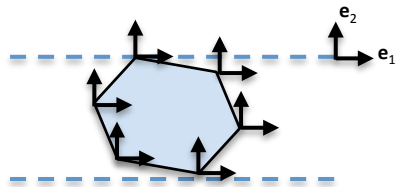
MPAS-CICE Workflow #1: 3D Tensor operations, momentum on **vertices**

1. Solve momentum equation in 2D at vertex (MPAS-CICE subroutine)

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

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

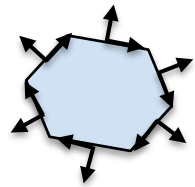
$\mathbf{u}_v = 0$ at boundary



2. Interpolate to edge, rotate

$$\mathbf{u}_e = u_e \mathbf{n}_e + v_e \tilde{\mathbf{n}}_e$$

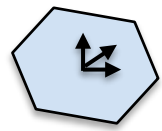
basis: edge normal & tangent in $\mathbf{R}^3$



3. Strain rate, R3, from edge to cell (Tensor operation subroutine)

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

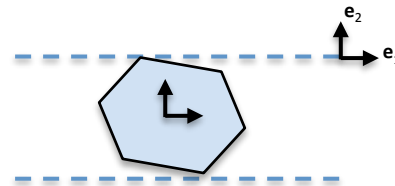
basis: $\mathbf{R}^3$



4. Rotate to 2D

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

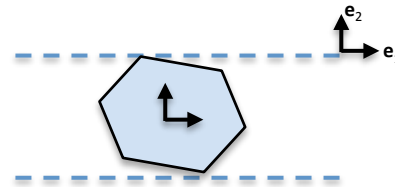
basis: ($\mathbf{e}_1$,$\mathbf{e}_2$)



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

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

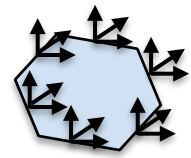
basis: ($\mathbf{e}_1$,$\mathbf{e}_2$)



6. Rotate to R3, interpolate to edge

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

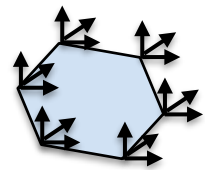
basis: $\mathbf{R}^3$



7. Divergence of Stress Tensor in 3D from edge to vertex (Tensor operation subroutine)

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

basis: $\mathbf{R}^3$



8. Rotate to 2D

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

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