$1,2$

1

$J(\nu, T)$

$\nu$

$T$

$T^{\mathrm{RJ}}$

$$k_{\mathrm{bolt}}\, T^{\mathrm{RJ}} = J(\nu, T).$$

$T^{\mathrm{RJ}} = T$

$h\nu << k_{\mathrm{bolt}}\, T$

$h\nu >> k_{\mathrm{bolt}}\, T$

$C$

$$C = c_{\mathrm{dark}} + g\left(T_{\mathrm{ant}}^{\mathrm{tot}} + T_{\mathrm{rec}}\right),$$



$g$

$T_{\text{rec}}$



$$T_{\rm ant}^{\rm tot} = \frac{T_{\rm ant}^{\rm sig} + G_{\rm im}\, T_{\rm ant}^{\rm ima}}{1 + G_{\rm im}},$$





$g_{\mathrm{ima}}$





$T_{\mathrm{atm}}$

$T_{\text{astro}}$

$$T_{\mathrm{ant}} = F_{\mathrm{eff}} \left[ T_{\mathrm{atm}} \exp(-a\tau) + T_{\mathrm{astro}} \right] + (1 - F_{\mathrm{eff}}) T_{\mathrm{loss}}$$

$F_{\text{eff}}$

$\tau$

$a$

$$a = 1/\sin(\text{elevation});$$

$T_{\mathrm{cab}}$

$T_{\mathrm{amb}}$

$$T_{\text{loss}} = \alpha T_{\text{cab}} + (1 - \alpha) T_{\text{amb}},$$

$\alpha$

$T_{\mathrm{sky}}$



$$T_{\mathrm{sky}} = F_{\mathrm{eff}} T_{\mathrm{emi}}^{\mathrm{tot}} + (1 - F_{\mathrm{eff}}) T_{\mathrm{loss}} \cdot$$

$$T_{\mathrm{emi}}^{\mathrm{tot}} = \frac{T_{\mathrm{emi}}^{\mathrm{sig}} + G_{\mathrm{im}}\, T_{\mathrm{emi}}^{\mathrm{ima}}}{1 + G_{\mathrm{im}}},$$

$$T_{\mathrm{emi}}^{\mathrm{sig}} = T_{\mathrm{atm}}^{\mathrm{sig}} \left\{1 - \exp\left(-a\tau_{\mathrm{sig}}\right)\right\} \quad \text{and} \quad T_{\mathrm{emi}}^{\mathrm{ima}} = T_{\mathrm{atm}}^{\mathrm{ima}} \left\{1 - \exp\left(-a\tau_{\mathrm{ima}}\right)\right\}.$$

$$\tau = \tau_{\mathrm{dry}} + \tau_{\mathrm{wet}},$$

$\tau_{\mathrm{dry}}$





$$\tau_{\mathrm{wet}} = \alpha_{\mathrm{H_2O}}\, \mathrm{w}_{\mathrm{H_2O}}$$



$$\frac{T_{\rm hot} - T_{\rm sky}^{\rm tot}}{C_{\rm hot} - C_{\rm sky}^{tot}} = \frac{T_{\rm hot} - T_{\rm cold}}{C_{\rm hot} - C_{\rm cold}},$$










$T_{\text{sky}}^{\text{tot}}$

$$T_{\mathrm{a}}^{\star} = T_{\mathrm{cal}} \, \frac{C_{\mathrm{on}} - C_{\mathrm{off}}}{C_{\mathrm{hot}} - C_{\mathrm{off}}},$$

$T_{\mathrm{cal}}$

$T_{\mathrm{cal}}$

$$(1 + G_{\mathrm{im}}) \left[ T_{\mathrm{emi}}^{\mathrm{sig}} - T_{\mathrm{bg}} \right]$$



$$(1 + G_{\mathrm{im}}) \left[ T_{\mathrm{loss}} - T_{\mathrm{emi}}^{\mathrm{sig}} \right] \exp(a\tau_{\mathrm{sig}})$$

$$G_{\mathrm{im}} \left[ T_{\mathrm{emi}}^{\mathrm{sig}} - T_{\mathrm{bg}} \right] \left[ \exp \left\{ a(\tau_{\mathrm{sig}} - \tau_{\mathrm{ima}}) \right\} - 1 \right]$$

$$\frac{1+G_{\mathrm{im}}}{F_{\mathrm{eff}}}\,[T_{\mathrm{hot}}-T_{\mathrm{loss}}]\,\exp(a\tau_{\mathrm{sig}}).$$



$$T_{\mathrm{cal}} = (T_{\mathrm{hot}} - T_{\mathrm{sky}}) \frac{1 + G_{\mathrm{im}}}{F_{\mathrm{eff}} \, \exp\left(-a\tau_{\mathrm{sig}}\right)}.$$





$O_3$

2



$1 - \exp(-a\tau)$

$$T_{\mathrm{emi}} \propto T_{\mathrm{atm}} \left[1 - \exp(-a\tau)\right]$$

$$T_{\mathrm{cal}} \propto \exp(a\tau)$$

$\exp(-a\tau)$

$(T_{\text{hot}} - T_{\text{sky}})$

$$[1 + G_{\mathrm{im}}] \,/\, [F_{\mathrm{eff}} \, \exp(-a\tau)]$$


$G_{\mathrm{im}}^{\mathrm{true}}$


$F_{\text{eff}}^{\text{true}}$









$$\frac{T_{\mathrm{cal}}^{\mathrm{meas}} - T_{\mathrm{cal}}^{\mathrm{true}}}{T_{\mathrm{cal}}^{\mathrm{true}}} = \frac{F_{\mathrm{eff}}^{\mathrm{true}}(1 + G_{\mathrm{im}}^{\mathrm{meas}})}{F_{\mathrm{eff}}^{\mathrm{meas}}(1 + G_{\mathrm{im}}^{\mathrm{true}})} \exp\left[a(\tau_{\mathrm{mod}} - \tau_{\mathrm{true}})\right] - 1$$