Regional MOM6 in CESM:

Progress, ongoing work, next steps

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Accelerate regional ocean + carbon cycle + Earth system model setup

Make **data assimilation** radically easier + useful for model tuning

Build a **broad** and **sustainable community** around these tools

After ~18 months, a growing collaboration!

NCAR

Cornell University

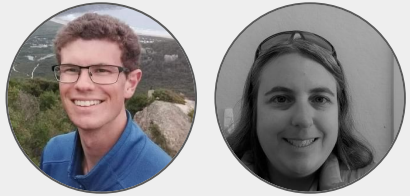
Recinto Universitario de Mayagüez

Woods Hole Oceanographic Institution

University of Colorado

Australian National University

COSIMA

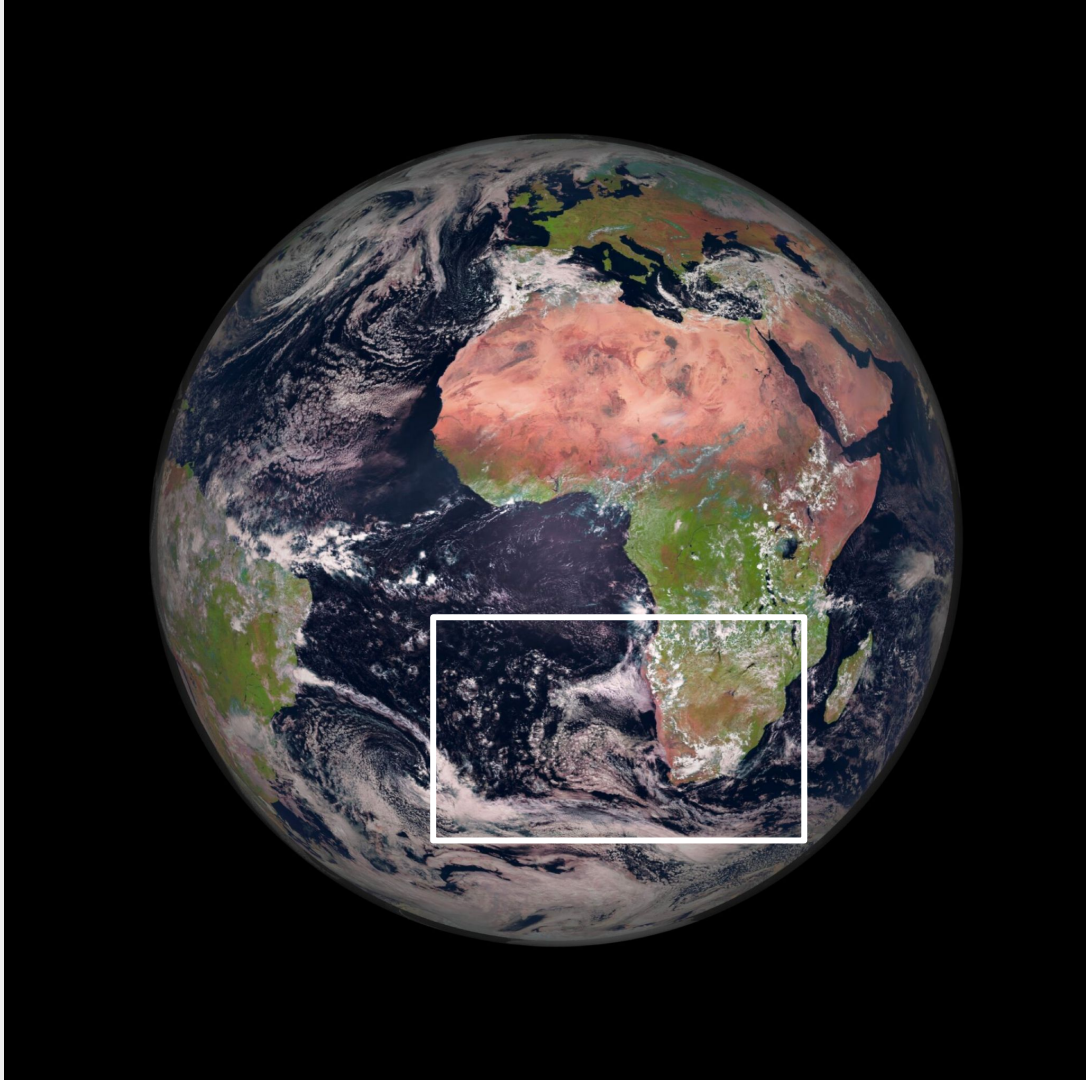


Why model ocean regions in an Earth system model?

Powerful infrastructure for case management, interpolation, long simulations, and coupling

