Argovis: A Next Generation Platform for co-located Oceanic and Atmospheric Data to Accelerate Climate Science and Education

Donata Giglio
Bill Mills, Megan Scanderbeg, Sarah Purkey, Susan Anil, Tyler Tucker

Collaborators: Sam Shen, Julien Pierret, Lynne Talley, Gui Castelao, Matt Mazloff, Aneesh Subramanian, Steve Diggs, Lynne Merchant, Andrew Barna, Giovanni Seijo-Ellis

URL: argovis.colorado.edu
Twitter: ArgovisWebApp, @ArgovisCU
Contact: donata.giglio@colorado.edu

University of Colorado Boulder

Outline

- What is Argovis?
- Examples of educational activities using
  - Argovis API
  - Argovis web interface
- Summary

Argovis is a web app and database

The **goal**: make it easy for anyone (both scientists and non-scientists) to visualize and access co-located datasets using a browser or not

What data are available

- Argo profiles*, curated set
- Gridded Argo data**
- Weather events, e.g. ***
- SOSE sea ice coverage
- Float trajectory forecasts by Chamberlain et al.
- … *more to come in 2022!*

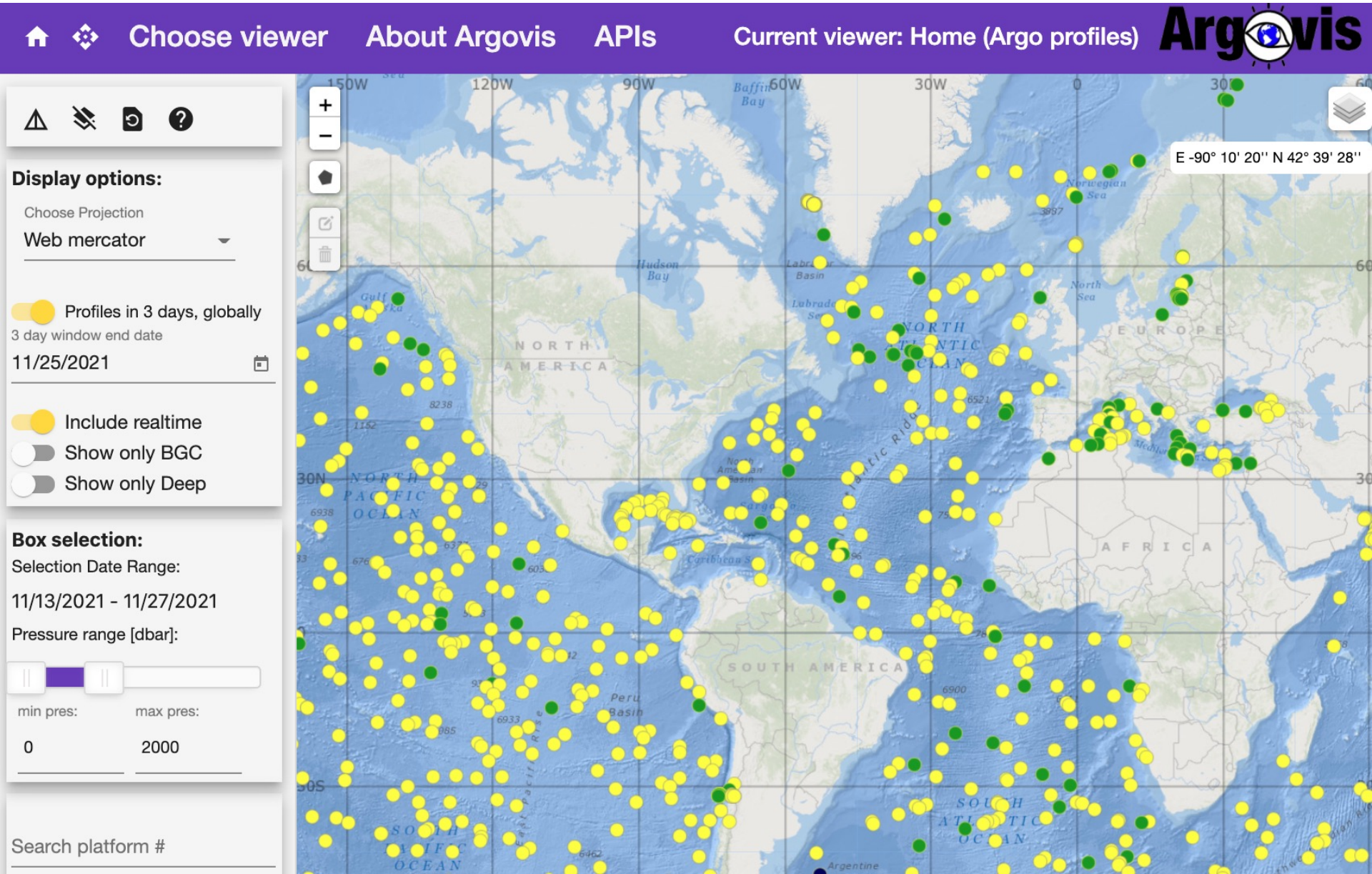
* http://doi.org/10.17882/42182 ** Roemmich and Gilson, 2009 *** Guan and Waliser, 2015

How to access and visualize data

- Visiting Argovis web pages at argovis.colorado.edu

Tucker, T., D. Giglio, M. Scanderbeg, and S.S. Shen, 2020: *Argovis: A Web Application for Fast Delivery, Visualization, and Analysis of Argo Data*. J. Atmos. Oceanic Technol., 37, 401–416, https://doi.org/10.1175/JTECH-D-19-0041.1

Profiles globally: a 3-day window



Toggle to show/hide profiles in a 3-day window, globally.

Select end date for the 3-day window.

Argovis

Choose viewer | About Argovis | APIs | Current viewer: Home (Argo profiles) | Argovis

Display options:

Choose Projection

Web mercator

Profiles in 3 days, globally

3 day window end date

11/25/2021

Include realtime

Show only BGC

Show only Deep

Box selection:

Selection Date Range:

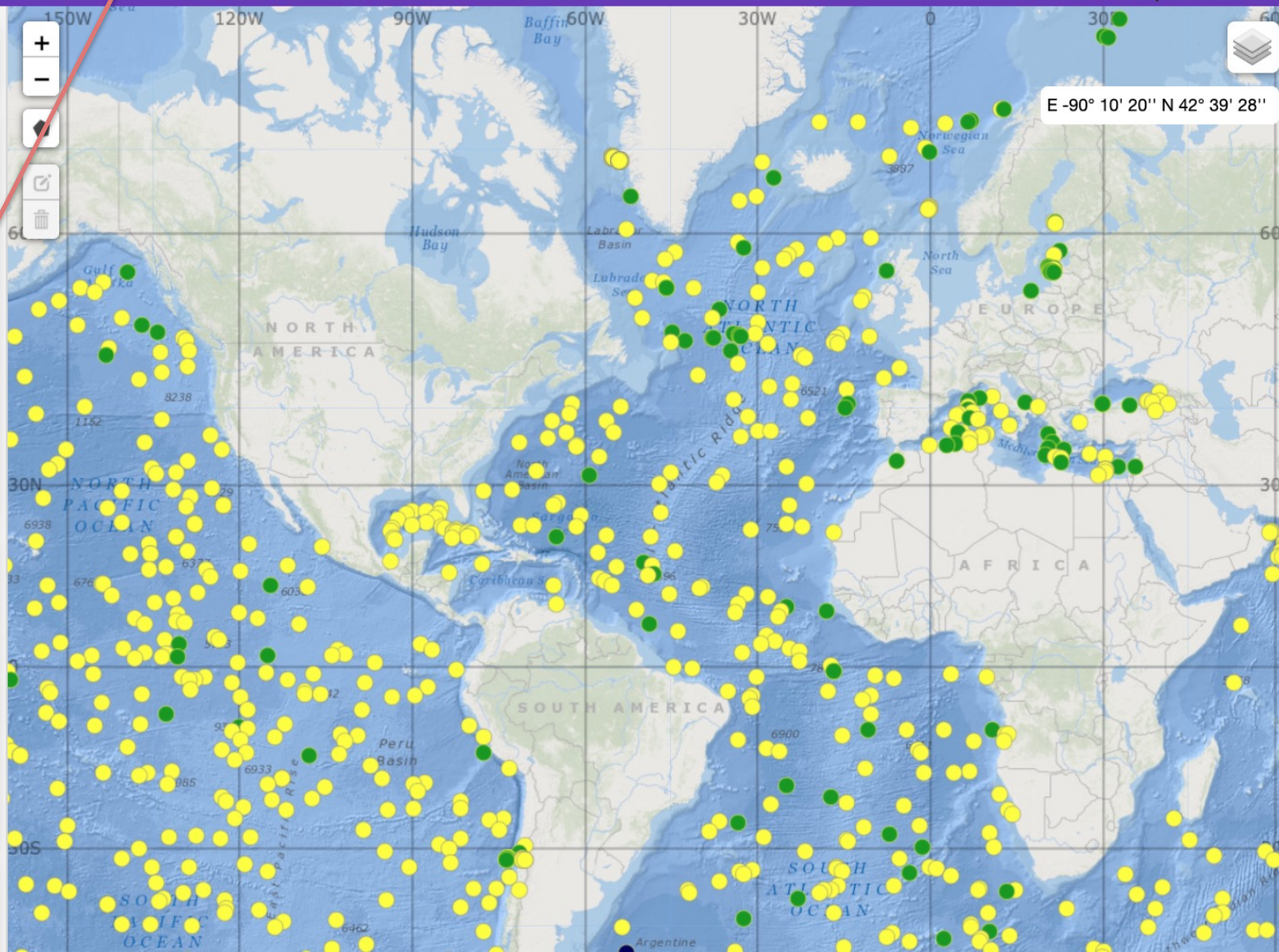
11/13/2021 - 11/27/2021

Pressure range [dbar]:

min pres: 0

max pres: 2000

Search platform #



How to access and visualize data

- Visiting Argovis web pages at argovis.colorado.edu
  - browse previous presentations and slides for available features
  - stay tuned for more features in 2022!

- Querying data (via API) from a programming environment of choice

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Interactive Jupyter notebook for hydrographic ocean data exploration, retrieval and visualization via the Argovis API

Authors: Susanna Anil, Steve Diggs, Sarah Purkey, Donata Giglio, Megan Scanderbeg, Tyler Tucker

This notebook allows for a deeper look at the latest ocean data to explore scientific questions to better understand the Earth's climate.

By utilizing programming interfaces, like Jupyter notebooks, we aim to enhance students understanding of oceanography and coding fundamentals with interactive examples to explore our natural world through data, programming and visualization.

Choose an interface:

Web interface

API

What education modules are available using the Argovis API?

This page features the available education modules that access the Argovis data via API, and usually, plot the returned data.

Please check out the media page for presentation slides on some of the educational modules listed below. Also, please visit the API pages to find exmaple scripts to access the Argovis database via API.

For Juptyer Notebooks, click on launch binder to prepare the Notebook in your browser. It may take a few moments to load. When it has loaded, click on the file ending in '.ipynb' to launch the Python Notebook.

To understand what levels the education modules are aimed at, please use this legend:
■ high school ● undergraduate ▲ graduate

Jupyter Notebook to plot Argo profile data from Argovis via API

● **Authors:** Susanna Anil, Steve Diggs, Sarah Purkey, Donata Giglio, Megan Scanderbeg, Tyler Tucker

Description: This Notebook introduces basic oceanography concepts and some basic programming concepts. Users access Argo profiles in a selected region and time. The profiles are then properly formatted, and their locations are plotted on a map. In addition, all profiles are plotted and users can choose plot axes for comparison of different parameters.

Access to Notebook

Link to introductory slides:

Juptyer Notebook to plot path of Tropical Cyclones and nearby Argo floats via API

● **Authors:** Giovanni Seijo-Ellis, Donata Giglio, Sarah Purkey, Megan Scanderbeg, Tyler Tucker

Description: This Notebook introduces students to tropical cyclones, sea-ice and Argo datasets to explore air-sea interactions. Students co-locate the datasets with Argo profiles to explore different aspects of the climate system: ocean

Choose an interface:

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Access to Notebook

You can run the notebook on the browser: no need to install anything!

Link to introductory slides:

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Interactive Jupyter notebook for hydrographic ocean data exploration, retrieval and visualization via the Argovis API

Learning Objectives

1. Apply a structured approach to answer scientific questions about our natural world through data
2. Apply coding skills to access oceanographic data from state-of-the-art platforms
3. Produce graphs to visualize the data
4. Describe graphs of the data and what information we can extract from them

Learning Objective #2
Load ocean profile data for the region of interest

```
: #replace the following variables
startDate='2020-3-10'
endDate='2020-4-29'
presRange ='[0,500]'
shape = gulf_coords

# do not change code below
strShape = str(shape).replace(' ', '')
selectionProfiles = get_selection_profiles_loop(startDate, endDate, strShape, presRange)
selectionProfiles;
```

Users select:

- Start and end date
- Pressure range
- Region to examine

Some preset regions >

```
#options for regions to examine
south_coords = [[[-149.238281,-36.456636],[-141.879737,-37.077133],[-134.445218,-37.237608],
                 [-127.024817,-36.93345],[-119.707031,-36.173357],[-120.058594,-59.977005],
                 [-127.546527,-60.582449],[-135.216859,-60.756782],[-142.865732,-60.492308],
                 [-150.292969,-59.800634],[-149.238281,-36.456636]]]
gulf_coords = [[[-94.35249,27.365753],[-97.097603,24.402577],[-93.332877,20.489146],
                [-87.124507,22.099636],[-80.783791,23.47067],[-86.195584,29.161741],
                [-94.35249,27.365753]]]
pacific_coords = [[[164.355469,29.840644],[164.882812,-29.840644],[172.623113,-29.990522],
                   [-180,-29.701812],[-180,-29.701812],[-179.648438,-29.688053],
                   [179.648437,29.688053],[172.007811,29.985384],[164.355469,29.840644]]]
atlantic_coords = [[[-40.078125,29.840644],[-33.368671,30.338837],[-26.614528,30.492027],
                    [-19.863281,30.297018],[-20.039063,-30.145127],[-26.724822,-30.384017],
                    [-33.419918,-30.281826],[-40.078125,-29.840644],[-40.078125,29.840644]]]
labrador_coords = [[[-144.84375,36.031332],[-136.038755,36.210925],[-127.265625,35.746512],
                    [-128.144531,22.755921],[-136.543795,24.835311],[-145.195313,26.431228],
                    [-144.84375,36.031332]]]
```

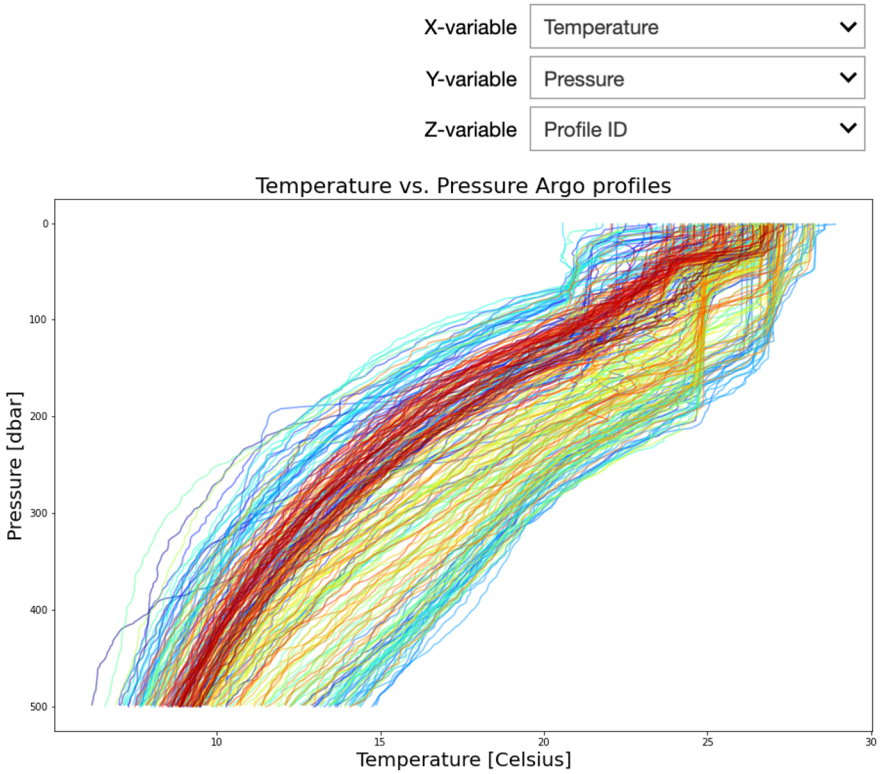
Guiding questions:

1. **Describe your study region. Would you best describe your region as polar, subpolar, or tropical?**
2. **What is a mixed-layer? Would you expect shallow or deep mixed-layers in your study region?**

Learning Objective #3, #4
Example: Plot property vs property using widgets

Users select:

- X-variable: temperature, pressure, or salinity
- Y-variable: pressure, temperature, salinity, longitude or latitude
- Z-variable (what to group the variables by): profile ID, day, year or month

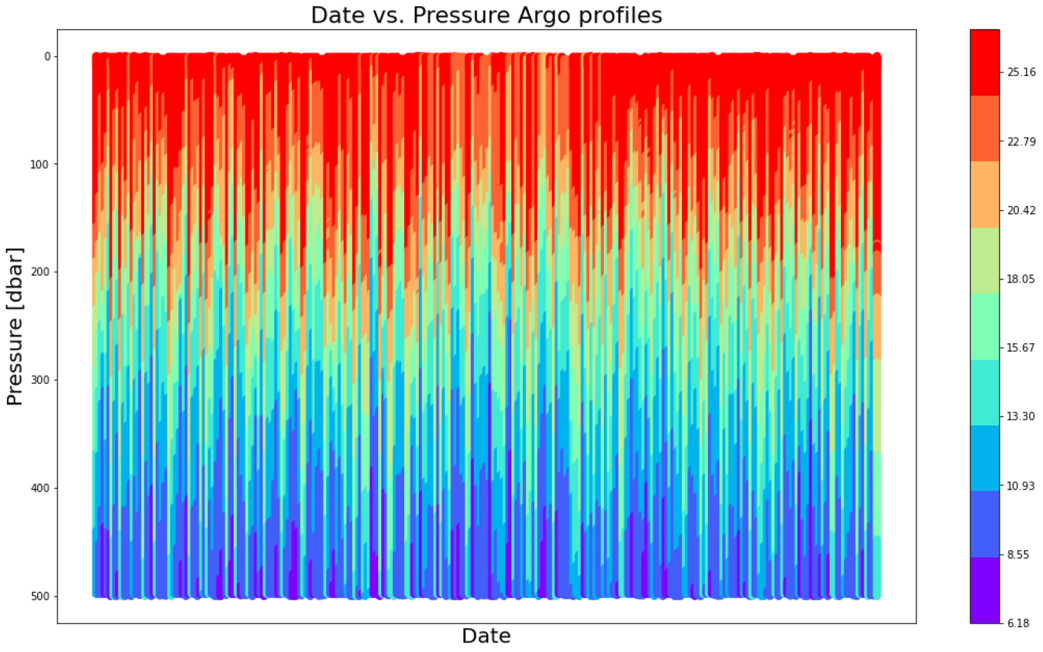


Guiding questions:

1. **With the property plot function, plot temperature vs pressure. What is the mixed layer depth? Does it vary in time? If so, how?**
2. **Now plot salinity vs pressure, do any of your above answers change. Why or why not?**

Learning Objective #3, #4

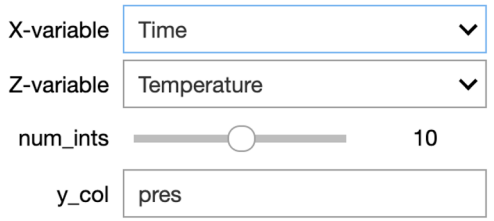
Example: plot temporal variability of subsurface data



Users select:

- X-variable: time, longitude, or latitude
- Z-variable: temperature or salinity
- Number of intervals

Y-variable is set as pressure



Guiding questions:

1. **Do properties vary in time in the subsurface?**
2. **Now, pick a different region in the ocean and answer again all the questions. How is this region different or the same?**

Interactive Jupyter notebook for hydrographic ocean data exploration, retrieval and visualization via the Argovis API

This interactive notebook features:

- Easy to understand parameter modifications suitable for beginner to intermediate Python programmers
- Widgets for user-specifications and instant replotting of features
- Engaging discussion questions to help interpret the content produced by graphs

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Exploring the evolution of the mixed layer depth using the Argovis web interface

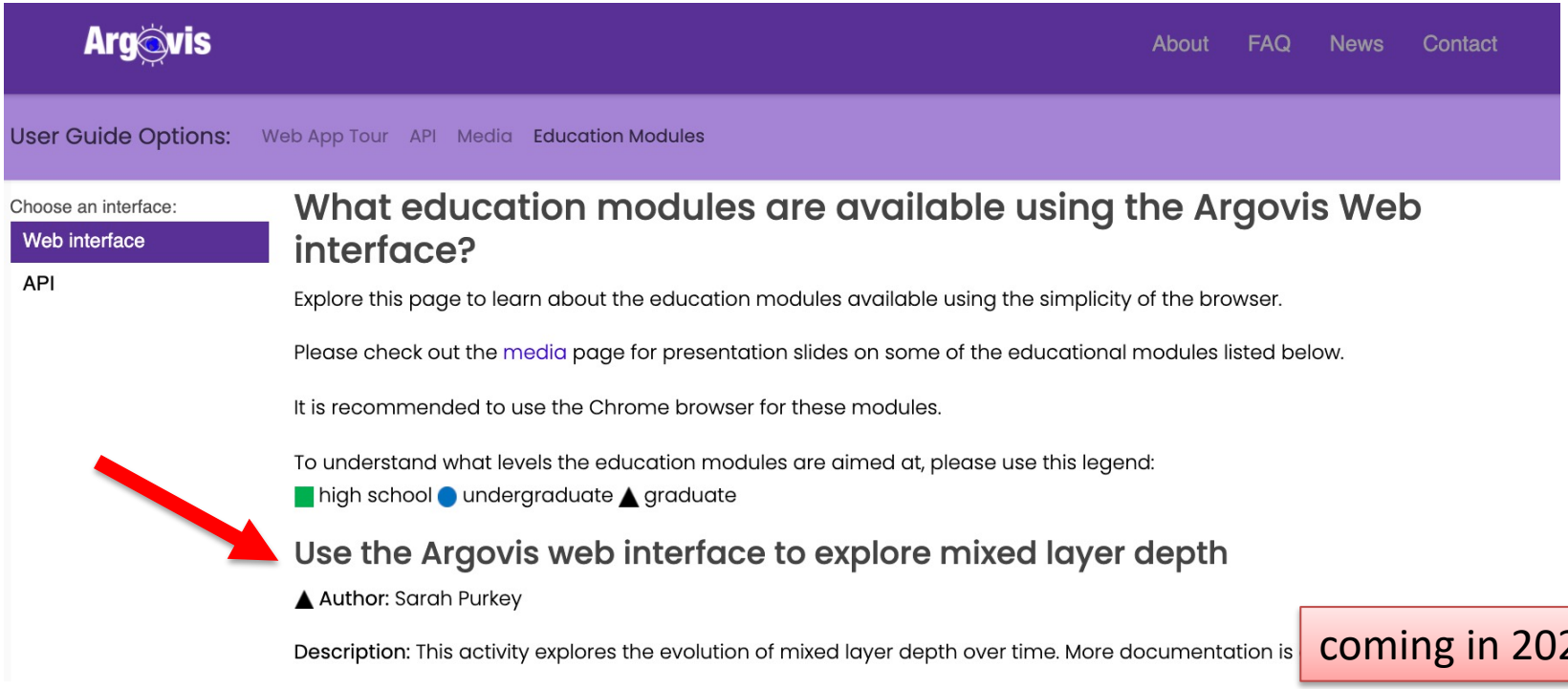
Author: Sarah Purkey

Learning Objectives

1. Identify the mixed layer, thermocline, thermostad, halocline, minimum and maximum in ocean profiles.
2. Describe the variability in mixed layer depth and properties

