Submarine Cables
and the
Ocean Environment

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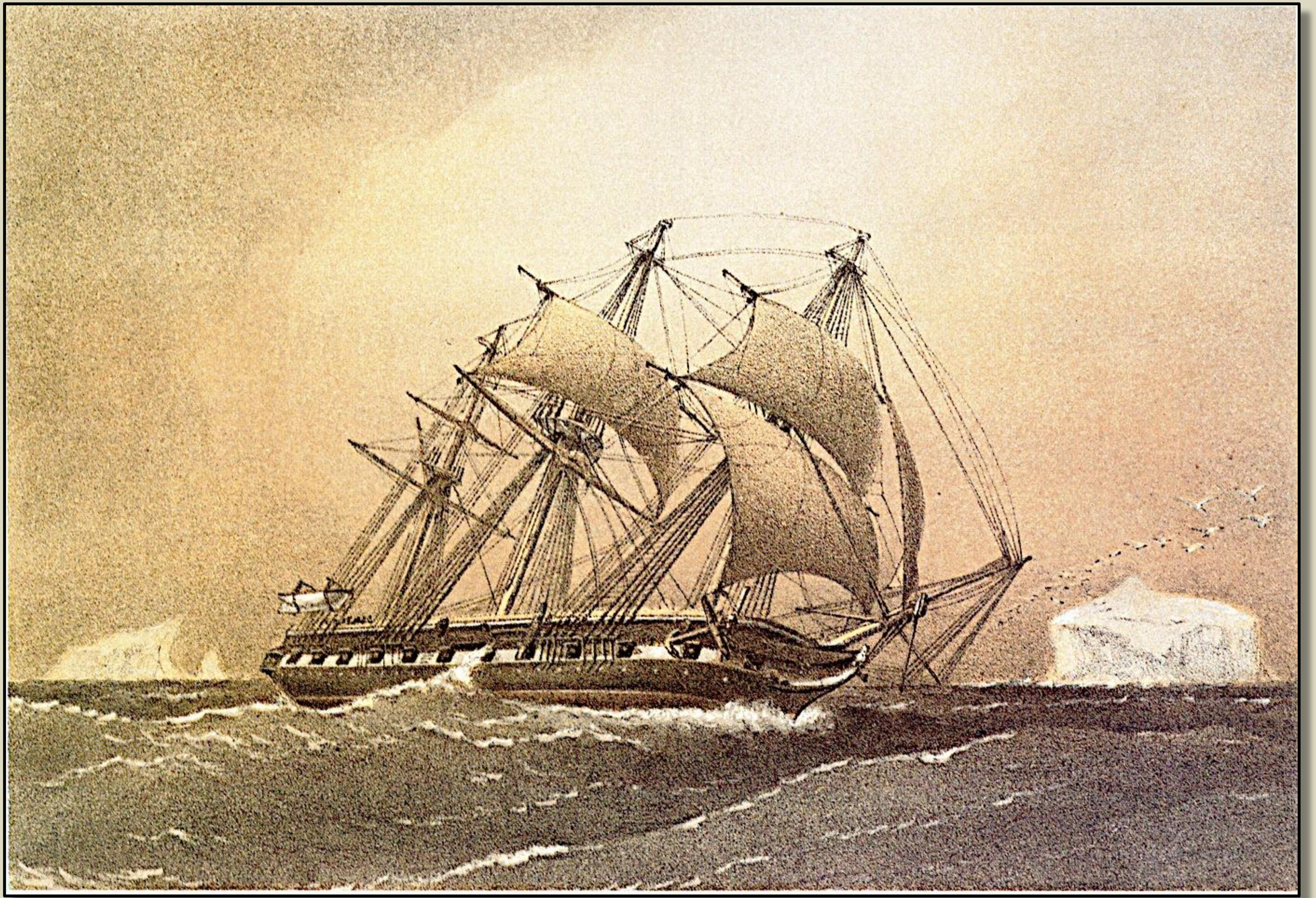
Outline

- Sargasso Sea - general observations
- Natural hazards and cables
    - earthquakes
    - subsea landslides and turbidity currents
    - deep currents
    - ocean/climate change
    - whales
    - sharks
- Synopsis

