

Both the external ( $R_D$ ) and internal ( $L_D$ ) Rossby deformation radii are important length scales in the ocean.

a. Use typical values of ocean depth (Fig. 1.1) and buoyancy frequency (Fig. 3.4) to estimate  $L_D$  and  $R_D$  in the Atlantic Ocean at a latitude of  $5^\circ N$ ,  $30^\circ N$  and  $55^\circ N$ .

With typical values of  $D = 2000\text{m}$  and  $N = 10^{-3} \text{ s}^{-1}$  we get the following results:

	$5^\circ N$	$30^\circ N$	$55^\circ N$
$R_D$ (km)	11002	1918	1171
$L_D$ (km)	157	27	17

b. Provide a priori arguments whether effects of stratification are important in (i) the 'gyre' circulation, (ii) the mean Gulf Stream, and (iii) rings which develop from the Gulf Stream (see Fig. 2.10).

For the gyres, we estimate  $L \approx 1000 \text{ km}$  and  $L_D \approx 30 \text{ km}$  at midlatitudes, so  $L_D/L \ll 1$  and hence limited influence of stratification. For the Gulf Stream, with  $L \approx 100 \text{ km}$  and  $L_D \approx 30 \text{ km}$  the influence of stratification is substantial and for rings with a radius of  $50 \text{ km}$ , the effects of stratification are dominant.

c. Same as b. but now for the effects of ocean-atmosphere deformation.

Only for the gyres, the horizontal scale is large enough to have some influence as  $R_D$  is large.