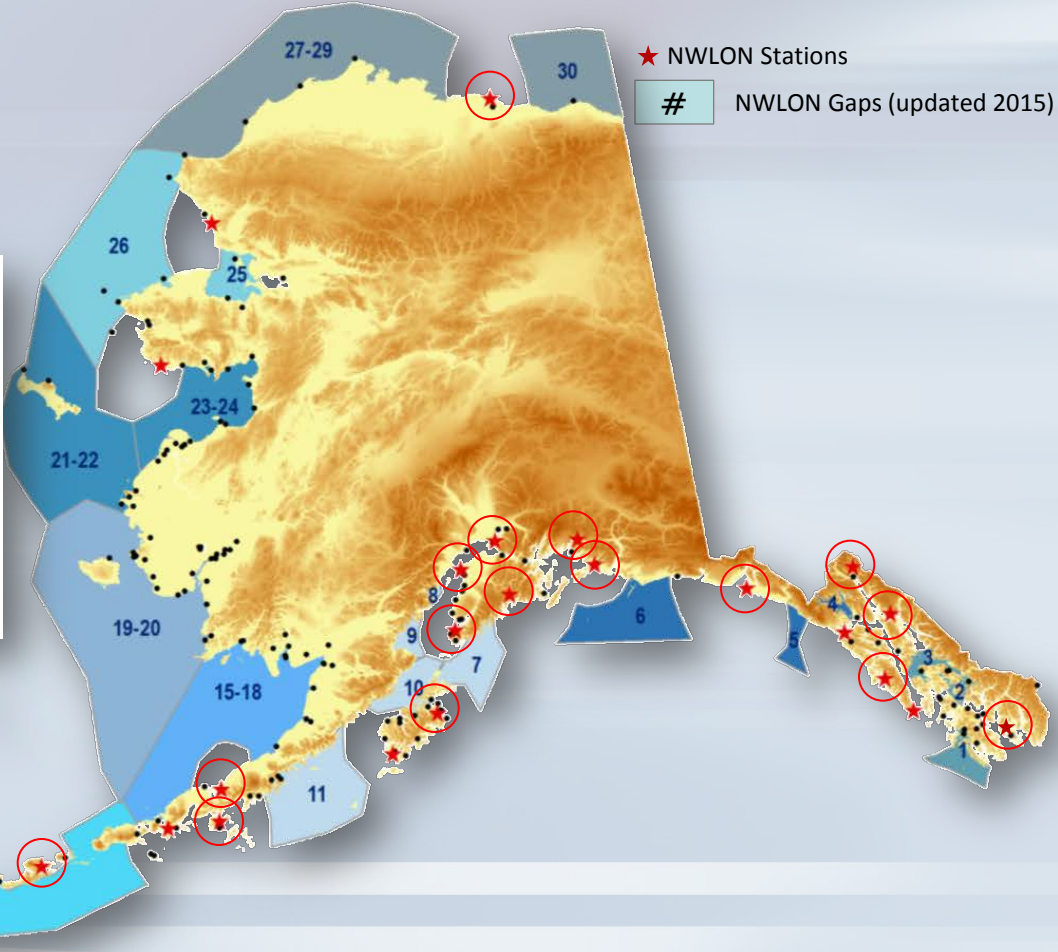
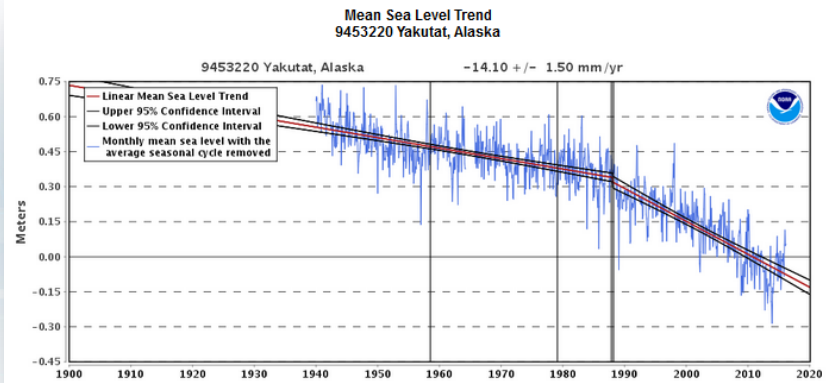
- 26 active tide gauges;