Open, rapid development

Options for resolution, vertical grids



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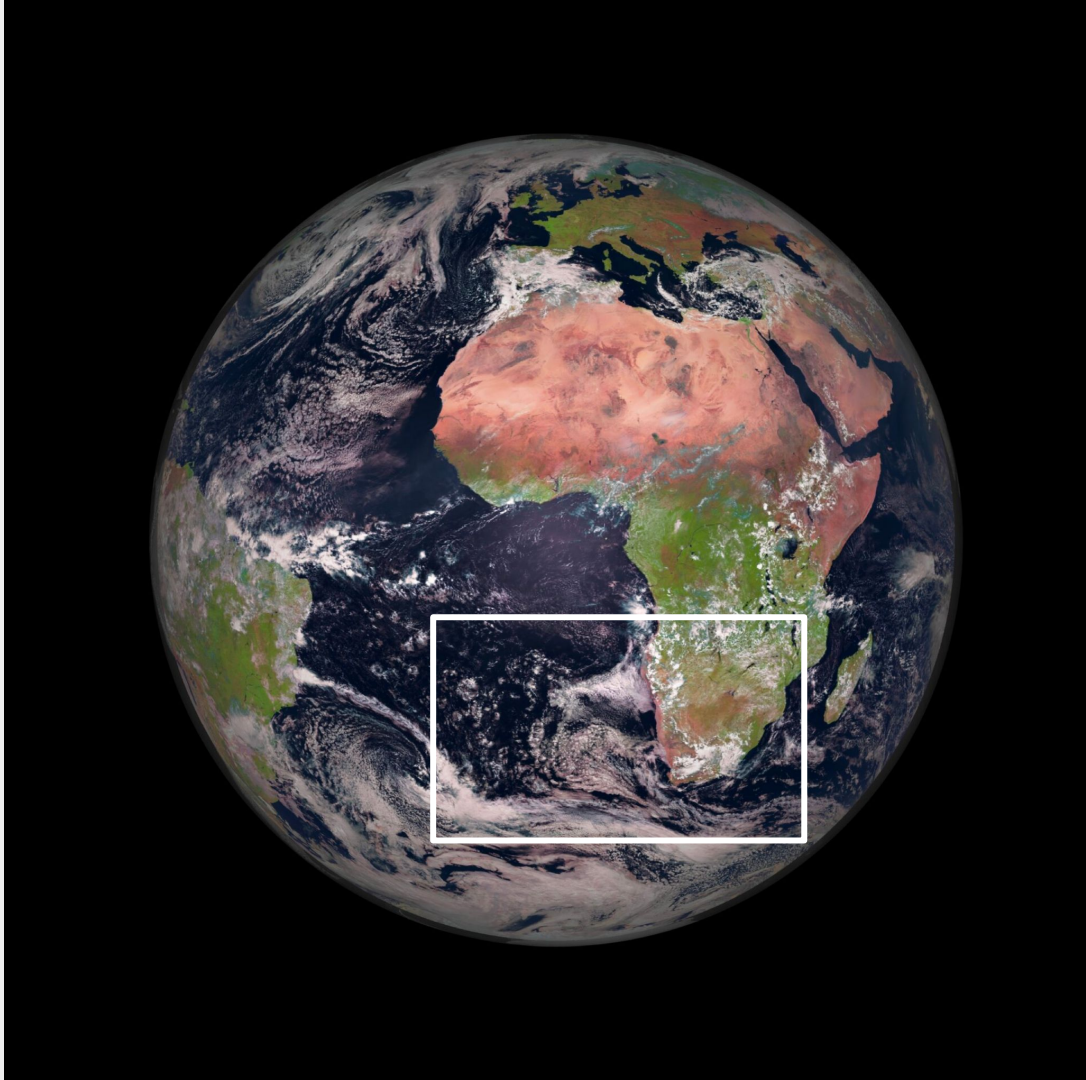
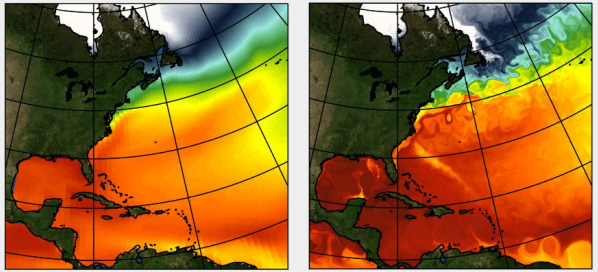
Climate change impacts are often unresolved by global models

Regional modes can be fit for purpose



Why model ocean regions in an Earth system model?

A shortcut to kilometer scales!



