Coriolis

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PHYS 3202

Transform from Inertial to Rotating Reference Frame

$$\frac{d_f \mathbf{u}_f}{dt} = \frac{d_r \mathbf{u}_r}{dt} + 2\Omega \times \mathbf{u}_r + \Omega \times \Omega \times \mathbf{x}$$

$$\text{accel. in } R_f = \text{accel. in } R_r + \text{Coriolis} + \text{centripetal}$$

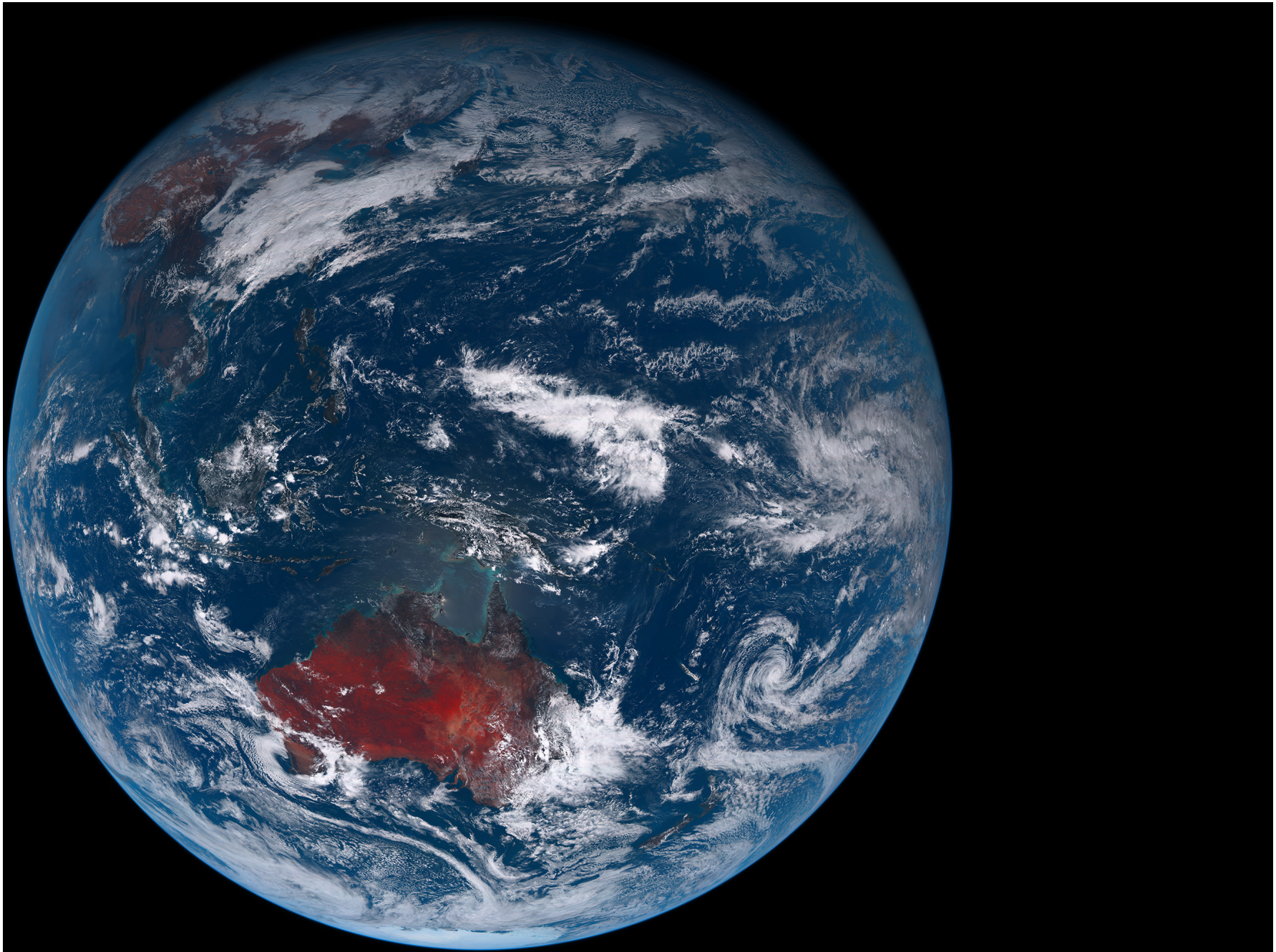
Substituted into the Navier-Stokes momentum equation:

$$\frac{D_r \mathbf{u}_r}{Dt} + 2\Omega \times \mathbf{u}_r + \Omega \times \Omega \times \mathbf{x} = \mathbf{g} - \frac{\nabla p}{\rho} + \nu \nabla^2 \mathbf{u}_r$$

