We thank reviewer #1 for a thorough and constructive review. This review helped us to significantly improve the flow of the manuscript particularly the Methods section. All comments have been addressed as described below. Reviewer's comments are copied below and have been italicized, our responses are in normal black font, citation from the manuscript are in blue font, ~~strikethrough~~ text was deleted, and new sentences that were added in the revised version, in response to reviewer comments, are shown in red font text.

Major comments

Introduction

- *No major comments*

Methods

- *The Methods need substantial reorganizing and clarification:*
    - *More details should be added to the POLYMER atmospheric correction description. Why does it improve data recovery in areas impacted by glint and adjacency effect? What version did you use? Where was it downloaded from? What was it run on? What flags were used? What ancillary data was used?*

We added a statement in section 2.1.1

All analyses for this study were conducted using the University of Maine's high-performance Linux computing cluster following the processing pipeline shown in Fig. A1.

We modified paragraph 2.1 to include more information about POLYMER:

[Main text paragraph 2.1]:

2.1 Level-3 multi-satellite composites

Additionally, we applied the POLYMER atmospheric correction (Steinmetz et al., 2011) to further improve data recovery in areas impacted by glint and adjacency effect (e.g. close to shore and clouds~~, see Steinmetz et al., 2011)~~. POLYMER is an atmospheric correction based on a spectral matching method to decompose the top of the atmosphere (TOA) signal into an atmospheric model and an ocean reflectance model. A three-term polynomial fit is used to model the atmospheric reflectance with the first term accounting for non-spectral scattering such as glint, and the last term accounting for adjacency effect from clouds and white surfaces (Steinmetz et al., 2011). By utilizing the entire TOA spectrum and accounting for adjacency effects and residual glint in its polynomial fit terms, this method improves the retrieval of high-quality data around clouds and from pixels affected by sun glint compared to standard atmospheric correction methods (Frouin et al., 2009, 2012). All analyses for this study were conducted using the University of Maine's high-performance Linux computing cluster following the processing pipeline shown in Fig. A1. ~~The conceptual diagram of the processing pipeline, from level-1 to level-3, is shown in Fig. A1~~.

The references Frouin et al., 2009, 2012 have been added to the reference list. We added the version, the download reference, information on ancillary data, and the computer system used in paragraph 2.1.1:

[Main text paragraph 2.1.1 – lines 85 - 86]:

We processed these L1A images into atmospherically corrected level-2 remote sensing reflectance (R_{rs}) data using the POLYMER algorithm (version v4.17beta2; Steinmetz 2023) and ancillary data from the European Centre for Medium-Range Weather Forecasts reanalysis model version 5 model (i.e. ERA5).

The reference associated with the POLYMER version used (version v4.17beta2; Steinmetz, 2023) from the HYGEOS GitHub has been added to the reference list.

We provided a direct reference for the flag application in the Readme file of POLYMER (POLYMER flags) that lists the flag recommendation. We prefer to keep the specificity of flags in the Readme file rather than listing the flags in the main text to avoid a long and hard to follow Methods section, but we can include it if necessary.

[Main text - line 86 – 87]:
We removed bad quality data pixels by applying the flags and recommendations of POLYMER (see reference POLYMER flags)~~(Steinmetz et al., 2011)~~.

The reference associated with the readme file listing the flag recommendations (Steinmetz 2023a) from the HYGEOS GitHub has been added to the reference list.

- *You should also be citing this paper as well: François Steinmetz and Didier Ramon "Sentinel-2 MSI and Sentinel-3 OLCI consistent ocean colour products using POLYMER", Proc. SPIE 10778, Remote Sensing of the Open and Coastal Ocean and Inland Waters, 107780E (30 October 2018); https://doi.org/10.1117/12.2500232*

We added a statement in paragraph 2.1, line 81:

[Main text paragraph 2.1]:

The POLYMER atmospheric correction was initially developed for the Medium Resolution Imaging Spectrometer sensor (MERIS) but was adapted to produce consistent ocean color products between MODIS, VIIRS, and OLCI sensors among others (Steinmetz et al. 2018).

The reference Steinmetz et al. (2018) have been added to the reference list.