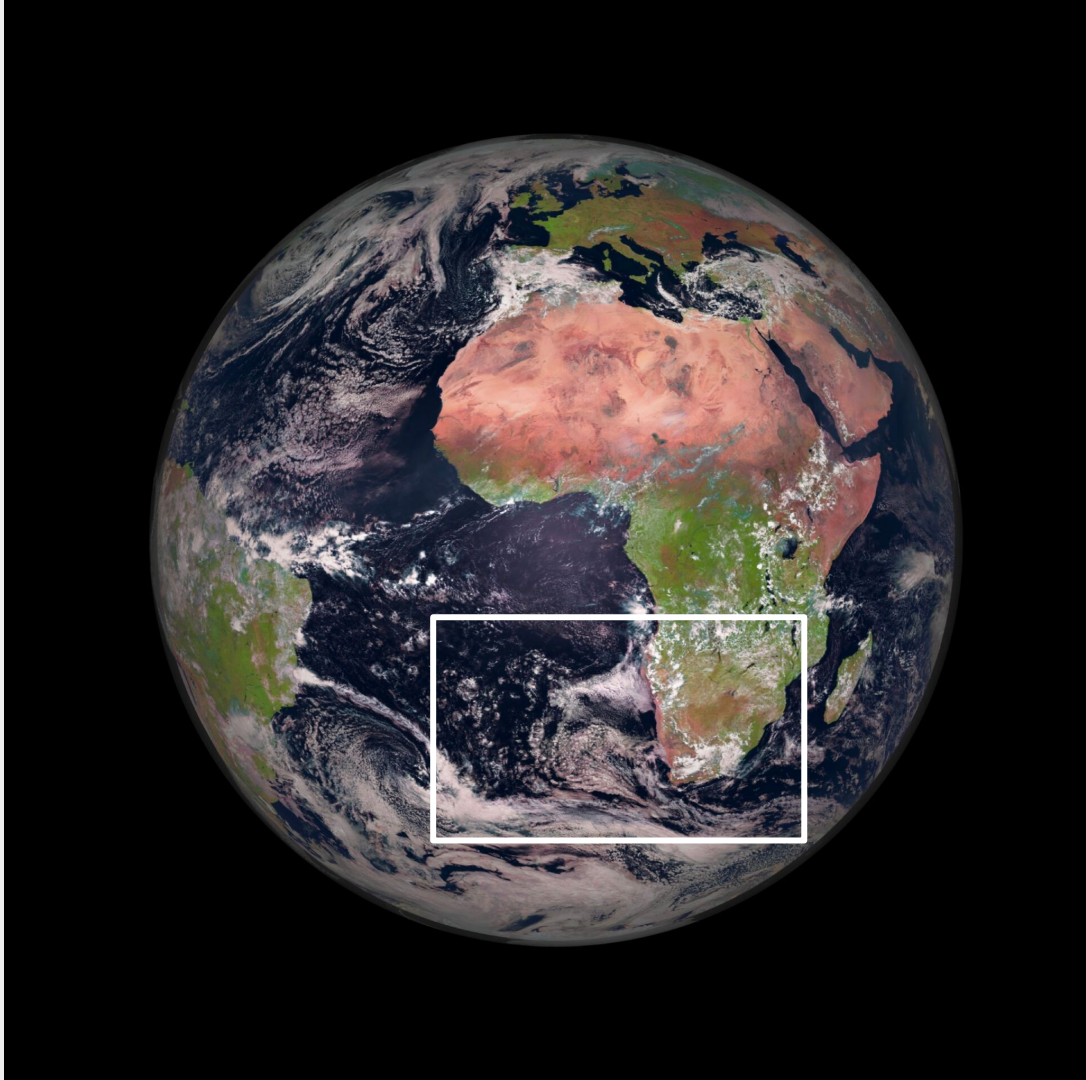
Resolution

Duration / ensembles

Complexity

Regional modeling is important!

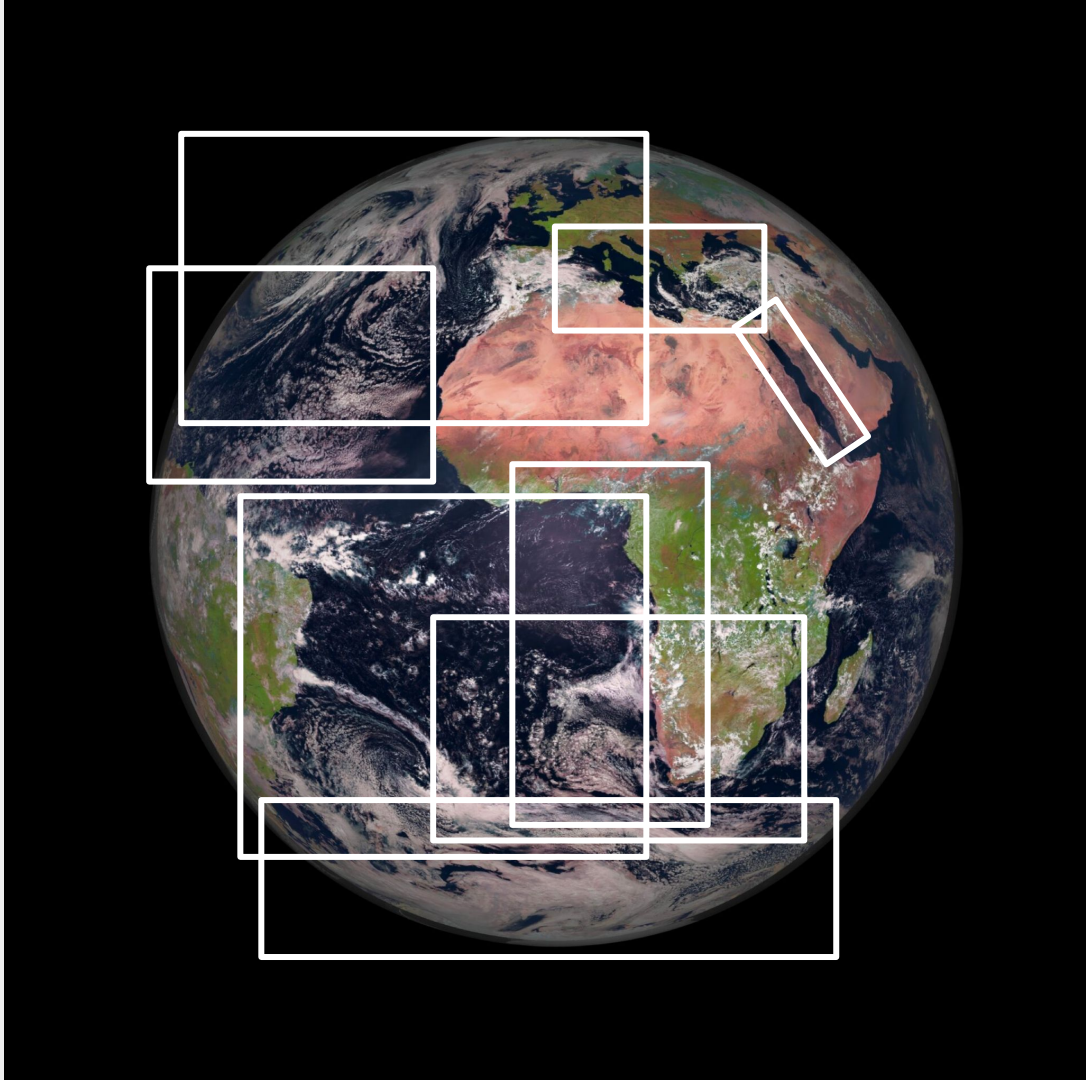
We want to support a growing community.



Regional modeling is important!

We want to support a growing community.

But how can we support a proliferation of regional domains?



We aim to accelerate *regional ocean model generation* and *tuning for purpose*

regional_model_nbd.ipynb

Markdown | Python 3 (ipykernel)

Set up CESM / MOM6 / MARBL

```
[ ]: # Define bounds for a regional domain
     # Generate regional ocean grid
     # Extract lateral boundary conditions from (e.g.) a large ensemble simulation
```

Set up data assimilation

```
[ ]: # Define desired observations (including hypothetical obs for experimental design)
     # Download and stage observations for this region and time period
     # Define DART namelist options
```

Save this configuration for reproducibility

```
[ ]: # Define other xml options, etc.
     # Save experiment options
```

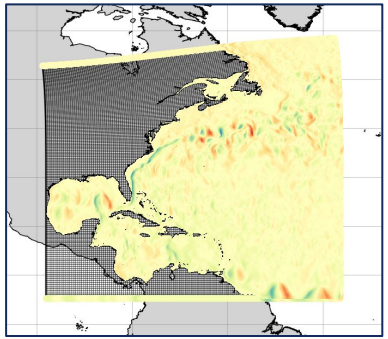
Run high-resolution regional CESM or CESM-DART and analyze output

```
[ ]: # Fire up DASK
     # Plot state-space metrics of interest (e.g., carbon uptake)
     # Plot observation-space metrics of interest using DART tools
```

Iterate to develop a scientifically useful model configuration!

