Atmospheric Sciences 528: Atmospheric Data Analysis
Dr. Jared Marquis (Fall 2024)
Assignment #4: Chaos
Due: 6 December 2024 at 11:59PM
50 pts

Lorenz (1984; 1990; 2006) analyzed the system of ordinary differential equations:

$$\frac{dx}{dt} = -y^2 - z^2 - ax + AF$$

$$\frac{dy}{dt} = xy - bxz - y + G$$

$$\frac{dz}{dt} = bxy + xz - z$$

where x represents the strength of a circumpolar westerly current, y and z denote the cosine and sine phases of a superposed chain of large-scale waves, t is a normalized time such that 1 normalized time unit equals 5 days, and *a, b, F,* and *G* are constants.

Your assignment is to:

a. Perform two simulations using this system of equations and two different initial conditions (given below). To solve this system of equations, use forward time differencing. Thus, one obtains the value of $x(t+\Delta t)$ using

$$x(t+\Delta t) = x(t) + \Delta t \frac{dx}{dt}(t) = x(t) + \Delta t[-y(t)^2 - z(t)^2 - ax(t) + aF]$$

b. Use the values a=0.25, b=4.0, F=8.0, and G=1.0.
c. The two initial conditions for the simulations are $(x_0, y_0, z_0) = (2.5, 1.0, 0.0)$ and $(2.49, 1.0, 0.0)$.
d. Run your simulations out to 120 days (real time) using a time step of 4 hours [normalized time step of *4/(24*5)*].

You should link your github repository to the course's blackboard site. Within this repository, you should have:

a. Your code (or spreadsheet that shows how you performed the simulations).
b. Plots of x, y, and z for each simulation.
c. A discussion of the results. Are the two simulations the same throughout the whole period? If not, when do they diverge? If the ending points are different, what does this say regarding the importance of providing NWP models (assuming this serves as a proxy for one) with accurate and balanced initial conditions?