Marine Heatwaves and their depth structure on the Northeast US continental shelf

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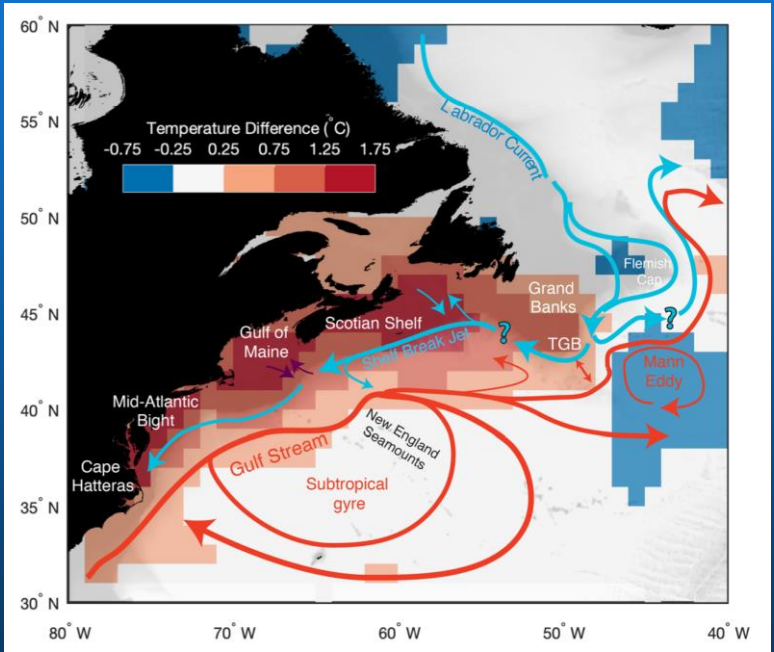
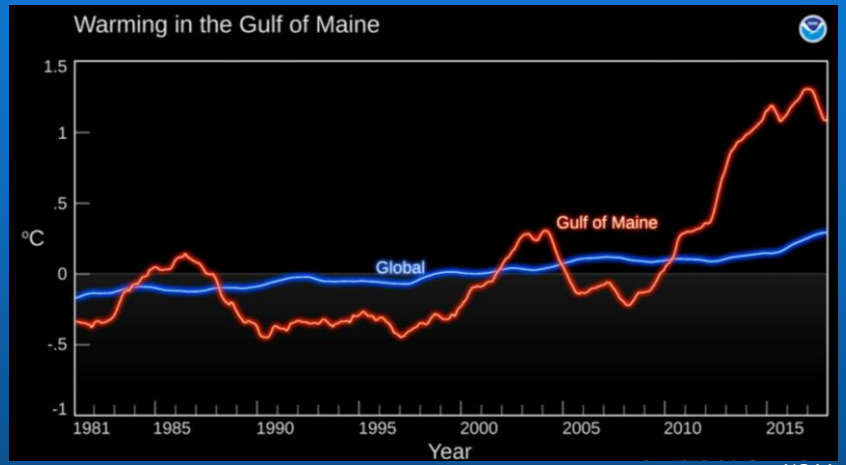
Outlook

- Motivation
  - Why this region?
  - Why Marine Heatwaves?
- Data & Methods
- Results
  - Impact of model resolution
  - MHWs and their depth structure
- Summary & future work

Highly dynamical and intensively warming region



Gonçalves Neto et al. 2021

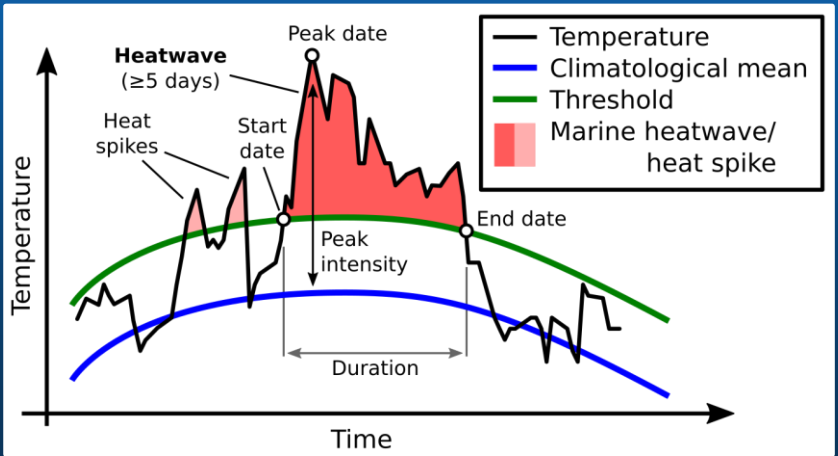


NOAA

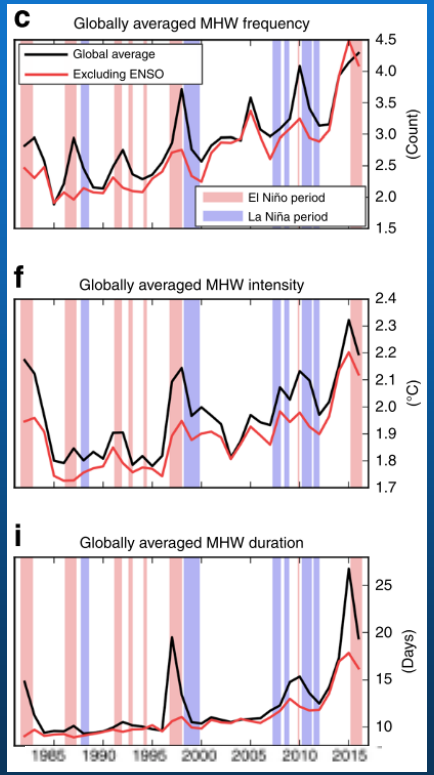
- Among the fastest warming regions globally
- Dynamical region on all scales
- Highly biologically productive

Marine Heatwaves and their changes

- Ocean extreme events
- Frequency, duration and intensity increase globally
- Can have devastating impacts
- Little knowledge about depth structure



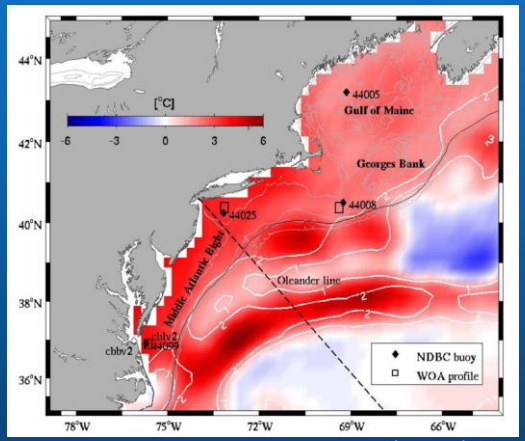
http://www.marineheatwaves.org/all-about-mhws.html



