**Table 17.1** Physical meaning of the terms in the equations describing momentum conservation for mean flow in a turbulent field.

\[
\frac{\partial \mathbf{u}}{\partial t} + \mathbf{u} \cdot \nabla \mathbf{u} + \nabla P = -\nabla \cdot \tau + \nabla \times (\mathbf{v} \times \mathbf{u}) - \rho \frac{\partial \mathbf{f}}{\partial t} + \nabla \cdot \mathbf{V} = \frac{\partial \mathbf{u}}{\partial x} + \frac{\partial \mathbf{v}}{\partial y} + \frac{\partial \mathbf{w}}{\partial z} = \frac{1}{\rho} \frac{\partial P}{\partial x} + \frac{\partial (\mathbf{u}' \cdot \mathbf{u}')}{{\partial y} + \frac{\partial (\mathbf{u}' \cdot \mathbf{w}')}{{\partial z}}}
\]

TERM I  Storage of mean momentum  
TERM II  Advection of mean momentum  
TERM III Influence of Earth’s rotation and gravity  
TERM IV Influence of mean pressure gradients  
TERM V Influence of viscous stress on mean motion (or divergence of molecular momentum flux)  
TERM VI Influence of turbulent stress on mean motion (or divergence of turbulent momentum flux)

**Table 17.2** Physical meaning of the terms in the equation describing moisture conservation for mean flow in a turbulent field.

\[
\frac{\partial q}{\partial t} + \mathbf{u} \cdot \nabla q + \nabla q - \frac{S}{\rho_t} + \mathbf{v} \cdot \nabla q = -\frac{1}{\rho_d} \frac{\partial P}{\partial x} + \frac{\partial (\mathbf{v}' \cdot \mathbf{q}')}{{\partial y} + \frac{\partial (\mathbf{v}' \cdot \mathbf{q}')}{{\partial z}}}
\]

TERM I  Storage of mean moisture  
TERM II  Advection of mean moisture  
TERM III Mean 'body' source of moisture per unit volume  
TERM IV Mean creation of moisture as vapor per unit volume by evaporation of other water phases  
TERM V Divergence of mean molecular moisture flux  
TERM VI Divergence of turbulent moisture flux
### Table 17.3 Physical meaning of the terms in the equation describing heat conservation for mean flow in a turbulent field.

\[
\begin{align*}
\frac{\partial \bar{T}}{\partial t} + \bar{u} \frac{\partial \bar{T}}{\partial x} + \bar{v} \frac{\partial \bar{T}}{\partial y} + \bar{w} \frac{\partial \bar{T}}{\partial z} &= - \nabla \cdot \mathbf{q} - \frac{E}{\rho c_p} + \nu \nabla^2 \bar{T} - \left( \frac{\partial \overline{u'v'\theta}}{\partial x} + \frac{\partial \overline{v'w'\theta}}{\partial y} + \frac{\partial \overline{w'u'\theta}}{\partial z} \right) \\
\end{align*}
\]

<table>
<thead>
<tr>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>TERM I</td>
<td>Mean storage of heat</td>
<td></td>
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<td></td>
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<tr>
<td>TERM II</td>
<td>Advection of heat by mean wind</td>
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<tr>
<td>TERM III</td>
<td>Mean heat source from net radiation divergence</td>
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<tr>
<td>TERM IV</td>
<td>Mean heat source by latent heat release</td>
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<tr>
<td>TERM V</td>
<td>Divergence of mean molecular heat flux</td>
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</tr>
<tr>
<td>TERM VI</td>
<td>Divergence of turbulent heat flux</td>
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</tbody>
</table>

### Table 17.4 Physical meaning of the terms in the equation describing conservation of scalars in a turbulent field.

\[
\begin{align*}
\frac{\partial \bar{c}}{\partial t} + \bar{u} \frac{\partial \bar{c}}{\partial x} + \bar{v} \frac{\partial \bar{c}}{\partial y} + \bar{w} \frac{\partial \bar{c}}{\partial z} &= S_c + \nu \nabla^2 \bar{c} - \left( \frac{\partial \overline{u'c'}}{\partial x} + \frac{\partial \overline{v'c'}}{\partial y} + \frac{\partial \overline{w'c'}}{\partial z} \right) \\
\end{align*}
\]