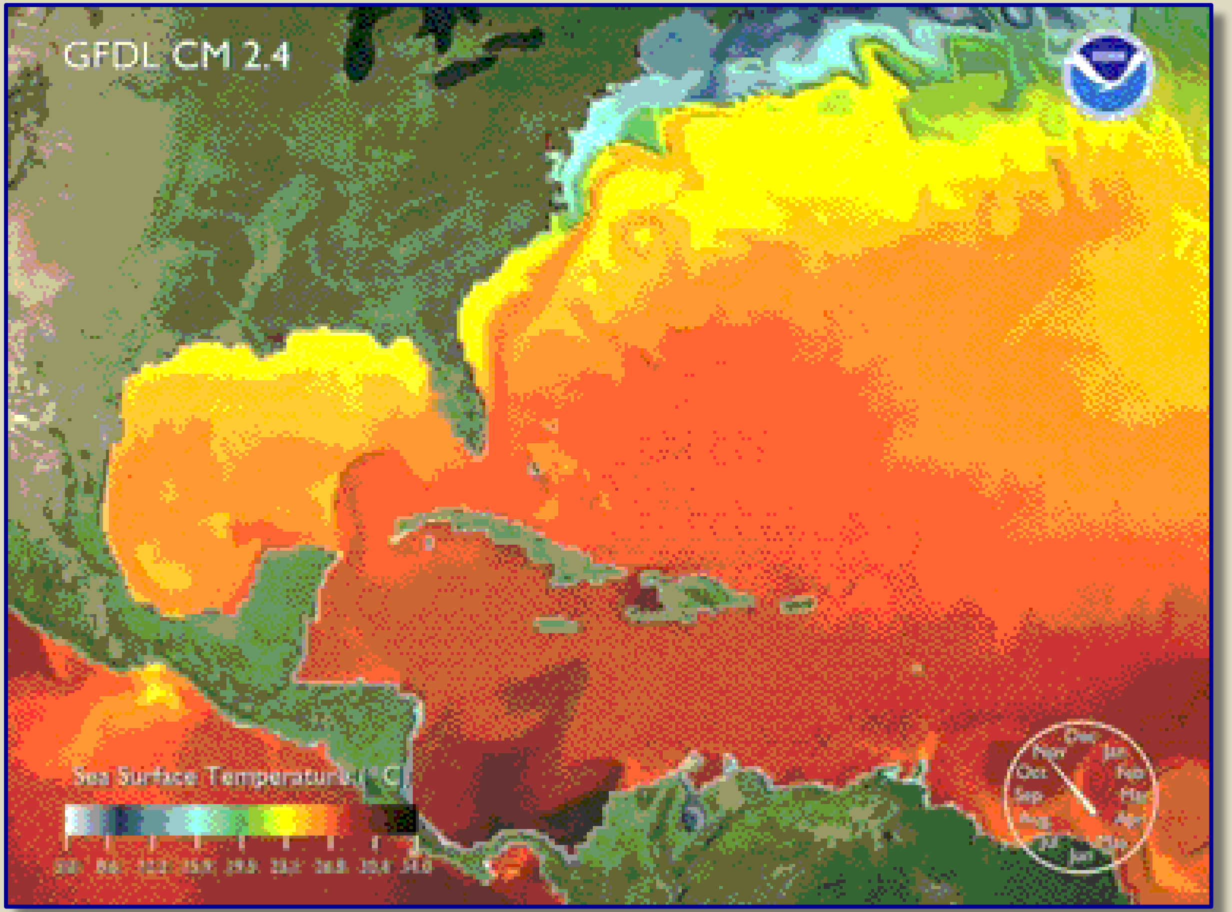
Subsea cables and science



Source: HMS Challenger by W. F. Mitchell.

Source: NASA and C. Hadfield.