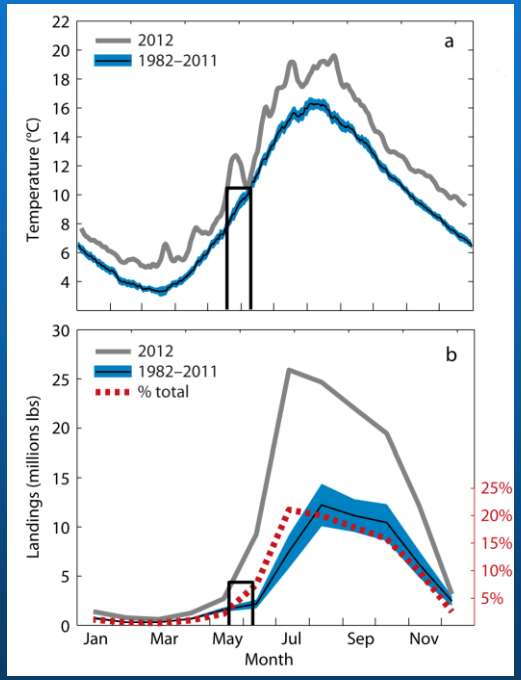
Oliver et al. 2019

Already strong events in this region

- 2012
  - Driven by air-sea fluxes
  - Severe impacts on local fishery



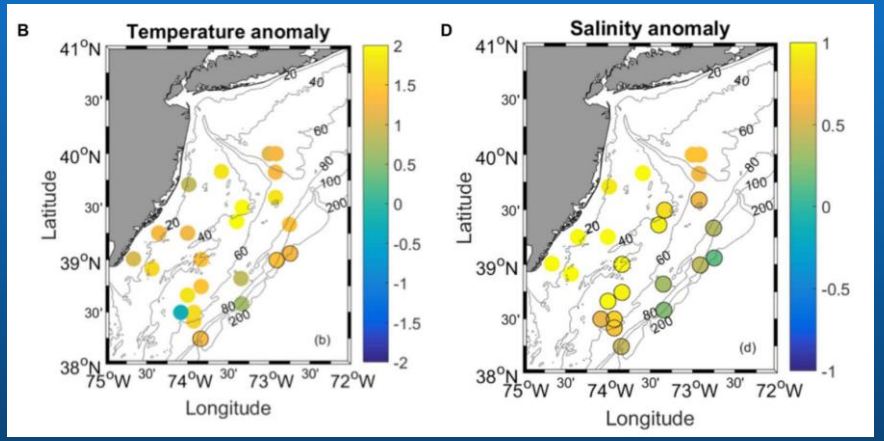
Chen et al. 2014



Mills et al. 2013

Already strong events in this region

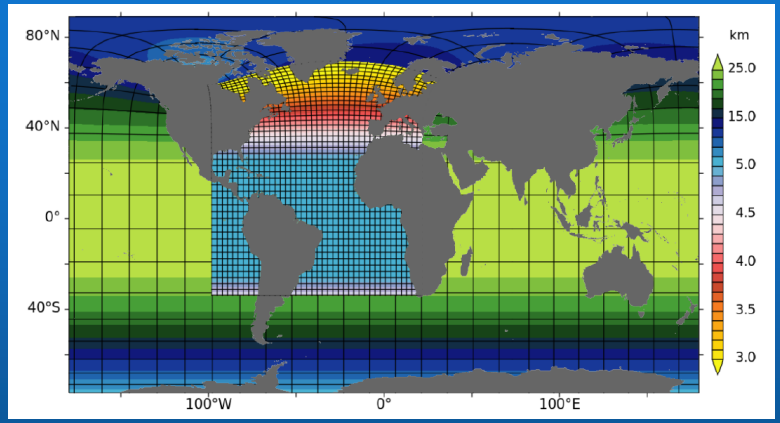
- 2012
  - Driven by air-sea fluxes
  - Severe impacts on local fishery
- 2017
  - Advective MHW
  - Likely by Warm Core Ring interaction



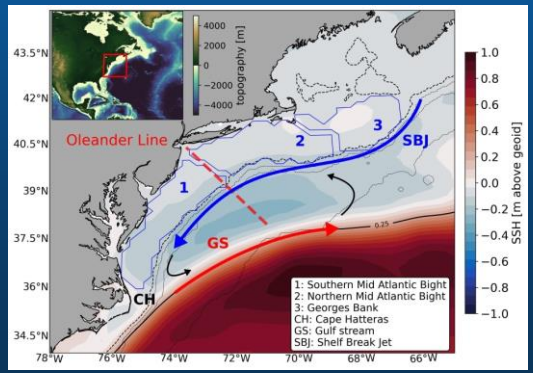
Gawarkiewicz et al. 2019

Data

- Observations
  - Satellite SST, SSH, SSS
  - Oleander Line T, U
- Ocean Models (NEMO)
  - ORCA025
    - 1/4° global
    - JRA55-do forcing
    - 1958-2016
    - 46 levels
    - Start from rest
  - VIKING20X
    - 1/20° nest
- MHWs in Shelf Boxes