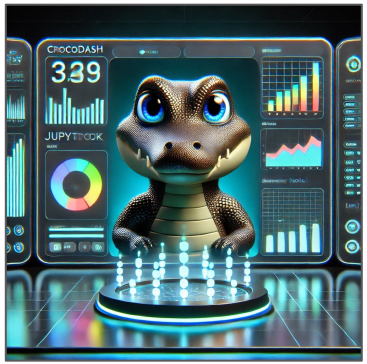
Major work packages

Reproducing scientifically validated setups



Integrating with data for carbon cycle science

Advancing data assimilation capabilities



A Jupyter frontend to tie it all together!

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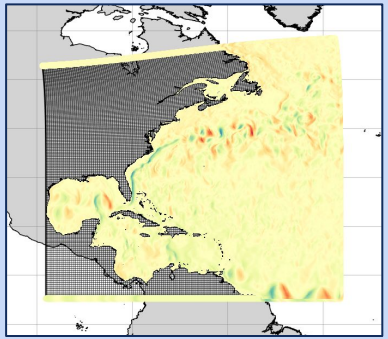

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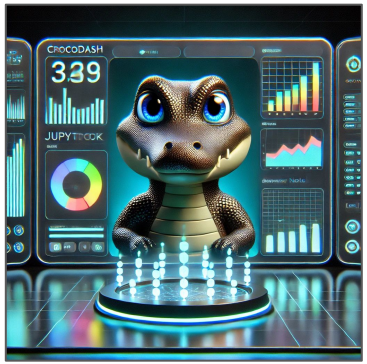

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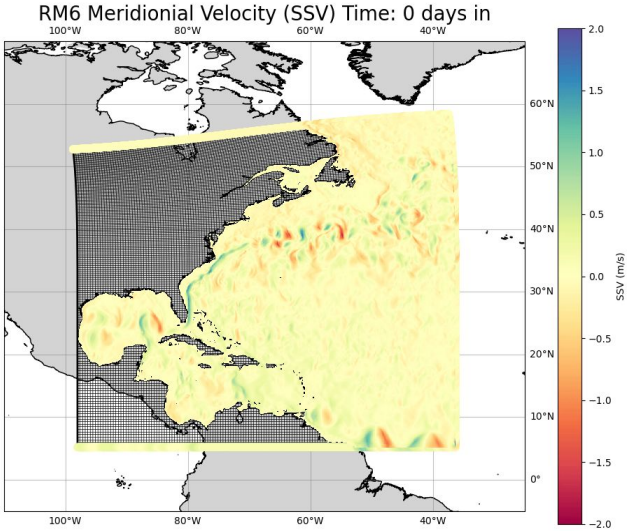
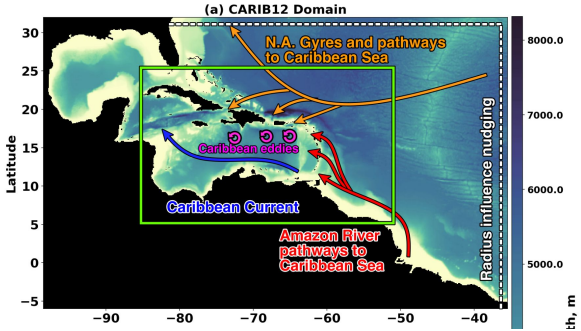


Hypotheses:

1. CESM-MOM6 recovers previous results...

2. ...including in a streamlined workflow!



A high-resolution physical–biogeochemical model for marine resource applications in the northwest Atlantic (MOM6-COBALT-NWA12 v1.0)

Andrew C. Ross[1], Charles A. Stock[1], Alistair Adcroft[1], Enrique Curchitser[2], Robert Hallberg[1], Matthew J. Harrison[1], Katherine Hedstrom[3], Niki Zadeh[1], Michael Alexander[4], Wenhao Chen[5], Elizabeth J. Drenkard[1], Hubert du Pontavice[5], Raphael Dussin[1,6], Fabian Gomez[7,8], Jasmin G. John[8], Dujuan Kang[9,2], Diane Lavoie[10], Laure Resplandy[11,12], Alizée Roobaert[13], Vincent Saba[14], Sang-Ik Shin[4], Samantha Siedlecki[15], and James Simkins[2]

CARIB12: a regional Community Earth System Model/Modular Ocean Model 6 configuration of the Caribbean Sea

Giovanni Seijo-Ellis[1], Donata Giglio[1], Gustavo Marques[2], and Frank Bryan[2]

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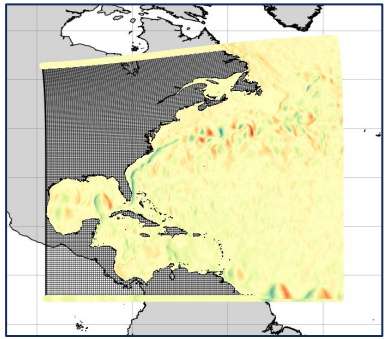

