

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

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

$$\hat{y}_{clmn} = f(x_{clmn}; e^{K_{clm}}, e^{r_{clm}}, e^P)$$

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

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

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

$\alpha_c = \begin{cases} 0 & \text{if } c = 0; \\ N(\alpha^\mu, \eta^\alpha) & \text{if } c = 1. \end{cases}$	
$\beta_c = \begin{cases} 0 & \text{if } c = 0; \\ N(\beta^\mu, \eta^\beta) & \text{if } c = 1. \end{cases}$	
$v_c = \begin{cases} 0 & \text{if } c = 0; \\ N(v^\mu, (e^{\sigma^v})^{-1}) & \text{if } c = 1. \end{cases}$	$\sigma^v \sim N(\eta^v, (\psi^v)^{-1})$

$$K^p \sim N(K^\mu, (\eta^{K,p})^{-1})$$

$$r^p \sim N(r^\mu, (\eta^{r,p})^{-1})$$

$$\nu^p \sim N(\nu^\mu, (\eta^{\nu,p})^{-1})$$

$$P \sim N(P^\mu, (\eta^P)^{-1})$$

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

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

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

Taking logs

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

Similarly for  $r_{clm}$

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


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

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

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

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  $\tau_{cl}^r$

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

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

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

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

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  $r_l^o$

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


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

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

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

Taking logs

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


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

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

$$\delta_l \sim \text{Bern}(p)$$

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

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


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

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  $\sigma^\nu$

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

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

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

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

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  $\omega_{2l}$

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


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

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

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

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


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

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

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

Taking logs

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

Similarly for  $\beta_2$

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

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

$$v_c \sim N(v^\mu, (e^{\sigma^v})^{-1})$$

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

Taking logs

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

$\sigma^v$  is similar to both  $\sigma^Z$  and  $\sigma^\nu$

$$l\pi(\sigma^v|\theta) = -\frac{1}{2}(\sigma^v - \eta^v)^2 \psi^v + \frac{1}{2}(\sigma^v - (v_2 - v^\mu)^2 e^{\sigma^v}) + C$$

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

$$K^p \sim N(K^\mu, (\eta^{K,p})^{-1})$$

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

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  $\nu_p$

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

similarly for  $v_p$

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


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$$y_{clmn} \sim N(\hat{y}_{clmn}, (e^{\nu_l + v_c})^{-1})$$

$$P \sim N(P^\mu, (\eta^P)^{-1})$$

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

Taking logs

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