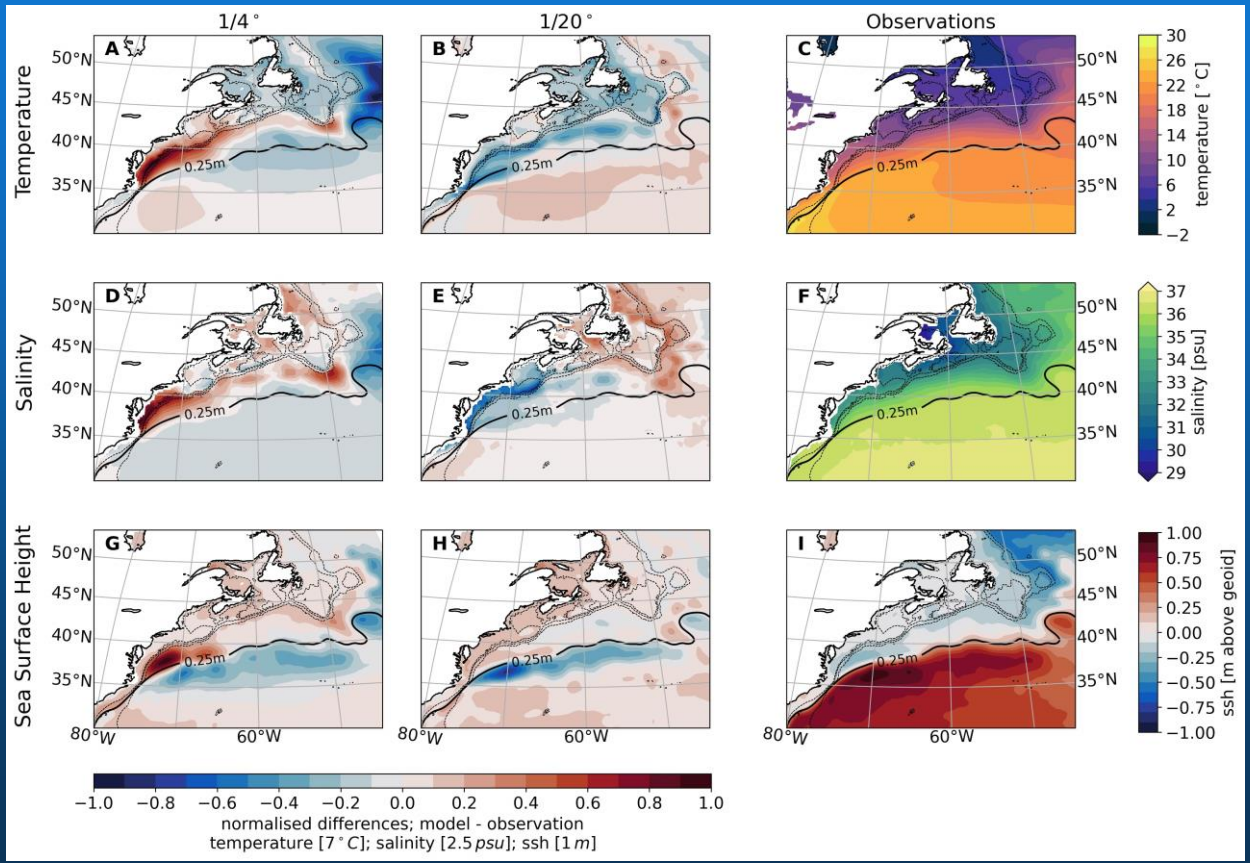


Biastoch et al. 2021



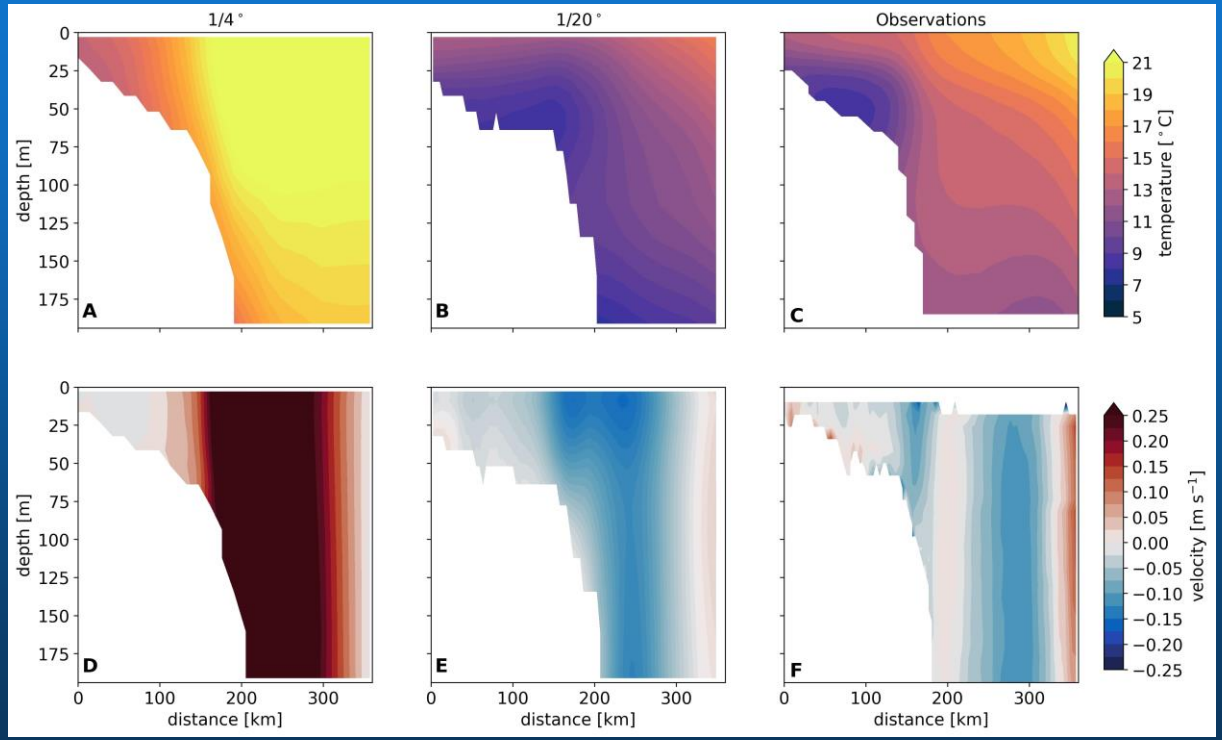
Gulf Stream representation depends on resolution

- Too far north GS seperation in ORCA025
  - Too warm and saline shelf
- Flow around the grand banks
- VIKING20X way better
  - Only some caveats

