



National  
Weather  
Service

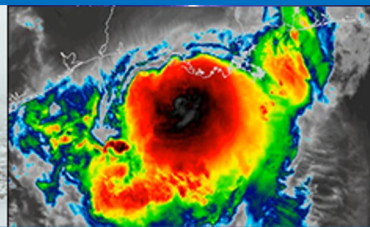
# JEDI-based Ocean Color Data Assimilation for NOAA NCEP's Unified Forecast System

JPSS PGRR team:

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Contributors:

EMC's Marine DA Team, Travis Sluka (JCSDA), Kriti Bhargava (JCSDA),  
John Dunne (GFDL), and many others



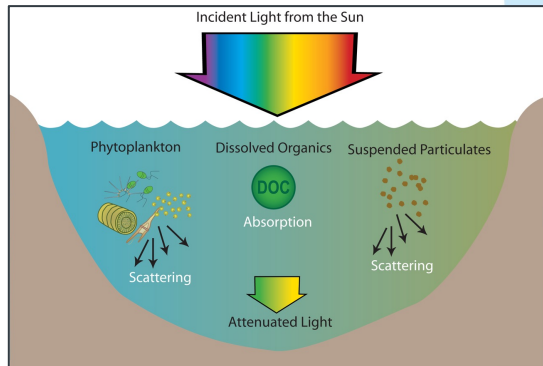


# Outline

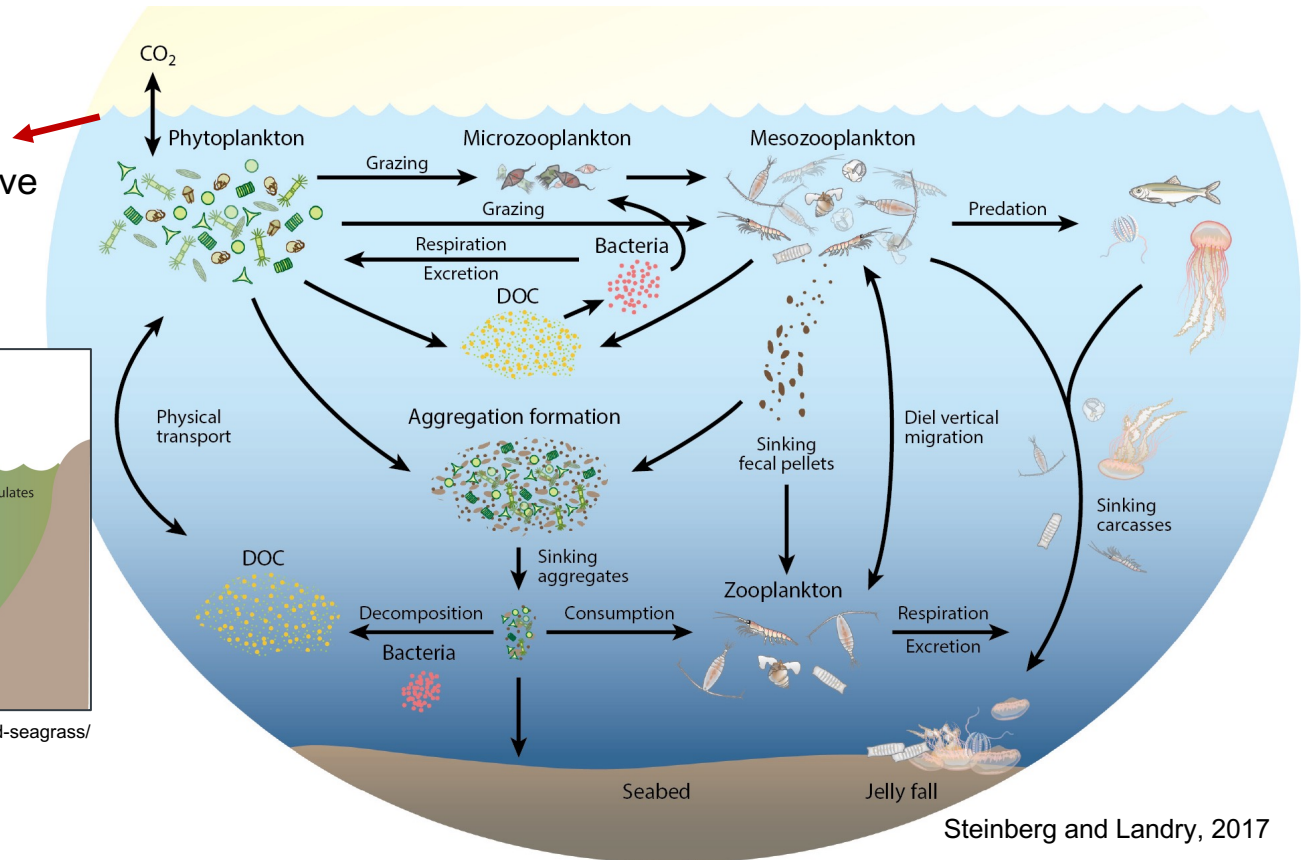
- Why *ocean biogeochemistry* in operational weather forecasts?
  - What is JEDI? What is UFS/GFSv17? How does an ocean biogeochemical model interface with JEDI for UFS applications?
  - NOAA NCEP's ocean physical, biogeochemical, and sea-ice retrospective observation database and analysis systems
  - UFS initialization experiments and science questions: e.g., *how does proper ocean BGC initialization affect ocean physical prediction skills of the UFS?*
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# Ocean biophysical feedback – light penetration

