# Brief Overview of Data Sources: Tide Gauges and CORS

Beth Sciaudone

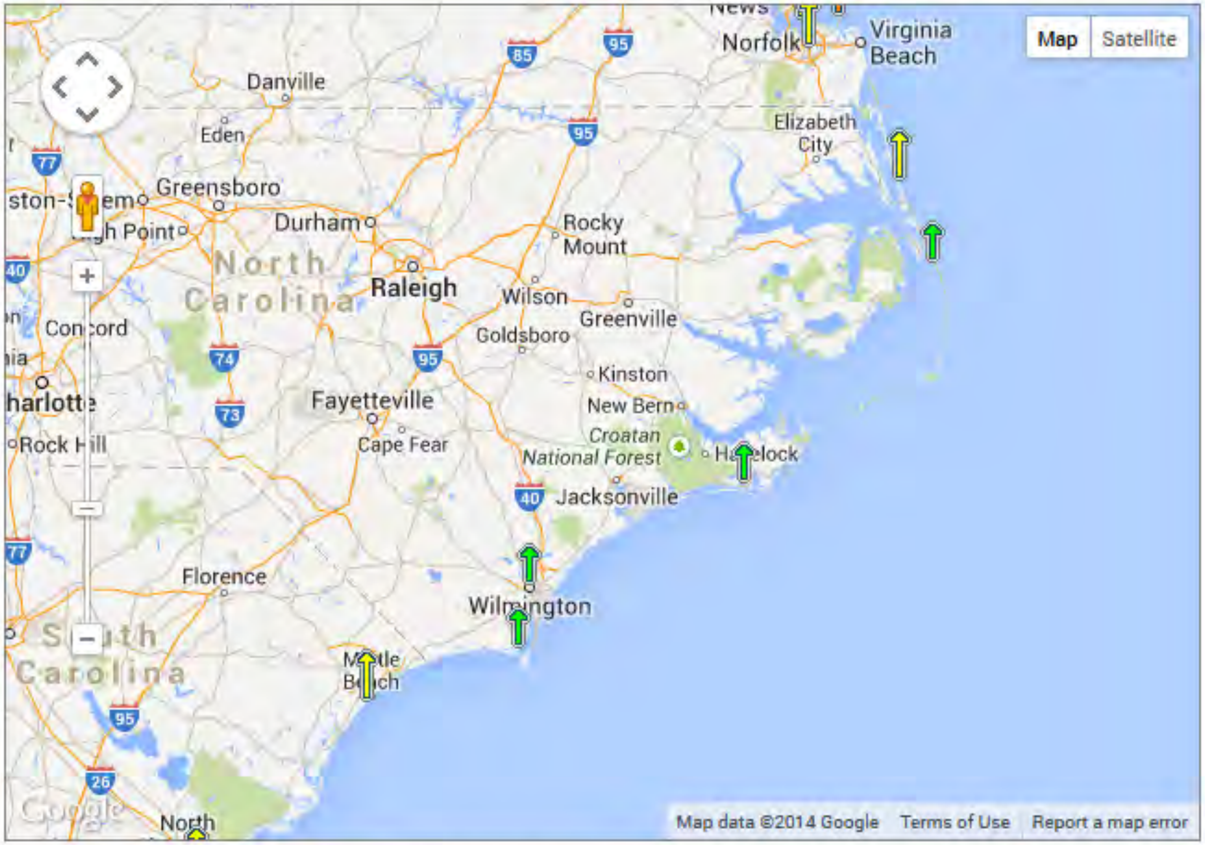
# NC Tide Gauges (NOAA) with Sea Level Trends Published

- **8651370 Duck, North Carolina**
  - **Continuous data 1978-2011 4.59 +/- 0.94 mm/yr**
  - **Trend has not yet been updated**
- **8652587 Oregon Inlet Marina, North Carolina**
  - **Discontinuous data 1977-2006 2.82 +/- 1.76 mm/yr**
  - **Updated trend to 2013 3.65 +/- 1.37 mm/yr**
- **8656483 Beaufort, North Carolina**
  - **Mostly continuous data 1953-2006 2.57 +/- 0.44 mm/yr**
  - **Updated trend to 2013 2.71 +/- 0.37 mm/yr**
- **8658120 Wilmington, North Carolina**
  - **Continuous data 1935-2006 2.07 +/- 0.40 mm/yr**
  - **Updated trend to 2013 2.02 +/- 0.36 mm/yr**
- **8659084 Southport, North Carolina**
  - **Discontinuous data – 1933-2006 2.08 +/- 0.46 mm/yr**

# Sea Level Trends

East Coast | West Coast | Gulf Coast | Alaska | Hawaii | Global

View in Google Earth



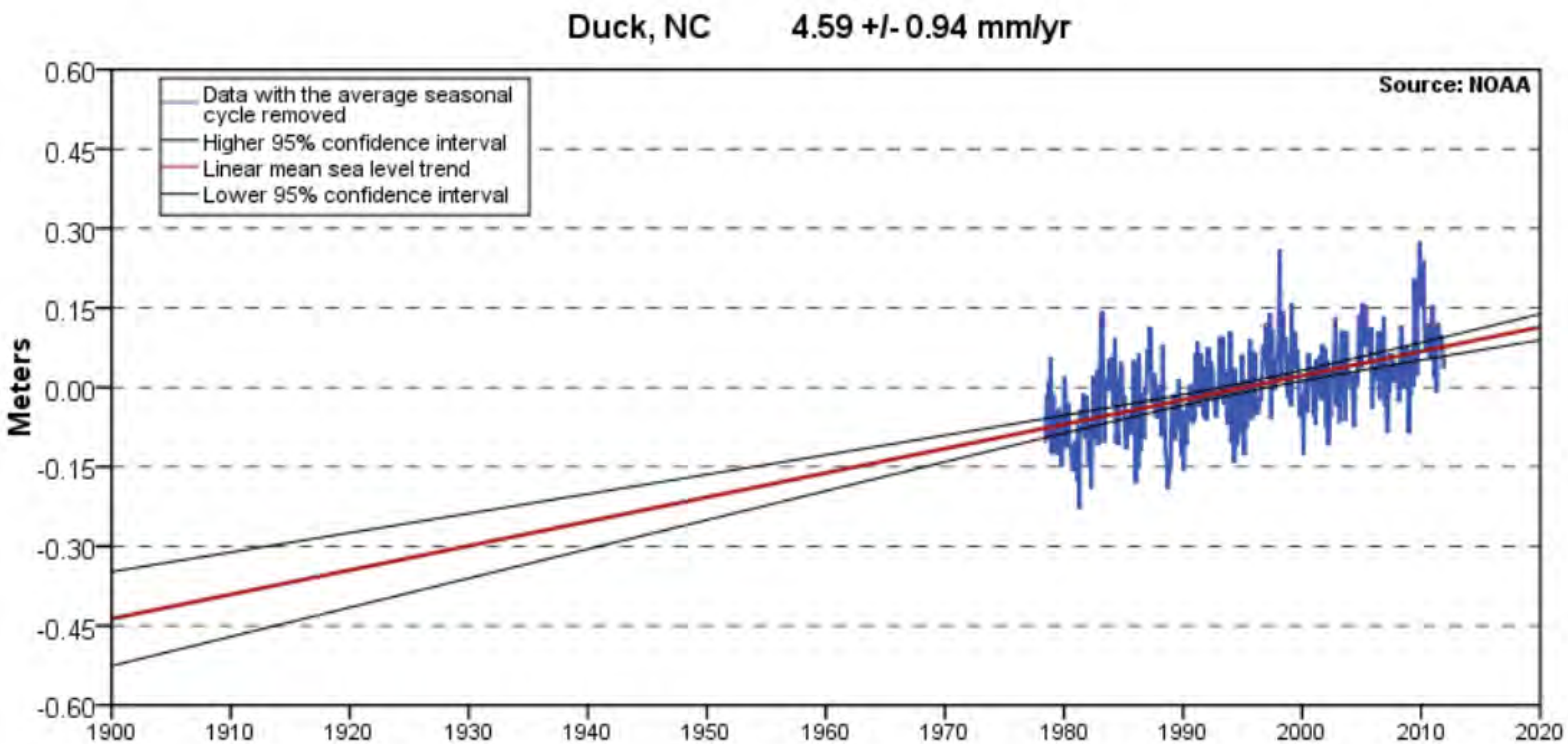

*The map above illustrates regional trends in sea level, with arrows representing the direction and magnitude of change. Click on an arrow to access additional information about that station.*

## Sea Level Trends

mm/yr (feet/century)