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>TERM I</td>
<td>Mean storage of scalar</td>
<td></td>
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<tr>
<td>TERM II</td>
<td>Advection of scalar by mean wind</td>
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<tr>
<td>TERM III</td>
<td>Mean body source of scalar</td>
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</tr>
<tr>
<td>TERM IV</td>
<td>Divergence of mean molecular scalar flux</td>
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<td></td>
</tr>
<tr>
<td>TERM V</td>
<td>Divergence of turbulent scalar flux</td>
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</tbody>
</table>
Table 17.5 The suite of equations that describe the evolution of mean atmospheric flow in the ABL including the effect of turbulent flux divergence.

Ideal Gas Law:

\[ \overline{p} = R \rho_s T \]

Conservation of Mass:

In general

\[
\frac{\partial \rho}{\partial t} = - \rho \left( \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} \right)
\]

In the ABL

\[
\frac{\partial \rho}{\partial t} = - \rho \left( \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} \right) = 0
\]

Conservation of Momentum:

\[
\frac{\partial \overline{u}}{\partial t} + \overline{u} \frac{\partial \overline{u}}{\partial x} + \overline{v} \frac{\partial \overline{u}}{\partial y} + \overline{w} \frac{\partial \overline{u}}{\partial z} = - f \overline{V} - \nu - \frac{\partial (\overline{u} u')}{\partial x} - \frac{\partial (\overline{v} v')}{\partial y} - \frac{\partial (\overline{w} w')}{\partial z}
\]

\[
\frac{\partial \overline{v}}{\partial t} + \overline{u} \frac{\partial \overline{v}}{\partial x} + \overline{v} \frac{\partial \overline{v}}{\partial y} + \overline{w} \frac{\partial \overline{v}}{\partial z} = - f \overline{U} - \nu - \frac{\partial (\overline{v} v')}{\partial x} - \frac{\partial (\overline{v} v')}{\partial y} - \frac{\partial (\overline{w} w')}{\partial z}
\]

\[
\frac{\partial \overline{w}}{\partial t} + \overline{u} \frac{\partial \overline{w}}{\partial x} + \overline{v} \frac{\partial \overline{w}}{\partial y} + \overline{w} \frac{\partial \overline{w}}{\partial z} = - g \left( \frac{\partial (\overline{u} w')}{\partial x} + \frac{\partial (\overline{v} w')}{\partial y} + \frac{\partial (\overline{w} w')}{\partial z} \right)
\]

Conservation of Moisture:

\[
\frac{\partial \overline{q}}{\partial t} + \overline{u} \frac{\partial \overline{q}}{\partial x} + \overline{v} \frac{\partial \overline{q}}{\partial y} + \overline{w} \frac{\partial \overline{q}}{\partial z} = S_j + E - \frac{\partial (\overline{u} q')}{\partial x} - \frac{\partial (\overline{v} q')}{\partial y} - \frac{\partial (\overline{w} q')}{\partial z}
\]

Conservation of Energy:

\[
\frac{\partial \overline{\theta}}{\partial t} + \overline{u} \frac{\partial \overline{\theta}}{\partial x} + \overline{v} \frac{\partial \overline{\theta}}{\partial y} + \overline{w} \frac{\partial \overline{\theta}}{\partial z} = \frac{\partial (\overline{u} \theta')}{\partial x} + \frac{\partial (\overline{v} \theta')}{\partial y} + \frac{\partial (\overline{w} \theta')}{\partial z}
\]

Conservation of a Scalar Quantity:

\[
\frac{\partial \overline{c}}{\partial t} + \overline{u} \frac{\partial \overline{c}}{\partial x} + \overline{v} \frac{\partial \overline{c}}{\partial y} + \overline{w} \frac{\partial \overline{c}}{\partial z} = S_j - \left( \frac{\partial (\overline{u} c')}{\partial x} + \frac{\partial (\overline{v} c')}{\partial y} + \frac{\partial (\overline{w} c')}{\partial z} \right)
\]