1 Overview of Model

Given temperature (T) and orbital distance (a), calculate the amount of pCO_2 (P) needed to make that distance have that temperature:

$$P = P(T, a)$$

Then use this pCO_2 value to calculate the global temperature sensitivity parameter

$$\frac{dT}{dP} = \frac{dT}{dP}(P)$$

This is then used to calculate γ, which is defined as the growth timescale over the climate timescale.

$$\gamma = \frac{t_G}{t_C} = \left(\frac{CN_{max}}{R_0 \Delta T}\right) \frac{dT}{dP}$$

1. Let some model be specified by initial pCO_2 value

$$P_i = inital\ pCO_2\ value$$

2. Then we first calculate the initial temperature sensitivity

$$\left.\frac{dT}{dP}\right|_i = \frac{dT}{dP}(P_i)$$

3. Then I use this to calculate the initial gamma.

$$\boxed{\gamma_i = \left(\frac{CN_{max}}{R_0 \Delta T}\right) \left.\frac{dT}{dP}\right|_i}$$

4. Use this to calculate the anthropogenic population

$$N_A = \frac{N_{max}}{\gamma_i}$$

5. Use this to calculate the initial population for the model

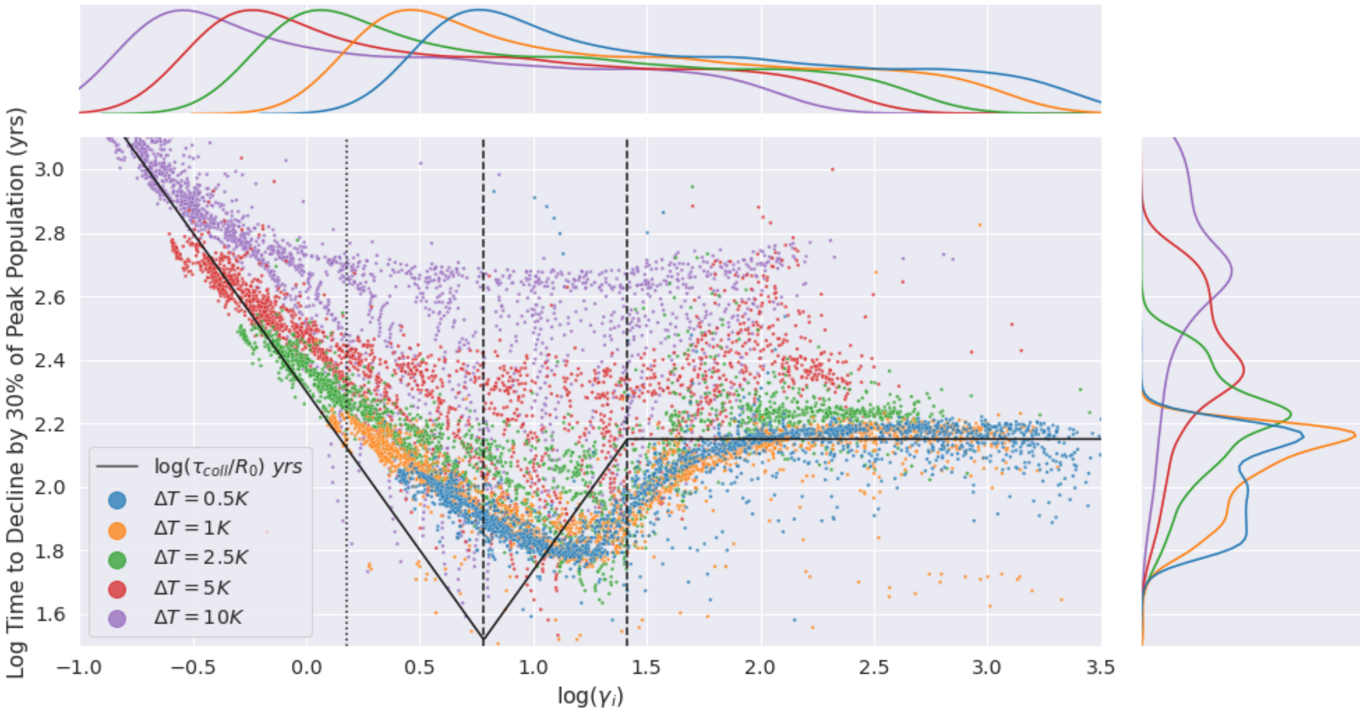
$$N_i = \frac{N_A}{1,000}$$

6. Then **run the model** using the inputs P_i, N_i. Where $P_i = P(T_i, a_i)$.
7. Then calculate the average temperature sensitivity