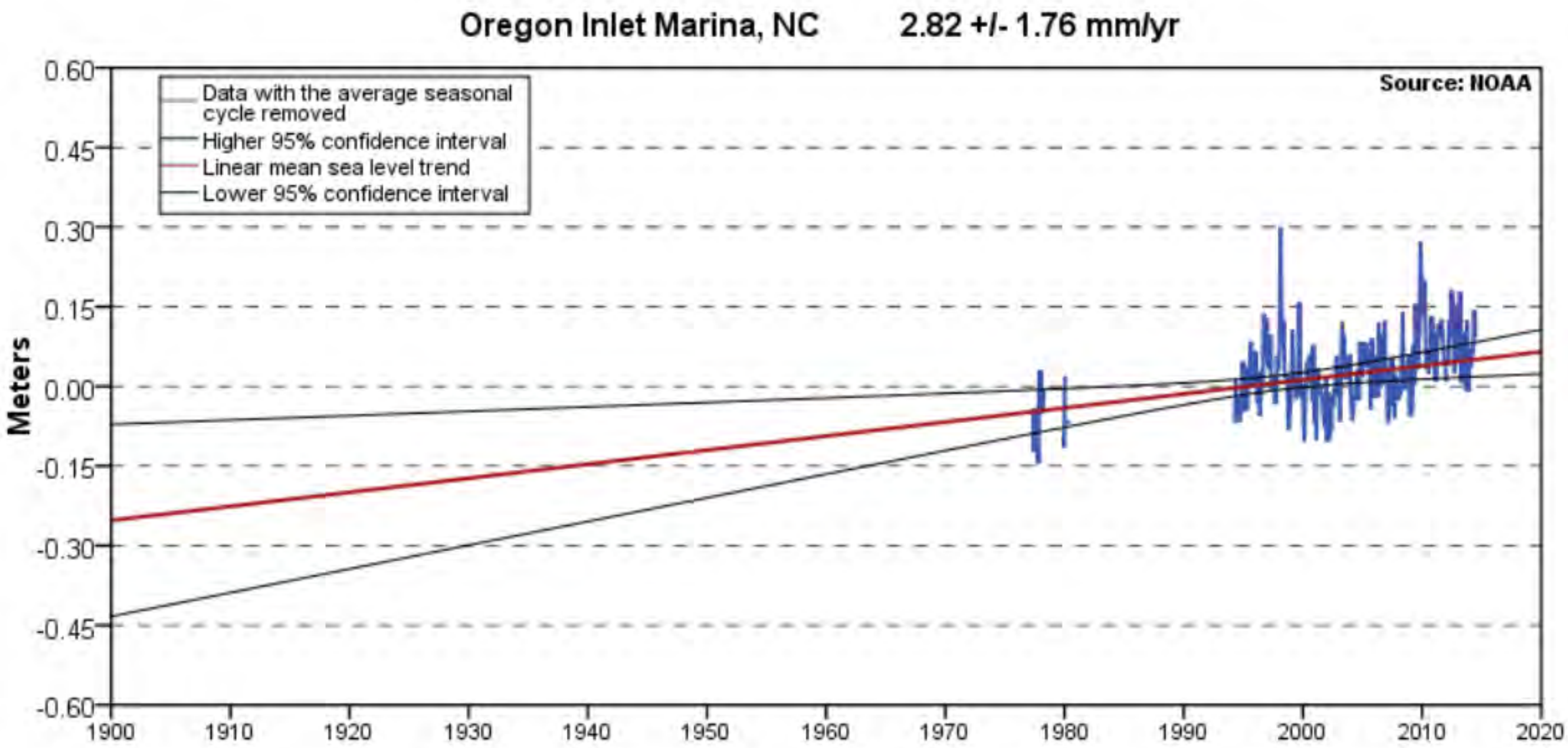
| | | | |
|---|---|---|---|
| 15 to 21 (5 to 7) | 6 to 9 (2 to 3) | -3 to 0 (-1 to 0) | -12 to -9 (-4 to -3) |
| 12 to 15 (4 to 5) | 3 to 6 (1 to 2) | -6 to -3 (-2 to -1) | -15 to -12 (-5 to -4) |
| 9 to 12 (3 to 4) | 0 to 3 (0 to 1) | -9 to -6 (-3 to -2) | -18 to -15 (-6 to -5) |

# 8651370 Duck




**The mean sea level trend is 4.59 millimeters/year with a 95% confidence interval of +/- 0.94 mm/yr based on monthly mean sea level data from 1978 to 2011 which is equivalent to a change of 1.51 feet in 100 years.**

