Pan-Arctic chlorophyll *a* concentration dynamics from surface ocean color observations

Adrien Stella[1], Camille Lique[1], Elodie Martinez[1], Laurent Oziel[2]

Context

- Arctic blooms have changed significantly over the past decades, and new primary production patterns are arising. While the overall trend is an increase, we have yet to fully understand disparities in phytoplankton dynamics between different Arctic regions and their changes in response to a changing environment.
- Here, we compare satellite-derived chlorophyll-a concentration (chl, a proxy for phytoplankton biomass) from over two decades of observations throughout all Arctic regions, thereby characterizing regional seasonal cycles with both chl amplitude and phenology and highlighting different inter-annual variations.

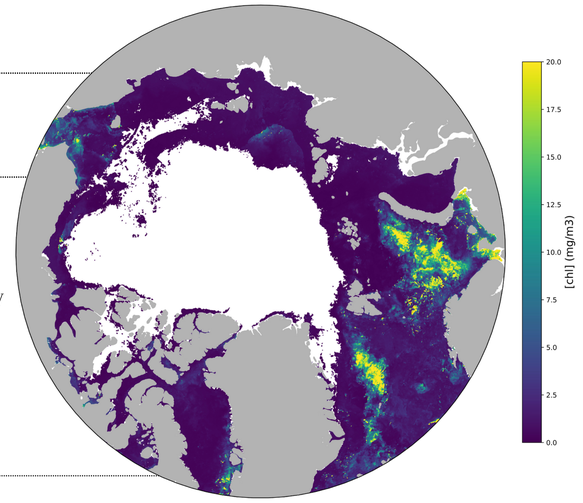
Data & Methods

We use two satellite surface chl datasets - 4km resolution, 8-day composites:

- **Lewis et al., 2020** Arctic-specific ocean color (AOReg.emp algorithm), MODIS sensor only
- ESA Ocean-Color Climate Change Initiative (**OC-CCI**), multi-sensor chl

The Arctic is divided into the 10 subregions associated with the Lewis et al., 2020 dataset.
Seasonal cycles are computed by averaging the full time-series over each 8-day window.
Anomalies to the corresponding seasonal cycle are studied for each region separately.

Figure 1 • Maximal chl value in 2020
Lewis et al., 2020 dataset



Results

Figure 2 • Seasonality and evolution of average chl in 4 different regions

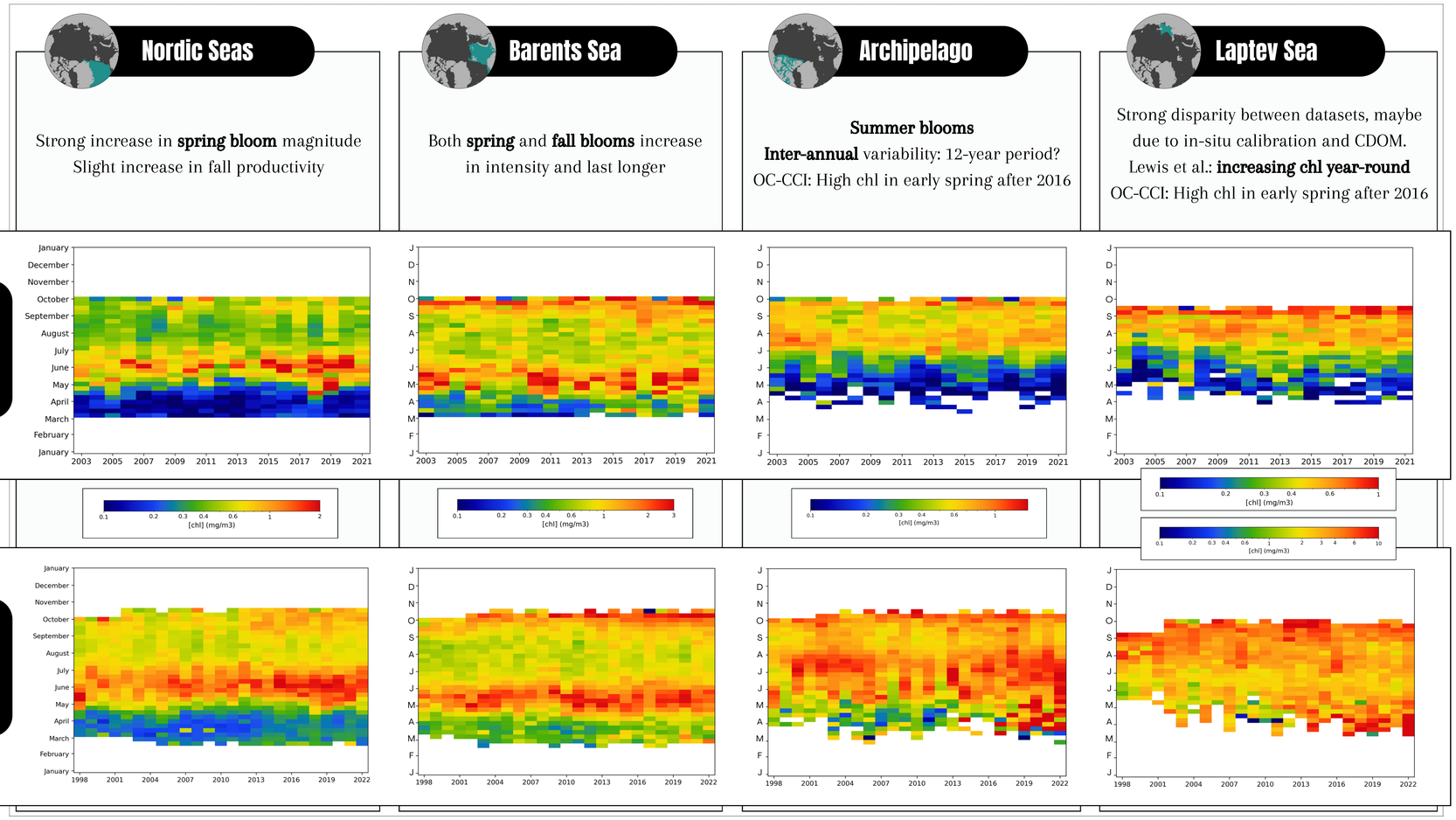
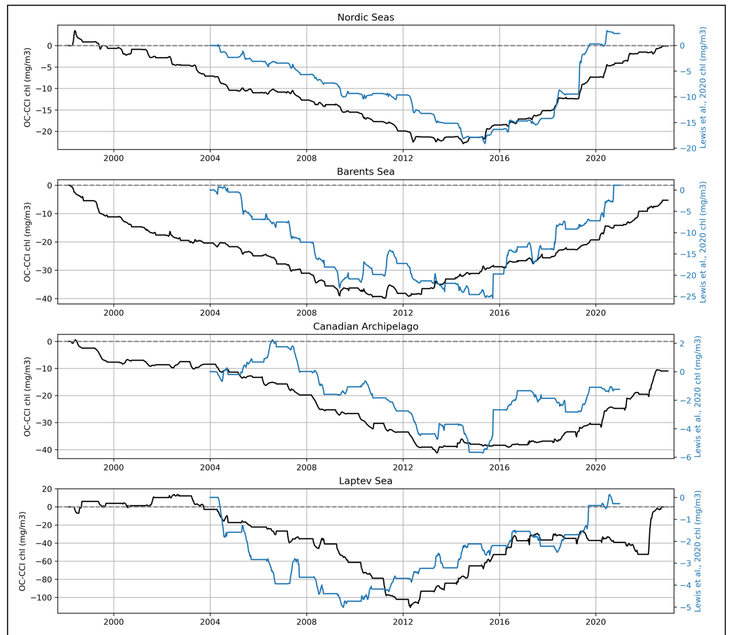


