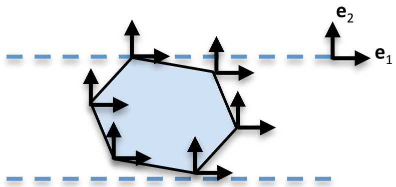
MPAS-CICE Workflow #2: 2D Tensor operations, Momentum equation on **vertices**
Advantages: Reduces to CICE on quads. Much less computation than #1 due to 2D.
Disadvantages: Pole problem. All 2D operations are inexact on sphere. Requires metric terms.

1. Solve Momentum Equation in 2D at vertex (MPAS-CICE subroutine)

$$\mathbf{u}_v = \begin{bmatrix} u_v \\ v_v \end{bmatrix}$$

basis: ($\mathbf{e}_1$,$\mathbf{e}_2$)

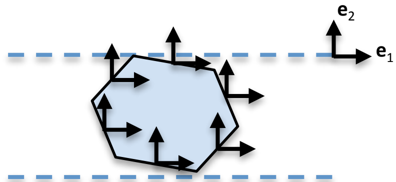
$\mathbf{u}_v = 0$ at boundary



2. Interpolate to edge, (no rotation)

$$\mathbf{u}_e = \begin{bmatrix} u_e \\ v_e \end{bmatrix}$$

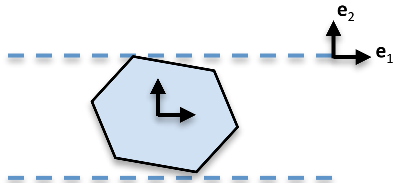
basis: ($\mathbf{e}_1$,$\mathbf{e}_2$)



3. Strain rate, 2D, from edge to cell

$$\varepsilon_i = [\nabla_s u]_i = \begin{bmatrix} \bullet & \bullet \\ & \bullet \end{bmatrix}$$

basis: ($\mathbf{e}_1$,$\mathbf{e}_2$)

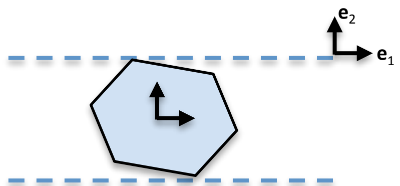


4. No interpolation or rotation required

5. Stress Tensor, 2D at cell (MPAS-CICE subroutine)

$$\sigma_v = \begin{bmatrix} \bullet & \bullet \\ & \bullet \end{bmatrix}$$

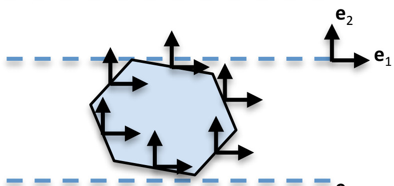
basis: ($\mathbf{e}_1$,$\mathbf{e}_2$)



6. Interpolate to edge (no rotation)

$$\sigma_e = \begin{bmatrix} \bullet & \bullet \\ & \bullet \end{bmatrix}$$

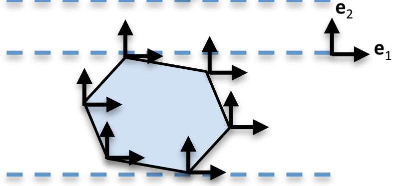
basis: ($\mathbf{e}_1$,$\mathbf{e}_2$)



7. Divergence of stress tensor in 2D, from edge to vertex

$$[\nabla \bullet \sigma]_v = \begin{bmatrix} \bullet \\ \bullet \end{bmatrix}$$

basis: ($\mathbf{e}_1$,$\mathbf{e}_2$)



8. No interpolation or rotation required