The Shallow, Intermediate and Deep Overturning Components of the Global Heat Budget

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SESSION OA4: THE GLOBAL OCEAN CIRCULATION

Meridional transports of mass, heat and freshwater are calculated using geostrophic velocity fields from previous studies [Reid's (1994, 1997) Atlantic and Pacific analyses and Robbins and Toole's (1997) Indian analysis] and Ekman transports based on Climatological winds. The results are presented as global overturning streamfunctions. Mass, heat and freshwater transports are also separated into process-based components: (1) shallowest component associated with wind-driven subtropical gyres in which warm waters are advected poleward by western boundary currents, cooled and returned equatorward in the interior in subducted layers. (2) The intermediate and deep components are associated with transport of warm waters which are transformed at subpolar and higher latitudes and return at depth. The calculated heat transports are too numerous to recount here -the N. Pacific shows the expected shallow overturn dominance and the N. Atlantic the Labrador Sea Water / North Atlantic Deep Water, with about equal contribution from both; recognition of the importance of LSW formation is critical. In the southern hemisphere, formation of Antarctic Intermediate Water and Southeast Indian Subantarctic Mode Water account for as much heat transport as LSW and NADW formation in the northern hemisphere. Complications in interpretation arise from the Indonesian throughflow connection between the Pacific and Indian and the continuity of the subtropical gyre between the Atlantic and Indian Oceans.

In the N.Pacific, the shallow gyre accounts for about 0.57 PW of the total of 0.63 PW total meridional heat transport, while North Pacific Intermediate Water formation accounts for only a very small amount. In the North Atlantic, the shallow gyre overturn accounts for 0-0.3 PW of the total 1.2 PW northward heat transport; Labrador Sea Water formation accounts for about 0.3 PW and North Atlantic Deep Water (NADW) formation about 0.6 PW. In the southern hemisphere, the Indian Ocean balances indicate inflow of 0.3 PW from an Indonesian throughflow mass balance of about 0.3PW, outflow of about 0.2 PW for each of the Southeast Indian SAMW and Antarctic Intermediate Water, and outflow of about 0.35 PW due to abyssal upwelling into the thermocline.