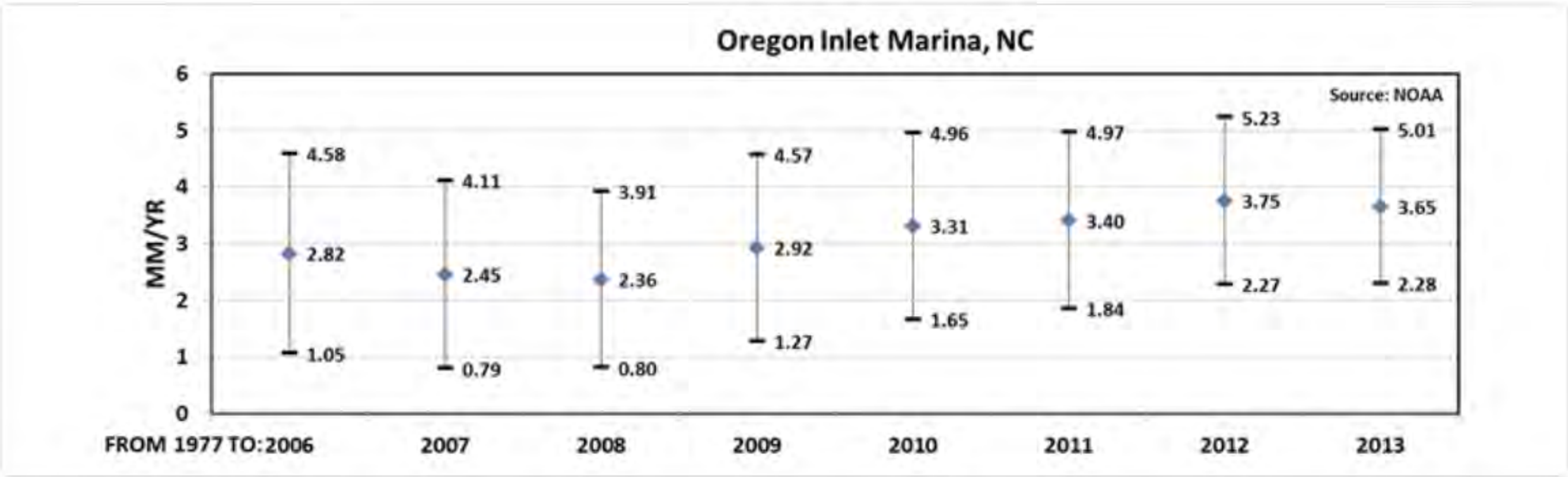
# 8652587 Oregon Inlet Marina



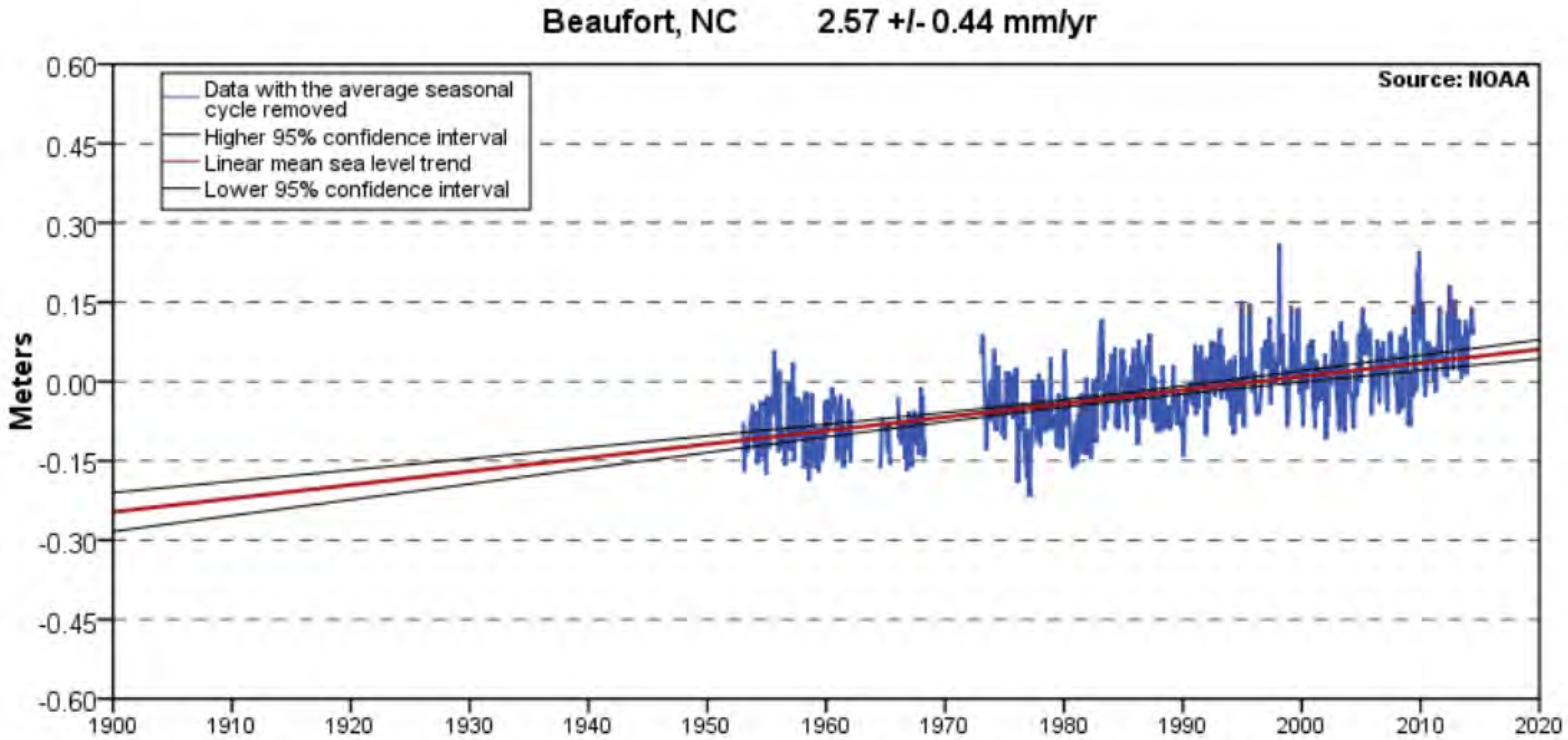

The mean sea level trend is 2.82 millimeters/year with a 95% confidence interval of +/- 1.76 mm/yr based on monthly mean sea level data from 1977 to 2006 which is equivalent to a change of 0.93 feet in 100 years.

# 8652587 Oregon Inlet Marina

- Updated Trends



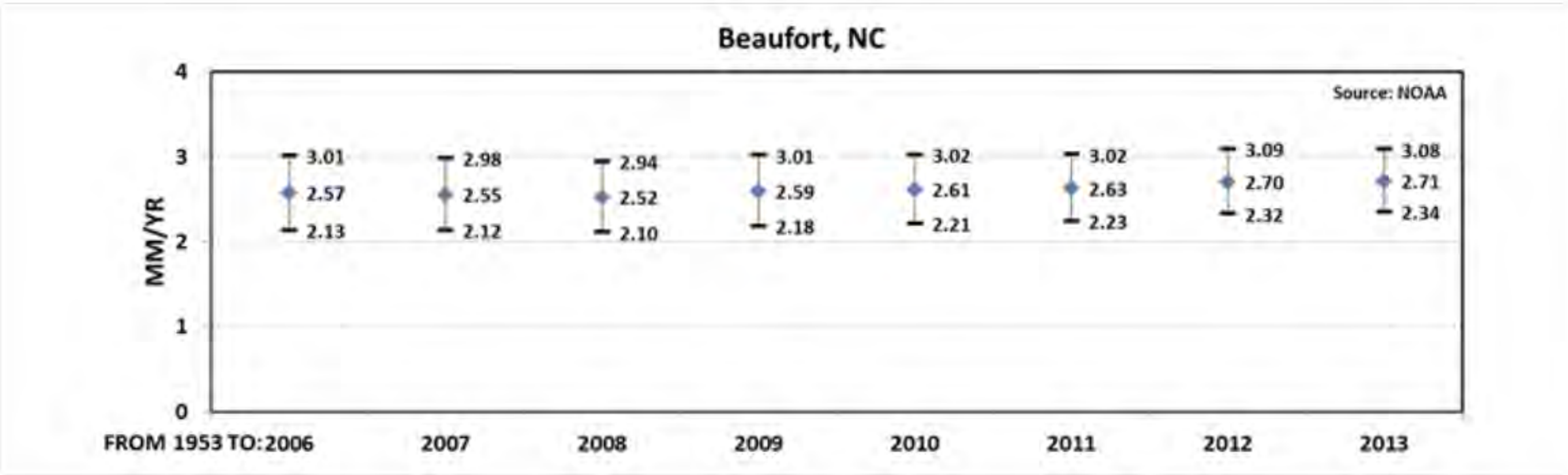
# 8656483 Beaufort



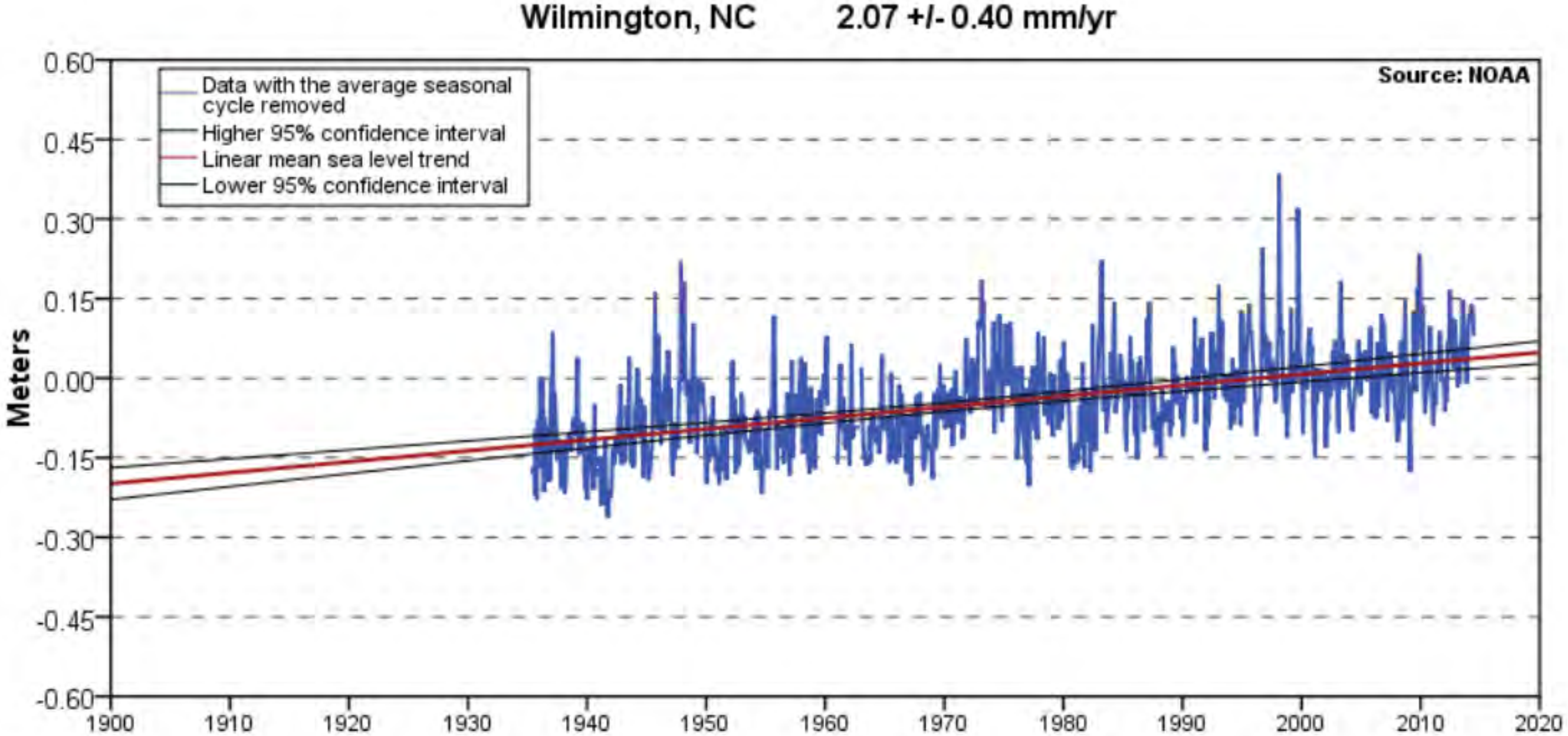

**The mean sea level trend is 2.57 millimeters/year with a 95% confidence interval of +/- 0.44 mm/yr based on monthly mean sea level data from 1953 to 2006 which is equivalent to a change of 0.84 feet in 100 years.**

