

# Stability

No simple criterion based on entropy:

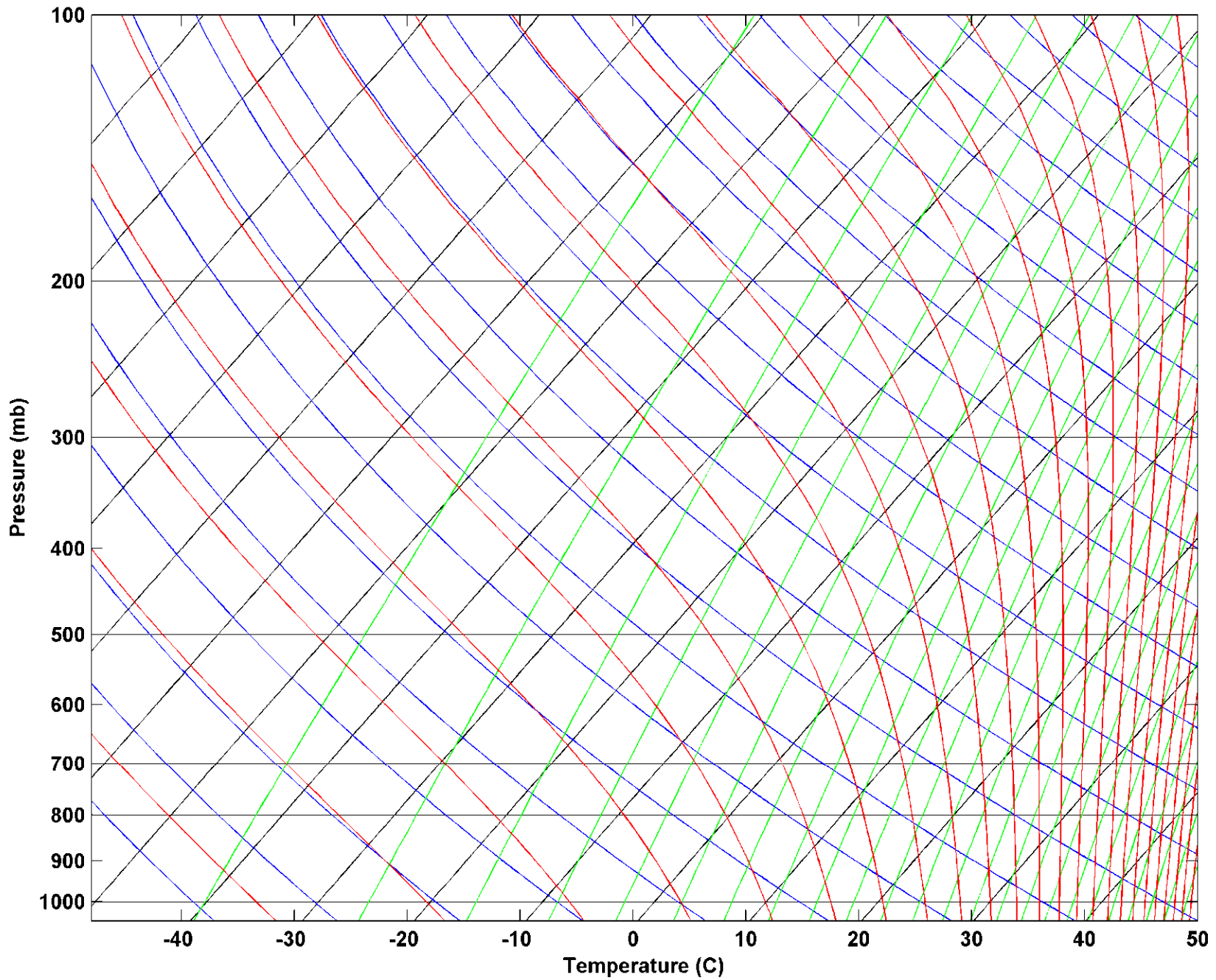
$$s_d = c_p \ln\left(\frac{T}{T_0}\right) - R_d \ln\left(\frac{p}{p_0}\right)$$