- *The headings in the Methods section seem disorganized to me. For Section 2.1 Level-3 Multi-satellite composites, you start with an intro paragraph and then have several subheadings. Consider merging the intro paragraph into the 2.1.1 section. The 2.1.2 In situ data sub-section seems out of place in this section, consider adding a new section just for in situ data and matchups. Perhaps this organization with just two sections?*

As suggested, we merged the opening paragraph and the subheadings 2.1.1 and 2.1.5 into section 2.1, however we decided to keep 2.1.4 separate because the merging into level-3 data described in this paragraph require the in situ sampling to be introduced before. Therefore, we have removed the sub-heading as suggested and kept only 3 sections explaining the method to create level-3 merged products:

- 2.1 Level-3 satellite products computation:
  This section includes the opening paragraph. 2.1.1 and 2.1.5
- 2.2 In situ data and matchups
  This section includes section 2.1.2 and 2.1.3
- 2.3 Level-3 multi-satellite products merging
  This section includes 2.1.4

We also noticed $\Sigma[Chla]_{IME}$ (section 2.1.1 lines 90 – 93) should be described after the method to detect the IME zones (section 2.2.2). We moved “We computed surface-integrated [Chla] as a metric for two dimensional phytoplankton biomass in metric tons of Chla per depth meter (mt.m−1) by summing the [Chla] of each pixel within a predefined zone (i.e. here, the zone influenced by IME) multiplied by the area of that pixel:

$$\sum[Chla]_{IME} = \sum_{n=1}^{N_{pixel_{IME}}} [Chla]_n \times area_{pixel_n}$$

”

from section 2.1.1 lines 90 – 93 to section 2.2.2 line 245.

- *The description of running POLYMER and l2gen should be in same paragraph/section. Right now, you have text on l2gen in the in situ and satellite matchups section which seems out of place.*

We moved “For comparison, we also generated the standard NASA Rrs using the atmospheric correction of SeaDAS (i.e. "l2gen") using the Ocean Color processor (OCSSW) V2022.3. We then estimated [Chla] from these Rrs using the same blended CI-OCx algorithm (i.e. chlor_a; Hu et al., 2019) and the simple OCx algorithm (i.e. chl_ocx; O’Reilly and Werdell, 2019).” into section “2.1 Level-2 satellite products computation”.

- *In Section 2.1.1, there is no description of how data was processed to Level-3 format. It seems to stop at L2.*

We have addressed this issue while re-organizing the method sections. The level-2 data production is now explained in section “2.1 Level-2 satellite products computation” and the merging of these level-2 data into level-3 products is described into “2.3 Level-3 multi-satellite products merging”

  - *Figure 1 seems okay in the Methods because it is a figure of the workflow. However, should Figures 2-3 be in the "Assessment" section since it is showing the results of the workflow? I don't think you should be referencing results figures in the Methods, save that for the Results (or "Assessment").*

We decided to include Figures 2 and 3 into the method to help understand how IME zones are not strictly developing around individual islands but instead encompassing island groups. We believe these two figures provide a good illustration justifying the strategy to detect IME around neighboring islands in section 2.2.3.

Assessment

- *Some of the text in the Assessment section would better belong in the Methods such as the description of merging and binning and the chl iteration step size*

We have moved the sentence about binning Lines 307-310 to the method section 2.3 such as suggested in the minor comment below.

We acknowledge the "Assessment" section still contains some methodological details including merging, binning, and the chl iteration step size however all these details are first presented in the method section. In the "Assessment" section, we assess our new approach, including the impact of merging, binning, and changing the iteration step size to demonstrate how these changes enhance IME detection using the algorithm developed in this study.

We have modified the sentence introducing the changes applied to the method from Messié et al. (2022) in the method section (line 206) to clarify that all the following statements describe the method updates developed in this study:

"We therefore extended the method proposed by Messié et al. (2022) by adding another set of detection protocols, here called step 2 and step 3."

Minor comments

- *The title on the preprint PDF is different than what is in the system.*

Thank you for pointing this issue, we did not updated the title in the system with the last version, we will make sure to correct this mistake.

