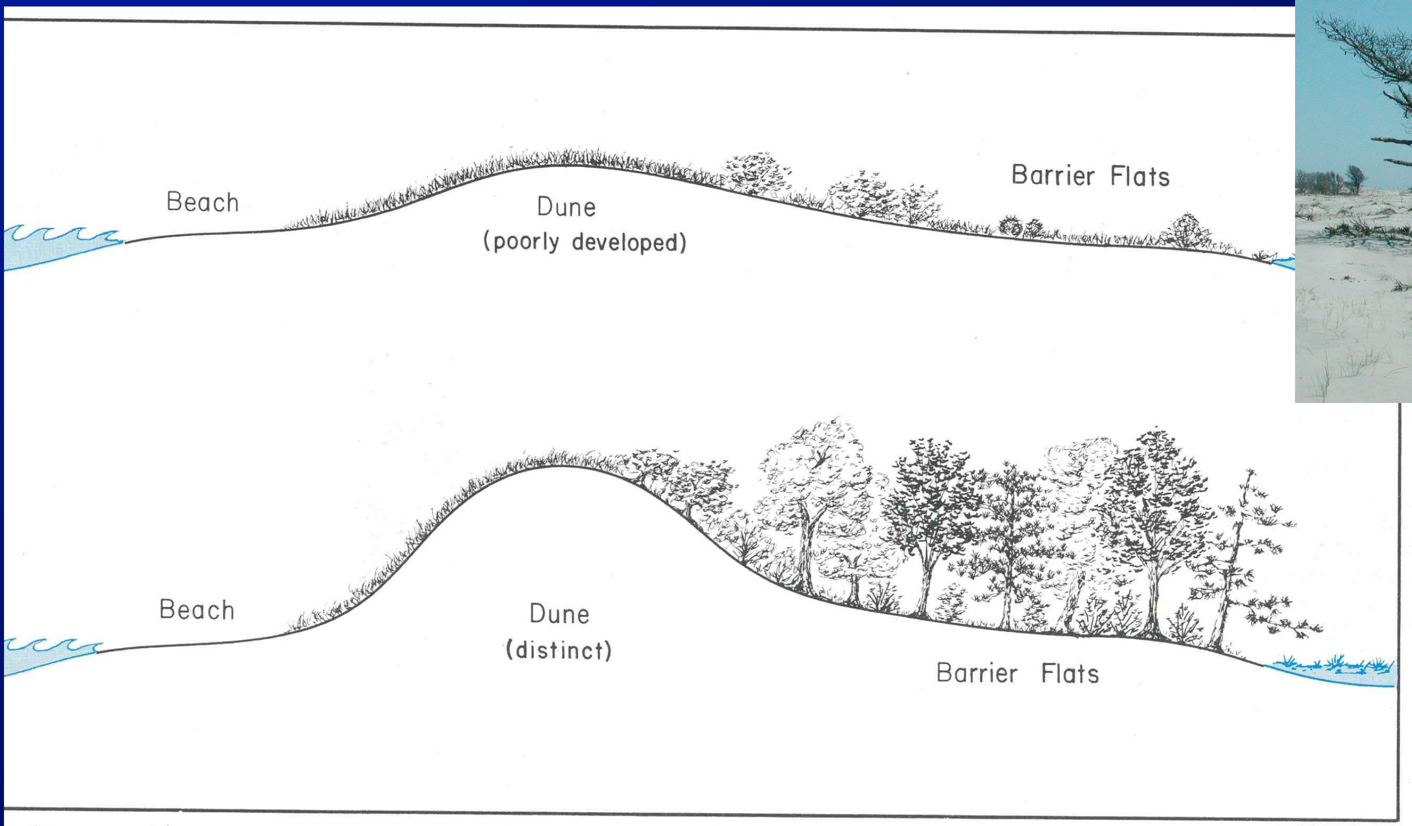
Barrier Island Barrier Flat (leeward edge)

Differences in Barrier Flat Development



Cross-sections across a barrier dune illustrating changes in vegetation due to differences in dune development. The poorly developed dune may be in a stage of early development or may not evolve to maturity due to rapid beach erosion and overwash.

