Appendix H

EQUATORIAL BALANCE RELATION

As shown in section 3.3, assuming that βy varies slowly compared to ψ, the linear balance relation given by (3.16) reduces to (3.17),

$$\nabla^2 (\beta y \psi) = \nabla^2 \phi. \tag{H.1}$$

Combining terms and letting $F = (\phi - \beta y \psi)$, (H.1) can be written as

$$\nabla^2 F = 0. \tag{H.2}$$

The Fourier ξ-transform of (H.2) is found to be,

$$\frac{d^2 F_m}{dy^2} - \frac{m^2}{a^2} F_m = 0, \tag{H.3}$$

by using a Fourier tranform pair similar to (2.19) for $F(x, y)$. The general solution of this second order ODE is

$$F_m(y) = A\, e^{\frac{m}{a} y} + B e^{-\frac{m}{a} y}, \tag{H.4}$$

which must satisfy our imposed boundary conditions $F \to 0$ as $y \to \pm\infty$. Because $e^{(m/a)y} \to \infty$ as $y \to \infty$, it's required that $A = 0$. Similarly, the other boundary condition requires that $B = 0$, leaving only the trivial solution

$$F_m = 0. \tag{H.5}$$

Inverse Fourier transforming (H.5) and then using the definition of F yields the equatorial balance relation (3.18),

$$\phi = \beta y \psi. \tag{H.6}$$