- *Line 5: Consider adding a after chlorophyll. Same on Line 20.*

We added "a" after chlorophyll line 5 and 20.

- *Line 8: Define POLYMER*

We would like to thank the reviewer for this suggestion. We have added a detailed description of POLYMER in section 2.1

- *Line 18: The way this sentence is written makes it seem like "their wake downstream.." refers to the winds and currents. Reword to make this more clear.*

We have reworded the sentence line 18 to improve clarity:

As winds and currents interact with island topography, they induce mesoscale processes (i.e. local upwelling, eddies) that form at the downstream wake of islands ~~their wake downstream of islands~~.

- *Line 28: Consider adding the citation to the end of this sentence.*

Since these two sentences refer to the same citation, we have moved the citation (Doty and Oguri, 1956) from line 29 to line 30.

- *Line 35: Consider changing "They" to "The authors"*

We have changed "They" by "The authors" line 35.

- *Line 77: Should define these satellite mission acronyms*

We have defined these satellite mission acronyms line 77.

- *Line 79: More information on the POLYMER atmospheric correction scheme should be included here. See major comment above.*

We have included information on the POLYMER atmospheric correction in this section.

- *Line 84: Include the time frame of data collected. What is "all"?*

We have added "consisted in six-month long time-series of satellite data" in this paragraph when we re-worked part of this section to address the major comment regarding method reorganization.

- *Line 84: Why did you download L1A data instead of L1B? Review differences here: https://oceancolor.gsfc.nasa.gov/resources/docs/productlevels/#:~:text=Level%201B%20data%20are%20Level,had%20instrument%2Fradiometric%20calibrations%20applied.&text=Level%202%20data%20consist%20of,the%20source%20Level%2 01%20data.*

We chose to download L1A instead of L1B data because the Python utility "getOC" used to batch download all satellite data only support L1A and L2 data for NASA satellite. Both L1A and L1B data can be processed using the POLYMER atmospheric correction.

- *Line 85: What Copernicus repository? Provide link(s).*

We downloaded data via the Copernicus Data Space Catalogue API. We have changed the sentence added a link for both NASA Ocean Color API and Copernicus API.

“We downloaded level-1 (L1A) top-of-the-atmosphere radiance of MODIS-Aqua, MODIS-Terra, VIIRS-SNPP, and VIIRS-JPSS1 via NASA’s common metadata repository application programming interface (CMR API), and the resampled 1 km spatial resolution OLCI-S3a and OLCI-S3b data via the Copernicus Data Space Catalogue API using the Python download utility "getOC" (getOC GitHub: Haëntjens and Bourdin, 2017)~~all MODIS and VIIRS level-1 (L1A) images in the vicinity of islands of interest from the Ocean Color repository, and OLCI level-1 images from the Copernicus repository~~.”

- *Line 88: What did you use to project the satellite data onto a plate-carre reference grid using NN interpolation?*

We used the Python SciPy library to project satellite data onto a plate-carre reference grid using NN interpolation and added this information in section 2.1.

“Subsequently, we projected each satellite image of the "study dataset" onto the same equally spaced 1 km spatial resolution plate-carré reference grid specific to each studied region of interest using nearest-neighbor interpolations from Python’s SciPy library.”

- *Line 91: Confused on how this is surface-integrated chla when you’re just summing chla concentration in each pixels by the area? Where does depth come into play?*

We renamed this parameter “surface-area integrated [Chla]” to clarify that it corresponds to [Chla] integrated over the surface area of IME and BO zones and not depth:
“We computed surface-area integrated [Chla] as a proxy for surface phytoplankton biomass integrated over entire IME and BO zones in two-dimensional ~~metric for two dimensional phytoplankton biomass in~~ metric tons of chlorophyll *a* ~~per depth meter~~ (mt.m−1) by summing the [Chla] of each pixel within IME and BO zones ~~a predefined zone (i.e. here, the zone influenced by IME)~~ multiplied by the area of that pixel”

We changed “surface-integrated [Chla]” with ”surface-are integrated [Chla]” throughout the text.

This description is now located in section formerly named “2.2.2 IME contour delineation” and now “2.4.2 IME contour delineation”, after the description of the IME and BO zones which improves clarity.

