# Risk-based Analysis of Property Vulnerability to Climate Change Threats and Adaptation Planning for EO13514 Compliance


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# Our Experience

**Mick Bilney**
**Principal**
**Cardno TEC,**
**Golden, Colorado**

- **30 Years international experience**
- **Organizational analysis and design**
  - **Programs, processes, structures**
- **Risk analysis, planning and decision-support**
- **Asset management and prioritization**
- **Management systems**
  - **Analysis, design, development**
  - **Metrics/Measurement**

**Michael Booth, Environmental**
**Associate Planner**
**Cardno TEC**
**Seattle, WA**

- **23 Years of experience**
- **Climate change adaptation planning**
- **Facility condition assessments**
- **NEPA/Capital Projects**
- **Natural Resource Restoration**
- **Code Development Mitigation**
- **Public Participation**
- **Federal Permitting**
- **Policy Development**

# Presentation Topics

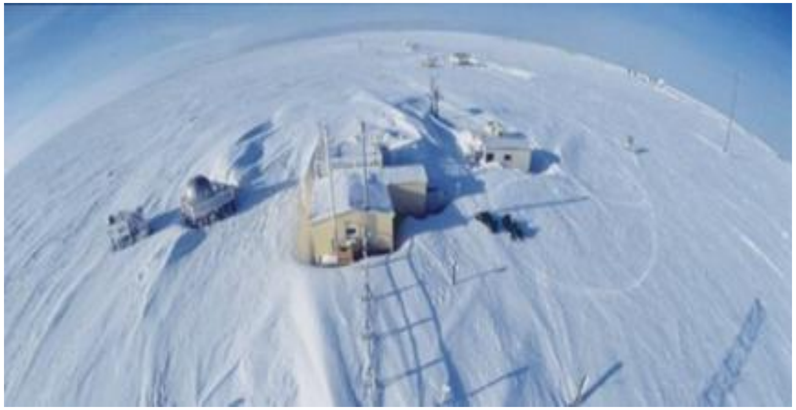
***"All the science, I don't understand. It's just my job five days a week!"***

***Elton John, Rocket Man***

- **This presentation is not about the science of Climate Change – it's about Asset Vulnerability and Risk to Climate Change Threats**

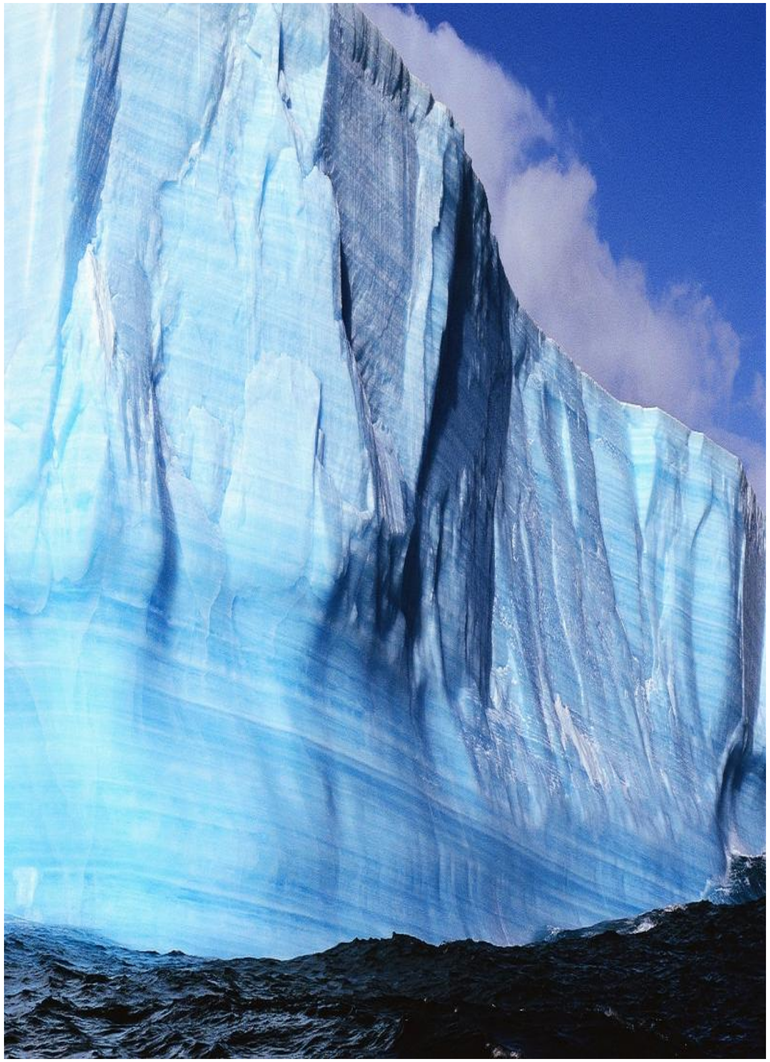
# NOAA Project Introduction

- NOAA Project Goals
- Data Sources
- Definition of Terms
- Threat and Event Types
- Risk Analysis Method and Process
- Properties Evaluated
- Conclusions and Recommendations
- Lessons Learned