# 8656483 Beaufort

- Updated Trends



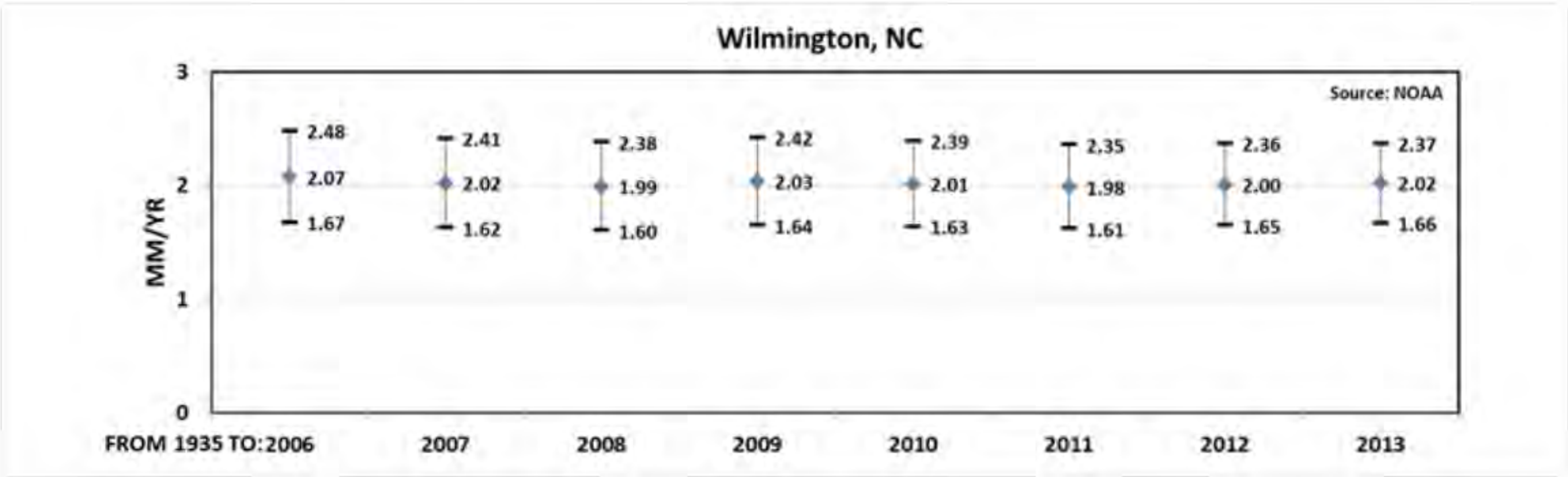
# 8658120 Wilmington



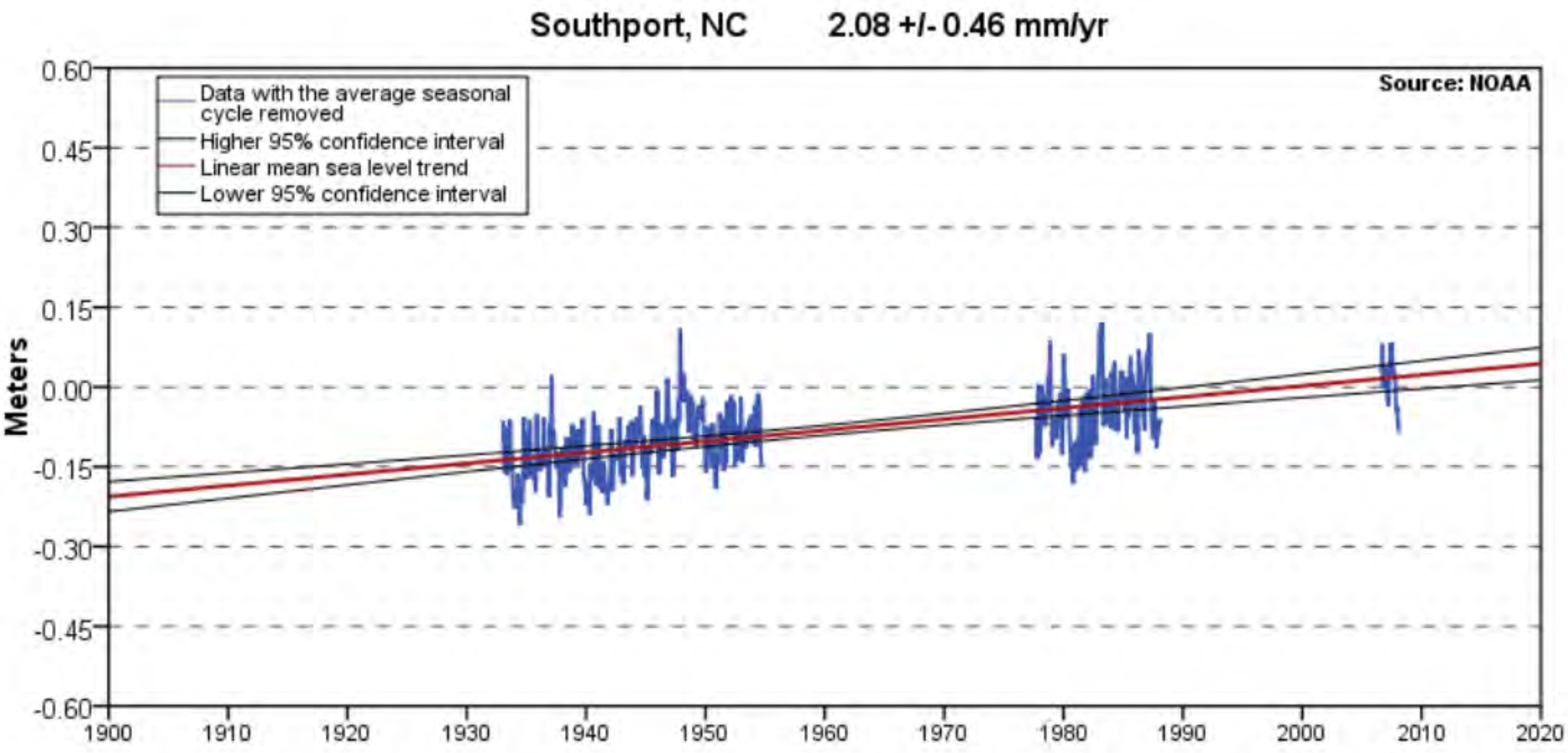

The mean sea level trend is 2.07 millimeters/year with a 95% confidence interval of +/- 0.40 mm/yr based on monthly mean sea level data from 1935 to 2006 which is equivalent to a change of 0.68 feet in 100 years.

# 8658120 Wilmington

- Updated Trends



# 8659084 Southport



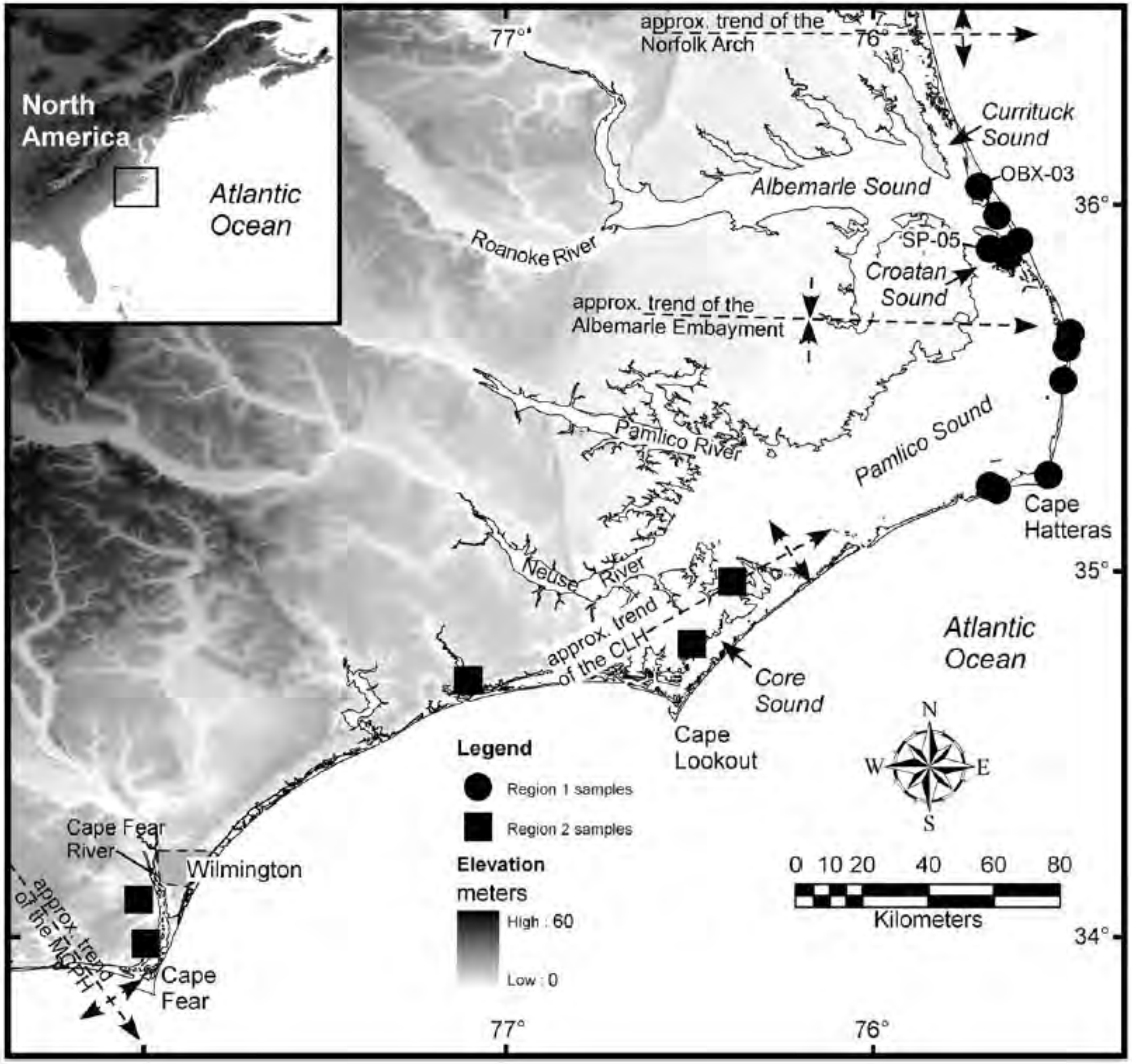

The mean sea level trend is 2.08 millimeters/year with a 95% confidence interval of +/- 0.46 mm/yr based on monthly mean sea level data from 1933 to 2006 which is equivalent to a change of 0.68 feet in 100 years.

