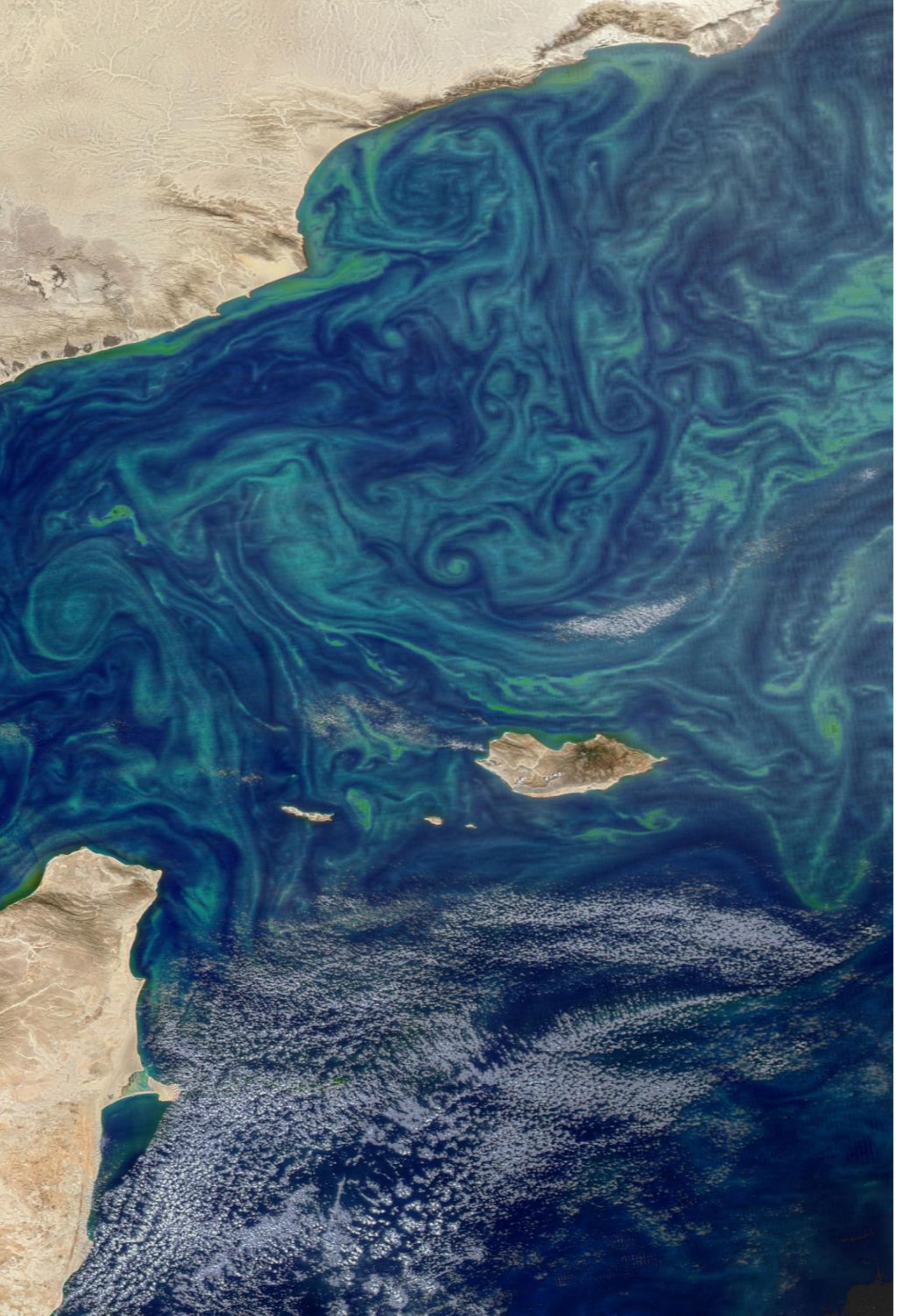

Mechanistic Drivers of the Particulate Backscattering-to-Chlorophyll *a* Relationship and Bias-assessment of Phytoplankton Carbon Algorithms

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The particulate backscattering coefficient (b_{bp}) has been suggested to be a good proxy for phytoplankton carbon biomass (C_{phyto}) and is used in some NPP global models.

