Printable page generated Wednesday, 31 Mar 2021, 14:43

# S397: End-of-module assessment (EMA)

**Cut-off-date:** Noon (BST) on Thursday 27 May 2021

## General advice for submitting your EMA

### Submission

You should submit your completed EMA in electronic form via the Open University's eTMA system. **You must submit your EMA in .doc or .docx format** (which can be created in either Word™ or Apache OpenOffice™. If you do not, the markers may be unable to mark your EMA. You can submit your EMA as one or more files zipped up together. Each separate file must be clearly labelled to show which part of this EMA it relates to. Ensure that you submit multiple files as a *single* submission; otherwise successive submissions will overwrite any previous work that you submitted.

## Word limits

S397 specifies *mandatory word limits* for your EMA answers. Word limits are specified so you understand the length of answers expected: much less than this and you are likely to have missed important points; much more and you are wasting both your and your tutor's time and effort. The word limits are absolute, with no 10% leeway; if you exceeded a word limit this will lead to a penalty, with marks being deducted from your score. Answering succinctly is also valuable preparation for workplace writing. The word limits for the questions in this are specified where relevant.

## Plagiarism

Plagiarism involves the verbatim use of material from other sources without suitable accreditation and passing it off as your own work. This is a serious offence and can lead to failure of the module or worse. Further details about plagiarism can be found on the 'Developing good academic practice' website and the OU Harvard guide to citing references.

Please note that plagiarism detection software will be used to check answers to this EMA. You should also read module specific information related to 'Turnitin and CopyCatch' and the 'Misuse of social networking sites' in the *Assessment* area of the S397 website before attempting this EMA. 'Essential documents' in the Study Support section (on StudentHome) provides details about the rules relating to the use of social networking and OU websites in general.

## Referencing

You should provide full references for your sources of information where appropriate in all your answers, using the correct format as detailed in the OU Harvard guide to referencing. You may lose marks if you fail to do so. When referring to any sources (whether printed or electronic) other than module materials, note that your main sources should be freely available to all Open University students and tutors and reference to restricted materials (e.g. websites that are available only to those with a password or who pay a fee, or company reports restricted to employees of that company) should be strictly limited. Note that sources where free access is provided for all Open University students and tutors via the Open University Library (e.g. some journals) are not considered to be 'restricted' in this sense.

*Note*: This assignment is worth 40% of the final total module score.

# Question 1

*This question carries 30% of the marks for this assignment and tests module learning outcomes KU4, KU5, CS3, KS3, KS5, PP2, PP3.*

In Activity 4.4.1 (Session 4.4.2), you performed a transient simulation of the climate and carbon-cycle response to historical anthropogenic $\mathrm{CO_2}$ emissions. This EMA question will explore this experiment in more detail. Firstly, you will use an ensemble of simulation outputs (which we have performed for you), supplemented by your own simulation data, to calibrate two uncertain model parameters. For this, you will use linear regression techniques that you are familiar with from Sessions 1.5.5 and 2.1.3. Secondly, you will apply your calibration of S397 GENIE to perform a climate change projection for a 'business-as-usual' climate change scenario. Finally, you will compare your projections with those of the IPCC's CMIP5 model inter-comparison, which used state-of-the-art Earth system models.

Note that the experiment you will perform is a simplified version of the experiment that you encountered in Session 4.2.7. Your experiment will only consider climate change due to $\mathrm{CO_2}$ emissions and it will assume all of these emissions occur over a fixed period of 100 years.

The two parameters you will consider are olr_adj, which controls the climate sensitivity (the uncertain dependence of global warming on $\mathrm{CO_2}$), and $k_{14}$, which controls strength of the terrestrial carbon sink through $\mathrm{CO_2}$ fertilisation. As for other parameters you have encountered, the default values can be seen (and changed) in the model input tabs. These two parameters are not precisely calibrated in S397 GENIE. The first objective of this question is to perform a calibration.

Download the EMA Question 1 GENIE data file, which contains outputs of an ensemble of twenty S397 GENIE simulations that repeat the experiment of Activity 4.4.1, except that they randomly vary these two important model parameters away from the default values that are used in the activity. These data are also available on the Assessment page.

a. Use the spreadsheet to create four scatterplots, one for each of the data pairs listed below. In each case you should supplement the 20 data points provided with a single additional data point from the simulation you performed in Activity 4.4.1. In each variable pairing, the first is the dependent variable, (model

output), which should be plotted on the $y$-axis, and the second the independent variable (model input), which should be plotted on the $x$-axis.

i. $\mathrm{CO_2}$ against olr_adj
ii. $\mathrm{CO_2}$ against $k_{14}$
iii. warming against olr_adj
iv. warming against $k_{14}$

**(10 marks)**

b. Use your spreadsheet to calculate the linear regression of warming against olr_adj. A straightforward way to do this is to right click on the plotted data points, select 'Add Trendline', and tick the boxes 'Linear', 'Display equation' and 'Display R-squared value'. Provide the equation and comment upon what the value of $R^2$ for this relationship tells you about the usefulness of the linear regression.

