The Antarctic Circumpolar Current (ACC) has been traditionally considered an “equivalent barotropic” current, where the direction of flow does not change with depth. Such velocity profiles are seen in numerical simulations (e.g. the Fine Resolution Antarctic Model) and in direct current meter measurements where instruments are spaced 100s of metres apart. However, rotation of the flow with depth is clearly seen in new high-vertical-resolution direct measurements of ACC velocity profiles from EM-APEX floats at the northern Kerguelen Plateau. Rotation with depth is particularly enhanced in profiles around a large cyclonic meander to the northeast of Kerguelen. Vertically-smoothed profiles from these floats show flow out of the meander at the surface and into its centre at depth, suggesting a vertical flow from deep to surface layers.

In this talk we describe the rotation in the velocity profiles and its relationship with the phase of the meander. We then explore two implications of the observed non-equivalent barotropic flow. For the flow to rotate with depth, the vertical structure must be significantly affected by vertical modes higher than the barotropic and first baroclinic modes. A linear decomposition into dynamical modes quantifies the relative contributions of each mode to the velocity field. We also investigate the implied upwelling in the cyclonic meander, estimating the vertical velocity from the equation for the conservation of heat.