ASME 433 Atmospheric Dynamics Dr. Yuh-Lang Lin
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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

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

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

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

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 ($w_s = 0$)

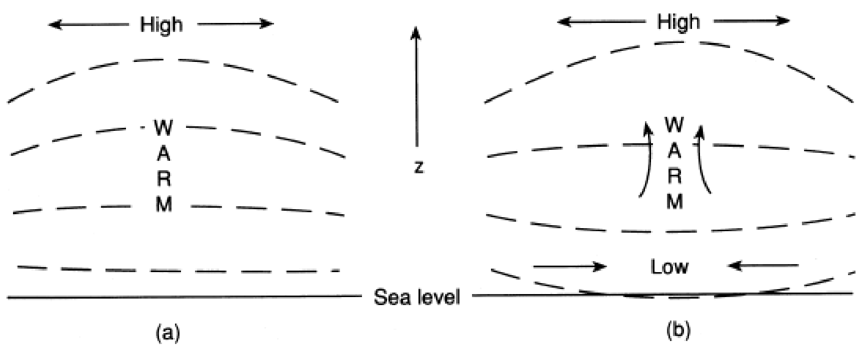

Fig. 3.11 Adjustment of surface pressure to a midtropospheric heat source. Dashed lines indicate isobars. (a) Initial height increase at upper level pressure surface. (b) Surface response to upper level divergence.

Adjustment of surface pressure to a midtropospheric heat source:

1. Heating in the midtroposphere
2. Adiabatic cooling with upward motion
3. Generate H at higher troposphere
4. Generate divergence in higher troposphere
5. Induce $\nabla \cdot V > 0$ in the air column

6. Eq. (3.44) implies: $\frac{\partial p_s}{\partial t} < 0$

7. Induce low-level converegence

8. Produce w > 0 in midtroposphere