**(4 marks)**

c. Assuming an observed 2017 warming relative to the pre-industrial era of $1.1\,^\circ\mathrm{C}$ use this observation to derive a tuned value for the olr_adj parameter.

*Hint*: find the value of olr_adj that gives the observed warming in your regression equation.

**(2 marks)**

d. The $\mathrm{CO_2}$ concentration depends upon both olr_adj and $k_{14}$. Why is this?

**(3 marks)**

e. Because of this more complex two-parameter dependency ($\mathrm{CO_2}$ depends upon *both* olr_adj and $k_{14}$), we require a multiple regression of simulated $\mathrm{CO_2}$ against olr_adj and $k_{14}$. The results of this regression are summarised in Table 1.

**Table 1 Multiple regression summary of simulated $\mathrm{CO_2}$ against olr_adj and $k_{14}$.**

| | **Coefficients** | **Standard error** | **$t$ statistic** | **$P$** |
|---|---|---|---|---|
| Intercept | 455.9 | 4.3 | 106.16 | 1.2E-26 |
| olr_adj | -13.88 | 7.60 | -1.83 | 8.46E-02 |
| $k_{14}$ | -0.06334 | 0.00744 | -8.51 | 9.99E-08 |

Use this regression relationship, together with the calibrated value of olr_adj that you derived in part (c), and the observed $\mathrm{CO_2}$ value for 2017 of $405\,\mathrm{ppm}$ to calibrate $k_{14}$.

*Hint*: find the value of $k_{14}$ that gives observed $CO_2$ in this two-variable regression equation.

**(2 marks)**

f. Configure S397 GENIE with your calibrated $k_{14}$ ('land' tab) and olr_adj ('atmosphere' tab) parameter values. Now perform an emissions-forced experiment by setting $\mathrm{emitG} = 0.5\,\mathrm{GtC\,yr^{-2}}$ ('other' tab), and running the model. This value for $\mathrm{emitG}$ gives cumulative emissions of $2500\,\mathrm{GtC}$, which crudely approximates the IPCC 'business-as-usual' scenario (called 'Representative Concentration Pathway 8.5') out to the year 2100. What are the simulated final $CO_2$ and warming in your calibrated model? In this scenario, IPCC estimates uncertain $CO_2$ to be in the range $794\,\mathrm{ppm}$ to $1142\,\mathrm{ppm}$ and warming in the range $3.3\,^\circ\mathrm{C}$ to $5.5\,^\circ\mathrm{C}$. Where do your simulated values lie with respect to these IPCC ranges?

**(4 marks)**

g. The experiment you performed uses only one model parametrisation, and takes parameter values that you have precisely tuned to reproduce historical observations. What are the problems with this approach, and how could you do a better experiment given more time and the flexibility of the research version of GENIE?

*Word limit*: **150** words

**(5 marks)**

# Question 2

*This question carries 10% of the marks for this assignment and tests module learning outcomes KS1, KS3, KS4, PP3.*

Download the EMA Question 2 graphs file, which plots the $CH_4$ concentration over time for six contrasting CRDS output datasets. In Activity 4.6.1 of Session 4.6.3, you performed a flux calculation based on a similar dataset. Here, we simplify the analysis by assuming that the input parameters are constant for all experiments, which means we can simply multiply the slope of each graph (change in $CH_4$ concentration divided by time over which that change happens) by a constant to determine the flux. The constant you should apply for these experiments is

$$32\,200\,\mathrm{mgCH_4\,m^{-2}\,day^{-1}\,ppm^{-1}\,s}.$$

To illustrate, if $CH_4$ concentration increases by $10\,\mathrm{ppm}$ over $1000\,\mathrm{s}$, the flux increase can be calculated as

$$32\,200\,\mathrm{mgCH_4\,m^{-2}\,day^{-1}\,ppm^{-1}\,s} \times \frac{10\,\mathrm{ppm}}{1000\,\mathrm{s}} = 322\,\mathrm{mgCH_4\,m^{-2}\,day^{-1}}$$

When completing the question it is worth keeping the following information in mind:

- Fluxes can be negative (net uptake) as well as positive (net emissions) pointing to oxidation of methane.
- At around ambient $CH_4$ concentration you may observe an initial increase in flux that goes against the long-term trend. This is simply a 'pulse' of methane that is being emitted as a consequence of a disturbance resulting from the positioning of the flux chamber. Consider data from regions of the dataset that you believe are most representative of steady background flux.

Considering these plots, answer the following questions:

a. Which dataset showed evidence of methane emission via bubbling? How many bubbles were observed?

**(2 marks)**

b. Considering the remaining (i.e. non-bubbling) datasets, which shows the lowest measured emission of methane (not uptake)? Explain your choice.

**(2 marks)**

c. Again ignoring any datasets that displayed evidence of bubbling, which dataset had the largest methane flux? Explain your choice.

**(2 marks)**

d. Again ignoring any datasets that displayed evidence of bubbling, which dataset(s) showed a net uptake of methane from the atmosphere? Explain your choice.

