

# Ocean physics and ecology: satellite and climate model data analysis

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## Introduction

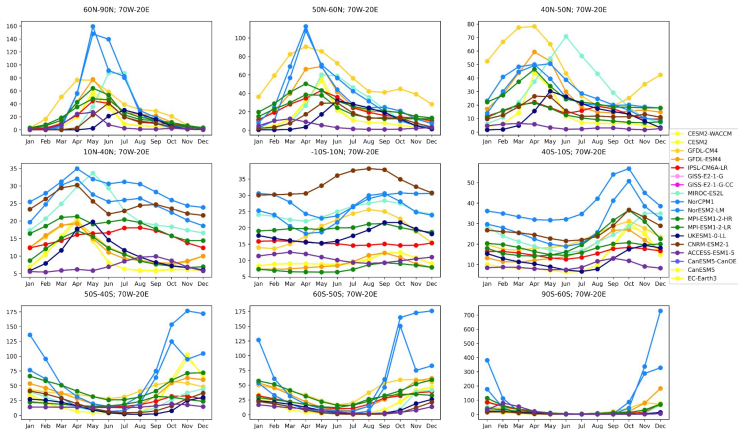
During the 10 weeks, we have worked on transitioning from the older CMIP5 models to the new CMIP6 models. To begin, we spent around a month alternating between reading about biogeochemical processes in the ocean and studying previously written code. Gaining a strong understanding of the research content as well as the methods of research was critical in helping us develop plots later in the summer that will assist in our understanding of the ecology of the ocean.

Our main research was focused on phytoplankton and their interactions with nutrients found in the ocean. Phytoplankton are critical as they account for around 50% of the total photosynthesis on Earth and our research aims to explore how their populations are affected by climate change.

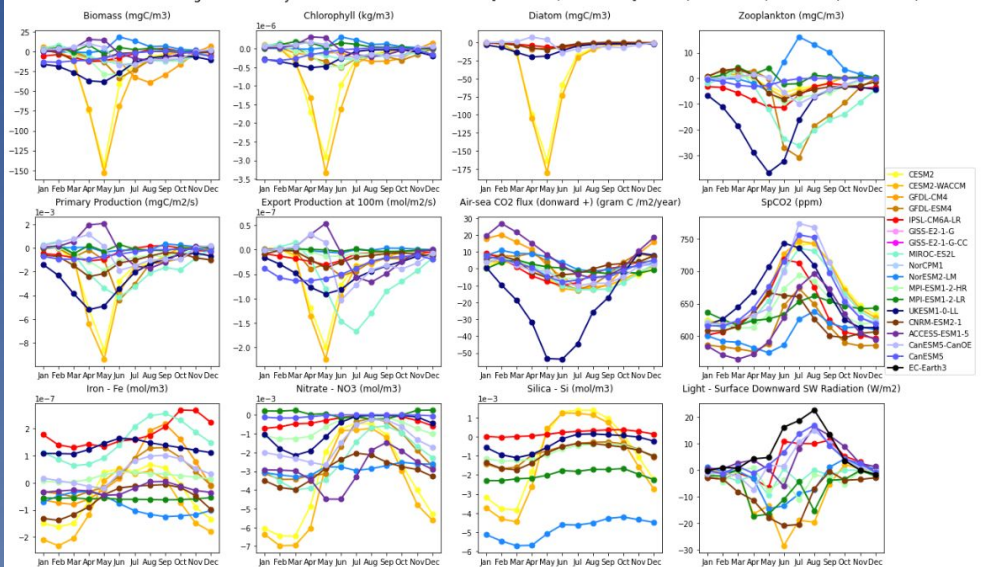
## Materials and Methods

The team primarily used Coupled Model Intercomparison Project Phase 6 (CMIP6) data along with the latest World Ocean Atlas Data (WOA 2018) to model variables in Python. The group used the period 1991-2010 for modelling the past and 2081-2100 for future models. The plot shown below is a model of phytoplankton biomass at different boxes in the Atlantic. We used 18 of the CMIP6 models for this plot in order to help understand possible errors and inaccuracies in specific models for when we do comparisons between different periods of time.

