# MCV shallow water dynamic core on cubed-sphere grid

Shallow water equations on cubed-sphere grid

Where are the covariant wind vectors, and are the contravariant wind vectors. is the geopotential height. is the kinetic energy, is the absolute vorticity, is the relative vorticity, is the Coriolis parameter, is the Jacobian of transformation.

In the curvilinear coordinate the axes are not orthogonal, but the Coriolis force can only be calculated by orthogonal wind, therefore the wind on contravariant coordinate is necessary to provide the orthogonal wind.

According to Nair(2005),

where

are the central angles on patches of the cube, and vary in

are defined as the arcs,

where is the radius of the earth, is the length of the cube edges.

On the curvilinear coordinate, converting contravariant vectors to covariant vectors by

where

We note .

Therefore

Converting contravariant wind to zonal/meridional wind

Converting covariant wind to zonal/meridional wind

kinetic energy can be rewritten as

Considering the topography, the total geopotential height becomes

where , is the surface height, and

The total vorticity is defined as

The equations are able to be expressed as flux form

where

Then we have

where

setting

The shallow water equations become

The eigenvalues of

Now we need to compute