ORIGINAL - ERROR REPORTED BY JERRY DAVIS, NORTH CAROLINA STATE UNIVERSITY, RALEIGH, NC

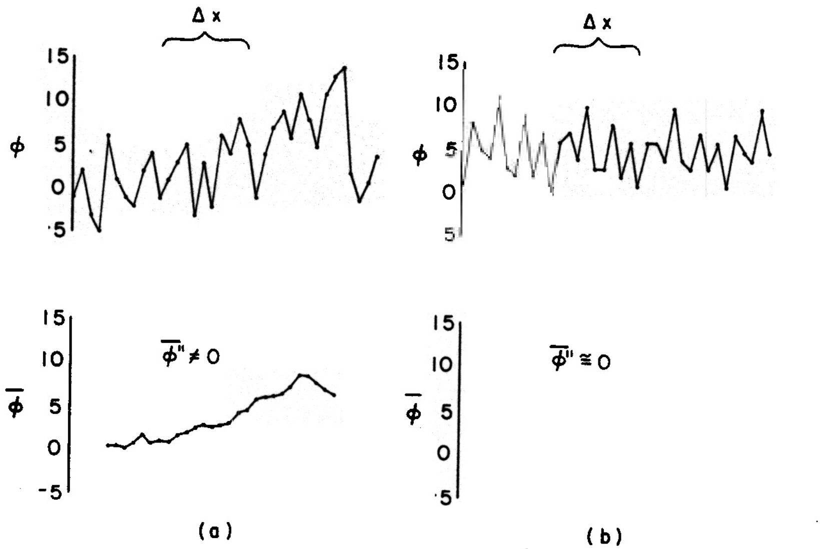

Fig. 4-2. A one-dimensional schematic illustration of a situation where (a) $\overline{\phi''} \neq 0$ and (b) $\overline{\phi''} \simeq 0$. The averaging length is illustrated by the interval Δx drawn on the figure ($\bar{\phi} = \frac{1}{10}\int_{x_i}^{x_i+10} \phi\, dx$). Since $\phi = \bar{\phi} + \phi''$, $\overline{\phi''} = 0$ only if $\bar{\phi} = \bar{\bar{\phi}}$.

Even with the simplifications, Eq. (4-7) contains two additional terms not found in Eq. (2-45) that involve the correlation between the subgrid-scale variables. The second of these terms, $\overline{\alpha'' \partial p'' / \partial x_i}$, could be eliminated if the assumption is made in Eq. (4-4) that $|\alpha''|/\bar{\alpha} \simeq |\alpha''|/\alpha_0 \ll 1$ [In Section 3.1, α_0 was defined as a synoptic-scale specific volume in the derivation of the approximate forms of the conservation-of-mass relation. The mathematical definition of this synoptic scale is given by Eq. (4-12).]

With this requirement on specific volume and the assumption that Eq. (3-11) can be written as

$$\frac{\partial}{\partial x_j} \rho_0 u_j \simeq \frac{\partial}{\partial x_j} \bar{\rho} u_j \quad \left(\text{since } \frac{|\alpha''|}{\bar{\alpha}} \simeq \frac{|\alpha''|}{\alpha_0} \ll 1\right), \tag{4-9}$$

using the simplifying assumptions given by Eq. (4-8), Eq. (4-5) can be written as

$$\bar{\rho}\frac{\partial \bar{u}_i}{\partial t} = -\frac{\partial}{\partial x_j} \bar{\rho}\,\bar{u}_j\,\bar{u}_i - \frac{\partial}{\partial x_j} \bar{\rho}\overline{u_j'' u_i''} - \frac{\partial \bar{p}}{\partial x_i} - \bar{\rho} g \delta_{i3} - 2\epsilon_{ijk}\Omega_j \bar{u}_k \bar{\rho}, \tag{4-10}$$

where, since $|\alpha''|/\bar{\alpha} \ll 1$, the pressure gradient term is represented by $\bar{\alpha}\, \partial \bar{p}/\partial x$. The remaining *subgrid-scale correlation term*, $\bar{\rho}\overline{u_j'' u_i''}$, represents the contributions of the smaller scales on the resolvable grid scale resulting from fluctuating velocity components and is in general very important in all aspects of dynamic

$$\bar{\rho}\,\frac{\partial \bar{u}_i}{\partial t} = -\frac{\partial}{\partial x_j}\,\bar{\rho}\,\bar{u}_j\,\bar{u}_i - \frac{\partial}{\partial x_j}\,\bar{\rho}\overline{u_j'' u_i''} - \frac{\partial \bar{p}}{\partial x_i} - \bar{\rho} g \delta_{i3} - 2\epsilon_{ijk}\Omega_j \bar{u}_k \bar{\rho}, \qquad (4.10)$$

CORRECTION