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A decomposition of the Atlantic Meridional Overturning Circulation into physical components using its sensitivity to vertical diffusivity

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We investigate the sensitivity of the Atlantic meridional overturning circulation to the vertical diffusion parameter κ in the global coupled atmosphere-ocean-sea-ice model CLIMBER-3α. The particularity of the oceanic general circulation component is its low-diffusive tracer advection scheme. We decompose the strength M_{max} of the Atlantic overturning into three components: (1) the flow M_S exported southward at 30° S, (2) the upwelling that balances vertical diffusion in the Atlantic, and (3) a wind-dependent upwelling W_{bound} along the Atlantic boundaries that is not due to vertical diffusion. The export of water at 30° S varies only weakly with κ, but is strongly correlated with the strength of the overflow over the Greenland-Scotland ridge. Location of deep convection is found to be mixing dependent such that a shift from the Nordic Seas to Irminger Sea is detected for high values of κ. The diffusion-induced upwelling in the Atlantic is mostly due to the uniform background value of κ while parameterisation of enhanced mixing over rough topography only weakly contributes to the overturning strength. It increases linearly with κ. This is consistent with the classic 2/3 scaling law only when taking the linear variation of the density difference to κ into account. W_{bound} is roughly constant with κ but depends linearly on the wind stress strength in the North Atlantic. Conclusions are drawn concerning the scaling of M_{max} with κ and its validity.