Geophysical Research Abstracts, Vol. 7, 10457, 2005
SRef-ID: 1607-7962/gra/EGU05-A-10457

The global ocean response to Southern Ocean surface warming

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The global ocean response to Southern Ocean surface warming is studied in an ocean model coupled to an atmospheric boundary layer model. The anomalous warming, imposed by reducing the surface heat loss due to long-wave radiation south of 35S, spreads northward in all basins by means of fast boundary-trapped Kelvin waves and by relatively slow advection in the eastern portions of the Southern Hemisphere subtropical gyres.

The largest changes in temperature take place at the 200-meter depth in the Pacific; the upper-ocean stratification in the tropical Pacific is effectively weakened and the thermocline is deepened, which has possible implications for ENSO. The temperature response in the Atlantic and Indian Oceans are noticeably weaker than in the Pacific. In particular, the anomalous warming in the Atlantic appears to be limited to the latitudes south of 35S; the warming in the Indian Ocean is also initially delayed compare to the Pacific basin, but later occurs due to anomalous heat advection in the Indonesian Throughflow. This asymmetry between the response in the Pacific and in the Atlantic and Indian basins is partly attributable to the differences in the adjustment of the circulation in the respective basins, as demonstrated by a “passive temperature” tracer experiment. For this experiment, anomalous surface heating is not applied, the circulation does not evolve from its initial state, and the passive tracer is subject to the same surface forcing as is the temperature in the main run. The tracer distribution evolves more similarly in the three basins than the temperature did in the main run. The changes in the tracer are, nevertheless, still more pronounced in the Pacific, which is explained by greater southward extent of the basin’s eastern boundary.