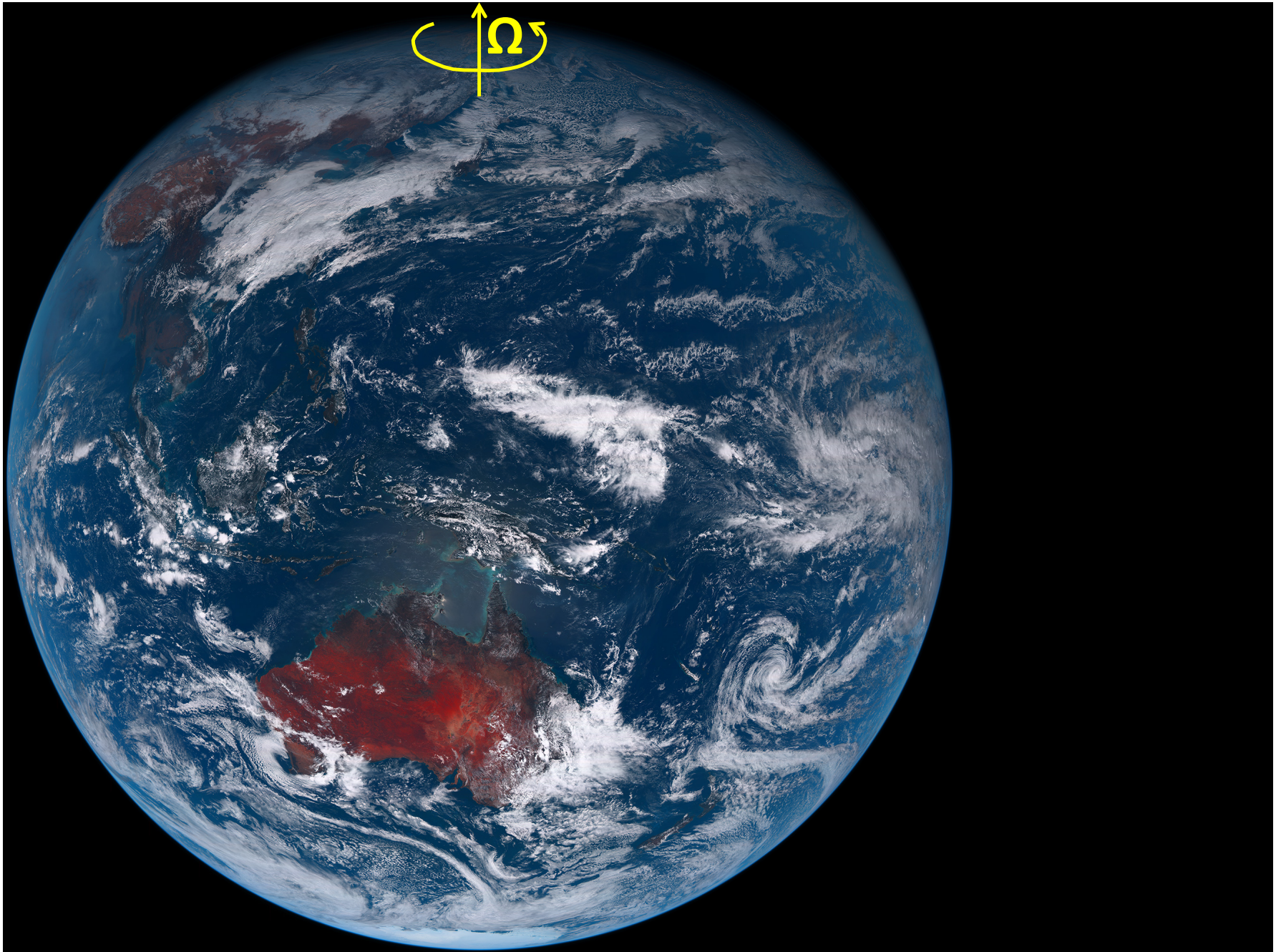
with the gravity and centripetal terms expressed as a geopotential:

$$\frac{D_r \mathbf{u}_r}{Dt} + 2\Omega \times \mathbf{u}_r = \mathbf{g}^* - \frac{\nabla p}{\rho} + \nu \nabla^2 \mathbf{u}_r$$

