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Chapter 4 Elementary Applications of the Basic Equations

4.6 Surface Pressure Tendency

Based on (3.37), we have at surface

$$\omega_s = \frac{\partial p_s}{\partial t} + V_a \cdot \nabla p_s - g\rho_s w_s \qquad (3.37)'$$

The second term on the right side is small when a low pressure system or a cyclone is approaching. This gives

$$\frac{\partial p_s}{\partial t} = \rho_s g w_s + \omega_s \qquad (3.37)''$$

From (3.39),

$$\omega(p) = \omega(p_s) - \int_{p_s}^{p} \left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} \right)_p dp. \qquad (3.39)'$$

Taking $p \to 0$ (i.e., top of the atmosphere),

$$\omega_s = \omega(p_s) = -\int_{0}^{p_s} \left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} \right)_p dp \qquad (3.39)'$$

Substituting ω_s of (3.39)' into (3.37)" yields

$$\frac{\partial p_s}{\partial t} = \rho g w_s - \int_0^{p_s} \left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} \right)_p dp \qquad (3.44)'$$

Special case: No terrain ($w_s = 0$)

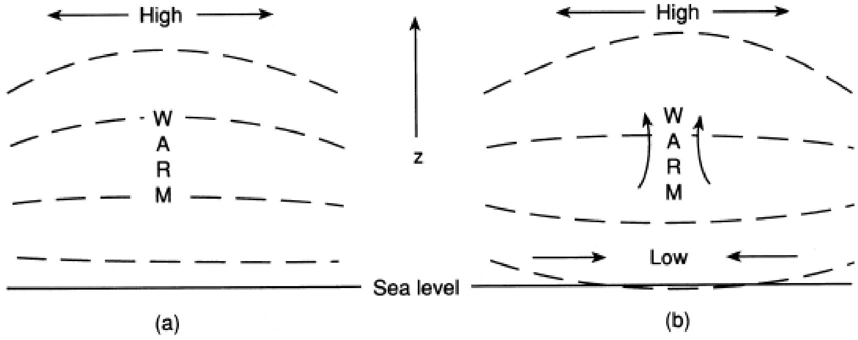

Fig. 3.11 Adjustment of surface pressure to a midtropospheric heat source. Dashed lines indicate isobars. (a) Initial height increase at upper level pressure surface. (b) Surface response to upper level divergence.

Adjustment of surface pressure to a midtropospheric heat source:

1. Heat the midtroposphere
2. Generate upward motion
3. Induced adiabatic cooling in the upper troposphere
4. Generate High pressure in upper troposphere
5. Produce divergence in upper troposphere
6. The average divergence of the air column increases ($\nabla \cdot V > 0$).
7. The surface pressure tendency equation, i.e. Eq. (3.44), implies:
   $$\frac{\partial p_s}{\partial t} < 0$$
8. Induce low-level convergence
9. Strengthen w > 0 in midtroposphere