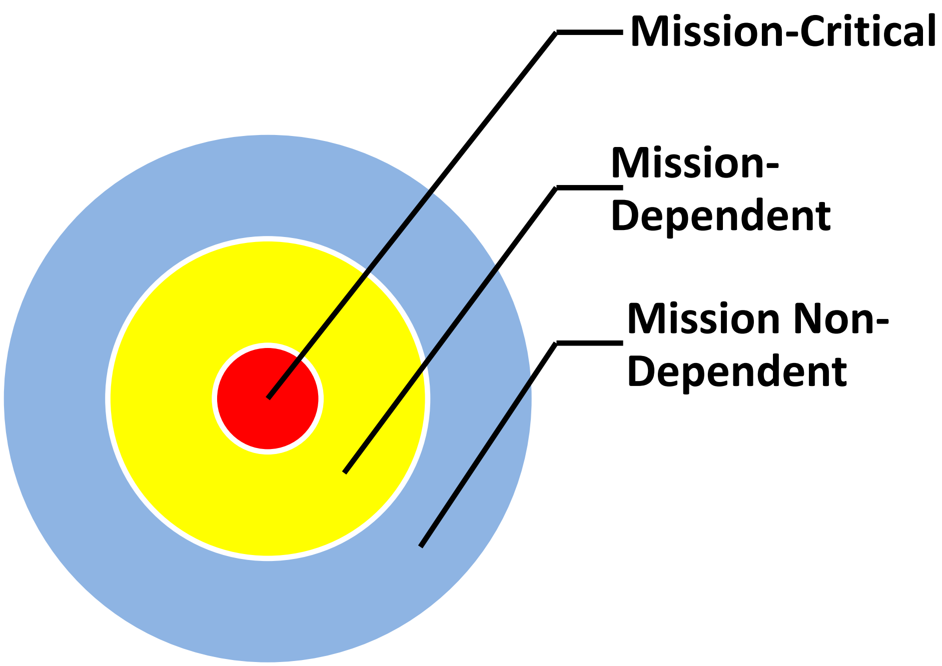
# NOAA Project Goals

- Meet requirements of EO 13514 for climate change adaptation planning
- Identify the Top 10 NOAA-owned properties most vulnerable to climate change threats/events
- Generate a high-level view of NOAA-owned facility vulnerability to climate change threats
- Develop a risk-based climate change threat vulnerability determination method  for NOAA management decision-support
- Identify data gaps and future resources to be addressed



# NOAA Property Inventory Focus

- **3214 - Initial inventory of DOC/NOAA and GSA owned or leased properties, reduced to:**
- **749 - NOAA-owned properties, reduced to:**
- **536 – NOAA-owned and occupied properties, reduced to:**
- **110 – NOAA-owned and defined Mission-Critical properties rated to identify:**
- **32 – NOAA-owned properties on 12 common "<u>complex" sites</u>**
- **Top 10 - NOAA-owned <u>properties</u> with the highest risk of climate change threat vulnerability**



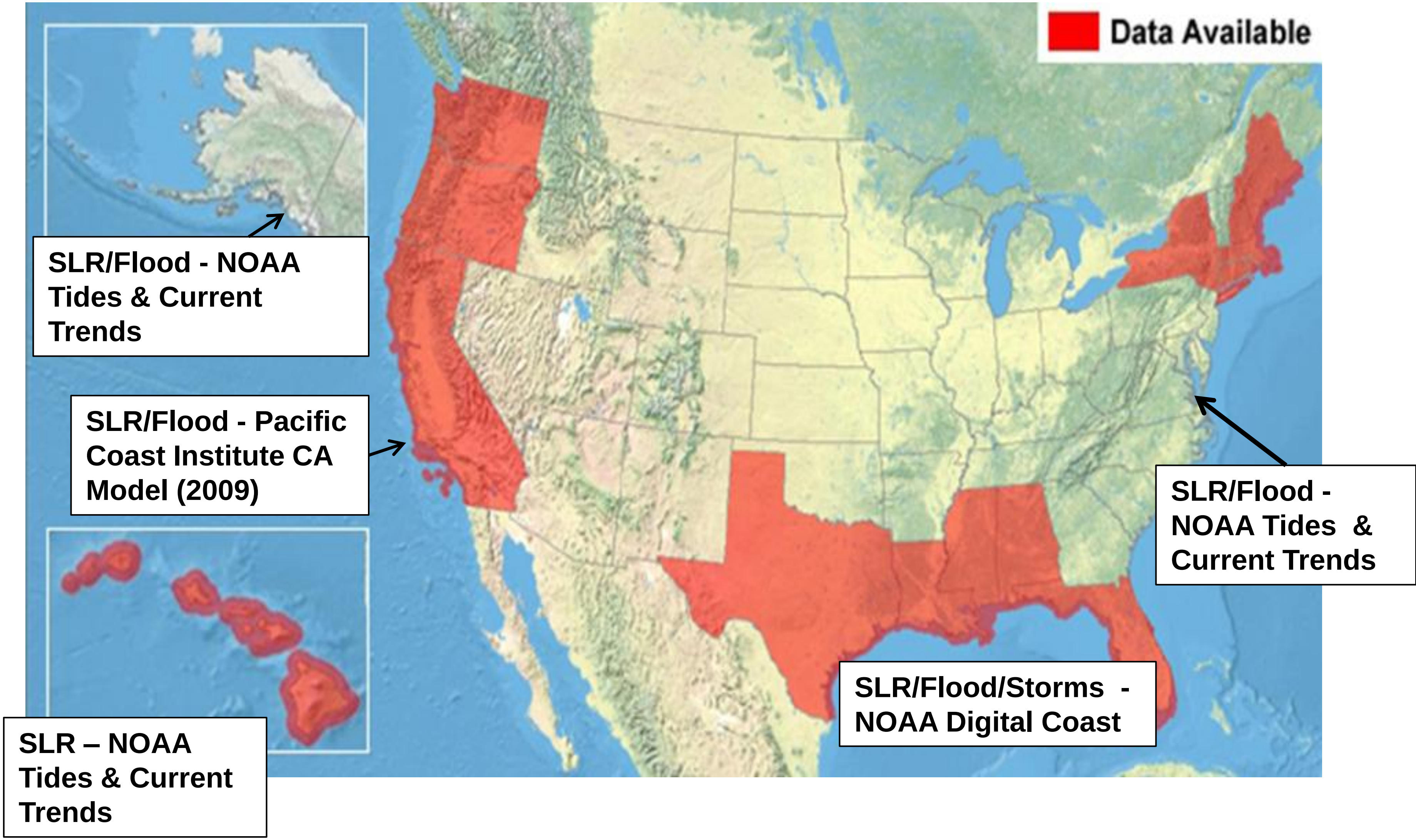
# Terms Used

- **Risk is related to two components:**
  - **<u>Threat</u> - condition that can produce a bad result (a bad event)**
  - **<u>Consequence</u> – the bad stuff that happens when a threat becomes a an event**
- **Risk is rated by combination of:**
  - **<u>Likelihood</u> – certainty (or uncertainty) of a bad event happening**
  - **<u>Severity</u> - how bad the bad threat or event could be**
- **Risk ratings are qualitative**