# CORS NC Coastal Stations


http://www.ngs.noaa.gov/CORS_Map/

# Other Sources of Information on Subsidence

- Published studies attempting to correlate GIA movements to local sea level change
- Snay et al. 2007, Horton et al. (incl Riggs) 2009
- Snay – CORS data – did not examine any stations in NC but did examine Gloucester Pt. VA (subsidence ~2.58 +/- 1.16 mm/yr) and Charleston SC (1.55 +/- 0.87 mm/yr)
- Horton – core data – Report SLR rates for late Holocene at 1.14 +/- 0.03 mm/yr in Region 1, 0.82 +/- 0.02 mm/yr in Region 2.
- Englehart et al. 2009 – salt marsh sedimentary sequences – report 1.0 +/- 1 mm/yr SLR for late Holocene




Map from Horton et al. 2009

# USACE Curve Calculator Values

- Auto Populates with Subsidence Values as Follows:
  - Beaufort: 0.790 mm/yr
  - Southport: 0.520 mm/yr
  - Wilmington: 0.430 mm/yr

# Discussion

- Other Available Data/Published Estimates of Subsidence/GIA?

# Brief Overview of IPCC AR5 2013 – Sea Level Change

Beth Sciaudone and Greg “Rudi” Rudolph

# IPCC Working Group I report The Physical Science Basis

- 5-year effort
- 250 authors, 40 countries
- 1500 pages
- 9,200 published peer-reviewed papers referenced
- 50,000 comments received
- Under the IPCC, a large number of "Expert Reviewers" are invited to comment on a particular chapter and the authors must then respond to each of these comments in turn.
- Since the report is based on published papers, the process is a peer review of the peer reviewed literature

Source: http://www.publications.parliament.uk/pa/cm201415/cmselect/cmenergy/587/587.pdf

# How does the IPCC AR5 Report estimate projected SLR?

- Climate Change Models: IPCC AR5 uses Process Based Models
- Four Scenarios or "Representative Concentration Pathways" (RCPs) – different greenhouse gas emissions and concentration levels
- Numbers refer to radiative forcing in W/sq. m. Radiative forcing, expressed is the additional energy taken up by the Earth system due to the enhanced greenhouse effect. More precisely, it can be defined as the difference in the balance of energy that enters the atmosphere and the amount that is returned to space compared to the pre-industrial situation.
- RCP2.6 – low greenhouse gases
- RCP4.5
- RCP6
- RCP 8.5 – highest greenhouse gases
- Scenarios are publicly available at http://tntcat.iiasa.ac.at:8787/RcpDb/dsd?Action=htmlpage&page=welcome
- Summary of characteristics of each scenario taken from http://tntcat.iiasa.ac.at:8787/RcpDb/dsd?Action=htmlpage&page=welcome#rcpinfo and http://www.mpimet.mpg.de/fileadmin/communication/Im_Fokus/IPCC_2013/uk_ipcc_A_guide_to_RCPs.pdf

# RCP 2.6

- RCP 2.6 was developed by the IMAGE modeling team of the Netherlands Environmental Assessment Agency. The emission pathway is representative for scenarios in the literature leading to **very low greenhouse gas concentration levels**. It is a so-called "peak" scenario: its radiative forcing level first reaches a value around 3.1 W/m2 mid-century, returning to 2.6 W/m2 by 2100. In order to reach such radiative forcing levels, **greenhouse gas emissions (and indirectly emissions of air pollutants) are reduced substantially over time.** The final RCP is based on the publication by Van Vuuren et al. (2007).

# RCP 2.6

This future would require:

- Declining use of oil
- Low energy intensity
- A world population of 9 billion by year 2100
- Use of croplands increase due to bio-energy production
- More intensive animal husbandry
- Methane emissions reduced by 40 per cent
- CO2 emissions stay at today's level until 2020, then decline and become negative in 2100
- CO2 concentrations peak around 2050, followed by a modest decline to around 400 ppm by 2100

# RCP 4.5

- RCP 4.5 was developed by the MiniCAM modeling team at the Pacific Northwest National Laboratory's Joint Global Change Research Institute (JGCRI). It is a **stabilization scenario where total radiative forcing is stabilized before 2100 by employment of a range of technologies and strategies for reducing greenhouse gas emissions.** The scenario drivers and technology options are detailed in Clarke et al. (2007). Additional detail on the simulation of land use and terrestrial carbon emissions is given by Wise et al (2009).

# RCP 4.5

This future is consistent with:

- Lower energy intensity
- Strong reforestation programmes
- Decreasing use of croplands and grasslands due to yield increases and dietary changes• Stringent climate policies
- Stable methane emissions
- CO2 emissions increase only slightly before decline commences around 2040

# RCP 6.0

- The RCP 6.0 was developed by the AIM modeling team at the National Institute for Environmental Studies (NIES), Japan. It is a **stabilization scenario where total radiative forcing is stabilized after 2100 without overshoot by employment of a range of technologies and strategies for reducing greenhouse gas emissions**. The details of the scenario are described in Fujino et al. (2006) and Hijioka et al. (2008).

# RCP 6.0

This future is consistent with:

- Heavy reliance on fossil fuels
- Intermediate energy intensity
- Increasing use of croplands and declining use of grasslands
- Stable methane emissions
- $CO_2$ emissions peak in 2060 at 75 per cent above today's levels, then decline to 25 per cent above today

# RCP 8.5

- The RCP 8.5 was developed by the MESSAGE modeling team and the IIASA Integrated Assessment Framework at the International Institute for Applies Systems Analysis (IIASA), Austria. The RCP 8.5 is characterized **by increasing greenhouse gas emissions over time representative for scenarios in the literature leading to high greenhouse gas concentration levels.** The underlying scenario drivers and resulting development path are based on the A2r scenario detailed in Riahi et al. (2007).

# RCP 8.5

This future is consistent with:

- Three times today's $CO_2$ emissions by 2100
- Rapid increase in methane emissions
- Increased use of croplands and grassland which is driven by an increase in population
- A world population of 12 billion by 2100
- Lower rate of technology development
- Heavy reliance on fossil fuels
- High energy intensity
- No implementation of climate policies

