Most urgent, high-priority, scientific questions in your field that have the potential to transform scientific knowledge of the ocean and the critical role of the ocean in the Earth system?

OCEANIC CURRENT FEEDBACK TO THE ATMOSPHERE

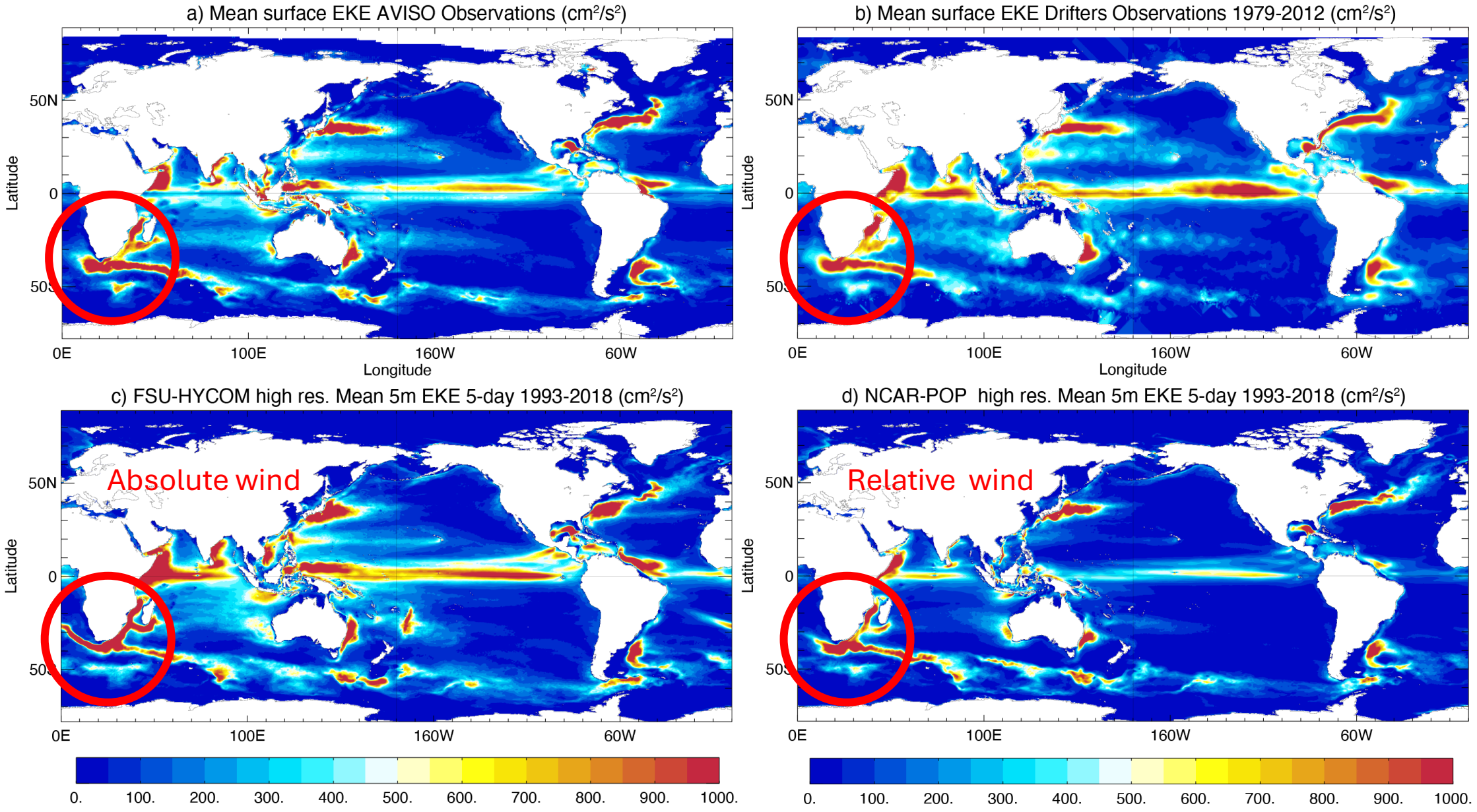
Impact on ocean prediction

Eric Chassignet

Current state of the art

- Routine global ocean prediction at 1/12° (~6 km at mid-latitudes) (Mercator, HYCOM GOFS 3.1, BlueLINK, etc.)
- State-of-the art global ocean prediction at 1/25° (~3 km at mid-latitudes) with tides (HYCOM GOFS 3.5 uncoupled, Navy ESPC coupled)
- Decadal climate integration of coupled ocean-ice-atmosphere models with ocean resolution at ~1/10°
- Prototypes global and basin-scale ~1/50° simulations (~1.5 km at mid-latitudes) with tides (MITgcm, NEMO, HYCOM, ROMS)

- **The impact of increased resolution in HighResMIP simulations on climate and variability has been documented in several studies, including Moreno-Chamarro et al. (2021) who discuss the impact on biases.**
- **Surface oceanic current feedback to the atmosphere has been shown to correct long-lasting biases in the representation of ocean dynamics by providing an energy sink mechanism (Renault et al., 2020).**
- **It is however strongly dependent on the horizontal grid spacing**



Chassignet et al. (2020)

- **The main issue we are currently facing is that current global ocean prediction models are too coarse (8 to 4 km) and the so-called “eddy killing effect” associated with relative winds is too strong, even if the current feedback is taken into account**
- **As you increase resolution, the sink of energy due to the ocean current feedback (eddy-killing) is however needed to obtain realistic levels of surface eddy kinetic energy.**

EKE per resolution and wind-stress formulation (Gulf of Mexico)

