Problem sheet VI

1. Atmospheric eddy

(a) A circular eddy in the atmosphere has a velocity of $10\,\mathrm{ms}^{-1}$ at a radius (R) of 500 km. What is the value of the circulation at this radius and what is the mean value of the vorticity within R?

(b) If there is no vorticity in the region outside of R, what is the velocity at a radius of 1000 km? (Hint: If the vorticity is zero and the flow is circularly symmetrric then $(1/r)\cdot(rv)_r) = 0)$).

2. Two-dimensional vortex

A two-dimensional vortex of uniform vorticity Λ and a radius a is located in an uniform flow moving at a velocity U. Show that at the edge of the vortex there will be a stagnation point if $(U/\Lambda \cdot a)$=0.5.

3. Rossby and Ekman numbers

If large scale atmospheric and oceanic eddies are characterised by veloctiy and length scales such that:

- atmosphere: $U = 10\,\mathrm{ms}^{-1}$, $L = 1000\,\mathrm{km}$
- ocean: $U = 0.01\,\mathrm{ms}^{-1}$, $L = 100\,\mathrm{km}$

What are the typical values for the Rossby Number and the Ekman Number of such flows? (Note that the Coriolis parameter $f = 2\Omega \sin\phi$ is order of $10^{-4}\mathrm{s}^{-1}$).

4. Geostrophic approximation

Surface pressure gradients on weather charts are of the order of 10 hPa per 1000 km. What would be the corresponding value of the geostrophic velocity?