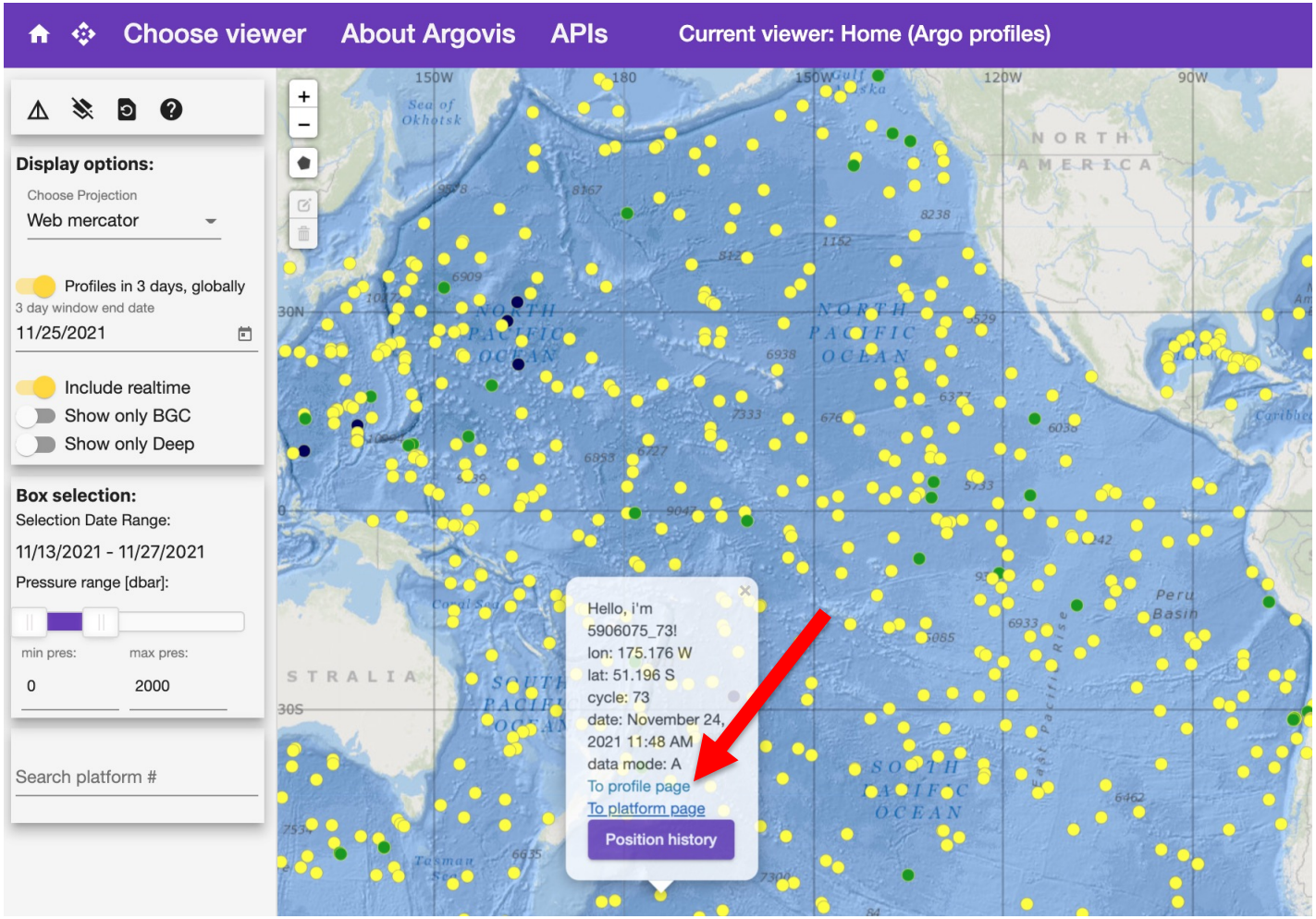
Exploring the evolution of the mixed layer depth using the Argovis web interface

Author: Sarah Purkey



Learning Objective #1

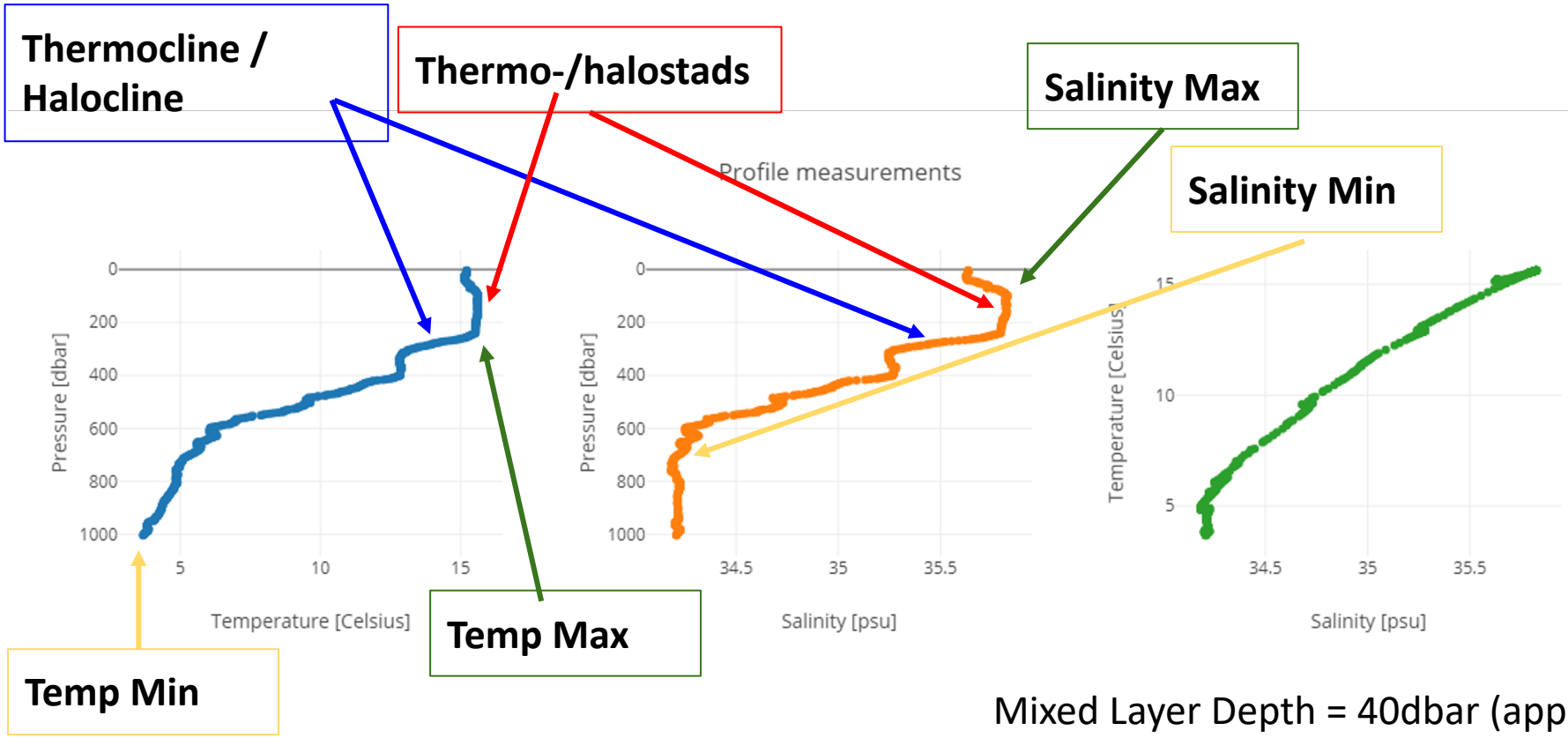
Visit
argovis.colorado.edu



Guiding question:

1. **Click through a few dots and look at the profile page. Identify the mixed layer, thermocline, thermostad, halocline, minimum and maximum in ocean profiles.**

Learning Objective #1
Ocean structures and vocabulary



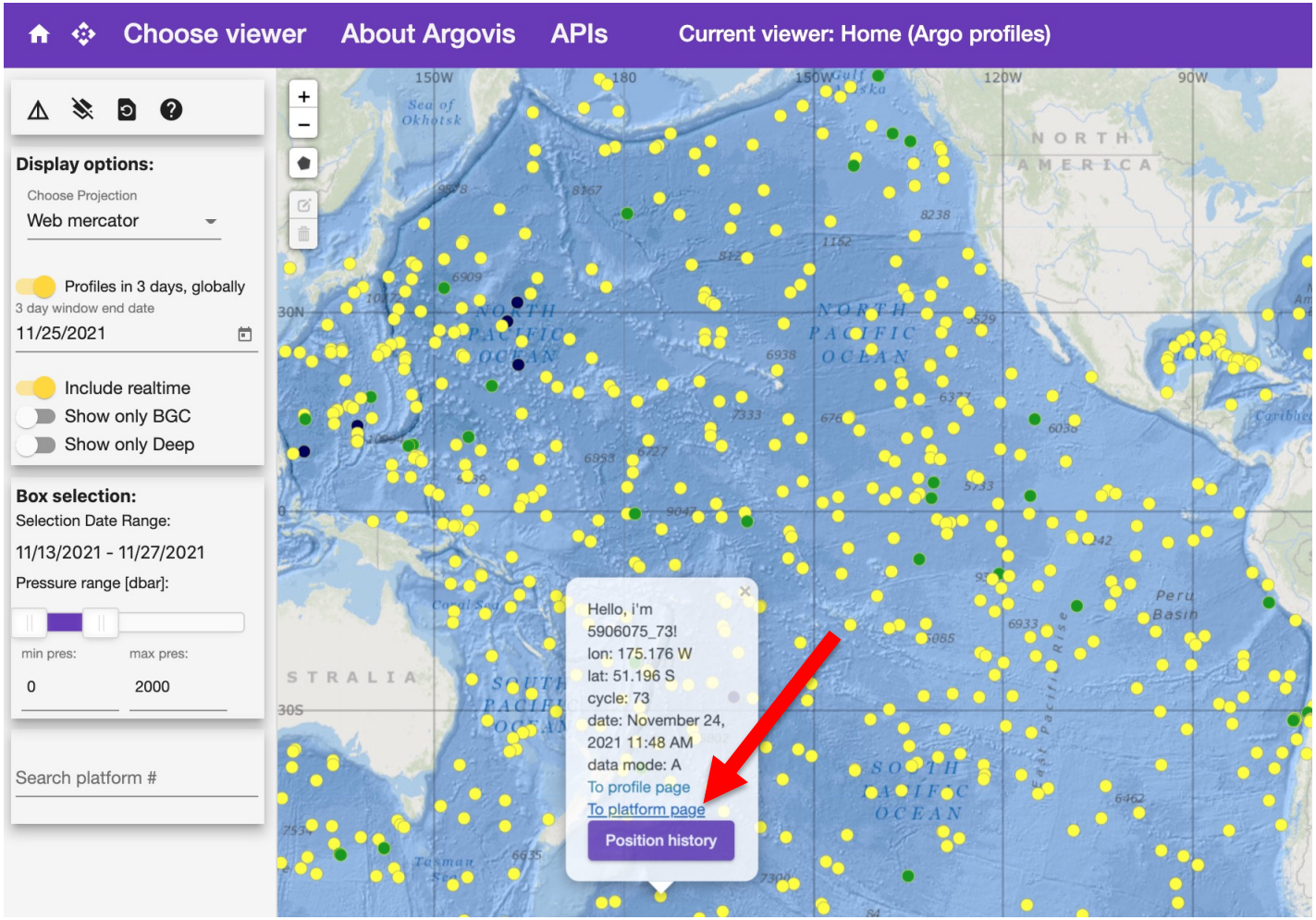
Mixed Layer Depth = 40dbar (approx)
Temperature (avg) = 15 degC
Salinity (avg) = 35.6psu

Guiding question:

1. **Click through a few dots and look at the profile page. Identify the mixed layer, thermocline, thermostad, halocline, minimum and maximum in ocean profiles.**

Learning Objective #2

Visit
argovis.colorado.edu

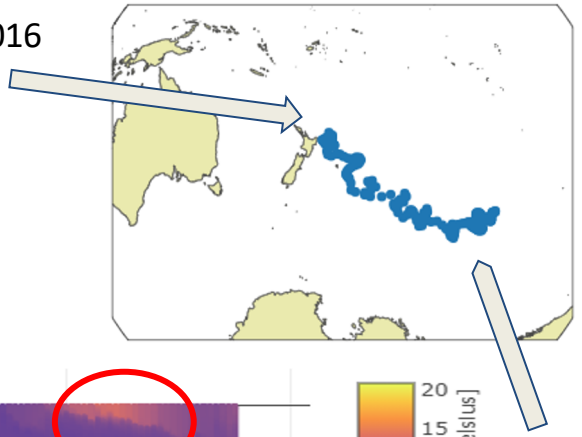


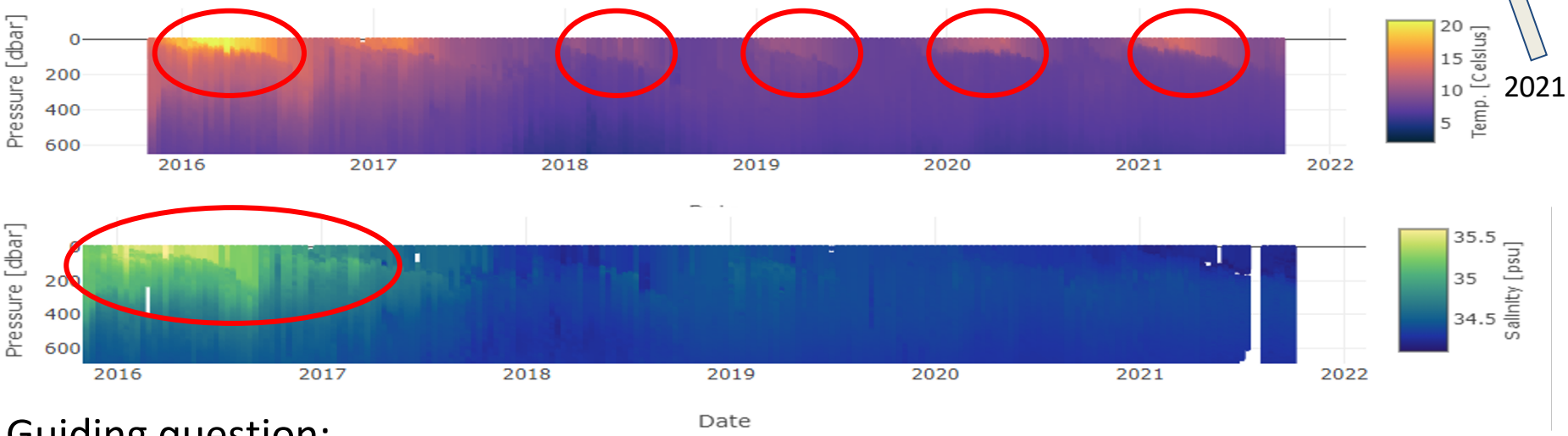
Guiding question:

1. **Click through a few floats and look at the platform page. Zoom in to the upper 500 m of the salinity and temperature plots. Can you identify variability in the mixed layer depth? You may need to look at a few floats to find a good example.**

Learning Objective #2

Explore spatial and seasonal temporal variability in the temperature and salinity profiles measured by the floats in different oceanographic regimes.