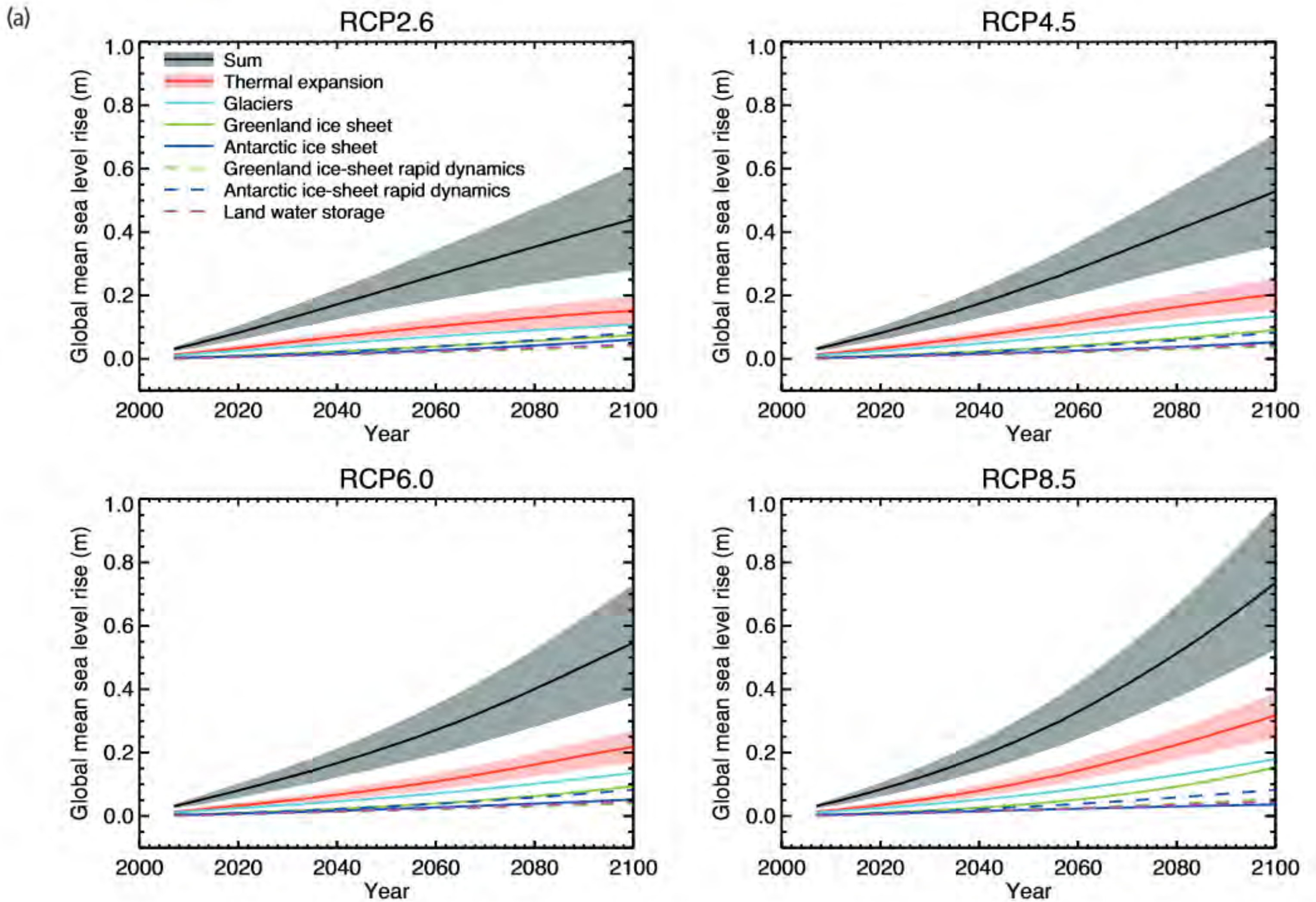
# Process Based Models

- Include breakdown of components of SLR (Table 13.5 p. 1182):
  - Thermal expansion
  - Glaciers (excluding glaciers on Antarctica but including glaciers peripheral to the Greenland ice sheet
  - Greenland ice sheet Surface Mass Balance (including height SMB feedback)
  - Antarctic ice sheet SMB (including interaction between SMB change and outflow)
  - Greenland ice sheet rapid dynamics
  - Antarctic ice sheet rapid dynamics
  - Land water storage

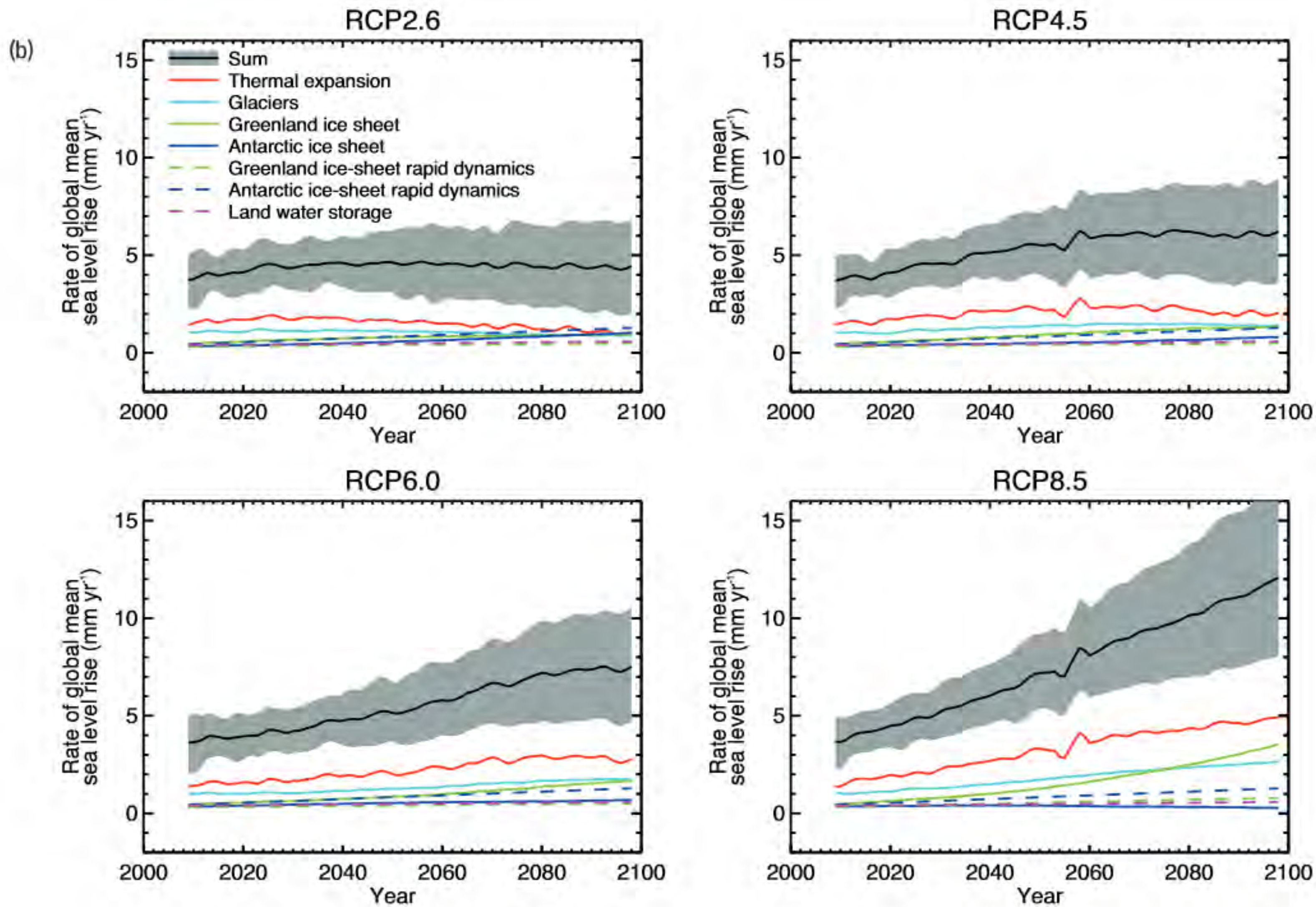
# Process Based Model Results Summary Table: 13.5 p. 1182

| | SRES A1B | RCP2.6 | RCP4.5 | RCP6.0 | RCP8.5 |
|---|---|---|---|---|---|
| Thermal expansion | 0.21 [0.16 to 0.26] | 0.14 [0.10 to 0.18] | 0.19 [0.14 to 0.23] | 0.19 [0.15 to 0.24] | 0.27 [0.21 to 0.33] |
| Glaciers[a] | 0.14 [0.08 to 0.21] | 0.10 [0.04 to 0.16] | 0.12 [0.06 to 0.19] | 0.12 [0.06 to 0.19] | 0.16 [0.09 to 0.23] |
| Greenland ice-sheet SMB[b] | 0.05 [0.02 to 0.12] | 0.03 [0.01 to 0.07] | 0.04 [0.01 to 0.09] | 0.04 [0.01 to 0.09] | 0.07 [0.03 to 0.16] |
| Antarctic ice-sheet SMB[c] | –0.03 [–0.06 to –0.01] | –0.02 [–0.04 to –0.00] | –0.02 [–0.05 to –0.01] | –0.02 [–0.05 to –0.01] | –0.04 [–0.07 to –0.01] |
| Greenland ice-sheet rapid dynamics | 0.04 [0.01 to 0.06] | 0.04 [0.01 to 0.06] | 0.04 [0.01 to 0.06] | 0.04 [0.01 to 0.06] | 0.05 [0.02 to 0.07] |
| Antarctic ice-sheet rapid dynamics | 0.07 [–0.01 to 0.16] | 0.07 [–0.01 to 0.16] | 0.07 [–0.01 to 0.16] | 0.07 [–0.01 to 0.16] | 0.07 [–0.01 to 0.16] |
| Land water storage | 0.04 [–0.01 to 0.09] | 0.04 [–0.01 to 0.09] | 0.04 [–0.01 to 0.09] | 0.04 [–0.01 to 0.09] | 0.04 [–0.01 to 0.09] |
| Global mean sea level rise in 2081–2100 | 0.52 [0.37 to 0.69] | 0.40 [0.26 to 0.55] | 0.47 [0.32 to 0.63] | 0.48 [0.33 to 0.63] | 0.63 [0.45 to 0.82] |
| Greenland ice sheet | 0.09 [0.05 to 0.15] | 0.06 [0.04 to 0.10] | 0.08 [0.04 to 0.13] | 0.08 [0.04 to 0.13] | 0.12 [0.07 to 0.21] |
| Antarctic ice sheet | 0.04 [–0.05 to 0.13] | 0.05 [–0.03 to 0.14] | 0.05 [–0.04 to 0.13] | 0.05 [–0.04 to 0.13] | 0.04 [–0.06 to 0.12] |
| Ice-sheet rapid dynamics | 0.10 [0.03 to 0.19] | 0.10 [0.03 to 0.19] | 0.10 [0.03 to 0.19] | 0.10 [0.03 to 0.19] | 0.12 [0.03 to 0.20] |
| Rate of global mean sea level rise | 8.1 [5.1 to 11.4] | 4.4 [2.0 to 6.8] | 6.1 [3.5 to 8.8] | 7.4 [4.7 to 10.3] | 11.2 [7.5 to 15.7] |
| Global mean sea level rise in 2046–2065 | 0.27 [0.19 to 0.34] | 0.24 [0.17 to 0.32] | 0.26 [0.19 to 0.33] | 0.25 [0.18 to 0.32] | 0.30 [0.22 to 0.38] |
| Global mean sea level rise in 2100 | 0.60 [0.42 to 0.80] | 0.44 [0.28 to 0.61] | 0.53 [0.36 to 0.71] | 0.55 [0.38 to 0.73] | 0.74 [0.52 to 0.98] |
| Only the collapse of the marine-based sectors of the Antarctic ice sheet, if initiated, could cause GMSL to rise substantially above the *likely* range during the 21st century. This potential additional contribution cannot be precisely quantified but there is *medium confidence* that it would not exceed several tenths of a meter of sea level rise. | | | | | |

