Some key points:

- The continental shelf and slope system in the northeastern United States is undergoing profound and accelerated changes in recent years. It is among the most rapidly warming regions in the world oceans and that is projected to continue further in the 21st century (**Slide 2**).

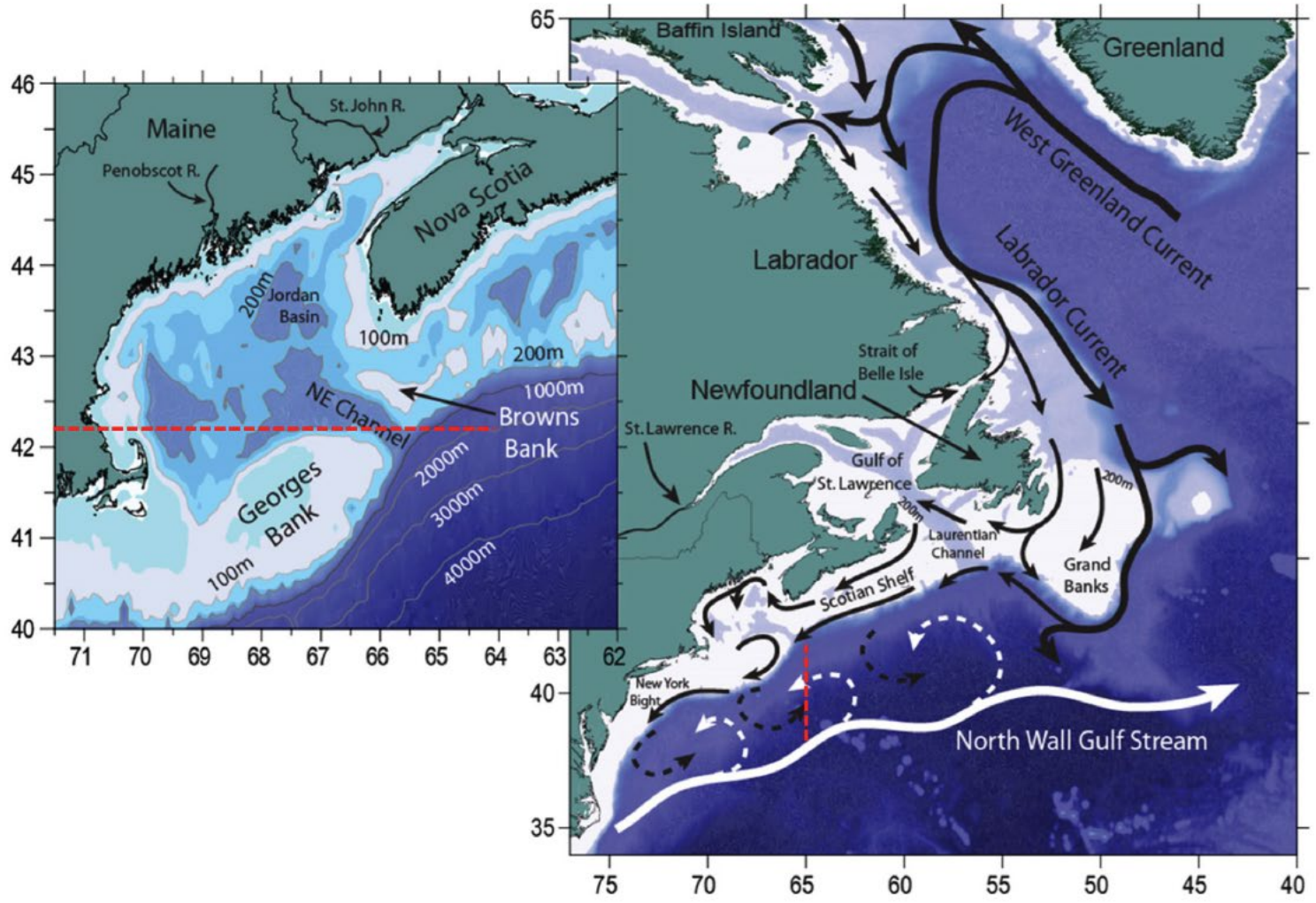
- The warming has already had major impacts on the ocean circulation and ecosystem that supports a productive fishing industry.