# Data Sets and Models Used

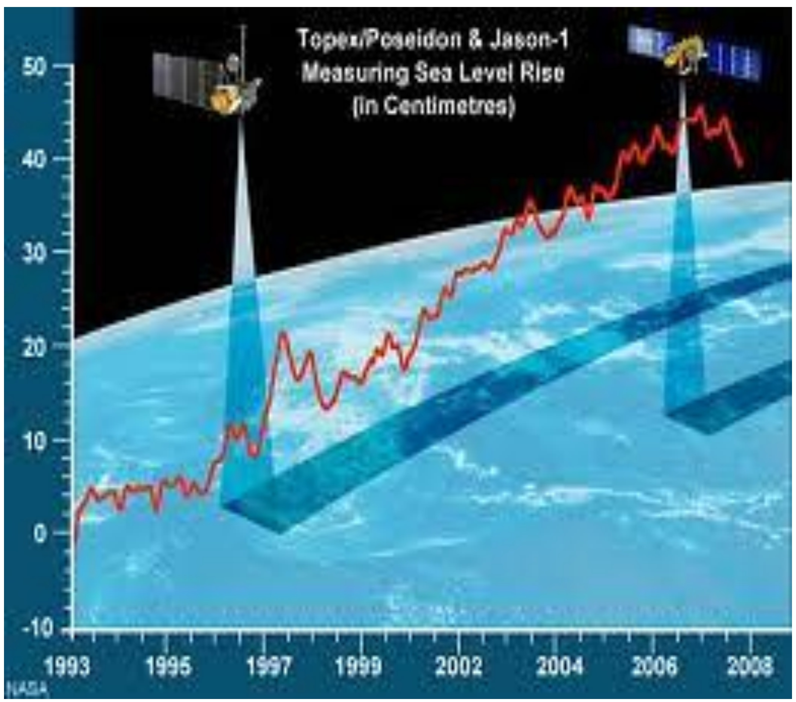
- NOAA Digital Coast – Inundation and SLR Viewer
- NOAA Tides & Currents Sea Levels
- NOAA Sea Level Rise & Coastal Flooding Impacts viewer
- Nature Conservancy – Climate Wizard
- FEMA Map Service Center
- California Coast – Pacific Institute

# NOAA Digital Coast Data Coverage -2012



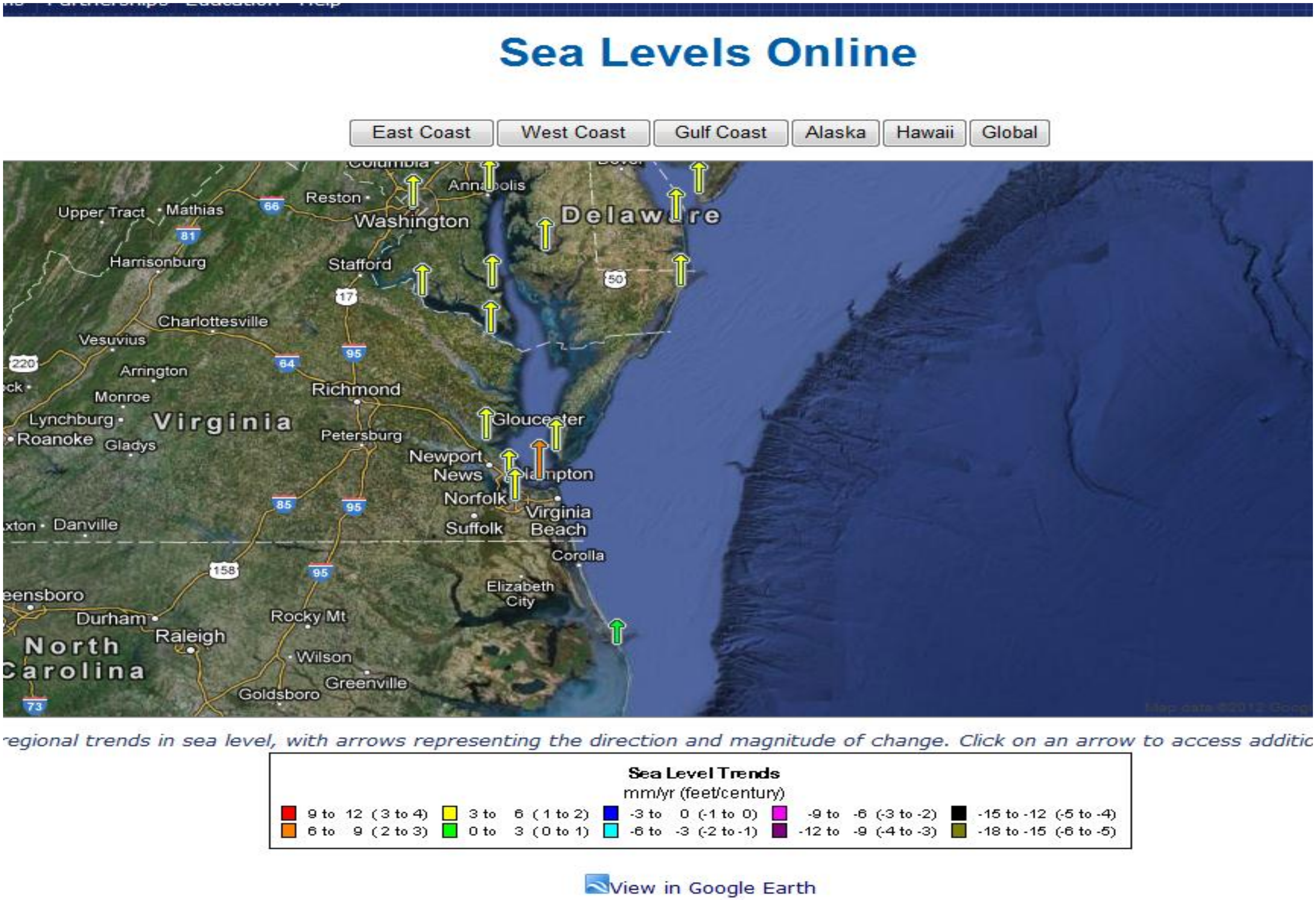
# SLR

- Proximity to shoreline (> 1 mile; < 1 mile)
- Sea Level Trend – Tide Gauges NOAA
- Digital Coast Data Set