- *Line 96: Not sure you need to hyphenate hyperspectral*

The hyphen was deleted in “hyperspectral”.

- *Line 110: Capitalize Python*

We capitalized “Python”.

- *Line 112: You describe how all satellite data is processed to Level-3 using same scheme as aforementioned but this was never described.. You don’t introduce the terms reprojecting, nudging, or merging until now. What is nudging?*

This issue was addressed while re-organizing the method section following the major comment above. “Nudging” in this case means “adjusting” or “calibrating” satellite data to in situ data. Section 2.3 now explains the nudging and merging methods before it is mentioned elsewhere.

- *Line 114: OCSSW stands for Ocean Color Science Software*

The OCSSW acronym was defined as suggested.

- *Line 119: Consider adding the satellite overpass times for each sensor. How do they match up with the 10:30am local time for in situ data collection?*

We have added each satellite overpass time for reference in section 2.2. Satellite data were not matched with HPLC sampled at 10:30 local time. As explained in section 2.1.2 correlations between a_p and total chlorophyll *a* concentration were used to estimate [Chla] from continuous measurements of a_p, and as explained in section 2.1.3 satellite data were matched with these continuous estimates of [Chla].

- *Line 120: The sentence about recommended Level-2 masks needs a citation. Masks or flags? Did you use recommended L2 or L3 flags?*
  https://oceancolor.gsfc.nasa.gov/resources/atbd/ocl2flags/

We applied the L2 default flags. We have clarified this sentence and moved it to section 2.1 following the method section reorganization: “For comparison, we also generated the standard NASA Rrs using the atmospheric correction of SeaDAS (i.e. "l2gen") using the Ocean Color ~~processor~~Science Software (OCSSW) V2022.3, on which we applied the Level-2 default flags (NASA OBPG flags).”

The parenthesis (NASA OBPG flags) refers to the level-2 default flags webpage

- *Line 120: Are you working with Rrs or nLw? Are these both included when running l2gen and POLYMER?*

We have corrected this sentence we computed median coefficients of variation or Rrs not nLw to check for match-ups validity. We only generated Rrs using l2gen and POLYMER for this study. Note that Rrs or nLw can be used interchangeably to check for match-up validity using their coefficient of variance because nLw = Rrs × F_0 where F_0 is the extra-terrestrial solar flux at the time of observation.

- *Line 136: What is GlobColour?*

GlobColour is the ocean color merging processor distributed by Copernicus. We added “Copernicus' multi-satellite Global Ocean Colour processor (i.e. GlobColour)” to explain what GlobColour stands for. More details about the GlobColour can be found in the work cited in this sentence (Garnesson et al., 2019).

- *Line 138: Why would this described merging strategy require simulation of 510 nm band? Line 162: This sentence should have a citation*

By "*simulation of 510 nm band"* we meant band shifting procedure to approximate Rrs for bands not available for all sensors before merging Rrs. We have clarified this sentence:
"This method offers two important advantages; (1) it does not require any band shifting procedure to merge Rrs between sensors with different spectral bands ~~simulations of the 510 nm band, which are not available on VIIRS and MODIS~~, and (2) it benefits from sensor-specific algorithm coefficients that account for variability in Rrs across sensors to produce consistent products (Garnesson et al., 2019)."

- *Line 168: Did you use the 300m spatial resolution of OLCI? Section 2.1.4: Did you merge data from all 6 satellite sensors? What spatial resolution did you use for merged product? If 1km, then OLCI data was "upsampled"?*

We used resampled OLCI products distributed by Copernicus to start at the same nominal spatial resolution than MODIS and VIIRS L2 products. We added this information in section 2.1:

"We downloaded level-1 (L1A) top-of-the-atmosphere radiance of MODIS-Aqua, MODIS-Terra, VIIRS-SNPP, and VIIRS-JPSS1 from the Ocean Color repository, and the resampled 1 km spatial resolution OLCI-S3a and OLCI-S3b data from the Copernicus Data Space repository using the Python download utility "getOC" (getOC GitHub: Haëntjens and Bourdin, 2017 ~~https://github.com/OceanOptics/getOC~~)."