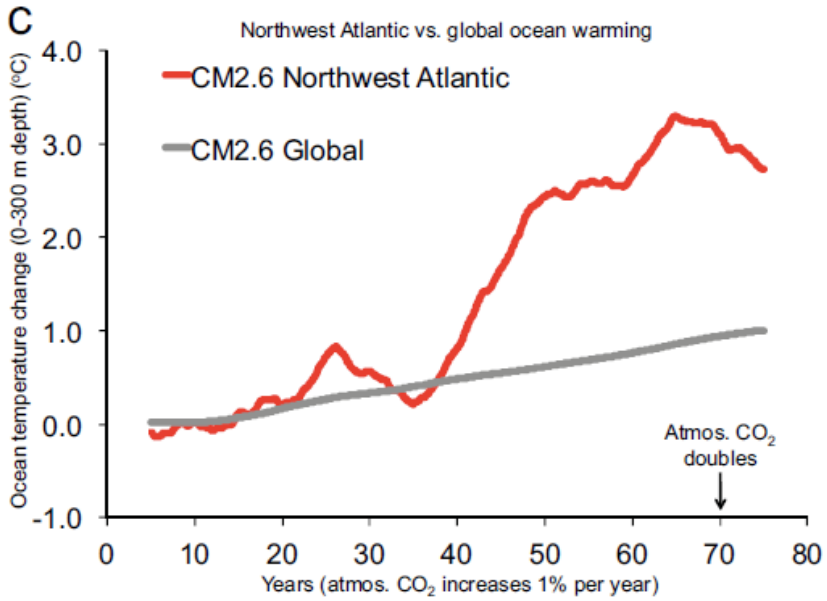
- The New England shelf supports a rich fishing industry.

- The ocean conditions on the New England shelf are determined by the interplay of (1) cold, fresh waters of Arctic origin coming down from the North and (2) warm, salty tropical waters brought up the U.S. East Coast by the Gulf Stream (**Slides 2 & 3**).

- Warm core eddies or warm core rings spinning off the Gulf Stream bring warm water from further offshore onto the New England shelf (**Slide 4**).

- Locally, the Cape Cod Outer Coastal Current that runs along the Outer Cape is an important oceanographic feature that transports fresh, cold waters from the North southwards and is associated with rich fishing grounds off the Cape.

