These Frequently Asked Questions (FAQs) have been written in support of "Industrial Era Global Ocean Heat Uptake Doubles in Recent Decades" By Peter J. Gleckler, Paul J. Durack, Ronald J. Stouffer, Gregory C. Johnson and Chris E. Forest – published in *Nature Climate Change* online 18 January 2016 (DOI: 10.1038/nclimate2915).

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Why is it important to understand ocean temperature changes?
The heat capacity of the Earth's entire atmosphere is equaled by the top 3.5 meters (11 feet) of the ocean, a very small fraction compared to the amount of heat stored by the full-depth ocean. Accordingly, the ocean's massive heat capacity accounts for more than 90% of the heat gained by the climate system over the last several decades as greenhouse gas concentrations have increased. Thus, to obtain an accurate estimate of how much the Earth has warmed, it is critical that we have accurate global ocean temperature measurements.

How do scientists measure ocean temperature?
The H.M.S. Challenger expedition (1872—1876) provided an early globe-circling set of high quality measurements of subsurface ocean temperature. Measurement methods have evolved since then, with increasingly sophisticated and accurate observations from research vessels stopped "on station" eventually supplemented by less accurate but more plentiful data from underway measurement systems on research, commercial, naval, and other vessels. Development of the robotic drifting ocean profiling instrument called the Argo float has radically changed the amount of ocean information available to scientists. Starting from a few Argo floats in 1999, a global partnership of oceanographers has grown the array to more than 3,900 in 2015. These instruments drift freely in the oceans, providing oceanographers with measurements of temperature to 2,000-meters (6,500 feet) depth. Thanks to Argo, we now have a much better observational coverage of the upper half of the global ocean volume than would ever be possible from ships.

Are climate models reliable tools to investigate observed changes to ocean temperature?
Climate models are routinely tested by comparing them to observations on various space and time scales within the ocean, atmosphere, land, and ice systems. Discrepancies highlight places where models have problems but can also highlight issues with the observations. For example, there are some cases where consistency tests between climate models and observations have helped uncover problems with observational data, for example with satellite based microwave measurements of lower atmospheric temperature. For the oceans, the key difficulties are the scarcity of ocean observations combined with a changes in the observing system over time. By making careful comparisons of changes in average ocean temperatures over time spans and depth layers that take these evolving, sparse observations into account, model performance can be tested and validated under these constraints.

What are the implications of long-term ocean warming?
Quantifying how much heat is accumulating in the Earth system is critical to improving our understanding of climate change already underway and to better assess how much more we can expect in decades and centuries to come. Our comparisons of various observed estimates of ocean warming over a range of time and depth ranges to results from the latest generation of climate models validates the performance of these models. In turn these models estimate that half the ocean warming since the start of the industrial era has occurred in the last two decades. A key lesson to be learned from our work is that observing the global ocean is critical. Recent improvements in global coverage of ocean observations in the upper half of the ocean volume have substantially increased our ability to diagnose changes in the climate system. With ocean warming penetrating to full ocean depth in models and observations in recent times, in order to better understand past and future climate changes, it is imperative that the full-depth global ocean be adequately observed, as it plays a critically important role in the Earth's climate and its change.

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