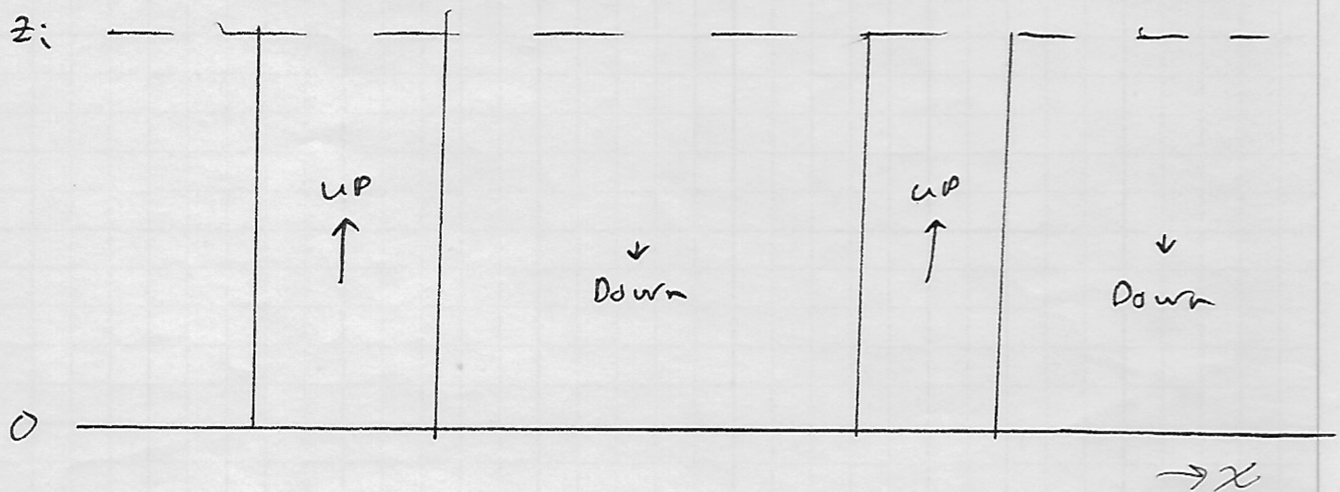
z_i
0
up
Down
up
Down
→ x

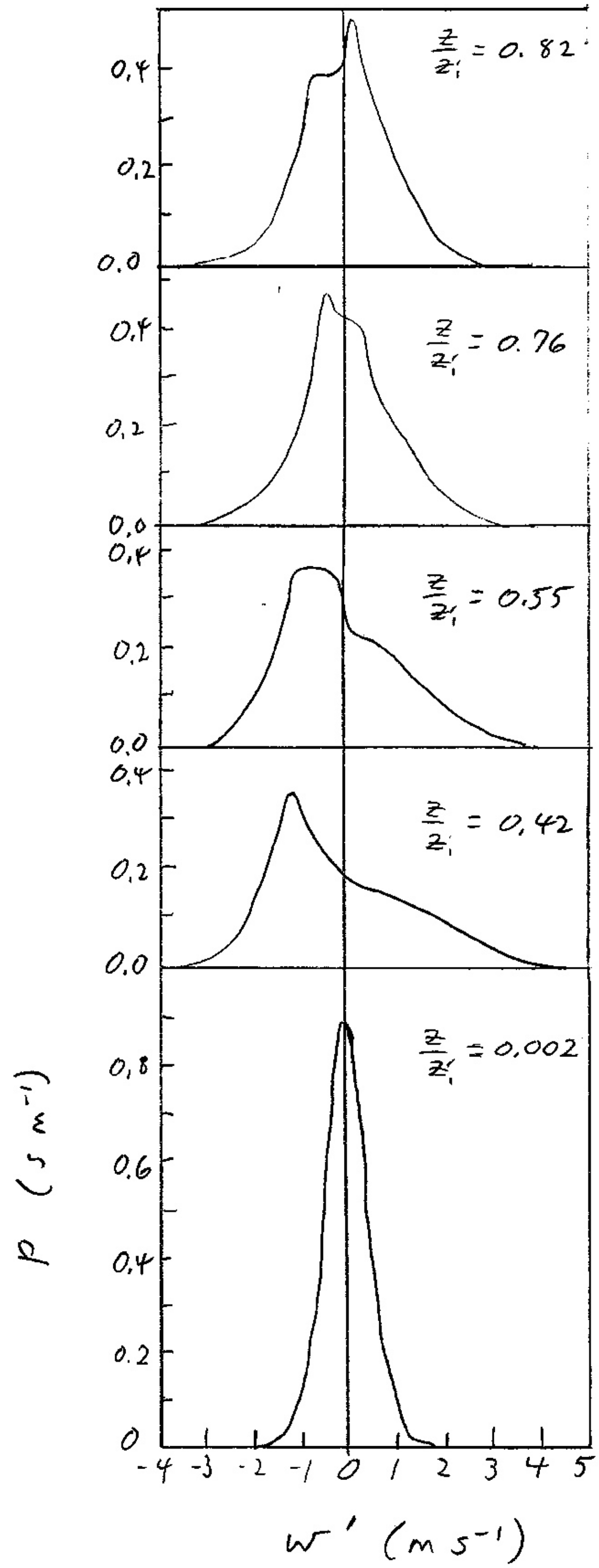

Fig. 11.9 Smoothed probability density function, P, for vertical velocity, w', showing the negatively skewed frequency distribution typical of convective mixed layers.