# Process Based Model Results: Figure 13.11 p. 1181 (a) SLR



# Process Based Model Results: Figure 13.11 p. 1181 (b) SLR rate



# The data used to create these plots are available for use

- The time series for GMSL rise plotted in (a) are tabulated in Annex II (Table AII.7.7), and the time series of GMSL rise and all of its contributions are available in the Supplementary Material. The rates in (b) are calculated as linear trends in overlapping 5-year periods. (caption of Figure 13.11)

**Table AII.7.7 |** Global mean sea level rise (m) with respect to 1986–2005 at 1 January on the years indicated. Values shown as median and *likely* range; see Section 13.5.1.

| Year | SRES A1B | RCP2.6 | RCP4.5 | RCP6.0 | RCP8.5 |
|---|---|---|---|---|---|
| 2007 | 0.03 [0.02 to 0.04] | 0.03 [0.02 to 0.04] | 0.03 [0.02 to 0.04] | 0.03 [0.02 to 0.04] | 0.03 [0.02 to 0.04] |
| 2010 | 0.04 [0.03 to 0.05] | 0.04 [0.03 to 0.05] | 0.04 [0.03 to 0.05] | 0.04 [0.03 to 0.05] | 0.04 [0.03 to 0.05] |
| 2020 | 0.08 [0.06 to 0.10] | 0.08 [0.06 to 0.10] | 0.08 [0.06 to 0.10] | 0.08 [0.06 to 0.10] | 0.08 [0.06 to 0.11] |
| 2030 | 0.12 [0.09 to 0.16] | 0.13 [0.09 to 0.16] | 0.13 [0.09 to 0.16] | 0.12 [0.09 to 0.16] | 0.13 [0.10 to 0.17] |
| 2040 | 0.17 [0.13 to 0.22] | 0.17 [0.13 to 0.22] | 0.17 [0.13 to 0.22] | 0.17 [0.12 to 0.21] | 0.19 [0.14 to 0.24] |
| 2050 | 0.23 [0.17 to 0.30] | 0.22 [0.16 to 0.28] | 0.23 [0.17 to 0.29] | 0.22 [0.16 to 0.28] | 0.25 [0.19 to 0.32] |
| 2060 | 0.30 [0.21 to 0.38] | 0.26 [0.18 to 0.35] | 0.28 [0.21 to 0.37] | 0.27 [0.19 to 0.35] | 0.33 [0.24 to 0.42] |
| 2070 | 0.37 [0.26 to 0.48] | 0.31 [0.21 to 0.41] | 0.35 [0.25 to 0.45] | 0.33 [0.24 to 0.43] | 0.42 [0.31 to 0.54] |
| 2080 | 0.44 [0.31 to 0.58] | 0.35 [0.24 to 0.48] | 0.41 [0.28 to 0.54] | 0.40 [0.28 to 0.53] | 0.51 [0.37 to 0.67] |
| 2090 | 0.52 [0.36 to 0.69] | 0.40 [0.26 to 0.54] | 0.47 [0.32 to 0.62] | 0.47 [0.33 to 0.63] | 0.62 [0.45 to 0.81] |
| 2100 | 0.60 [0.42 to 0.80] | 0.44 [0.28 to 0.61] | 0.53 [0.36 to 0.71] | 0.55 [0.38 to 0.73] | 0.74 [0.53 to 0.98] |

# Semi-Empirical Models

- Discussion of semi-empirical models takes place in Section 13.5.2. (p. 1182-1183).
- The semi-empirical approach regards a change in sea level as an integrated response of the entire climate system, reflecting changes in the dynamics and thermodynamics of the atmosphere, ocean and cryosphere; it does not explicitly attribute sea level rise to its individual physical components. SEMs use simple physically motivated relationships, with various analytical formulations and parameters determined from observational time series, to predict GMSL.
- Results for various semi-empirical models for scenario RCP4.5 are presented in Table 13.6 p 1184 and compared to process based projections.

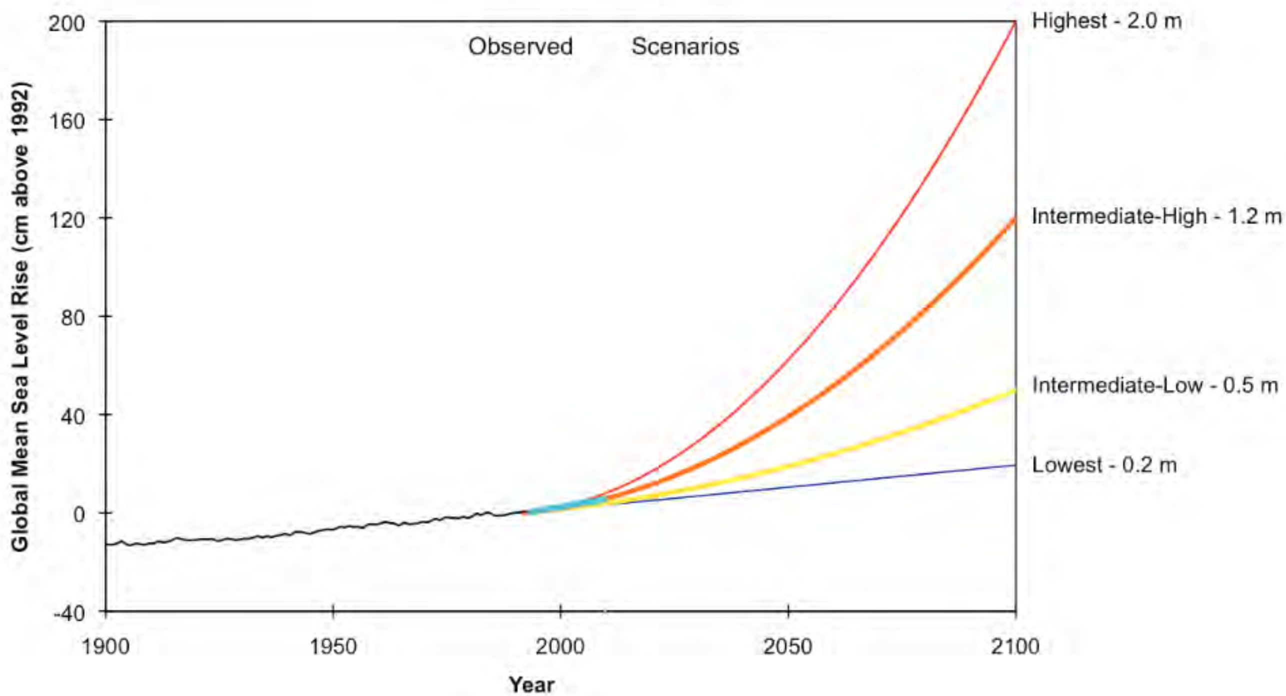
# Semi-Empirical Model Result Comparison Table 13.6 p. 1184

| | From | To | 5% | 50% | 95% |
|---|---|---|---|---|---|
| **Scenario RCP4.5** | | | | | |
| IPCC AR5 (also in Table 13.5) | 1986–2005 | 2081–2100 | 0.32 | 0.47 | 0.63 |
| Grinsted et al. (2010) calibrated with Moberg et al. (2005) temperature | 1986–2005 | 2081–2100 | 0.63 | 0.88 | 1.14 |
| Rahmstorf et al. (2012b) calibrated with Church and White (2006) GMSL | 1986–2005 | 2081–2100 | 0.79 | 0.86 | 0.93 |
| Rahmstorf et al. (2012b) calibrated with Church and White (2011) GMSL | 1986–2005 | 2081–2100 | 0.57 | 0.63 | 0.68 |
| Rahmstorf et al. (2012b) calibrated with Jevrejeva et al. (2008) GMSL | 1986–2005 | 2081–2100 | 0.82 | 0.97 | 1.12 |
| Rahmstorf et al. (2012b) calibrated with proxy data | 1986–2005 | 2081–2100 | 0.56 | 0.88 | 1.24 |
| Jevrejeva et al. (2012a) calibrated with Goosse et al. (2005) radiative forcing | 1986–2005 | 2081–2100 | 0.43 | 0.56 | 0.69 |
| Jevrejeva et al. (2012a) calibrated with Crow-ley et al. (2003) radiative forcing | 1986–2005 | 2081–2100 | 0.48 | 0.65 | 0.80 |
| Jevrejeva et al. (2012a) calibrated with Tett et al. (2007) radiative forcing | 1986–2005 | 2081–2100 | 0.65 | 0.85 | 1.05 |
| Schaeffer et al. (2012) | 1986–2005 | 2081–2100 | 0.58 | 0.80 | 1.05 |

# Some Alternative Sources of Sea

- NOAA (2012): Global Sea Level Rise Scenarios for the United States National Climate Assessment - http://cpo.noaa.gov/sites/cpo/Reports/2012/NOAA_SLR_r3.pdf

We have very high confidence (>9 in 10 chance) that global mean sea level will rise at least 0.2 meters (8 inches) and no more than 2.0 meters (6.6 feet) by 2100.