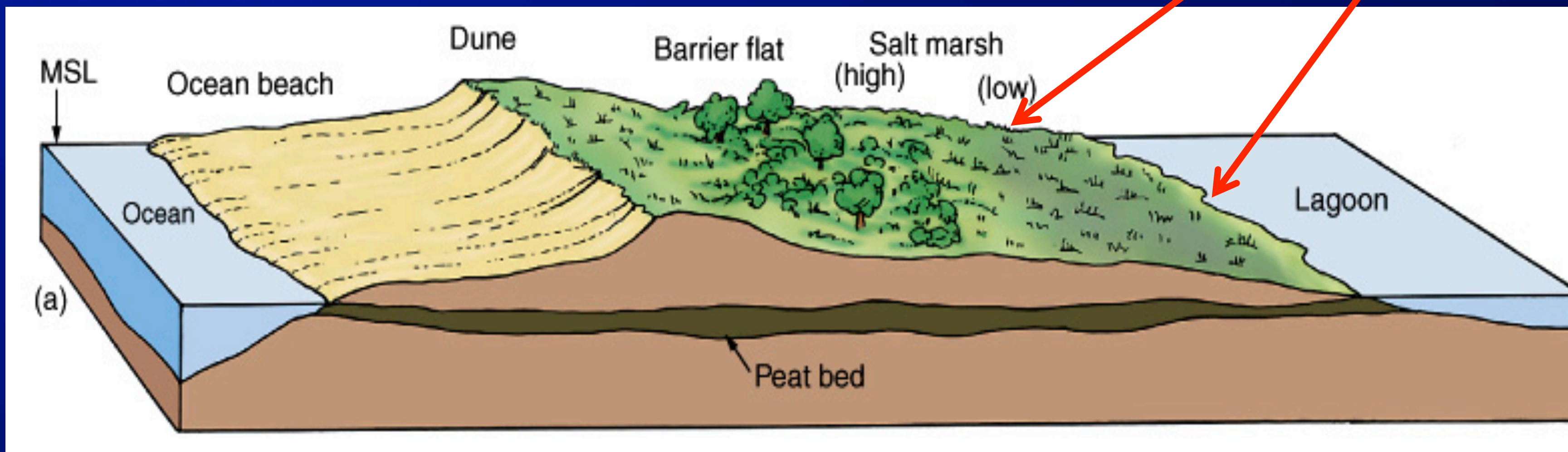
Recall image of forest relics nearly buried by sand

Importance of stable dune in protecting leeward barrier flats (composed of freshwater flora) from overwash & salt spray

Leatherman, 1988

Major barrier island environments

Beach/berm Dunes Barrier flat **Salt marsh/tidal flat**



- Bayward of barrier flat; formed from mix of overwash sand, bay mud, occasional oysters, and organic peat
- *Spartina patens* (higher marsh) grades to *Spartina alterniflora* (lower marsh)
- Generally protected/leeward, dissected by brackish tidal creeks; oyster bars
- Tidal flat is located at extreme bayward edge of marsh; exposed during low tide; photosynthetic algal mats, trapping/binding finer bay sediment