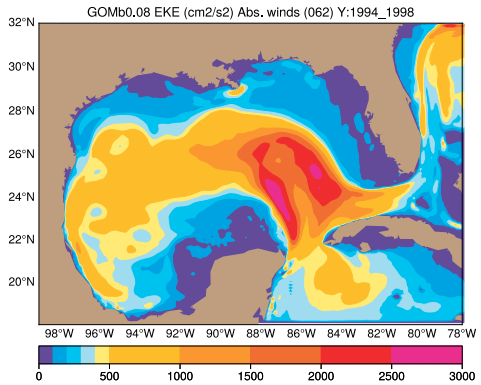
8 km

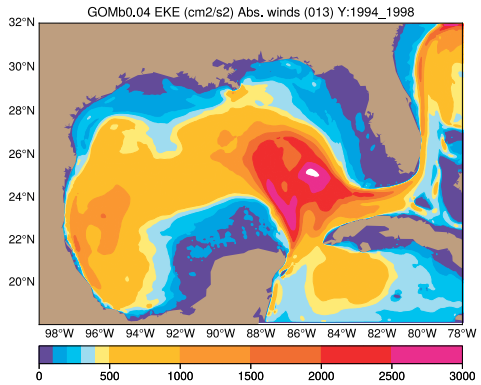
4 km

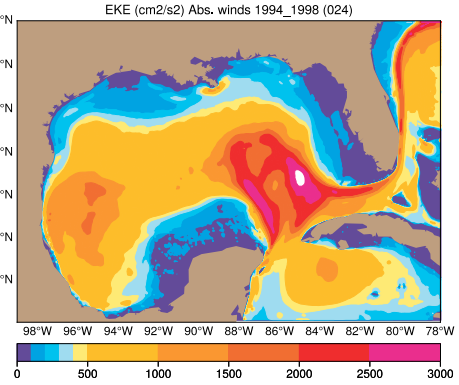
2 km

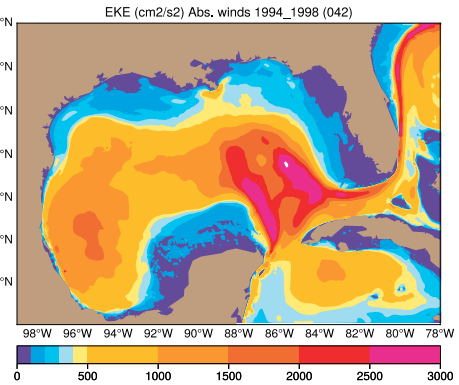
1 km

Absolute winds

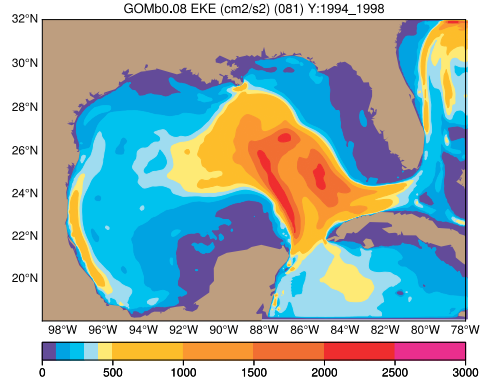


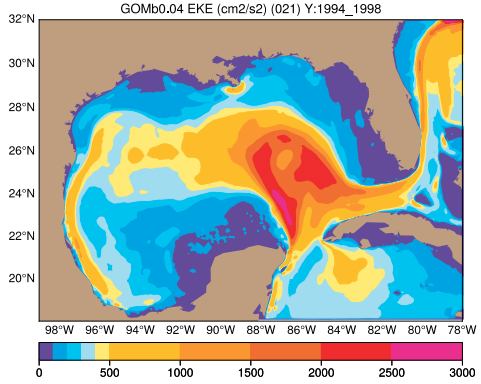


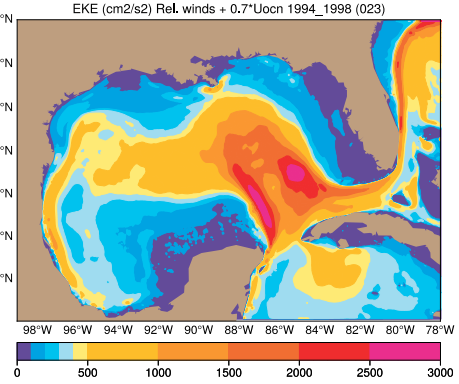