But C_{phyto} data is scarce in space and time, therefore b_{bp}-Chl relationships can be used to derive these algorithms

Problems:

- b_{bp} is a proxy of all particles in the ocean, not only phytoplankton
- Scarce C_{phyto} field data and biased in space and time

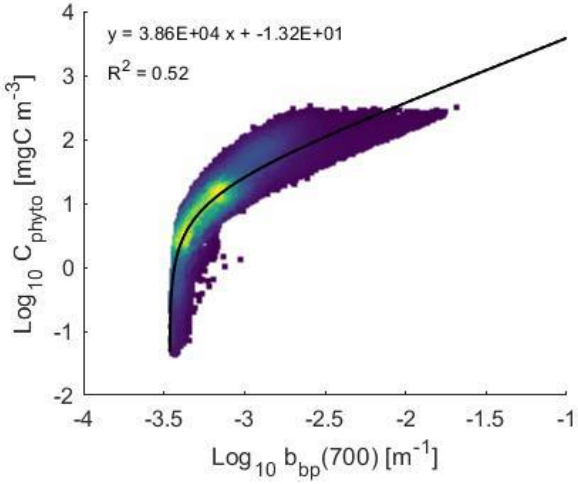
We use a global ocean circulation model (MITgcm) with optics embedded in it and the Bgc-Argo data-set to:

- Understand how well does b_{bp} estimate C_{phyto}
- Understand b_{bp}-Chl relationships and their potential to obtain C_{phyto}

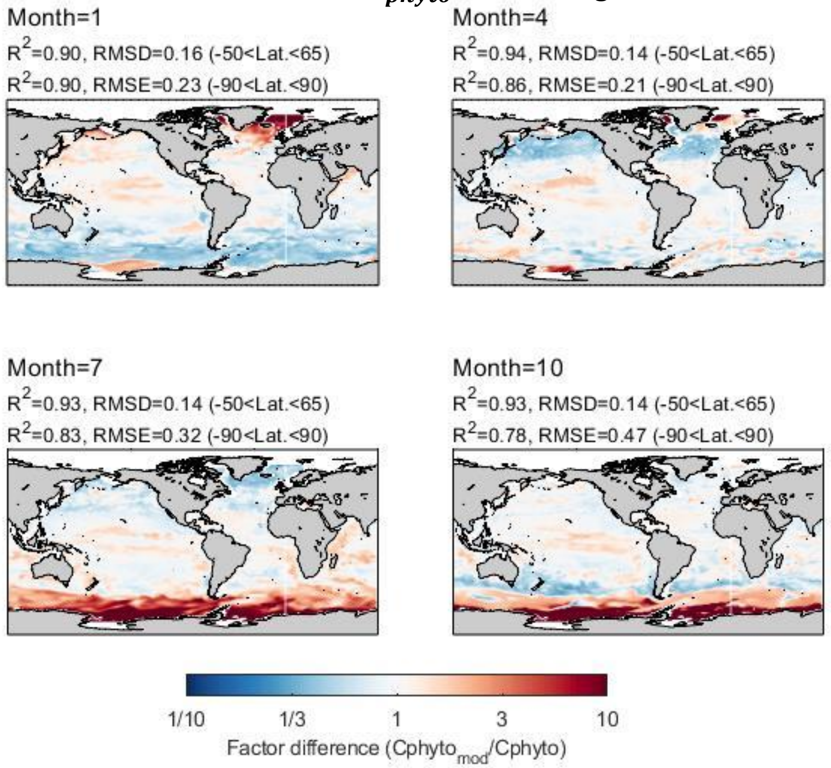
Is b_{bp} a good proxy of Cphyto?

