$$c = 1, 2 \qquad \text{(Condition)}$$
$$l = 1, ..., L_c \qquad \text{(ORF)}$$
$$m = 1, ..., M_{cl} \qquad \text{(Repeat)}$$
$$n = 1, ..., N_{clm} \qquad \text{(Time Point)}$$

$$y_{clmn} \sim \mathrm{N}(\hat{y}_{clmn}, (e^{\upsilon_l + \nu_c})^{-1})$$
$$\hat{y}_{clmn} = f(x_{clmn}; e^{K_{clm}}, e^{r_{clm}}, e^P)$$

$$K_{clm} \sim \mathrm{N}(e^{\alpha_c + (K_l^o + \delta_l \gamma_{cl})}, (e^{\tau_{cl}^K})^{-1}) \qquad\qquad \tau_{cl}^K \sim \mathrm{N}(\sigma^K, (\phi^K)^{-1})$$
$$r_{clm} \sim \mathrm{N}(e^{\beta_c + (r_l^o + \delta_l \omega_{cl})}, (e^{\tau_{cl}^r})^{-1}) \qquad\qquad \tau_{cl}^r \sim \mathrm{N}(\sigma^r, (\phi^r)^{-1})$$

$$K_l^o \sim \mathrm{N}(K^p, (e^{\sigma^{K,o}})^{-1}) \qquad\qquad \sigma^{K,o} \sim \mathrm{N}(\eta^{K,o}, (\psi^{K,o})^{-1})$$
$$r_l^o \sim \mathrm{N}(r^p, (e^{\sigma^{r,o}})^{-1}) \qquad\qquad \sigma^{r,o} \sim \mathrm{N}(\eta^{r,o}, (\psi^{r,o})^{-1})$$
$$\nu_l \sim \mathrm{N}(\nu_\mu, (e^{\sigma^\nu})^{-1}) \qquad\qquad \sigma^\nu \sim \mathrm{N}(\eta^\nu, (\psi^\nu)^{-1})$$
$$\delta_l \sim Bern(p)$$

$$\gamma_{cl} = \begin{cases} 0 & \text{if } c = 0; \\ \mathrm{N}(0, (e^{\sigma^\gamma})^{-1}) & \text{if } c = 1. \end{cases} \qquad\qquad \sigma^\gamma = \begin{cases} 1 & \text{if } c = 0; \\ \mathrm{N}(\eta^\gamma, \psi^\gamma) & \text{if } c = 1. \end{cases}$$

$$\omega_{cl} = \begin{cases} 0 & \text{if } c = 0; \\ \mathrm{N}(0, (e^{\sigma^\omega})^{-1}) & \text{if } c = 1. \end{cases} \qquad\qquad \sigma^\omega = \begin{cases} 1 & \text{if } c = 0; \\ \mathrm{N}(\eta^\omega, \psi^\omega) & \text{if } c = 1. \end{cases}$$

$$\alpha_c = \begin{cases} 0 & \text{if } c = 0; \\ \mathrm{N}(\alpha^\mu, \eta^\alpha) & \text{if } c = 1. \end{cases}$$

$$\beta_c = \begin{cases} 0 & \text{if } c = 0; \\ \mathrm{N}(\beta^\mu, \eta^\beta) & \text{if } c = 1. \end{cases}$$

$$\upsilon_c = \begin{cases} 0 & \text{if } c = 0; \\ \mathrm{N}(\upsilon^p, (e^{\sigma^\upsilon})^{-1}) & \text{if } c = 1. \end{cases} \qquad\qquad \sigma^\upsilon \sim \mathrm{N}(\eta^\upsilon, (\psi^\upsilon)^{-1})$$

$$K^p \sim \mathrm{N}(K^\mu, (\eta^{K,p})^{-1})$$
$$r^p \sim \mathrm{N}(r^\mu, (\eta^{r,p})^{-1})$$
$$\nu^p \sim \mathrm{N}(\nu^\mu, (\eta^{\nu,p})^{-1})$$
$$\upsilon^p \sim \mathrm{N}(\upsilon^\mu, (\eta^{\upsilon,p})^{-1})$$
$$P \sim \mathrm{N}(P^\mu, (\eta^P)^{-1})$$

$$y_{clmn} \sim \mathrm{N}(\hat{y}_{clmn}, (e^{\upsilon_l + \nu_c})^{-1})$$

$$K_{clm} \sim \mathrm{N}(e^{\alpha_c + (K_l^o + \delta_l \gamma_{cl})}, (e^{\tau_{cl}^K})^{-1})$$

$$\pi(K_{clm}|\theta) = \sqrt{\frac{e^{\tau_{cl}^K}}{2\pi}} e^{-\frac{1}{2}(K_{clm} - e^{\alpha_c + (K_l^o + \delta_l \gamma_{cl})})^2 e^{\tau_{cl}^K}} \prod_{n=1}^{N_{clm}} \sqrt{\frac{e^{\upsilon_l + \nu_c}}{2\pi}} e^{-\frac{1}{2}(y_{clmn} - \hat{y}_{clmn})^2 e^{\upsilon_l + \nu_c}}$$

