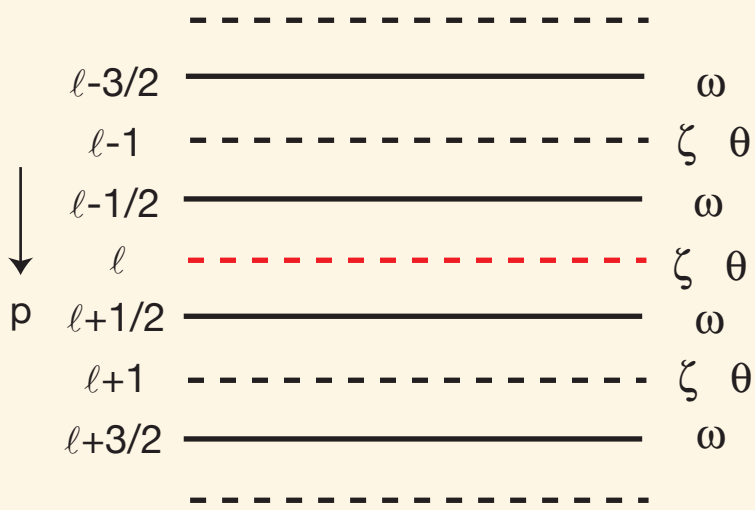
COUPLING BETWEEN VELOCITY AND THERMAL FIELDS IN VERTICALLY DISCRETE MODELS

Lorenz grid



$$\left(\frac{\partial}{\partial t}+\mathbf{v}\cdot\nabla\right)(\zeta+f)-f_0\frac{\partial\omega}{\partial p}=0 \qquad (1)$$

$$\left(\frac{\partial}{\partial t}+\mathbf{v}\cdot\nabla\right)\frac{\partial}{\partial p}\left(\frac{f_0}{\sigma}\theta\right)-f_0\frac{\partial\omega}{\partial p}=0 \qquad (2)$$

For the Lorenz grid, discrete expressions for $-f_0\frac{\partial\omega}{\partial p}$ are different between (1) and (2).

For (1) at ℓ : $$\left(\frac{\partial\omega}{\partial p}\right)_\ell \Rightarrow \frac{\omega_{\ell+1/2}-\omega_{\ell-1/2}}{(\Delta p)_\ell} \qquad (3)$$

For (2) at ℓ :

$$\left(\frac{\partial}{\partial p}\frac{\theta}{\sigma}\right)_\ell \Rightarrow a_\ell\left(\frac{\partial}{\partial p}\frac{\theta}{\sigma}\right)_{\ell+1/2}+b_\ell\left(\frac{\partial}{\partial p}\frac{\theta}{\sigma}\right)_{\ell-1/2}$$

$$\left(\frac{\partial\omega}{\partial p}\right)_{\ell+1/2} \Rightarrow \alpha_{\ell+1/2}\frac{\omega_{\ell+3/2}-\omega_{\ell+1/2}}{(\Delta p)_{\ell+1}}+\beta_{\ell+1/2}\frac{\omega_{\ell+1/2}-\omega_{\ell-1/2}}{(\Delta p)_\ell}$$

$$\left(\frac{\partial\omega}{\partial p}\right)_{\ell-1/2} \Rightarrow \alpha_{\ell-1/2}\frac{\omega_{\ell+1/2}-\omega_{\ell-1/2}}{(\Delta p)_\ell}+\beta_{\ell-1/2}\frac{\omega_{\ell-1/2}-\omega_{\ell-3/2}}{(\Delta p)_\ell}$$

$$\left(\frac{\partial\omega}{\partial p}\right)_\ell \Rightarrow a_\ell\left[\alpha_{\ell+1/2}\frac{\omega_{\ell+3/2}-\omega_{\ell+1/2}}{(\Delta p)_{\ell+1}}+\beta_{\ell+1/2}\frac{\omega_{\ell+1/2}-\omega_{\ell-1/2}}{(\Delta p)_\ell}\right]+b_\ell\left[\alpha_{\ell-1/2}\frac{\omega_{\ell+1/2}-\omega_{\ell-1/2}}{(\Delta p)_{\ell+1}}+\beta_{\ell-1/2}\frac{\omega_{\ell-1/2}-\omega_{\ell-3/2}}{(\Delta p)_l}\right] \qquad (4)$$

Thus potential vorticity cannot be defined.