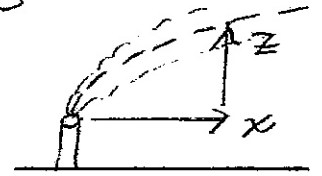


C. Solution of Eqs for Special Cases

ie, how to find Z vs. x
centerline

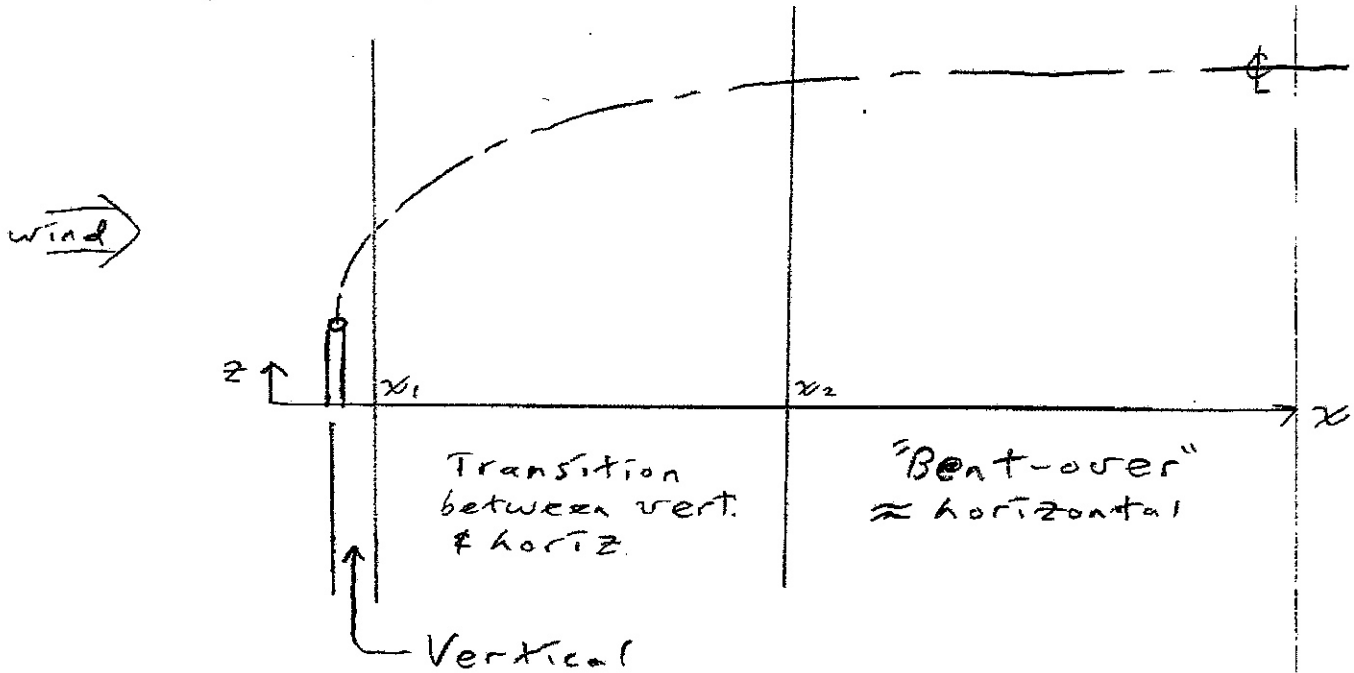


1. Definitions of Special Cases -

a) "Jet" = momentum dominates

"Buoyant Plume" = buoyancy dominates

b) Stages of plume rise



c) Typical initial conditions: vertical

$r = r_0$ plume radius = stack radius

$w = w_0$ = velocity out of top of stack

$U_{sc} = w$ plume is initially vertical

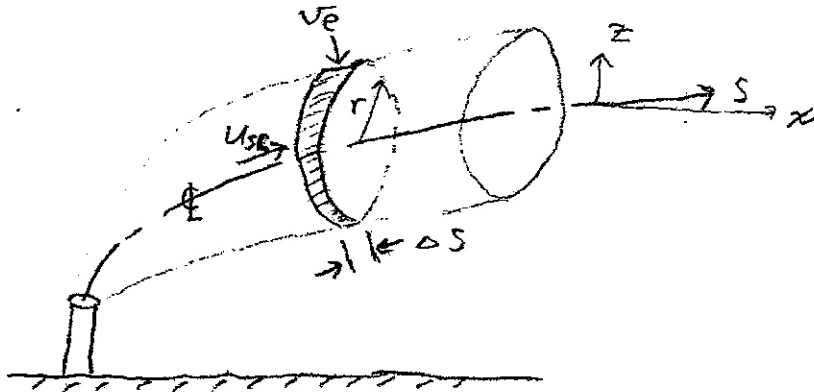
"jet" ie, initially even buoyant plumes act like a jet.

A. Derivation of Conservation Eqs.

1. Volume Conservation

Stull

A
2/6



where:

s = distance along centerline (\hat{x})

U_{sc} = velocity (axial) along \hat{x}

v_e = lateral (radial) entrainment velocity

Volume Budget:

$$\text{Volume Flow In} = \text{Volume Flow Out}$$

$$\text{Vol. Flow Along Axis} + \text{Vol. Entrained from Sides} = \text{Vol. Out}$$

[But volume flow rate = velocity times area thru which it flows]

$$U_{sc1} \cdot \pi r_1^2 + v_e \cdot 2\pi r \cdot \Delta s = U_{sc2} \cdot \pi r_2^2$$

where 1 = in
2 = out

$$\therefore 2 r v_e = \frac{[U_{sc2} r_2^2 - U_{sc1} r_1^2]}{\Delta s}$$

Let $\Delta s \rightarrow ds$:

$$2 r v_e = \frac{d(U_{sc} \cdot r^2)}{ds}$$

Define an entrainment flux $E \equiv 2 \cdot r \cdot v_e$

$$\boxed{\frac{d(U_{sc} \cdot r^2)}{ds} = E}$$

= eq. (3.1) on p 122 of VW text

(3.1)