Taking logs

$$l\pi(K_{clm}|\theta) = -\frac{1}{2}(K_{clm} - e^{\alpha_c + (K_l^o + \delta_l \gamma_{cl})})^2 e^{\tau_{cl}^K} - \sum_{n=1}^{N_{clm}} \frac{1}{2}(y_{clmn} - \hat{y}_{clmn})^2 e^{\nu_l + \upsilon_c} + C$$

Similarly for r_{clm}

$$l\pi(r_{clm}|\theta) = -\frac{1}{2}(r_{clm} - e^{\beta_c + (r_l^o + \delta_l \omega_{cl})})^2 e^{\tau_{cl}^r} - \sum_{n=1}^{N_{clm}} \frac{1}{2}(y_{clmn} - \hat{y}_{clmn})^2 e^{\nu_l + \upsilon_c} + C$$

$$K_{clm} \sim \mathrm{N}(e^{\alpha_c + (K_l^o + \delta_l \gamma_{cl})}, (e^{\tau_{cl}^K})^{-1})$$

$$\tau_{cl}^K \sim \mathrm{N}(\sigma^K, (\phi^K)^{-1})$$

$$\pi(\tau_{cl}^K|\theta) = \sqrt{\frac{\phi^K}{2\pi}} e^{-\frac{1}{2}(\tau_{cl}^K - \sigma^K)^2 \phi^K} \prod_{m=1}^{M_{cl}} \sqrt{\frac{e^{\tau_{cl}^K}}{2\pi}} e^{-\frac{1}{2}(K_{clm} - e^{\alpha_c + (K_l^o + \delta_l \gamma_{cl})})^2 e^{\tau_{cl}^K}}$$

Taking logs

$$l\pi(\tau_{cl}^K|\theta) = -\frac{1}{2}(\tau_{cl}^K - \sigma^K)^2 \phi^K + \sum_{m=1}^{M_{cl}} \frac{1}{2}(\tau_{cl}^K - (K_{clm} - e^{\alpha_c + (K_l^o + \delta_l \gamma_{cl})^2} e^{\tau_{cl}^K}) + C$$

Similarly for τ_{cl}^r

$$l\pi(\tau_{cl}^r|\theta) = -\frac{1}{2}(\tau_{cl}^r - \sigma^r)^2 \phi^r + \sum_{m=1}^{M_{cl}} \frac{1}{2}(\tau_{cl}^r - (r_{clm} - e^{\beta_c + (r_l^o + \delta_l \omega_{cl})^2} e^{\tau_{cl}^r}) + C$$

$$K_{clm} \sim \mathrm{N}(e^{\alpha_c + (K_l^o + \delta_l \gamma_{cl})}, (e^{\tau_{cl}^K})^{-1})$$

$$K_l^o \sim \mathrm{N}(K^p, (e^{\sigma^{K,o}})^{-1})$$

$$\pi(K_l^o|\theta) = \sqrt{\frac{e^{\sigma^{K,o}}}{2\pi}} e^{-\frac{1}{2}(K_l^o - K^p)^2 e^{\sigma^{K,o}}} \prod_{c=1}^{2} \prod_{m=1}^{M^{cl}} \sqrt{\frac{e^{\tau_{cl}^K}}{2\pi}} e^{-\frac{1}{2}(K_{clm} - e^{\alpha_c + (K_l^o + \delta_l \gamma_{cl})})^2 e^{\tau_{cl}^K}}$$

Taking logs

$$l\pi(K_l^o|\theta) = -\frac{1}{2}(K_l^o - K^p)^2 e^{\sigma^{K,o}} + \sum_{c=1}^{2} \sum_{m=1}^{M^{cl}} \frac{1}{2}(K_{clm} - e^{\alpha_c + (K_l^o + \delta_l \gamma_{cl})})^2 e^{\tau_{cl}^K} + C$$