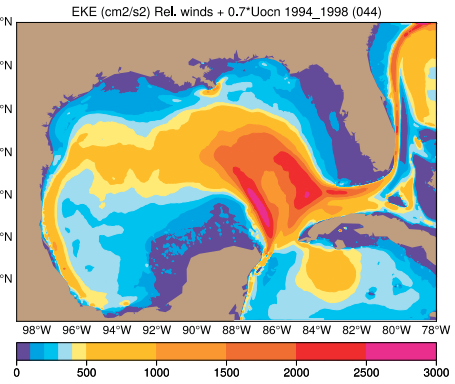


Ocean current feedback: 0.7*Uocn

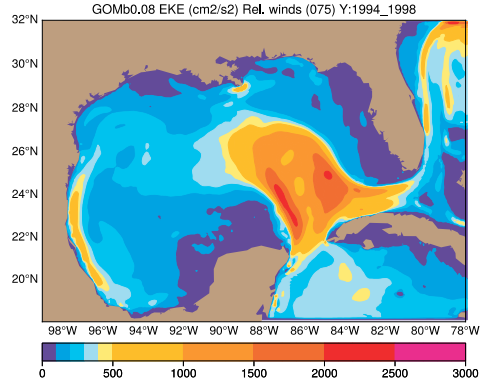


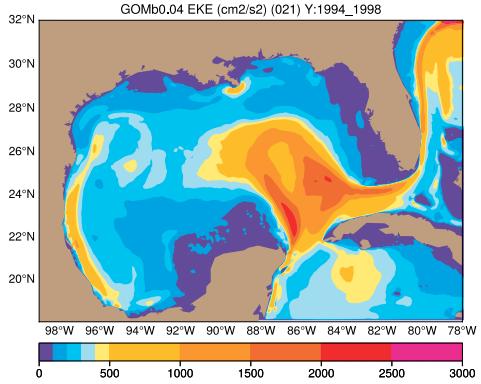


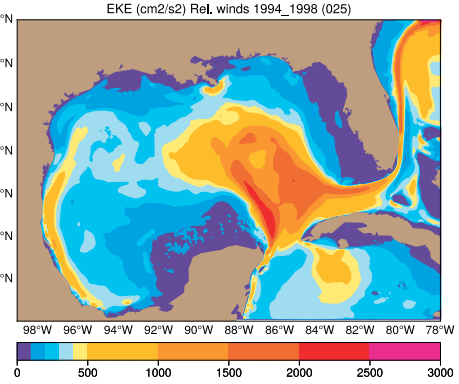


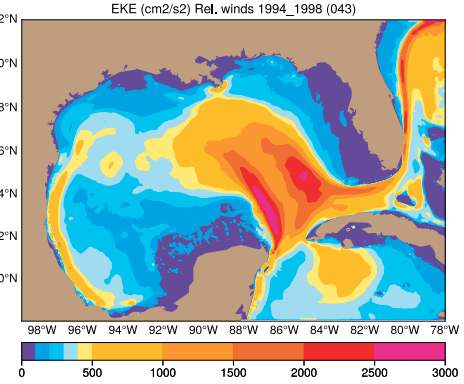


Relative winds

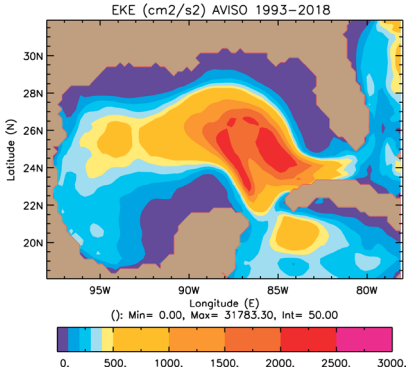




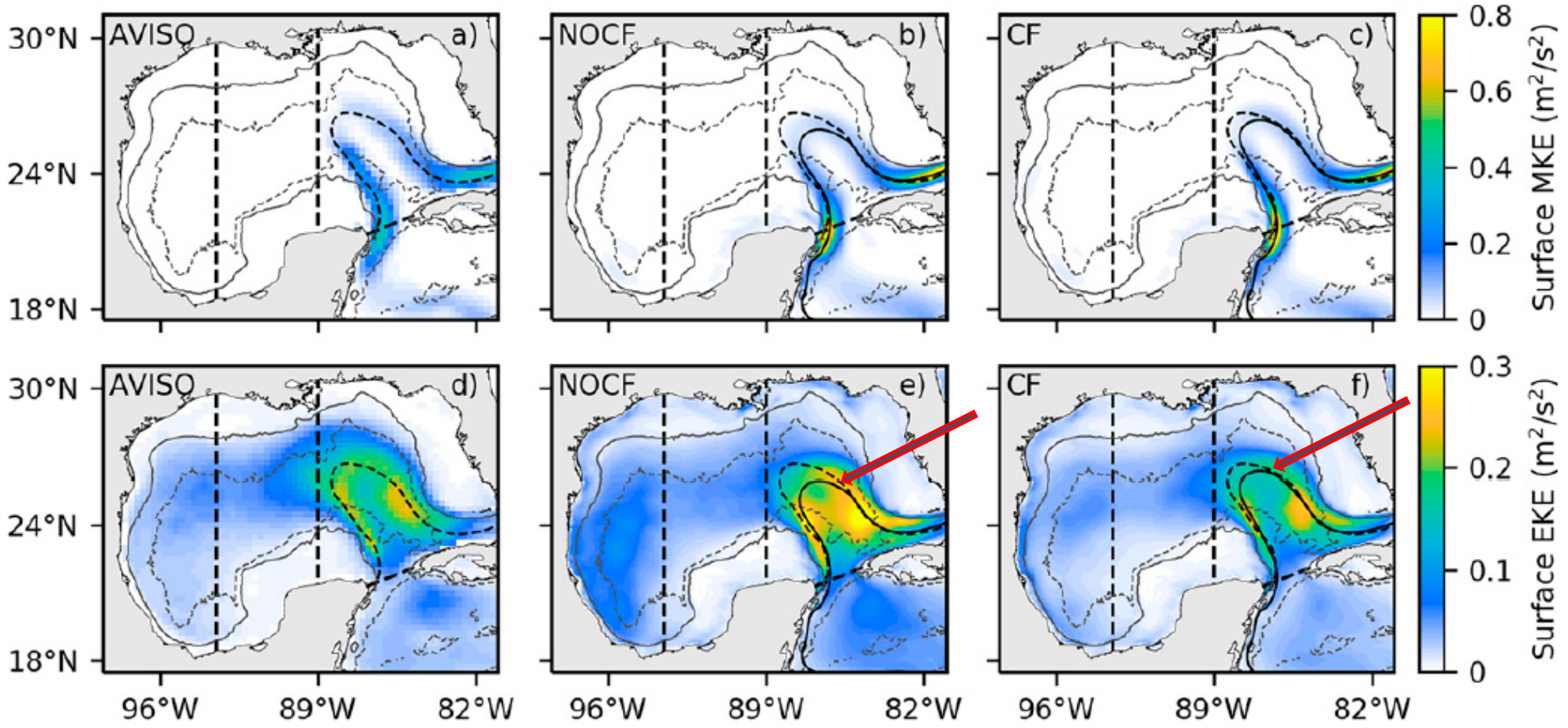




AVISO (1993-2018)