Barrier Island Marsh/Tidal Flat

Spartina patens:
high-marsh cord grass

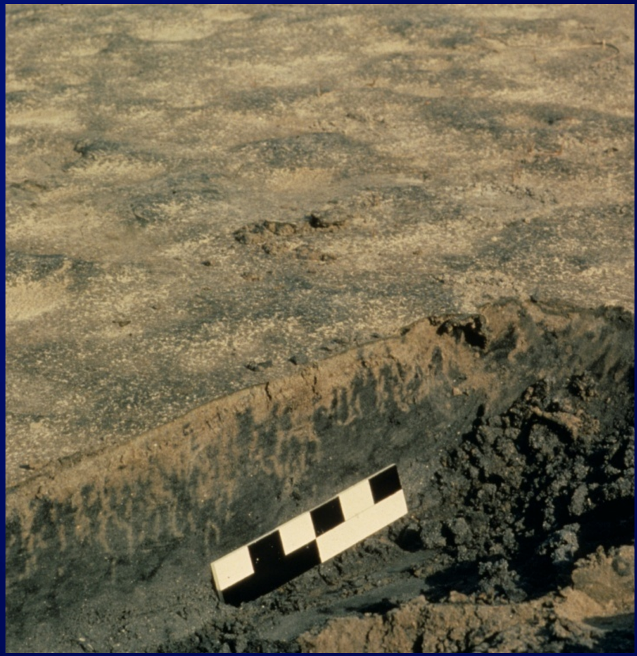
Peat, mud, mussels, *bay oysters*

Barrier Island Marsh/Tidal Flat

Spartina alterniflora meadows

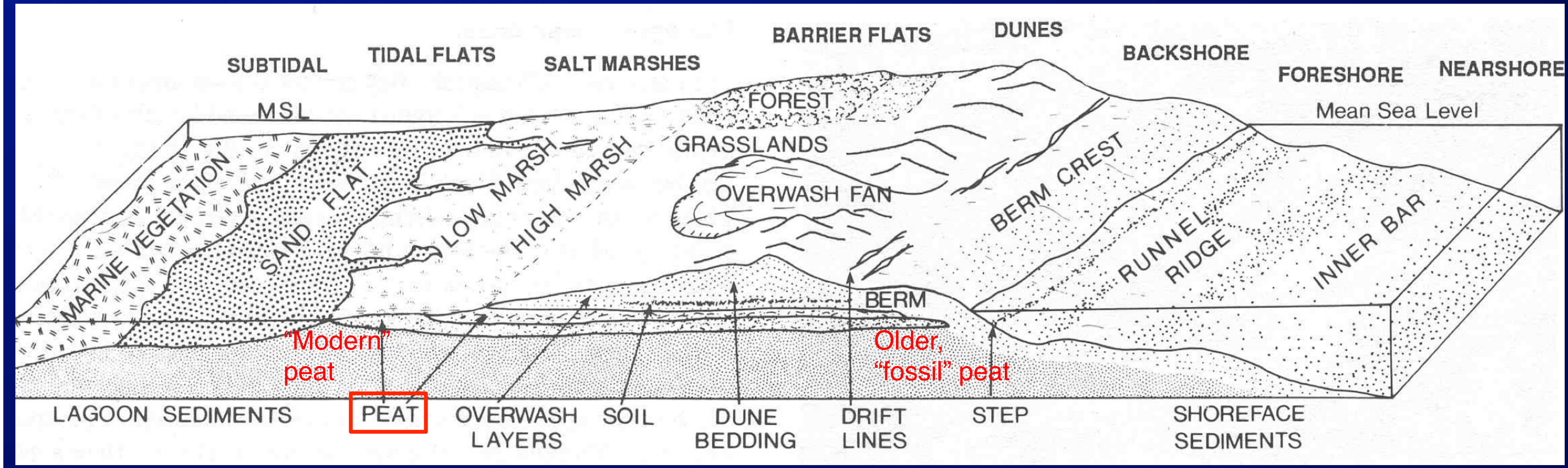
Core-evidence of overwash

Broad tidal flat with algal mats, emergent during low tide; note burrows from oxic surface into anoxic, organic-rich (peaty) sand and mud



The significance of ancient bayside peat (and brackish oysters) showing up on the modern oceanside beach…

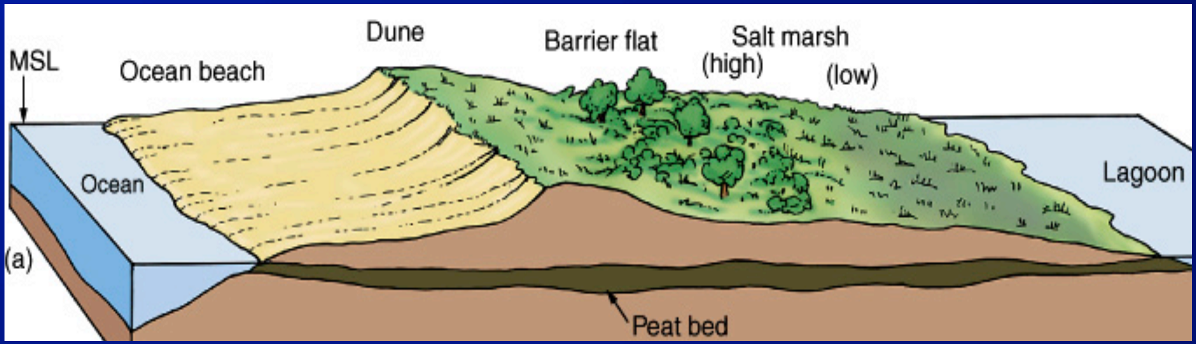
Leeward / Bayside ← Windward / Oceanside