Light penetration and radiative heating is sensitive to water constituents, e.g. phytoplankton



<https://ecosystemsontheedge.org/underwater-light-and-seagrass/>



Steinberg and Landry, 2017



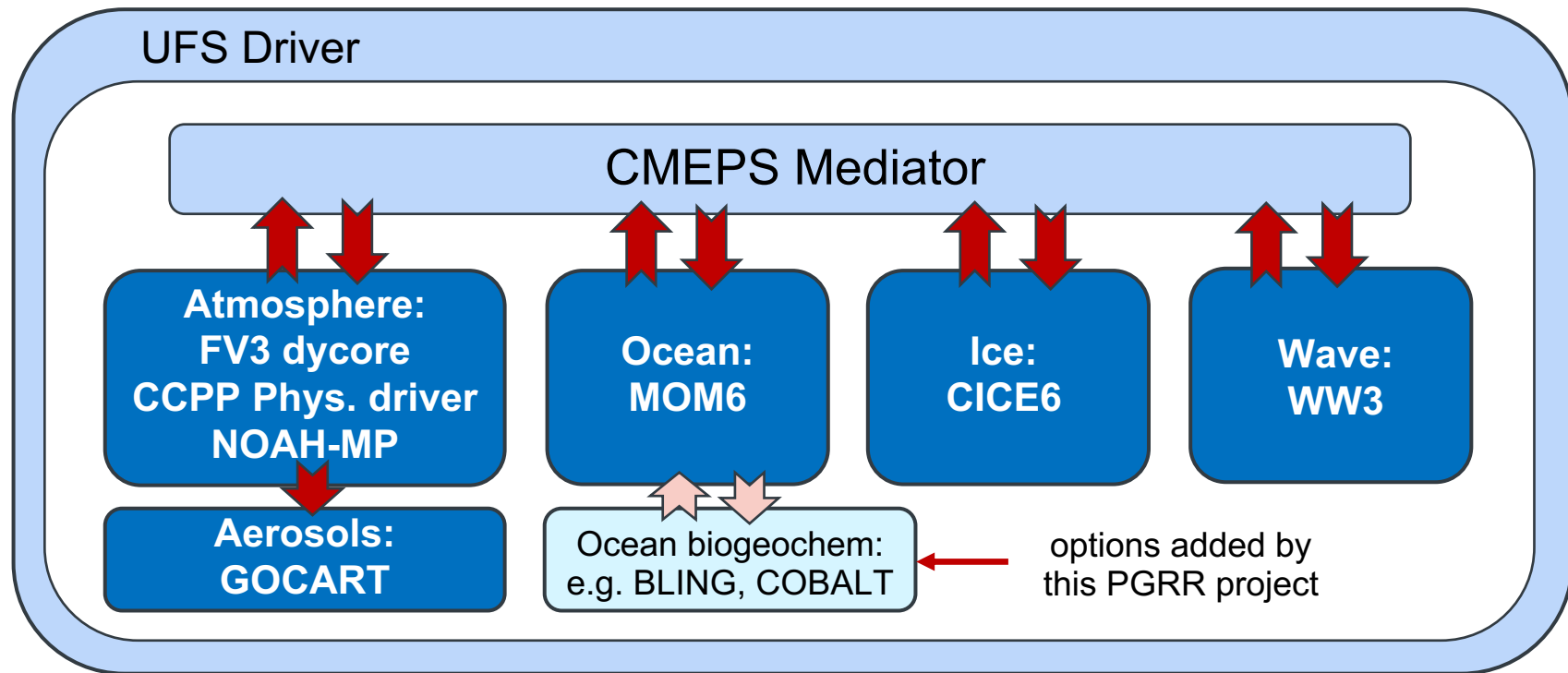
## *JPSS-PGRR FY21-23 “Implementation of ocean biogeochemical modeling and ocean color data assimilation in the Unified Forecast System in support of NCEP’s MRW, S2S, and ecological predictions”*

The **overarching goals** of this project are to ...