$$\alpha = \alpha(s_d, p)$$

$$s = c_p \ln\left(\frac{T}{T_0}\right) - R_d \ln\left(\frac{p}{p_0}\right) + L_v \frac{q}{T} - qR_v \ln(H)$$

$$\alpha = \alpha(s, p, q_t)$$

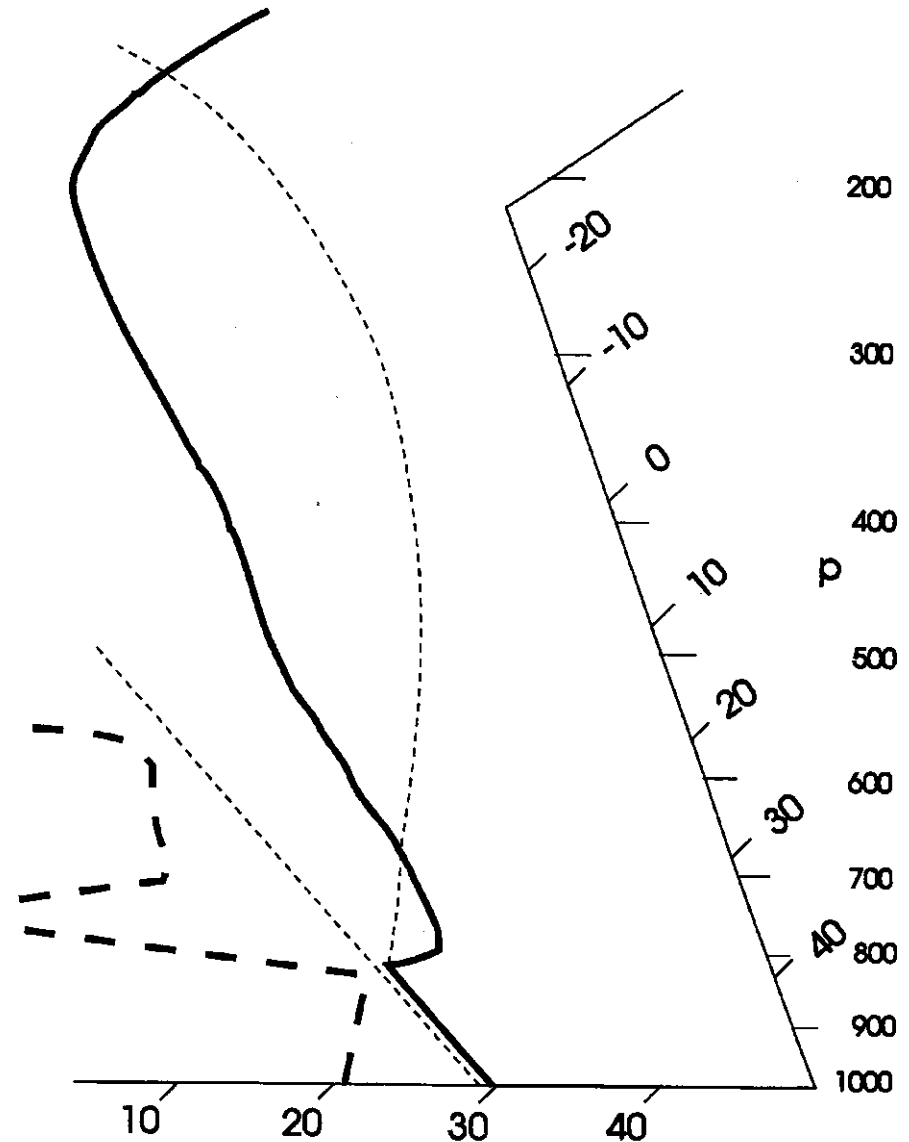
# The Thermodynamic Diagram



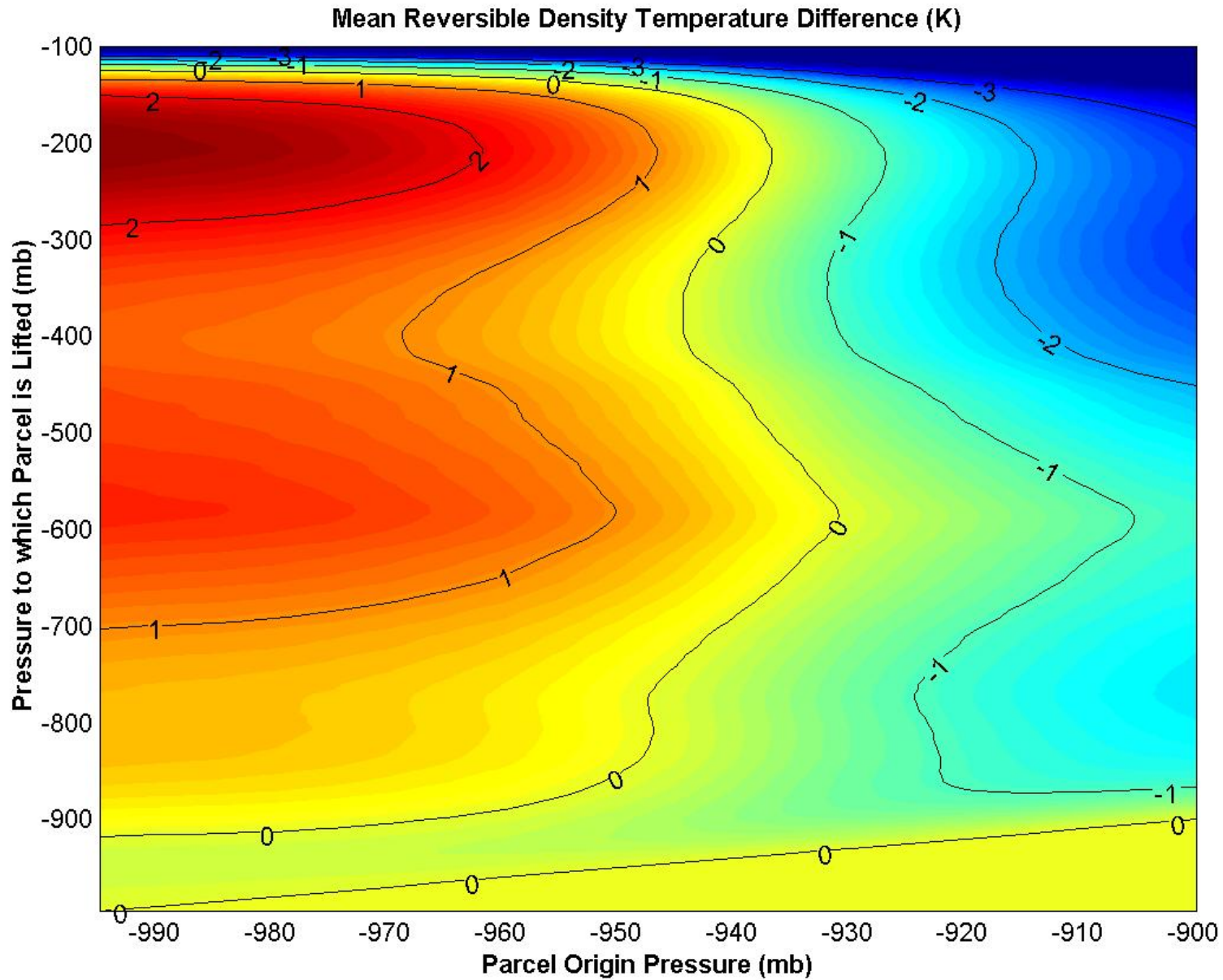
# Stability Assessment using Tephigrams:

Convective Available Potential Energy  
(CAPE):