Coriolis Term: $2\Omega \times \mathbf{u}$



Coriolis Term: $2\Omega \times \mathbf{u}$



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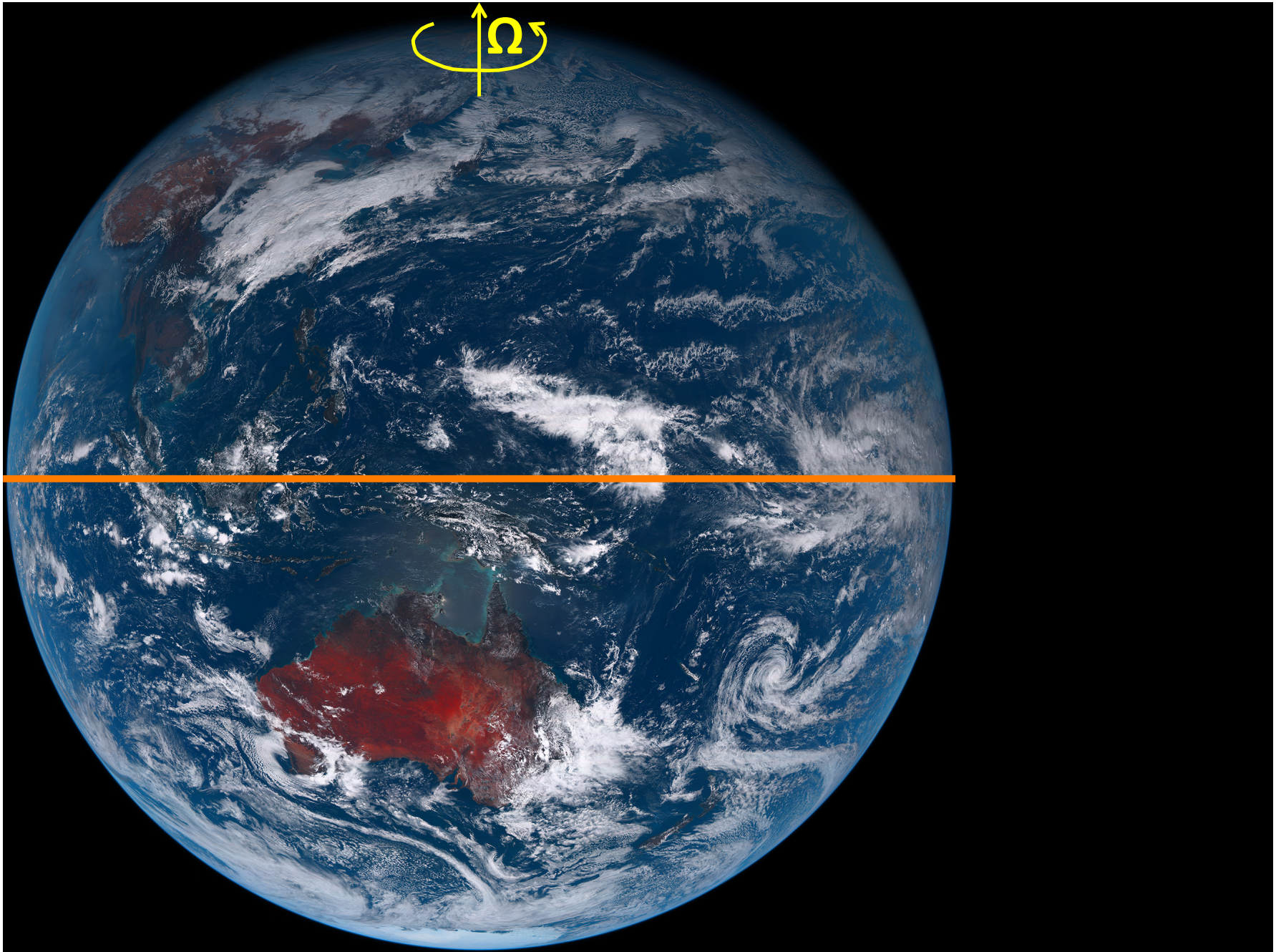
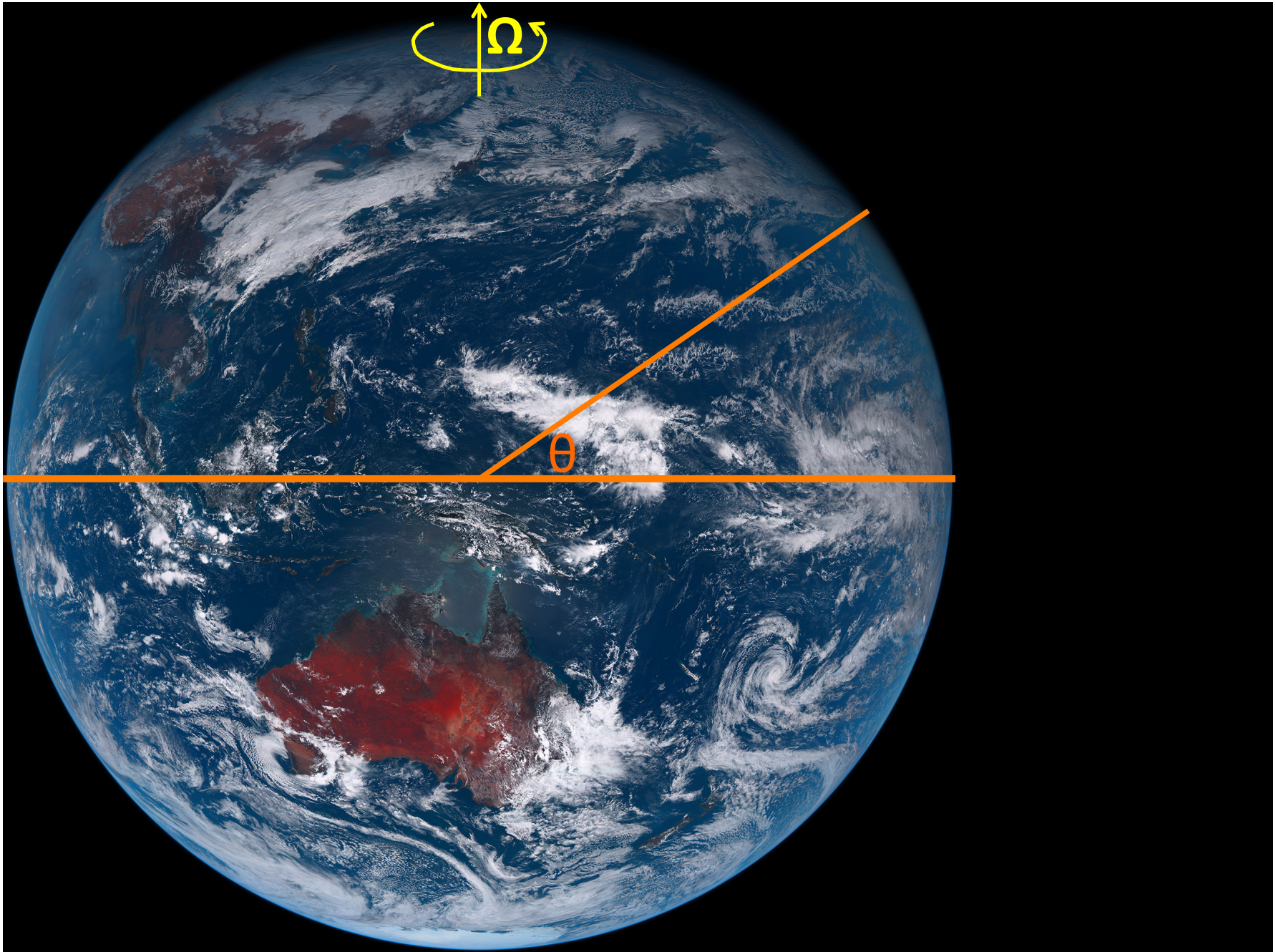
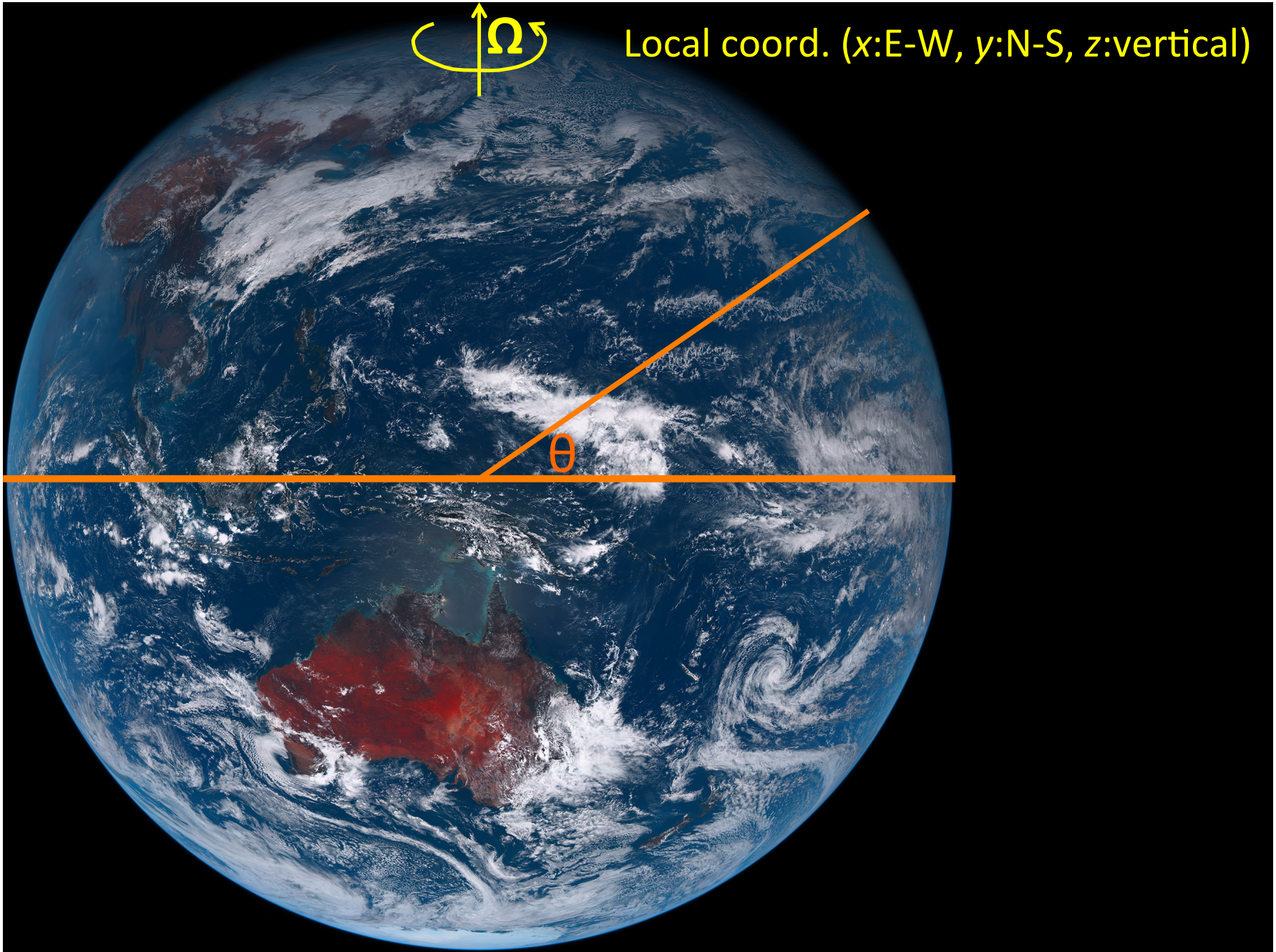


