Abstract:

Separating slow natural variations and trends from possible effects of anthropogenic climate change is made very difficult by the dearth of long, consistent ocean time-series. The Hawaii Ocean Time-series (HOT) project has provided a benchmark dataset for the North Pacific subtropical gyre, at Station ALOHA, north of Oahu, since 1988. The first 21 years of HOT data provide useful information on decadal variability and trends after accounting for annual and shorter period variations.

Robust decadal variations and linear trends with complex vertical structure emerge for temperature, salinity and density. Dynamic height (0/1000 dbar) increased ~1.6 mm/yr, comparable to mean sea level changes in the Hawaiian Islands, and to estimates of the thermal expansion contribution to global mean sea level rise. However, maximum warming in the upper ocean is not at the surface, and cooling actually occurs near 250 m. Density decreased in the upper 1000 m, except in the upper 50 m where the warming trend (~0.12K/decade) was more than offset by increasing salinity in the upper 170 m. The mixed layer (ML) deepened by 4.4 m/decade.

Reanalyses show large decadal variations of surface forcing (wind stress and buoyancy fluxes), as well as large differences among analyses, making trend estimates very uncertain. Rainfall based on rain gauge data from the Hawaiian Islands and from satellite estimates appears to have decreased over the HOT record, which is consistent with the increase of upper ocean salinity at ALOHA. The explanation of these results involves spatially-varying trends in surface forcing, as well as variations in advection. Adequately quantifying these variations will require sophisticated ocean circulation models with advanced data assimilation techniques.