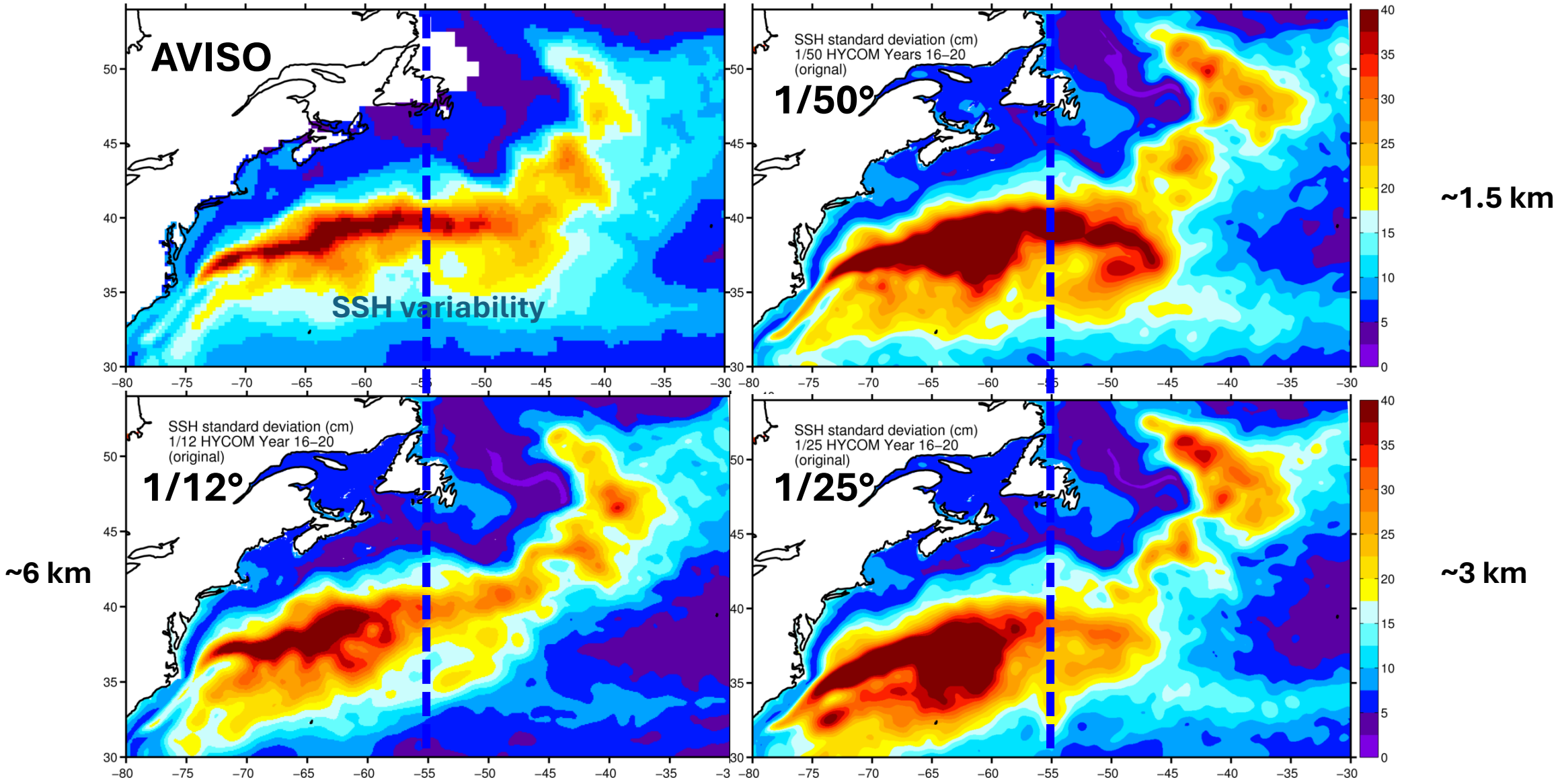
Coupled ocean-atmosphere configurations



Larranaga et al. (2022)

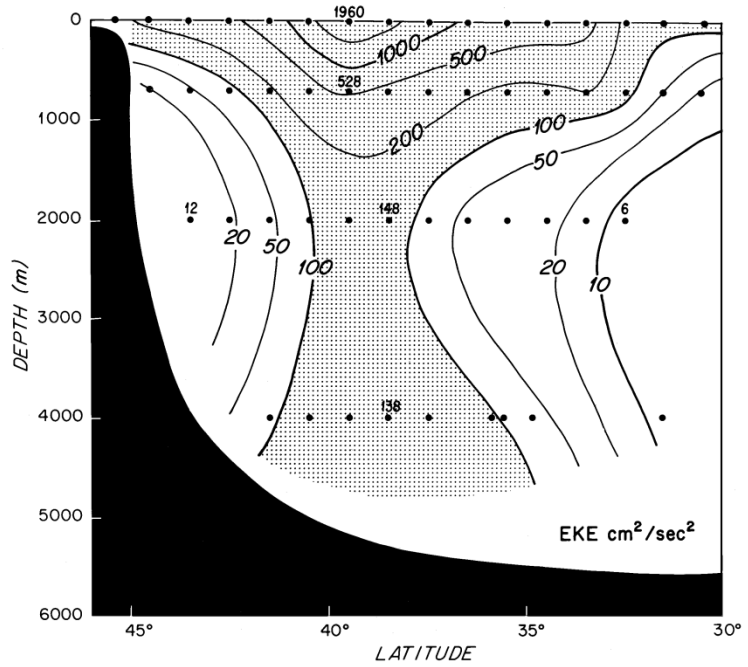
Impact of horizontal resolution (Gulf Stream region)