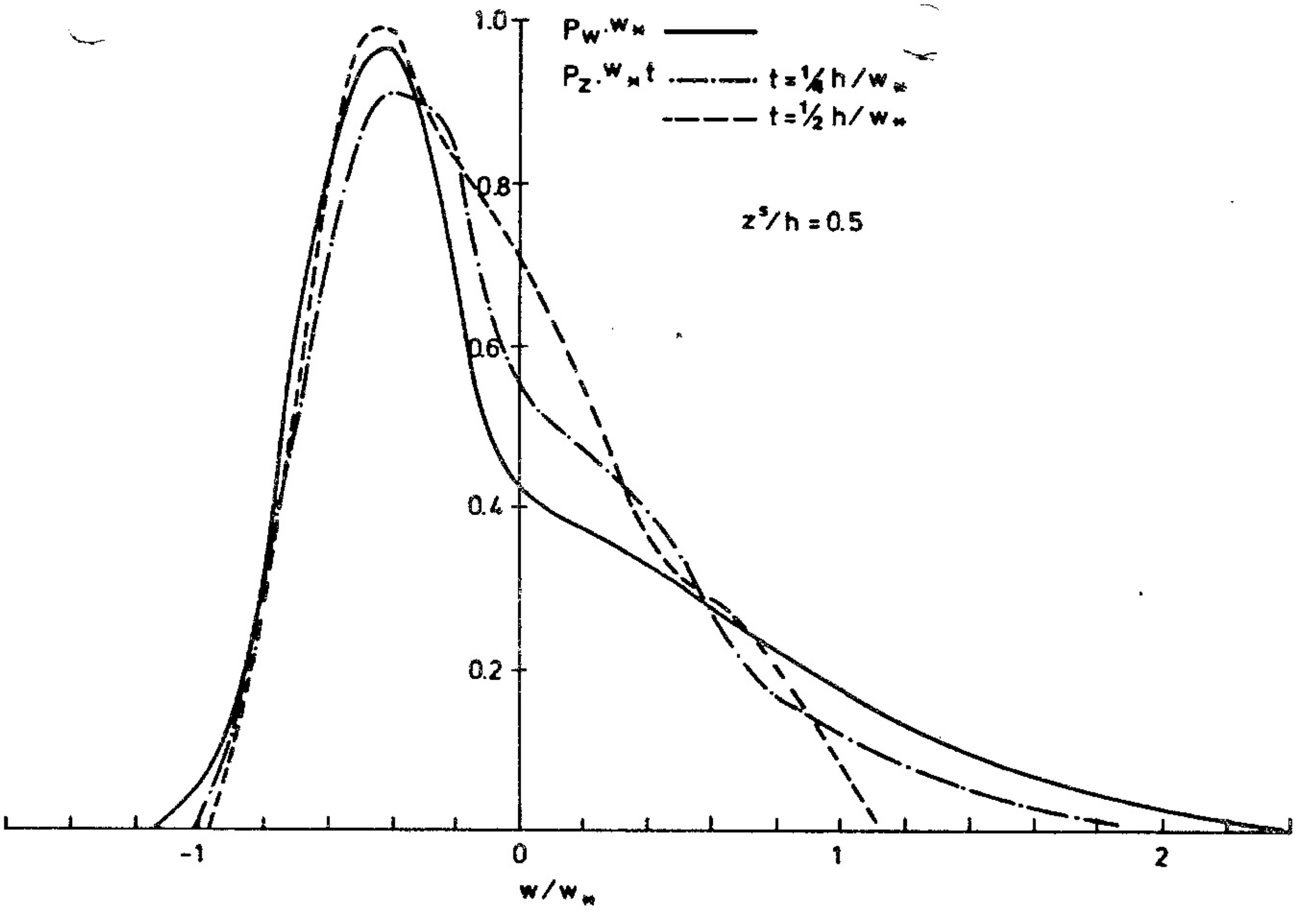

Figure 5.14. Plots of the probability density of the vertical velocity fluctuations at z = 0.5 h (from Figure 5.13) superposed on the vertical displacement density functions p_z of particles released at the same elevation.

