This directory contains the code for one particular sensitivity analysis of the planets simulation:

Name: SA28 - hidden variables

Description: The main objective is to study how temperature can be regulated and how different processes can cause it to be stabilised or to change. Therefore, there has to be an ODE for planetary temperature. However, in reality it is sometimes more complicated than can be represented solely by processes that directly impact on temperature. There are also intervening variables which impact on temperature but undergo their own dynamics, including changing in response to their own values and temperature. Some examples are the concentrations of greenhouse gases (or the greenhouse effect overall) such as carbon dioxide. Another example is the overall extent of ice-sheets on Earth and the amount of water locked up in them. This list could be extended, in particular when planets very unlike Earth are also considered. In this sensitivity analysis, extra ODEs are included for hidden variables.

This is the most complex of the sensitivity analyses and is implemented by allowing three additional state variables to influence the rate of change of planetary temperature:

Each of these three state variables has its own set of feedbacks and its own long-term forcing (its own ODE and its own randomly-determined dynamics), and is also influenced by the prevailing planetary temperature:

where *k1* to *k6* are coefficients which are each given random values between -1 and +1, *f0* to *f3* are functions whose shapes are set randomly using a similar procedure to that for determining *f* in the standard version of the model, and to are time-dependent forcings determined in a similar manner to that for determining in the standard version of the model. Each perturbation was made to influence all four state variables, and hence altered T both directly but also indirectly through changing the values of *X1* to *X3.* The number of perturbations in all size classes was reduced by a factor of 4.

The following files were altered in order to implement this sensitivity analysis:

determine\_perturbations.m

calc\_attractor\_properties.m

calc\_runaways.m

calc\_planet\_properties.m

determine\_feedbacks.m

calc\_planet\_freqs.m

ts\_master.m

ts\_slave.m

ts\_analyser.m

planets\_ODE.m

planets\_jac.m

events\_pl.m

initialise\_slave.m

initialise\_master.m

plot\_scatterplots.m

plot\_planet\_histograms.m

set\_constants.m

calc\_run\_properties.m

array\_transfers.m

summary\_for\_paper.m

calc\_run\_freqs.m

The following files were created in order to implement this sensitivity analysis:

determine\_coefficients.m

determine\_initial\_values.m

determine\_trends.m

The files determine\_initial\_T.m and dcetermine\_trend.m were removed (replaced with determine\_initial\_values.m and determine\_trends.m)