Coriolis Term: $2\Omega \times \mathbf{u}$



Coriolis Term: $2\Omega \times \mathbf{u}$



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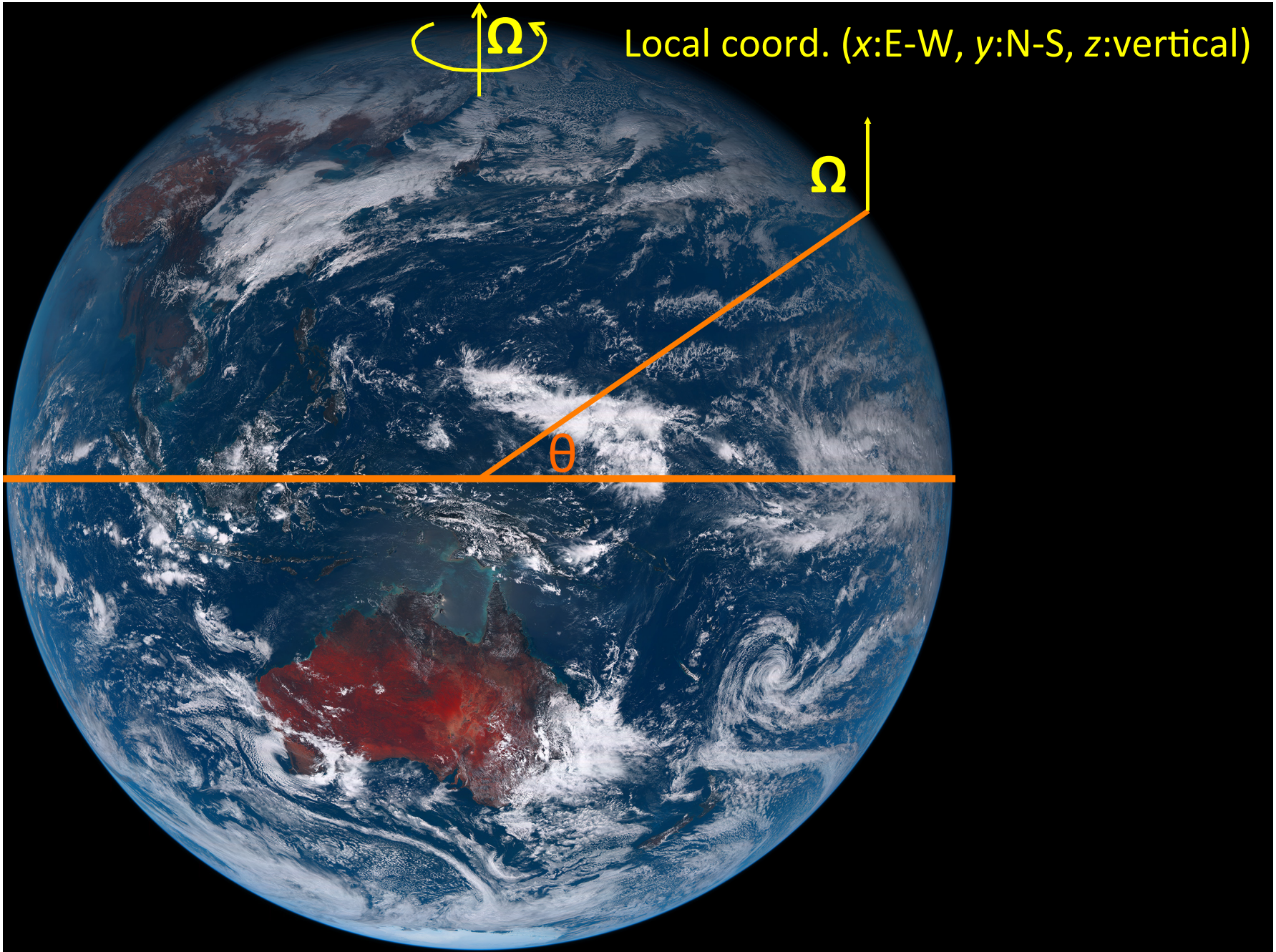
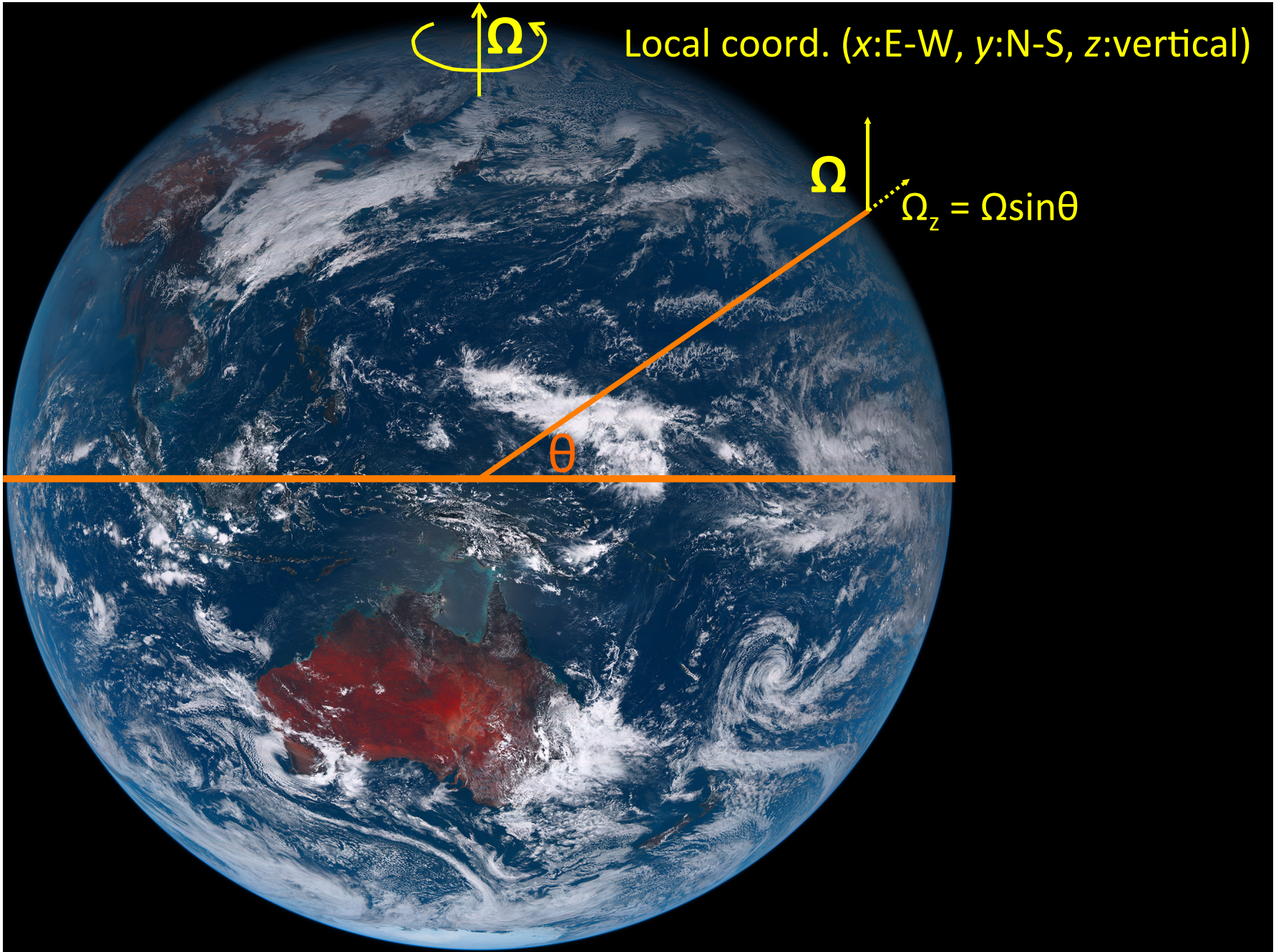
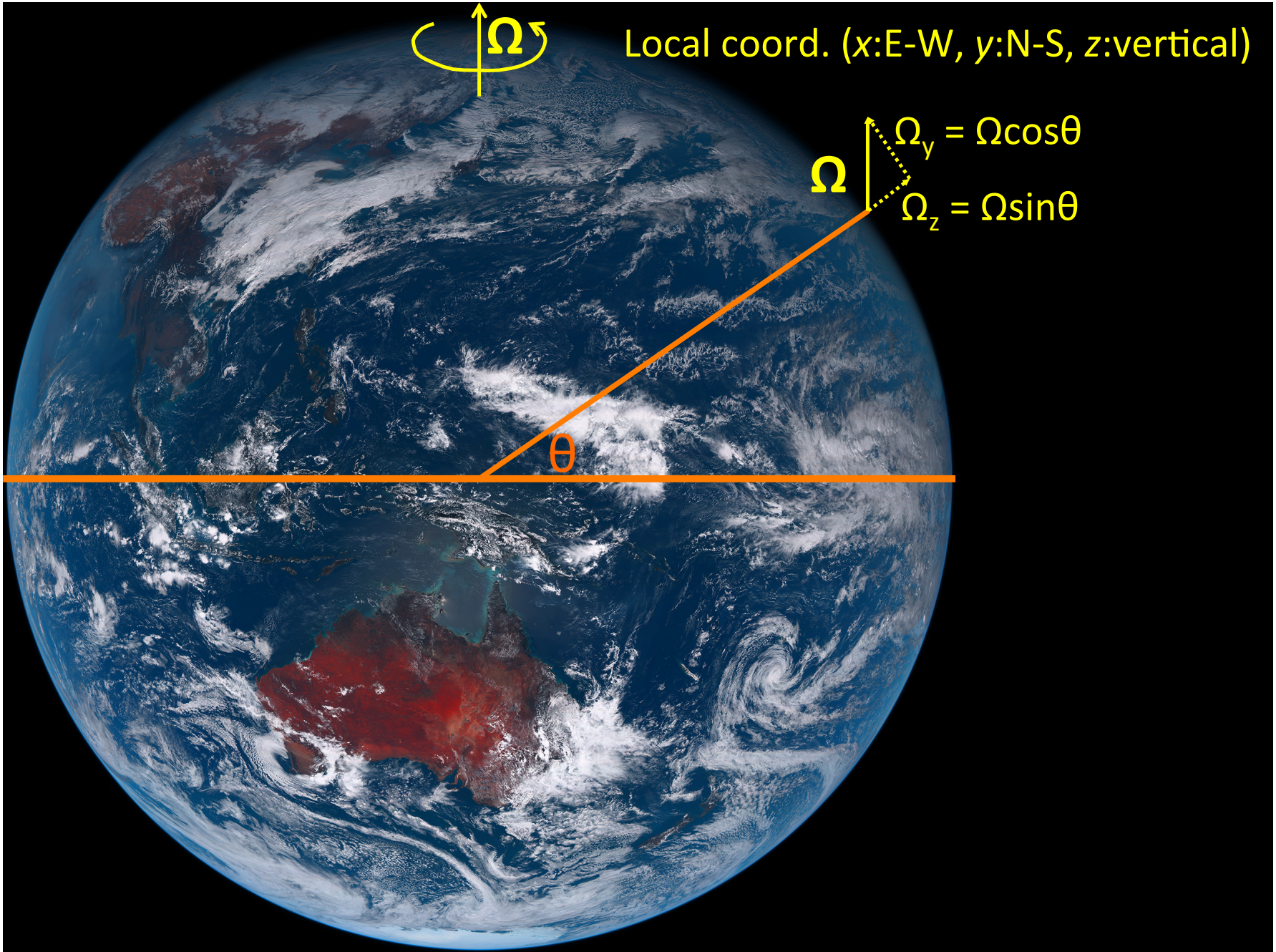


