Session: C9 Poster: M163A

Climate change in upper-ocean stratification as inferred from the IPCC-Ar4 models

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The stratification in the upper-ocean influences both entrainment of nutrient-rich deep waters in the surface layer, as well as deep-water ventilation. Both processes (entrainment and ventilation) have a large influence upon biological activity in the euphotic zone by regulating the nutrient supply and oxygen levels. The projected sea surface temperature (SST) increase is expected to reduce the surface density, leading to increased stratification. Global warming is also expected to change the hydrological cycle, with increased precipitation vs. evaporation in the Tropics and high-latitudes, and reduced precipitation in the Subtropics. Thus, surface salinity will also change. In this study we will use a subset of the IPCC-AR4 models to examine the changes in the surface density over the World Ocean, and the relative contribution of temperature and salinity to the density changes. The changes are computed as differences between the average conditions in 2050-2099 from the SRES-A2 emission scenario for the 21st century, and 1950-1999 from the 20th century simulations. An estimate of upper-ocean stratification is obtained by considering the difference between density at 200m and surface density. Our results show large increases in stratification in many areas of the World Ocean, and in particular in the northeast Pacific. According to some models, stratification changes can be as large as 100% in the Gulf of Alaska and in the California Current System, with salinity being the major contributor.