# NOAA (2012) Guidance on How to Develop Regional/Local Sea Level Scenarios

***Table 3.*** Template for developing regional or local sea level scenarios

| Contributing Variables | Scenarios of Sea Level Change | | | |
|---|---|---|---|---|
| | **Lowest Scenario** | **Intermediate-Low Scenario** | **Intermediate-High Scenario** | **Highest Scenario** |
| Global mean sea level rise* (m) | 0.2 | 0.5 | 1.2 | 2.0 |
| Vertical Land Movement (subsidence or uplift)** | | | | |
| Ocean Basin Trend*** (from tide gauges and satellites) | | | | |
| Total Relative Sea Level Change | | | | |
| Extreme Water Level (from existing flood models or long-term tide gauges) | | | | |

* Equations from Section 4.3 can be used to calculate scenarios of sea level change over desired period and to populate the global mean SLR term in the first row.

** This row can be populated using, in part, the information found in Sections 5.1.

*** This row can be populated using, in part, the information found in Sections 3.1, 3.2, 3.3 and 5.3.

# Some Alternative Sources of Sea Level Rise Estimates

- USACE Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation http://www.publications.usace.army.mil/Portals/76/Publications/EngineerTechnicalLetters/ETL_1100-2-1.pdf
- USACE Curve Calculator https://corpsclimate.us/ccaceslcurves.cfm
- The USACE calculator computes NOAA (2012) curves as well as NRC Scenarios described in NRC (1987) and modified to account for different existing rates of SLR and adjusted tidal epochs. (exact equations given in http://www.publications.usace.army.mil/Portals/76/Publications/EngineerRegulations/ER_1100-2-8162.pdf)

# USACE Curve Calculator – Ex.

This on-line Sea Level Change Calculator produces the amount of predicted sea level change from 1992 forward.

| | |
|---|---|
| USACE SLC Coeffcients: | 0.0000000 0.0000271 0.0001130 |
| Base Year (Mid Point of NTDE): | 1992 |
| Enter Project Start Year: | 2015 |
| Rate of Eustatic Sea Level Rise per year in mm: | 1.7 |
| Rate of Subsidence per year in mm: | 0.430 |
| Select the closest NOAA gauge station to the right: | NC, Wilmington: 72 yrs |
| Enter FEMA Base Flood Elevation (ft): | 0 (NAVD88) - Datum Shift to MSL (ft): -0.03 |
| Enter Project End Year: | 2045 |
| Enter Interval: | 5 |
| Include NOAA Curves: NOAA Technical Report OAR CPO-1 | ☑ |
| Output Units: | ○ Feet ◉ Meters |
| Chart Size: | Height: 500 Width: 800 |
| Compute Curves Based on: | ◉ EC 1165-2-212 ○ EC 1165-2-211 (superseded) |

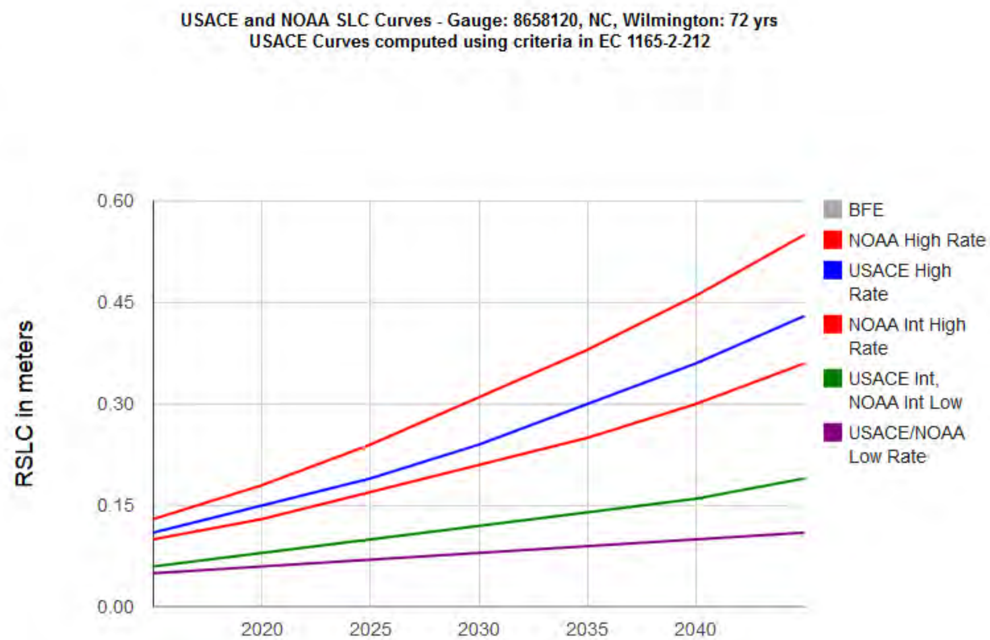
Calculate Curves | Reset Fields

**USACE Curves computed using criteria in USACE EC 1165-2-212**

**NOAA Curves computed using criteria in NOAA SLR Report 06-Dec-2012**

Gauge: 8658120, NC, Wilmington: 72 yrs
All values are in meters

| Year | NOAA Low | USACE Low | NOAA Int Low | USACE Int | NOAA Int High | USACE High | NOAA High |
|---|---|---|---|---|---|---|---|
| 2015 | 0.05 | 0.05 | 0.06 | 0.06 | 0.10 | 0.11 | 0.13 |
| 2020 | 0.06 | 0.06 | 0.08 | 0.08 | 0.13 | 0.15 | 0.18 |
| 2025 | 0.07 | 0.07 | 0.10 | 0.10 | 0.17 | 0.19 | 0.24 |
| 2030 | 0.08 | 0.08 | 0.12 | 0.12 | 0.21 | 0.24 | 0.31 |
| 2035 | 0.09 | 0.09 | 0.14 | 0.14 | 0.25 | 0.30 | 0.38 |
| 2040 | 0.10 | 0.10 | 0.16 | 0.16 | 0.30 | 0.36 | 0.46 |
| 2045 | 0.11 | 0.11 | 0.19 | 0.19 | 0.36 | 0.43 | 0.55 |



# Climate Central: NC and the Surging Sea

- Relies on NOAA and collaborating agency predictions for US National Climate Assessment
  - Parris, A., P. Bromirski, V. Burkett, D. Cayan, M. Culver, J. Hall, R. Horton, K. Knuuti, R. Moss, J. Obeysekera, A. Sallenger, and J. Weiss (2012). “Global Sea Level Rise Scenarios for the US National Climate Assessment.” *NOAA Tech Memo OAR CPO-1. 37 pp.*
- For this report and as presented by the Surging Seas Risk Finder, we developed projections at long-term NOAA water level stations at Wilmington and Beaufort, and also at the Chesapeake Bay Bridge Tunnel in Virginia, near the North Carolina border. Our “medium” projections for the North Carolina sites averaged **1.1 feet by 2050** and **3.8 feet by 2100**, and were **1.5 feet** and **4.8 feet** for the Virginia site, where land is subsiding rapidly. The full range of projections, slow to fast, was **0.5-1.8 ft** in North Carolina, and **1.0-2.1 ft** in Virginia, by midcentury; and, respectively, **1.6-6.4 ft**, and **2.7-7.2 ft**, by the end of the century.

# Discussion

- Given a range of global sea level rise estimates, how should the global estimates be adjusted to the North Carolina coast?
- Are existing methods (USACE/NOAA) sufficient and/or recommended?
- What additional data is needed?
  - Subsidence Rates (CORS, historical geologic analyses, etc.)
  - Updated Sea Level Trends at NOAA Stations (e.g., Duck)
  - Regional Delineation