- Support NOAA/NCEP’s **operational weather forecasts** at subseasonal-to-seasonal (S2S) scales by improving ocean state initialization through the ingestion of near real-time ocean biogeochemical data and the integration of biophysical feedback in the marine component of the UFS;
- Start building NOAA/NCEP’s **ecological forecast capabilities** for monitoring critical changes and “tipping points” in coastal ecosystems.

# UFS MRW-S2S application prototype 8

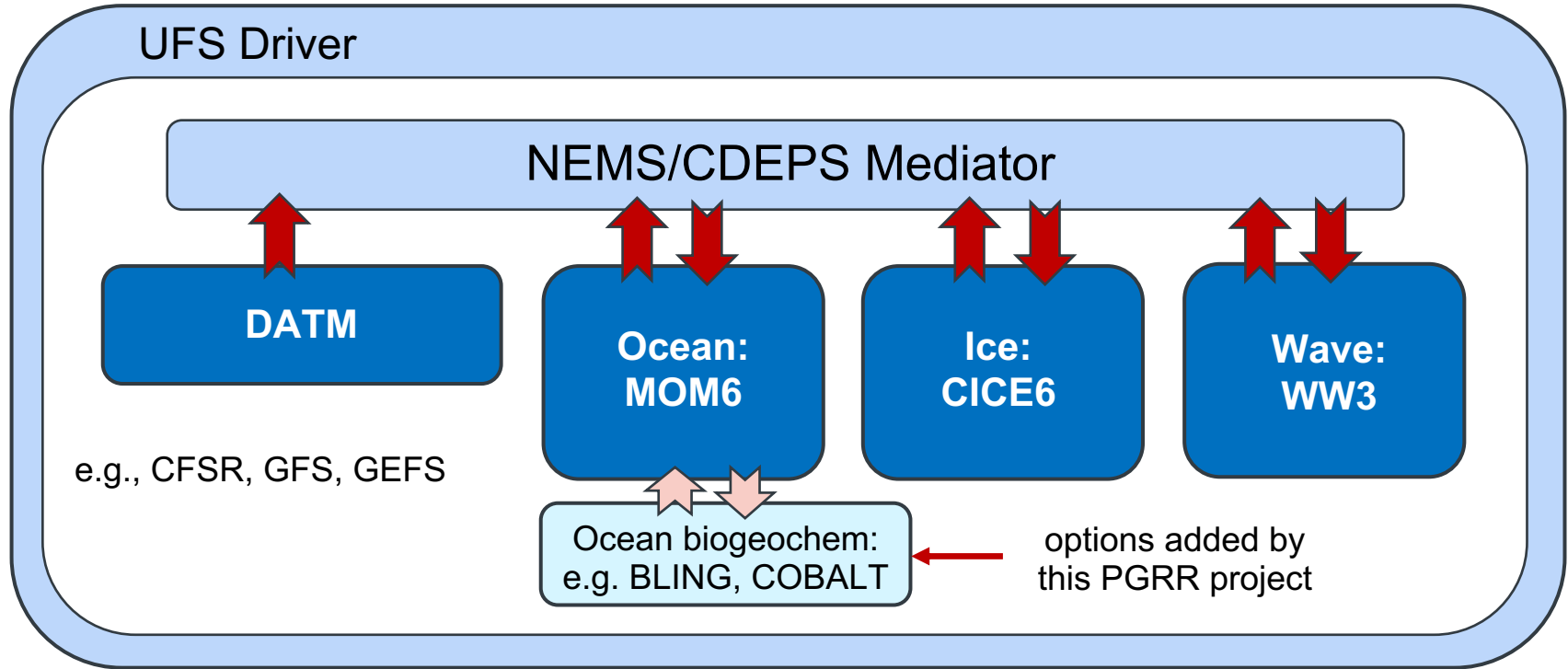
## Global coupled model configuration



Adapted from figure by Global UFS-coupled team

# UFS MRW-S2S application prototype 8

## DATM component for retrospective marine DA

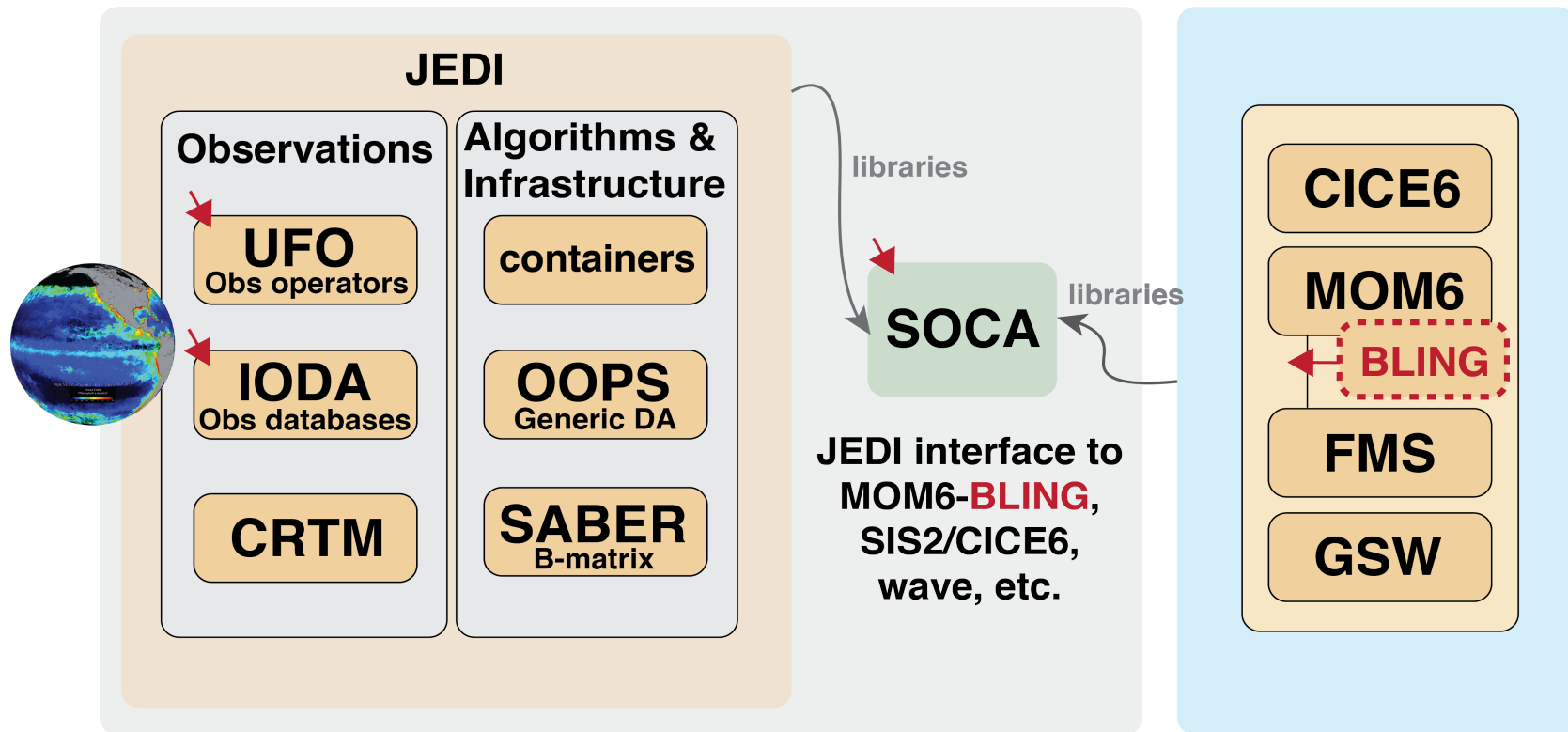


Adapted from figure by Global UFS-coupled team

# Joint Effort for Data Assimilation Integration (JEDI)

## JCSDA Repositories

## External Repositories



# Joint Effort for Data Assimilation Integration (JEDI)

## OOPS

### (Object- Oriented Prediction System)

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- Generic data assimilation algorithms
  - Variational (\***3D**, 4D, \***EnVar**, \***hybrid**, EDA)
  - local ensemble DA (\***LETKF**, hybrid-gain)
  - ***planned: particle filters***

\*tested with UFS DATM  
for marine DA @EMC

#### Implemented as:

- C++ templates
- OOPS expects certain classes to be implemented (either directly by the model interface, or from the other various JEDI building blocks)

Slide credit: T. Sluka et al.



