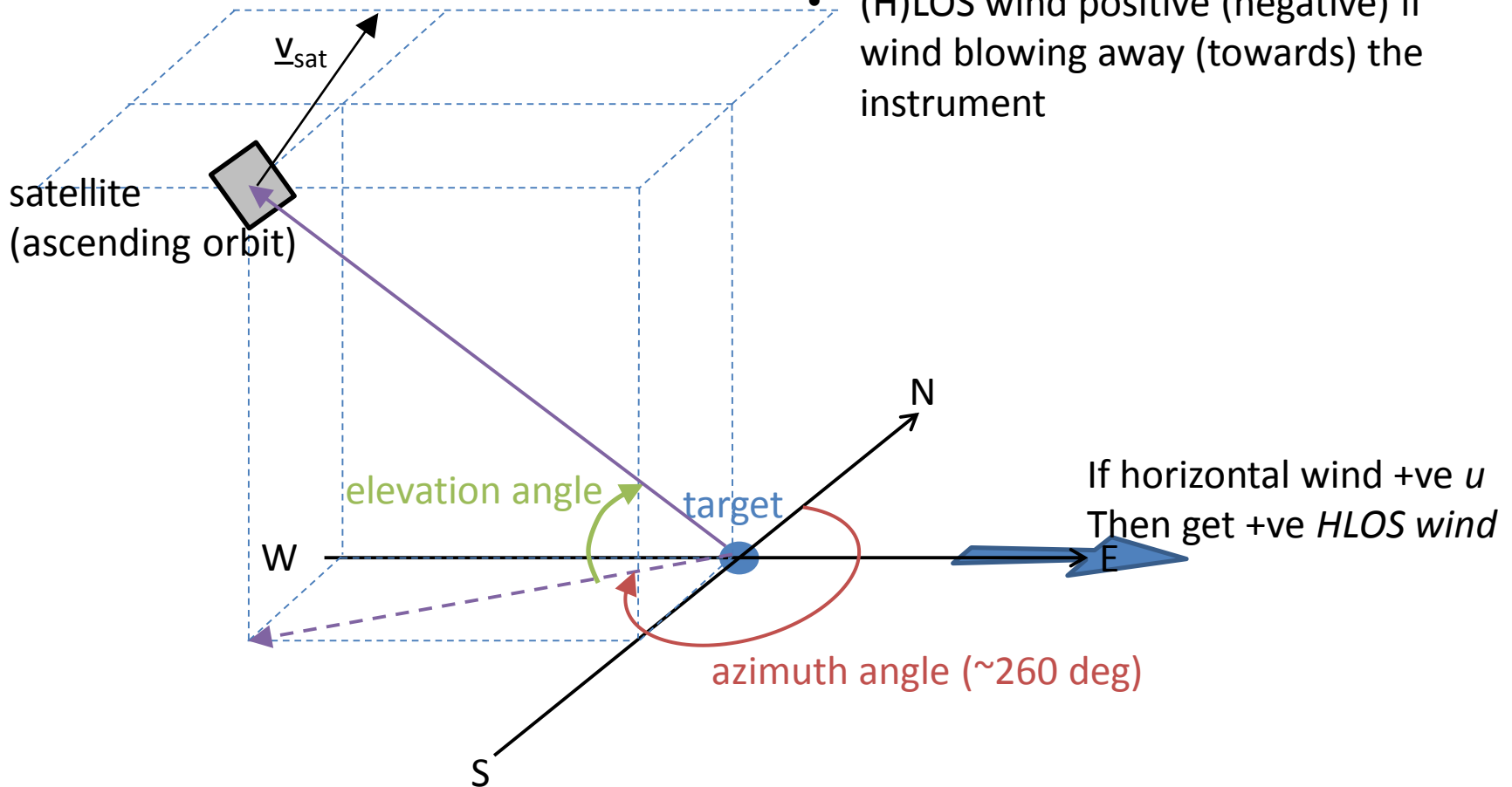
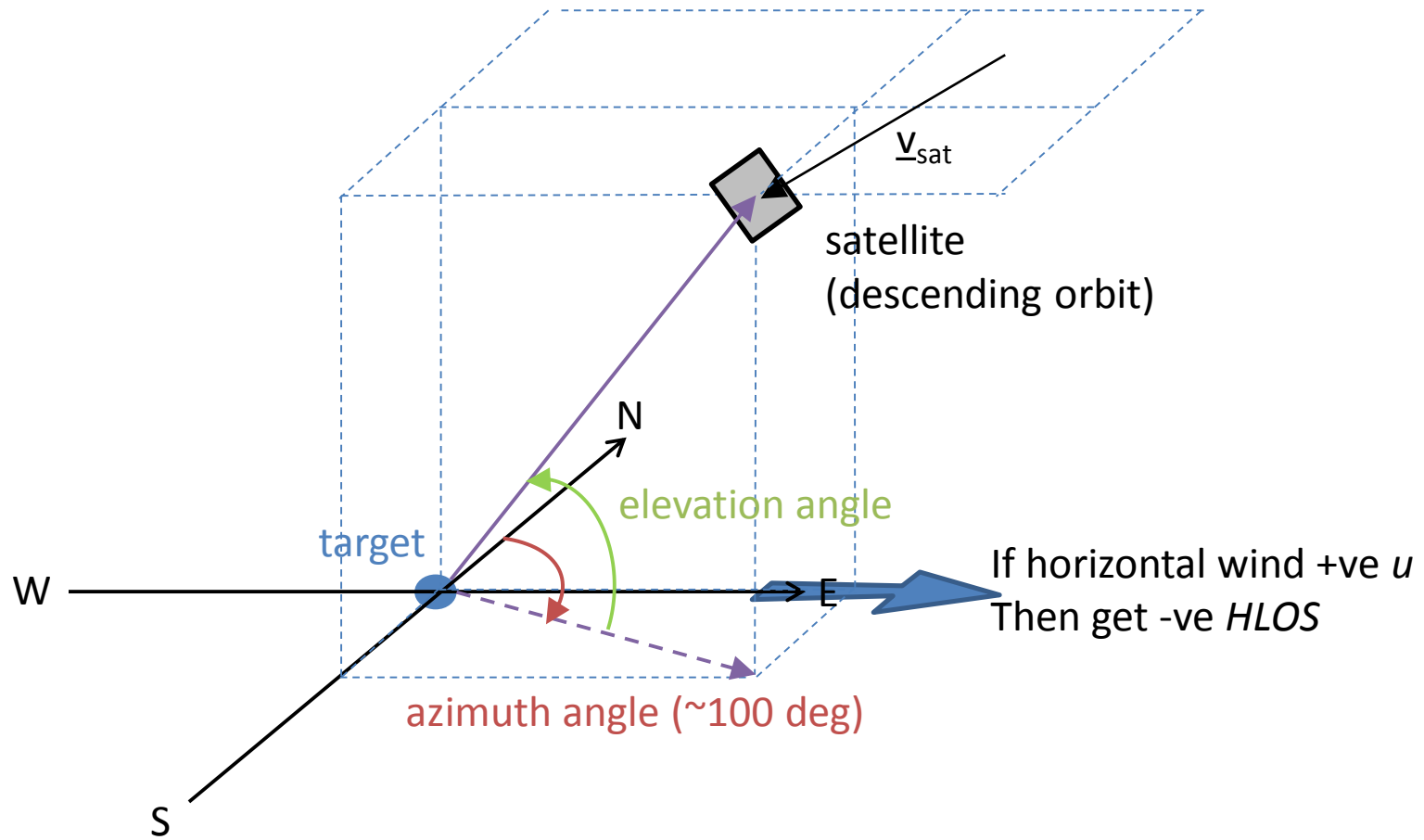
