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Sensitivity of heat transport and its vertical structure to vertical mixing and to a shutdown of the Atlantic overturning circulation

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The sensitivity of the ocean's poleward heat transport to vertical mixing has been the object of a number of studies. Most of them employ ocean general circulation models (OGCMs) with idealized basin geometries and/or surface boundary conditions, and often without surface winds. Here we address this issue by using a climate model consisting of an OGCM coupled to a statistical-dynamical atmosphere. The Atlantic poleward heat transport is found to be sensitive to the background vertical mixing only at low latitudes; elsewhere the associated changes are negligible. Even in this region, a weaker sensitivity is found compared to previous work with uncoupled OGCMs, but consistent with a recent study with a climate model of similar complexity. In order to assess the oceanic heat pathways contributing to the poleward oceanic heat transport, we calculate the heat function, recently introduced by Boccaletti et al. (2005). The surface intensification of northward heat transport is similar to previous results and shown not to depend strongly on the value of the background vertical diffusivity employed. Under a shutdown of North Atlantic deep water formation leading to a collapse of the North Atlantic meridional overturning circulation, the Atlantic northward heat transport is reduced by 60-80% at most latitudes, with the interhemispheric heat transport practically vanishing. The largest heat function anomalies are found within the upper ocean. Our results thus suggest a relevant role of the Atlantic meridional overturning circulation in the northward oceanic heat transport through its effect on the upper flow, even far away from deep water formation regions.