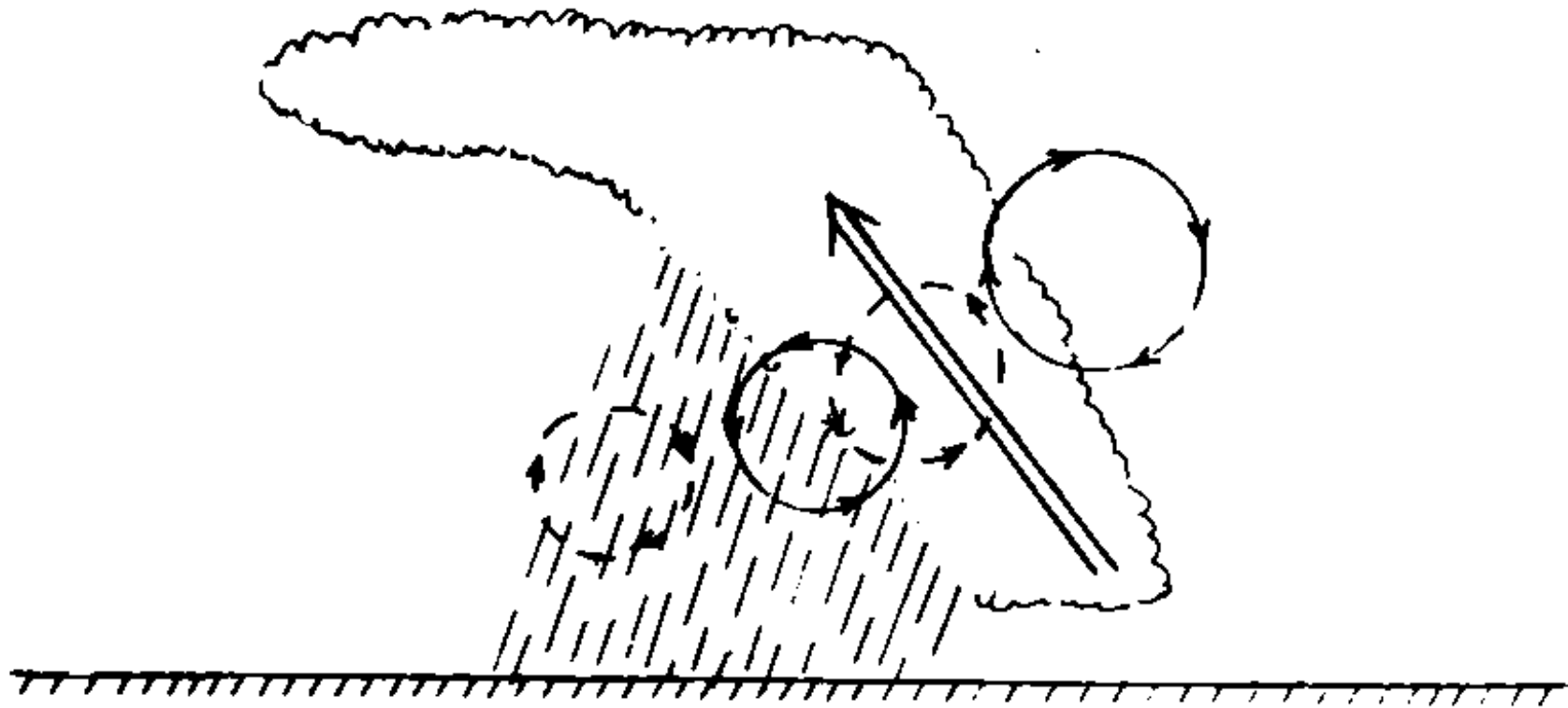
$$\begin{aligned} CAPE_i &\equiv \int_{p_n}^{p_i} (\alpha_p - \alpha_e) dp \\ &= \int_p^{p_i} R_d (T_{\rho_p} - T_{\rho_e}) d \ln(p) \end{aligned}$$