CMIP6 Model average seasonality for Atlantic phyc 1991-2010



CMIP6 Model average seasonality difference for North Atlantic [45N-50N, 25W-35W] Future(2081-2100) - Present(1991-2010)

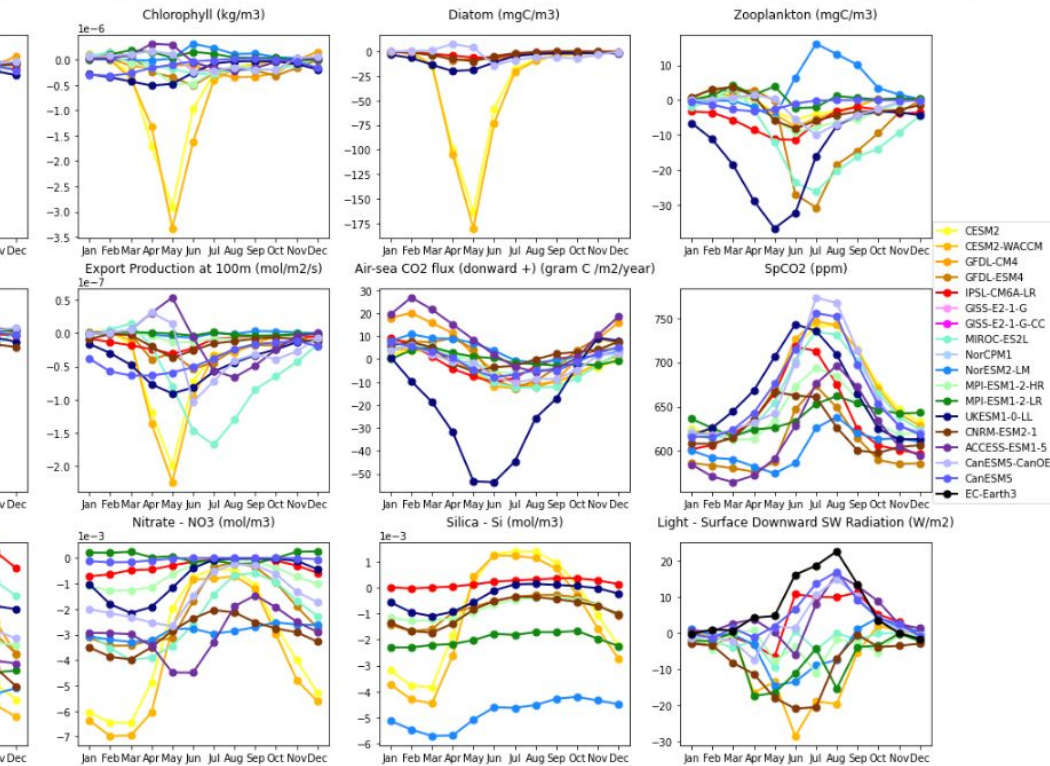


## Summary and Conclusions

From these plots, we are able to analyze present (1991-2010) ocean data and future climate model projections (2081-2100). In doing so, we were able to confirm the seasonal cycle of phytoplankton (biomass) and zooplankton. Zooplankton populations peak in the summer months after phytoplankton bloom in the spring- an expected result, as zooplankton graze on phytoplankton.