Ward, et al., 1989

… Evidence of island "rollover", or "retrogradation"

And… Assateague is even eroding from the *bayside!*



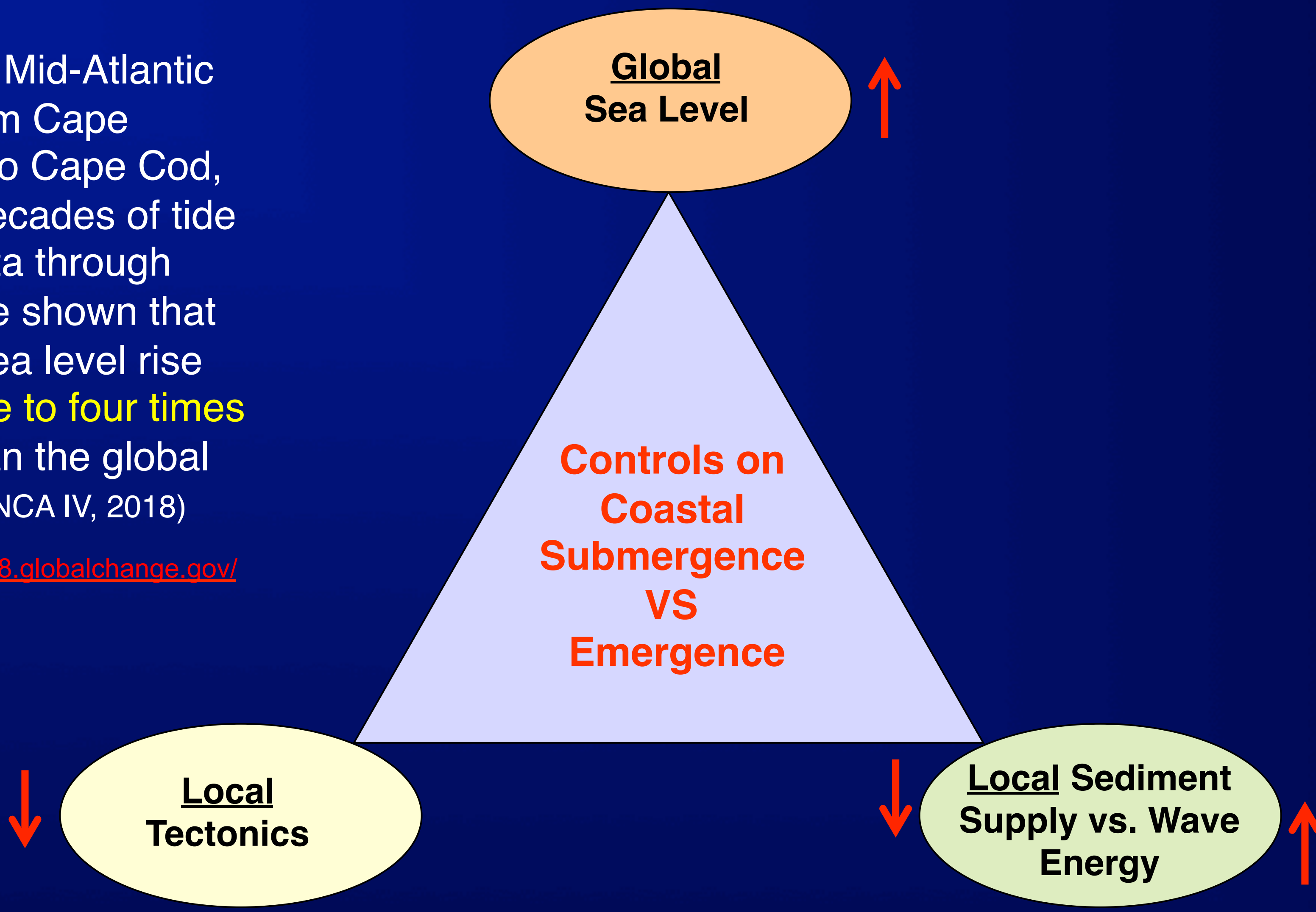
Cyclonic storm winds during prolonged flood conditions can whack the low-standing leeward side of barrier islands (causing bayside breaching – as in 1933) by piling-up deep storm surge and creating taller, more powerful waves

