Sea Levels:

- Global sea levels increased throughout the 20th century after 2,000 years of relative stability.
- Taking an average of water levels from all oceans, sea levels have risen at a rate of 0.06 inches per year from 1880-2013.
- Since 1993, this has increased to an average rate of 0.11-0.14 inches per year.
- The trend of rising global sea levels masks deeper complexities in the data. Regional trends vary as some areas experience more rapid land elevation and in some coasts sea levels have actually decreased.

Causes: (https://sealevel.nasa.gov/understanding-sea-level/causes/drivers-of-change)

- Global:
    - Ice loss (Greenland and Antarctica) - Greenland is the largest contributor to global ice loss. It melted 0.09mm per year between 1992 and 2001, and 0.59mm between 2002 and 2011.
    - Glaciers and ice caps - accounts for ⅓ of rising and warming sea levels. 2.6-2.9mm per year over the last 20 years.
    - Thermal expansion - between 19711 and 2010, the estimated rate of thermal expansion was 0.4 - 0.8mm per year with a confidence level of 90-100%
    - Postglacial rebound, self attraction, and loading - AKA Glacial isostatic adjustment. Lowers sea levels by about 0.3mm per year.
    - Land hydrology - water cycles accelerate in response to climate change increasing risk of more extreme weather conditions i.e. droughts and floods.
- Regional:
    - Ocean circulation - wind and density gradients caused by warming/ cooling temperatures move sea levels higher in some areas and lower in others.
    - The ENSO factor (El Niño and La Niña) - El Niño increases sea levels because there tends to be more rainfall over oceans, whereas in La Niña most rainfall occurs over land, reducing water levels.
    - Gravity - the changing of the gravitational pull of the Earth's poles.

Consequences:

- Tides: although tidal changes are cyclical, their impact is amplified by a rise in overall sea level. Rising tides can cause floods in coastal zones and other areas that were previously unaffected.
- Storm surge: higher than average rise of coastal water (above astronomical high tide).
- Subsidence: land sinking which occurs naturally. Coupled with rising sea levels can leave land areas more prone to flooding, mudslides, and earthquakes.

Observations: (https://sealevel.nasa.gov/understanding-sea-level/observations/overview)

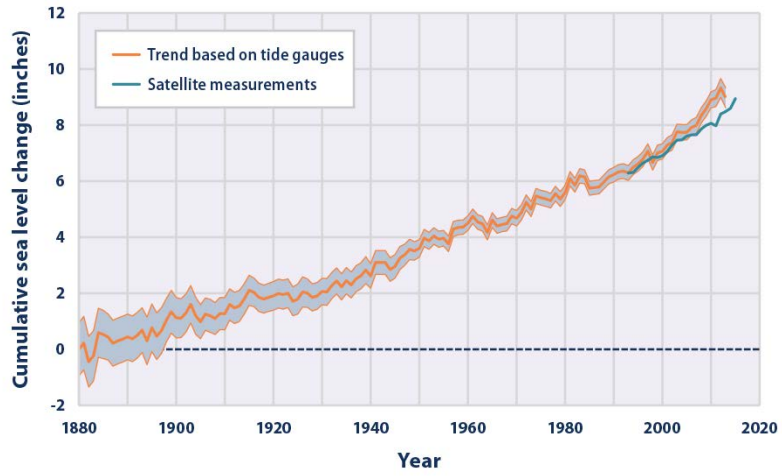
- Tide gauges
- Satellite altimetry
- Satellite gravimetry
- Argo floats and in-situ observations
- Paleo observations

Projections: (https://sealevel.nasa.gov/understanding-sea-level/projections/overview)