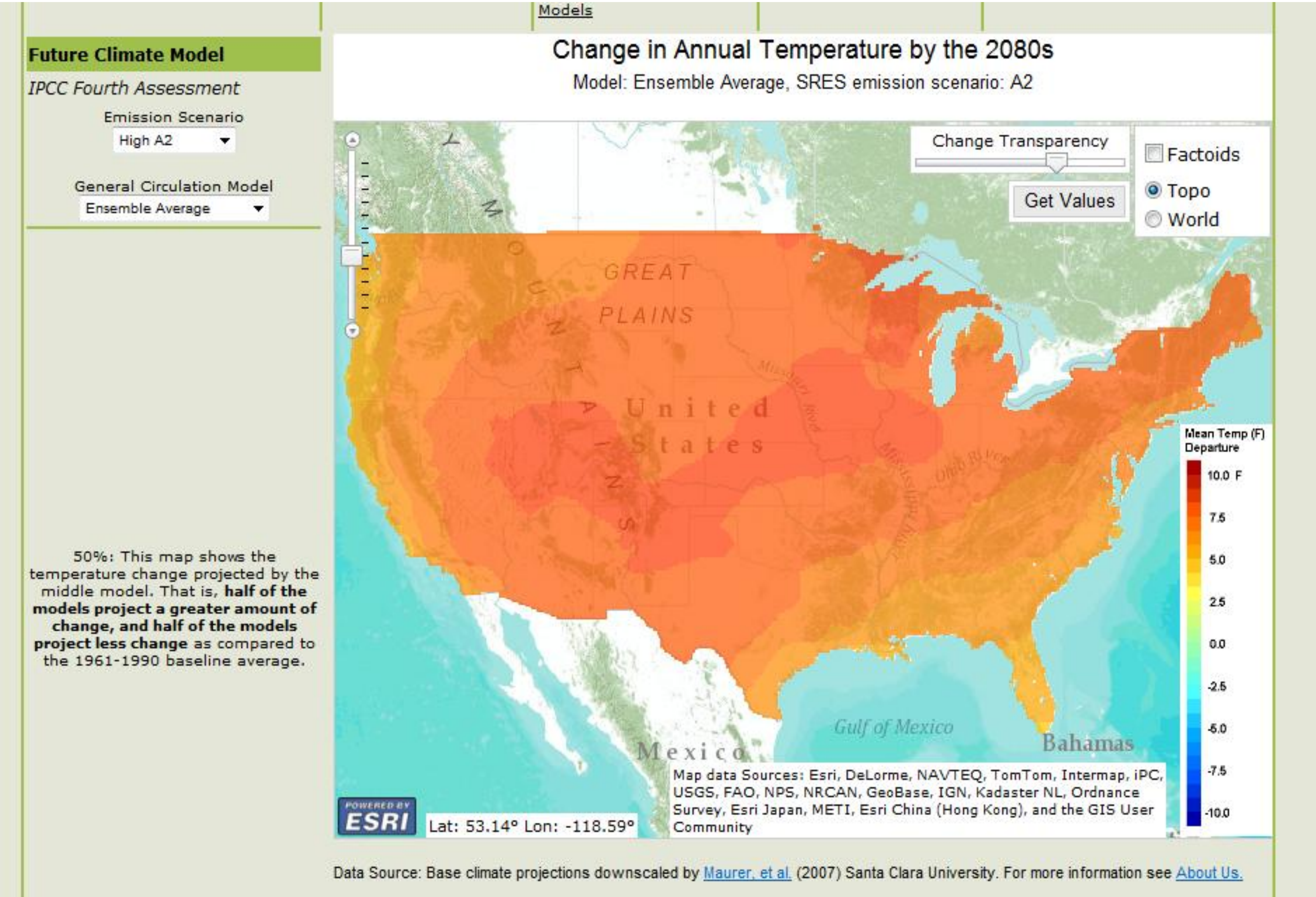



Sea Level, NC Tide Gage

# NOAA SLR Trends Site

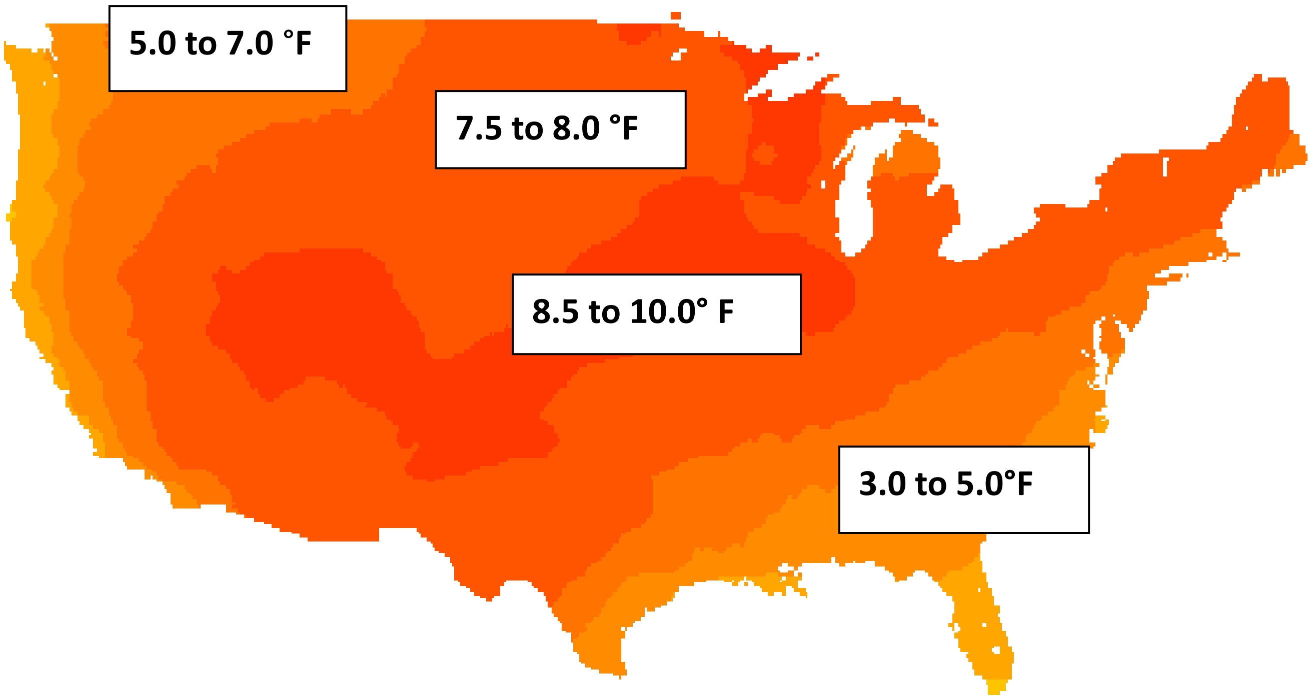


# Temperature Site

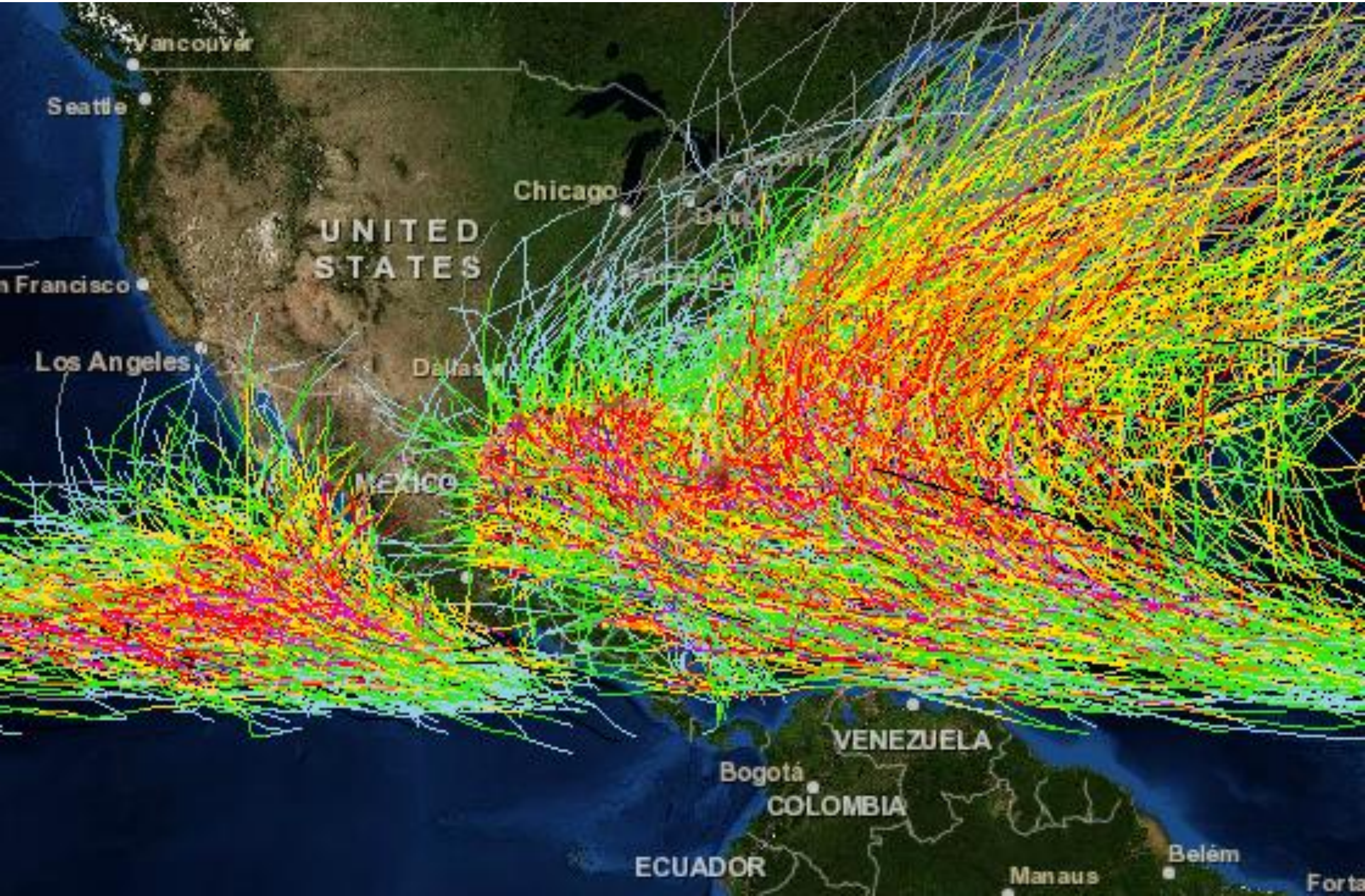


# NOAA Properties and Projected Temperature Increase

- **Temperature change projected by 2080 as compared to the 1961-1990 baseline average (Avg. est. from models-A1B)**