We also compared subpolar Atlantic and Pacific boxes. For the CESM2 subpolar box in the North Atlantic, we see that observed nitrate ( $\text{NO}_3$ ) is in the middle range of all modeled  $\text{NO}_3$  in winter and spring. In the summer, however, observed  $\text{NO}_3$  goes to zero, while model  $\text{NO}_3$  goes to zero in only half of the models. Biological uptake by phytoplankton is too weak in the summer in some models. On the other hand, at ocean station PAPA in the subpolar North East Pacific, the opposite is observed. In the summer,  $\text{NO}_3$  is higher in observations than in most models. In most models, phytoplankton growth is too high during the summertime at PAPA. This is explained by phytoplankton not being iron limited enough compared to reality. We can therefore deduce the iron cycle is not correct in most models here. Furthermore, we were able to study differences in present and future data. We found that across multiple models, phytoplankton populations and the nutrients they rely on (eg. nitrate) are projected to decrease. Phytoplankton are responsible for 50% of photosynthesis performed on Earth. Drops in phytoplankton population would affect climate on a global scale. Projections like these demonstrate the need to take action to prevent further climate change. In future plots, we are interested in studying various ratios such as grazing rate/primary production, biomass/chl ratios, zoopl/total biomass, and Si/ $\text{NO}_3$ . Understanding the relationship between such variables will ultimately allow us to draw further conclusions on future climate projections.

Seasonality difference for North Atlantic [45N-50N, 25W-35W] Future(2081-2100) - Present(1991-2010)



We compared subpolar Atlantic and Pacific boxes. For the CESM2 subpolar box in the North Atlantic, we see that observed nitrate (NO<sub>3</sub>) is in the middle range of all modeled NO<sub>3</sub> in winter and spring. In the summer, however, observed NO<sub>3</sub> goes to zero, while model NO<sub>3</sub> goes to zero in only half of the models. Biological uptake by phytoplankton is too weak in the summer in some models. On the other hand, at ocean station PAPA in the subpolar North East Pacific, the opposite is observed. In the summer, NO<sub>3</sub> is higher in observations than in most models. In most models, phytoplankton growth is too high during the summertime at PAPA. This is explained by phytoplankton not being iron limited enough compared to reality. We can therefore deduce the iron cycle is not correct in most models here.

# Title which simply addresses the nature of the research presented in the poster

Names of those who were involved with this body of work

Contact information provided here to reach the authors of this body of research

## Things to Keep in Mind

- The poster is supposed to be a snapshot of months (or years) worth of research, data collection, analysis, etc. Don't try to put every detail on one page!
- Pull out the main components of research, including charts, images, slides, graphs or whatever it is you need to really get the main point(s) across to the reader.
- Cramping the poster full of text does 2 things:
  - 1- Makes people skip over your hard work
  - 2- Slows down the ability for those engaged in your work to access the main points, and understand the research quickly



18 Font Text for Captions of Images/Charts/Graphs/Etc.

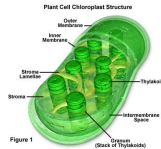
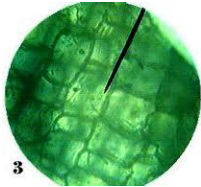


Figure 1

## Formatting

- USING ONLY CAPITAL LETTERS MAKES READING DIFFICULT
- High contrasting colors are better and easier to follow
- Consistency in Font, text size for headings, body, captions, etc.
- Stick with a non-serif based fonts (i.e. Arial)
- Organize information moving from top to bottom, across the columns in your poster.



3

Using a caption to describe an image can be more productive than a paragraph.

## Images

- Try to use images with a resolution of 150 dpi
- Do not use screen shot images (if possible) in the poster, they tend to be fuzzy when printed at poster size
- When putting images into a poster, please don't copy and paste! Instead, go to **Insert>Photo>Picture From File** this will help you to manage this document easier without slowing it down
- There are no logos in this template. If you want to add a Penn, CHOP, PennMedicine, PennVet, Upenn's Shield, etc. logo please ask us to add it when you visit the Poster Printing Lab!

## Logos

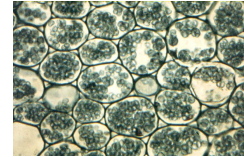
- We want to ensure that your poster receives the right type of logo image file to produce a high resolution, high quality print.

