Subject parameter distribution:

$$\underbrace{\begin{bmatrix} \text{T0m\_eta1}_i \\ \text{cint}_i \\ \text{drift\_eta1}_i \\ \text{diff\_eta1}_i \\ \text{mvarYobs}_i \\ \text{T0var\_eta1}_i \end{bmatrix}}_{\boldsymbol{\phi}(i)} \sim \text{tform} \left\{ N \left(\begin{bmatrix} \text{raw\_T0m\_eta1} \\ \text{raw\_cint} \\ \text{raw\_drift\_eta1} \\ \text{raw\_diff\_eta1} \\ \text{raw\_mvarYobs} \\ \text{raw\_T0var\_eta1} \end{bmatrix}, \begin{bmatrix} \text{rawPCov\_1\_1} & \text{rawPCov\_2\_1} & 0 & 0 & 0 & 0 \\ \text{rawPCov\_2\_1} & \text{rawPCov\_2\_2} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \right) + \underbrace{\begin{bmatrix} \text{raw\_T0m\_eta1\_Cohort2} & \text{raw\_T0m\_eta1\_Cohort3} & \text{raw\_T0m\_eta1\_Cohort4} \\ \text{raw\_cint\_Cohort2} & \text{raw\_cint\_Cohort3} & \text{raw\_cint\_Cohort4} \\ \text{raw\_drift\_eta1\_Cohort2} & \text{raw\_drift\_eta1\_Cohort3} & \text{raw\_drift\_eta1\_Cohort4} \\ \text{raw\_diff\_eta1\_Cohort2} & \text{raw\_diff\_eta1\_Cohort3} & \text{raw\_diff\_eta1\_Cohort4} \\ \text{raw\_mvarYobs\_Cohort2} & \text{raw\_mvarYobs\_Cohort3} & \text{raw\_mvarYobs\_Cohort4} \\ \text{raw\_T0var\_eta1\_Cohort2} & \text{raw\_T0var\_eta1\_Cohort3} & \text{raw\_T0var\_eta1\_Cohort4} \end{bmatrix}}_{\boldsymbol{\beta}} \underbrace{\begin{bmatrix} \text{Cohort2} \\ \text{Cohort3} \\ \text{Cohort4} \end{bmatrix}}_{\mathbf{z}} \right\}$$

Initial latent state:

$$\underbrace{\begin{bmatrix} \text{eta1} \end{bmatrix}(t_0)}_{\boldsymbol{\eta}(t_0)} \sim N \left(\underbrace{\begin{bmatrix} \text{T0m\_eta1} \end{bmatrix}}_{\substack{\text{T0MEANS}}}, \underbrace{UcorSDtoCov\left\{\begin{bmatrix} 0.001 \end{bmatrix}\right\}}_{\substack{\mathbf{Q^*}_{t0} \\ \text{T0VAR}}} \right)$$

Deterministic change:

$$\underbrace{\text{d}\begin{bmatrix} \text{eta1} \end{bmatrix}(t)}_{\text{d}\boldsymbol{\eta}(t)} = \left(\underbrace{\begin{bmatrix} \text{drift\_eta1} \end{bmatrix}}_{\substack{\mathbf{A} \\ \text{DRIFT}}} \underbrace{\begin{bmatrix} \text{eta1} \end{bmatrix}(t)}_{\boldsymbol{\eta}(t)} + \underbrace{\begin{bmatrix} \text{cint} \end{bmatrix}}_{\substack{\mathbf{b} \\ \text{CINT}}} \right) \text{d}t \quad +$$

Random change:

$$\underbrace{UcorSDtoChol\left\{\begin{bmatrix} \text{diff\_eta1} \end{bmatrix}\right\}}_{\substack{\mathbf{G} \\ \text{DIFFUSION}}} \underbrace{\text{d}\begin{bmatrix} W_1 \end{bmatrix}(t)}_{\text{d}\mathbf{W}(t)}$$

Observations:

$$\underbrace{\begin{bmatrix} \text{Yobs} \end{bmatrix}(t)}_{\mathbf{Y}(t)} = \underbrace{\begin{bmatrix} 1 \end{bmatrix}}_{\substack{\boldsymbol{\Lambda} \\ \text{LAMBDA}}} \underbrace{\begin{bmatrix} \text{eta1} \end{bmatrix}(t)}_{\boldsymbol{\eta}(t)} + \underbrace{\begin{bmatrix} 0 \end{bmatrix}}_{\substack{\boldsymbol{\tau} \\ \text{MANIFESTMEANS}}} +$$

Observation noise:

$$\underbrace{\begin{bmatrix} \text{mvarYobs} \end{bmatrix}}_{\substack{\boldsymbol{\Theta} \\ \text{MANIFESTVAR}}} \underbrace{\begin{bmatrix} \epsilon_1 \end{bmatrix}(t)}_{\boldsymbol{\epsilon}(t)}$$

System noise distribution per time step: $\Delta\begin{bmatrix} W_{j\in[1,1]} \end{bmatrix}(t-u) \sim N(0, t-u)$ **Observation noise distribution:** $\begin{bmatrix} \epsilon_{j\in[1,1]} \end{bmatrix}(t) \sim N(0,1)$

Note: $UcorSDtoChol$ converts lower tri matrix of standard deviations and unconstrained correlations to Cholesky factor,

$UcorSDtoCov =$ transposed cross product of UcorSDtoChol, to give covariance, See Driver & Voelkle (2018) p11.

Individual specific notation (subscript i) only shown for subject parameter distribution – pop. means shown elsewhere.