Tracking Atlantic Water Pulses Simulated in an Ultra High-Resolution Ocean/Sea-Ice Model

Luke Dorrian, Julie L. McClean
Scripps Institution of Oceanography at University of California, San Diego

Abstract

Atlantic Water (AW) enters the Arctic through multiple passages with significant temporal and spatial variability. The fate of AW, including where it moves, mixes, cools and sinks is determined by the competition between many different physical processes. The progression of AW "pulses" is examined for 1990-2009 in a CORE II-forced ultra-high resolution coupled ocean-sea ice model. Through transect analysis and computation of the net ocean heat flux convergence, we examine the progression AW-sourced heat as it propagates through the Eurasian Basin.

Model Description

The UH8to2 coupled ocean/sea-ice simulation uses a tripolar global grid with poles located in Greenland & Siberia. Its resolution ranges from 8 km at the equator to 2 km near polar regions [1]. The ocean component is POP2 while the sea-ice component is CICE5. UH8to2 uses 60 z-levels, with vertical resolution from 10m over the upper 160 meters to 250m at depth, with a maximum depth of 5.5 km. The model is forced by the atmospheric reanalysis CORE-II CIAF [2] over 1975-2009 but is analyzed for 1990-2009

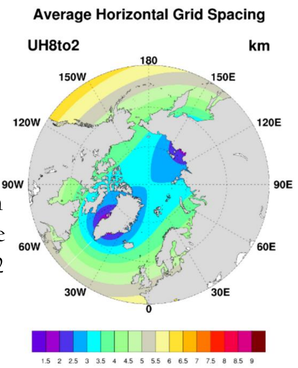


Fig 1. Square root of the horizontal area (km) of grid cells in the Arctic in the UH8to2 model [1]

Documenting Atlantic Water Pulses

The simulation shows AW reaching farther into the Eurasian Basin over the 2002-2009 period. Ocean instabilities help advect the AW signal to the interior [3]. This QR code can be used to view the 1990-2009 time evolution of the θ (potential temperature) field at 155, 351 and 1245 meters:

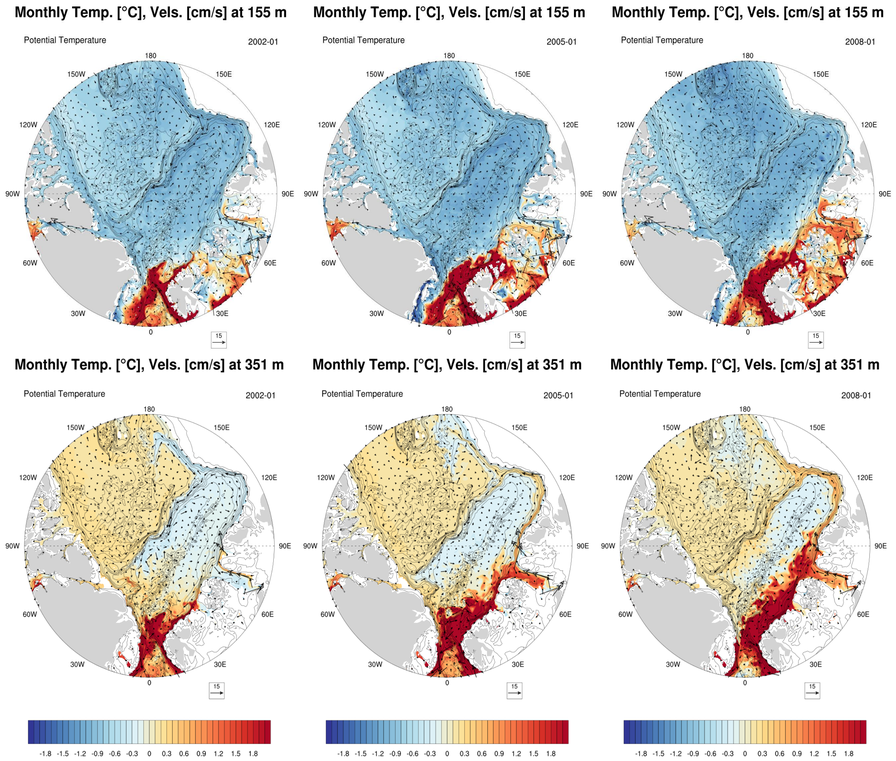
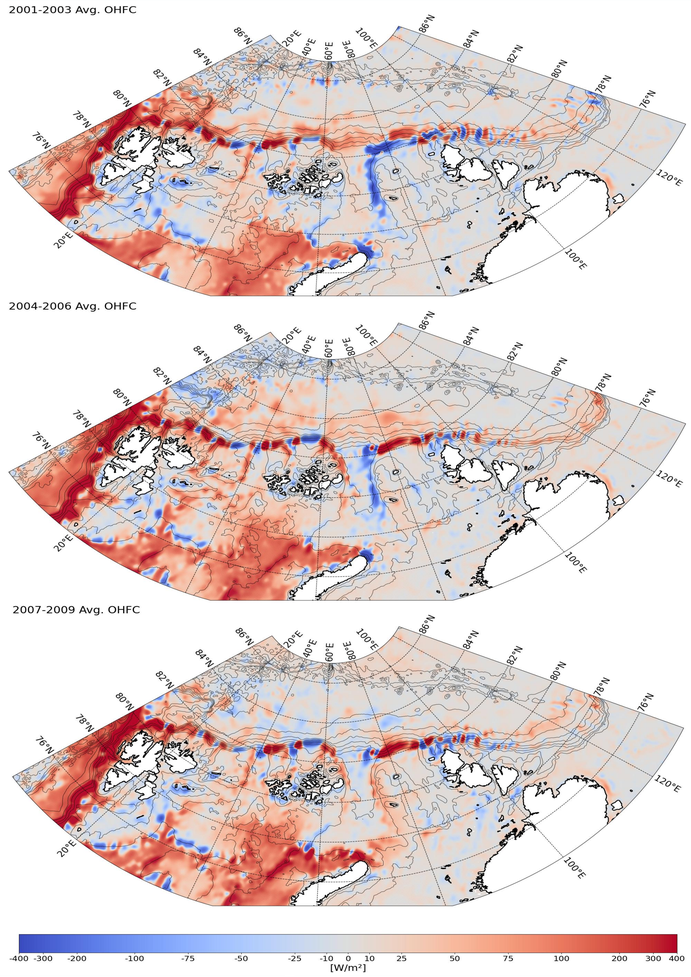


