



FIGURE 4.1: Arrangement of variables. t indicates scalar points where temperature, salinity, density, pressure and horizontal divergence are defined. (u,v,w) indicates vector points, and f indicates vorticity points where both relative and planetary vorticities are defined

4.1.2 Discrete Operators

Given the values of a variable q at adjacent points, the differencing and averaging operators at the midpoint between them are :

$$\delta_i[q] = q(i + 1/2) - q(i - 1/2) \quad (4.1a)$$

$$\bar{q}^i = \{q(i + 1/2) + q(i - 1/2)\} / 2 \quad (4.1b)$$

Similar operators are defined with respect to $i + 1/2$, j , $j + 1/2$, k , and $k + 1/2$. Following (2.11a) and (2.11d), the gradient of a variable q defined at a t -point has its three components defined at u -, v - and w -points while its Laplacian is defined at t -point. These operators have the following discrete forms in the curvilinear s -coordinate system :

$$\nabla q \equiv \frac{1}{e_{1u}} \delta_{i+1/2}[q] \mathbf{i} + \frac{1}{e_{2v}} \delta_{j+1/2}[q] \mathbf{j} + \frac{1}{e_{3w}} \delta_{k+1/2}[q] \mathbf{k} \quad (4.2)$$