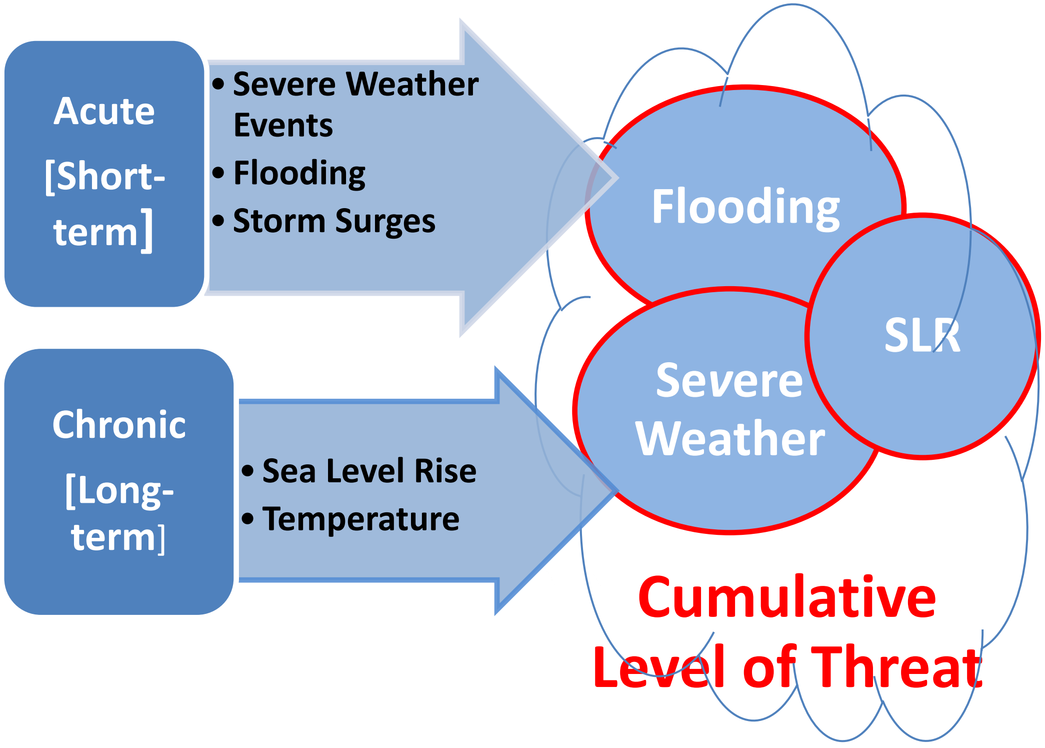


# NOAA Storm Tracks Site



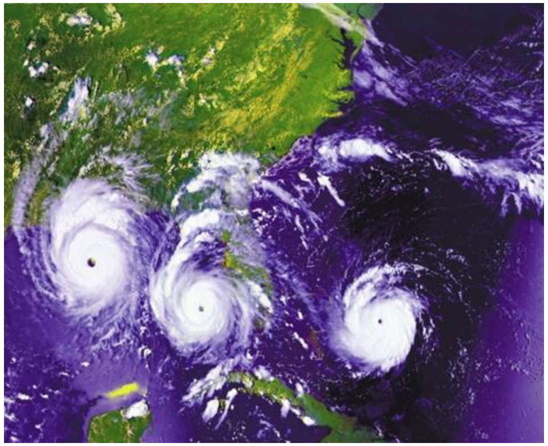
# Temporal Aspect: 2012-2100

- Short- term, *acute* threat events
- Long-term *chronic* threat events
  - Due to different end dates of model results acute and chronic give consistency.
- Acute (Short-Term Duration) – periodic severe weather events (hurricanes and flooding) occur suddenly; duration usually < 1 year.
- Chronic (Long-Term Duration) - gradual (temperature change/sea level rise) slowly changing over time



# Qualitative Risk Analysis Process

- **Obtained Federal Real Property Management (FRPM) inventory of NOAA properties (GSA-owned and NOAA-owned)**
- **Inserted locations of NOAA-occupied, owned and leased properties into Excel and GIS database**
- **Defined key Climate Change Threats and events for analysis**
- **Analyzed NOAA owned properties for proximity to projected Climate Change Threats**
- **Focused analysis on NOAA-defined Mission-Critical property**
- **Identified Top 10 properties with highest qualitative risk rating**



# Likelihood, Severity and Risk Elements

- Threat-event likelihood elements:
  - Sea Level Rise (SLR)
  - Elevation and distance to water
  - Temperature Increase
  - Flood – FEMA risk designations
  - Precipitation Change
  - Severe Weather - historical storm tracks (hurricanes and typhoons)
- Determined likelihood with threat- event combinations
- Established severity as Current Replacement Value (CRV) due to monetary impact to NOAA
- Identified risk ratings by combining likelihood and severity ratings
- Set levels of risk: High, Medium, Low

# Likelihood x Severity = Risk (Qualitative)

## Example Likelihood Matrix

**Sea Level Rise Vulnerability Likelihood**

| | Located within a model-defined SLR affected area | Proximity to shoreline (less than 1 Mile) | Proximity to shoreline (More than 1 Mile) |
|---|---|---|---|
| Located within a model-defined SLR affected area | **High** | **High** | **High** |
| Elevation less than 25 feet MSL | **High** | **High** | **Medium** |
| Elevation greater than 25 MSL | **High** | **Medium** | **Low** |
| If Sea Level Rise at nearest station has a negative trend: | **Low** | | |

| SEVERITY | |
|---|---|
| **If CRV > $9.5 mm** | **High** |
| **If CRV < $9.5 mm but > $1 mm** | **Medium** |
| **If CRV < $ 1 mm** | Low |

# Regional Property Risk Portfolio

| Region | Number of Properties Rated "High" Risk | Number of Properties Rated "Medium" Risk | Number of Properties Rated "Low" Risk |
|---|---|---|---|
| East Coast | 28 | 9 | 2 |
| Midwest | 2 | 1 | |
| Pacific | | 6 | 4 |
| Rocky Mountain | | | 3 |
| West Coast | 2 | 11 | 41 |
| Grand Total | 32 | 27 | 50 |

