



## **What causes ocean heat transport into the modern Atlantic Ocean?**

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An important feature of the modern global overturning circulation is the southern inflow to the Atlantic Ocean of warm upper ocean water from the Indo-Pacific oceans, compensated by an outflow of dense water. This is traditionally attributed to deep water formation occurring in the North Atlantic, but not in the Indo-Pacific oceans. Here, semi-analytical theory and numerical experiments with an intermediate complexity model are used to show that the classical interpretation is incomplete.

More deep upwelling occurs in the Indo-Pacific oceans than the Atlantic Ocean because there is more energy available for diapycnal mixing to balance the upwelling. (In most models, which lack horizontal variations in vertical diffusivity, this is simply because the Atlantic is small compared with the Indo-Pacific oceans.) This net upwelling is essential to maintain interbasin exchanges. By increasing the relative strength of the energy source in the Atlantic basin, it is found that net Indo-Pacific to Atlantic heat transport can be reduced almost to zero without reducing North Atlantic deep water formation or introducing North Pacific deep water formation. This result is obtained whether or not deep water formation and/or upwelling in the Southern Ocean is present.

These findings have implications for ocean circulation during the Last Glacial Maximum, when tide model evidence suggests that there may have been more energy available for diapycnal mixing in the deep North Atlantic than in the Indo-Pacific oceans.