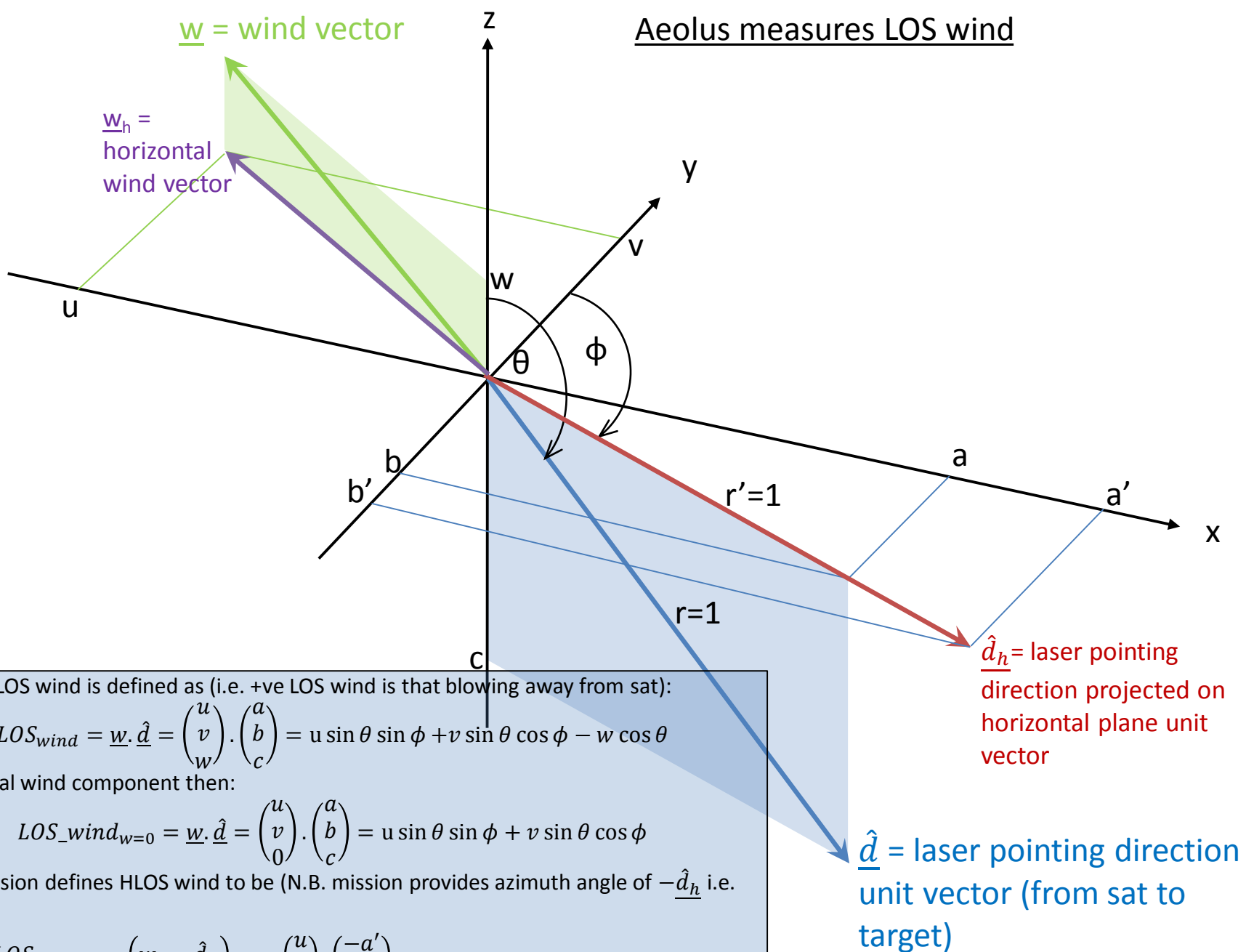