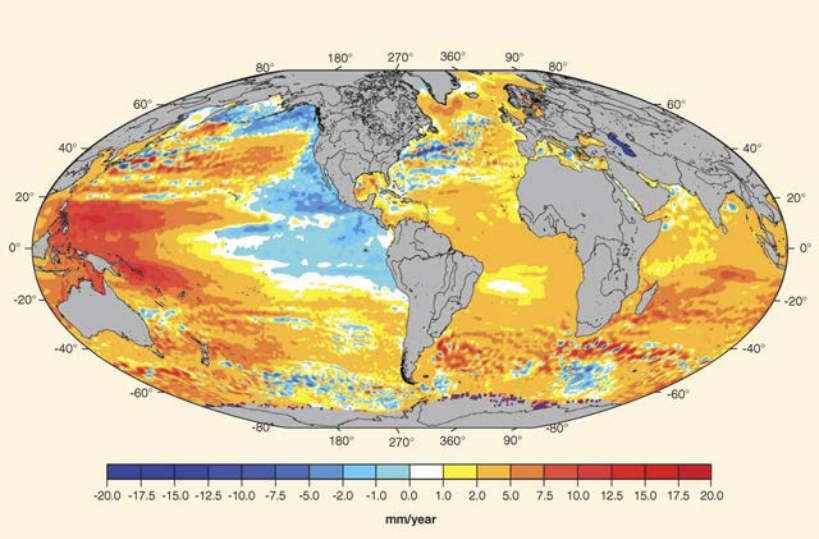
- Climate models
    - Ocean modelling - used to measure sea surface temperature (SST), mean dynamic topography (height of ocean surface above horizontal surface
- Empirical projections
    - Projections of global sea rise is usually made up to the year 2100.
    - Models include level of greenhouse gas emissions, how ice sheets respond to warming temperatures, and thermal expansion

Sources of Information:

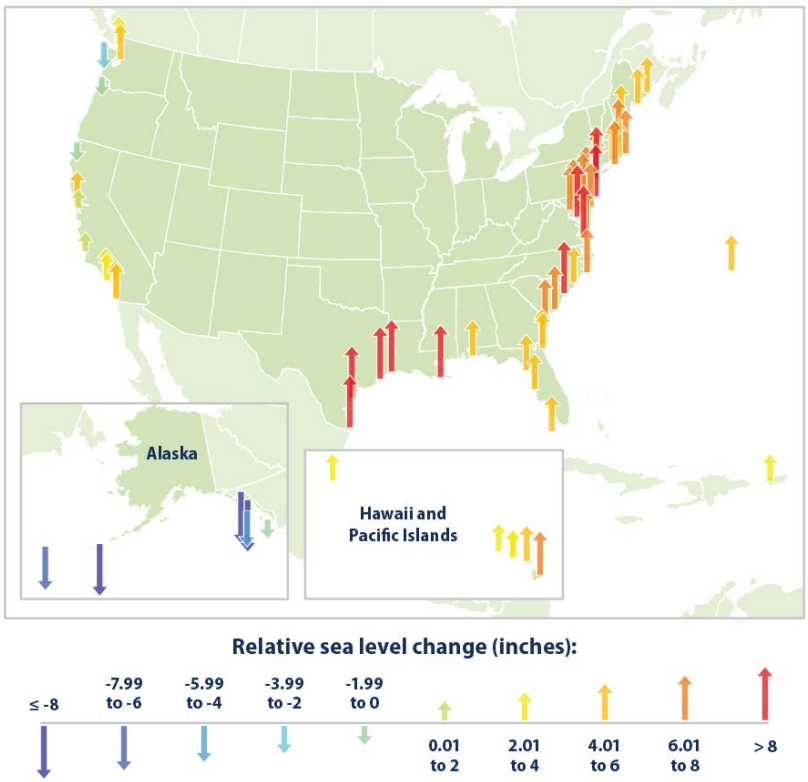
- National Oceanic and Atmospheric Administration http://www.noaa.gov/
- Climate Change Indicators: Sea Level (EPA) https://www.epa.gov/climate-indicators/climate-change-indicators-sea-level
- Sea Level Change - Observations from Space https://sealevel.nasa.gov/
- Rising Sea Levels - Highlights https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level



Global Average Absolute Sea Level Change, 1880–2015 (Data sources: CSIRO, 2015; NOAA 2016.)



Regional Sea Level Trends from Satellite Altimetry, Oct 1992 - July 2009 (Data Source: Nicholls and Cazenay/ Science.)



Relative Sea Level Change Along U.S. Coasts, 1960–2015 (Data Source: NOAA, 2016.)