Similarly for r_l^o

$$l\pi(r_l^o|\theta) = -\frac{1}{2}(r_l^o - r^p)^2 e^{\sigma^{r,o}} + \sum_{c=1}^{2} \sum_{m=1}^{M^{cl}} \frac{1}{2}(r_{clm} - e^{\beta_c + (r_l^o + \delta_l \omega_{cl})})^2 e^{\tau_{cl}^r} + C$$

$$y_{clmn} \sim \mathrm{N}(\hat{y}_{clmn}, (e^{v_l + \nu_c})^{-1})$$

$$\nu_l \sim \mathrm{N}(\nu_\mu, (e^{\sigma^\nu})^{-1})$$

$$\pi(\nu_l|\theta) = \sqrt{\frac{e^{\sigma^\nu}}{2\pi}} e^{-\frac{1}{2}(\nu_l - \nu_\mu)^2 e^{\sigma^\nu}} \prod_{c=1}^{2} \prod_{m=1}^{M_{cl}} \sqrt{\frac{e^{\nu_l + vc}}{2\pi}} e^{-\frac{1}{2}(y_{clmn} - \hat{y}_{clmn})^2 e^{\nu_l + vc}}$$

Taking logs

$$l\pi(\nu_l|\theta) = -\frac{1}{2}(\nu_l - \nu_\mu)^2 e^{\sigma^\nu} + \sum_{c=1}^{2} \sum_{m=1}^{M_{cl}} \frac{1}{2}(\nu_l - (y_{clmn} - \hat{y}_{clmn})^2 e^{\nu_l + v_c}) + C$$

$$K_{clm} \sim \mathrm{N}(e^{\alpha_c + (K_l^o + \delta_l \gamma_{cl})}, (e^{\tau_{cl}^K})^{-1})$$

$$r_{clm} \sim \mathrm{N}(e^{\beta_c + (r_l^o + \delta_l \omega_{cl})}, (e^{\tau_{cl}^r})^{-1})$$

$$\delta_l \sim Bern(p)$$

$$\pi(y_{2lm}|, \delta_l = 1, \theta) = (p) \times \prod_{m=1}^{m_{2l}} \sqrt{\frac{e^{\tau_{2l}^K}}{2\pi}} e^{-\frac{1}{2}(K_{2lm} - e^{\alpha_c + (K_l^o + \delta_l \gamma_{2l})})^2 e^{\tau_{2l}^K}} \sqrt{\frac{e^{\tau_{2l}^r}}{2\pi}} e^{-\frac{1}{2}(r_{2lm} - e^{\beta_c + (r_l^o + \delta_l \omega_{2l})})^2 e^{\tau_{2l}^r}}$$

$$\pi(y_{2lm}|, \delta_l = 0, \theta) = (1-p) \times \prod_{m=1}^{m_{2l}} \sqrt{\frac{e^{\tau_{2l}^K}}{2\pi}} e^{-\frac{1}{2}(K_{2lm} - e^{\alpha_2 + (K_l^o)})^2 e^{\tau_{2l}^K}} \sqrt{\frac{e^{\tau_{2l}^r}}{2\pi}} e^{-\frac{1}{2}(r_{2lm} - e^{\beta_2 + (r_l^o)})^2 e^{\tau_{2l}^r}}$$

$$K_l^o \sim \mathrm{N}(K^p, (e^{\sigma^{K,o}})^{-1})$$

$$\sigma^{K,o} \sim \mathrm{N}(\eta^{K,o}, (\psi^{K,o})^{-1})$$

$$\pi(\sigma^{K,o}|\theta) = \sqrt{\frac{\psi^{K,o}}{2\pi}} e^{-\frac{1}{2}(\sigma^{K,o}-\eta^{K,o})^2\psi^{K,o}} \prod_{l=1}^{L} \sqrt{\frac{e^{\sigma^{K,o}}}{2\pi}} e^{-\frac{1}{2}(K_l^o-K^p)^2 e^{\sigma^{K,o}}}$$

Taking logs

$$l\pi(\sigma^{K,o}|\theta) = -\frac{1}{2}(\sigma^{K,o}-\eta^{K,o})^2\psi^{K,o} + \sum_{l=1}^{L} \frac{1}{2}(\sigma^{K,o}-(K_l^o-K^p)^2 e^{\sigma^{K,o}}) + C$$