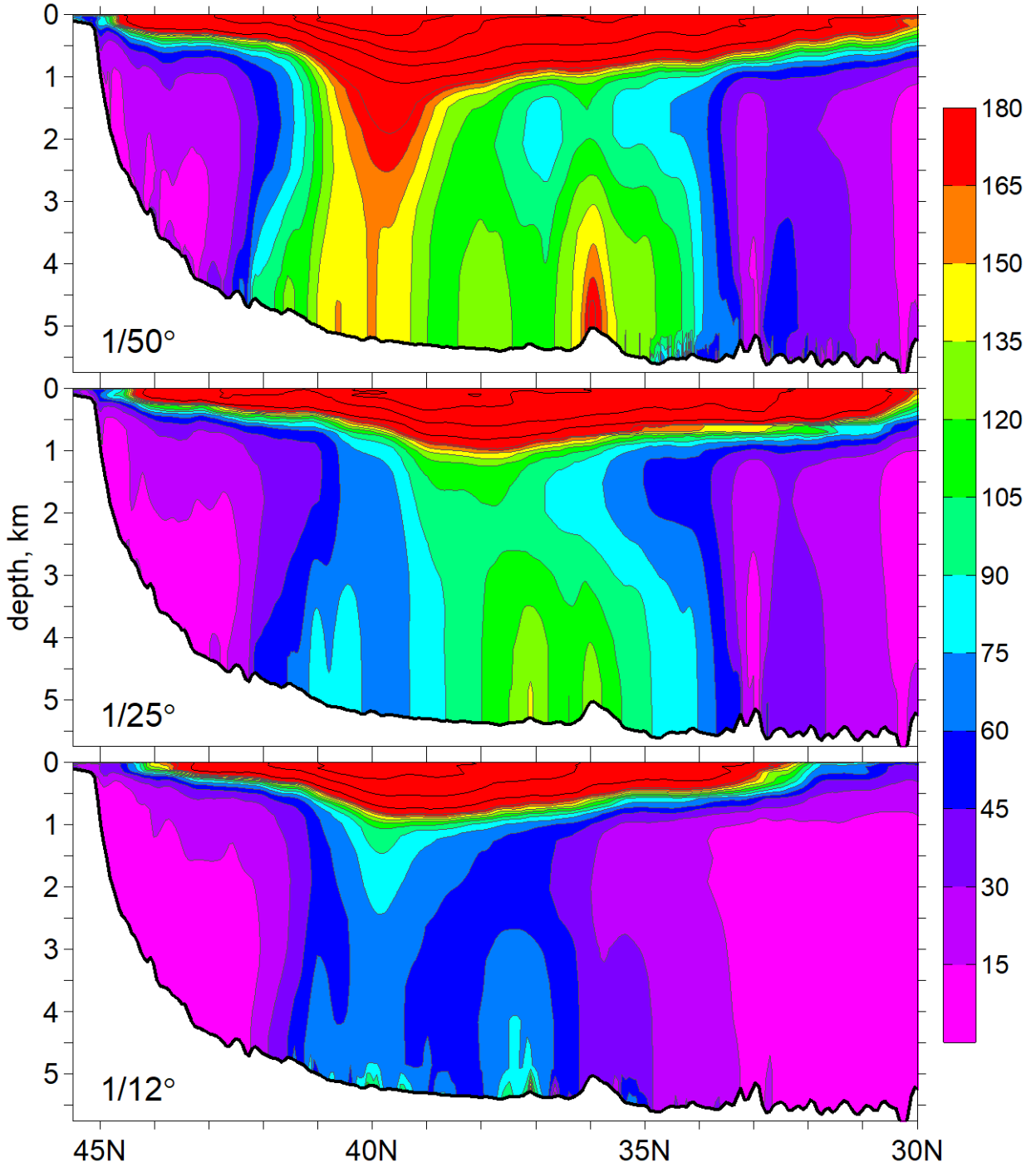
SSH variability (Chassignet et al., 2017)



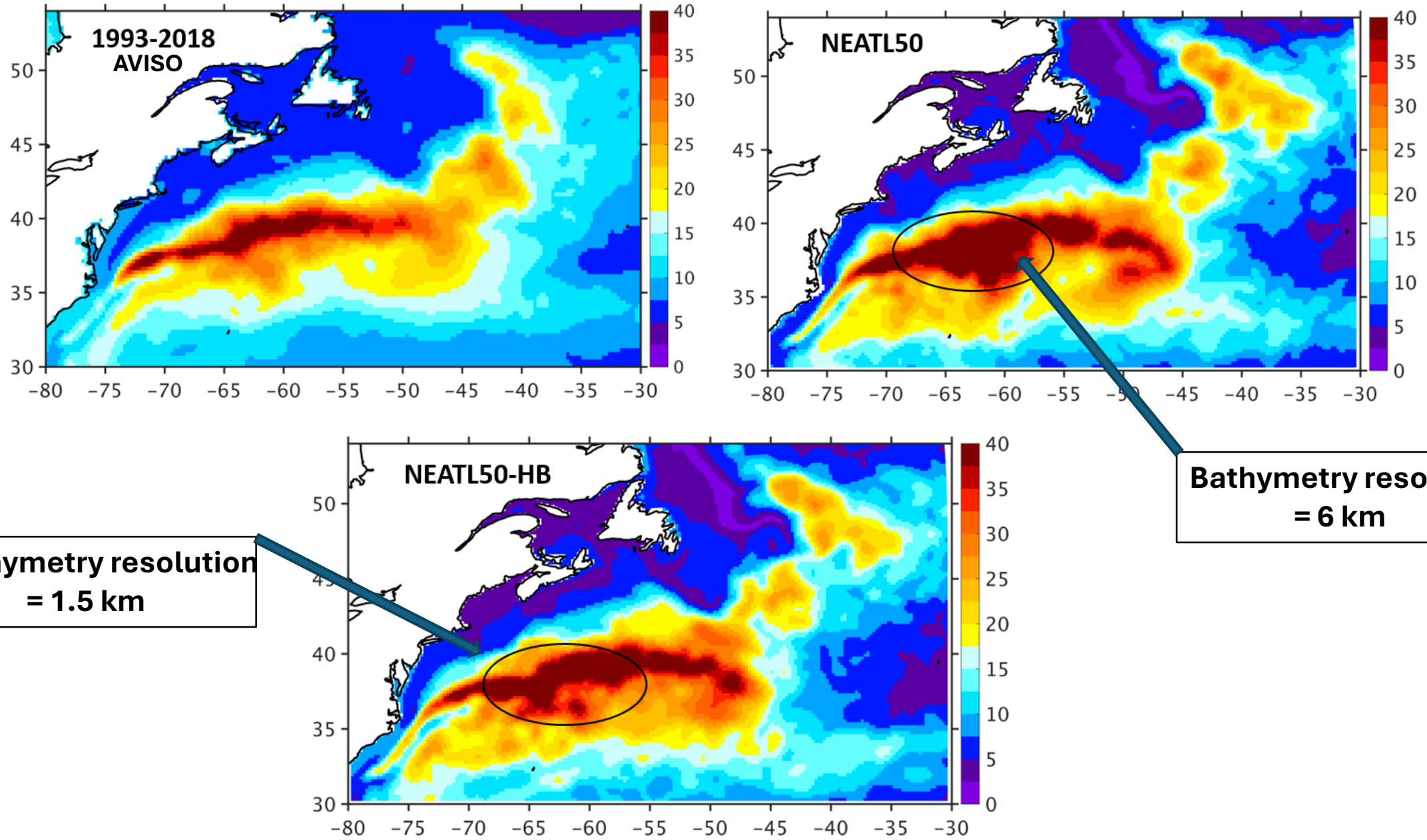
Mean Eddy Kinetic Energy at 55°W

(Richardson, 1985)

