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The performance of different vertical turbulence parameterizations in modelling the development of the seasonal thermocline in the Gulf of Finland

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The effect of different parameterisations of vertical turbulence on the accuracy of the seasonal thermocline evolution was studied with a 3D hydrodynamic model COHERENS in the Gulf of Finland in the Baltic Sea. The vertical turbulence parameterizations used in this study included two algebraic parameterizations and k-model with four different sets of stability functions. The modelled values of temperature were verified against hydrographic dataset with over 300 vertical profiles of temperature measured in the Gulf of Finland in June-August 1996. The sea surface temperature was modelled with relatively good accuracy with all the turbulence parameterizations. The comparison of the calculated mean values of thermocline depth for the whole summer and for individual months showed that all turbulence parameterisations underestimated the thermocline depth. However, there were differences in the ability of the different turbulence parameterisations to model the thermocline depth. The mean values were estimated with highest accuracy with k-model using the stability functions based on Munk-Anderson relations when no limitations for the mixing length were applied. The comparison of individual profiles showed that generally there was too low gradient in the modelled temperature profiles compared to the measured profiles. The sensitivity of the modelled thermocline depth on the accuracy of the meteorological forcing was studied by increasing the forcing wind speed to better match the measured values of wind speed in the central Gulf of Finland. The sensitivity test showed that an increase in the wind speed only slightly improved the performance of the turbulence parameterizations in modelling the thermocline depth and that the underestimation of the thermocline depth was still of order of several meters. Further studies are needed to evaluate the effect of improved horizontal and vertical resolution and thus better description of the bottom topography on the accuracy of the modelled vertical temperature stratification.