Assateague Island; bayside erosion of freshwater "barrier flat" trees; normal marsh-grass buffer totally gone

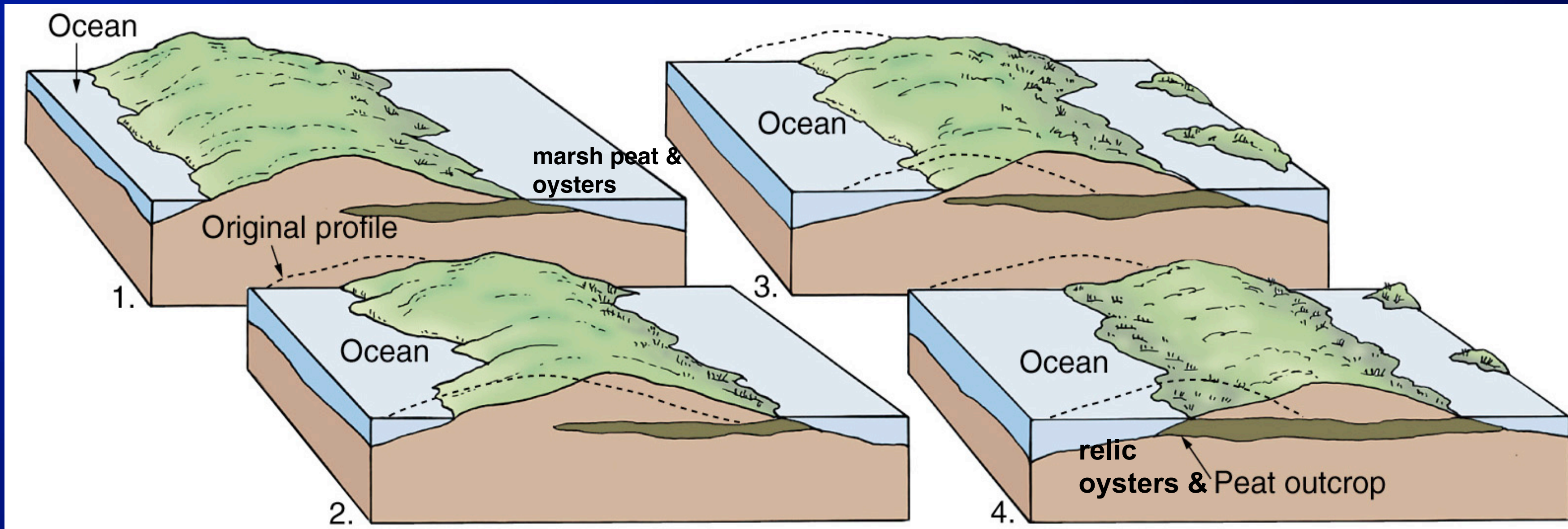
3 Interactive Submergence Factors,
3 Strikes Against Barrier Islands…

Along the Mid-Atlantic coast, from Cape Hatteras to Cape Cod, several decades of tide gauge data through 2009 have shown that rates of sea level rise were three to four times higher than the global average (NCA IV, 2018)