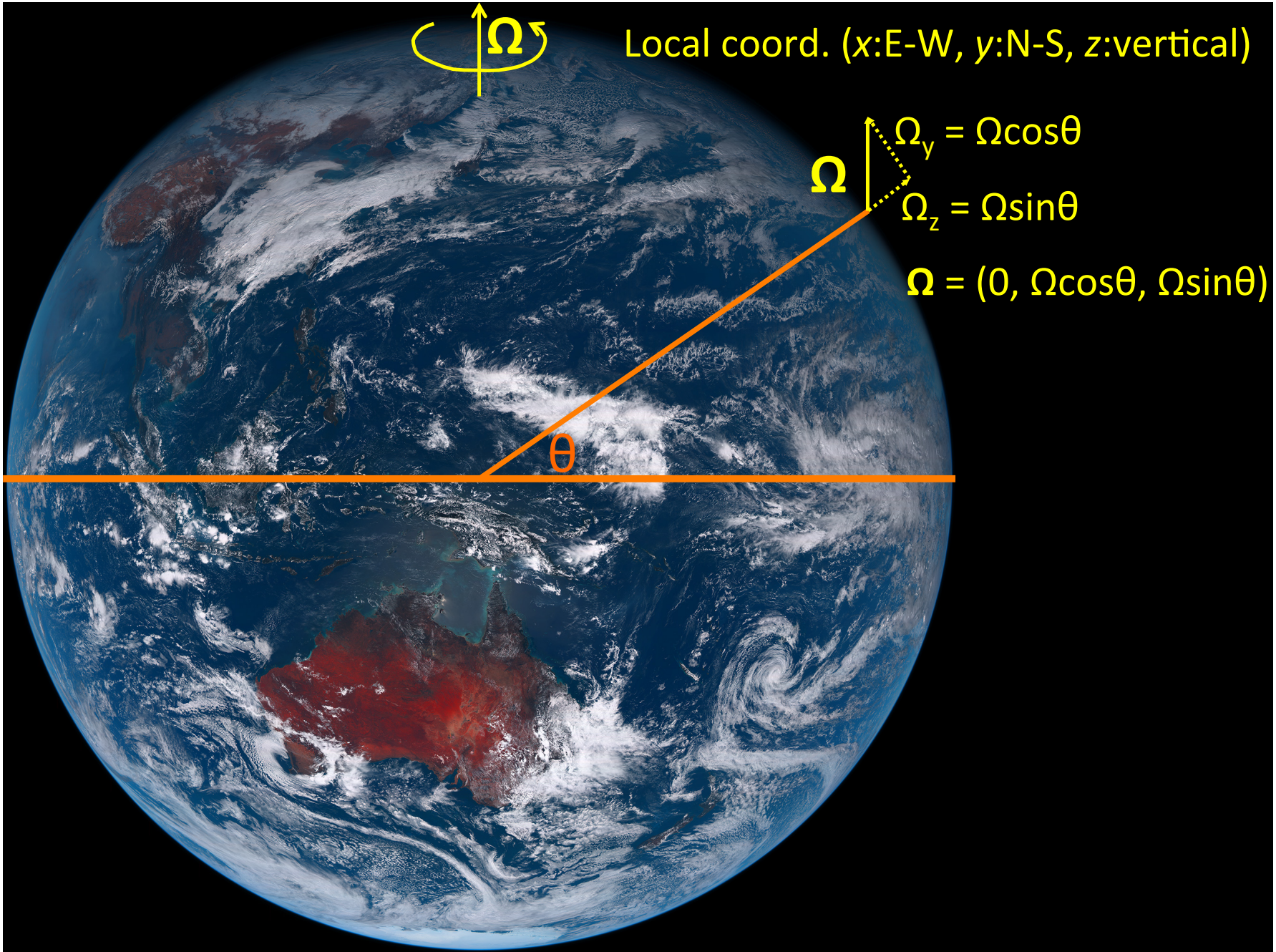
Coriolis Term: $2\Omega \times \mathbf{u}$



