Climate effects of ocean overturning on heat content anomalies and atmospheric CO_2

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The climate effect of the meridional overturning circulation (MOC) is discussed in terms of two separate examples, the connection with decadal heat anomalies in the North Atlantic and the longer-term connection with atmospheric CO_2. Firstly, historical temperate date over the last 60 years suggest that there are thermal anomalies extending to depths of 1 to 2 kilometres over the subtropical and subpolar gyres, which often have the opposing sign in each gyre. A dynamical assimilation of the historical data suggests that these decadal thermal anomalies are primarily formed by the convergence in ocean heat transport: the subtropical thermal anomalies are mainly controlled by the convergence in the Ekman heat transport, while the subpolar thermal anomalies are instead controlled by the convergence in the MOC-Ekman heat transport. Secondly, coupled carbon and general circulation model experiments suggest that there is a long-term effect on atmospheric CO_2 whenever overturning anomalies connect to changes in the Southern Ocean: increasing residual circulation leads to increasing long-term atmospheric CO_2. This relationship is a consequence of partly compensating processes, increased overturning enhaces the subduction of carbon, but at the same time enhancing the upwelling of regenerated carbon.