Sargasso Sea – surface circulation

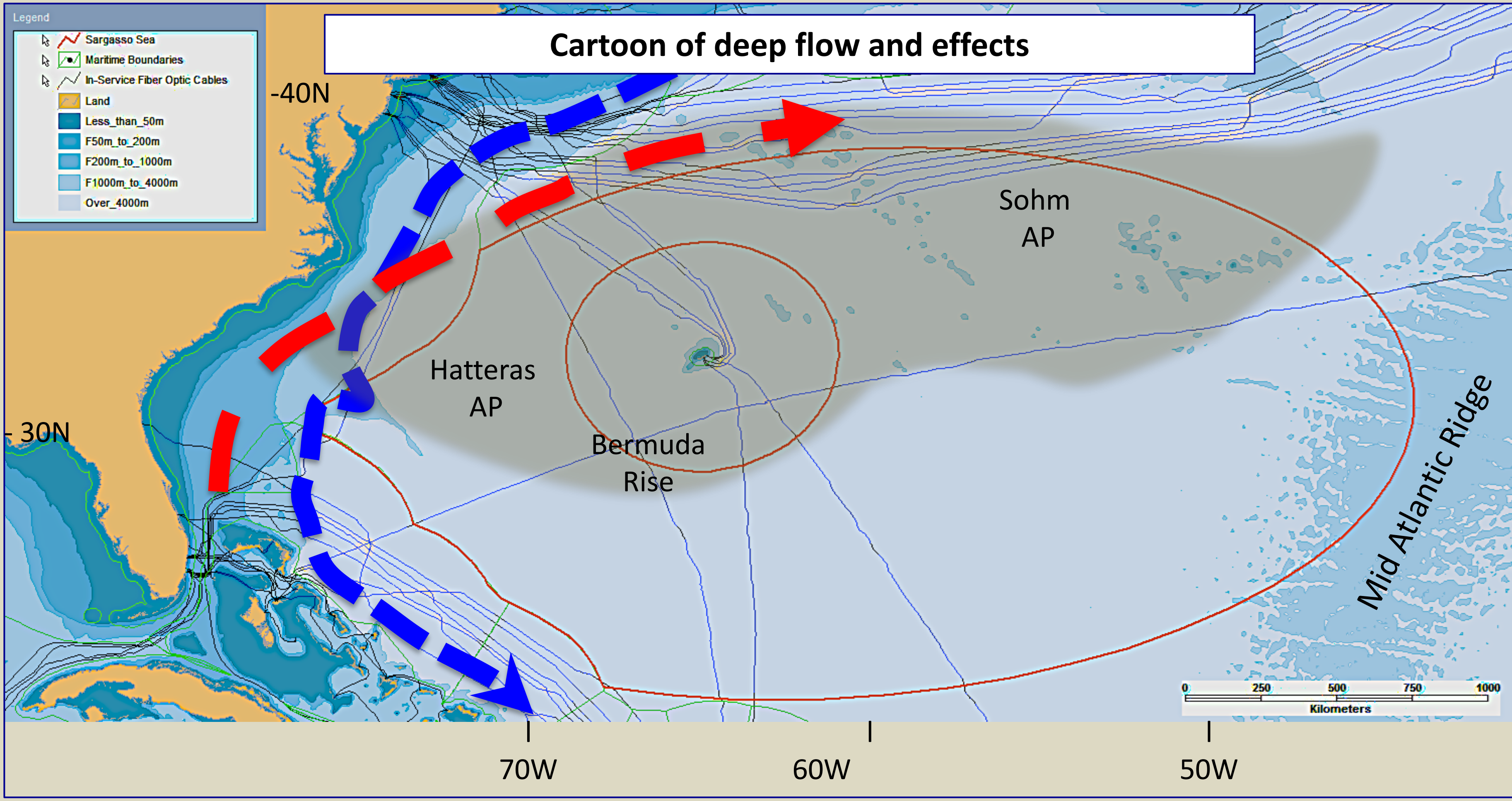


- Gulf Stream is a large (~70 Sv), energetic, eddy-rich flow whose perturbations dominate W to N Sargasso Sea.

- Lesser flows form eastern (Canary Current) and southern (N. Equatorial and Antilles currents) limits of the Sea

Source: GFDL, NOAA.

