

ESE 134: Cloud and Boundary Layer Dynamics (due April 19):

[Problems adapted from Stull (1988).]

1. Turbulence kinetic energy (TKE) budget.

- (a) Which term(s), if any, represent the production of TKE
 - i. in a stratocumulus topped boundary layer?
 - ii. in a cumulus topped boundary layer with light trade winds?
- (b) Which terms are loss terms in the TKE budget, and why?
- (c) Which terms redistribute TKE, without producing or destroying it?
- (d) Define (i) free convection and (ii) forced convection, and discuss how their TKE budgets differ.

2. Thermodynamics.

- (a) Under which circumstances is the virtual potential temperature θ_v conserved during adiabatic ascent of air, and when is it not conserved?
- (b) What is the rate of change of the virtual potential temperature with height in cloudy (saturated) air?

3. Boussinesq approximation. A large eddy simulation code is written using the Boussinesq approximation. Apart from any considerations of computational expense, how suitable do you think this code is for simulating cumulonimbus clouds near the equator? What are its chief limitations?