National Oceanic and Atmospheric Administration

Alaska Tide Records

- 26 active tide gauges; only 17 with extended records




Alaska Tide Records


- 26 active tide gauges; only 17 with extended records
- 8 stations (5 active) co-located with continuous GNSS

NOAA Technical Report NOS 139

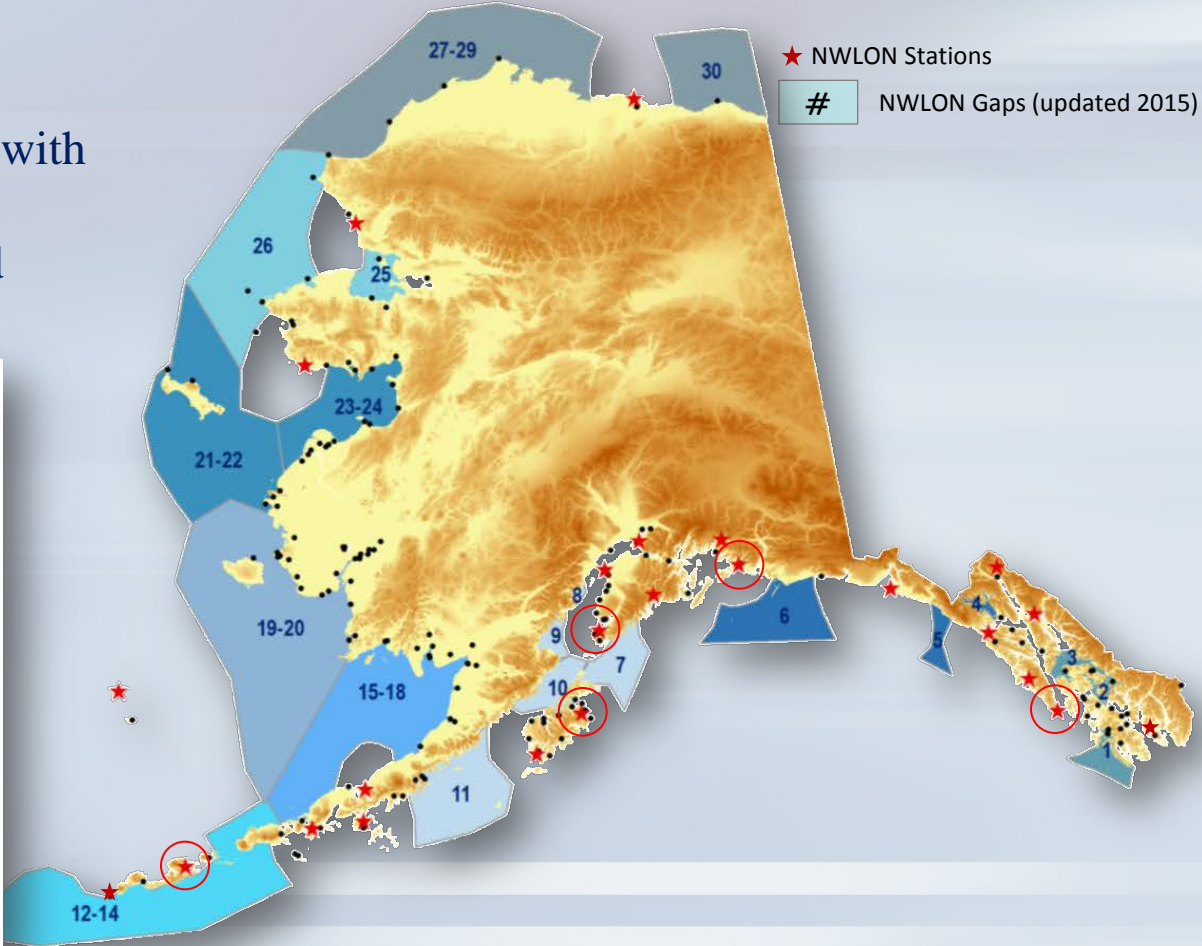
NOAA Guidance Document for Determination of Vertical Land Motion at Water Level Stations Using GPS Technology



