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Two empirical seawater density models estimated based on the analysis of WOA09 and WOCE-04 oceanographic data

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We formulate two empirical seawater density models which closely approximate the actual seawater density distribution. A methodology of finding the empirical density models is based on the analysis of the oceanographic data of pressure/depth, salinity, and temperature from the World Ocean Atlas 2009 (provided by NOAA's National Oceanographic Data Center) and the World Ocean Circulation Experiment 2004 (provided by the German Federal Maritime and Hydrographic Agency). The seawater density values are calculated according to the thermodynamic equation of seawater TEOS - 10. The global seawater density model is defined as a function of the ocean depth (to account for density variations due to pressure) and geographical latitude (to account for density variations due to salinity and temperature). A more complex functional density model is then formulated to account for a large seawater density gradient within the pycnocline caused mainly by a combination of decreasing water temperature and increasing salinity with depth. The results of numerical analysis reveal that the new functional model based on the depth and latitudinal density variations approximates the actual seawater density distribution with a relative accuracy better than 0.45%. When incorporating the pycnocline density gradient correction, the accuracy further improves to about 0.25% (except for the shelf seas with the presence of the continental hydrological signal and other oceanographic factors). The results also show that the average seawater density (estimated from the experimental data used in this study) is 1038.5 $\pm$ 2.4 kg/m3.