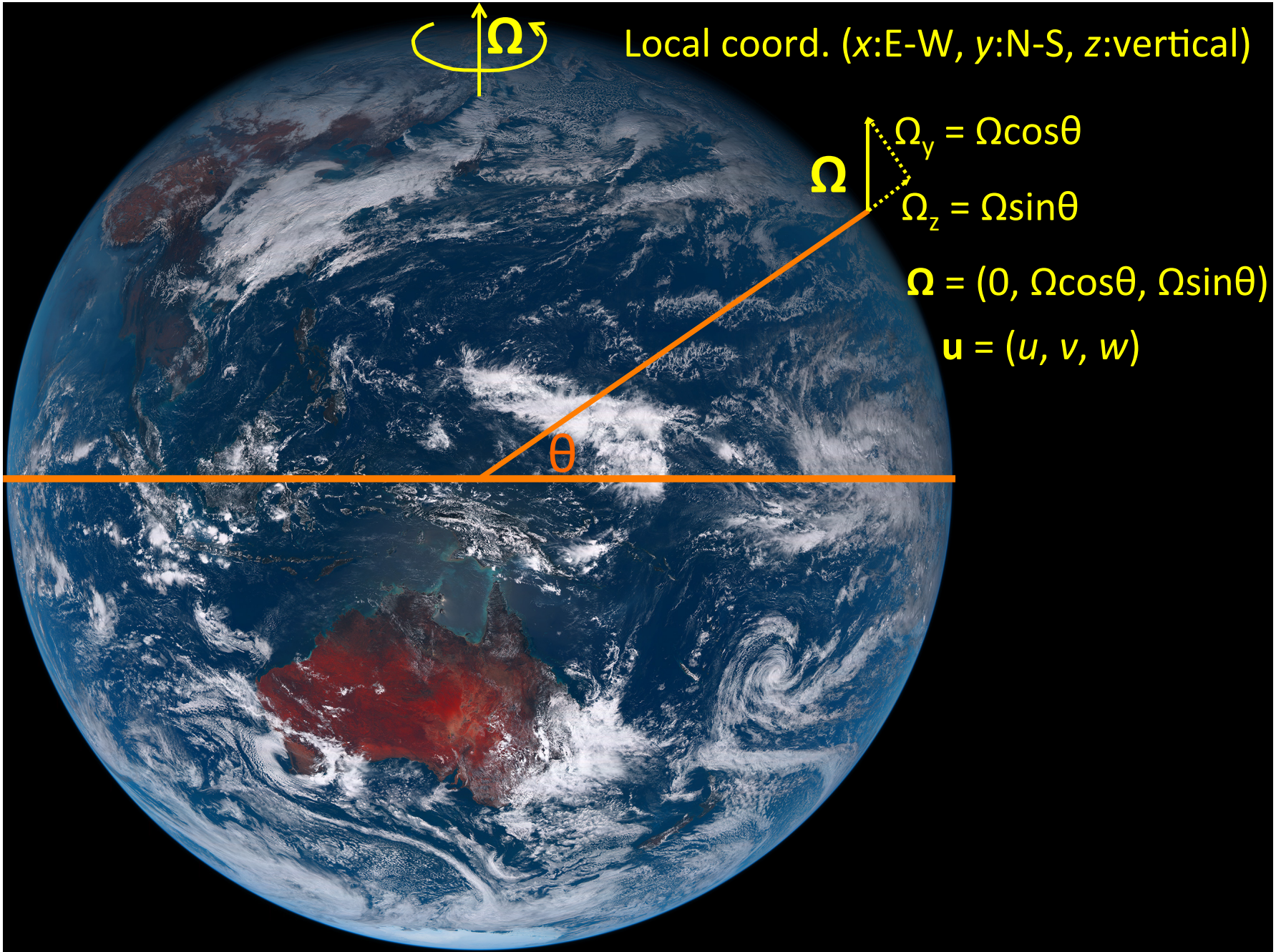
Coriolis Term: $2\Omega \times \mathbf{u}$



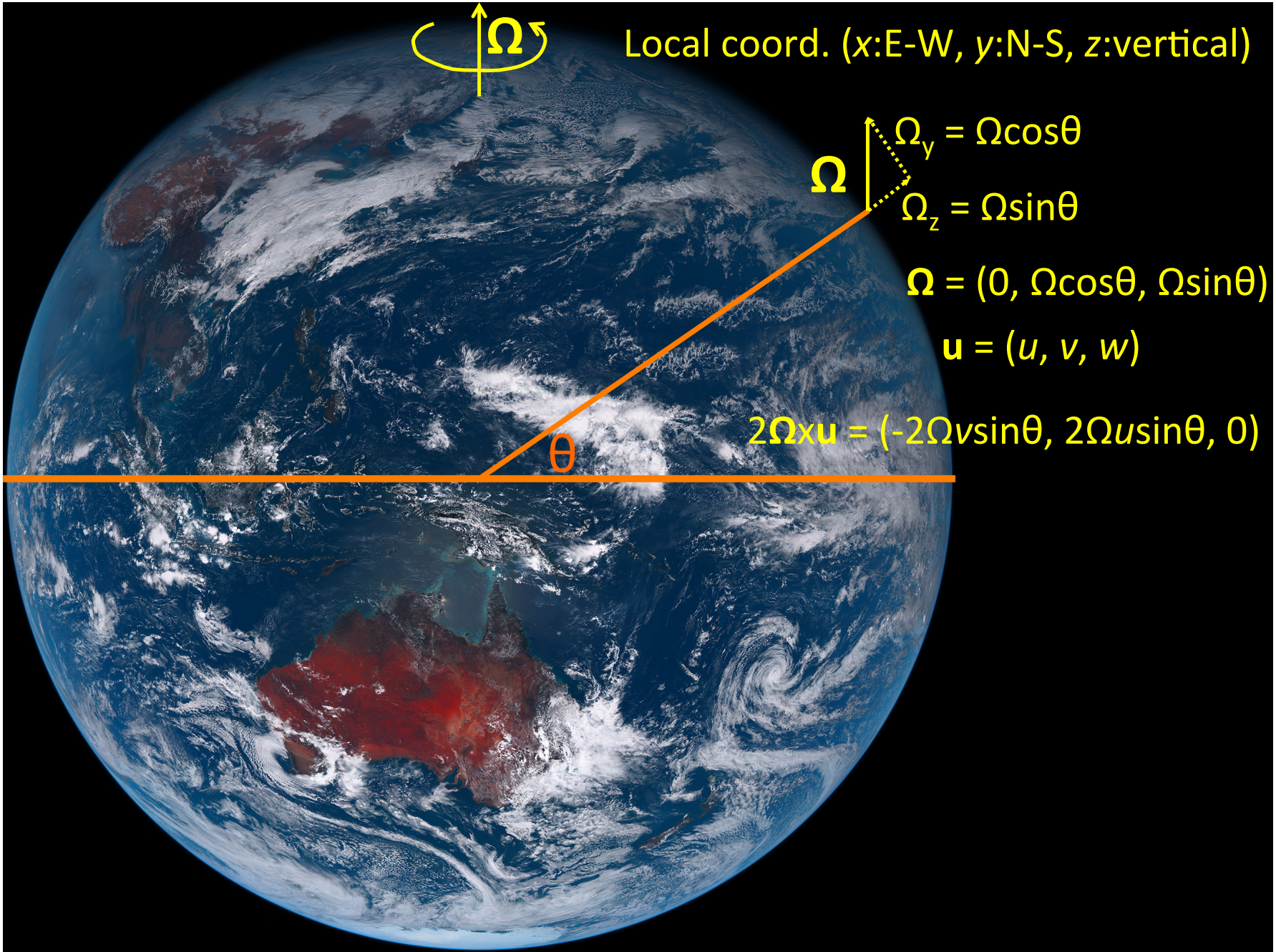
Coriolis Term: $2\Omega \times \mathbf{u}$