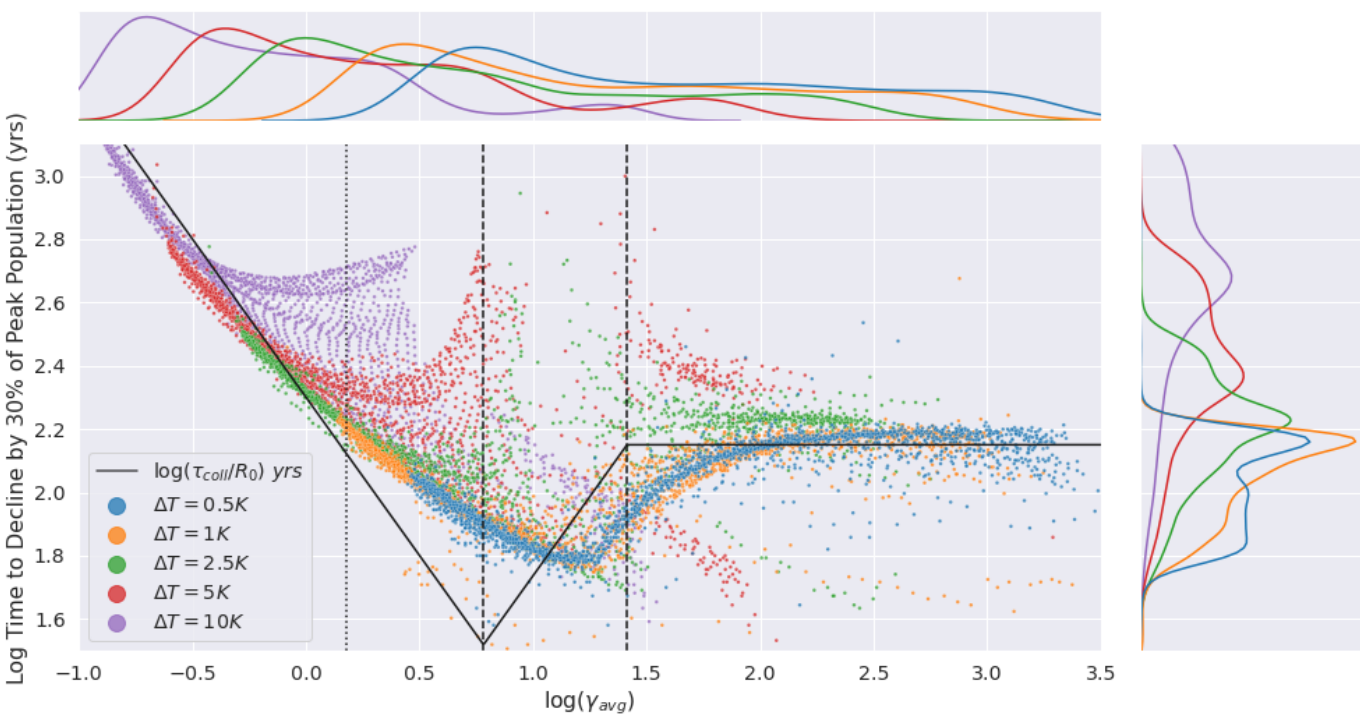
$$\left.\frac{dT}{dP}\right|_{avg} = \frac{T_f - T_i}{P_f - P_i}$$