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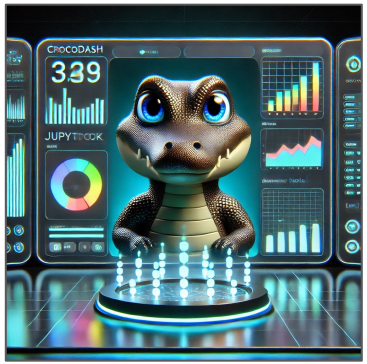
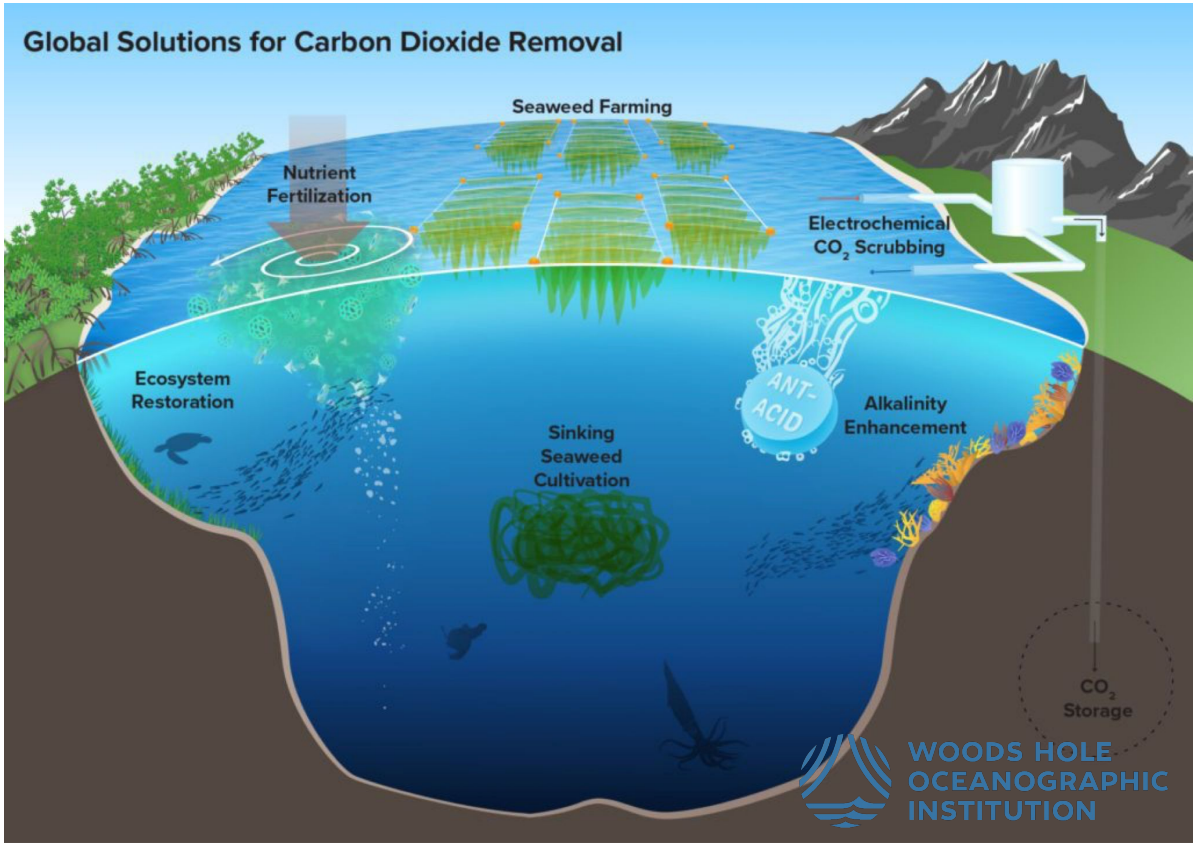
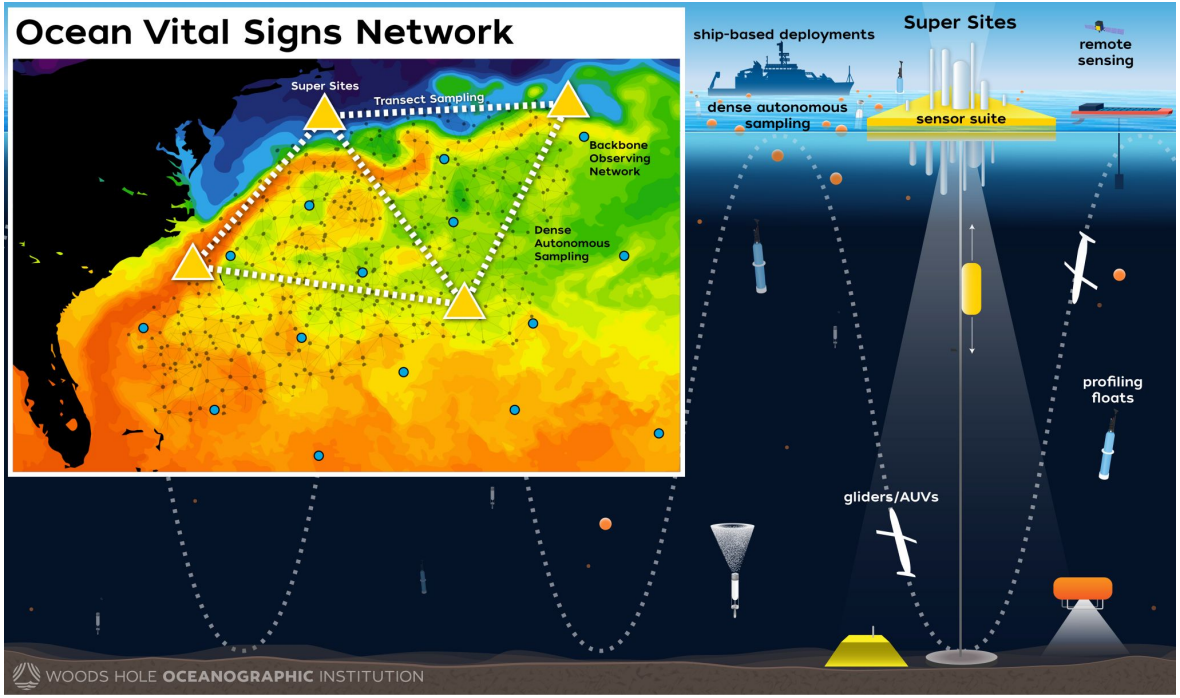


A Jupyter frontend to tie it all together!