Figure 2. January 2002, 2005 and 2008 θ Field at 155m (top), 351m (bottom). Color ranges are uniform across plots. Isobath contours are plotted every 500 meters in addition to 100 and 250 meters.

Ocean Heat Flux Convergence



The ocean heat flux convergence (OHFC) is calculated using the total heat flux covariances (UET, VNT) integrated from the surface to the seafloor, converted to W/m^2. OHFC magnitudes are highest near the Fram Strait but remain large along the boundary currents in the Eurasian Basin.

According to **Fig. 5**, the western interior of the Nansen Basin experiences a surge in OHFC over the 2004-2006 period and then decreases over 2007-2009. Additionally, the St. Anna Trough changes from net heat divergence to convergence over 2007-2009.

Fig 3. 2001-2003 time-averaged OHFC (top) compared to 2004-2006 (middle) and 2007-2009 (bottom) period

Transect Analysis

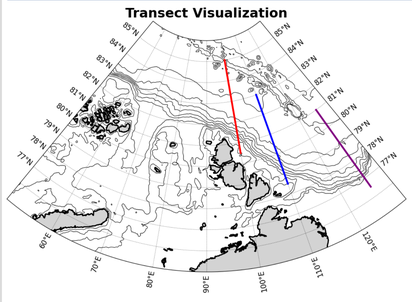


Fig 4. Visualization of the 100°E (red), 110°E (blue), and 126°E (purple) transects

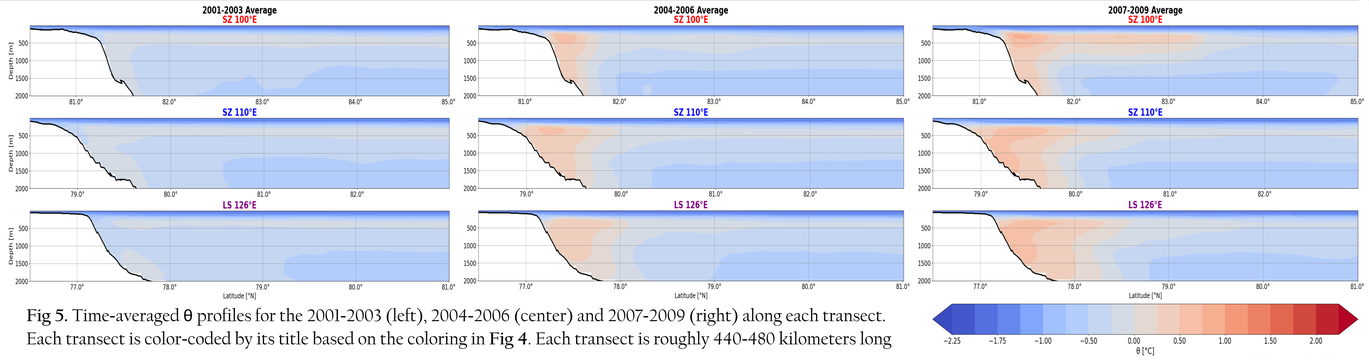


Fig 5. Time-averaged θ profiles for the 2001-2003 (left), 2004-2006 (center) and 2007-2009 (right) along each transect. Each transect is color-coded by its title based on the coloring in **Fig 4**. Each transect is roughly 440-480 kilometers long

AW first rapidly propagates along the continental slope with a deep θ signal. The arrival of more offshore AW often lags the onshore signal. For additional information, a compilation of the time evolution of θ along the transects is linked in the QR code to the right. It has been suggested from idealized modeling studies that an offshore baroclinic current could form via intense buoyancy loss [4].

Discussion and Future Work

We offer lateral and vertical information about the progression of AW pulses as simulated in an ultra high-resolution ocean-sea ice model. From visual inspection, some AW heat appears to be advected offshore in the form of eddies. The movement of these eddies aligns well with the isobaths, suggesting topographic steering. The combined effects of eddy dynamics and topography may offer a sustained pathway for AW to enter the interior of the Eurasian Basin. However, this must be investigated using methods like heat budget analysis and particle tracing. In addition, we are highly interested in comparing the representation of eddy dynamics, stratification and other processes relevant to AW pulses between UH8to2 and other ultra high-resolution simulations like FESOM2 and HYCOM.

Contact:

Luke Dorrian
Scripps Inst. of Oceanography/UCSD
9500 Gilman Drive, La Jolla, CA 92093
ljdorrian@ucsd.edu

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