Hurricane Problems

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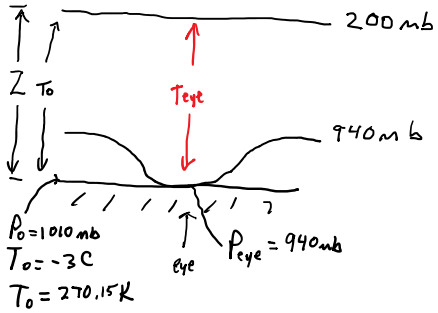


Hypsometric Eq

$$Z_{outside} = 29.3\,T_o \ln\left(\frac{P_o}{200mb}\right) = 29.3\,T_{eye} \ln\left(\frac{P_{eye}}{200mb}\right) = Z_{eye}$$

(meters / K; T_o in K)

$$T_{eye} = T_o \frac{(\ln P_o - \ln 200mb)}{\ln P_{eye} - \ln 200mb}$$ (Kelvin)

$\Delta T = T_{eye} - T_o$

$$\Delta T = T_o \frac{\ln P_o - \ln P_{eye}}{\ln P_{eye} - \ln 200mb}$$ where $P_o = 1010$ mb

$\Delta T = 270.15K \frac{\ln 1010 - \ln 940}{\ln 940 - \ln 200}$

$\Delta T = 12$ K

$\Delta T = T_{eye} - T_o$

Homework:

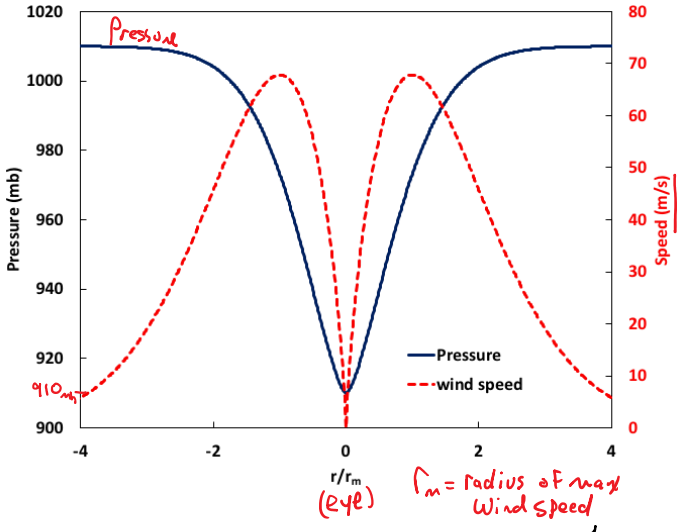
$$\Delta T = 270.15K \frac{\ln 1010mb - \ln P_{eye}}{\ln P_{eye} - \ln 200mb}$$

Will show that $\Delta P = P_o - P_{eye}$

ρ = Surface density

$\rho \sim 1.2$ Kg/m^3

$$\Delta P = 1.81\,\rho\,V_m^2$$ ←



$$P(r) = P_o - \Delta P\, e^{-(r/r_m)^b}$$ → Parameterization

b = fitting Parameter

b = 1.5

Cyclostrophic flow

Force Balance

$$\frac{dP}{dr} = \frac{\rho V(r)^2}{r}$$

$$\frac{dP}{dr} = b\left(\frac{r^{b-1}}{r_m^b}\right)\Delta P\, e^{-(r/r_m)^b}$$

$$V(r) = \left[\frac{b}{\rho}\frac{r^b}{r_m^b}\Delta P\, e^{-(r/r_m)^b}\right]^{1/2}$$

Radius of max speed

$\partial V/\partial r = 0$, solve for r, $r = r_m$

$$V_{max} = \left(\frac{b}{\rho}\frac{\Delta P}{e}\right)^{1/2}$$ b = 1.5, e = 2.72

$$\Delta P = 1.81\,\rho V_{max}^2$$

Saffir-Simpson Hurricane Wind Scale

The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous, however, and require preventative measures. In the western North Pacific, the term "super typhoon" is used for tropical cyclones with sustained winds exceeding 150 mph.

Category	Sustained Winds	Types of Damage Due to Hurricane Winds
1	74-95 mph 64-82 kt 119-153 km/h	**Very dangerous winds will produce some damage:** Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 83-95 kt 154-177 km/h	**Extremely dangerous winds will cause extensive damage:** Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129 mph 96-112 kt 178-208 km/h	**Devastating damage will occur:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156 mph 113-136 kt 209-251 km/h	**Catastrophic damage will occur:** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	157 mph or higher 137 kt or higher 252 km/h or higher	**Catastrophic damage will occur:** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.