Similarly for $\sigma^{r,o}$

$$l\pi(\sigma^{r,o}|\theta) = -\frac{1}{2}(\sigma^{r,o}-\eta^{r,o})^2\psi^{r,o} + \sum_{l=1}^{L} \frac{1}{2}(\sigma^{r,o}-(r_l^o-r^p)^2 e^{\sigma^{r,o}}) + C$$

and similarly for σ^{ν}

$$l\pi(\sigma^{\nu}|\theta) = -\frac{1}{2}(\sigma^{\nu}-\eta^{\nu})^2\psi^{\nu} + \sum_{l=1}^{L} \frac{1}{2}(\sigma^{\nu}-(\nu_l-\nu^p)^2 e^{\sigma^{\nu}}) + C$$

$$K_{clm} \sim \mathrm{N}(e^{\alpha_c + (K_l^o + \delta_l \gamma_{cl})}, (e^{\tau_{cl}^K})^{-1})$$

$$\gamma_{cl} = \begin{cases} 0 & \text{if } c = 0; \\ \mathrm{N}(0, (e^{\sigma^\gamma})^{-1}) & \text{if } c = 1. \end{cases}$$

$$\pi(\gamma_{2l}|\theta) = \sqrt{\frac{e^{\sigma^\gamma}}{2\pi}} e^{-\frac{1}{2}(\gamma_{cl})^2 e^{\sigma^\gamma}} \prod_{m=1} M_{2l} \sqrt{\frac{e^{\tau_{2l}^K}}{2\pi}} e^{-\frac{1}{2}(K_{2lm} - e^{\alpha_2 + (K_l^o + \delta_l \gamma_{2l})})^2 e^{\tau_{2l}^K}}$$

Taking logs

$$l\pi(\gamma_{2l}|\theta) = -\frac{1}{2}(\gamma_{2l})^2 e^{\sigma^\gamma} - \sum_{m=1}^{M_{2l}} \frac{1}{2}(K_{2lm} - e^{\alpha_2 + (K_l^o + \delta_l \gamma_{2l})})^2 e^{\tau_{2l}^K} + C$$

Similarly for ω_{2l}

$$l\pi(\omega_{2l}|\theta) = -\frac{1}{2}(\omega_{2l})^2 e^{\sigma^\omega} - \sum_{m=1}^{M_{2l}} \frac{1}{2}(r_{2lm} - e^{\beta_2 + (r_l^o + \delta_l \omega_{2l})})^2 e^{\tau_{2l}^r} + C$$

σ^γ is similar to both $\sigma^{K,o}$ and $\sigma^{r,o}$

$$l\pi(\sigma^\gamma|\theta) = -\frac{1}{2}(\sigma^\gamma - \eta^\gamma)^2 \psi^\gamma + \sum_{m=1}^{M_{2l}} \frac{1}{2}(\sigma^\gamma - (\gamma_{2l})^2 e^{\sigma^\gamma}) + C$$

σ^ω is similar to both $\sigma^{K,o}$ and $\sigma^{r,o}$

$$l\pi(\sigma^\omega|\theta) = -\frac{1}{2}(\sigma^\omega - \eta^\omega)^2 \psi^\omega + \sum_{m=1}^{M_{2l}} \frac{1}{2}(\sigma^\omega - (\omega_{2l})^2 e^{\sigma^\omega}) + C$$

$$K_{clm} \sim \mathrm{N}(e^{\alpha_c + (K_l^o + \delta_l \gamma_{cl})}, (e^{\tau_{cl}^K})^{-1})$$

$$\alpha_c = \begin{cases} 1 & \text{if } c = 0; \\ \mathrm{N}(\alpha^\mu, \eta^\alpha) & \text{if } c = 1. \end{cases}$$

$$\pi(\alpha_2|\theta) = \sqrt{\frac{\eta^\alpha}{2\pi}} e^{-\frac{1}{2}(\alpha_2 - \alpha^\mu)^2 \eta^\alpha} \prod_{m=1} M_{2l} \sqrt{\frac{e^{\tau_{2l}^K}}{2\pi}} e^{-\frac{1}{2}(K_{2lm} - e^{\alpha_2 + (K_l^o + \delta_l \gamma_{2l})})^2 e^{\tau_{2l}^K}}$$

Taking logs

$$l\pi(\alpha_2|\theta) = -\frac{1}{2}(\alpha_2 - \alpha^\mu)^2 \eta^\alpha + \sum_{m=1}^{M_{2l}} \frac{1}{2}(K_{2lm} - e^{\alpha_2 + (K_l^o + \delta_l \gamma_{2l})})^2 e^{\sigma^{\tau_{2l}^K}} + C$$