Silver Spring, Maryland
August 2015



noaa National Oceanic and Atmospheric Administration
U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Center for Operational Oceanographic Products and Services
National Geodetic Survey

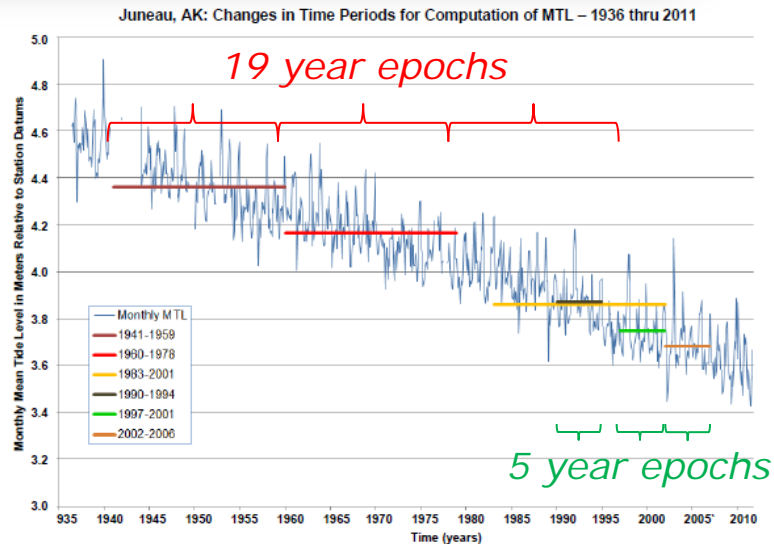


Alaska Tide Records

- 26 active tide gauges; only 17 with extended records
- 8 stations (5 active) co-located with continuous GNSS
- Discontinuous records; few repeat secondary/tertiary stations
- Modified Procedure for 5-year Tidal Epochs

NOAA Technical Report NOS CO-OPS 068

Implementation of Procedures for Computation of Tidal Datums in Areas with Anomalous Trends in Relative Mean Sea Level

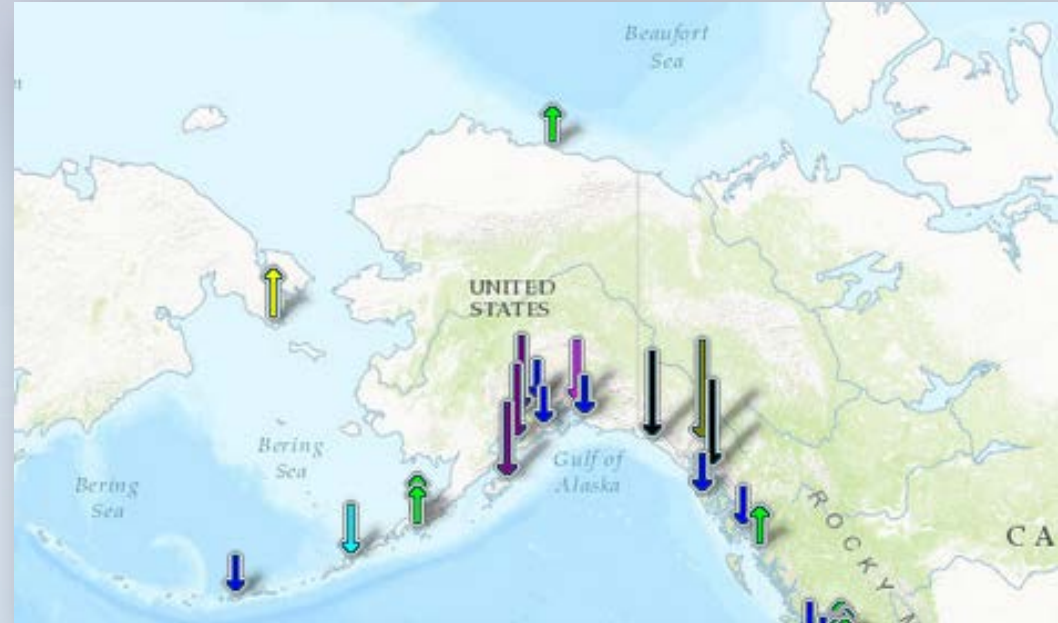


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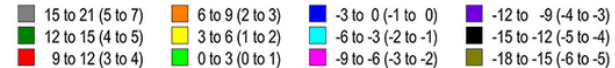
Alaska Tide Records

