Initial latent state:

$$\underbrace{\begin{bmatrix}\text{ss\_level}\\ \text{ss\_velocity}\end{bmatrix}(t_0)}_{\boldsymbol{\eta}(t_0)} \sim \mathrm{N}\left(\underbrace{\begin{bmatrix}-44.507\\ 0.383\end{bmatrix}}_{\text{T0MEANS}}, \underbrace{UcorSDtoCov\left\{\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}\right\}}_{\underbrace{\mathbf{Q}^*{}_{t0}}_{\text{T0VAR}}}\right)$$

Deterministic change:

$$\underbrace{\mathrm{d}\begin{bmatrix}\text{ss\_level}\\ \text{ss\_velocity}\end{bmatrix}(t)}_{\mathrm{d}\boldsymbol{\eta}(t)} = \left(\underbrace{\begin{bmatrix}0 & 1\\ -0.456 & -0.676\end{bmatrix}}_{\underbrace{\mathbf{A}}_{\text{DRIFT}}}\underbrace{\begin{bmatrix}\text{ss\_level}\\ \text{ss\_velocity}\end{bmatrix}(t)}_{\boldsymbol{\eta}(t)} + \underbrace{\begin{bmatrix}0\\ 0\end{bmatrix}}_{\underbrace{\mathbf{b}}_{\text{CINT}}}\right)\mathrm{d}t \quad +$$

Random change:

$$\underbrace{UcorSDtoChol\left\{\begin{bmatrix}0 & 0\\ 0 & 31.233\end{bmatrix}\right\}}_{\underbrace{\mathbf{G}}_{\text{DIFFUSION}}}\underbrace{\mathrm{d}\begin{bmatrix}W_1\\ W_2\end{bmatrix}(t)}_{\mathrm{d}\mathbf{W}(t)}$$

Observations:

$$\underbrace{[\text{sunspots}](t)}_{\mathbf{Y}(t)} = \underbrace{\begin{bmatrix}1 & 0\end{bmatrix}}_{\underbrace{\boldsymbol{\Lambda}}_{\text{LAMBDA}}}\underbrace{\begin{bmatrix}\text{ss\_level}\\ \text{ss\_velocity}\end{bmatrix}(t)}_{\boldsymbol{\eta}(t)} + \underbrace{[49.55]}_{\underbrace{\boldsymbol{\tau}}_{\text{MANIFESTMEANS}}} \quad +$$

Observation noise:

$$\underbrace{\underbrace{[0]}_{\boldsymbol{\Theta}}}_{\text{MANIFESTVAR}} \quad \underbrace{[\epsilon_1](t)}_{\boldsymbol{\epsilon}(t)}$$

System noise distribution per time step: $\Delta[W_{j\in[1,2]}](t-u) \sim \mathrm{N}(0, t-u)$

Observation noise distribution: $[\epsilon_{j\in[1,2]}](t) \sim \mathrm{N}(0,1)$

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.