Circulation Générale Permanente dans les Oceans
—un calcul numérique complémentaire—*

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Abstract: In previous papers was shown a theoretical pattern of the stationary general
circulation which is produced by the wind stress and the variation of the water density at the
surface in an ocean bounded by two meridians on the basis of the following assumptions:
1) the depth of the ocean is constant,
2) there is practically neither northern boundary nor southern boundary,
3) all the non-linear terms are negligible in the equations of motion,
4) in the equation of density (equation of continuity), the vertical gradient of the density
is approximated throughout by a constant and the terms of horizontal advection are
completely negligible,
5) there is no friction at the bottom,
6) the density is constant at the bottom,
7) the Coriolis parameter is a constant \(0.7 \times 10^{-4} \text{ sec}^{-1}\) in the northern hemisphere,
\(-0.7 \times 10^{-4} \text{ sec}^{-1}\) in the southern hemisphere, although its first derivative with respect
to the latitude is taken into account,
8) the coefficients of the eddy diffusivity and of the eddy viscosity are constant
everywhere and finally,
9) the friction due to the horizontal eddy viscosity is proportional to the horizontal
velocity.

The equations being thus linearised, the solution is distinctly separated into two parts: the one
determined by the wind stress (wind-driven circulation) and the other determined by the variation
of density at the surface (convective circulation).

In the present study, the assumption (9) is removed but the others, though some of them are
less valid, are left untouched, because the mathematical analysis would be too complicated without
them. No remarkable difference is found in the principal features between the previous results
and the results now obtained. The convective circulation is of essential importance to the formation
of some characteristic currents such as the Kuroshio, the Gulf Stream, the subarctic gyres, the
deep countercurrents off the western boundary. The calculated velocity of these currents agrees
with the observed one. It is to be noted that the most important features of the distribution of
the water density at the surface are probably influenced by the heat flux received at the sea
surface. Contrary to our usual notion, the major cause of the general circulation is not the wind
stress, but the heat flux. The wind stress may be predominant in the equatorial region only.
Some of the discrepancies between the observed and calculated features of the general circulation
would disappear by assuming more irregular lateral boundaries and bottom topography and by
taking more rigorously into consideration the variation of the Coriolis parameter with the latitude.

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