# Top Tier Complexes Vulnerable to Climate Change Threat

| Complex Name | City | State |
|---|---|---|
| Barrow Observatory - (Global Monitoring Division (GMD)) | BARROW | AK |
| Dr. Nancy Foster Florida Keys Sanctuary | KEY WEST | FL |
| Milford Biological Laboratory | MILFORD | CT |
| NCCOS CCFHR Beaufort Laboratory | BEAUFORT | NC |
| NCCOS Cooperative Oxford Lab | OXFORD | MD |
| Northeast Fisheries Science Center | WOODS HOLE | MA |
| NESDIS CDA WALLOPS | WALLOPS ISLAND | VA |
| National Marine Fisheries Services(NMFS) Laboratory | PASCAGOULA | MS |
| National Ocean Service (NOS) Charleston Laboratory | CHARLESTON | SC |
| Oceanic & Atmospheric Research/Atlantic Oceanographic & Meteorological Laboratory (OAR/AOML) | KEY BISCAYNE | FL |
| Panama City Laboratory | PANAMA CITY | FL |
| Southeast Fisheries Science Center | GALVESTON | TX |

# Top 10 Owned Properties Vulnerable to Climate Change Threat

| Property Name | Complex Name | City | State |
|---|---|---|---|
| New/main Laboratory | Milford Biological Lab | MILFORD | CT |
| Admin. Building (Building #1) | NCCOS CCFHR Beaufort Lab | BEAUFORT | NC |
| Ecology N. Wing (Building #3) | NCCOS CCFHR Beaufort Lab | BEAUFORT | NC |
| Ecology Building (Building #2) | NCCOS CCFHR Beaufort Lab | BEAUFORT | NC |
| Main/lab Building | NE Fisheries Science Center | WOODS HOLE | MA |
| Laboratory Building #1 | Panama City Laboratory | PANAMA CITY | FL |
| Bldg. 302-research Lab/offices | Southeast Fisheries Center Lab | GALVESTON | TX |
| Bldg. 216-researchLabs/offices | Southeast Fisheries Center Lab | GALVESTON | TX |
| Bldg. 306-scientific Labs/Office | Southeast Fisheries Center Lab | GALVESTON | TX |
| Wet Laboratory | Southeast Fisheries Center Lab | GALVESTON | TX |

# Google Earth Example: What If?

- Demonstration of what could be done with Google if an agency had sufficient resources

# Conclusions From Analysis

- Although, original analysis designed to identify Top 10 Properties
  - To obtain value, study needed to look beyond 10
  - Need to place more emphasis on complexes
- Regional concentration of properties with higher level of vulnerability on East Coast
  - Due to SLR, uplift, subsidence
- Observed multiple data gaps

# Recommendations: Technical-Reliability

- Use LIDAR, property elevation, review of subsidence in locality and other available site information
- Standardize the longitude and latitude of each location onto one primary building on each complex site
  - Longitude and Latitude are sometimes on the SE corner of the building, dock or in the center point of a parking lot for a consistent point across all properties
  - This removes variable locations and allows for more consistent points in GIS databases.
- Develop interactive GIS – Google Earth Mapping for NOAA use

# Recommendations: Risk-Reliability

- **Develop standardized, consistently applied methodology for determining Mission-Critical, Mission-Dependent, and Non Mission-Dependent as defined by FRPC property status to help:**
  - **Assure consistent application and accurate risk designation**
  - **Assure status determination consistent across all NOAA organizations**
- **Design method to be Defensible, Auditable, Repeatable, Transparent (DART)**
- **Conduct site-specific analysis and develop mitigation strategies for high likelihood properties**
- **Conduct site-specific collateral threat reviews, e.g. Salt Water Inundation, Utility and Transportation disruption**
- **Develop mitigation measures and climate change adaptation planning per EO13514**

# Recommended Next Steps

- **Include analysis of leased properties**
- **Identify mitigation strategies for short-term and long term**
- **Identify locations for area studies**
- **Reduce real property footprint, renovation, disposal**
- **Inform facility condition assessments**
- **Target other high-likelihood complexes for further analysis**
- **Evaluate other criteria for designating severity, e.g.**
  - **Environmental, safety, societal**
  - **Operational costs, age, economic effects of property loss**
- **Address data gaps**

# Questions from Lessons Learned

- **Where is your agency on the EO requirements?**
- **Is your agency participating in the interagency committees/task force?**
- **Do you have a good data base inventory of your facilities? (Example: Correct GPS location, building type, function, age, and cost replacement value)**
- **Is your facility data base updated on an annual basis?**
- **Have you established standardized objective criteria in determining mission criticality?**
- **Are you using the Federal Real Property Management definitions of mission criticality?**
- **Have you evaluated your owned <u>and</u> leased properties?**

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# BACK UP SLIDES FOR MORE INFORMATION IF NEEDED

# Screening Approach

**The approach on evaluating the known data set for likelihood and severity indicators:**

- **Categorized climate event scenarios into groups representative of High, Medium and Low “levels” of likelihood and severity.**
- **The source data sets were used as projections of the future state**
- **Grouping the future state into a three levels of indicators is much more conservative and repeatable than evaluating the properties based on individual given values**
- **The analyses were intentionally simple and straight forward to allow for repeatability of the process.**
- **Emphasis was on simplicity over complexity**
- **Emphasis was on information necessary and sufficient for decision-maker support**

# Screening Approach

- **In general, the values of High, Medium, or Low are associated with the following mathematical properties of the data sets:**

- **High - high values are mathematically associated with values that are well above the mean, or average, value for the indicator. These values may be orders of magnitude larger than values for medium, or low.**

- **Medium – medium values are mathematically associated with values that are distributed around the mean, or average, of the data set. These values are associated with the "middle-of-the-road" of the data.**

- **Low - low values are mathematically associated with values that are well below the mean, or average the data set. These values tend to be much lower than the mean value.**

