The Visualization of Ocean Movement in Southern Ocean

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Introduction: Ocean is continuous and always moving. The ocean holds about 97% of the Earth's water and the Earth's surface is covered by 71% of the ocean. This makes ocean is vital to the Earth's system and be the driving force to the climate. Certainly that the ocean is an important regulator of the climate due to the capability on transporting the huge amounts of fresh water, nutrient and heat. The surface and deep ocean have been connected by ocean movement. The purpose of this study is to visualize the Southern Ocean movement for understanding how it can affected the climate change of our earth. This is a time dependent study for 360 days. The geometry of the map of Southern ocean is in 2 dimensions and the parameter used in this study are shown below.

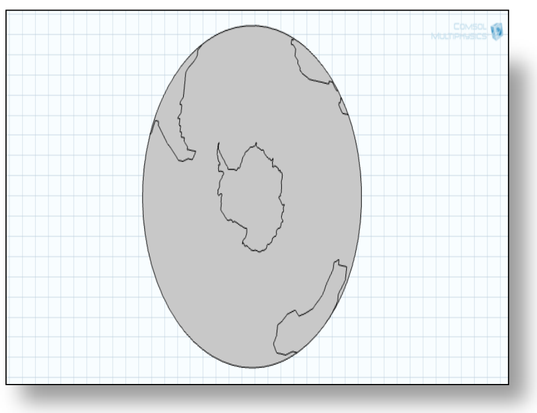

Figure 1. Geometry of Southern Ocean

Parameter	Units
Density	kg/m^3
Temperature	K
velocity	m/s^2
Pressure	Pa

Table 1. Parameter

Computational Methods: Comsol Multiphysics 4.4 is used to perform the simulation. Water is choose as the material for the ocean. Then, the module implement to this study is heat transfer (heat transfer in fluids) and fluid flow (turbulent flow). The suitable initial condition and boundary condition are as follow :

1) Heat transfer in fluids

Initial Condition : $T_0 = 273.15 + 100 * \left(\frac{x^2}{33^2} + \frac{y^2}{33^2}\right)$

Boundary condition : Open boundary, temperature and outflow (figure 2)

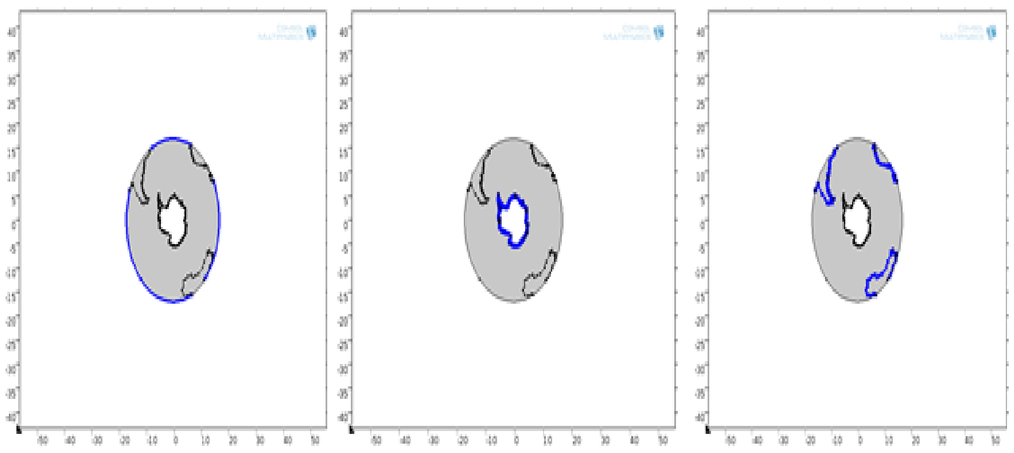

Figure 2. The illustrated of boundary condition.

2) Turbulent flow

Initial condition : $u_0 = 0$

Boundary condition : Slip

Results: The results show the temperature behaviour of southern ocean movement. The red colour represent the hot region while blue colour represent cold region. The movement of ocean is from the high to low temperature. The results also show the increasing of temperature near the Antarctica region (in the centre).

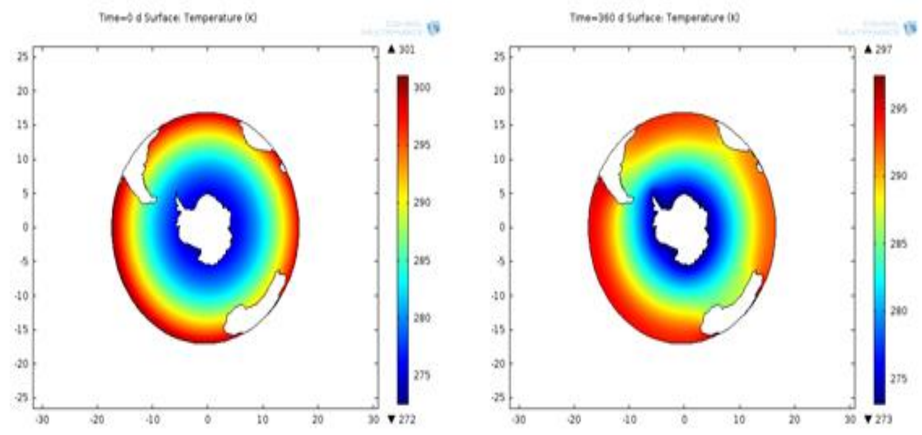

Figure 3. The Temperature (in Kelvin) in Surface in the Beginning of Days (left) and at 360 days (right).

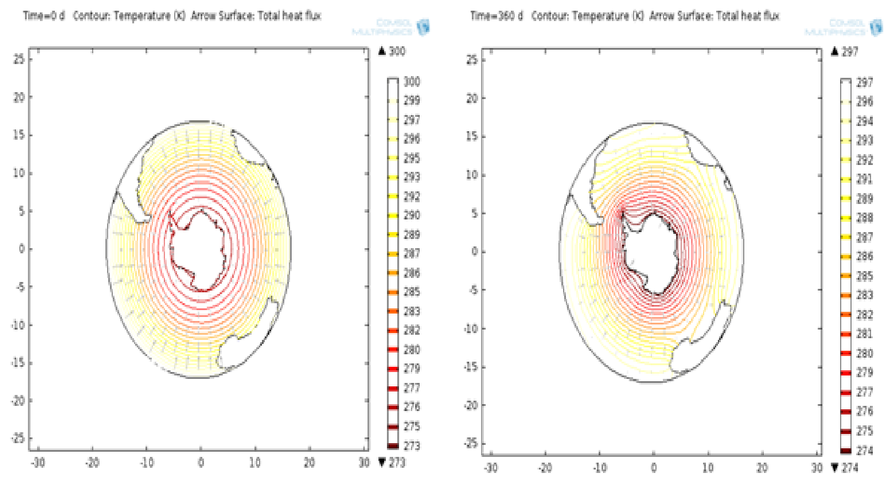

Figure 4. The Temperature (in Kelvin) in Contour in the Beginning of Days (left) and at 360 days (right).

Conclusions: As a conclusion, it can be seen that Comsol Multiphysics is a good platform to visualize the movement of the Southern Ocean related to the temperature behaviour. It also able to implement the mathematical modelling for ocean movement in Southern Ocean in physics mode with some parameter that are important in understanding the works of ocean. Due to the ice melting in Antartica, the temperature near the region is increasing.

References:

1. Charette, M. and Smith, Walter H. F., The volume of Earth's ocean. Oceanography, 23 (2): 112–114 (2010).
2. IPCC-AR5, Fifth Assessment Report: Climate Change 2013: The Physical Science Basis (2013).