**METO 3100**

**CLIMATE AND THE EARTH SYSTEM**

**In Class Activity 25**

**Project Eddie Module: Paleoclimate and ocean Biogeochemistry**

Part 1. Productivity and Micronutrients (Continued)

Review the findings you discovered in the previous activity. Make sure the Data Analysis ToolPak is installed and working in Excel. If you need a review on how to use it, watch this video again: <https://www.youtube.com/watch?v=vFcxExzLfZI>

Because dust-borne Fe is an important micronutrient that can promote organic carbon export we might expect to find a correlation between dust inputs (fluxes) and organic carbon export (productivity).

1) With Excel, open the file “In Class Activities 24 and 25.xlx”, which is posted in Canvas under the Paleoclimate module. Make two plots of productivity on the y-axis vs. age on the x-axis, one plot for the Loveley et al., 2017 data and one for the Martinez-Garcia et al., 2014 data. Plot only the data for the most recent 100 kyr. Format the plot according to your preferences but make sure to label your axes with their variables and units. Copy and paste the two plots below.

2) What are the units for each of the two productivity time series? What type of proxy data do they each use?

3) Looking at the most recent 100 kyr of each data set, when do productivity maxima occur? Is the temporal pattern the same between the two productivity time series?

Equatorial Pacific Maxima (2):

Southern Ocean Maxima (3):

4) Can you compare these productivity data sets to one another qualitatively? Can you compare them quantitatively? How do the data sets’ units inform your answer?

5) Make two scatter plots of dust and productivity (i.e., one plot for each of the two sites) over the most recent 100 kyr. Add a trendline to each plot and calculate the R-value (correlation coefficient) that describes the relationship between the two variables. Be sure to consider which is the dependent and independent variable so that your x and y axes are correct. Note: this is not asking you to create another time-series plot, here you are comparing productivity and dust. Format the plots according to your preferences but make sure to label your axes with their variables and units. Copy and paste the two plots below.

6) What is the R-value for the linear best fit line relating dust and productivity for the equatorial Pacific site? Is this a strong relationship? What does the sign of this relationship tell you?

7) What is the R-value for the linear regression relating dust and productivity for the Southern Ocean site? Is this a strong relationship? What does the sign of this relationship tell you?

8) Calculate and interpret the p-values for each of these two correlations. Is either one statistically significant?

9) Propose a hypothesis that might explain the relationships you found. How would you test that hypothesis? What type of experiment(s) could help you gather data to assess this hypothesis?

Part 2. Productivity and Climate

Thus far we have examined dust-driven iron fertilization at two sites in the global ocean: the equatorial Pacific and the Southern Ocean. Scientists have obtained a substantial body of data showing that glacial changes to the Southern Ocean were important in increasing the amount of carbon present in deep ocean bottom waters. Data show that deep waters formed in the Southern Ocean were more carbon-rich during glacial periods, reflecting both greater productivity in that region and lower upwelling of carbon-rich waters. In this part of the activity, you will choose a dataset among those included in the other spreadsheets of the Excel file to examine the consequences of this carbon “sequestration” for climate and the deep ocean.

Before choosing a dataset, refresh your memory (using the module slides or by asking Alex) as to what each of the proxies represents (benthic foraminifera oxygen isotopes (δ18O), authigenic uranium (aU), and Antarctic *p*CO2).

10) Write a hypothesis that you will test with your selected dataset.

11) Plot your chosen dataset alongside (separate plot or separate y-axis) the Southern Ocean productivity data (full 500 ka time series). Adjust the range of the x-axes so that they are appropriate for your comparison dataset (δ18O, aU, or *p*CO2). Note: If you choose the *p*CO2 data you will need to convert the time units from years to ka.

12) What, roughly, is the average periodicity of the data sets (time between one data maximum and the next)?

13) Examine the temporal relationship between your proxy and the Southern Ocean productivity dataset. Are the data sets in phase or out of phase?

14) What do your previous two answers suggest about the relationship between the two datasets?

15) What do your plots suggest about your hypothesis from question 10? What additional information might you need or want to investigate further?

Team up with partners who explored the other two datasets. Show your plots to your collaborators and explain your findings.

16) What are the temporal relationships between the four data sets (Southern Ocean productivity, δ18O, aU, or *p*CO2)? Comment on leads or lags between the data sets, relative rates of change, timing of minima and maxima.

17) How could you examine the relationships between these datasets? What kinds of issues might you need to resolve first?

18) What do the relationships you observed suggest about the interrelated nature of these datasets? Are any related? Do any appear unrelated? How might you test any apparent relationships, especially to see if they are causal or simply correlative?