Data Assimilation and Climate
AIMS Rwanda, March, 2020

Lab Activities
Climate Models

Consider the discretized zero-dimensional climate model

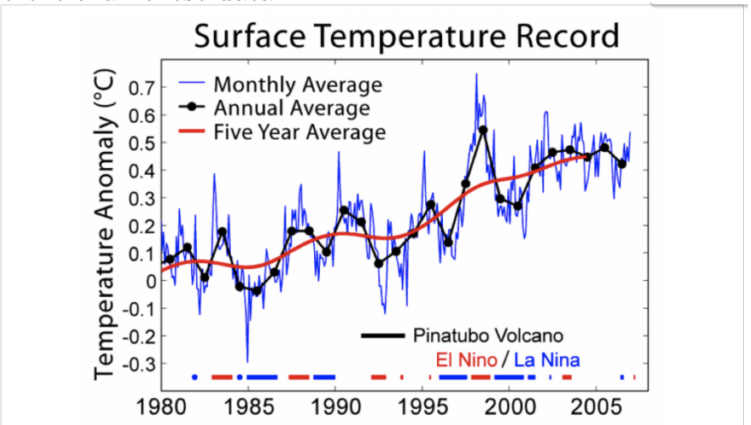
$$T(t_{j+1}) = T(t_j) + \frac{dt}{C_p} S(1-\alpha) - \frac{dt}{C_p} 4\epsilon\sigma T(t_j)^4 \tag{1}$$

1. (a) Use the following information to estimate the global mean surface temperature $T(t_j)$ at times $t_1, \ldots, ...t_{1000}$ where $t_0 = 0$ and $t_j = j * dt$:

$$S = 1372\ Wm^2, \alpha = 0.3, \epsilon = 0.61, \sigma = 5.67 \times 10^{-8}\ Wm^{-2}K^{-4},$$
$$C_p = 1.05 \times 10^{23}\ JK^{-1}, dt = 1 \times 10^{21}, T(t_0) = 0.$$

Plot $T(t_j)$ vs t_j for $j = 0, \ldots, 1000$. Discuss what you observe on the Slack channel "activities". In particular, could you have guessed the graph would have this form by just looking at equation (1)?

(b) Given the values of $T(t_j)$ you found in 1a, now plot estimates of the global mean surface temperature anomaly. The temperature anomaly is found by first calculating $mean(T) = T_{mean}$ and then plot $T_{anom}(t_j) = T(t_j) - T_{mean}$. Once plotted, discuss how your graph looks different than these data



The last 25 years of globally averaged instrumental surface temperature measurements from the HadCRUT3 dataset.
Credit: Robert Rohde

(c) Vary values of the parameters in 1a and see if you can get a graph of $T_{anom}(t_j)$ that looks like the above data. If you can get a similar looking graph, please post your parameter values and graph on the Slack channel "activities".