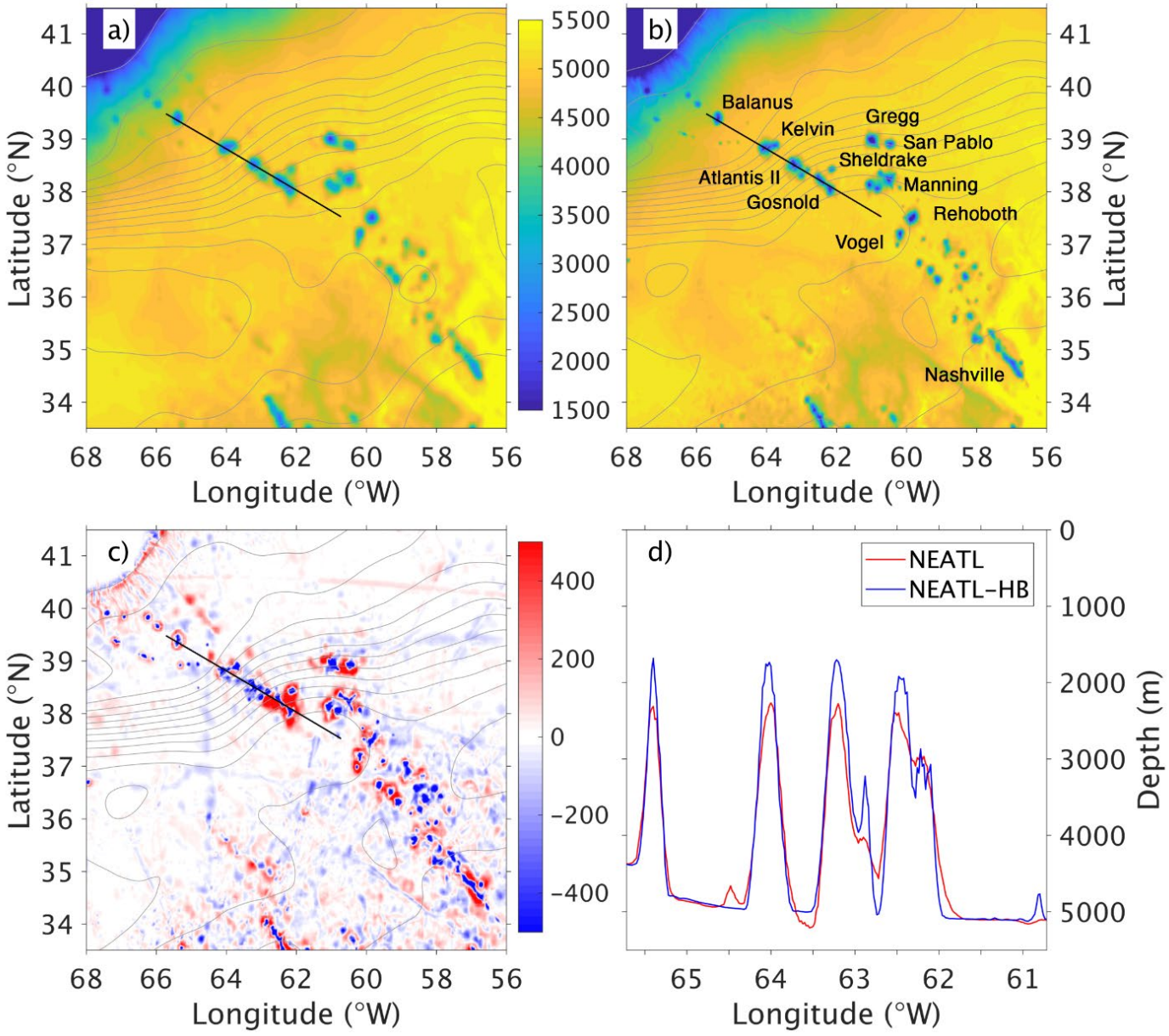




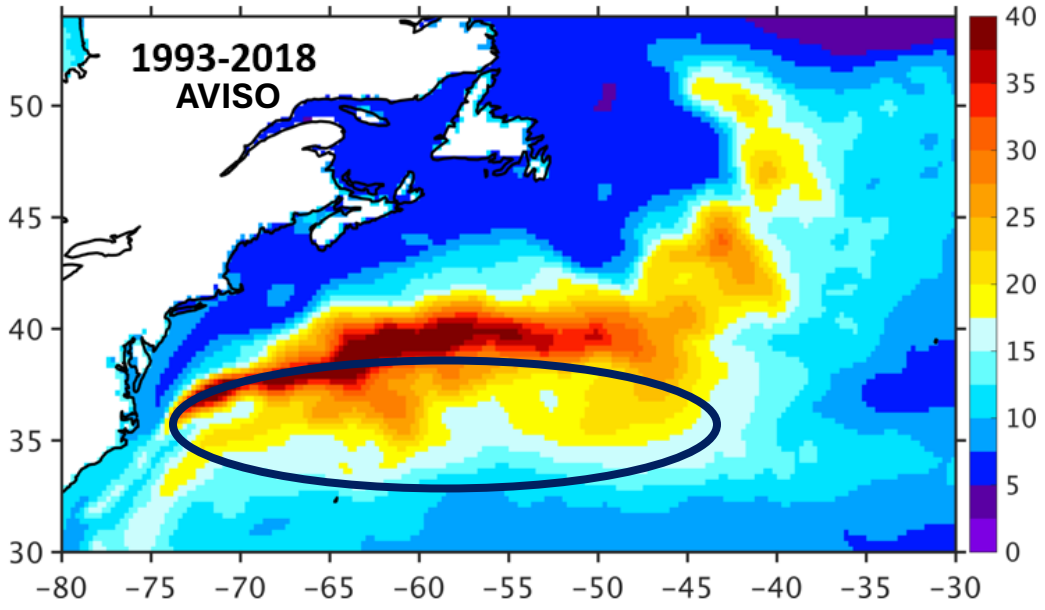
Discrepancy: Higher EKE around the NESMC

