$$
\begin{aligned}
\frac{\partial u}{\partial t} - \beta y v &= -\frac{\partial \phi}{\partial x}, \\
\frac{\partial v}{\partial t} + \beta y u &= -\frac{\partial \phi}{\partial y}, \\
\frac{\partial \phi}{\partial t} + c^2 \left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} \right) &= 0.
\end{aligned}
$$