Implementation

<u>Geolocation EKF</u>

$$\text{state:}\quad x = \begin{bmatrix} p^i_{obj,n} \\ p^i_{obj,e} \\ \mathbb{L} \end{bmatrix} \qquad y = \begin{bmatrix} p^i_{mav,n} \\ p^i_{mav,e} \\ p^i_{mav,d} \end{bmatrix}$$

Assumes $p^i_{obj,d} = 0$
(flat earth assumption)

$$\dot{\hat{\mathbb{P}}}_{mav} = \begin{bmatrix} V_g \cos\chi \\ V_g \sin\chi \\ 0 \end{bmatrix}$$

Prediction Equations: $\dot{\hat{x}} = f(\hat{x}, u)$

$$\begin{bmatrix} \dot{\hat{p}}^i_{obj,n} \\ \dot{\hat{p}}_{obj,e} \\ \dot{\hat{\mathbb{L}}} \end{bmatrix} = \underbrace{\begin{bmatrix} 0 \\ 0 \\ -\begin{pmatrix} \hat{p}^i_{obj,n} - \hat{p}^i_{mav,n} \\ \hat{p}^i_{obj,e} - \hat{p}^i_{mav,e} \\ 0 - \hat{p}_{mav,d} \end{pmatrix}^T \begin{pmatrix} \hat{V}_g \cos\hat{\chi} \\ \hat{V}_g \sin\hat{\chi} \\ 0 \end{pmatrix} \cdot \dfrac{1}{\hat{\mathbb{L}}} \end{bmatrix}}_{f(\hat{x},u)}$$

Implementation

$$A = \frac{\partial f}{\partial x} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \frac{-\hat{V}_g \cos\hat{\chi}}{\hat{\mathbb{L}}} & \frac{-\hat{V}_g \sin\hat{\chi}}{\hat{\mathbb{L}}} & \frac{\begin{pmatrix} \hat{p}^i_{obj,n} - \hat{p}^i_{mav,n} \\ \hat{p}^i_{obj,e} - \hat{p}^i_{mav,e} \\ -\hat{p}_{mav,d} \end{pmatrix}^T \begin{pmatrix} \hat{V}_g \cos\hat{\chi} \\ \hat{V}_g \sin\hat{\chi} \\ 0 \end{pmatrix}}{\hat{\mathbb{L}}^2} \end{bmatrix}$$

<u>Measurement Equations:</u> $y = h(x,u)$

$$\underbrace{\begin{bmatrix} p^i_{mav,n} \\ p^i_{mav,e} \\ p^i_{mav,d} \end{bmatrix}}_{y} = \underbrace{\begin{bmatrix} p^i_{obj,n} \\ p^i_{obj,e} \\ 0 \end{bmatrix} - \mathbb{L} \begin{bmatrix} \check{\ell}^i_n \\ \check{\ell}^i_e \\ \check{\ell}^i_d \end{bmatrix}}_{h(x,u)}$$

Implementation

$$C = \frac{\partial h}{\partial x} = \begin{bmatrix} 1 & 0 & -\breve{\ell}^i_n \\ 0 & 1 & -\breve{\ell}^i_e \\ 0 & 0 & -\breve{\ell}^i_d \end{bmatrix}$$

where

$$\breve{\boldsymbol{\ell}}^i = \begin{pmatrix} \breve{\ell}^i_n \\ \breve{\ell}^i_e \\ \breve{\ell}^i_d \end{pmatrix} = R^i_b R^b_g R^g_c \breve{\boldsymbol{\ell}}^c$$

so

$$\frac{\partial h}{\partial x} = \left[\begin{array}{cc|c} 1 & 0 & \\ 1 & 1 & -R^i_b R^b_g R^g_c \breve{\ell}^c \\ 0 & 0 & \end{array}\right]$$