- We use the MITgcm model to investigate b_{bp}-C_{phyto} relationship
- We get an algorithm by fitting a linear regression to the b_{bp}-C_{phyto} relationship of the surface pixels of the MITgcm
- We compare the C_{phyto} estimated by the algorithm relative to the "real" C_{phyto} of the model

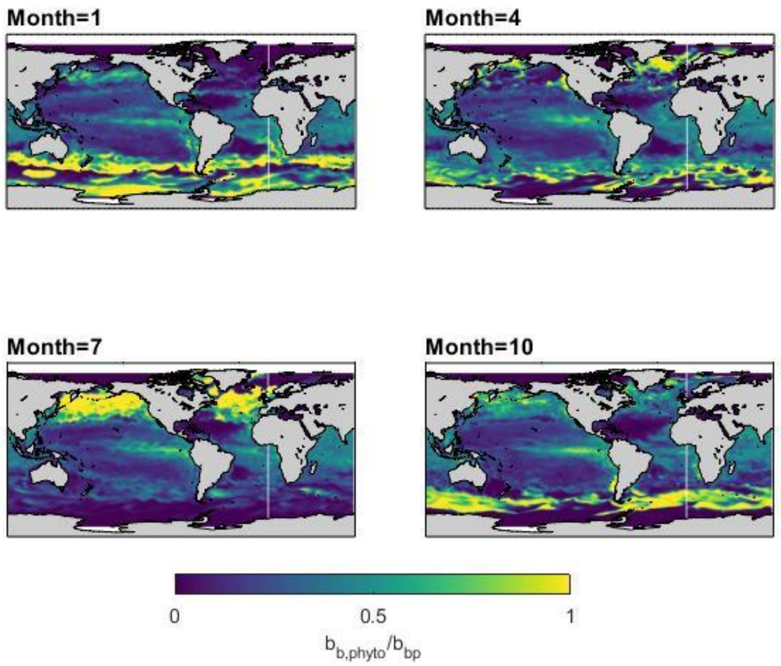
Regression in the MITgcm model using a robust method



Comparison of C_{phyto} obtained from the algorithm relative to the "real" C_{phyto} in the MITgcm



Phytoplankton contribution to the b_{bp} signal



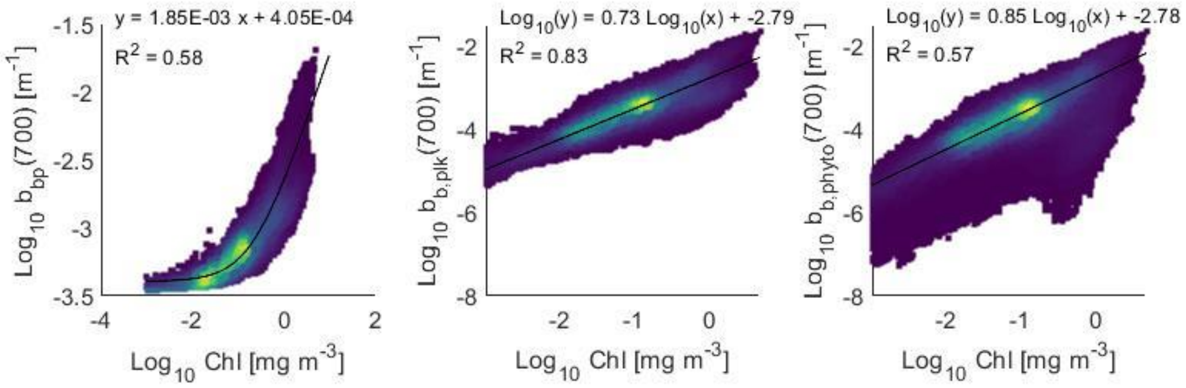
Results:

- Algorithm tends to deviate by a factor less than 2 in most regions
- Worst fits are in winter of high latitudes, in those regions phytoplankton has a very low contribution to b_{bp} (where heterotrophic bacteria and detritus dominate the b_{bp} signal)