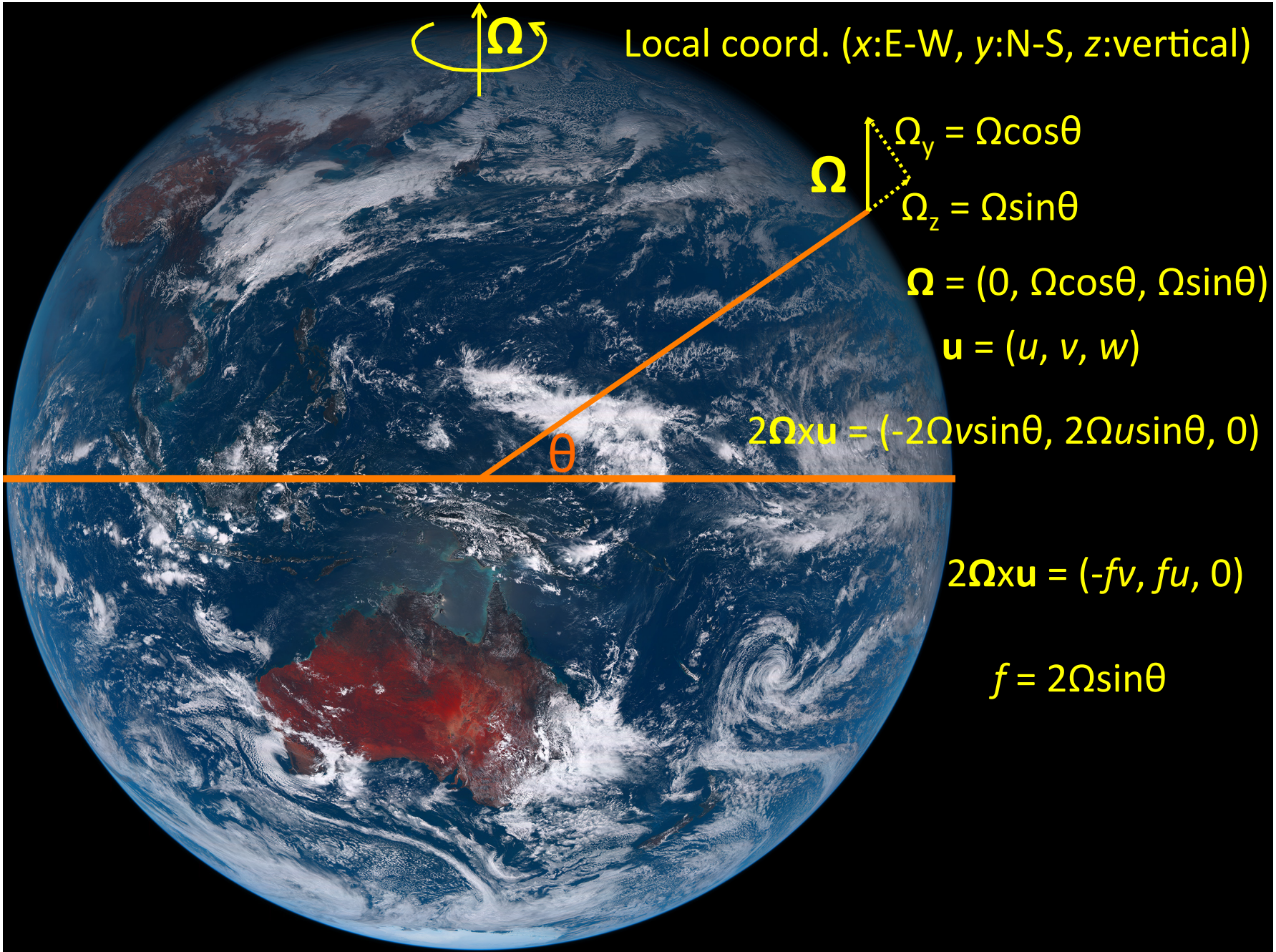
Coriolis Term: $2\Omega \times \mathbf{u}$



Coriolis Term: $2\Omega \times \mathbf{u}$



Coriolis Term: $2\Omega \times \mathbf{u}$



Momentum Equation on a Rotating Planet

Navier-Stokes momentum equation in a rotating frame:

$$\frac{D\mathbf{u}}{Dt} + 2\Omega \times \mathbf{u} + \Omega \times \Omega \times \mathbf{x} = \mathbf{g} - \frac{\nabla p}{\rho} + \nu \nabla^2 \mathbf{u}$$

Navier-Stokes for Flow on a Rotating Planet

$$\frac{D\mathbf{u}}{Dt} + 2\Omega \times \mathbf{u} = \mathbf{g}^* - \frac{\nabla p}{\rho} + \nu \nabla^2 \mathbf{u}$$