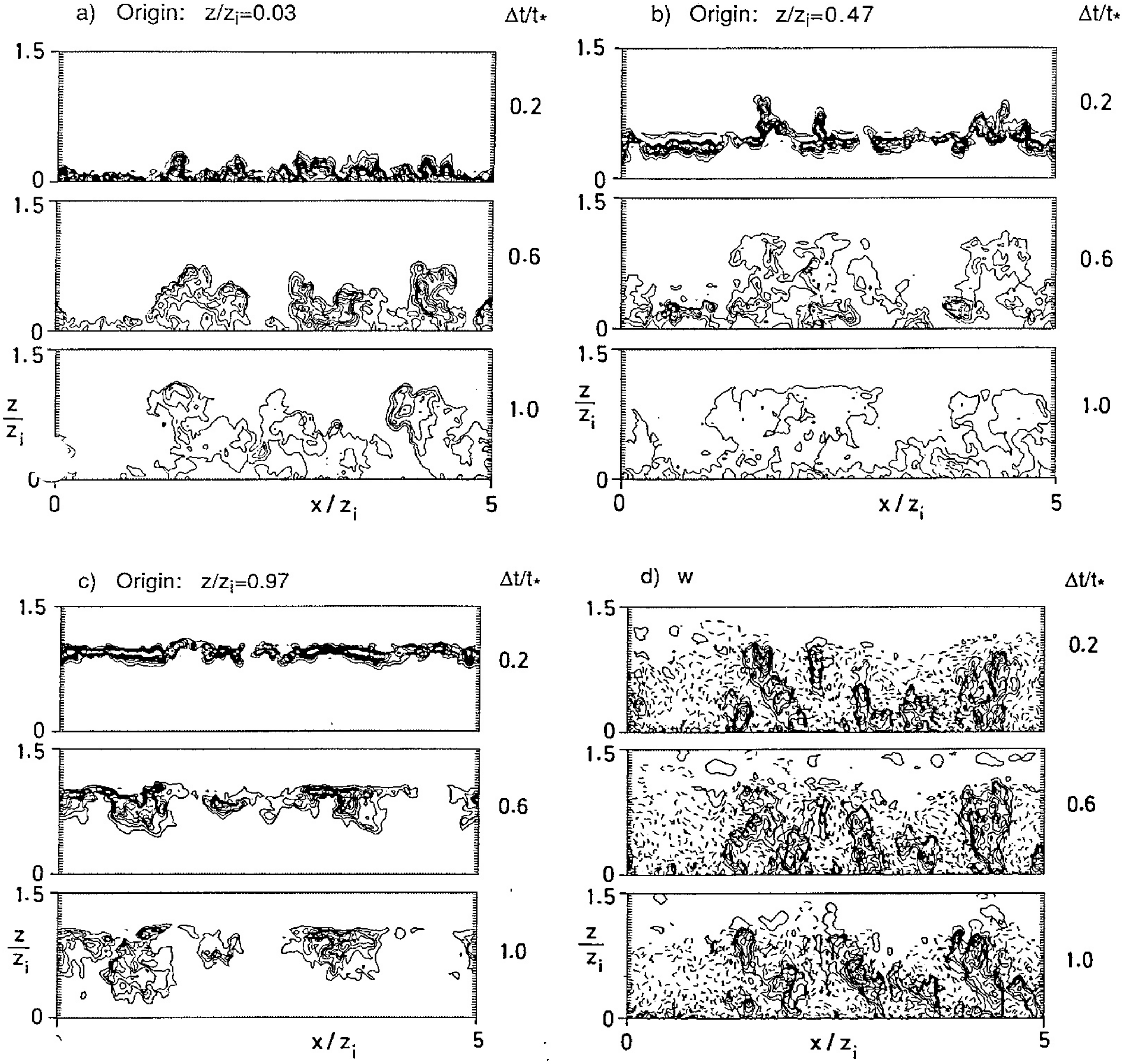

FIG. 4. (a) Scalar concentration at $t/t_* = 0.2$, 0.6, and 1.0 for air originating at $z/z_i = 0.03$. The fine grid LES model was used, and the contour intervals are 0.05, 0.15, 0.25, . . . , 0.95; (b) as in (a), for air originating at $z/z_i = 0.47$; (c) as in (a), for air originating at $z/z_i = 0.97$; (d) vertical velocity field at the same times. The contour interval is 0.3 m s^{-1}, and the dashed contours represent negative velocities.

