# Tutorial 4

# Thrmodynamic diagrams

1. Stuve diagram

   Stuve diagram adopts temperature, $T$, and $(p/p_0)^{R_d/c_p}$ as its thermodynamic coordinates.

   This choice of coordinates makes that isolines of potential temperature are linear.

   Plot a Skew-T diagram with isolines of (see Fig.1):

   - temperature, $T$
   - pressure, $p$
   - potential temperature $\theta = T\,(p_0/p)^{R_d/c_p}$
   - mixing ratio $r = \epsilon e_s(T)/(p - e_s(T))$
   - equivalent potential temperature $\theta_e = \theta \exp\left(L_v(T) r_s/c_p T\right)$

2. Skew-T diagram

   Skew-T diagram adopts temperature, $T$, and $\ln p$ as its thermodynamic coordinates.

   The logarithm of pressure is chosen for the vertical coordinate rather than the pressure itself because in an isothermal atmosphere height varies with $\ln p$, and hence for a realistic temperature profile the ordinate is roughly proportional to height. Isotherms are skewed at an angle of about 45° from the vertical. The exact angle of skewness is chosen so that adiabats and isotherms are orthogonal at 1000 hPa and 0°C.

   Plot a Skew-T diagram with isolines of (see Fig.2):

   - temperature, $T$
   - pressure, $p$
   - potential temperature $\theta = T\,(p_0/p)^{R_d/c_p}$
   - mixing ratio $r = \epsilon e_s(T)/(p - e_s(T))$

- equivalent potential temperature $\theta_e = \theta \exp\left(L_v(T) r_s / c_p T\right)$

3. Plot temperature and dew point temperature from the ACE2 sounding. In file tutorial_4_sounding_1.txt you will find values of: pressure (hPa), height (m), temperature, (C), relative humidity (%).

   Discuss the stability of the atmosphere.