Aeolus geometry

- Azimuth= angle (clockwise from North) of the horizontal projection of the target to satellite pointing vector
- (H)LOS wind positive (negative) if wind blowing away (towards) the instrument







Complete LOS wind is defined as (i.e. +ve LOS wind is that blowing away from sat):

$$LOS_{wind} = \underline{w} \cdot \underline{\hat{d}} = \begin{pmatrix} u \\ v \\ w \end{pmatrix} \cdot \begin{pmatrix} a \\ b \\ c \end{pmatrix} = u \sin \theta \sin \phi + v \sin \theta \cos \phi - w \cos \theta$$

If no vertical wind component then:

$$LOS_{wind_{w=0}} = \underline{w} \cdot \underline{\hat{d}} = \begin{pmatrix} u \\ v \\ 0 \end{pmatrix} \cdot \begin{pmatrix} a \\ b \\ c \end{pmatrix} = u \sin \theta \sin \phi + v \sin \theta \cos \phi$$

Aeolus mission defines HLOS wind to be (N.B. mission provides azimuth angle of $-\hat{d}_h$ i.e. ϕ'):

$$HLOS_{wind} = -(\underline{w}_h \cdot -\underline{\hat{d}}_h) = -\begin{pmatrix} u \\ v \end{pmatrix} \cdot \begin{pmatrix} -a' \\ -b' \end{pmatrix}$$

$$= -u \sin(\phi + \pi) - v \cos(\phi + \pi) = -u \sin \phi' - v \cos \phi' = \frac{LOS_{wind_{w=0}}}{\sin \theta}$$

Propagation of uncertainty in HLOS wind forward model

$$HLOS_{wind} = -u \sin \phi' - v \cos \phi' - w \cot \theta$$

$$\begin{aligned} \sigma_{HLOS_{wind}}^2 &= \left| \frac{\partial HLOS_{wind}}{\partial u} \right|^2 \sigma_u^2 + \left| \frac{\partial HLOS_{wind}}{\partial v} \right|^2 \sigma_v^2 + \left| \frac{\partial HLOS_{wind}}{\partial w} \right|^2 \sigma_w^2 + \left| \frac{\partial HLOS_{wind}}{\partial \phi'} \right|^2 \sigma_{\phi'}^2 \\ &+ \left| \frac{\partial HLOS_{wind}}{\partial \theta} \right|^2 \sigma_{\theta}^2 \end{aligned}$$

$$\begin{aligned} \sigma_{HLOS_{wind}}^2 &= \sigma_u^2 \sin^2 \phi' + \sigma_v^2 \cos^2 \phi' + \sigma_w^2 \cot^2 \theta + \\ &\sigma_{\phi'}^2 (u^2 \cos^2 \phi' + v^2 \sin^2 \phi' - 2uv \sin \phi' \cos \phi') + \sigma_{\theta}^2 w^2 \operatorname{cosec}^4 \theta \end{aligned}$$

Total differential of HLOS wind forward model

$$\begin{aligned} dHLOS_{wind} &= \frac{\partial HLOS_{wind}}{\partial u} du + \frac{\partial HLOS_{wind}}{\partial v} dv + \frac{\partial HLOS_{wind}}{\partial w} dw + \frac{\partial HLOS_{wind}}{\partial \phi'} d\phi' + \frac{\partial HLOS_{wind}}{\partial \theta} d\theta \\ &= -du \sin \phi' - dv \cos \phi' - dw \cot \theta + (v \sin \phi' - u \cos \phi') d\phi' + d\theta w \operatorname{cosec}^2 \theta \end{aligned}$$