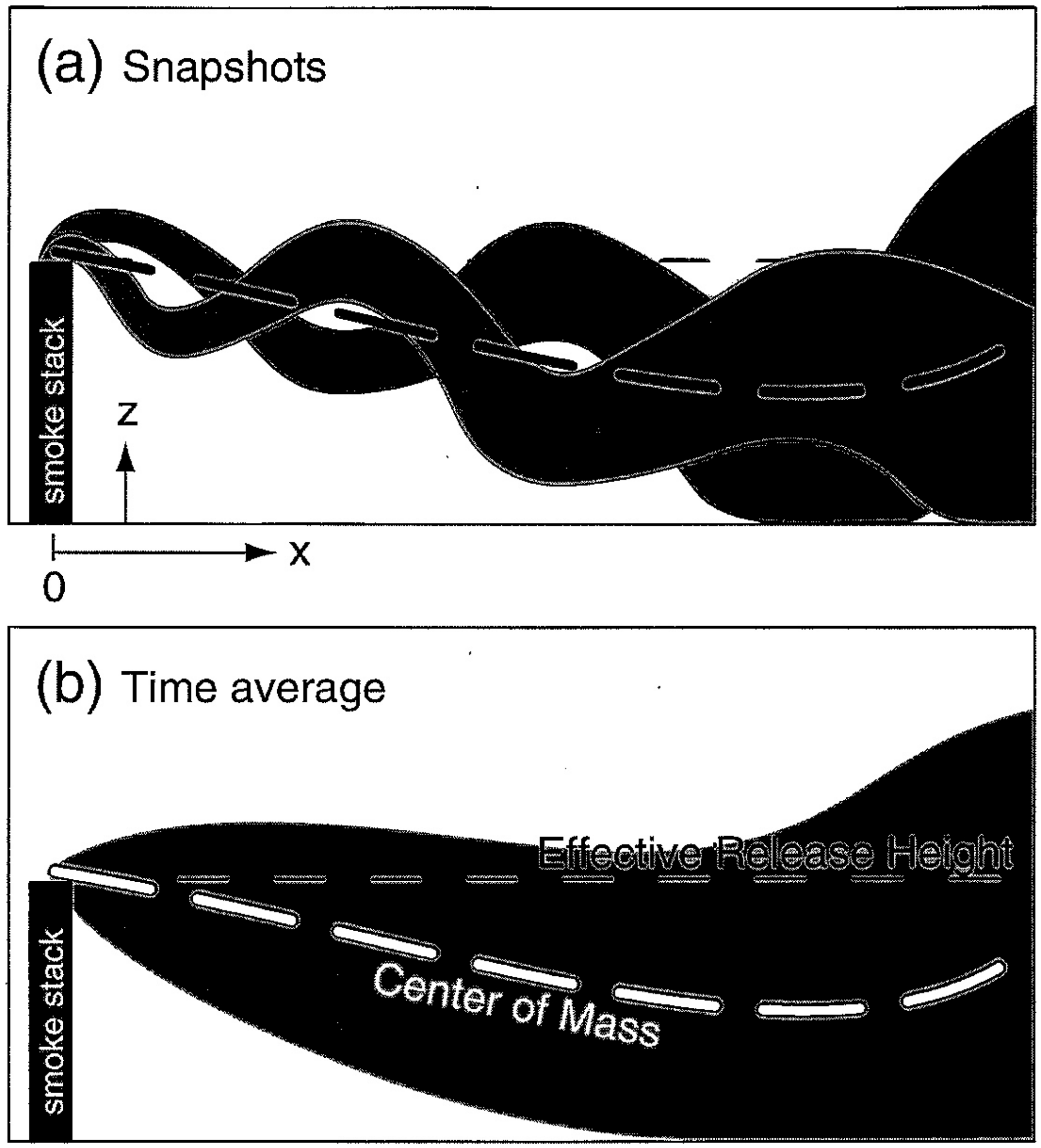

FIG. 1. (a) Illustration of snapshots of looping smokestack plumes (grey shaded) and (b) their time-averaged spread. Heavy dashed line in both figures is the time averaged center of mass, and the thin dashed line is the effective release height.

Free convection ~~dispersion~~ plume rise

Lamb, 1982: Diffusion in the Convective Boundary Layer. "Atmos. Turb. and Air Pollution Modelling." Ed. by Nieuwstadt & Van Dop. Reidel. 159–229.

1. Free convection if:

$$\frac{g}{\theta_v}\overline{w'\theta_v} > -\overline{u'w'}\frac{\partial \bar{u}}{\partial z} \quad \text{from TKE eq.}$$

In more practical terms, we can use free convection for dispersion calculations if:

a) $\bar{U} < 6\, w_*$ $\quad (w_* = \textcircled{\sim}\ 1\text{-}2\ m/s)$

b) $\frac{z_i}{(-L)} > 10$ $\quad$ or $\quad u_* < 3 w_*$

and c) $z_{stack} > |L|$

2[illegible] Free convection scale times and distances:

z_i = vert. scaling distance ≃ scale of largest eddies

$t_* \equiv \frac{z_i}{w_*}$ = scaling time ≃ 10–30 min

$x_* = \bar{U} t_*$ = horizontal scaling distance

$= \frac{\bar{u}}{w_*} \cdot z_i$

∴ Dimensionless dispersion is

$$\boxed{\frac{\sigma_z}{z_i}} \text{ and } \boxed{\frac{\sigma_y}{z_i}}$$

∴ Dimensionless smoke-plume downwind distance is

$$X = \frac{x}{x_*} = \text{or } \boxed{\frac{x\, w_*}{z_i\, \bar{u}}}$$