# Temperature Vulnerability Likelihood

| | |
|---|---|
| Mean temperature increase is 6.35° | The ratings are based on one standard deviation distance from the mean temperature rise. |

| | |
|---|---|
| Temperature less than 5.1° | Low |
| Temperature greater than 5.1° but less than 7.6° | Medium |
| Temperature greater than 7.6° | High |

# Severe Storms Vulnerability Likelihood

**Step 1 - 2012 - 2080 likelihood (based on historical storm tracks)**

| | |
|---|---|
| Sites that have experienced more than 16 hurricane/TS events since 1925 | High |
| Sites that have experienced 9-16 hurricane/TS events since 1925 | Medium |
| Sites that have experienced less than 9 hurricane/TS events since 1925 | Low |

**Step 2: 2080 likelihood (based on designation from Step 1: Precipitation and SL R)**

| **SLR -->** | High | | Medium | | Low | |
|---|---|---|---|---|---|---|
| **Precipitation -->** | Greater than 5% | Less than 5% | Greater than 5% | Less than 5% | Greater than 5% | Less than 5% |
| **High** | High | High | High | High | High | High |
| **Medium** | High | High | High | Medium | Medium | Medium |
| **Low** | Medium | Medium | Medium | Low | Low | Low |

# Flood Vulnerability Likelihood

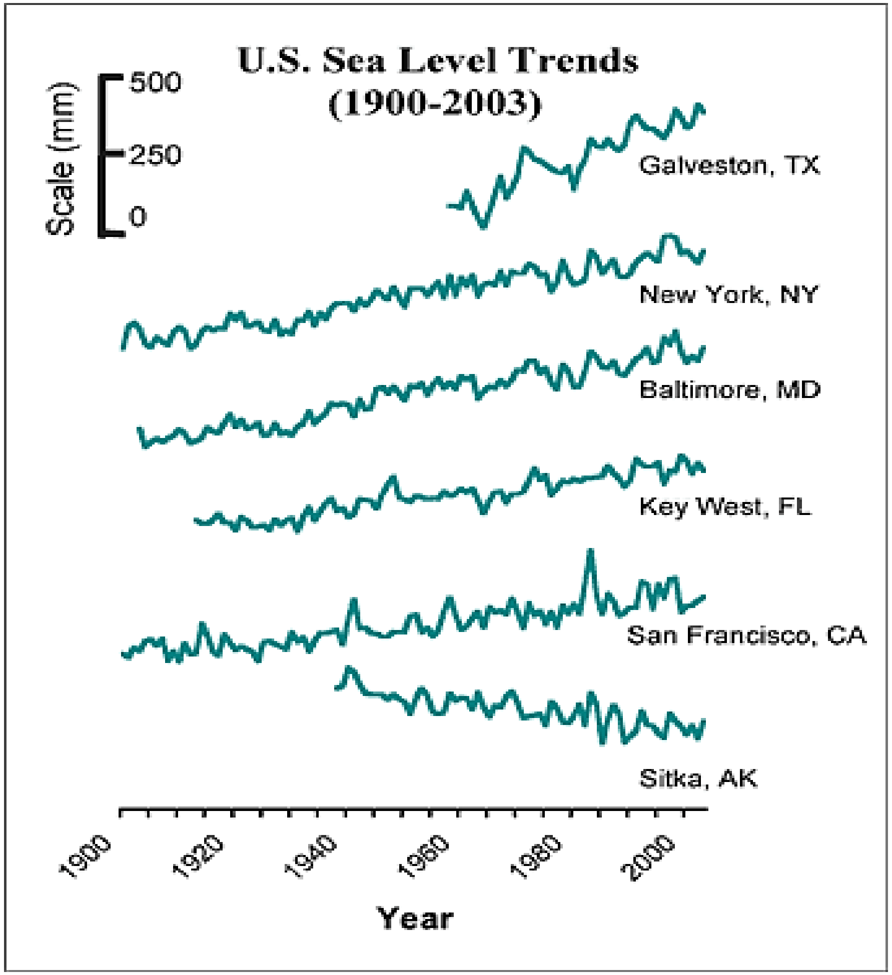
**Step 1 - 2012 - 2080 likelihood (based on precipitation change and current FEMA designation)**

| | Precipitation Increase | |
|---|---|---|
| | **Greater than 5%** | **Less than 5% or decrease** |
| FEMA Designated "High Risk" | High | High |
| FEMA Designated "Moderate to Low" | Medium | Medium |
| FEMA Designated "Possible None" | Medium | Low |
| FEMA Designated "Undetermined" | Low | Low |

**Step 2 - 2080 likelihood (based on designation from Step 1 and SLR)**

| **SLR -->** | **High** | **Medium** | **Low** |
|---|---|---|---|
| **High** | High | High | High |
| **Medium** | High | Medium | Medium |
| **Low** | Medium | Low | Low |

# Sea Level Trends – West Coast vs. East Coast




Source: Monthly and Annual Mean Sea Level Station Files from the Permanent Service for Mean Sea Level (PSMSL) at the Proudman Oceanographic Laboratory

# Regional Differences on Sea Level and our planet

- A broad region of the mid-Atlantic coastline along the United States is sinking slowly due to the subsidence of the glacial fore-bulge  and sedimentation.  While there is glacial rebound effect with uplifting in the Hudson Bay region since the end of the last ice age.
- The Mississippi delta region of Louisiana is rapidly sinking due to the loading of the lithosphere and compaction of the sediments deposited by the Mississippi River.
- The Texas coastline is also sinking, likely due to similar causes, in addition to oil and gas extraction.
- The volcanically active Island of Hawaii is sinking relative to the other islands in the Hawaiian chain.
- Some areas of the northern California, Oregon, and Washington coastline are rising slowly due to the tectonic effects of subduction beneath the North American continent.
- Rapid uplift in southeastern Alaska is believed to be due to the melting of mountain glaciers. The sea level trends for tide stations  based only on data since the major earthquakes in March 1964 and March 1957, respectively. The trends show rapid post-earthquake tectonic uplift at most locations.