- Eulerian approach for particles
- $\rho'_g = \theta \rho_g$
- θ = void fraction (V_g/V_{tot})
- ρ'_p = bulk particle density

Table 1. Summary of Conservation Equations for Gas–Particle Mixtures

Continuity equation

Gas phase:	$\partial \rho'_g/\partial t + \nabla \cdot (\rho'_g \mathbf{v}_g) = r_p$
Particle phase:	$\partial \rho'_p/\partial t + \nabla \cdot (\rho'_p \mathbf{v}_p) = -r_p$
Mixture:	$(\partial/\partial t)(\rho'_p + \rho'_g) + \nabla \cdot (\rho'_g \mathbf{v}_g + \rho'_p \mathbf{v}_p) = 0$

Momentum equation

Gas phase:	$(\partial/\partial t)(\rho'_g \mathbf{v}_g) + \nabla \cdot (\rho'_g \mathbf{v}_g \mathbf{v}_g) = -\nabla p + \nabla \cdot [\theta \boldsymbol{\tau} + (1-\theta)\boldsymbol{\tau}_a] - \mathbf{f}_p + \rho'_g \mathbf{g} + \mathbf{v}_p r_p$
Particle phase:	$(\partial/\partial t)(\rho'_p \mathbf{v}_p) + \nabla \cdot (\rho'_p \mathbf{v}_p \mathbf{v}_p) = \mathbf{f}_p + \rho'_p \mathbf{g} - \mathbf{v}_p r_p$
Mixture:	$(\partial/\partial t)(\rho'_g \mathbf{v}_g + \rho'_p \mathbf{v}_p) + \nabla \cdot (\rho'_g \mathbf{v}_g \mathbf{v}_g + \rho'_p \mathbf{v}_p \mathbf{v}_p) = -\nabla p + \nabla \cdot [\theta \boldsymbol{\tau} + (1-\theta)\boldsymbol{\tau}_a] + (\rho'_g + \rho'_p)\mathbf{g}$

Energy equation (total)

Gas phase:	$(\partial/\partial t)[\rho'_g(i_g + v_g^2/2)] + \nabla \cdot [\rho'_g \mathbf{v}_g (h_g + v_g^2/2)] = -\nabla \cdot [\theta \mathbf{q} + (1-\theta)\mathbf{q}_s] - q_{cp} + q_{rg} + r_p(\bar{h}_s + v_p^2/2 + w'^2/2) - \nabla \cdot [(1-\theta) p \mathbf{v}_p] + \nabla \cdot [\theta \boldsymbol{\tau} \cdot \mathbf{v}_g + (1-\theta)\boldsymbol{\tau}_a \cdot \mathbf{v}_p] - \mathbf{v}_p \cdot \mathbf{f}_p + \rho'_g \mathbf{g} \cdot \mathbf{v}_g + \bar{p}_s s_v$
Particle phase:	$(\partial/\partial t)[\rho'_p(i_p + v_p^2/2)] + \nabla \cdot [\rho'_p \mathbf{v}_p (i_p + v_p^2/2)] = -r_p(\bar{h}_s + v_p^2/2 + w'^2/2) + \mathbf{v}_p \cdot \mathbf{f}_p + \rho'_p \mathbf{g} \cdot \mathbf{v}_p + q_{cp} + q_{rp} - \bar{p}_s s_v$
Mixture:	$(\partial/\partial t)[\rho'_g(i_g + v_g^2/2) + \rho'_p(i_p + v_p^2/2)] + \nabla \cdot [\rho'_g \mathbf{v}_g (h_g + v_g^2/2) + \rho'_p \mathbf{v}_p (i_p + p/\rho_p + v_p^2/2)] = -\nabla \cdot [\theta \mathbf{q} + (1-\theta)\mathbf{q}_s] + \theta q_{rg} + q_{rp} + \nabla \cdot [\theta \boldsymbol{\tau} \cdot \mathbf{v}_g + (1-\theta)\boldsymbol{\tau}_a \cdot \mathbf{v}_p] + \mathbf{g} \cdot (\rho'_p \mathbf{v}_p + \rho'_g \mathbf{v}_g)$

from Smoot and Pratt, Pulverized-Coal Combustion and Gasification, Plenum, New York, p. 39 (1979). (See Table 9.1, p. 239 of Smoot and Smith, 1985)

Cloud Model

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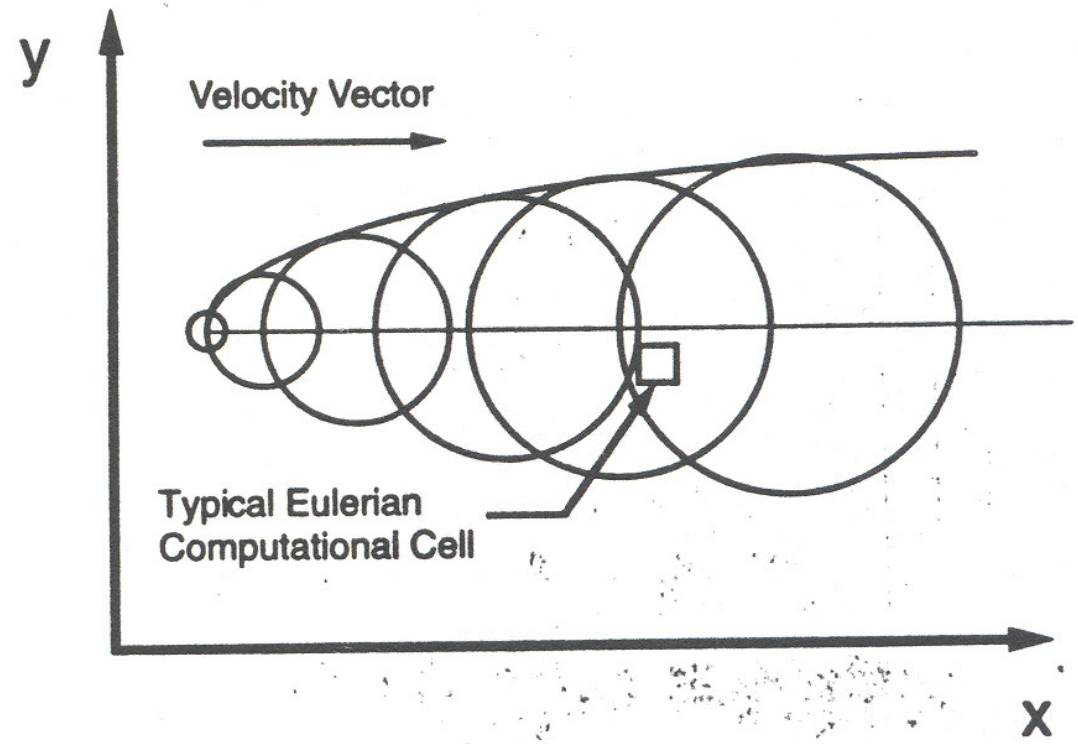

Figure 4. Lagrangian view of dispersion in a one-dimensional flow. Each circle is a measure of the spatial extent of a pdf for particle position at successive times during the flow. The position of a typical Eulerian computational cell is also illustrated. Particles of many different residence times contribute to the overall population of particles in the cell.