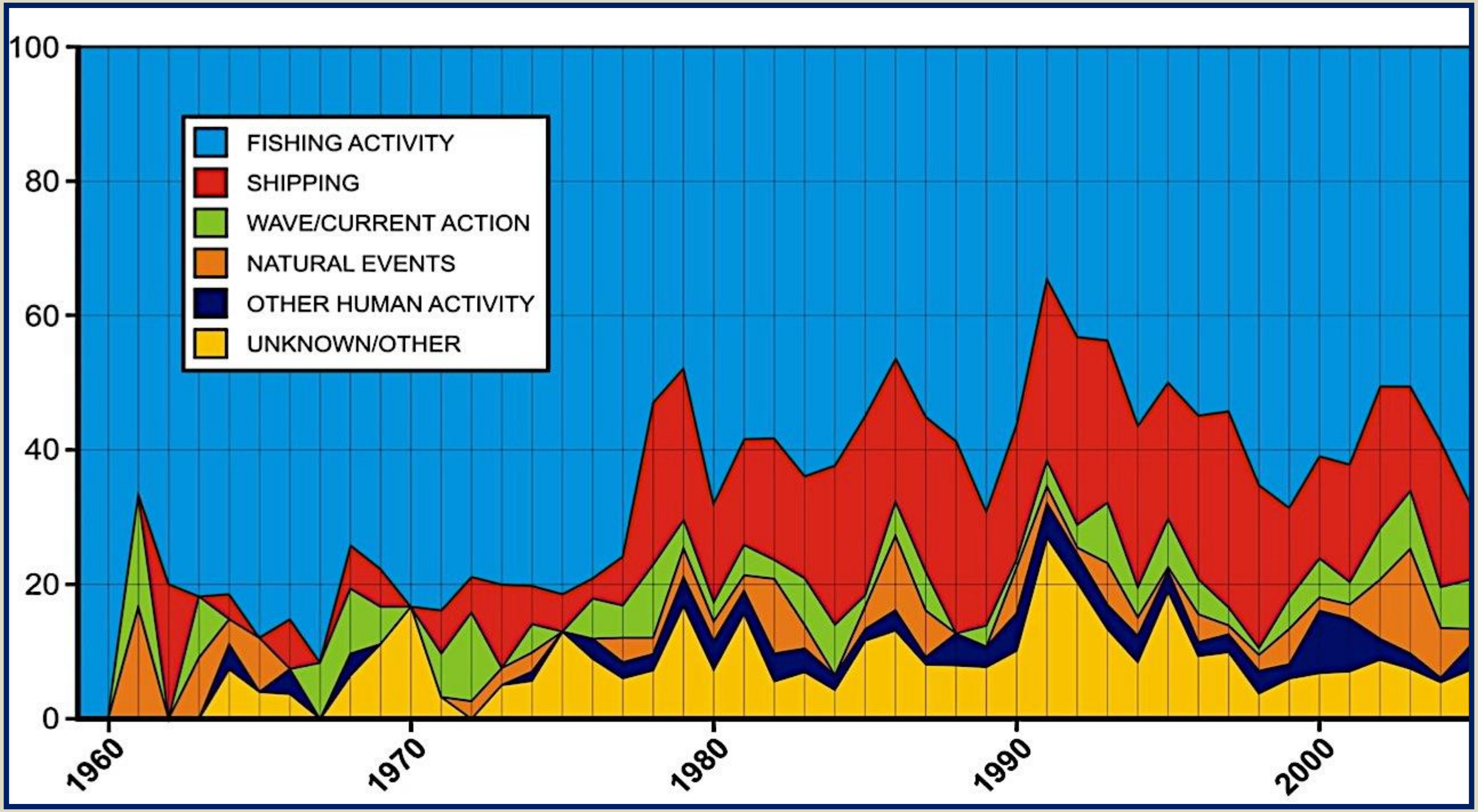
Deep circulation



- Gulf Stream eddies (red) and deep western boundary undercurrent (blue) move sediment. Speeds at 4000m typically 5-10cm/s but rise to >40cm/s in "deep-sea storms"
- Turbulence maintains turbid layer up to 2000m thick (grey).
- Muddy deposits still dominate the Sargasso Sea floor.

Source: McCave Tucholke, 1986; Hall & Bryden 1985;

