EFFECT OF ISLAND SHAPE ON OCEANIC WAKE FORMATION

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Abstract
We investigate the formation and evolution of oceanic wakes, generated by obstacle of the shape of Madeira Island without consideration of bathymetry around it (i.e. with vertical sides), instead of realistic or quasi-realistic studies, using ROMS – Regional Ocean Modeling System. Obtained results showed that oceanic wakes formations were sensitive for different Reynolds, Rossby and Burger number regimes. Wake asymmetries induce different behaviour for cyclonic and anticyclonic eddies than that showed by Dong at al. (2007), where they investigated island wakes around an idealized cylindrical island.

Numerical model set up
The island was centred in a geostrophic channel like configuration with a prescribed surface intensified meridional (southward) inflow at the upstream boundary (i.e., our study is dedicated to the wakes, generated at the eastern and western part of our obstacle). Eastern and Western channel boundaries were set to slippery-tangential and zero normal conditions, whereas boundaries around the island were set to zero-normal and no-slip flow. A clamped condition with a sponge layer was applied at the southern outflow boundary for outgoing current and density profile. The initial conditions for the entire domain were set equal to the upstream boundary condition except at the island points.

Results
Figure 1 shows how the *Re* regime of the incoming flow affects eddy shedding behaviour. For *Re*<50 eddy shedding does not occur. As *Re* increases, eddies develop transient meanders, detaching from the island at regime between *Re* = 50 and 100. At *Re*>100 eddies are fully detached from the island.

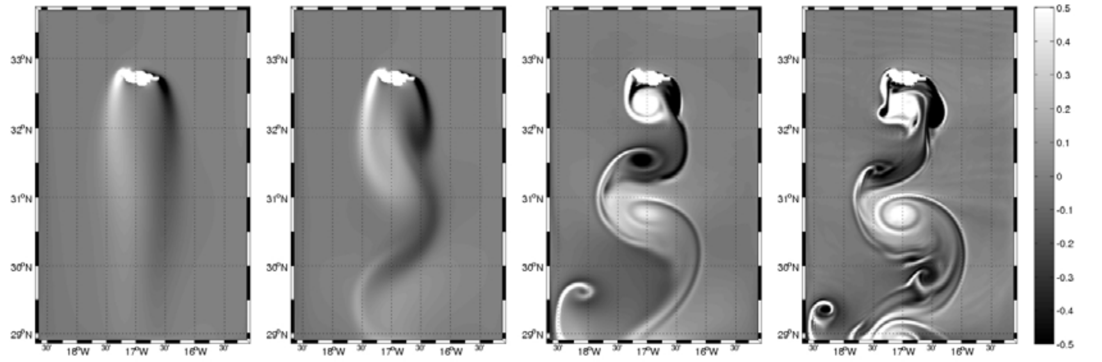

Figure 1. *Re* sensitivity studies for *Re*= 50, 100, 500 and 1500 (from left to right). Colours represent surface vertical vorticity.

Figure 2 shows an eddy shedding cycle. During a period of 15 days two vortices (cyclonic and anticyclonic) were formed. The formation of vortices occurs in a period of around one week (compare vorticity maps of the 30th and 45th model days: the first one closely resembles the other).

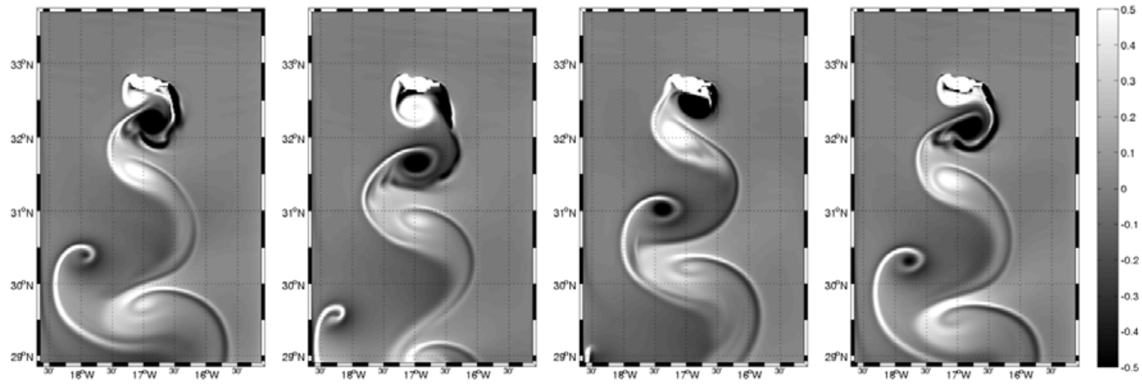

Figure 2. Time varying shedding for 30th, 35th, 40th and 45th model days (from left to right). Colours represent surface vertical vorticity.

Figure 3 summarizes asymmetry between cyclonic and anticyclonic eddies at the model domain. For small *Re* numbers both types of eddies have almost the same values of mean vorticity (difference in mean vorticities is close to zero). Increasing *Re* leads to intensification of cyclonic vortices in comparison to anticyclonic ones. Mean vorticity of cyclonic eddies became greater than for anticyclones. At the same time, the area occupied by cyclones decreases.

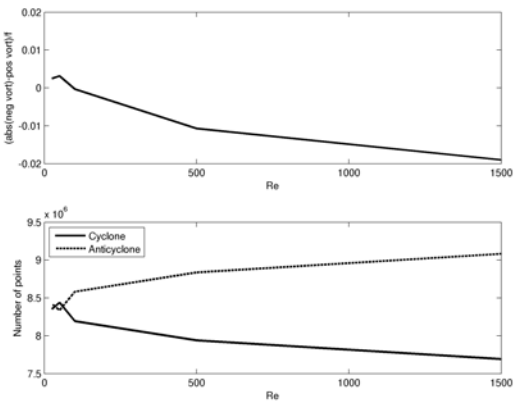

Figure 3. Asymmetry between cyclonic and anticyclonic vortices for various *Re* number regimes.

Concluding remarks and future work

Obtained results showed that oceanic wakes formations were sensitive to three dimensionless parameters that representing a ratio between inertial and frictional forces - Reynolds number (*Re*), rotational effects - Rossby number (*Ro*) and stratification effects - Burger number (*Bu*). Further work will include more detailed studies about how the direction of incoming flow affects wake formation processes. It will also helps to understand how the island asymmetry affects eddies activity.

References

Dong, C., J. C. McWilliams and A. Shchepetkin, 2007: Island Wakes in Deep Water, Journal of Physical Oceanography, **37**, 962-981.

Shchepetkin, A. F., and J. C. McWilliams, 2005: The Regional Ocean Modeling System: A split-explicit, free-surface, topography-following-coordinate oceanic model, Ocean Modelling, **9**, 347-404.