## PowerPoint to PDF

- To save this document as a PDF, go to **File>Print**. At the bottom left hand corner, there is a button, **"PDF"** — click on this button and scroll to: **"Save as PDF..."**
- Open your PDF after creating the file to make sure the poster is not cut off. If it is, go to: **File>Print**, **"Page Setup"** and click the button above the **"PDF"** button. Check to see that the size and orientation are the same as the poster you have been working on.
- Even if you have already made your PDF document before coming to your appointment, it is always good to bring the PowerPoint file as a backup in case there are any issues.

## Fluorescent Colors

- Be aware that fluorescent colors will print darker than they seem in your document.
- If you really need an image to stand out, avoid fluorescent colors (Dark Blue, Dark Purple on Black) because the details may not show up as you need them to appear.



## Before Coming In

- Schedule an appointment online with us at: <http://www.library.upenn.edu/forms/biomed/posterprinting.html>
- Make sure your appointment is scheduled with enough time ahead of your deadline!
- Bring your method of payment; we accept VISA, Mastercard, PennCash, Departmental Copy Cards and Departmental Account Numbers.  
**\*\*\*We DO NOT accept cash.\*\*\***
- Don't forget your poster! Bring a backup method as well in case your file will not open (USB, CD, External Hard Drives, email to yourself, etc.)
- Most Importantly!!  
Be aware that as this time, we do NOT offer any sort of design services for your poster. Come prepared with the document you wish to print, we are glad to help with any minor details ☺
- Check, check, check! to make sure you have caught all errors, typos, formatting issues, stray lines/objects/text, etc. in your document BEFORE coming to your appointment. It will save you time (and a headache)!
- Try to use colors, font and text sizes that allow the reader to easily move through the work. This, for example:

## Basic Print Tips

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a logo!

# Name of the project

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## Names and contact info of contributing persons

### Abstract

- This poster template will scale up to 42 inches by 48 inches. 42 inches is the widest we can print on one side. (Longer formats are possible, but the template needs adjustment.)
- To use this template, simply replace the text in these sections. Download template and insert your content.

### Background

- This template contains some style and format suggestions.
- We recommend the white background for clarity and simplicity, but you can easily change the background by right clicking on the slide and going to the option that says “format background”.
- Note that for big chunks of text, a sans-serif font is easier to read. This font is Calibri.
- When writing for a poster, simplify everything and avoid over-writing.
- The best posters are designed with *empathy*: Put yourself in the position of the audience and think about what they will want to know.

### Results

- Avoid images from the web. They are low resolution and become “pixilated” on enlargement.
- Figures can be produced directly in PowerPoint or imported from other programs, like Excel..
- Graphs produced in scientific graphic programs should be saved in jpeg or tiff format before inserting.

#### Sample table:

	Intervention	Control	P
Age (sd)	52 (6.8)	53 (7.0)	0.23
% Male	34	33	0.32
C	28	25	0.12
D	10	17	0.02
E	12	15	0.74
F	72	70	0.54

#### Sample graph

### Methods

- Emphasize points with *italics* or in **boldface**.
- Underlining is less attractive and can be distracting.
- Less is often more. Make effective use of negative space.
- Figures can be produced directly in PowerPoint or imported from other programs.
- Imported figures and photographs often work well if saved in jpeg format. A grey border can soften a photograph’s visual impression in the poster.
- Avoid “chart junk” and unnecessary ink in creating charts.
- For example, avoid three dimensional bar graphs or pie charts when presenting two dimensional data.

### Implications

- A few take-aways or next steps can help position your presentation or make your points more enduring.
- Depending upon your goals, you might come with a stack of business cards, copies of your abstract, or even copies of a completed manuscript to give away to interested parties. Attach them to your poster in the bottom right or make them available in other ways.
- If you have suggestions for improving this template or this process, please let us know.

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## Names and contact info of the contributing persons

### Abstract

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- To use this template, simply replace the text in these sections
- Download template and insert your content.

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#### ▪ Sample table:

	Intervention	Control	P
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C	28	25	0.12
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### Methods

- Emphasize points with *italics* or in **boldface**.
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- Less is often more. Make effective use of negative space.
- Avoid harsh contrasting colors that create visual vibration.

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