Understanding global subsurface marine heatwaves

SHUJING ZHANG[1,2], NEIL J. HOLBROOK[1,2], ALEX SEN GUPTA[2,3], ANNIE FOPPERT[4]

[1] *Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania 7001, Australia*

[2] *Australian Research Council Centre of Excellence for Climate Extremes*

[3] *Climate Change Research Centre, The University of New South Wales, Sydney, New South Wales 2052, Australia*

[4] *Australian Antarctic Program Partnership, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, Australia*

Marine heatwaves (MHWs) are prolonged warm ocean temperature extremes that can have profound impacts on marine organisms. Most commonly, MHWs have been identified at the ocean surface using daily satellite sea surface temperature data, but they also occur in the subsurface. Recent studies have characterized subsurface MHWs within the global upper ocean, while there is a lack of global investigations into drivers due to sparse hydrographic observations. A comprehensive framework is needed to understand the underlying ocean processes responsible for global subsurface MHWs.

This study uses monthly ocean temperature (T) and salinity (S) from gridded ARGO data since 2004 to detect subsurface MHWs in the upper 2000m of the global ocean. Using a theoretical decomposition method, we differentiated temporal temperature changes caused by water-mass property shifts (spice) from those resulting from isopycnal displacements (heave). In the Northeast Pacific Ocean case study, we found both spice and heave contribute to subsurface temperature variabilities, with dominance varying by depth and season. Winter-spring variability in the upper 50-100dbar is driven by spice mainly due to local mixing and subduction, while summer-autumn variability is dominated by the heave of the thermocline. In the layer from 100-200dbar, year-round temperature variability is driven by the persistence of winter spice anomalies subducted from the surface. For depths below 200dbar, heaving processes emerge as the most significant driver of temperature variability throughout the year. This diagnostic approach which is applicable to any ocean region at any depth, not only provides insights into the physical processes but also helps to classify subsurface MHWs into different types that may have different impacts on pelagic marine species.