NCAR/IMAGe Summer Workshop Lecture 1

Shortcomings of Boussinesq and what to do about it:

* In the compressible atmosphere, ρ depends on p as well as T

* Density ρ decreases with height as pressure p decreases

* The natural background state is <u>not</u> constant density ρ_0, but rather a background density that decreases with height [pressure]

$\Longrightarrow$ a background of constant

$$\boxed{\text{Potential Temperature}}$$

$\boxed{\text{Homework}}$

* Assume another layer of hydrostatic balance

$$\tilde{\rho} = \rho_1(z) + \rho'(\underline{x},t) = -bz + \rho'(\underline{x},t)$$

$$\hat{p} = p_1(z) + p'(\underline{x},t)$$

with $-\frac{1}{\rho_0}\underline{\nabla} p_1(z) = \frac{bz}{\rho_0}\underline{g}$, $\underline{g} = -g\hat{z}$

* Move into the rotating frame $\underline{\Omega} = \Omega\hat{z}$

* Define $\rho' = \left(\frac{b\rho_0}{g}\right)^{1/2}\theta$, $N = \left(\frac{gb}{\rho_0}\right)^{1/2}$

$P = p'/\rho_0$ $\Longrightarrow$ NOT POTENTIAL TEMP!

$\underline{\nabla}\cdot\underline{u} = 0$,

$$\frac{D\underline{u}}{Dt} + 2\Omega\hat{z}\times\underline{u} + N\theta\hat{z} = -\underline{\nabla}P + \nu\nabla^2\underline{u}$$

$$\frac{D\theta}{Dt} - N(\underline{u}\cdot\hat{z}) = \kappa\nabla^2\theta$$

Homework Lecture 1 Smith

$\boxed{1}$ Show that $\dfrac{p}{\rho^\gamma}$ = constant, $\gamma = c_p/c_v$

For an adiabatic ideal gas, and therefore

the potential temperature $\theta = T\left(\dfrac{p_s}{p}\right)^{R/c_p}$

is also constant in an adiabatic ideal gas,

where p_s is constant.