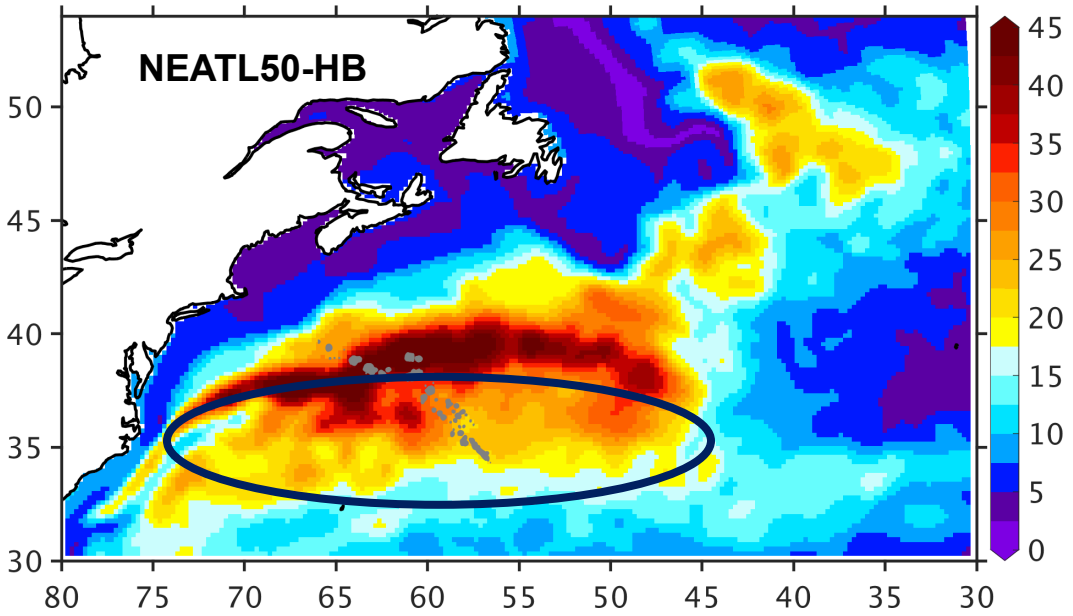


Small difference in bathymetry => high impact on EKE



Chassignet et al. (2023)

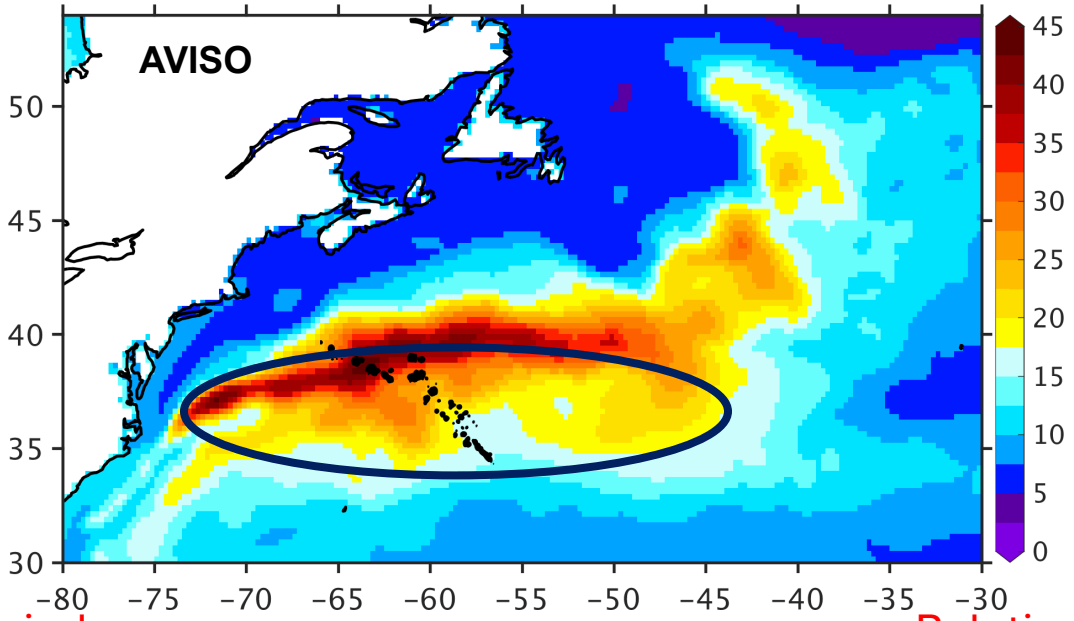




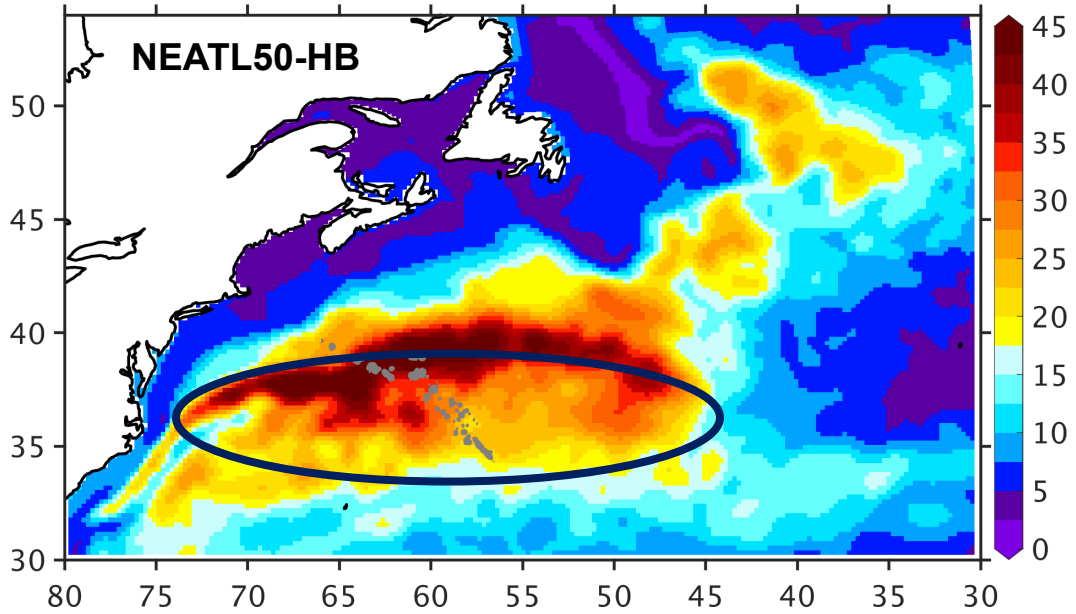
- **Viscosity as a function of grid spacing (1/12° and 1/25°)**
- **Same viscosity for 1/25° and 1/50°**