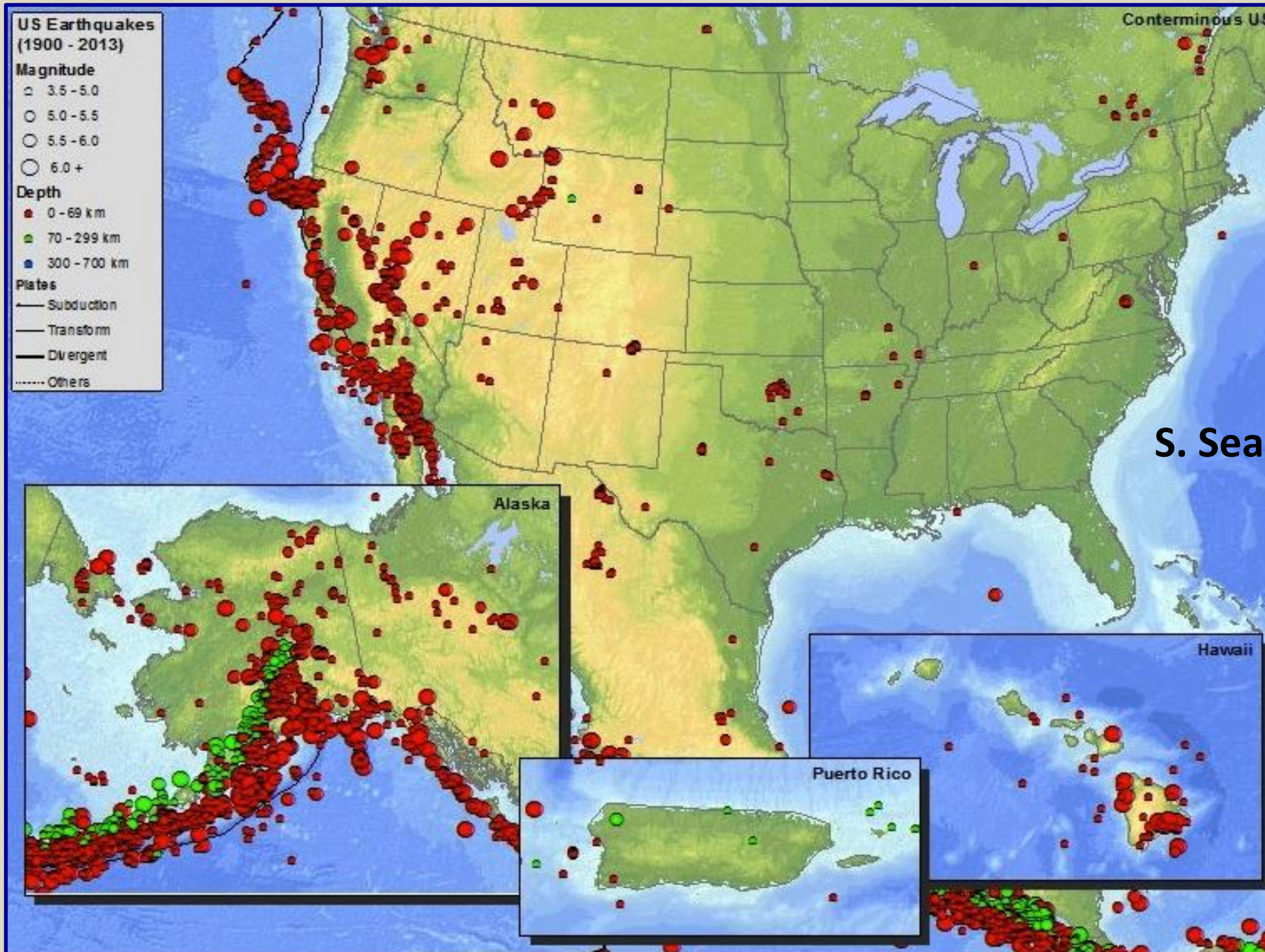
Natural hazards and cables



- **Natural hazards** ▮▮ **cause, on average, <10% of all cable faults world-wide**

Source: Wood & Carter, 2008; Journal Ocean Engineering.