A motivating use case: Marine carbon dioxide removal (mCDR)

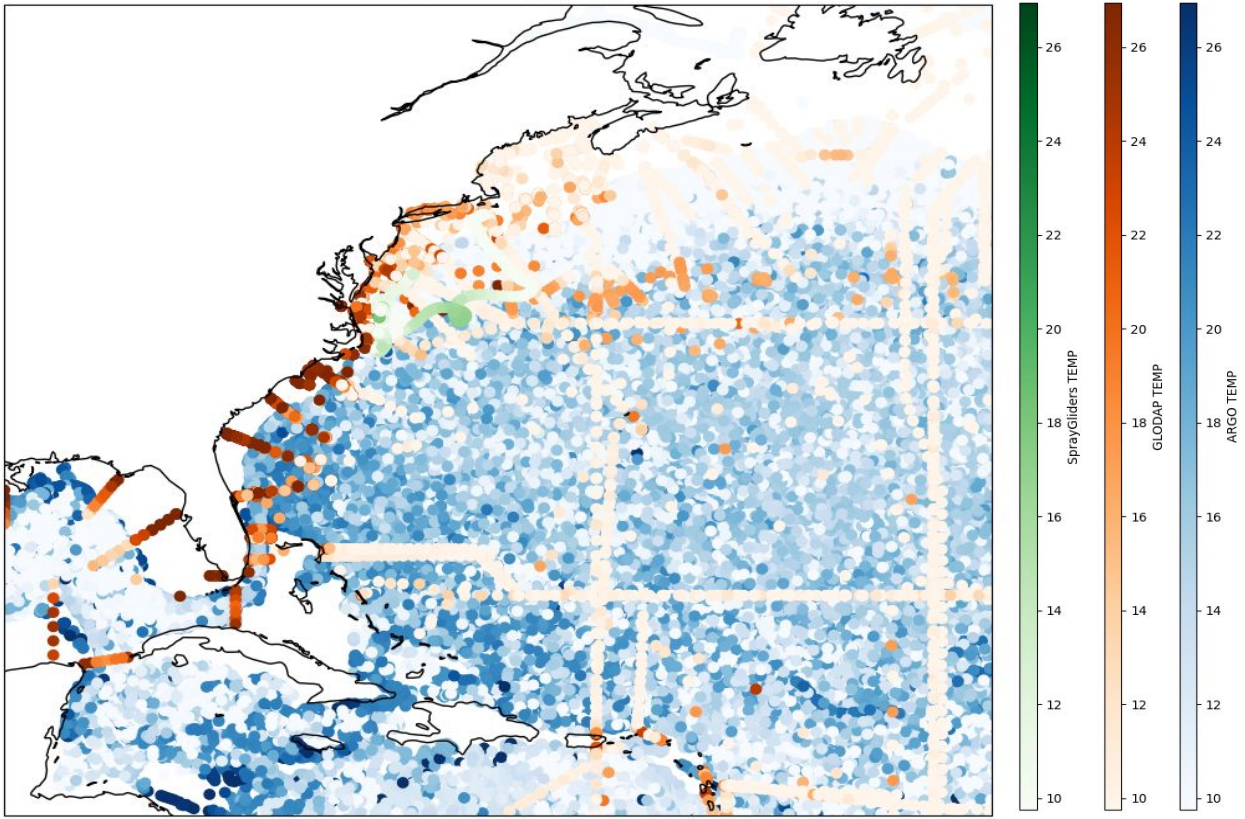


A prerequisite: Better understanding of regional carbon cycling



WOODS HOLE OCEANOGRAPHIC INSTITUTION

CrocoLake: A novel interface to **continuously-updated** oceanographic observations in **parquet** format for **near-real-time data assimilation**.



Parquet

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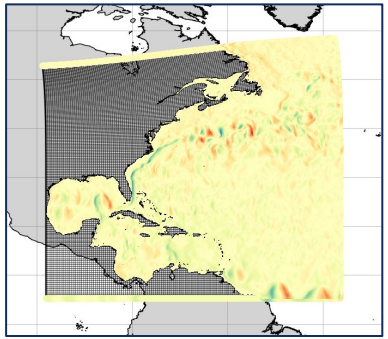

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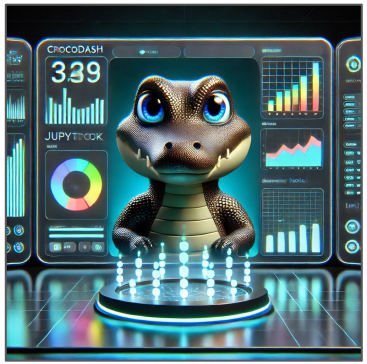
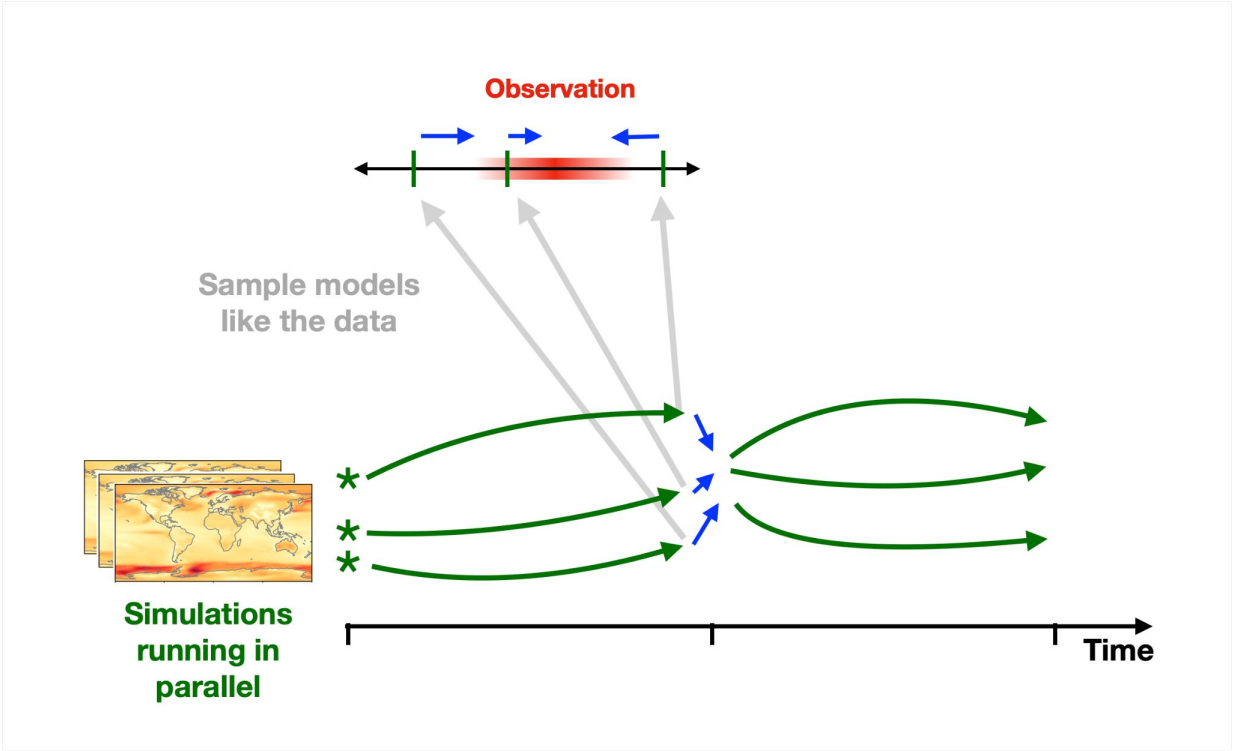