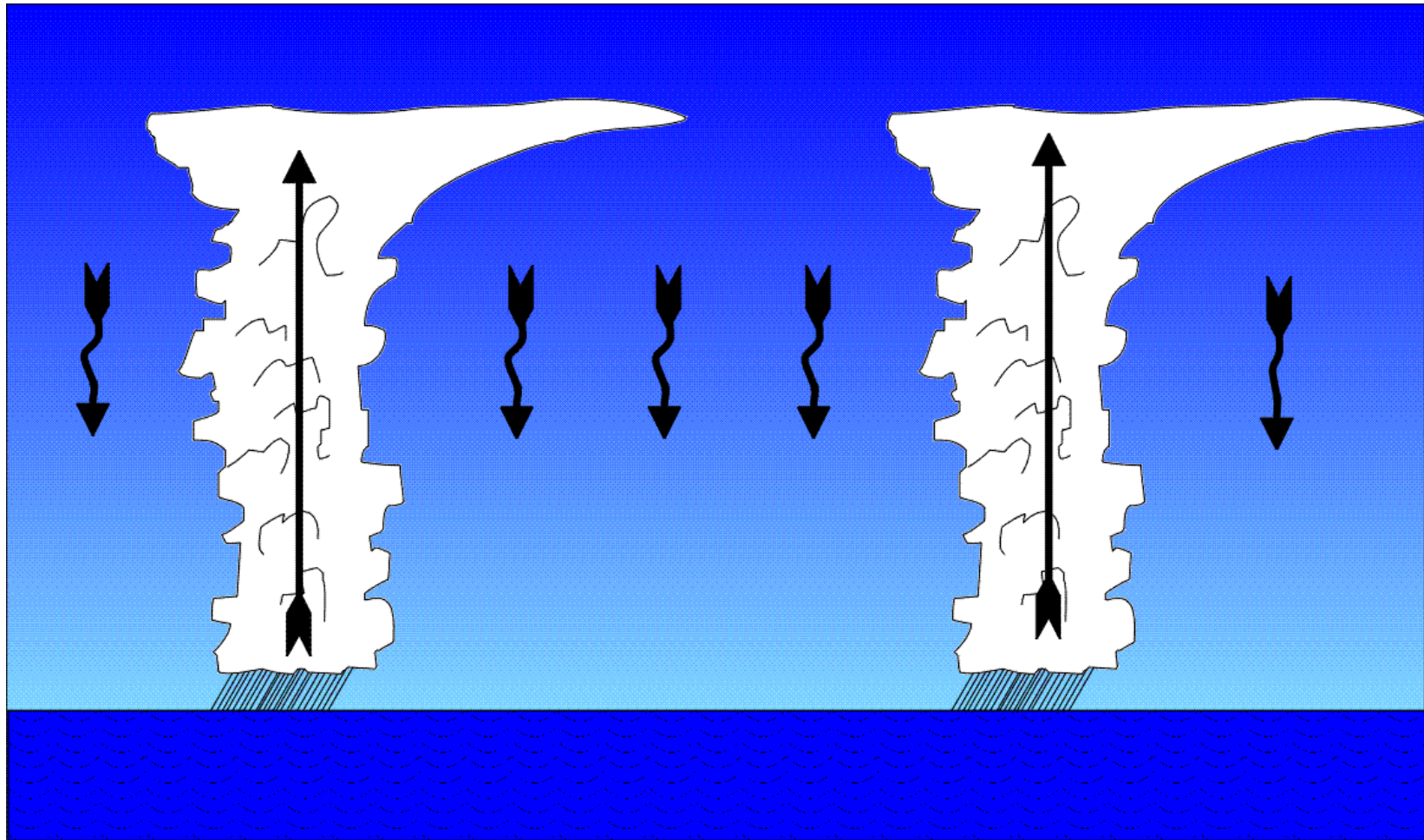
# Other Stability Diagrams:



# Precipitation Effects:



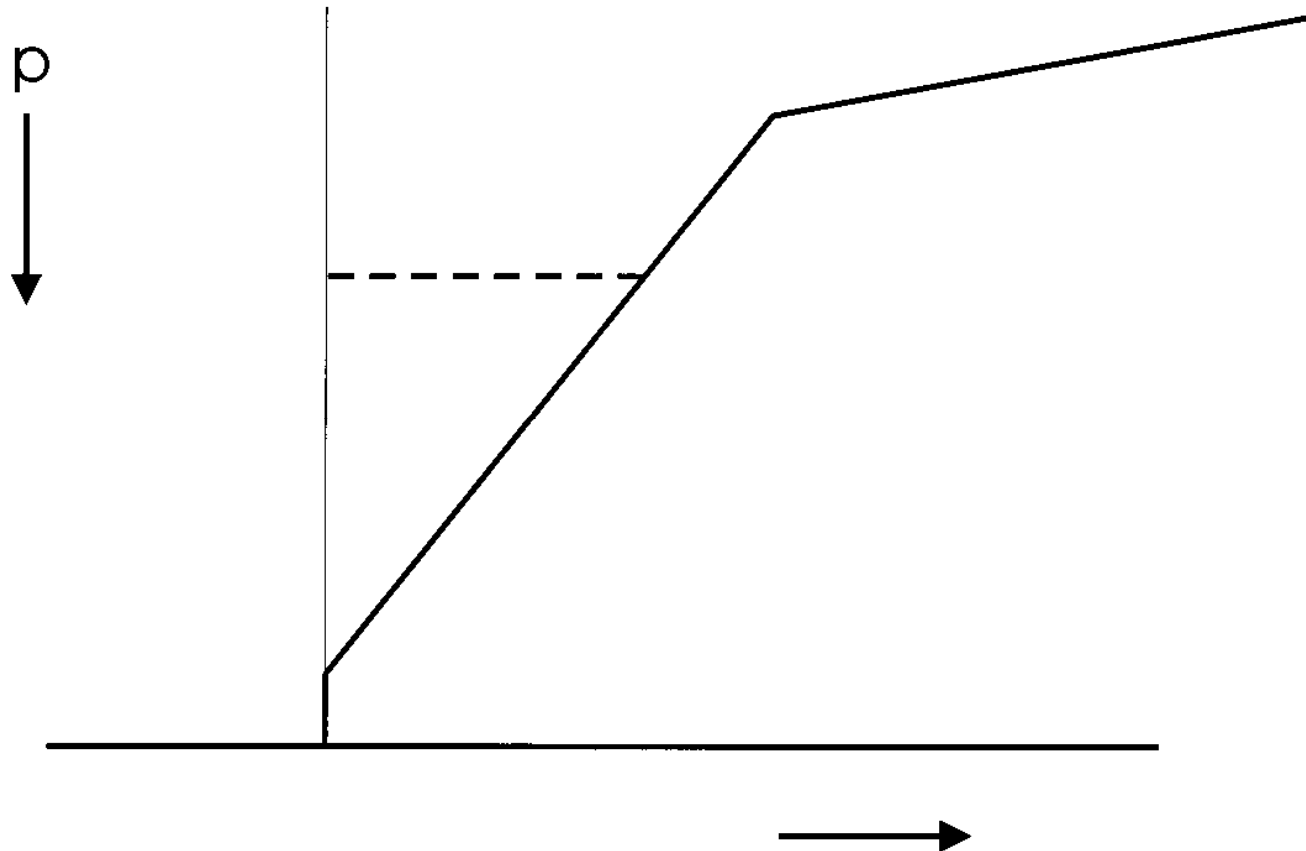
# Precipitating Convection favors Widely Spaced Clouds (Bjerknes, 1938)



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# Buoyancy Reversal:



