

## Role of the Southern Ocean in the post-2002 global warming hiatus

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In spite of increasing atmospheric CO<sub>2</sub> concentration, the warming rate of the global-mean surface temperature slows down in the twenty-first century. Almost all of Coupled Model Intercomparison Project phase5 (CMIP5) climate model simulations fail to reproduce this global warming hiatus. Here, we discuss how the excess energy from top-of-atmosphere is stored in the ocean and quantify the influence of the ocean heat uptake on the surface temperature anomaly. Our numerical simulation, where wind stress anomaly in the equatorial Pacific Ocean is prescribed from reanalysis data, suggests that subsurface warming in the Pacific Ocean takes place at the beginning phase of global warming hiatus (1998-2002) as reported in a previous study. We newly clarify that this subsurface anomaly is transported into the Southern Ocean at the latter phase of hiatus (after 2002), which leads to Southern Ocean heating acceleration below subsurface. The historical observed data of ocean temperature also supports this scenario; warming trend of the Southern Ocean after 2002 is detected in data and its spatial pattern is consistent with our simulation. This result provides us with a clear evidence that the deeper parts of the Southern Ocean has a critical role in the post-2002 global warming hiatus.

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