Water being diverted in a flood in Helsinki, Finland (latitude 60° N) flows along a channel of width 50 m in a south direction at a speed of 4 m/s. On which side of stream is the water level highest (from the standpoint of an observer on the bank) and by how much?

**Solution:** The water experiences a Coriolis force $\vec{F}_C = -2m\vec{\omega} \times \vec{v}$ We will analyze this force in spherical polar coordinates for which $\hat{z}$ is the rotation axis of the Earth, pointing from S pole to N pole. In that frame, the polar angle is the complement of the latitude: $\theta = 30^\circ$ and

$\vec{\omega} = \omega \hat{\phi} = \omega \left( \hat{r} \cos \theta - \hat{\theta} \sin \theta \right)$

$\vec{v} = v \hat{\theta}$

$\vec{F}_C = -2m\vec{\omega} \times \vec{v} = -2m\omega v \cos \theta \hat{\phi}$

The surface of the water will be perpendicular to the total force acting upon the water. Since $\vec{F}_C$ points W, the water on the W bank will be highest. That angle of the water surface is $\tan \alpha = \frac{2\omega v \cos \theta}{g} = \frac{2 \cdot (2\pi) (4 m/s) \cos 30^\circ}{(9.8 m/s^2)(24 \cdot 3600 s)} = 5 \cdot 10^{-5} \text{ rad}$

The difference in height of the water on the two sides is $\delta = w tan \alpha = 2.5 mm$