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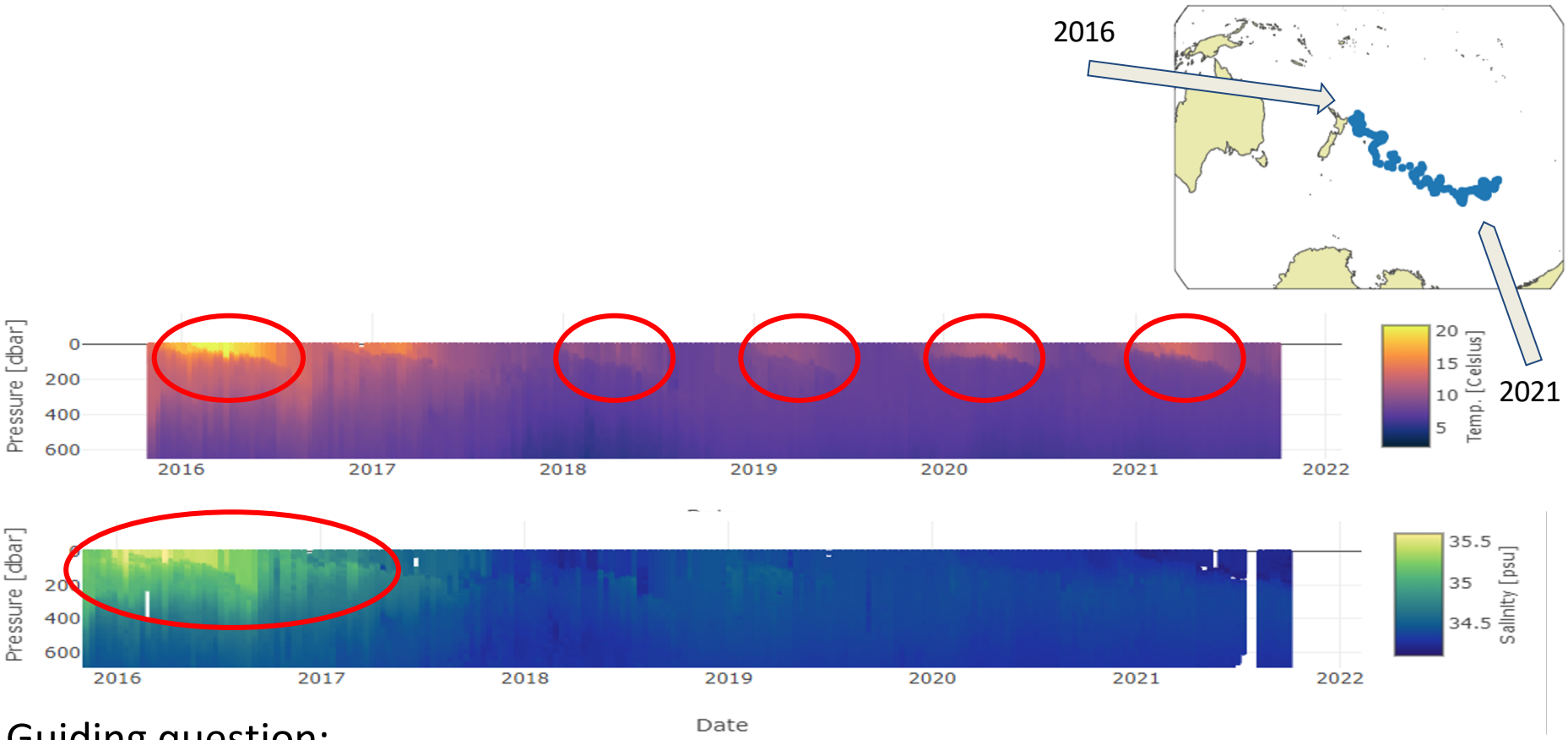
Learning Objective #2



Guiding question:

2. **Can you describe what is happening? Does the variability in the mixed layer depth correlate to a temporal variability or spatial (look at float position by cycle number on profile page and note the date of the profile)?**

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    - Clicker question: an example relevant for ocean currents
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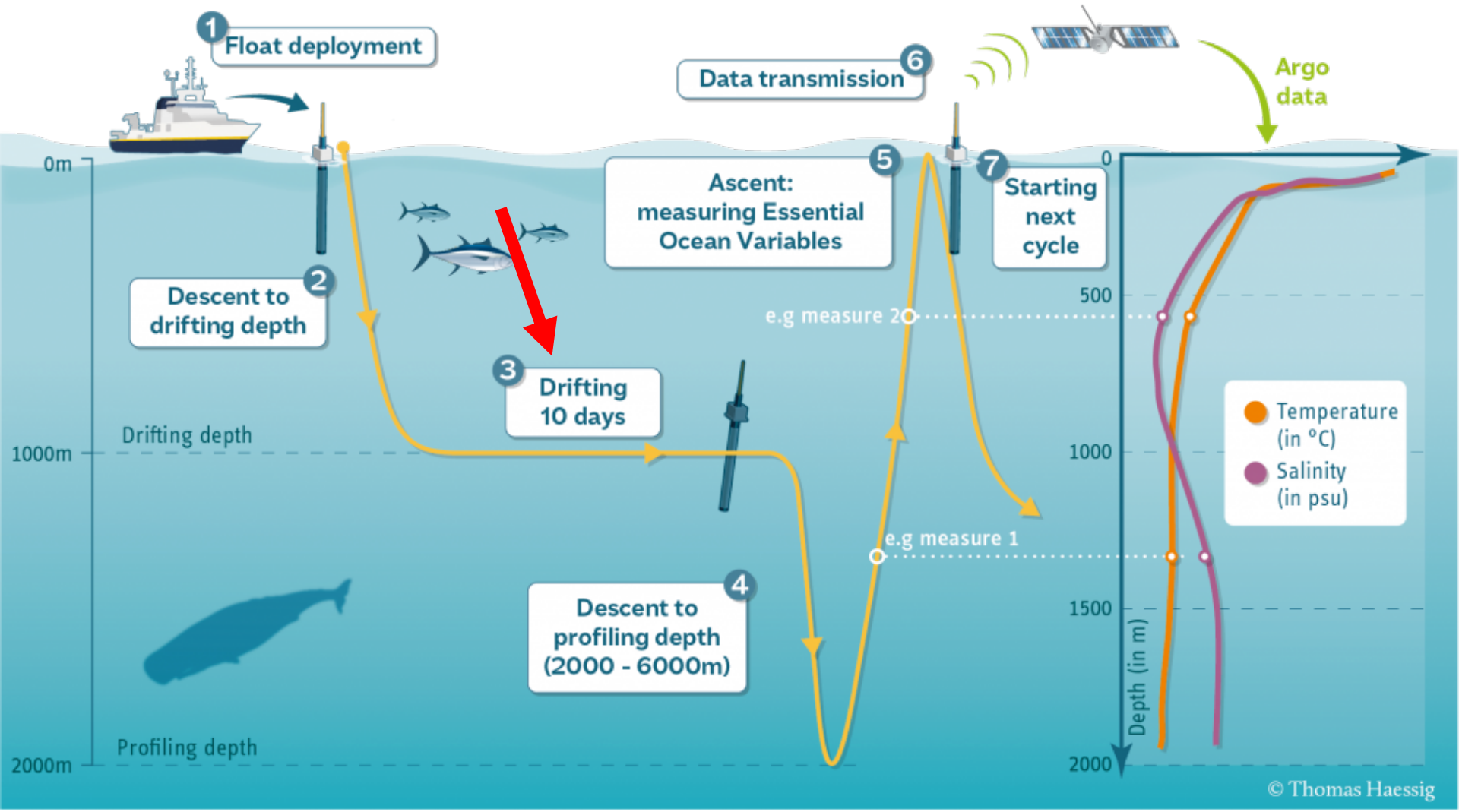
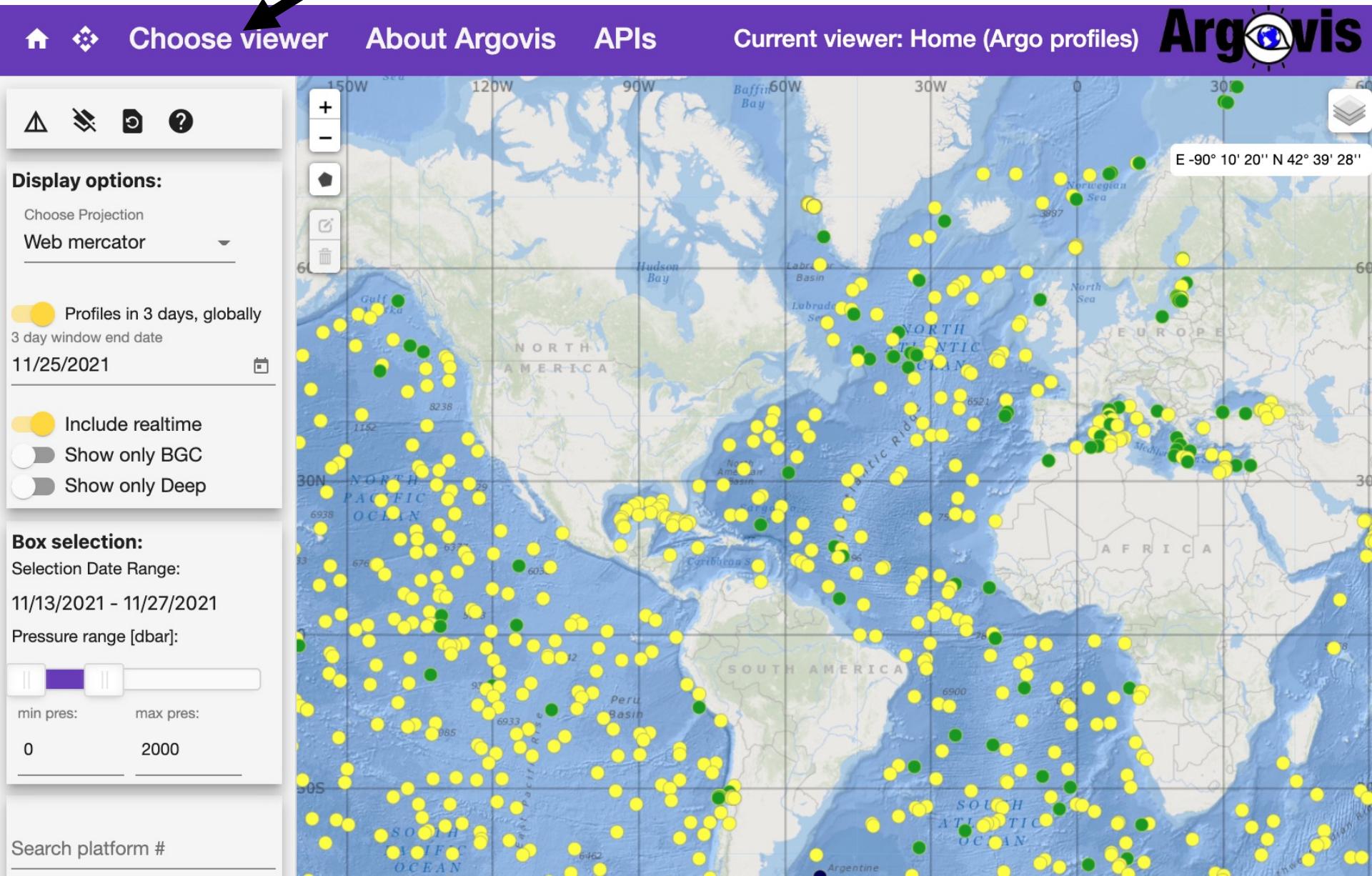
Argovis