Understanding the b_{bp}-Chl relationship

- Use the Darwin model to understand the b_{bp}-to-Chl relationship
- Use BGC-Argo data to compare trends

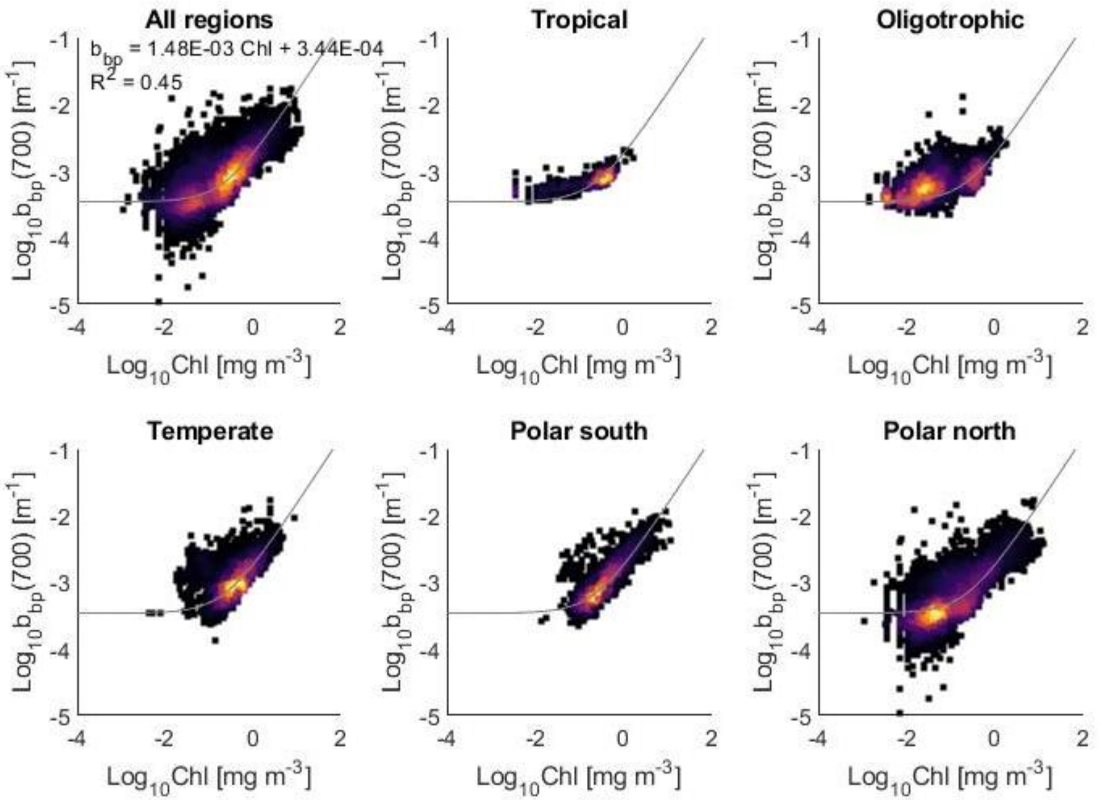
Trends in the MITgcm model:

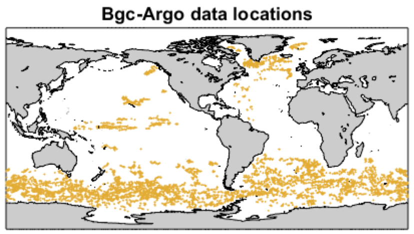


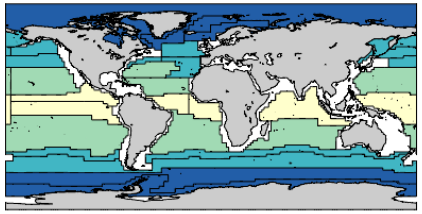
Results:

- A linear regression in the linear scale fits relatively well the b_{bp}-Chl trend (i.e. we do not get a bi-linear trend in the linear scale as observed in other studies)
  - This is also seen in the Argo data-set
- The bi-linear trend in the log-scale is a visual artifact from having a positive intercept. This positive intercept is mainly driven by a background b_{bp} of NAPs
- Once the background b_{bp} is removed, the trend becomes somewhat linear and a log-log fit seems better. Still, large variability.

