Master project

# Stratified flow of the Antarctic Circumpolar Current

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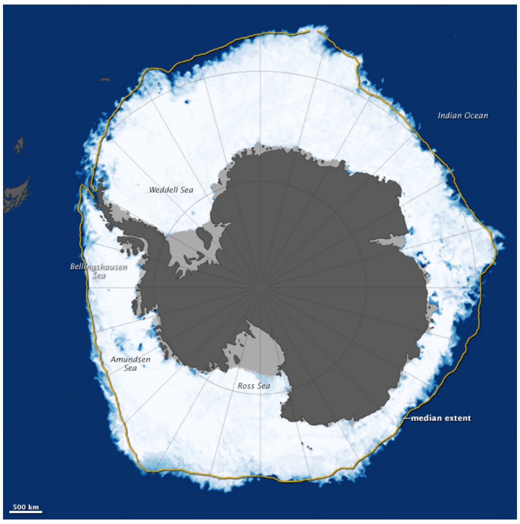
## Background.




*Antarctic Circumpolar Current* (ACC) is the only major current that circumnavigates the globe flowing eastwards through the southern regions of the Atlantic, Indian and Pacific Oceans along 23,000 km and having (in places) a width of over 2000 km. It is driven by the wind and the Coriolis forces, and it protects Antarctica from penetration of warm tropical waters, which results in the ice-sheet formation.

Besides the geographical location and forces that cause water circulation in the ocean, one needs to emphasize another important feature, which is a *stratification*. This is due to the differences in density, with warmer, lighter, less salty water layering on top of heavier, colder, saltier water. Mixing between layers occurs as heat slowly seeps deeper into the ocean and by the action of current, winds, and tides. But the greater the difference in density between the layers, the slower and more difficult the mixing becomes. This means that the water in the upper layers of the flow gets warmer and as a result intensifies ice melting.

## Project description and methodology.

The original model of the ACC (see [1]) was derived in spherical coordinates from the Euler equations. It was assumed that the water density is constant throughout the flow and thus, no stratification is present. However, recent research shows that inclusion of these effects leads to more realistic models [2, 3].

*In this project you will:*

**1.** Extend the model of the stratified flow of the ACC in spherical coordinates.
**2.** Derive equations for the free surface and for the interface.
**3.** Analyse properties of the flow, described by the obtained stratified model.

## References.

[**1**] A. Constantin, R. S. Johnson, *An Exact, Steady, Purely Azimuthal Flow as a Model for the Antarctic Circumpolar Current*, Journal of Physical Oceanography 46(12), doi: 10.1175/JPO-D-16-0121.1.

[**2**] C. Martin, R. Quirchmayr, *Exact solutions and internal waves for the Antarctic Circumpolar Current in spherical coordinates*, Mathematical and Computer Modelling, **55**(5-6), 2012, 1782–1786.

[**3**] J. Chu, C. Martin, K. Marynets, *Exact solutions for geophysical flows with variable density and forcing terms in spherical coordinates*, Applicable Analysis (2023), doi: 10.1080/00036811.2023.2207589.