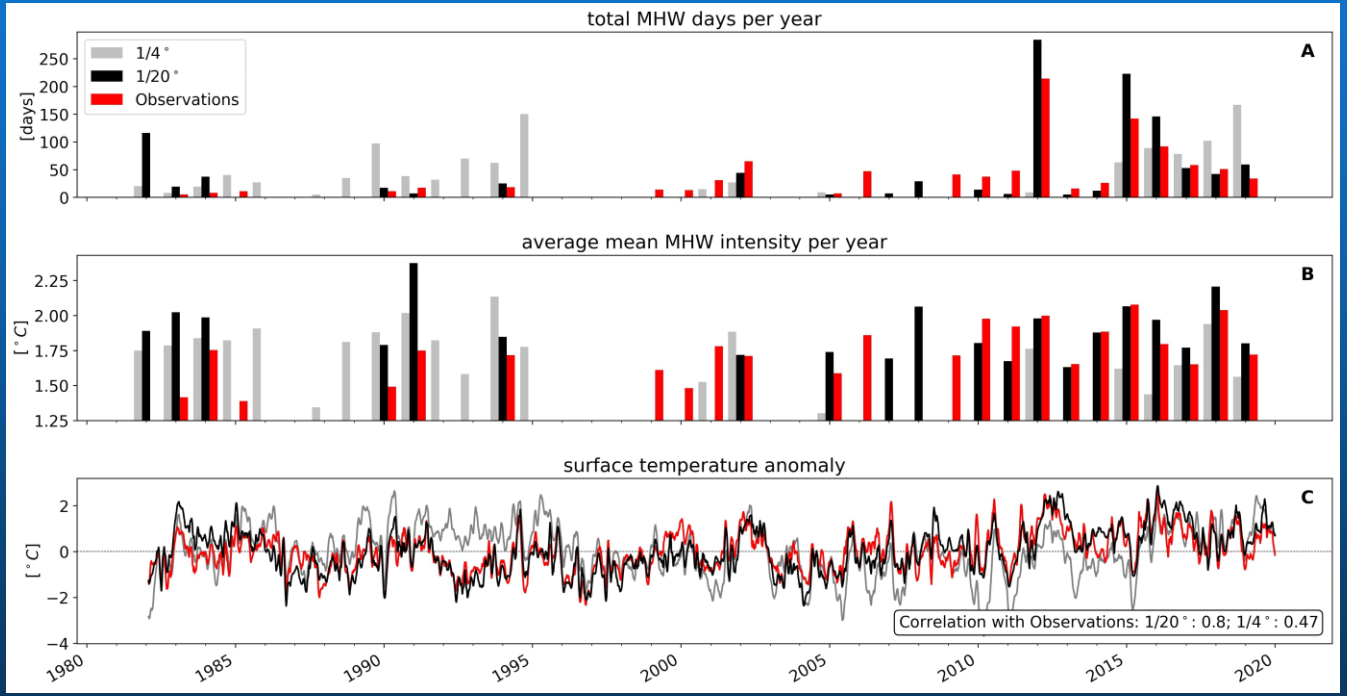


Shelf depends on Gulf Stream position

- Shelf in ORCA025 totally GS biased
- Cold pool
- Shelf Break Jet and Front

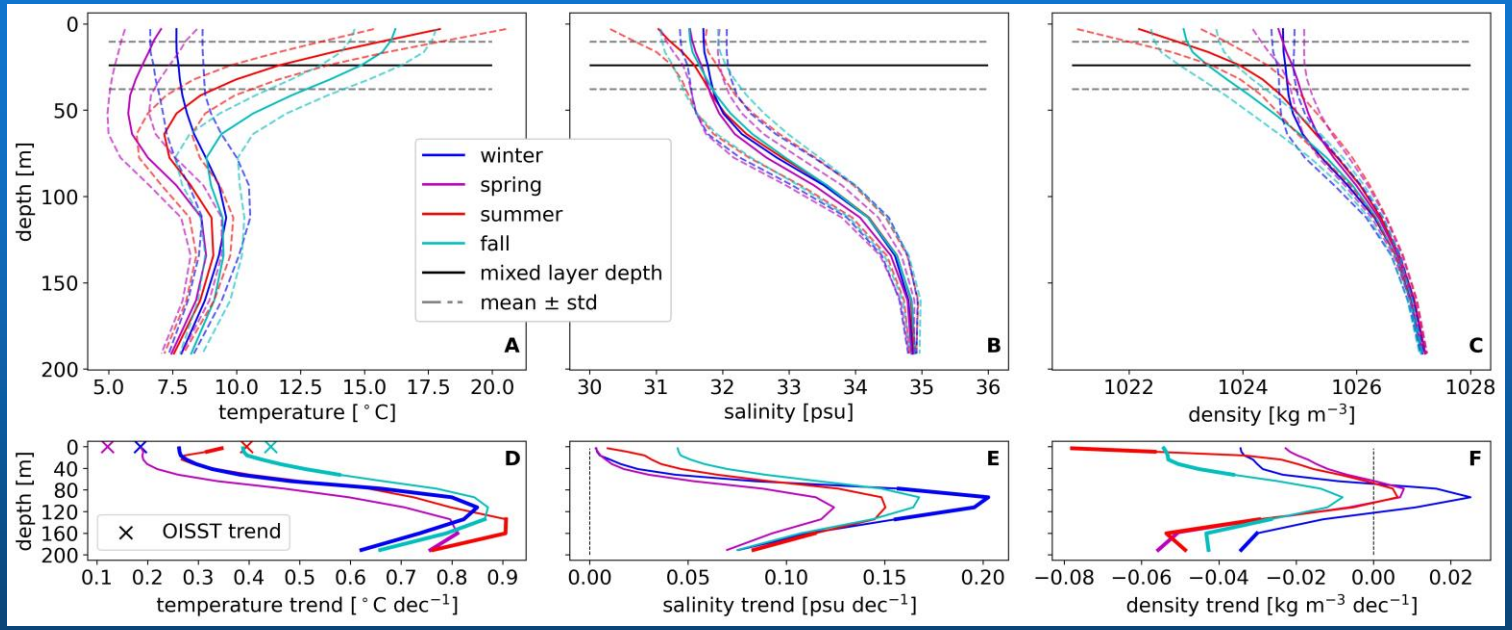


Surface MHWs and variability



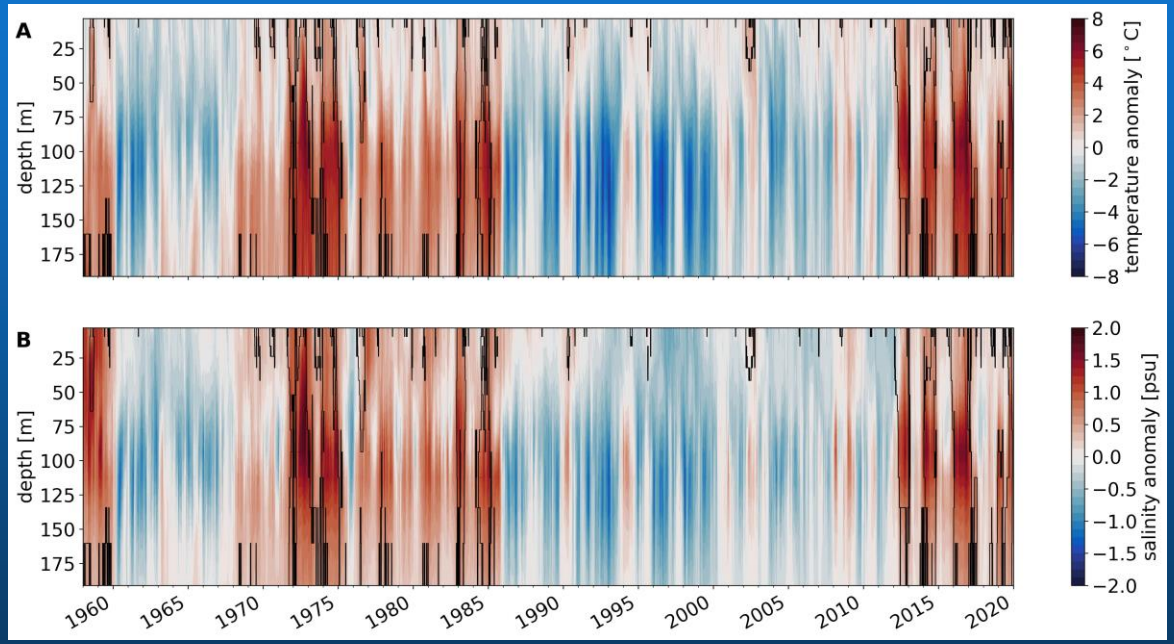
- MHWs align better in VIKING20X
- Surface forcing but also internal variability
- Exceedance of threshold or not?
- Correlation better in VIKING20X as well