- 26 active tide gauges; only 17 with extended records
- 8 stations (5 active) co-located with continuous GNSS
- Discontinuous records; few repeat secondary/tertiary stations
- Modified Procedure for 5-year Tidal Epochs
- Greatest unknowns in parts of the region most vulnerable to rising relative sea levels...

<http://tidesandcurrents.noaa.gov/sltrends/sltrends.html>



Sea Level Trends
mm/yr (feet/century)



Collaborative Efforts

- Integrated water level network
- Alaska's LCC network promotes coordination, dissemination, and development of applied science to inform landscape level conservation in the face of a changing climate and related stressors.



LANDSCAPE
CONSERVATION
COOPERATIVES



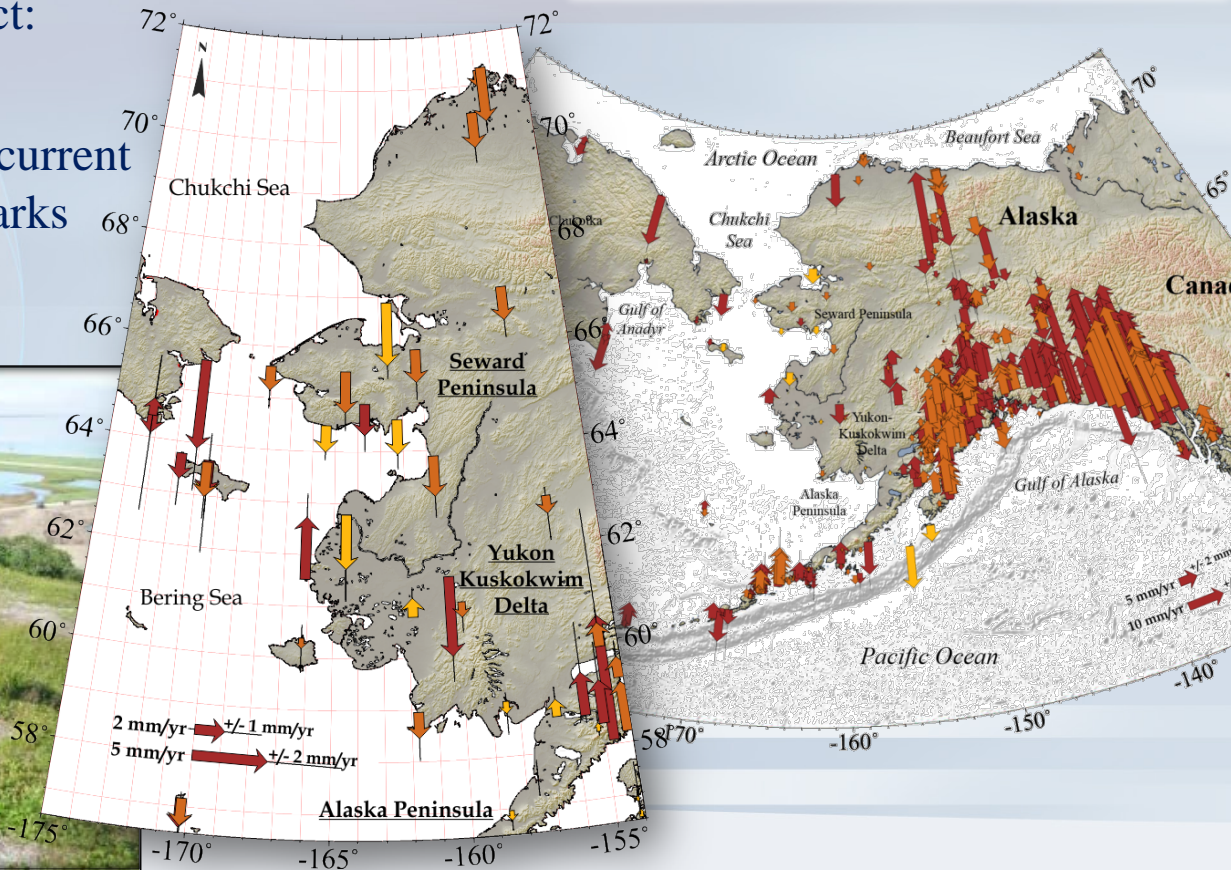
National Oceanic and Atmospheric Administration