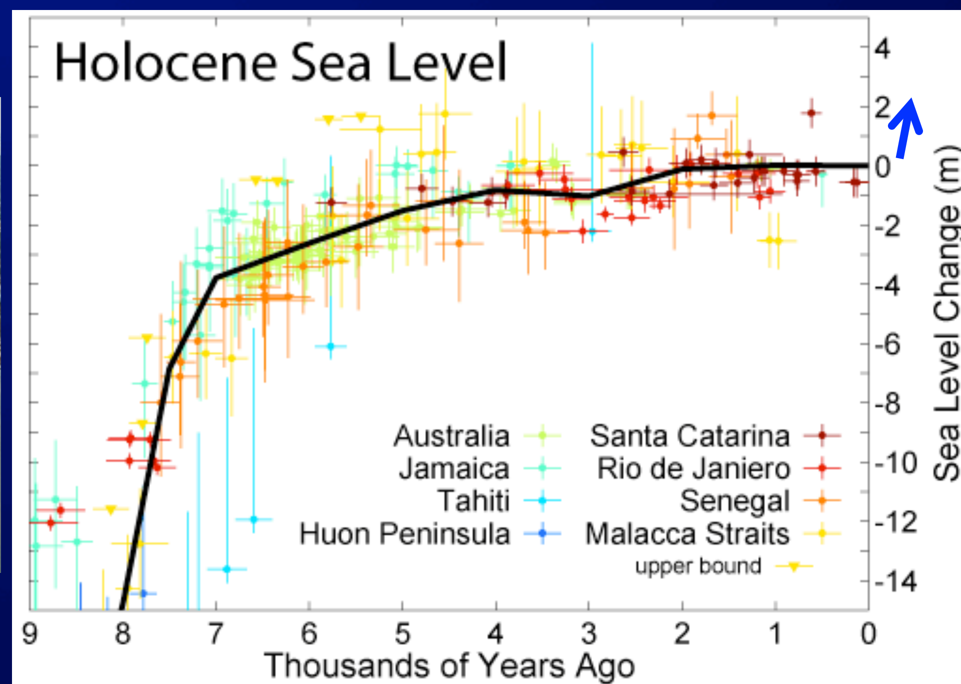
https://nca2018.globalchange.gov/chapter/8/



Barrier Island "Rollover" (Retreat, or Retrogradation)