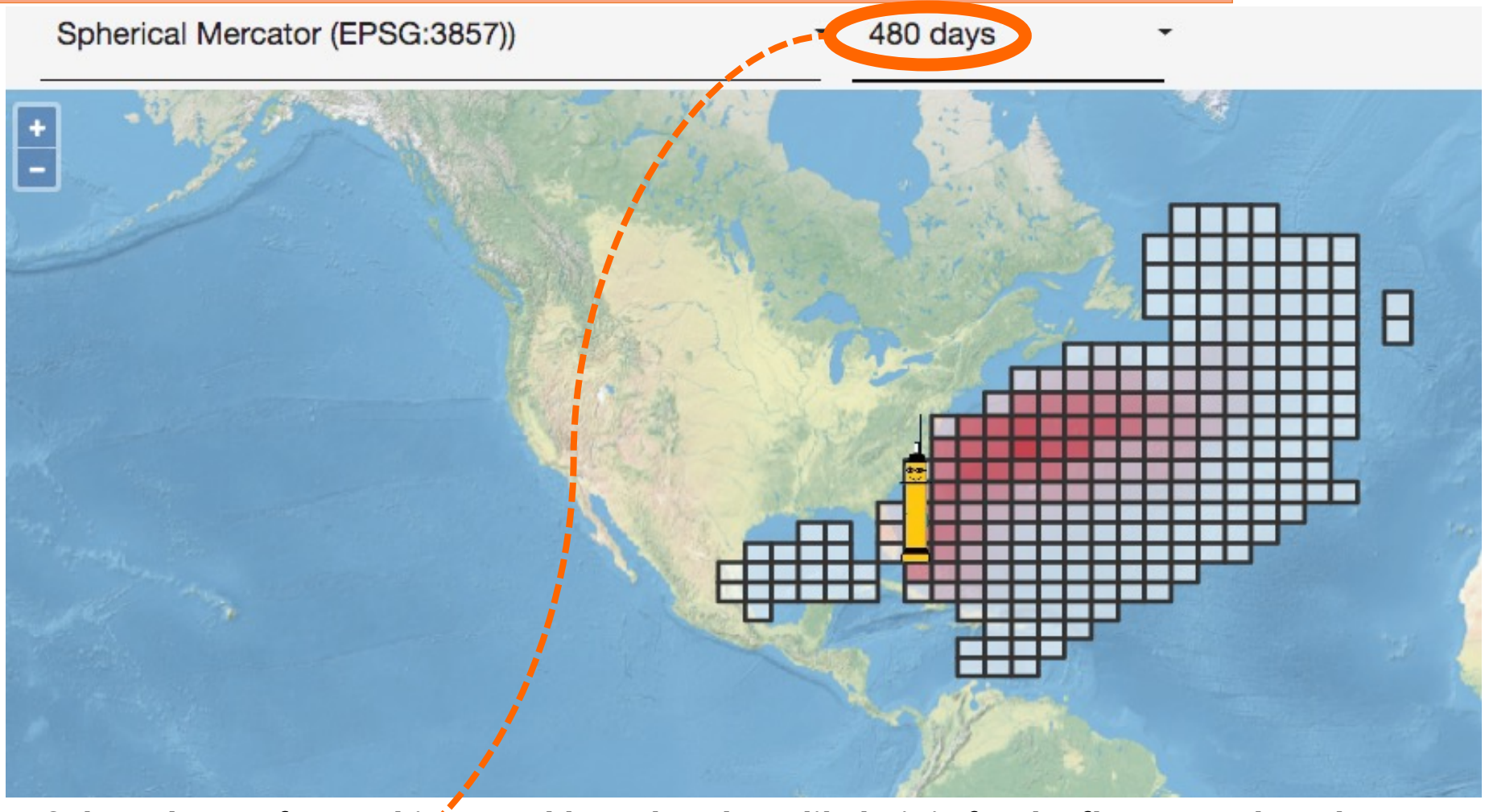
Argo floats move with ocean currents at ~1000m.