8. Then calculate the average gamma

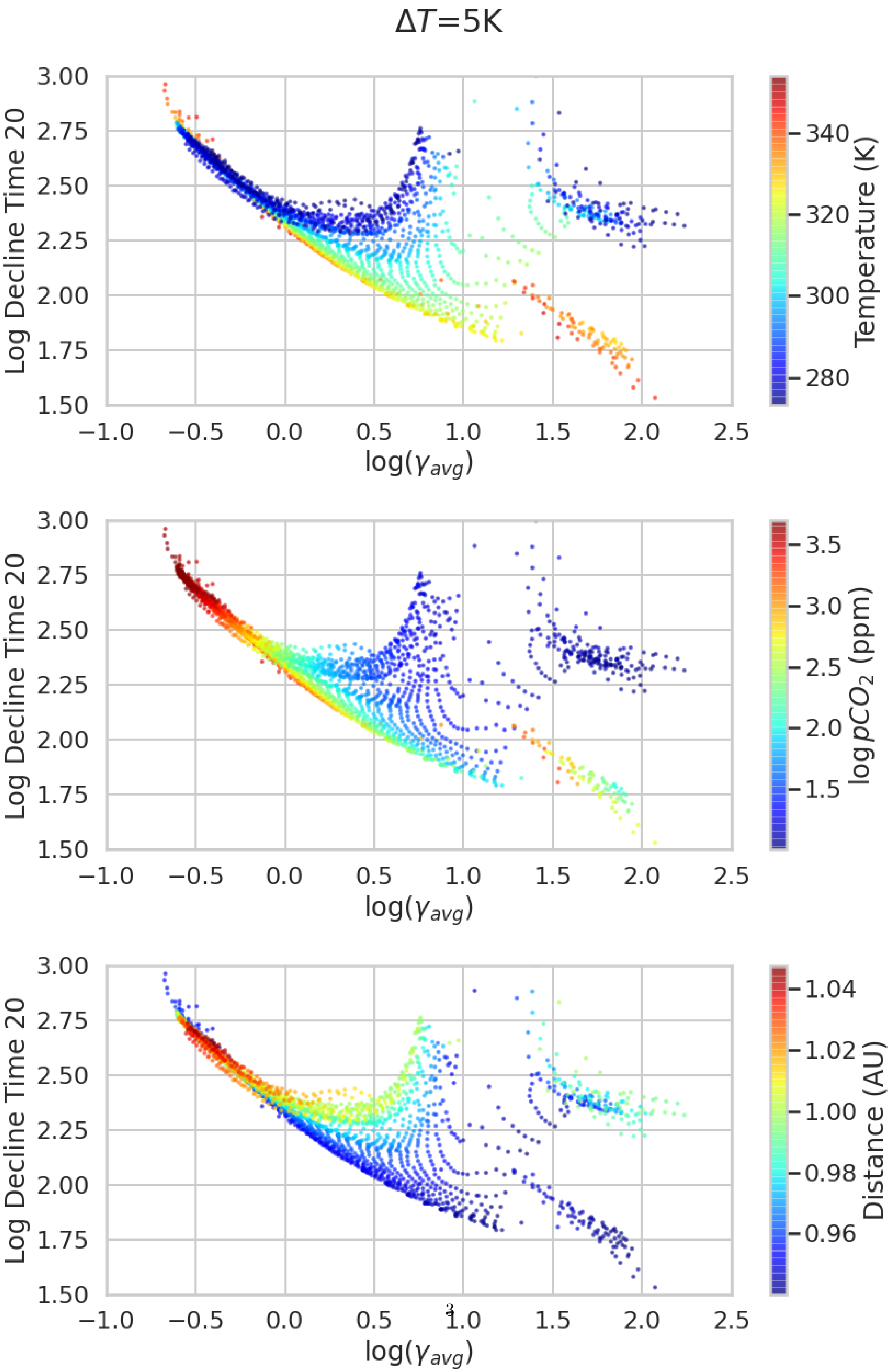
$$\boxed{\gamma_{avg} = \left(\frac{CN_{max}}{R_0 \Delta T}\right) \left.\frac{dT}{dP}\right|_{avg}}$$

