8.3, 8.6, 8.7, 8.10, 8.13

8.3 **Forest** $15 \frac{kg\,C}{m^2} (50 \times 10^{12}\, m^2) = 7.5 \times 10^{14}\, kg$

$= \boxed{7.5 \times 10^{11} \text{ tonne C}}$

Atmos: $(397 \times 10^{-6})(1.1 \times 10^{44} \text{ molecules})$

397 ppm (2012)

$= 437 \times 10^{38}$ C atoms $\left(\frac{1\text{ kg mole}}{6.023 \times 10^{26}\, C}\right)(12\, C)\, kg$

$= 8.7 \times 10^{38-26+2} = 8.7 \times 10^{14}\, kg$

$= \boxed{8.7 \times 10^{11} \text{ tonne C}}$

8.6 $(93M)\frac{(1.03)^2}{1.015^2} = 93(1.03)^2 = 93(1.061)$ 6% diff in S_o

Make easy 93M vs $93(1.03)^2 =$

$T = \left[(1-a)S_o/4\sigma\right]^{1/4}$ 6 Month $\frac{T_1}{T_2} = \left[\frac{1}{1.06}\right]^{1/4} = 0.986 = \frac{T_1}{T_2}$

Top $0.986 \times 255 = 251\,K$

Surface $\times\ 287 = 283\,K$

$6\% \Rightarrow \frac{6}{4} = 1.5\%$ effect

But in fact closest in Feb.,

So we have warm winters

cool summers hurrah

8.7 $T = (1-a)^{1/4} S_o^{1/4} C$

$\Delta T = \frac{\Delta S_o}{4}(1-a)^{1/4} C + \frac{\Delta a}{4}(1-a)^{-3/4} S_o C$

$\div$ by T: $\frac{\Delta T}{T} = \frac{1}{4}\frac{\Delta S_o}{S_o} + \frac{\frac{1}{4}\Delta a (1-a)^{-3/4}}{(1-a)^{1/4}} = \frac{1}{4}\frac{\Delta S_o}{S_o} + \frac{1}{4}\frac{\Delta a}{(1-a)}$

$\frac{\Delta T}{T} = \frac{1}{4}(0.1) + \frac{1}{4}\frac{.03}{0.7}$ or by Brute Force

$= 0.025 + 0.011 = 0.034$

$\Delta T = (255)(0.014) = 4\,K = \Delta T$

$\boxed{T_a = 255 + 4\,K = 259\,K}$

8.10 1 m/year ⇒ $\frac{1000\text{ kg}}{m^2\text{-}y}\left(\frac{2.3\text{ MJ}}{kg}\right)\left(\frac{1\text{ y}}{3.2\times10^7\text{ s}}\right) = 10^{3+6-7} \times 0.72$

$= 0.72\times10^2 = $ **72 w/m² Forcing**

8.13 $100\% = 10^{16}\text{ kg}\times 0.8 = 0.8\times10^{16}\text{ kg}$

$0.8\times10^{16}\text{ kg}\left(\frac{1\text{ kg mole}}{6.023\times10^{26}}\right)^{-1}\left(\frac{1}{12\text{ C}}\right) = 10^{16+26}\times 0.4 = 0.4\times10^{42}$ molecule

ppm C $= \frac{0.4\times10^{42}}{1.1\times10^{44}}\times10^6_{ppm} = 0.36\times10^4\text{ ppm} = $ **3600 ppm**

$f = 3.71\ln[C/C_0]/\ln 2 = 5.35\ln\left[\frac{C}{C_0}\right] = 5.35\ln\left[\frac{3600}{280}\right]$

$= 5.35\times2.6 = 13.7\text{ w/m}^2$

$\frac{d\text{ Forcing}}{dT} = \frac{3.7\text{ w/m}^2}{K}$ $dT = \frac{13.7}{3.7} \simeq 4\text{ K}$ too small!?

check 10^{16} kg Coal #!

There will be many more tons of CO_2 = use that