Figure 3 • Cumulated sum of mean chl anomaly to seasonal cycle



Slopes of cumulated sums of the chl anomaly change signs in the early 2010s in most regions: **chl shifts from below to above the seasonal cycle**, indicating a more productive last decade.

Discussion

a. While the global increase in chl is ubiquitous in the observed changes, we notice a **significant heterogeneity between evolutions of phytoplankton dynamics in different regions.** *How are seasonal cycles changing, and how does that differ from one area to another?*

b. Looking at regional mean values is a good first approximation but requires cautious interpretation. E.g. early spring high chl on the interior shelves in OC-CCI corresponds to **few data points in regions known to be ice-covered at that time**. *Do these chl values describe high biomass in polynya, CDOM, or biases?*

c. **These results will be further investigated in light of environmental changes.** E.g. the seasonal cycle anomaly sign shift coincides with a winter Arctic Oscillation index slope change (not shown). *What can ice concentration, stratification, mixed layer depth, or light level tell us about the observed chl changes?*

References

Lewis, K. M., van Dijken, G. L., & Arrigo, K. R. (2020). Changes in phytoplankton concentration now drive increased Arctic Ocean primary production. Science, 369(6500), 198–202.

Lewis, K. M. and K. R. Arrigo. 2020. Ocean Color Algorithms for estimating chlorophyll a, CDOM absorption, and particle backscattering in the Arctic Ocean. Journal of Geophysical Research: Oceans, 125, e2019JC015706. doi:10.1029/2019JC015706.

Sathyendranath, S, Brewin, RJW, Brockmann, C, Brotas, V, Calton, B, Chuprin, A, Cipollini, P, Couto, AB, Dingle, J, Doerffer, R, Donlon, C, Dowell, M, Farman, A, Grant, M, Groom, S, Horseman, A, Jackson, T, Krasemann, H, Lavender, S, Martinez-Vicente, V, Mazeran, C, Mélin, F, Moore, TS, Müller, D, Regner, P, Roy, S, Steele, CJ, Steinmetz, F, Swinton, J, Taberner, M, Thompson, A, Valente, A, Zühlke, M, Brando, VE, Feng, H, Feldman, G, Franz, BA, Frouin, R, Gould, Jr., RW, Hooker, SB, Kahru, M, Kratzer, S, Mitchell, BG, Muller-Karger, F, Sosik, HM, Voss, KJ, Werdell, J, and Platt, T (2019) An ocean-colour time series for use in climate studies: the experience of the Ocean-Colour Climate Change Initiative (OC-CCI). Sensors: 19, 4285. doi:10.3390/s19194285