Earthquakes

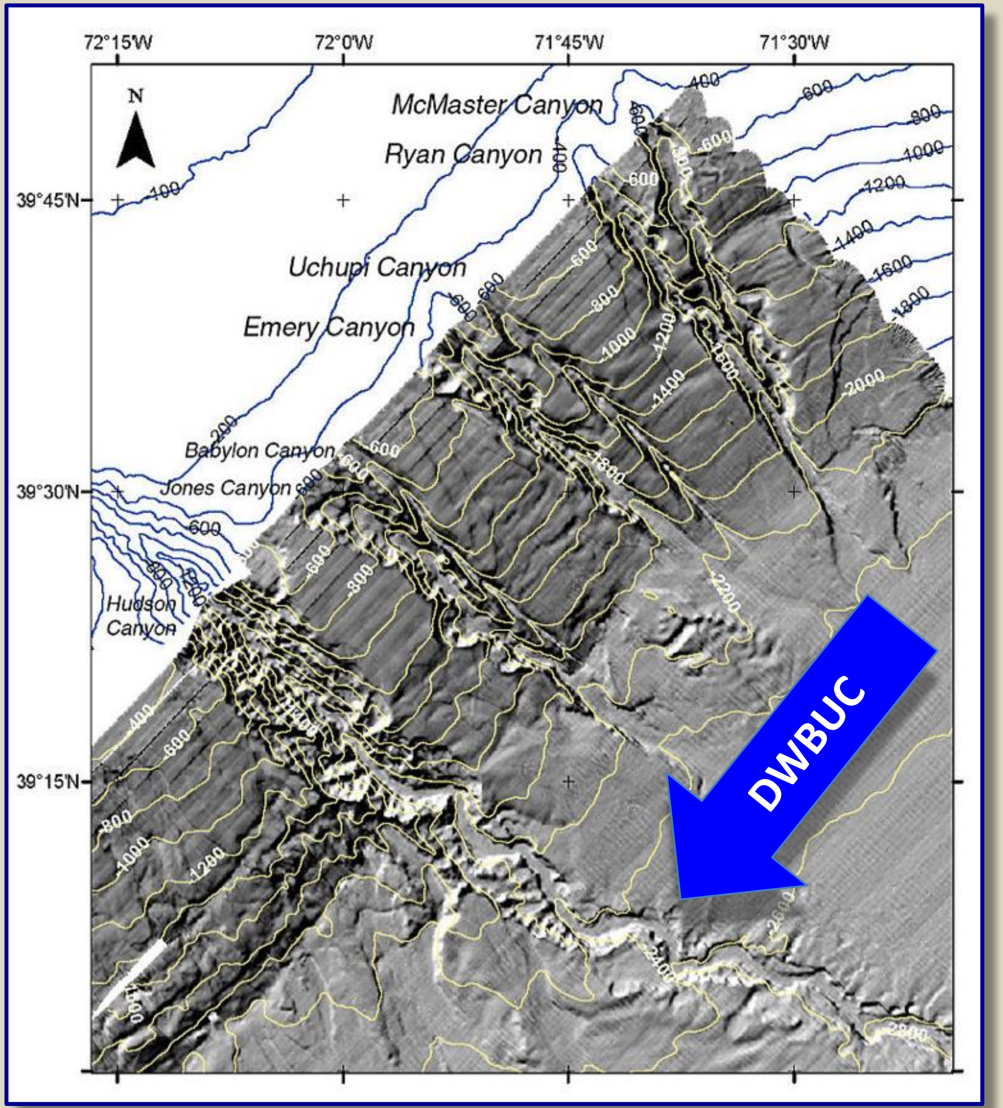


- Natural hazards prevail off active tectonic plate boundaries.
- Includes floods, subsea landslides, turbidity currents, tsunami.
- S. Sea off passive margin, hence seismic risk low but earthquakes do occur.

- **US earthquakes for 1900 – 2013 showing aseismic Sargasso Sea**

Source: US Geological Survey

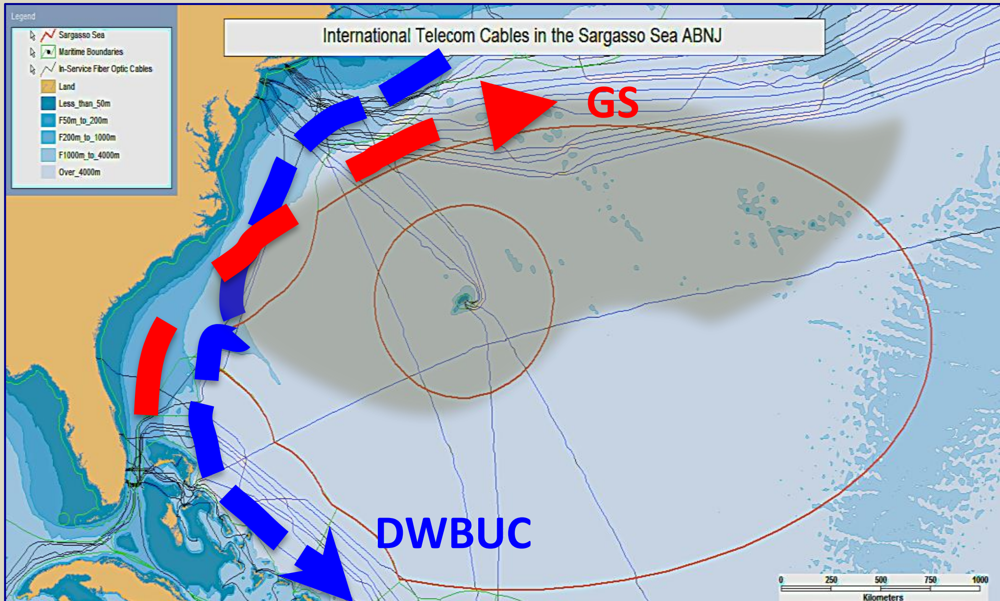
Subsea landslides/turbidity currents

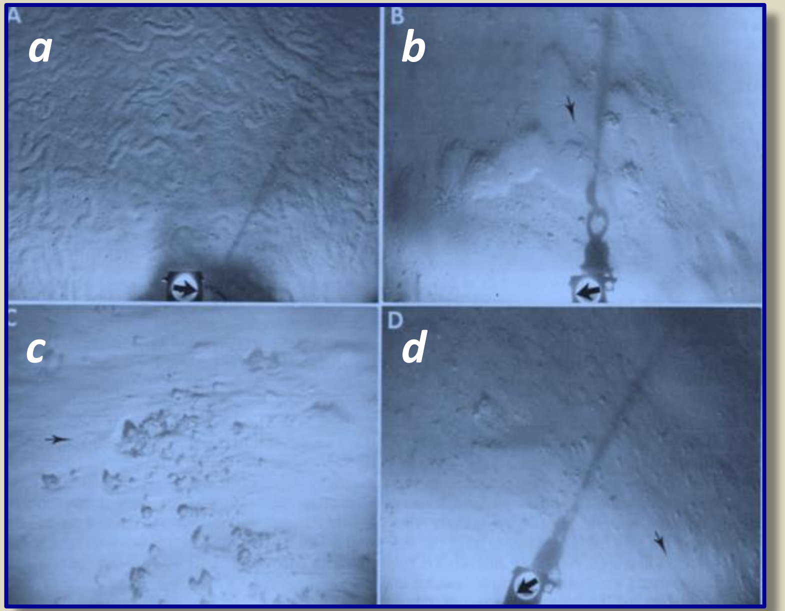


- At high sea level, rivers separated from canyons by continental shelf.
- But large canyons e.g. Wilmington, still guide sediment[1] into deep western boundary undercurrent (DWBUC).
- No <u>modern</u> turbidity current deposits on Hatteras Abyssal Plain[2] and no cable faults caused by such currents, suggest low risk.
- Contrasts when sea level is low resulting in landslide/turbidity current activity.
- But, infrequent events, e.g. 1929 Grand Banks e'quake, occur.