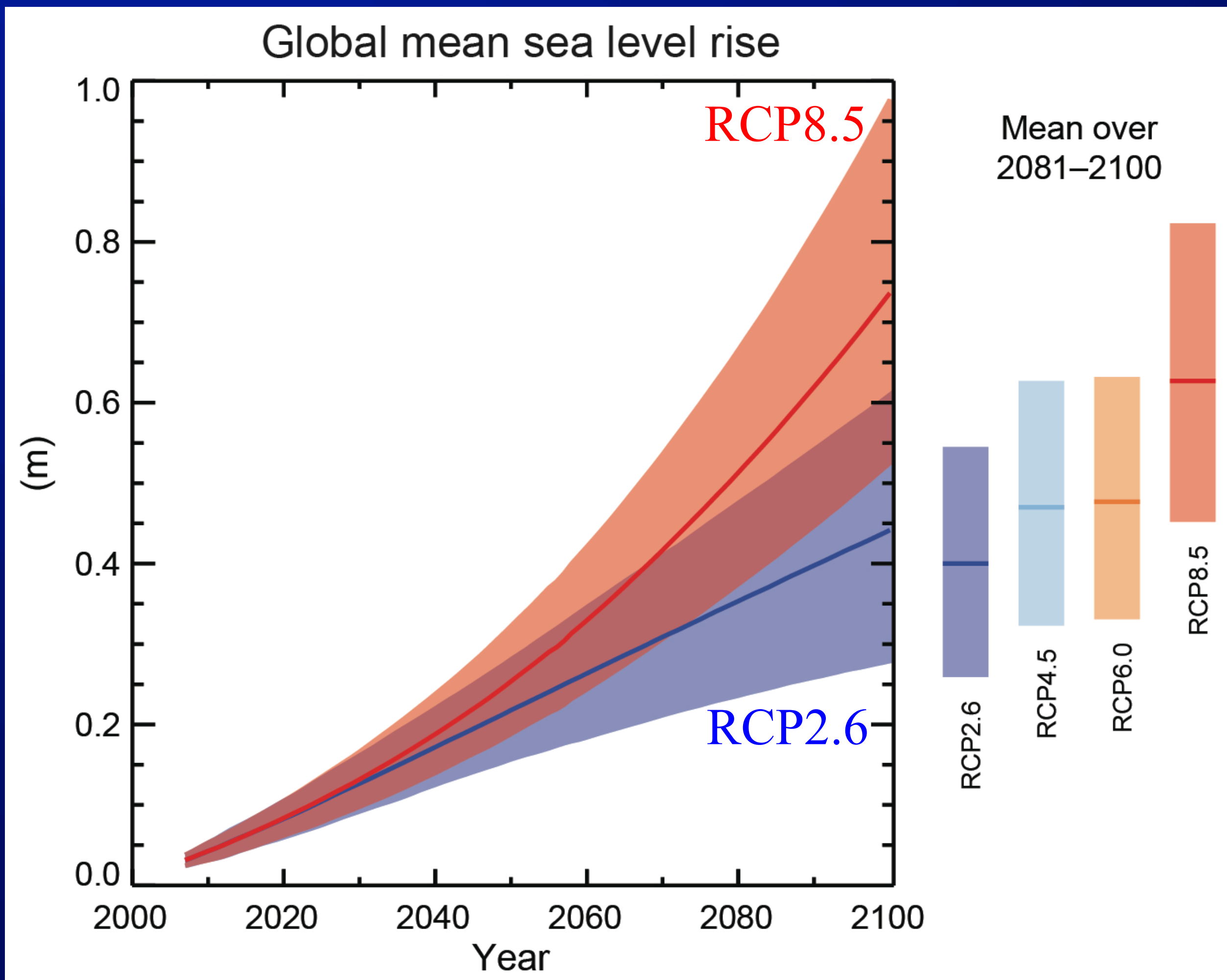


Accelerated *(engineered)* rollover of AI



Future Sea-level Rise: Ocean City

- Present rate of local SL rise ca. 5.7 mm/yr (1975-2018)
- Local subsidence (150-200 mm by 2100 AD) augments global rise
- *Cumulative increase of +4.3 ft. likely by 2100 AD (vs. 1992)*