Shelf hydrography and trends

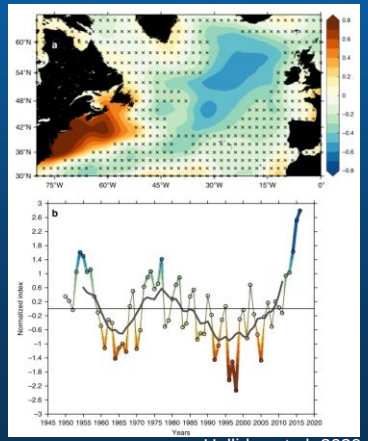


- Salinity stratified
- High seasonality
- Depth intensified trends

MHW depth structure

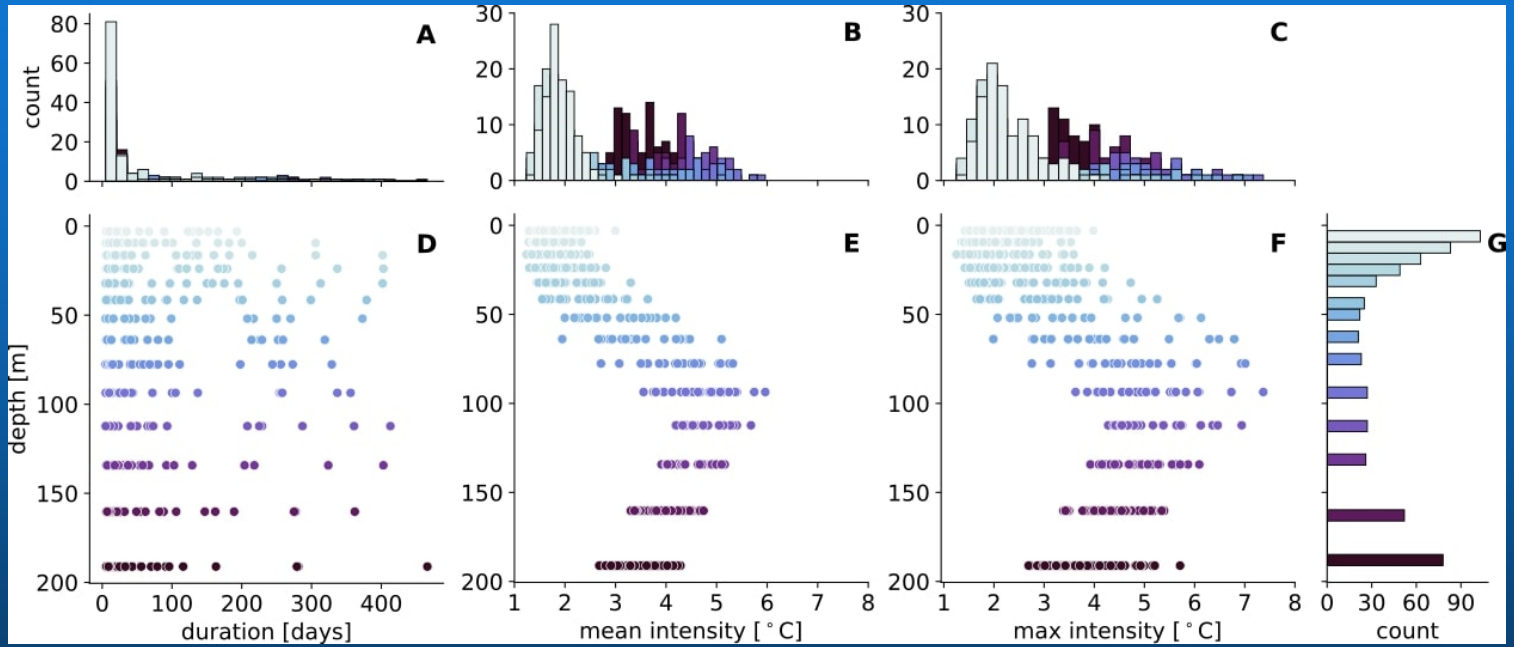


- All types of depth structures
- Highest anomalies at 100m
- Connection of temperature and salinity?
- Multi-decadal variability



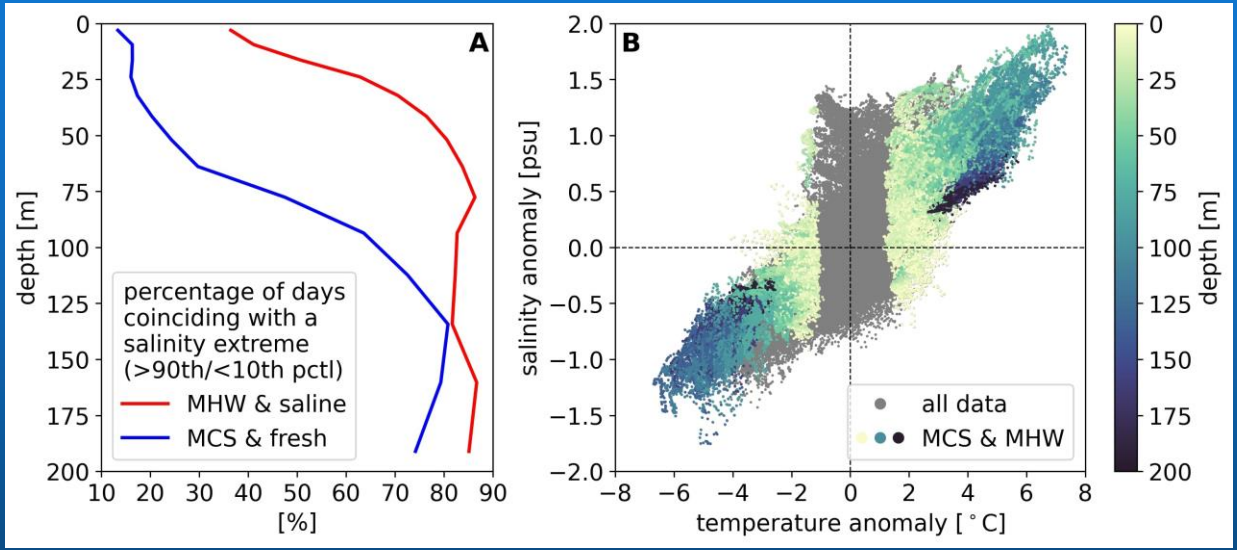
Holliday et al. 2020

Stronger MHWs at depth



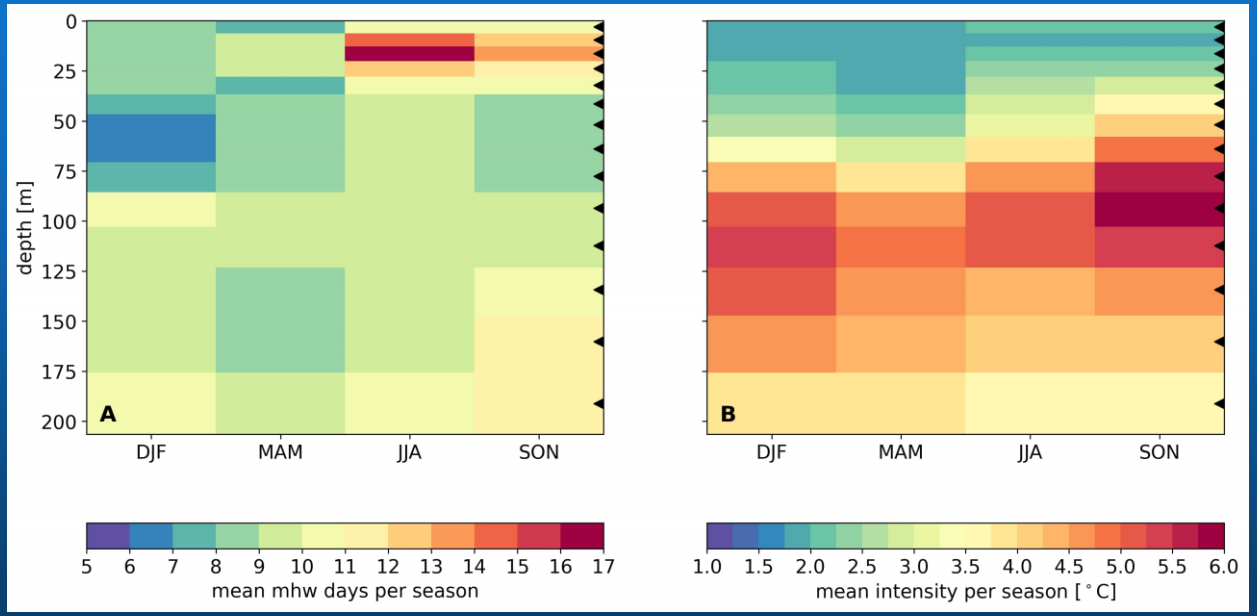
- Most events are short, some very long
- Highest intensity at depth