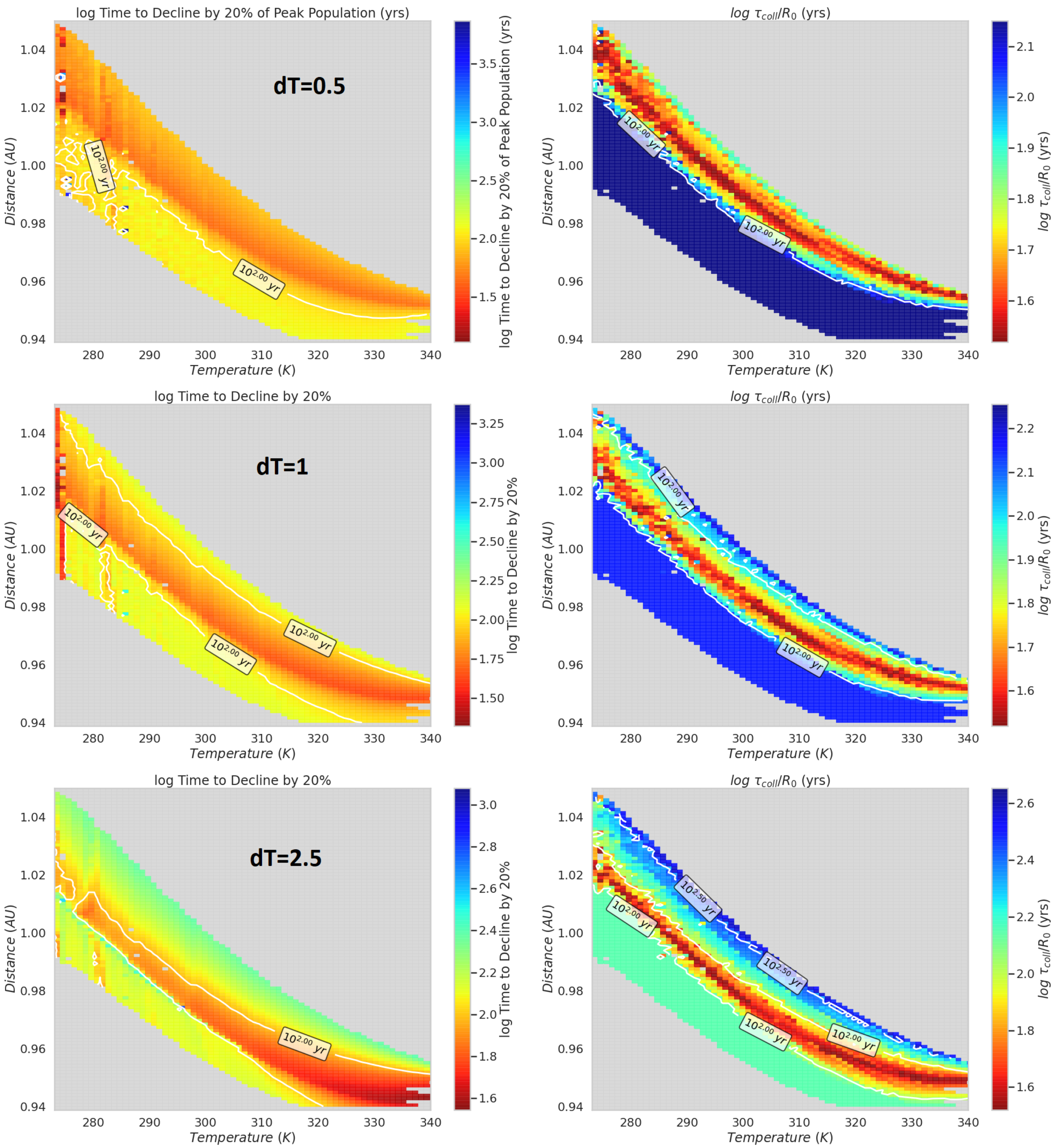


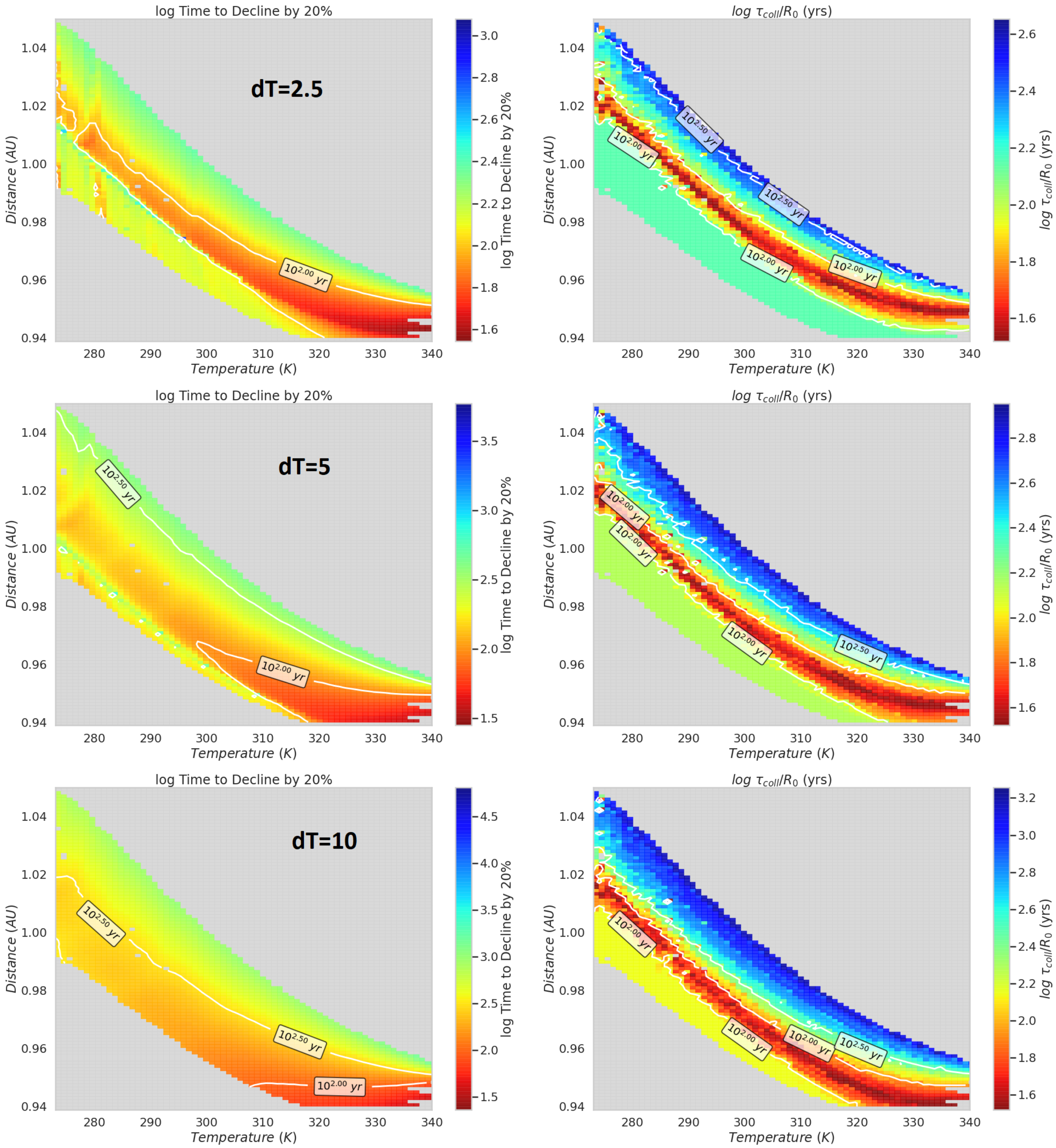
Log Time to Decline by 30% of Peak Population (yrs)
$\log(\tau_{coll}/R_0)$ yrs
$\Delta T = 0.5K$
$\Delta T = 1K$
$\Delta T = 2.5K$
$\Delta T = 5K$
$\Delta T = 10K$
$\log(\gamma_i)$



Log Time to Decline by 30% of Peak Population (yrs)
$\log(\tau_{coll}/R_0)$ yrs
$\Delta T = 0.5K$
$\Delta T = 1K$
$\Delta T = 2.5K$
$\Delta T = 5K$
$\Delta T = 10K$
$\log(\gamma_{avg})$


ΔT=5K
Log Decline Time 20
log(γ_avg)
Temperature (K)
280
300
320
340
log pCO_2 (ppm)
1.5
2.0
2.5
3.0
3.5
Distance (AU)
0.96
0.98
1.00
1.02
1.04
3.00
2.75
2.50
2.25
2.00
1.75
1.50
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
2.5


log Time to Decline by 20% of Peak Population (yrs)
dT=0.5
Distance (AU)
Temperature (K)
log Time to Decline by 20% of Peak Population (yrs)
$log\ \tau_{coll}/R_0$ (yrs)
$log\ \tau_{coll}/R_0$ (yrs)
log Time to Decline by 20%
dT=1
log Time to Decline by 20%
dT=2.5
$10^{2.00}$ yr
$10^{2.50}$ yr


log Time to Decline by 20%
dT=2.5
dT=5
dT=10
Distance (AU)
Temperature (K)
log Time to Decline by 20%
$log\ \tau_{coll}/R_0$ (yrs)
$10^{2.00}$ yr
$10^{2.50}$ yr

2 Miscelleneous