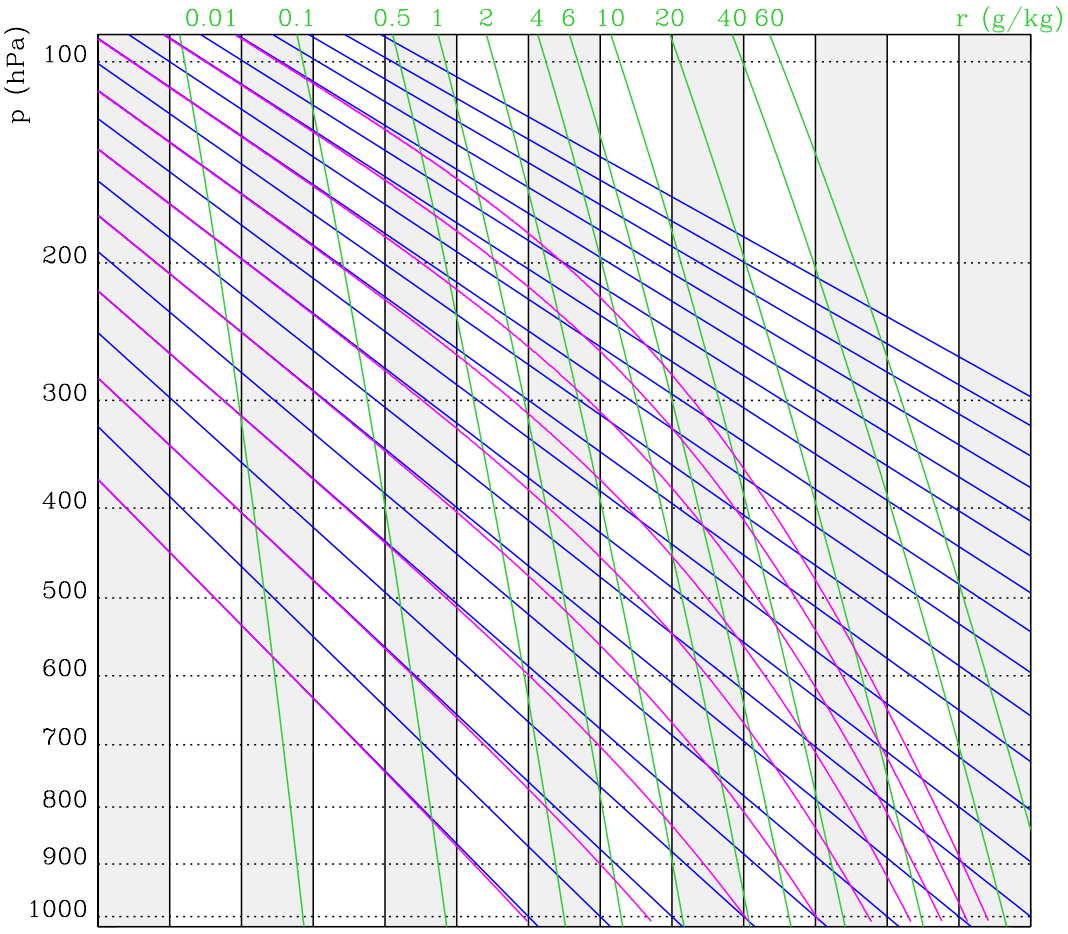


Figure 1: Stuve diagram. Black: $T = const$, dotted black: $p = const$, blue: $\theta = const$, green: $r_s = const$, violet: $\theta_e = const$.

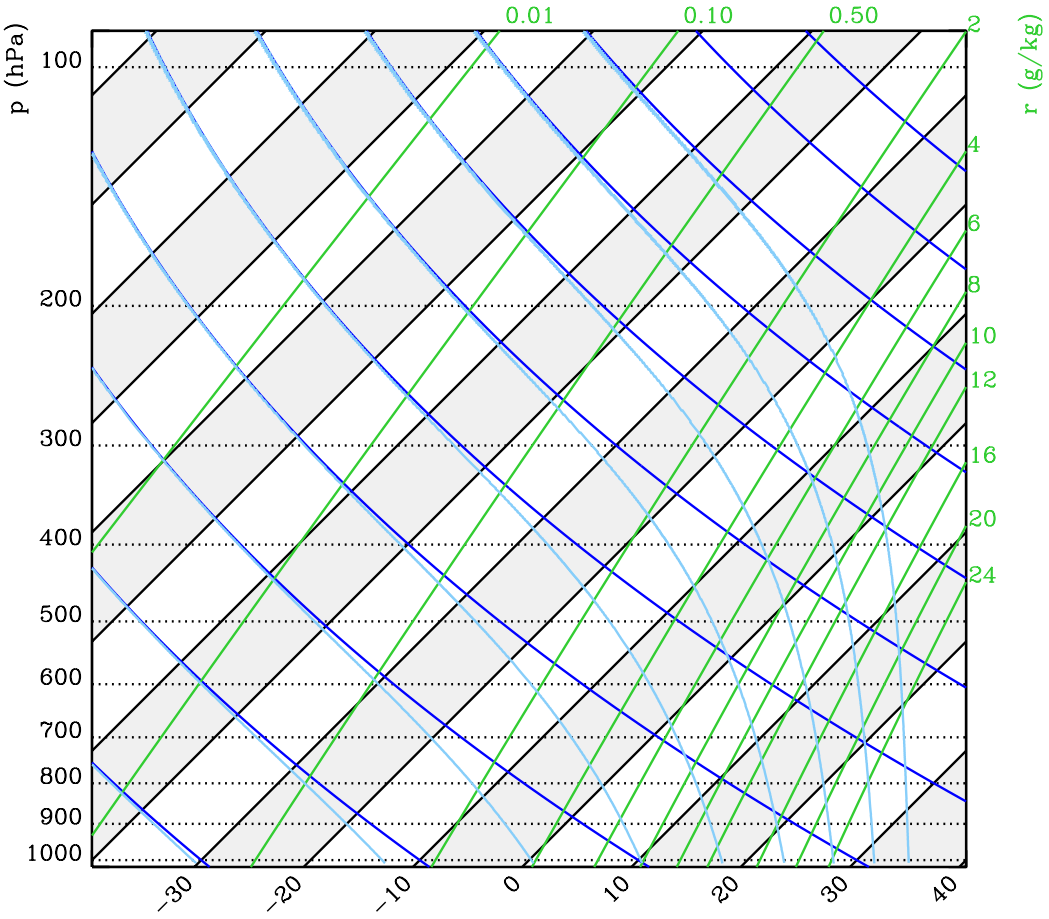


Figure 2: Skew-T diagram. Black: $T = const$, dotted black: $p = const$, blue: $\theta = const$, green: $r_s = const$, light blue: $\theta_e = const$.