PRELIMINARY RESULTS ABOUT THE STABILITY OF AN INTERMEDIATE WATER CURRENT

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Experiments are run on the 14 m diameter rotating platform to study the stability conditions for a constant volume flow rate current of intermediate water. The flow is introduced in a two-layer system in solid body rotation, along the sidewall of the tank, and then freely evolves. A sink allows to evacuate the intermediate water and ensures that the free surface height is constant (Fig. 1). Thus the initial conditions are the Coriolis parameter, the density difference (ρ_3-ρ_1) = O1‰, the layer thicknesses (the upper layer between 10 cm and 25 cm and the lower layer equal to 50 cm); the boundary conditions are the volume flow rate, the density, the initial width (L_0) and thickness (h_0) at the side of the intermediate current which is in geostrophic equilibrium when it leaves the source.

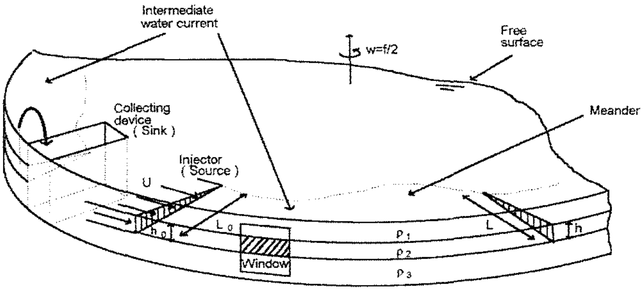

Fig. 1. Sketch of the experimental facility

The relevant parameters appear to be the Ekman number, $Ek_0=\upsilon(f.h_0^2)$, and Bürger number, $Bu_0=[(\rho_3-\rho_1).g.h_0/\rho2](f^2.L_0^2)$, defined at the injector level. The data collected from the experiments are very consistent, and it appears as shown in figure 2 that there are five typical flow regimes : (1) a stable current along the whole basin, (2) a serie of cyclonic vortices attached to the wall, with an upstream stable current, (3) a large cyclonic vortex attached to an anticyclonic instability, (4) dipoles shed from the current into the interior fluid, and (5) generation of lenses of intermediate water, alike meddies.

When both the initial values of the Ekman and Bürger numbers of the intermediate water current are large (Ek_0= 16.7 x 10^{-4}; Bu_0= 6.71), then the current remains stable along the tank wall (namely the width of the current is constant) and during the whole experiment. For intermediate values of the Ekman number ($5.10^{-4} \leq Ek_0 \leq 10.10^{-4}$) there is a significant evolution of the current as Bu_0 increases. For small values of Bu_0 (Bu_0 = 0.45; Ek_0 = 6.7 x 10^{-4}), there are dipoles formation. First, a meander forms, then grows in diameter while becoming thinner near the wall, and finally separates from the vein. Another meander then appears at the same location, while the dipole drifts upstream. Then, for a higher Bu_0 (Bu_0 = 0.75; Ek_0= 7.4 x 10^{-4}) a dipole still forms, but stays attached along the wall, remaining at the same location near the injector. In that instance, the cyclonic pole is significantly more energetic than its anticyclonic counterpart and is located upstream of the anticyclone which remains close to the wall. For still higher values of the Bürger number ($3 \leq Bu_0 \leq 6$), there is an upstream portion of the intermediate water current which is stable, whereas in the previous cases the instabilities occurred shortly after the injector. The length of that stable part of the current increases with increasing Bu_0. Downstream that stable part there appears series of cyclonic vortices which remain attached to the wall. For the largest value of Bu_0 in this range of Ek_0 (Bu_0 = 10.8; Ek_0= 7.7 x 10^{-4}) the current is stable over all along the tank, as is the case for higher values of Ek_0. In all instances with a stable part of the current, we observe periodical cyclonic eddies in the upper layer, above the stable part. There is as well a vertical recirculation of water from the upper and lower interfaces into the core of the intermediate water current.

For the smallest values of Ek_0 (Ek_0=2 x 10^{-4}) and Bu_0 (Bu_0 = 0.25) obtained in this set of experiments, there is formation of anticyclonic lenses of intermediate water which separate from the main flow, and are thus comparable with meddies. The process is similar to dipoles formation described above. Such a possibility of "meddy" formation even in the absence of any topographycal discontinuity seems new.

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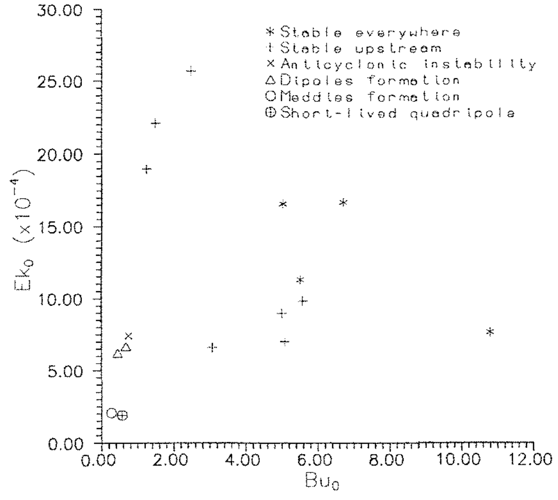

Fig. 2. Flow regime diagram.

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