Still higher EKE upstream of the NESC and south of Gulf Stream

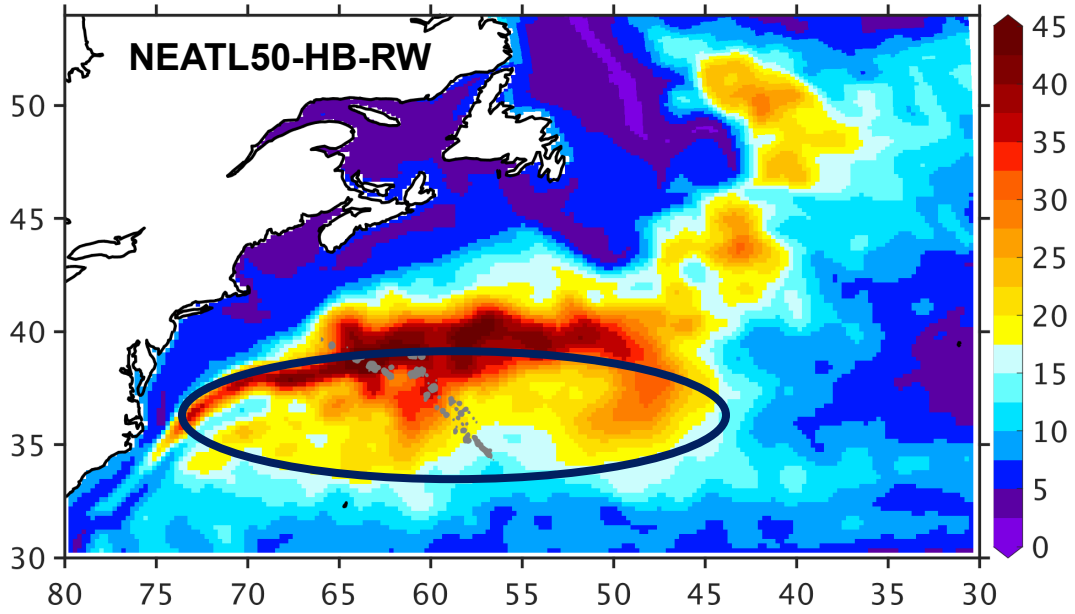
Relative wind impact on surface EKE



Absolute wind



Relative wind



Observations

- No clear mandate by agencies on how to further investigate ocean current feedback on the atmosphere and its impact on ocean prediction
- Competing interests and some duplication of efforts among agencies (NOAA, NASA, NSF, and ONR)
  - NOAA: No global high resolution coupled ocean-atmosphere system – upstaged by ECMWF and Met Office (1/10° ocean)
  - NASA: ***Prototype 1/24° ocean and 1/16° atmosphere*** (1 day of simulation for 1 day on computer time on 7,794 cores)
  - ONR: ***Ocean prediction with 1/25° ocean and T681L60 (18 km equivalent) atmosphere*** – no free run
  - NSF: NCAR 1/10° ocean and 1/4° atmosphere
- No US concerted effort to run km-scale ocean and atmospheric models, coupled or uncoupled.

Recommendations

- Sponsor a community effort to perform a coupled km-scale ocean – atmosphere nature run to better understand ocean-atmospheric feedback on short- and long-time scales
- Such a nature run can be used to improve multi-scale data assimilation techniques as well as an observing design system
- Promote ***OceanPredict.US***, an effort designed to coalesce the Nation's operational oceanography enterprise – US ocean prediction is fragmented when compared to the European Copernicus coordinated effort

OceanPredict.US

Coalescing the Nation's Operational Oceanography Enterprise

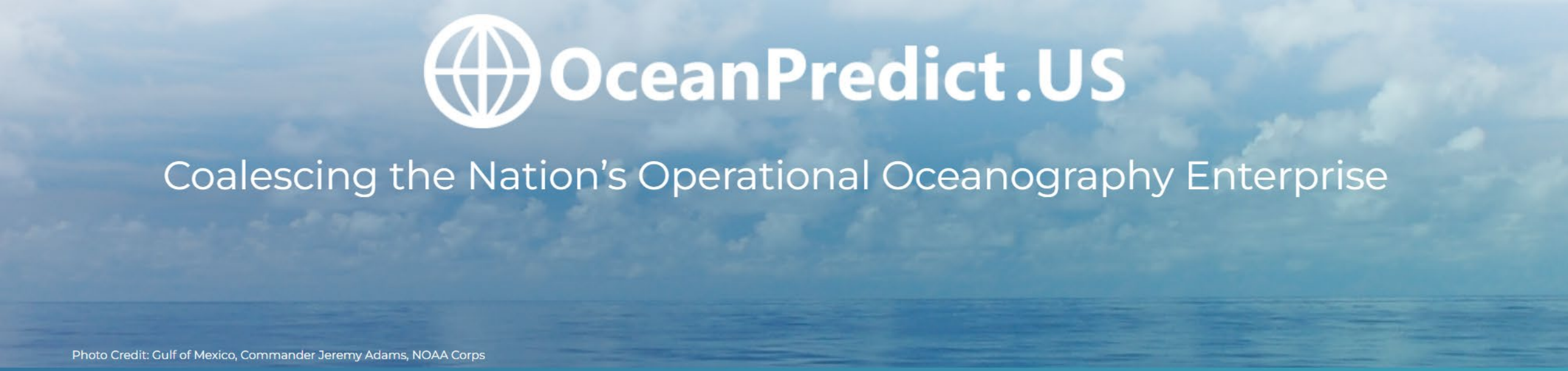


Photo Credit: Gulf of Mexico, Commander Jeremy Adams, NOAA Corps

VISION

Establish a framework for the U.S. operational oceanography enterprise, enabling the earth system science value chain from observation to decision-making and societal benefit.

Motivation

Operational oceanography within the U.S. needs to coalesce and evolve into a robust sustained national enterprise that knits together global, regional, and local components.

Transformative impact

OceanPredict.US aims coalesce the nation's operational oceanography components into a coherent national framework to integrate activities, inform decision-making, and provide greater return on ocean-observing investments.

Societal benefit

OceanPredict.US directly supports the Nation's contributions to addressing the United Nation's Sustainable Development Goals and provides the foundation for the Nation's Blue Economy and Blue Environment sectors.