Co-variability of temperature and salinity



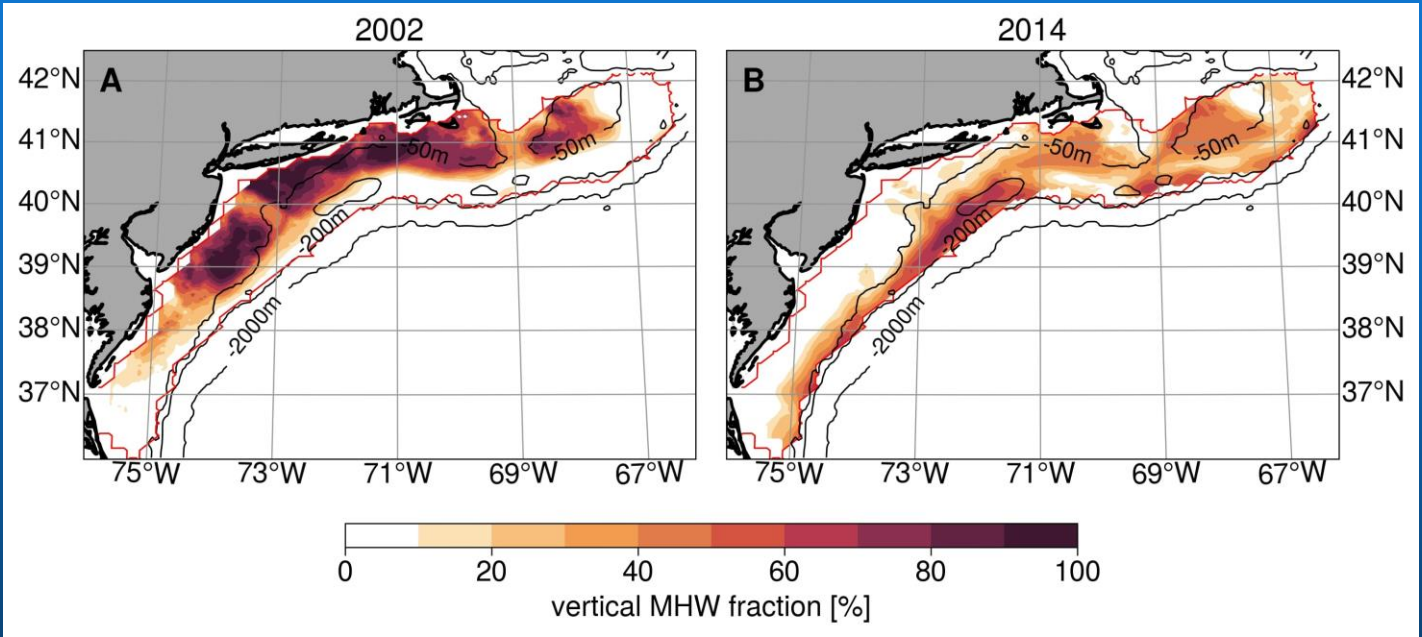
- MHWs co-occur with salinity extremes at depth
- Marine cold spells show similar structure
- Surface MHWs with fresh anomaly

Seasonal differences



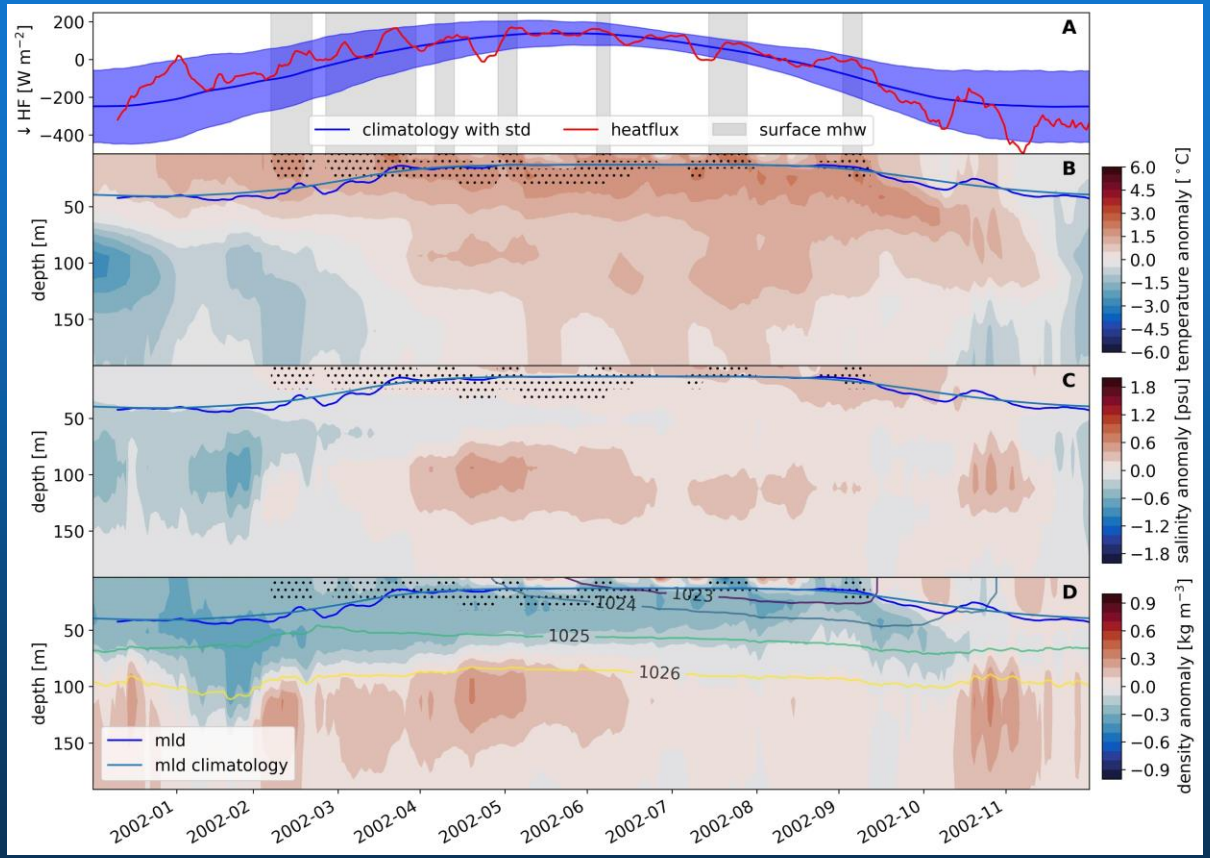
- Highest seasonality of occurrence at the surface
  - Air-sea flux influence
  - Shoulder season onset
- Strongest intensity in fall at depth
  - Warm core ring activity