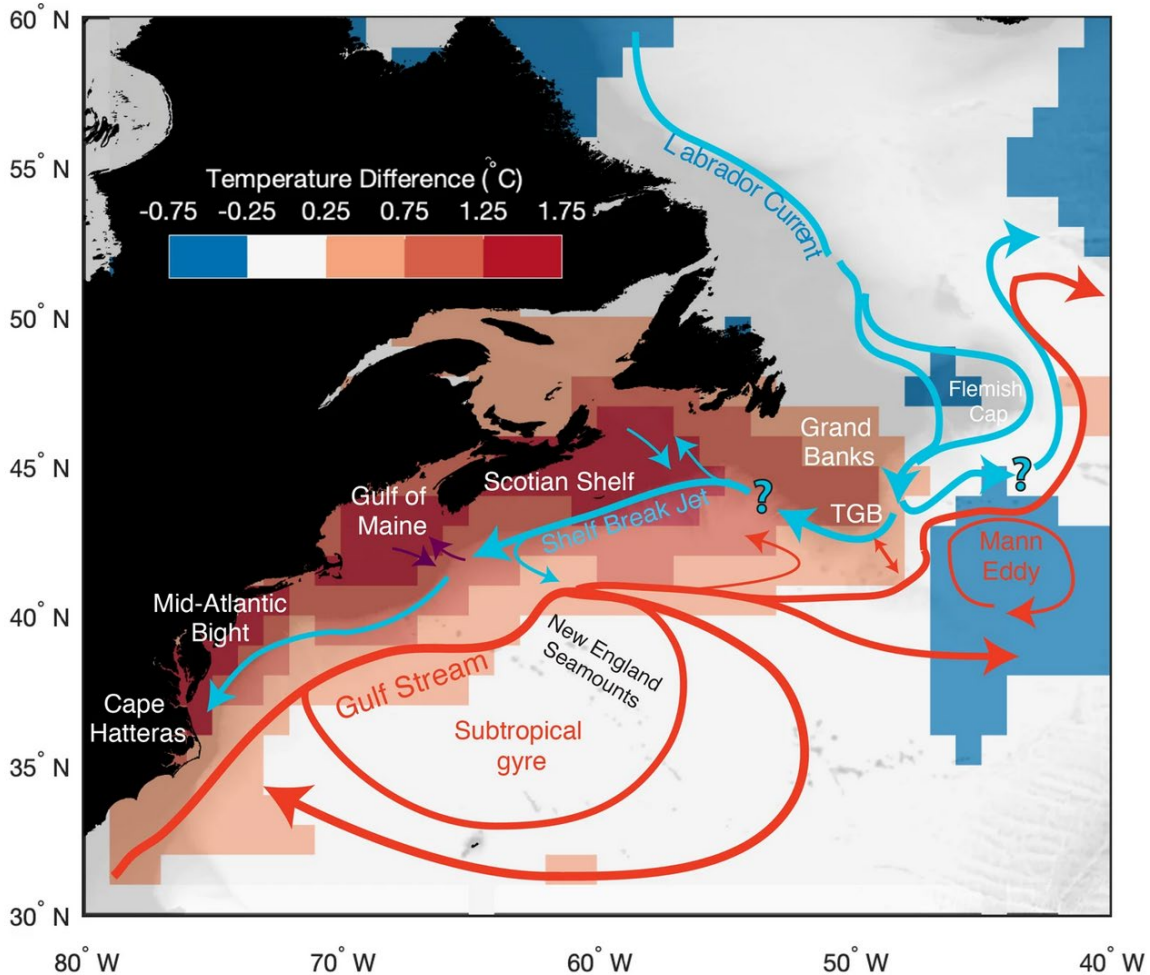




(c) Northwest Atlantic versus global upper-ocean (0–300 m) temperature change from CM2.6 in the 80 year 2x CO2 run. Ocean temperature change is smoothed by a 10 year moving average and is based on monthly differences between the 2x CO2 run and the preindustrial control run.