# BLING<sub>v2</sub> – Biogeochemistry with Light Iron Nutrient and Gas

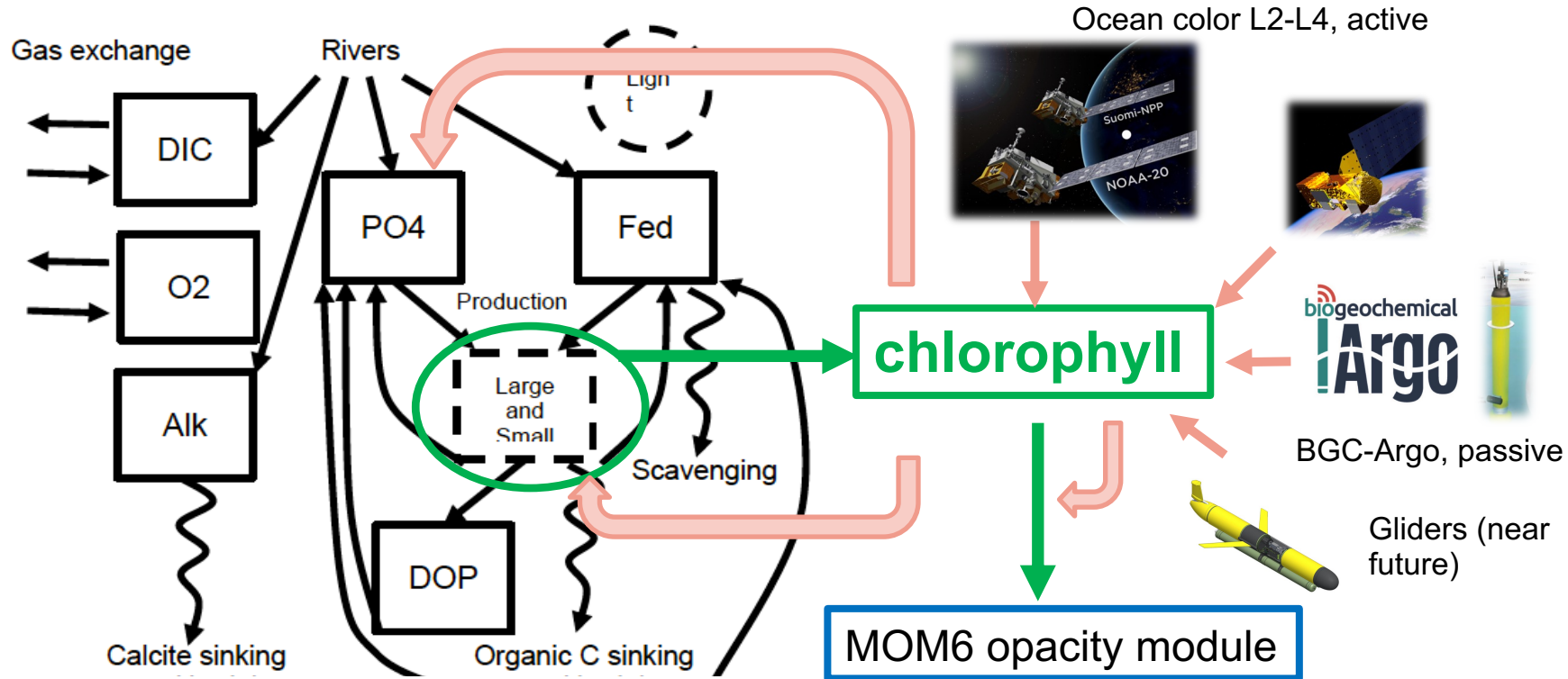


Figure. Simplified model schematic of BLING<sub>v2</sub> ocean biogeochemical model (Dunne *et al.*, 2020)