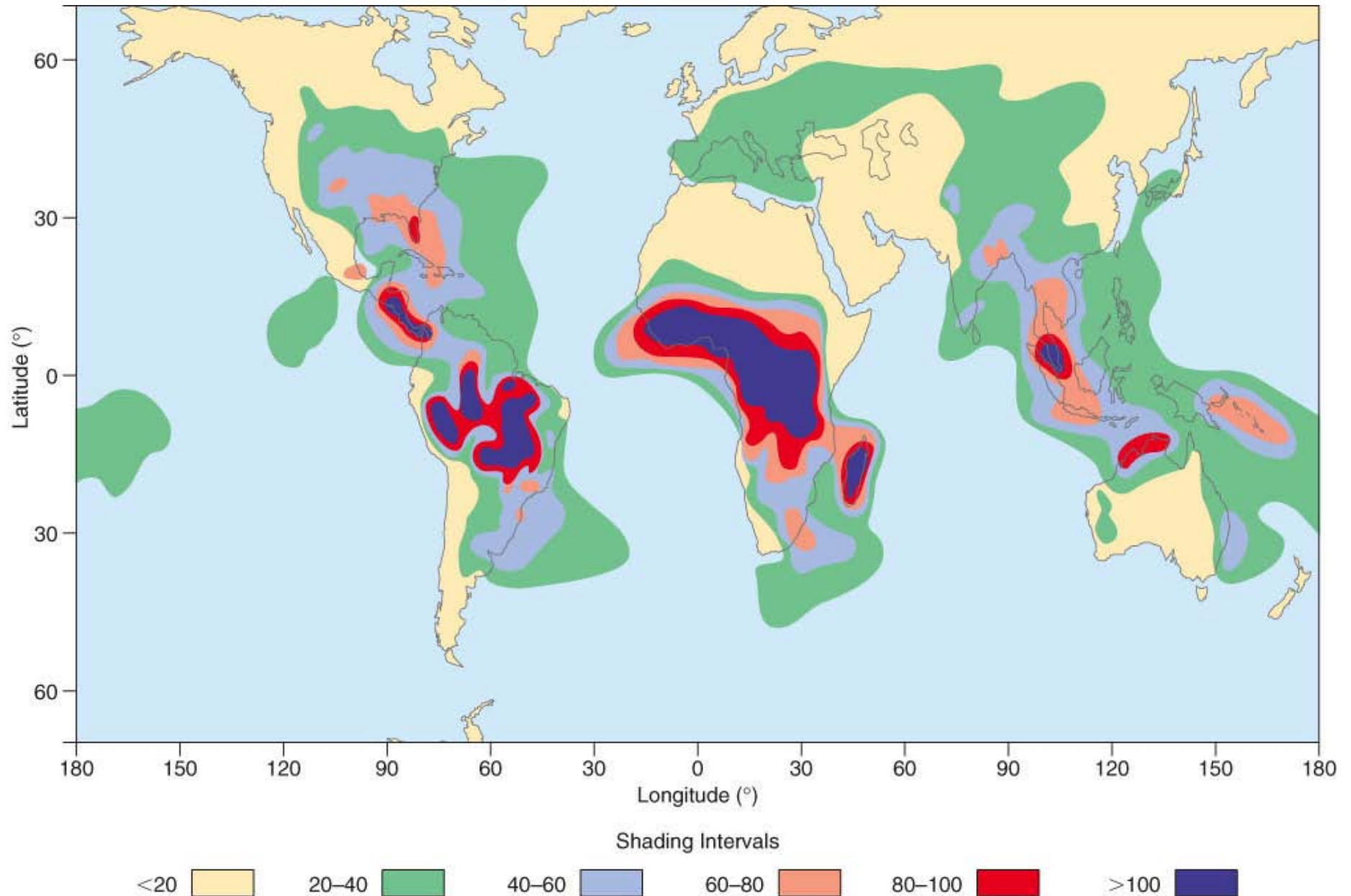
$$h_w = C_p T_v + gz - L_v l$$



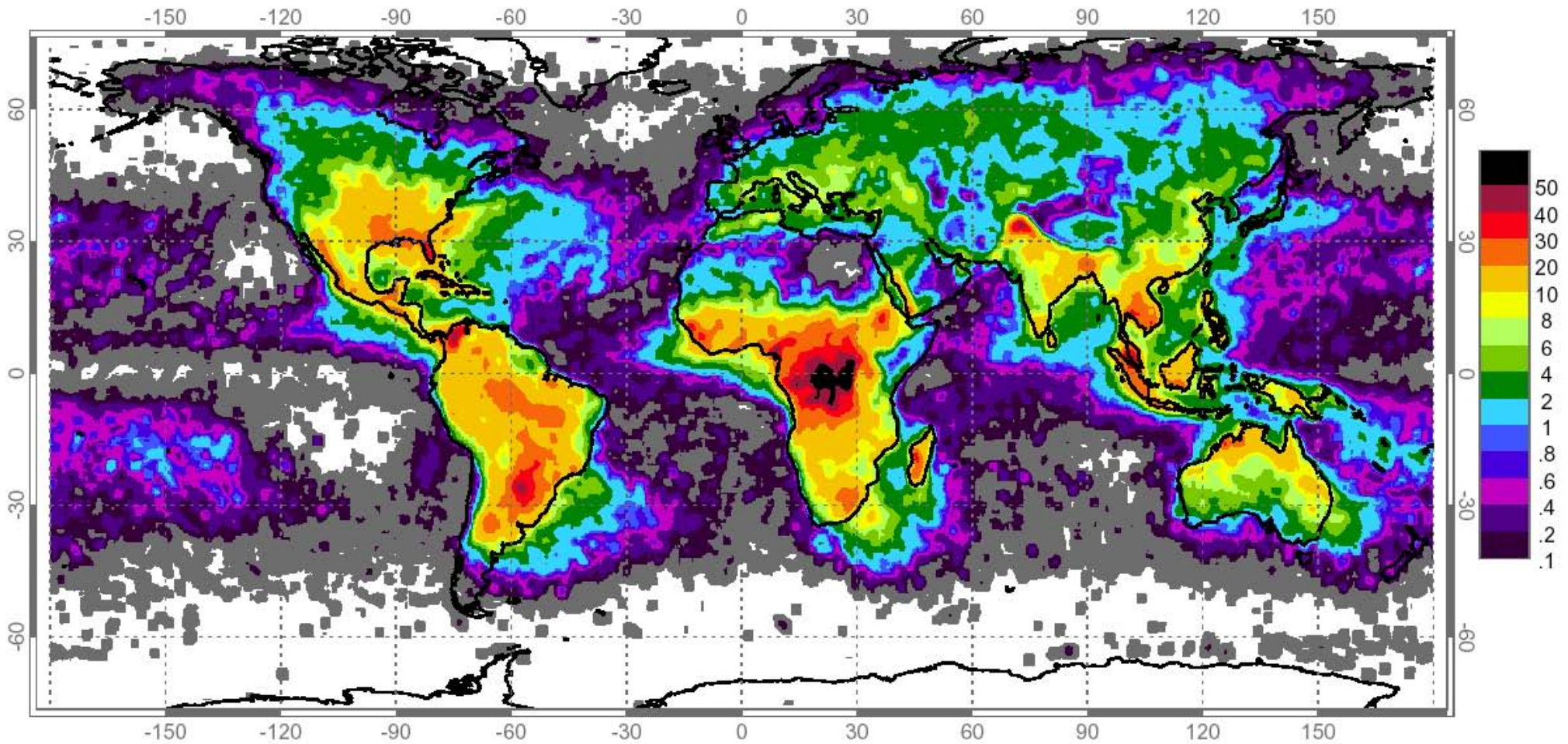
# Summary of Differences Between Dry and Moist Convection:

- Possibility of metastable states
- Strong asymmetry between cloudy and clear regions
- Typically, only thin layers near surface are unstable to upward displacements
- Mixing can cause buoyancy reversal
- Large potential for evaporatively cooled downdrafts
- Buoyancy of unsaturated downdrafts depends on supply of precipitation

# A climatology of the average number of thunderstorm days in a year



# Annual Lightning Frequency (from satellite)



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12.103 Science and Policy of Natural Hazards  
Spring 2010

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