Shelf vs. shelf break events

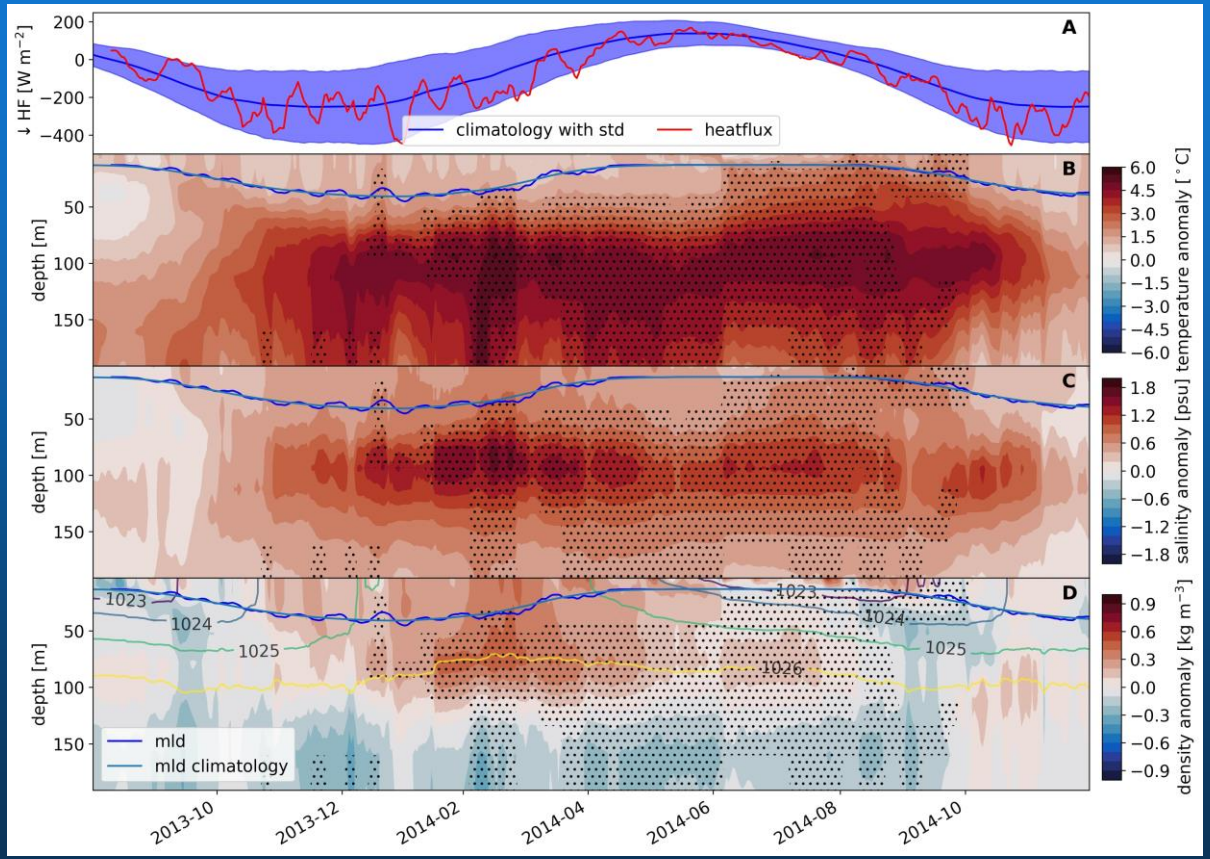


- Percentage of water column in MHW state
- Shallow and shoreward surface MHW in 2002
- Subsurface MHW at shelf break in 2014

2002



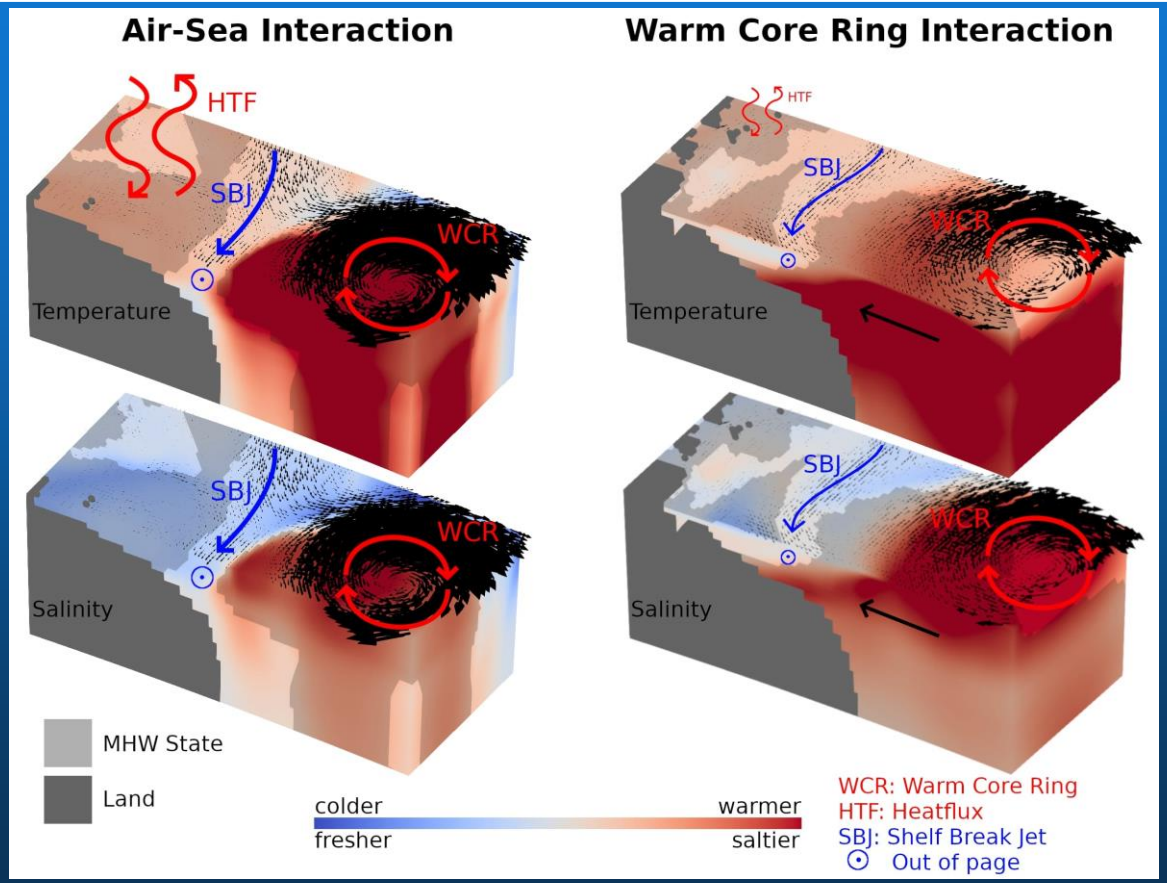
- Only upper 30m
- Moderate anomalies
- Heatflux forced
- Multiple short events
- No salinity signal