Bgc-Argo data-set

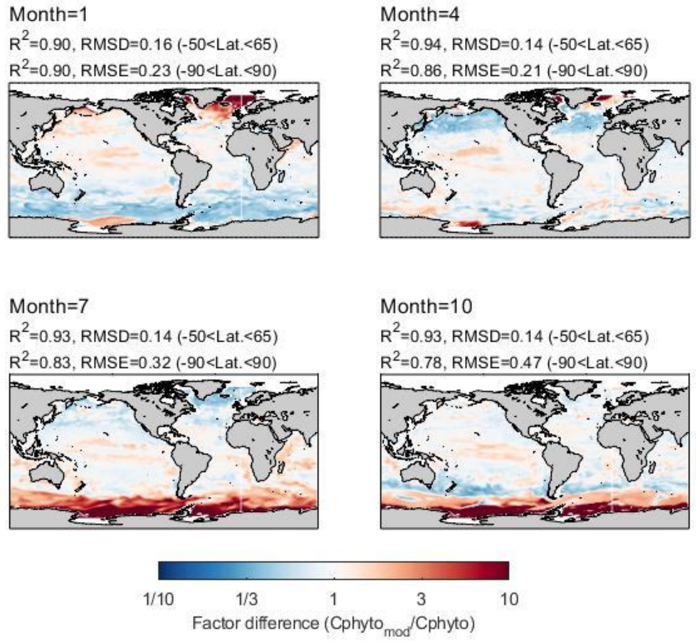




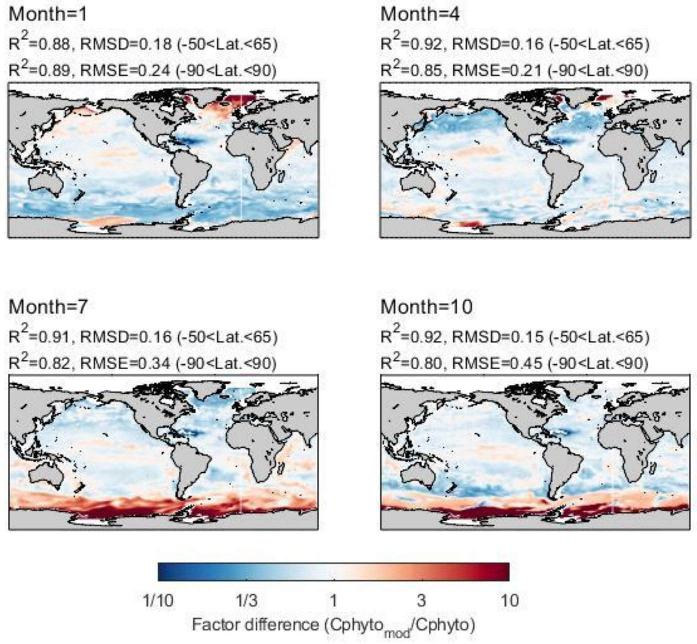


Using b_{bp}- Chl to get C_{phyto}?