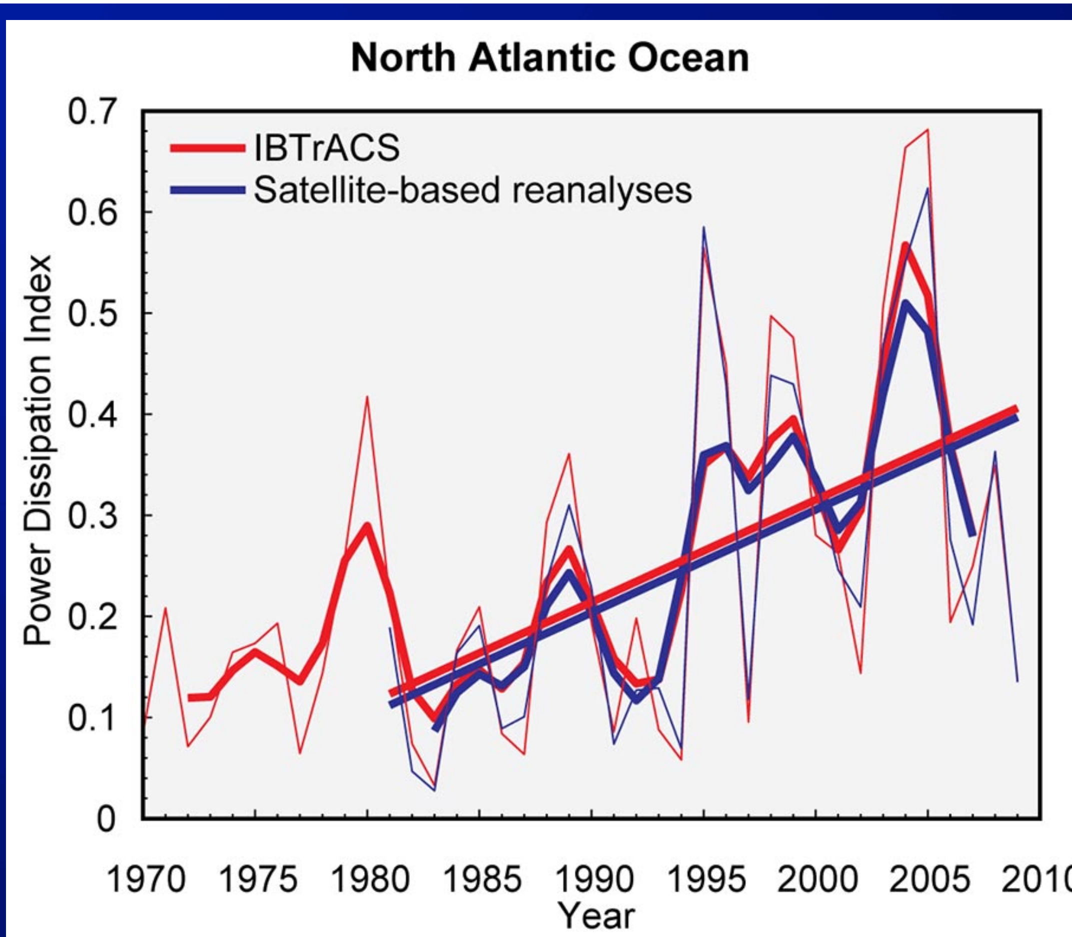


Full range by 2100 AD = 0.26 – 0.98 m above 1986-2005 global mean sea level *(w/o WAIS or EAIS surges)* *IPCC V, 2013*

Local Subsidence!

sinking 15-20 cm by 2100 AD

IPCC likely an *underestimate* given overly optimistic assumptions regarding AA and GL ice melt



2014 and 2018 National Climate Assessments (U.S. Global Change Research Program re. Northeast)

Observed Trends Show <u>Increasing</u> Hurricane Power

There is evidence of increase in both storm frequency and intensity during the cold season since 1950, with storm tracks shifted slightly towards the poles. *By late this century models on average project an increase in the number of strongest (Category 4 and 5) hurricanes.* The strongest hurricanes are anticipated to become both more frequent and more intense, with greater amounts of associated precipitation. Long-term coastal erosion, as driven by sea level rise and storms, is projected to continue, with one study finding the shoreline likely to erode at rates of at least 3.3 feet (1 m) per year among 30% of sandy beaches along the U.S. Atlantic coast.

Recurrence Interval of 1998-scale Wave Heights

Range of wave height (m)	Range of wave height (ft)	Percentage of observations offshore[1]	Percentage of observations nearshore[2]	Recurrence interval (years) for nearshore[3]
0.0–0.4	0.0–1.3	5.2	31	
0.5–1.4	1.5–4.6	69.5	61	1
1.5–2.4	4.9–7.9	20.0	7.1	2
2.5–3.4	8.2–11.2	3.8	0.9	3–7
3.5–4.4 = 1998	11.4–14.4	1.1	< 0.1	10–25
4.5–5.4	14.7–17.7	0.2	≪ 0.1	50 or greater
5.5–6.4	17.9–21.0	0.1		
6.5–7.4	21.2–24.3	0.1		

Annual distribution of wave height, Atlantic coast of Maryland.

1. NOAA data buoy 44009, 30 km (18.5 mi) east of Fenwick Island at the DE–MD state line in 28 m (92 ft) of water, period of record 1984–2005.
2. U.S. Army Corps of Engineers wave gauge MD002, approximately 1 km (0.6 mi) off Ocean City, Maryland, in 9 m (30 ft) of water; period of record 1993–2001.
3. Calculated by U.S. Army Corps of Engineers, refer to *http://sandbar.wes.army.mil*, station MD002.

The *most* extreme storm waves (> 4.5 m) come about once every 50 yrs…
…at least they *have in the past*.

Important question:

Are past storm intensities and frequencies a good model for the future?

Recent trends and models suggest not.

“Shifting Sands” Ch. 12; Krantz, et. al (2009)