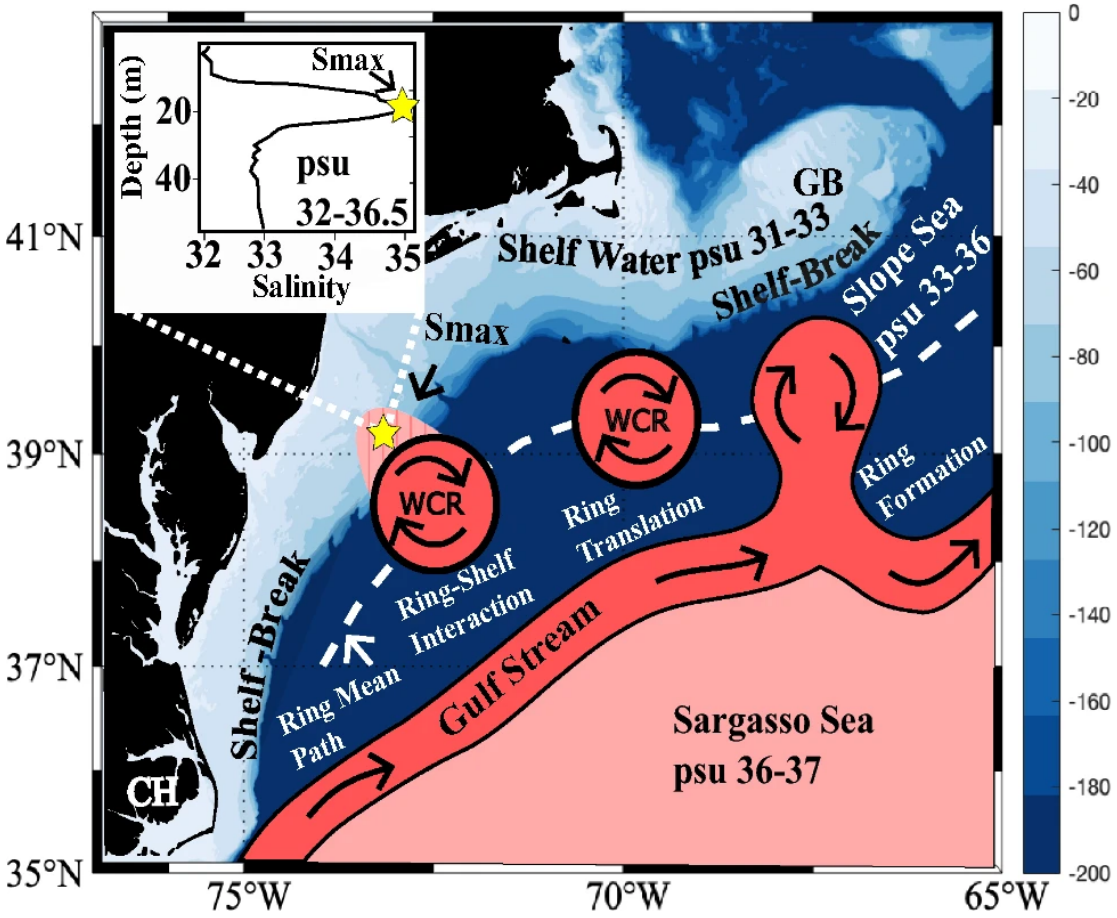
Figure 1. Northwest Atlantic Ocean and Labrador Sea bathymetry and major current systems. Black arrows are colder, fresher water associated with the Labrador Current. White arrows are warmer, saltier water associated with the Gulf Stream. Dashed arrows indicate mixing of waters (not currents) in the Slope sea. Inset shows location of the Northeast Channel (NEC; sill depth ca. 220 m) where a mix of these Slope and Shelf Waters enter the Gulf of Maine (reproduced from *Townsend et al.* [2010]). Red dashed lines represent the two transects of temperature and salinity profiles in Figures 7b and 7c.

Source: Saba et al. (2016) – Figures 1 and 4c



The red (blue) shading indicates warming (cooling) of the vertically averaged ocean temperature from the EN4 objective analysis to 2000 m, or the seafloor if it is shallower than 2000 m, in 0.5 °C increments (change in the unshaded region is between −0.25 and 0.25 °C). Background in grayscale shows the bathymetry of the region, with darker shades representing shallower areas. The main circulation features that influence the shelf properties are associated with the Gulf Stream (red) and the Labrador Current (blue) systems, as depicted with arrows. The purple arrows show the waters entering the Gulf of Maine are influenced by both current systems. Coastal and shelf areas of interest are indicated. TGB = Tail of the Grand Banks.

Source: Neto et al. (2021) – Figure 1



Schematic illustrating the proposed hypothesis that offshore forcing by the Gulf Stream drives the observed increase in the frequency of intrusions on the Northeast US Shelf. This increasing rate of intrusions starts with the doubling in the annual formation rate of Gulf Stream Warm Core Rings (Gangopadhyay et al., 2019). These rings then translate through the Slope Sea along the ring mean path (shown by the white dashed line) until they encounter the shelf between Georges Bank (labeled GB) and Cape Hatteras (labeled CH)[13]. The salty water within the Warm Core Rings interacts with the shelfbreak to form a Salinity Maximum intrusion. The top left corner of the schematic shows an example vertical salinity profile containing a salinity maximum intrusion from the EcoMon data. The yellow star marks the maximum salinity. This image was generated using Inkscape[14] and M_Map[15].

Source: Silver et al. (2023) – Figure 1