Visit the Argovis web app at argovis.colorado.edu
Click on "Choose viewer", then "Float Trajectory Forecast"

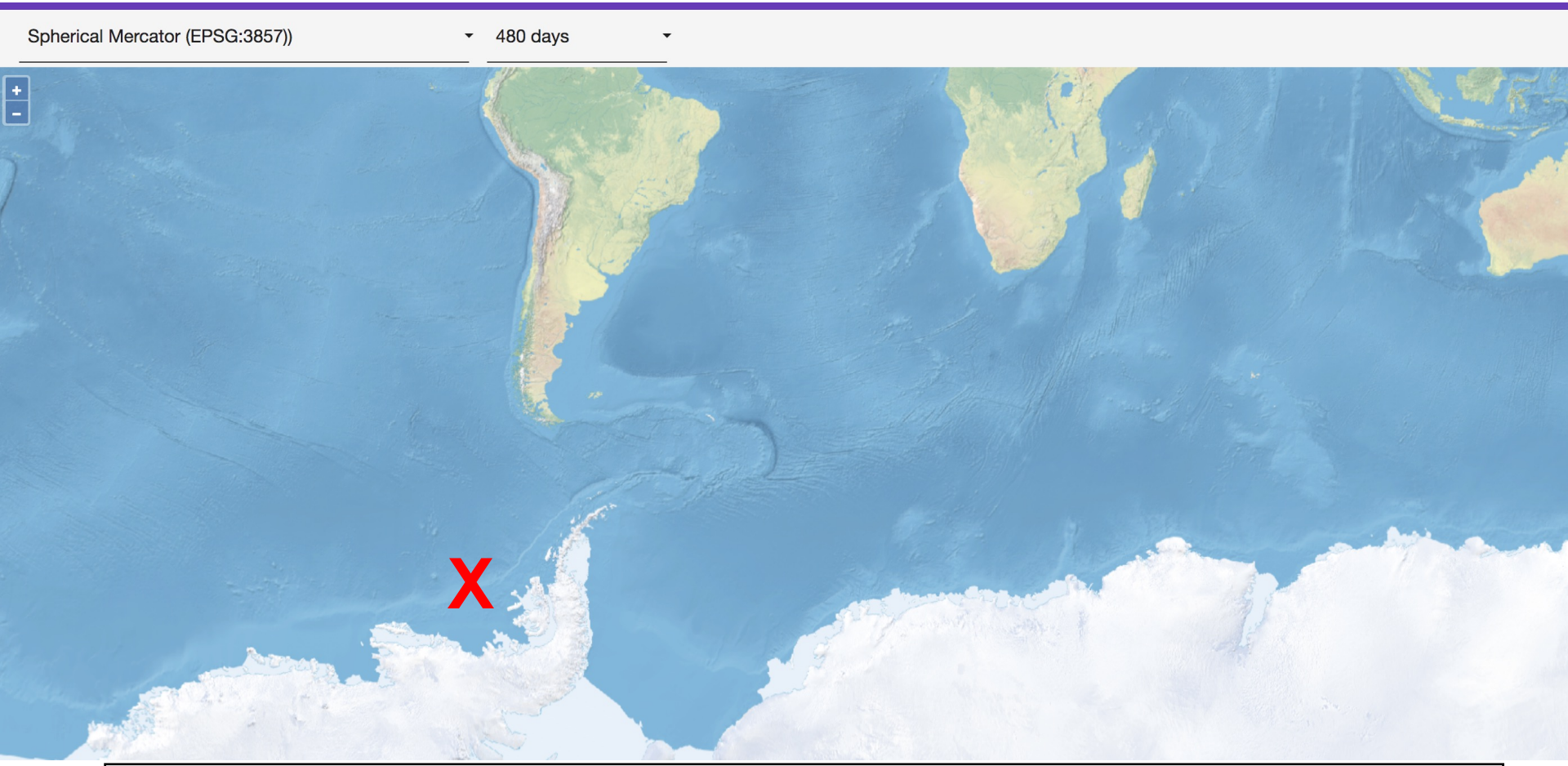


Visit the Argovis web app at argovis.colorado.edu
Click on "Choose viewer", then "Float Trajectory Forecast", then click on the map (anywhere in the ocean)



Colors change from white to red based on how likely it is for the float to end up there after 480 days. Red is more likely.

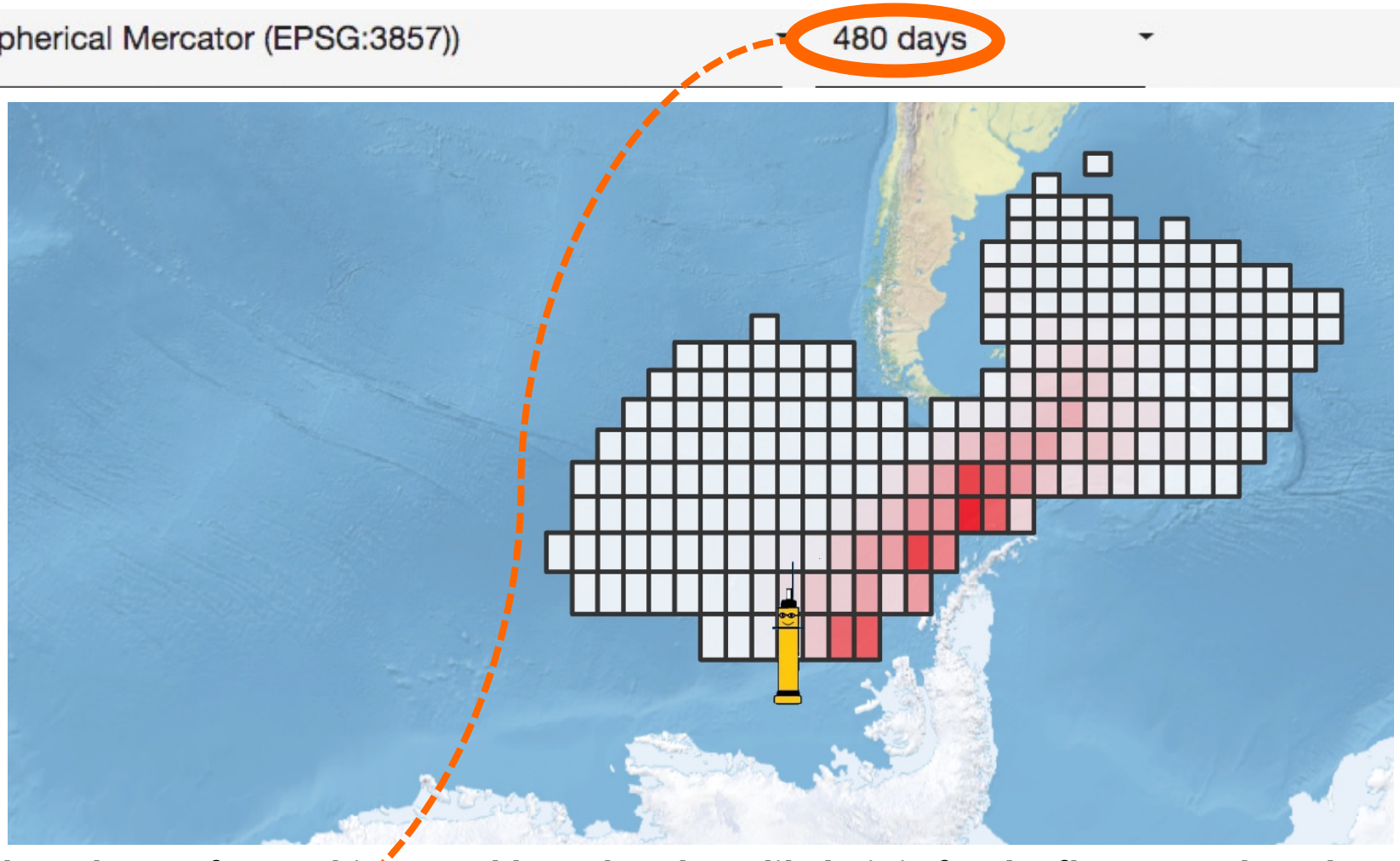
Visit the Argovis web app at argovis.colorado.edu
Click on "Choose viewer", then "Float Trajectory Forecast"



Question: If a float is deployed at the location of the red cross, where is it more likely to end up after 480 days?

A North-West **B** North **C** North-East **D** South

Visit the Argovis web app at argovis.colorado.edu
Click on "Choose viewer", then "Float Trajectory Forecast"



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Summary

- Argovis can be used for research, outreach, and educational activities
- Educational activities are available at https://argovis.colorado.edu/docs/Argovis_EdModule.html
- A user guide is available on the website at https://argovis.colorado.edu/docs/Argovis_User_Guide.html
- Stay tuned for more datasets and activities!
- User guide and educational activities will be upgraded with the new release of Argovis (in 2022)
- Please reach out if you have any questions! https://argovis.colorado.edu/docs/Argovis_About.html#contact