

Regional sea level change and ocean heat uptake in the Southern Ocean

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The Southern Ocean is one of the main regions of ocean heat uptake. We have analysed its regional patterns and its regional contribution to thermosteric sea level change in the 20th and 21st centuries, using output from the AR4 climate model ensemble. For the last three decades of the 20th century, the ensemble mean shows significant heat uptake in sections of a band around 45oS, north of the Antarctic Circumpolar Current (ACC). About half of this heat is taken up by the deep ocean below 700m depth. In the SRES A1B scenarios for the 21st century, the ensemble mean shows a significant ocean heat uptake in almost the entire Southern Ocean, with the exception of the south-west Pacific. For a subset of the models, we studied the roles played by the different heat transport processes (isopycnal, diapycnal, advective, convective) to establish the band pattern. The relation between across-model variance and the initial stratification of the model oceans was analysed. North of the ACC, the pattern of thermosteric sea level rise resembles that of ocean heat uptake. By contrast, substantial heat uptake in the south-east Pacific is hardly reflected in thermosteric sea level rise. This can be related to the small expansion coefficient at low temperatures, and to the heat being taken up and transported away by Antarctic Bottom Water (AABW). Deep ocean heat uptake - below 2000m - is significant in the ensemble mean in large parts of the Southern Ocean and the South Atlantic. The results stress that a considerable part of the total ocean heat uptake happens in the deep layers, calling for their improved observational coverage.