**(2 marks)**

e. Calculate the methane flux in Experiment 3. Show your working.

**(2 marks)**

# Question 3

*This question carries 60% of the marks for this assignment and tests module learning outcomes KU1, KU2, CS2, CS4, KS2, PP1, PP3.*

Cities face serious challenges to their environments and to the health and wellbeing of residents. Urban green spaces are increasingly recognised as having the potential to deliver multiple benefits. However, a greater understanding of these benefits, as well as the costs and risks associated with green infrastructure, is required to enable good decision making in planning and management.

For this question you will take on the role of a consultant who has been commissioned to write a report on the potential options for regenerating urban green spaces within the (imaginary) city of Harberton. Harberton is a mid-size city, covering an area of $80\,\mathrm{km}^2$ and with a population of 250 000. There is a range of sites of varying size and characteristics, scattered across the city, that Harberton city council believes could be used and funding has been allocated to spend on the regeneration of 30 hectares of urban ecosystems, with the primary objectives of:

i. boosting biodiversity,
ii. improving the carbon budget of the city by sequestering carbon, and
iii. generating associated health benefits.

You have been asked to provide two things in particular:

1. Information on the likely benefits that might be expected from this investment, including both monetary and non-monetary benefits, as relevant to the stated primary objectives.
2. A discussion of the relative merits of three different options for the number and size of locations targeted for regeneration, namely:
    (a) spending the entire budget regenerating a single large area of 30 ha close to the city centre,
    (b) targeting 30 smaller locations with an average area of 1 ha,
    (c) creating a narrow ‘corridor’ covering 30 ha along the river that runs through the city.

You should consider the audience for the report to be environmentalists and land managers with good science backgrounds, but who are not specialists in this topic area. You should base your report on the information and additional references provided in the S397 module materials (particularly Session 3.5.4), and on the following references:

Lepczyk, C.A. et al. (2017) ‘Biodiversity in the city: fundamental questions for understanding the ecology of urban green spaces for biodiversity conservation’, *BioScience*, vol. 67, no. 9, pp. 799–807

Plummer, R., McGrath, D and Sivarajah, S. (2020) ‘How cities can add accessible green space in a post-coronavirus world’ *The Conversation* https://theconversation.com/how-cities-can-add-accessible-green-space-in-a-post-coronavirus-world-139194

Davies, Z.G., Edmondson, J.L., Heinemeyer, A., Leake, J.R. and Gaston, K.J. (2011), ‘Mapping an urban ecosystem service: quantifying above-ground carbon storage at a city-wide scale’. *Journal of Applied Ecology*, 48: 1125-1134. doi:10.1111/j.1365-2664.2011.02021.x

You may also find it helpful to consult and appropriately cite other reliable sources (e.g. academic papers or websites). You will receive credit for including up to three further references external to the module material and beyond the references provided for you here (you will not be penalised for using more, but marks will not be awarded for using more than three).

Your answer should not exceed 1500 words in length, excluding the reference list. You will lose marks for exceeding this limit (see the Word limits section above for more details).

Your report should consist of the following sections:

- **Executive summary** Summarise, concisely, the background, main findings and recommendations of your report.

  *Word limit*: **175** words, including an appropriate title

  **(6 marks)**

- **Context** Briefly summarise the science context of urban ecosystem regeneration.

  *Word limit*: **175** words

  **(6 marks)**

- **Potential benefits and evidence** Discuss the potential benefits, both monetary and non-monetary, that might be anticipated from the regeneration programme, and explain the timescales over which they are likely to be realised.

  Summarise the scientific evidence on which your discussion of potential benefits are based, briefly describing relevant studies. Note: in your answer you should consider the scientific evidence behind the benefits, that is, details of how the quantitative and qualitative estimates were made.

  *Word limit*: **600** words

  **(20 marks)**

- **Risks and unknowns** Discuss the risks and unknown factors that could adversely impact the expected gains from any potential regeneration actions. Note: in your answer you should focus on risks and unknowns relating to the science of urban ecosystem regeneration (e.g. ecosystem disservices), rather than general risks that might be associated with any urban management project.

  *Word limit*: **300** words

  **(10 marks)**

- **Regeneration options** Discuss the three suggested options relating to the choice of number, size and location of target regeneration sites and the relative merits and drawbacks of the different options in relation to objectives of the programme and expected benefits. Recommend a strategy and justify your choice.

  *Word limit*: **250** words

**(8 marks)**

- **References** including citations in the report.

  **(4 marks)**

- The remaining 6 marks will be awarded for the clarity, conciseness and relevance of your report.

  **(6 marks)**

You should appropriately cite and reference the material used for writing the report. The guide for citation and referencing both module material and external literature is provided in the Harvard Guide to citing references.

You must write your report in your own words. If you do quote directly from any publications, or other sources, you must place the quotation inside double quotation marks “like this” and state the source, otherwise you are likely to be penalised for plagiarism. If in doubt please refer to the University’s plagiarism policy, http://www.open.ac.uk/students/charter/sites/www.open.ac.uk.students.charter/files/files/ecms/web-content/plagiarism.pdf

---