Student summary for the lecture by Ole Anders Nøst (Some basic ocean dynamics and the Southern Ocean circulation) by Ivana Cvijanovic

Effects of rotation - main concepts:

1. Geostrophic approximation: based on the balance between the Coriolis force and the pressure gradient force, flow parallel to isobaths, valid for small Rossby numbers, no change in vertical velocity component with depth.

2. Thermal flow: change of geostrophic flow with depth (vartical shearing of geostrophic wind) - parallel to isopycnals

3. Ekman transport: surface current moves to the right of direction of surface wind (in the Northern Hemisphere). And the movement of each layer of water is affected by the movement of the layer above in the same way (they continue turning to the right). The net movement of ocean water due to the wind is perpendicular to the wind (to the right of the wind in the NH and to the left in the SH)

4. Potential vorticity: conservable on a flow in absence of frictional or diabatic processes (conservation of angular momentum). A change in depth causes a change in circulation which forces the circulation to follow constant depth.

Rotation is important for large scale motions ($L > 10$ km) and overturning can not occur at these scales, at smaller non-rotation dominated scales overturning can occur (by means of eddie transport).

Southern Ocean circulation:

Main circulation features in the Southern ocean are the Antarctic Circumpolar Current (ACC), Ross Gyre and the Weddell Gyre.

ACC is the only current that can follow unblocked latitude circles and due to this eddy fluxes play an important role in heat transport (heat is transported by the eddies because no net meridional geostrophic flow can exist across the unblocked latitudes). This also has an effect in isolating the Antarctic continent from the warmer waters at lower latitudes and contributes the glacial climate of Antarctica; the heat that is carried poleward to balance the heat lost to the atmosphere is carried only by eddies.
Deep water spreads poleward and upward across the ACC and is balanced by equatorward flow of lighter and denser layers. This is partly due to the wind stress acting on the sea surface: south of the westerly wind stress maximum, the Ekman transport is divergent and deep water upwells into the surface layer; north of the westerly wind maximum, the Ekman transport is convergent and surface waters are downwelled into the ocean interior. The water masses exported from the Southern Ocean to lower latitudes as a part of this overturning circulation are responsible for renewing the intermediate and abyssal depths of the southern hemisphere oceans (Rintoul et al.).

Poleward of the ACC, in the Weddell and Ross seas, two cyclonic gyres are located. Circumpolar Deep Water (CDW) enters the Weddell gyre near its eastern edge at 25–30E. Within the gyre the CDW is modified and gradually cooled through mixing with adjacent water masses and upwelling/entrainment near the margins and in the interior.