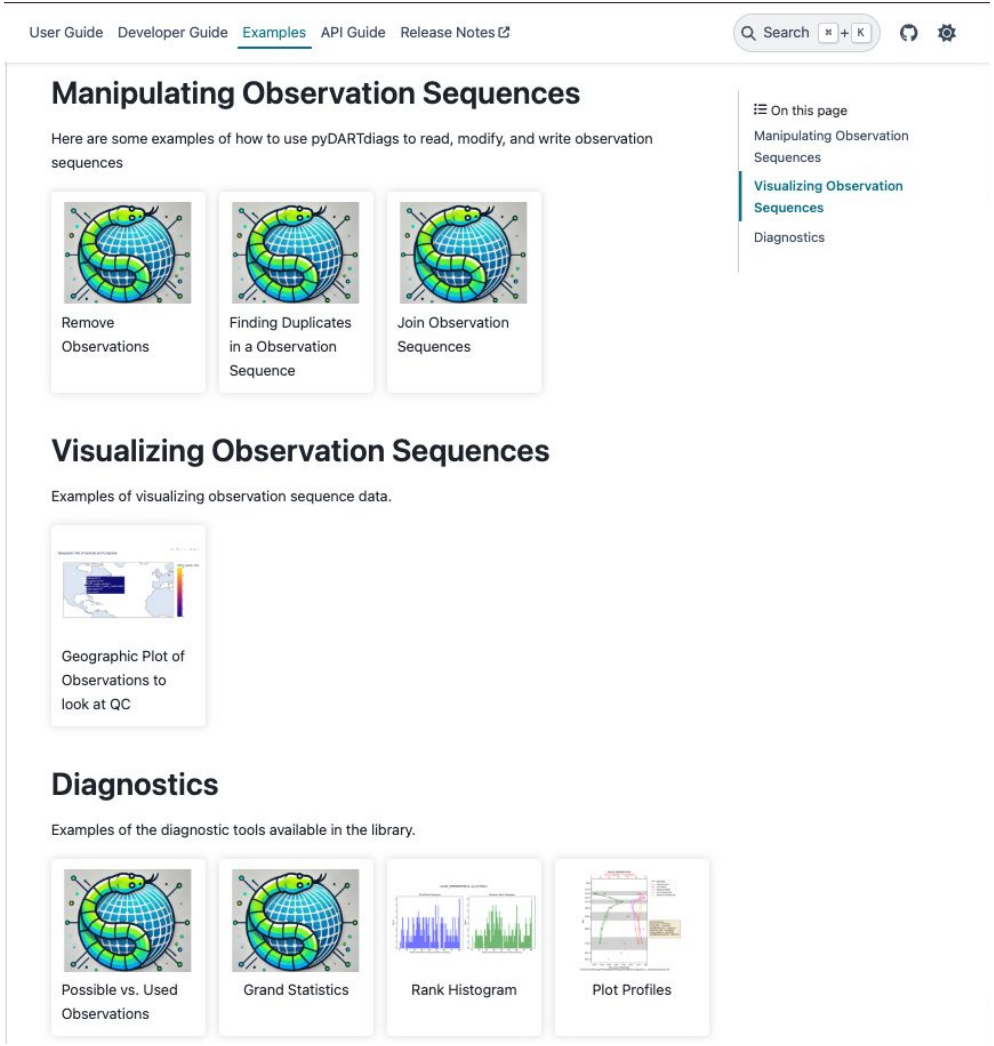
A Jupyter frontend to tie it all together!

Ensemble data assimilation (DA):