Sources: [1]Sandford et al., 1990; [2]Pratson & Laine 1989.

Deep currents

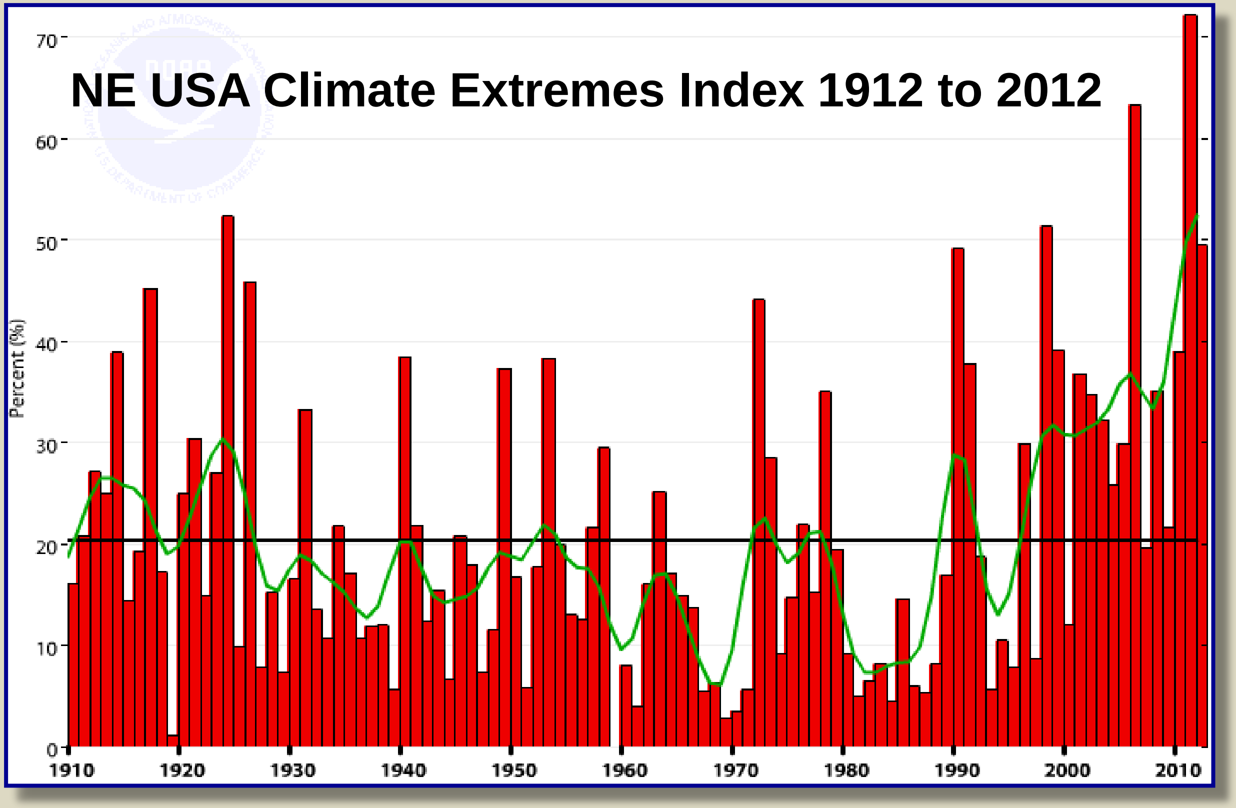




- Gulf Stream eddies plus DWBUC form variable benthic regime with erosion and transport especially near western S. Sea margin (e.g., *c,d*) during deep-sea storms when bottom flow speeds may >40cm/s (0.8knt).
- Despite sediment movement, cable faults are few attesting to their resilience.
- Within Sea, erosion and transport are reduced (e.g., *a*).

Sources; McCave & Tucholke, 1986; Hollister McCave 1984 Nature;

Climate/ocean change



- Gulf Stream warmer and stronger under poleward expansion of subtropical winds – more energetic eddies S. Sea margin?
- Overturning in N. Atlantic and deep-water formation off Antarctica may affect DWBUC – long term change?