Similarly for β_2

$$l\pi(\beta_2|\theta) = -\frac{1}{2}(\beta_2 - \beta^\mu)^2 \eta^\beta + \sum_{m=1}^{M_{2l}} \frac{1}{2}(r_{2lm} - e^{\beta_2 + (r_l^o + \delta_l \omega_{2l})})^2 e^{\sigma^{\tau_{2l}^r}} + C$$

$$y_{clmn} \sim \text{N}(\hat{y}_{clmn}, (e^{v_l + \nu_c})^{-1})$$
$$v_c \sim \text{N}(v_\mu, (e^{\sigma^v})^{-1})$$

$$\pi(v_2|\theta) = \sqrt{\frac{e^{\sigma^v}}{2\pi}} e^{-\frac{1}{2}(v_2 - v_\mu)^2 e^{\sigma^v}} \prod_{l=1}^{L} \prod_{m=1}^{M_{2l}} \sqrt{\frac{e^{v_2}}{2\pi}} e^{-\frac{1}{2}(y_{clmn} - \hat{y}_{clmn})^2 e^{\nu_l + v_2}}$$

Taking logs

$$l\pi(v_2|\theta) = -\frac{1}{2}(v_2 - v_\mu)^2 e^{\sigma^v} + \sum_{l=1}^{L} \sum_{m=1}^{M_{2l}} \frac{1}{2}(v_c - (y_{clmn} - \hat{y}_{clmn})^2 e^{\nu_l + v_c}) + C$$

$$K_l^o \sim \mathrm{N}(K^p, (e^{\sigma^{K,o}})^{-1})$$
$$K^p \sim \mathrm{N}(K^\mu, (\eta^{K,p})^{-1})$$

$$\pi(K_p|\theta) = \sqrt{\frac{\eta^{K,p}}{2\pi}} e^{-\frac{1}{2}(K^p-K^\mu)^2 \eta^{K,p}} \prod_{l=1}^{L} \sqrt{\frac{e^{\sigma^{K,o}}}{2\pi}} e^{-\frac{1}{2}(K_l^o-K^p)^2 e^{\sigma^{K,o}}}$$

Taking logs

$$l\pi(K_p|\theta) = -\frac{1}{2}(K^p - K^\mu)^2 e^{\eta^{K,p}} - \sum_{l=1}^{L} \frac{1}{2}(K_l^o - K^p)^2 e^{\sigma^{K,o}} + C$$

Similarly for r_p

$$l\pi(r_p|\theta) = -\frac{1}{2}(r^p - r^\mu)^2 e^{\eta^{r,p}} - \sum_{l=1}^{L} \frac{1}{2}(r_l^o - r^p)^2 e^{\sigma^{r,o}} + C$$

similarly for ν_p

$$l\pi(\nu^p|\theta) = -\frac{1}{2}(\nu^p - \nu^\mu)^2 \eta^{\nu,p} - \sum_{l=1}^{L} \frac{1}{2}(\nu_l - \nu^p)^2 e^{\sigma^\nu} + C$$

similarly for υ_p

$$l\pi(\upsilon^p|\theta) = -\frac{1}{2}(\upsilon^p - \upsilon^\mu)^2 \eta^{\upsilon,p} - \sum_{c=1}^{2} \frac{1}{2}(\upsilon_c - \upsilon^p)^2 e^{\sigma^\upsilon} + C$$

$$y_{clmn} \sim \mathrm{N}(\hat{y}_{clmn}, (e^{\nu_l+\upsilon_c})^{-1})$$
$$P \sim \mathrm{N}(P^\mu, (\eta^P)^{-1})$$

$$\pi(P|\theta) = \sqrt{\frac{\eta^P}{2\pi}} e^{-\frac{1}{2}(P^p-P^\mu)^2 \eta^P} \prod_{c=1}^{2} \prod_{l=1}^{L} \prod_{m=1}^{m_{cl}} \prod_{n=1}^{n_{clm}} \sqrt{\frac{e^{\nu_l+\upsilon_c}}{2\pi}} e^{-\frac{1}{2}(y_{clmn}-\hat{y}_{clmn})^2 e^{\nu_l+\upsilon_l}}$$

Taking logs

$$l\pi(P|\theta) = -\frac{1}{2}(P^p - P^\mu)^2 \eta^P - \sum_{c=1}^{2} \sum_{l=1}^{L} \sum_{m=1}^{m_{cl}} \sum_{n=1}^{n_{clm}} \frac{1}{2}(y_{lmn} - \hat{y}_{lmn})^2 e^{\nu_l+\upsilon_l} + C$$