Algorithm b_{bp}-C_{phyto}

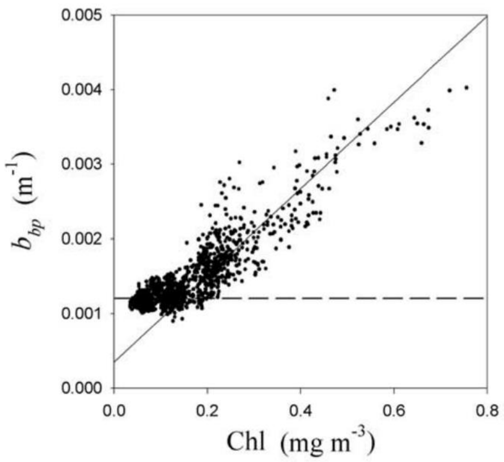


Algorithm using b_{bp}- Chl

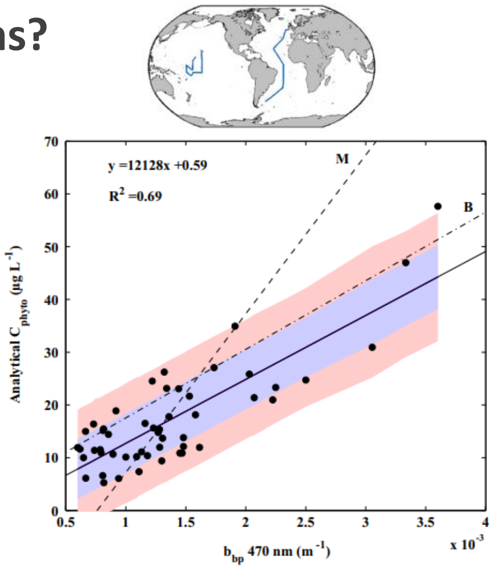


- No big differences if Chl- b_{bp} is used compared to C_{phyto}-b_{bp}
- Chl- b_{bp} relationships can be used to obtain C_{phyto} with similar performance if we had real C_{phyto} data
- The problem is how to convert b_{bp} to C_{phyto} …

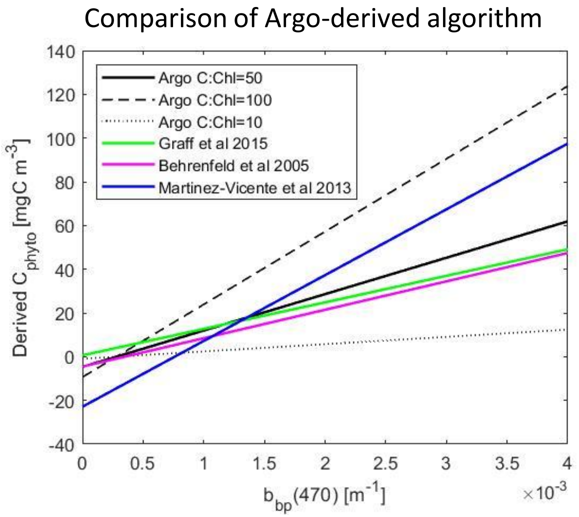
Biases in b_{bp}-based algorithms?