- Only subsurface signal
- Extreme anomalies
- Peak at 100m depth
- No strong heatflux deviations
- Very long-lasting
- Salinity with same signal
- WCR interaction

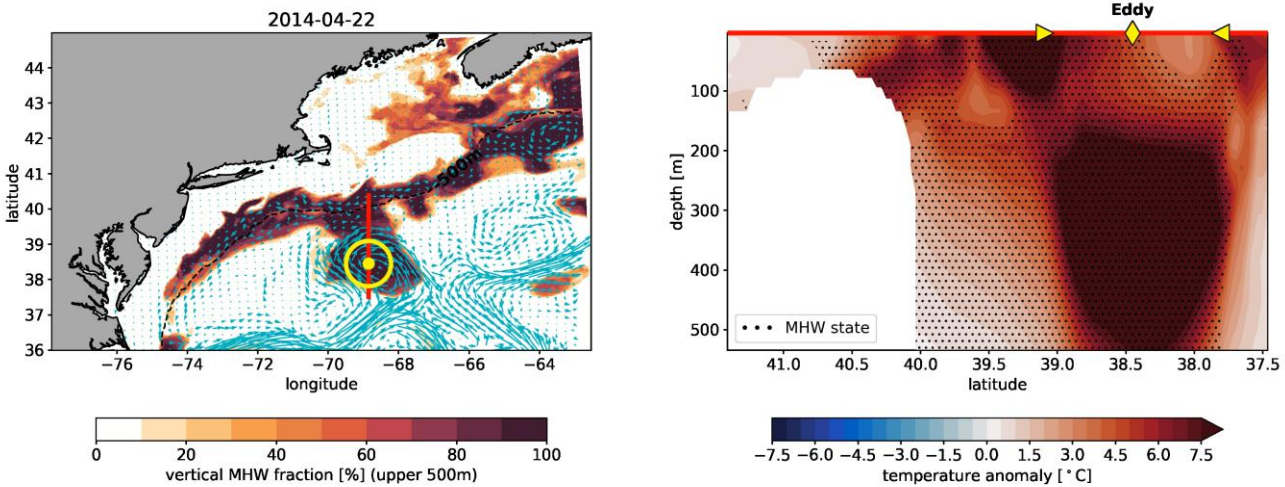
Summary

- MHWs can show variuos depth structures
  - Different impacts on different ecosystems
- Subsurface measurements are needed
- Dynamics of the region highly important
  - Longterm Trends and variability
- Model resolution is key

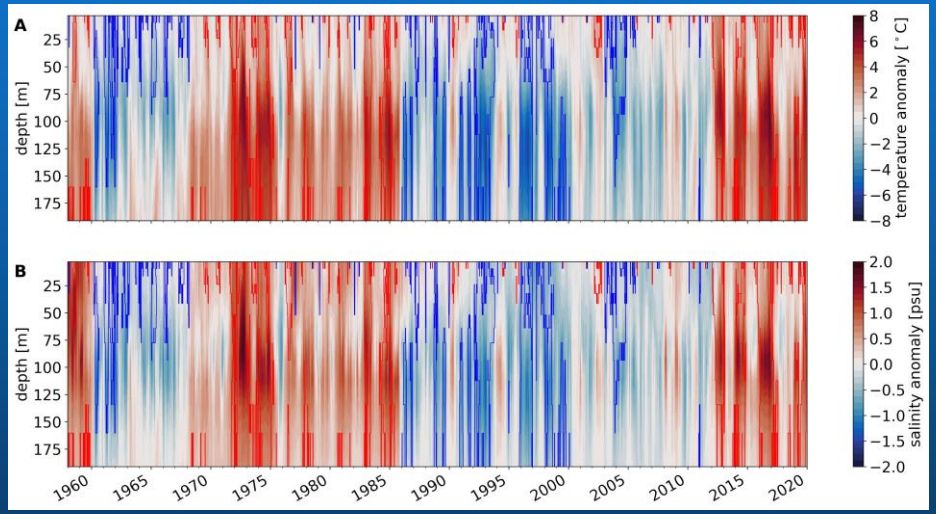


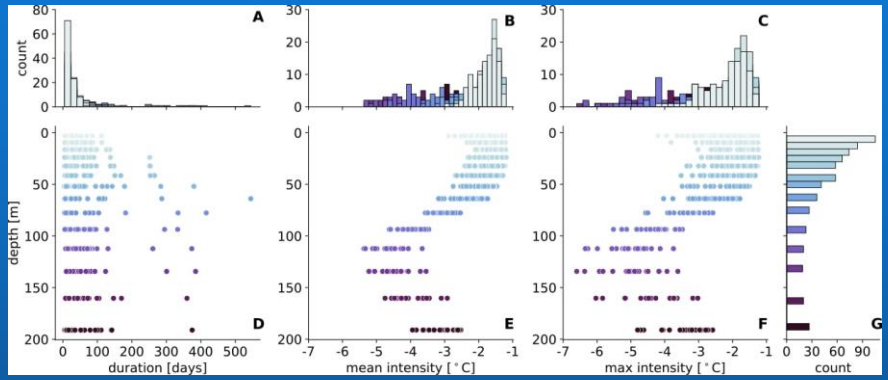
Outlook

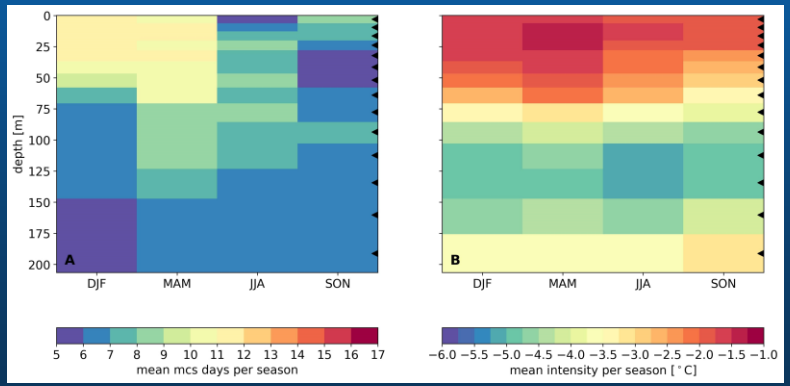
- Eddy tracking
  - Investigate dynamical processes for MHW formation
  - Model validation/statistical comparison to observations



Marine Cold Spells







2002 & 2014 spatio-temporal evolution