# Ocean Sea-ice Retrospective Observation Database

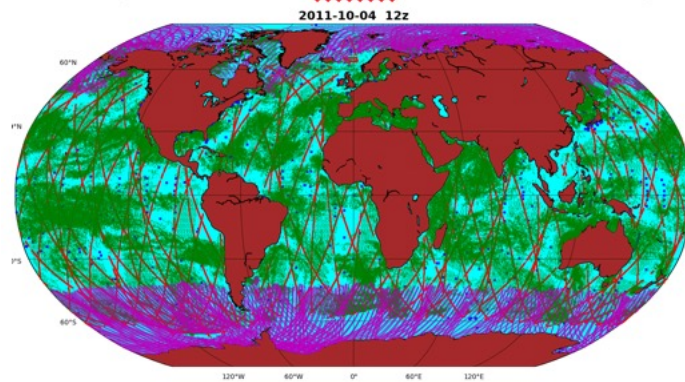
Insitu (T, S, u, v)		
Instrument	Platforms	Provider
Too many to list	TAO, PIRATA, RAMA, Argo, XBT, CTD	NOAA/NCEI
Argos and GPS tracked	drifting buoys	GDP
GPS trackers	Track OB	GODAE/FNMOC
GPS trackers	Track OB	
Too many to list	Drifting and Moored BUOY, CMAN, ERI and Hull of the ship, Bucket	
Too many to list	TESAC, Fixed and Moored BUOY, Argo	
Too many to list	TESAC, Fixed and Moored BUOY, Argo	

MW (sst, sss, ice concentration)		
Instrument	Satellite	Provider
SAR L-band	GPM (SMAP)	NASA/JPL
MIRAS	SMOS	ESA
SSMIS	DMSP F-17, F-18	NSIDC
...		

IR (sst)		
Instrument	Satellite	Provider
AVHRR	MetOp-A	GRHSST
AVHRR	MetOp-B	
AVHRR	MetOp-C	
AVHRR	NOAA-18	
AVHRR	NOAA-19	
VIIRS	Suomi-NPP	
VIIRS	NOAA-20	

Altimeter (ADT, freeboard)		
Instrument	Satellite	Provider
SARAL	Cryosat-2	RADS
Poseidon-3	Jason-2	
Poseidon-3	Jason-3	
SARAL	Sentinel-3	
Poseidon-4	Jason-CS / Sentinel-6	
ALtiKa/Argos-3	SARAL	
All	All	Copernicus

Example of ocean & seaice observation coverage



Slide credit: G. Vernieres et al.



# Ocean Sea-ice Retrospective Observation Database

*chlor\_a* database

✚ Assimilated

✚ Passive

2019-2021 exp.

Aqua-MODIS L3 (4-km, OB.DAAC, 2002-2022)

✚ SNPP-VIIRS L3 (4-km, CoastWatch, 2012-2022)

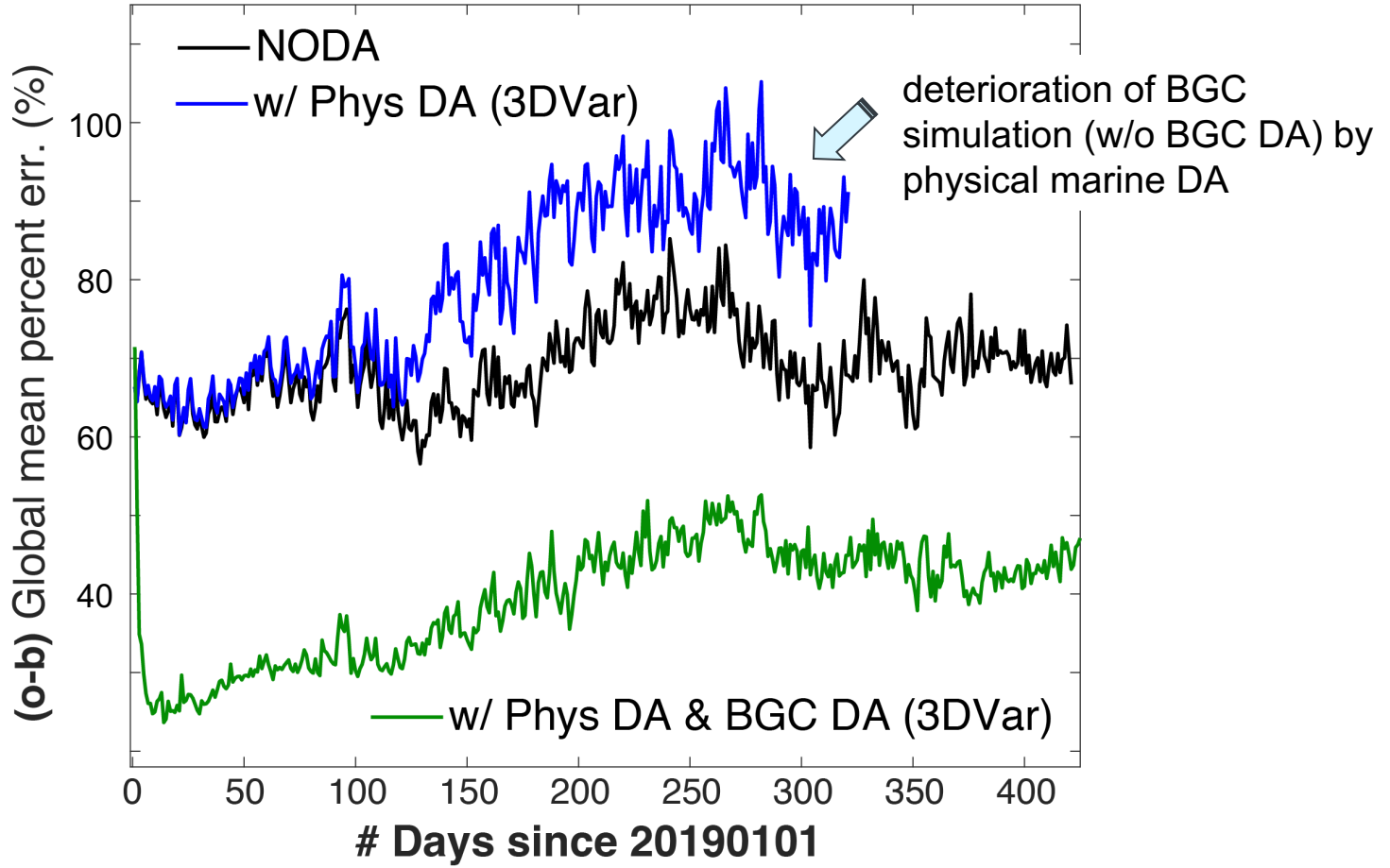
✚ NOAA20-VIIRS L3 (4-km, OB.DAAC, 2017-2022)

