# The 20th century global warming signature on the ocean at global and basin scales as depicted from historical reanalyses

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**Abstract**

Ocean heat content and its changes are fundamental metrics to monitor climate change. However, due to sparse observation sampling before the 1950s, accurate observation-based estimations only exist for the second half of the 20th century. A 16-member ensemble of historical ocean reanalyses is used for the first time to compile a unique estimate of 20th century oceanic warming rates. The reanalyses combine dynamical ocean general circulation models with historical observations and observation-based atmospheric forcing. Ocean heat content tendencies (OHCT) from the multireanalysis ensemble (MRE) agree well with independent estimates of ocean heat content, and show a coherent evolution with records of Earth's energy imbalance from atmospheric reanalyses and atmospheric CO2 concentration at a range of timescales. OHCT from reanalyses proves to be a more effective climate change proxy, that is, more closely related to independent climate indexes, than observed surface warming tendencies that contain high-frequency variability not related to the climate change signature, or historical coupled model simulations, which neglect interannual fluctuations. The ensemble mean estimate of the century-long ocean warming rate is 0.26±0.08Wm–2. The warming rate of 0.84±0.21Wm–2 estimated from 1993 onwards is unprecedented. The global decadal warming rate is persistently positive from about 1925 onwards, except for two neutral periods. The Indian Ocean exhibits the highest relative contribution to centennial heat accumulation, while the Atlantic Ocean plays an increasingly prominent role, especially during the 1995–2004 decade. These findings are in agreement with previous studies.

**Keywords:** historical reanalyses, ocean heat content, EEI, ensemble reanalyses

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