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Modelling ocean circulation in Deep-ocean aquaplanets

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Léger et al. (2004) and Küchner (2003) hypothesised that Ocean planets, Super-Earth planets with liquid-water oceans covering their whole surfaces may exist.

Planets with liquid water surfaces could have ocean depths of 70-100 km with bottom pressures of 1-5 GPa. To date, no general circulation models have been run on such oceans, primarily because of a lack of equation of state for seawater at such depths.

In this work a deep-water seawater Equation of State is implemented in the MITgcm ocean model. The EOS depends not only on the salinity and temperature but also on CO_2 concentration. Several proposed ocean compositions, in particular magnesium and sodium sulphates salts ,$H2O$ / ammonia mixes are investigated.

While geothermal plumes in pure water systems will rise through an the whole ocean depths, saline-enriched plumes do not, due to differential thermal expansions for saline fluids leading to a loss of buoyancy (Melosh et al., 2004). Vance and Brown (2005) have shown that double-diffusive convection is expected to be a significant feature of such high-pressure oceans: depending on ocean composition, a double-diffusive layer will frustrate deep ocean convective processes and hence heat transfer. Convection happens separately in the warm, saline layers below and cooler, more dilute layer above.

While this has been seen in isolated areas on Earth, such as the Red Sea, we explore the effects of heat and salin transfer through this layer on global circulation for deep ocean planet.