Ingesting data for initialized prediction and model improvement



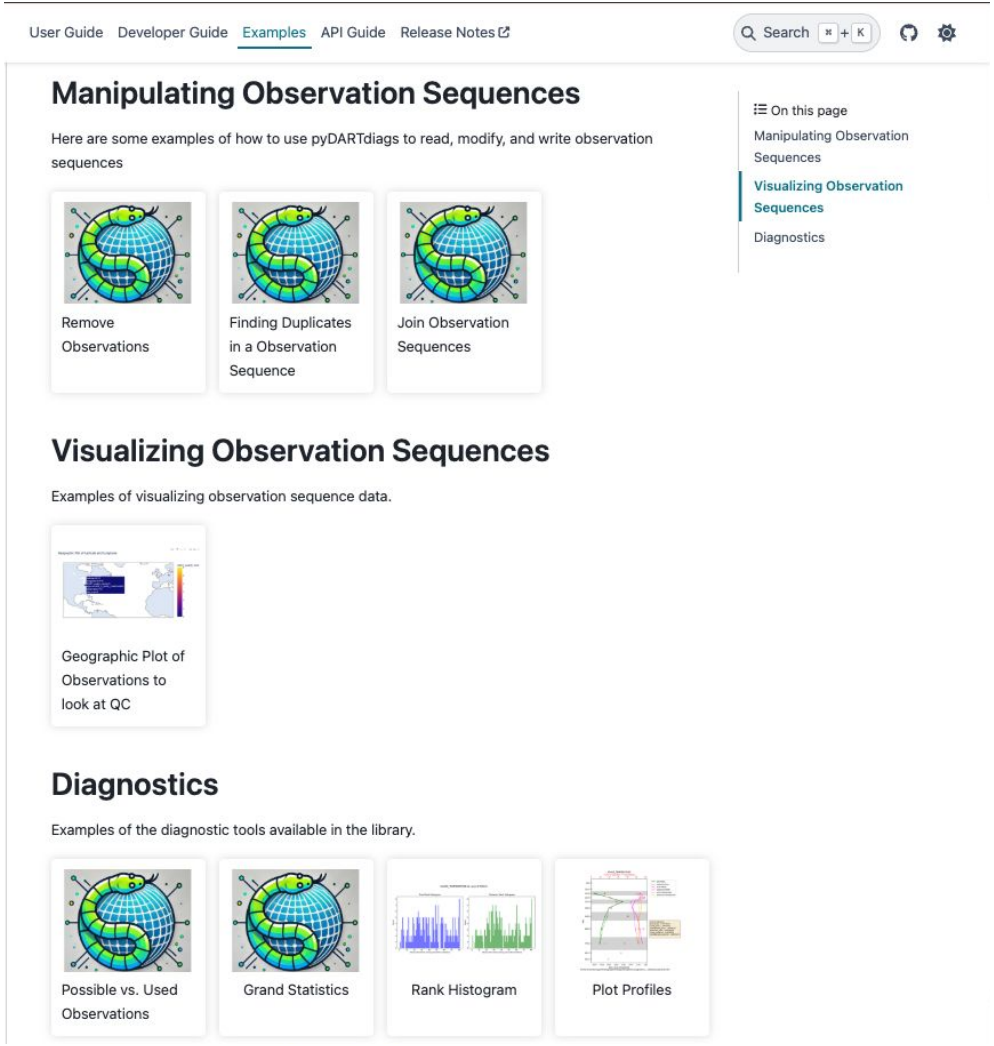
NCAR | DART



pyDARTdiags: Python frontends for powerful Fortan-based DA codes

NCAR | DART

DART interfaces exist for (nearly) every component model in CESM.



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NCAR | DART

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Recent milestone: Multi-instance CESM capabilities for regional MOM6.

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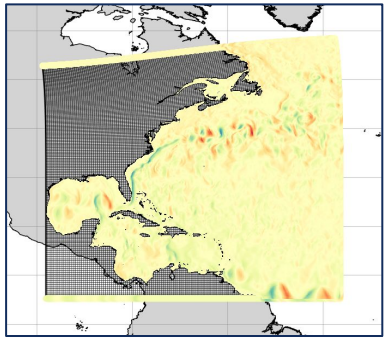

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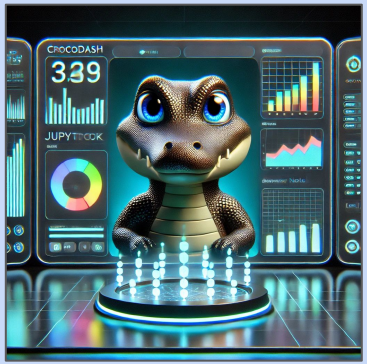


Manish's talk, up next!

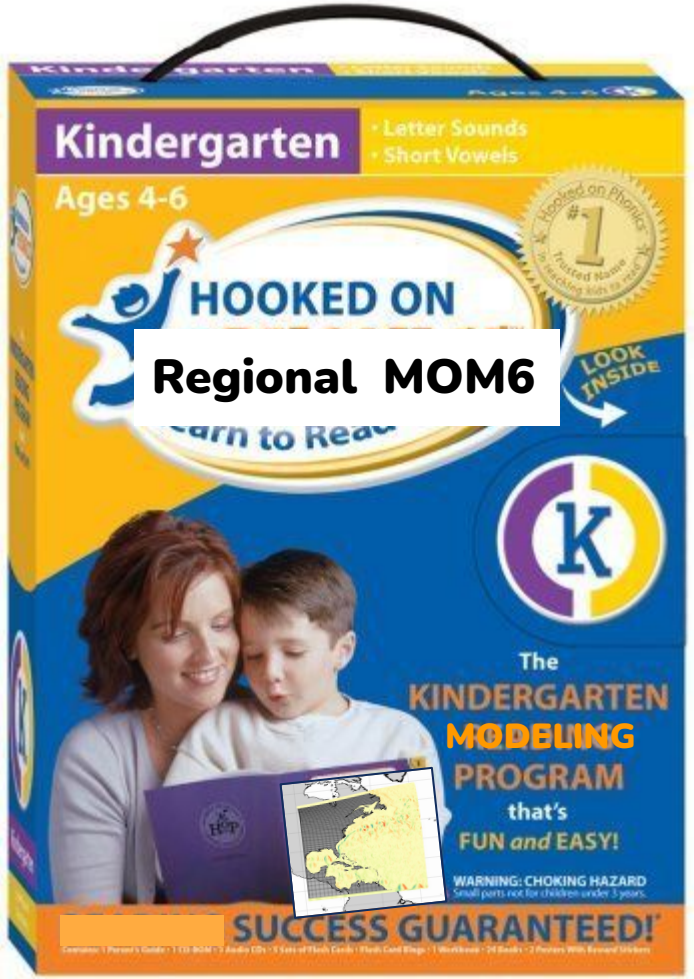
What's next?

How do we get people hooked into a collaborative project?

Hosting an **initial community workshop 13-17 October at NCAR.** Travel funds are available for 20 students / early careers.

- MOM6 introduction
- CrocoDash for regional modeling
- Git and collaborative workflows
- Hackathon: new domains, vertical coordinates, etc.
- ...

Please email damrhein@ucar.edu to be included in future announcements or be involved with planning!



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Building a **gallery** of use cases and notebooks

Advancing regional BGC (MOM6-MARBL)

Hiring a **SIParCS intern** on reproducibility and code correctness for summer '25

Check out our **repos** and reach out with questions!

https://github.com/CROCODILE-CESM
damrhein@ucar.edu