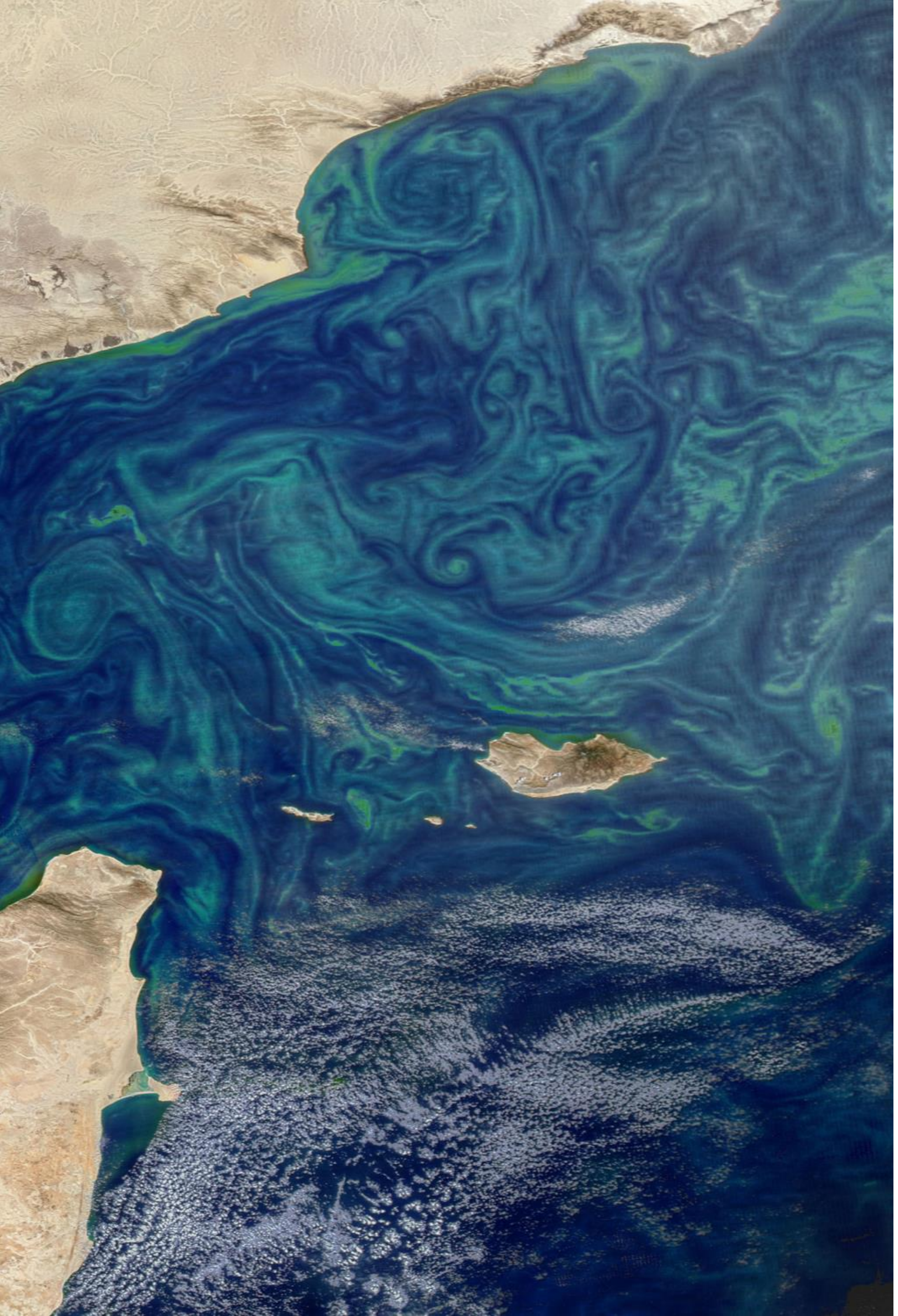
Behrenfeld et al 2005



Graff et al 2015



- Assumptions regarding conversions from b_{bp} to C_{phyto} can result in large differences
- Sampling bias in Graff et al 2005 did not have a strong effect in algorithm performance (tested, but not shown here) → differences in the linear regression across regions might not be that high



Conclusions:

- b_{bp}-based algorithm deviates by a factor of 2 in most regions
  - Some regions are heavily overestimated, specially winter high latitudes (b_{bp} signal is dominated by detritus and heterotrophic bacteria)
- No bi-linear trend at linear scale (either in the MITgcm or Argo data):
  - Bi-linear trend in the log scale emerges from having a positive intercept
- Algorithm derived from Argo data is similar to two of the existing algorithms, but assumptions on conversion factors need to be better constrained
- Sampling biases do not have a strong effect on the overall performance of the algorithm.

Knowledge gaps and next steps:

- Clearly, the limiting factor is the lack of C_{phyto} data
- Use the Argo b_{bp}-Chl data to see differences across regions/biomes
- Explore what has the largest uncertainty to estimate C_{phyto} → b_{bp} or Chl?
  - Uncertainties related to b_{bp} seem similar to the ones driven by differences in Chl:C_{phyto} ratios
  - However, b_{bp} gives a notion of Chl:C_{phyto} ratios