✚ NOAA20-VIIRS L3 (4-km, CoastWatch, 2021-2022)

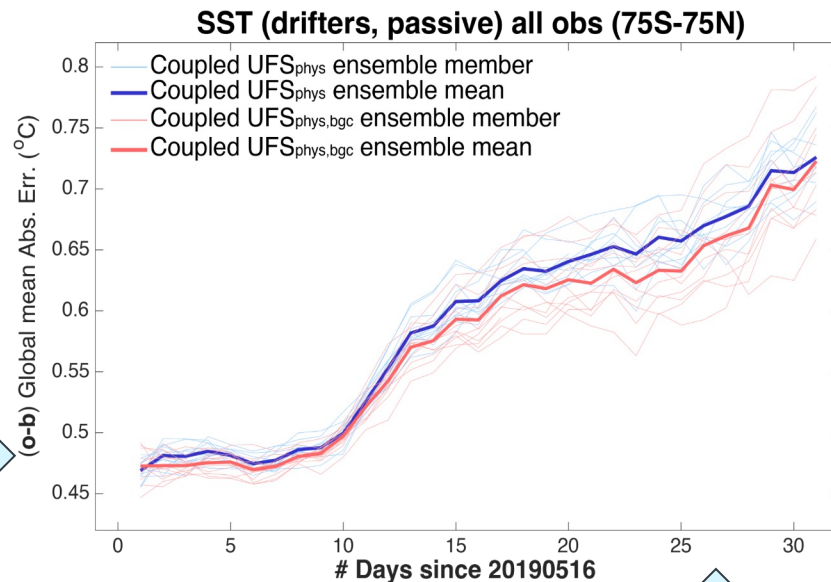
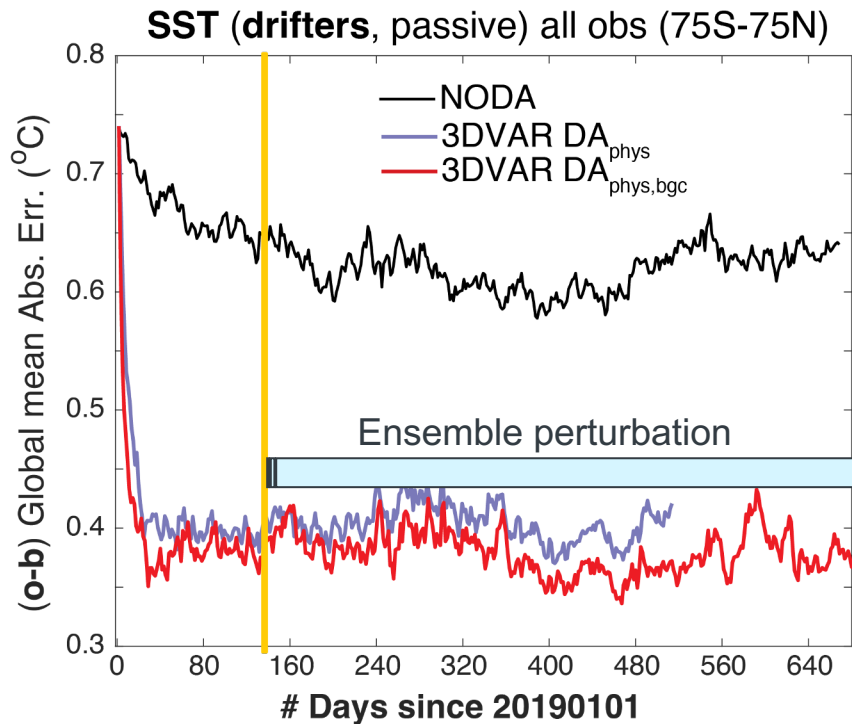
✚ VIIRS+OLCI DINEOF3 L4 (9-km, CoastWatch, 2018-2022)