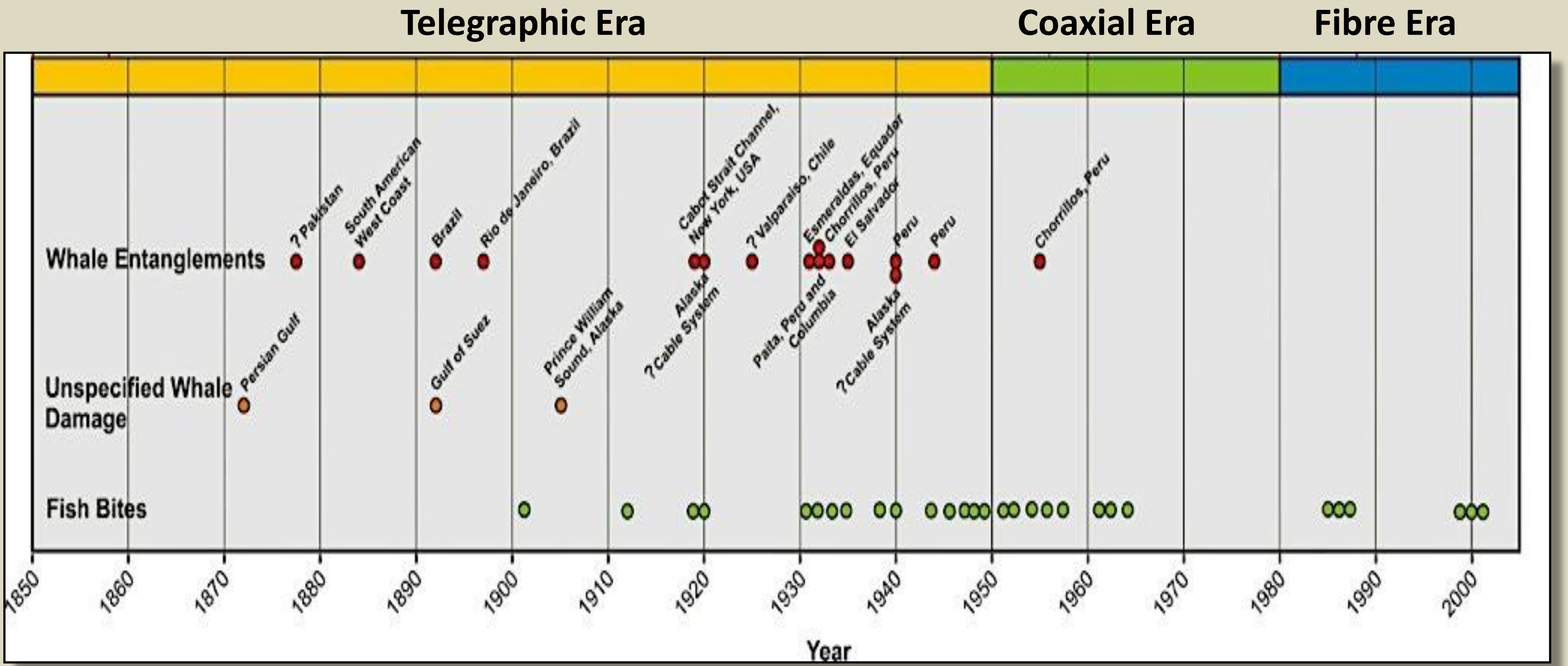
Source: NOAA www.ncdc.noaa.gov/extremes/cei/definition

Whale entanglements

- Study of 5460 faults revealed 16 entanglements of mainly sperm whales pre-1959.
- Entanglements ceased during transition from telegraph to coaxial cables.
- Transition saw improved cable design and laying that included laying cables under tension, torque balance, better repair techniques to reduce coiling, and burial.
- Apart from local rises, S. Sea depth exceed diving limits of sperm whales.

Sources: Heezen, 1957, DSR; Wood and Carter 2008, IEEE/JOE

Fish Bites (including sharks) world-wide



- **1901 – 1957 during telegraph era at least 28 cable-damaging bites.**
- **1959 – 2006 when coaxial and later (1988) fibre-optic systems prevailed, 11 cables repaired – 0.5% of all faults**
- **2008 – 2013 no faults related to fish bites.**

Sources: Wood & Carter, 2008; UNEP-ICPC 2009; ICPC Database.

Synopsis I

- ~1 fault per 6 years due to a natural hazard (current abrasion).
- Despite locally energetic deep environment, cables resilient.
- No record of faults due to modern submarine landslides/turbidity currents.
- Response of abyssal ocean to climate change is unclear but likely to be modest and within resilience of cables.
- World wide, faults caused by whales have ceased.
- Faults from fish bites not observed since ~2006.

Synopsis II – evidence-based understanding