Baseline Data: RSL trends



- UAF graduate research project: Kimber DeGrandpre
- Campaign GNSS surveys on current and superseded tidal benchmarks
- Vertical land motion models



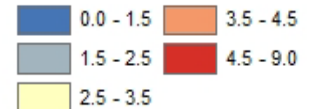
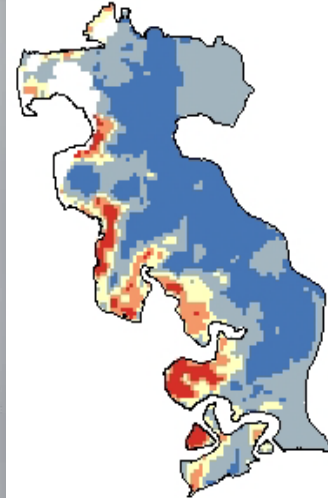
Ecosystem Science: Nesting Habitats



- PI: Dr. Sarah Saalfeld (*FWS/Manomet*)
- Identification of important environmental variables related to waterbird nest densities
- Predictive maps of nesting surfaces in SL scenarios
- 6 species:
 - Cackling Goose
 - Emperor Goose
 - Black Brant
 - Greater White-fronted Goose
 - Common Eider
 - Spectacled Eider



Spectacled Eider



Communication and Outreach

- Community Based Observing Opportunities
- Ongoing Webinar Series
- Coastal Resiliency Workshops



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DRAFT! USE WHAT YOU FEEL COMFORTABLE WITH

CLIMATE CHANGE IN WESTERN ARCTIC ALASKA 4 PEOPLE, CULTURE, FOOD SECURITY; POSSIBLE IMPACTS & RESPONSES

CHANGE IS HERE TODAY & ACCELERATING!
Clim change is already showing in the landscape with plants and animals that survive here and traditional ways of life. These changes will continue & intensify. (? and add further challenges already facing rural Alaska)

**POSTER 1
MARINE ENVIRONMENTS**

Overlooked paragraph - Bering Sea is one of the richest, most productive biologically productive ecosystems on the planet. Unique characteristics of this area - eg. important role of salmon & the Bering - make it unique, vulnerable to climate change.

COMPLEX (FUNCTIONAL) ECOSYSTEM BUILDING BLOCKS

SOME OF THE MARINE MAMMALS, SEA BIRDS, SALMONS & CRAB

The systems that support these high value resources - in particular, sea ice and stable ocean chemistry - are particularly vulnerable to climate change.

ICE MASSES

WHALES & OTHER MARINE MAMMALS

MURRES & OTHER SEABIRDS

FOODS & GODS (CRAB, SALMON & COD)

FORAGE FISH

ZOOPLANKTON

PLANKTON

THE FOUNDATION: PLANKTON & ZOOPLANKTON CURRENTS, OCEAN CHEMISTRY & TEMPERATURES

STORY #2: SALMON

Salmon is a keystone species in coastal ecosystems; impacts of climate change - changes stream temps & flows, changing ice, stream habitat, etc. - are not well known

STORY #4: SOUTHERN BERING SEA

Changes in food chains, water temperatures, most an environmental & subsistence fish - "The Bering Sea gets too warm it will provide fewer fish" - BERT/ASCP 2016

CITATIONS & SOURCES

Questions?

Thank You!