# Chl (VIIRS), all obs(75S-75N)



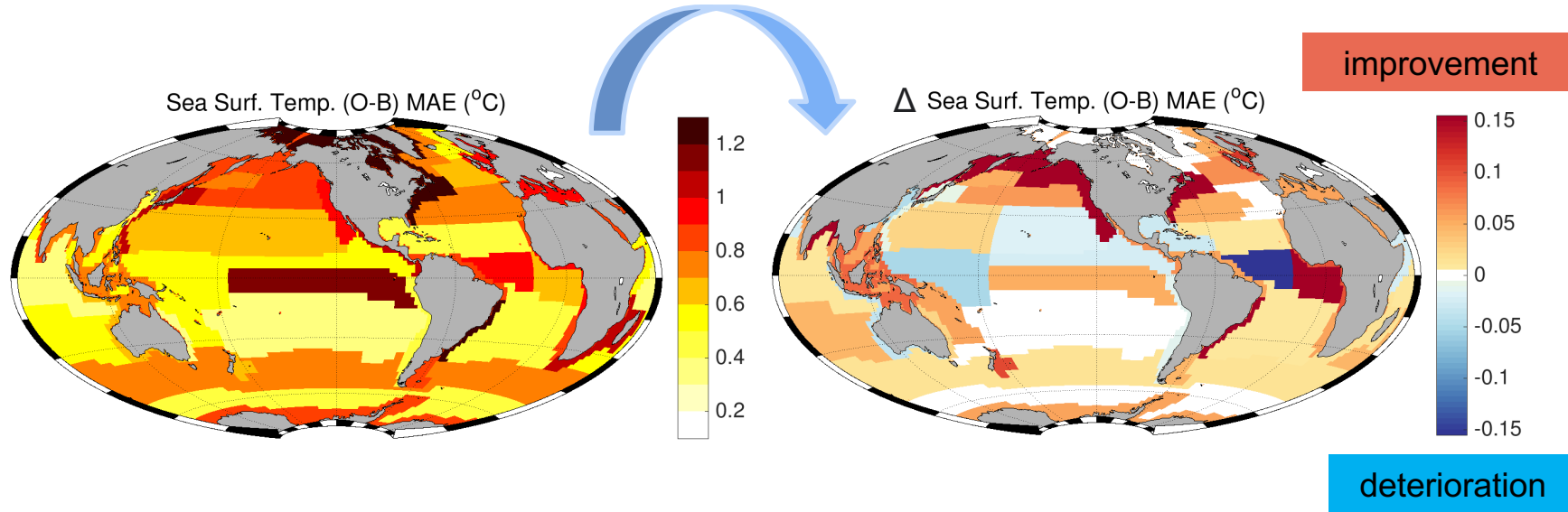
# Coupled UFS initialization w/ ocean BGC



fully coupled UFS reforecast w/ BLING  
ocean sea-ice reanalysis (DATM) w/ BGC DA

# Coupled UFS initialization w/ ocean BGC

diff. in SST prediction omb MAE -> Impact of BGC feedback



\*The global ocean is separated into 56 provinces for statistical analyses according to Longhurst (2007).



## Ongoing activities & next steps



- Proof-of-concept, multi-year ocean sea-ice reanalysis (NCEP)
- Enabling BGC in NCEP's global-workflow WCDA (NCEP)
- PACE hyperspectral radiance data assimilation via OASIM operator: optically distinct phytoplankton groups (NASA, JCSDA, NCEP)
- Possible JEDI applications for decadal to climate-scale predictions (NCEP, OAR/GFDL)

