Journal of
Marine Science: Research & Development
Perspective Open Access

The Combining Modern and Paleoceanographic Perspectives on Ocean Heat Uptake

Abidan Cohen*

Department of Marine science, Hebrew University of Jerusalem, Israel

Introduction

Monitoring Earth's energy imbalance requires monitoring changes in the heat content of the ocean. Recent observational estimates indicate that ocean heat uptake is accelerating in the twenty-first century. Examination of estimates of ocean heat uptake over the industrial era, the Common Era of the last 2000 years, and the period since the Last Glacial Maximum 20,000 years ago, permits a wide perspective on modern-day warming rates. In addition, this longer-term focus illustrates how the dynamics of the deep ocean and the cryosphere were active in the past and are still active today. The large climatic shifts that started with the melting of the great ice sheets have involved significant ocean heat uptake that was sustained over centuries and millennia, and modern-ocean heat content changes are small by comparison [1]. Two main mechanisms can potentially explain the spread in the magnitude of global warming simulated by climate models: deep ocean heat uptake and climate feedbacks. Here, we show that deep oceanic heat uptake is a major source of spread in simulations of 21st century climate change. Models with deeper baseline polar mixed layers are associated with larger deep ocean warming and smaller global surface warming. Based on this result, we set forth an observational constraint on polar vertical oceanic mixing. This constraint suggests that many models may overestimate the efficiency of polar oceanic mixing and therefore may underestimate future surface warming. Thus to reduce climate change uncertainties at time-scales relevant for policy-making, improved understanding and modeling of oceanic mixing at high latitudes is crucial.

A central contemporary challenge of climate science is to reduce uncertainties of climate change projections. Indeed, even the simplest possible metric of climate change the global increase of surface air temperature in response to a given radioactive forcing remains uncertain [2]. For example, when forced by the SRESA1B emission scenario, the state-the-art climate models used in the last Intergovernmental Panel on Climate Change (IPCC) report [Intergovernmental Panel on Climate Change, 2007] simulate a globally-averaged mean surface air temperature change of 2.6 K between 2070-2099 and 1950-1999 (ΔTas), with a two-sigma range of 1.7-3.5 K. At the regional scale, the inter-model standard deviation of surface temperature change is often even larger than for the global average: For example, it is roughly two times greater over most of continental USA and locally more than four times greater over high latitude oceans. To assess the relationship between baseline climatological MLD and simulated surface warming, we correlated the models ΔTas to their zonally-averaged MLD, for each latitude band [3]. Except in a few regions, the correlations are negative. Not surprisingly, large and statistically significant negative correlations are found only at high latitudes. In particular, very high negative inter-model correlations are obtained in the southern polar region (-0.7 to -0.8). Thus models with deeper baseline mixed layers at high latitudes are associated with smaller surface warming: the inter-model correlation between Tas and the spatial average of MLD south of 68°S and north of 58°N (MLDp in the following) is -0.82. The effect of deeper mixed layers at high latitudes on surface warming is global and not limited to Polar Regions. Monitoring Earth's energy imbalance requires monitoring changes in the heat content of the ocean. Recent observational estimates indicate that ocean heat uptake is accelerating in the twenty-first century. Examination of estimates of ocean heat uptake over the industrial era, the Common Era of the last 2000 years, and the period since the Last Glacial Maximum, 20,000 years ago, permits a wide perspective on modern-day warming rates. In addition, this longer-term focus illustrates how the dynamics of the deep ocean and the cryosphere were active in the past and are still active today [4]. The large climatic shifts that started with the melting of the great ice sheets have involved significant ocean heat uptake that was sustained over centuries and millennia, and modern-ocean heat content changes are small by comparison.

References

1. World Food and Agriculture -Statistical Yearbook 2020. Rome FAO: 366.
2. Half of Fish Consumed Globally is Now Raised on Farms, Study Finds. Science Daily: September 8, 2009.
3. Lloy R (1992) Pollution and Freshwater Fish. West By fleet: Fishing News Books.
4. Mance G (1987) Pollution Threat of Heavy Metals in Aquatic Environments. London: Elsevier.
5. Chellappa S, Bueno RMX, Chellappa T, Chellappa NT, Val VMFA (2009) Reproductive seasonality of the fish fauna and limnoecology of semi-arid Brazilian reservoirs. Limnologica 39: 325-9.

***Corresponding author:** Abidan Cohen, Department of Marine science, Hebrew University of Jerusalem, Israel; E-mail: xingmei.001@tsinghua.org

Received: August 01, 2021; **Accepted:** August 14, 2021; **Published:** August 21, 2021

Citation: Cohen A (2021) The Combining Modern and Paleoceanographic Perspectives on Ocean Heat Uptake. J Marine Sci Res Dev 11: 326.