- *Line 174: Keep consistent- change to 1 km*

We changed "one kilometer" to "1 km" line 174 and throughout the text and captions

- *Line 175: Need citation*

We added the citation for the GEBCO 2022 database used.

- *Line 176: Arc-seconds seems like a weird unit here.. can you convert to degrees or m? Section 2.2.1: What did you use to create masks and "manually correct" discrepancies? Python? GIS?*

Arc seconds is the unit of angular measurement at which GEBCO is distributed (see associated citation). It corresponds to 463m at the equator such as mentioned in the same parenthesis line 176: "(i.e. 15 arc-seconds corresponding to 463 m at the equator)."

- *Line 207: This needs a citation*

The citation for the global ocean ensemble physics reanalysis products was added.

- *Line 247: Are the equations in the paranthesis supposed to be exactly the same?*

The equations in the parenthesis are not the same, one represents delta chlorophyll concentration ($\Delta[\mathrm{Chla}]_{\mathrm{IME_T{-}BO_T}}$) while the other represents delta surface-area integrated chlorophyll ($\Delta\Sigma[\mathrm{Chla}]_{\mathrm{IME_T{-}BO_T}}$).

- *Line 249: What does SEM stand for here?*

SEM stands for standard error of the mean and was indeed only defined in the table of notation (Table 1). We have defined SEM at its first occurrence line 154

"We propagated errors associated with [Chla] estimation, nudging, and merging throughout each step to represent the final [Chla] uncertainty denoted as the standard error of mean (i.e. SEM) of the merged product ($SEM^{f}_{[\mathrm{Chla}]_{\mathrm{IME}}}$; see appendix B)."

- *Lines 307-310: Do these sentences belong in the Methods?*

Yes, the sentence starting line 307 belongs in the Methods, we moved it to section 2.1.4 and adjusted the previous two sentences accordingly:
"Time-series of 8-day ~~medians~~ periods were the smallest temporal binning we could achieve to recover nearly full satellite images in all the studied regions for six-month long time-series. Before computing the ~~medians~~ merged products of a given 8-day period and a given region, we grouped all re-projected level-2 images and removed outliers (see appendix C). To minimize the weight of outliers on the end level-3 products, the binning was performed with medians instead of averages."

- *Line 311: I don't think these figures are considered time-series? They are just snapshots, right?*

Indeed, these figures are snapshots. We added the reference for the time-series from the supplementary material and modified the sentence accordingly:
"Time-series of remote sensing maps (Bourdin, 2024a) and their snapshots (Fig. 2, Fig. 3) reveal the complexity of currents around islands and the rather chaotic advection patterns of IME into the open-ocean and between islands."

- *Line 435: Change to [chla]- keep consistent*

We chose to use chlorophyll *a* instead of [Chla] in this specific case because [Chla] refers to chlorophyll *a* concentration but this sentence is about absolute accumulation of chlorophyll *a*, not the concentration of chlorophyll *a*.
"This dynamic IME detection method permitted tracking in time the accumulation of chlorophyll *a* standing stock in surface waters, which suggested frequent temporal increases in phytoplankton biomass in addition to the spatial increase in phytoplankton biomass already detected around islands."

- *Figure 2: I wonder if labeling the islands on the map will help orient the readers?*

We thank the reviewer for this suggestion, we added labels on the map depicting the main archipelagoes.

- *Figure 4: What does "average or properties within the IME" mean?*

We acknowledge "average of properties" in Figure 4 and 5 captions are confusing. We modified the captions of Figure 4, 5, E1, and E2 to present separately each panel of the figures.

Please find below the final draft of the first 3 sections of the methods we have re-organized:

2 Method

2.1 Level-2 satellite products computation

The use of a single satellite sensor often results in maps with significant gaps in data due to intermittent cloud cover or glint (which depends on satellite-specific viewing angle). To address this, we have adapted NASA Ocean Color's processing strategy to produce level 3 custom-made composite products from level-1A (L1A) top-of-the-atmosphere radiance. We merged data collected by three different sensor types (Moderate Resolution Imaging Spectroradiometer - MODIS, Visible Infrared Imaging Radiometer Suite - VIIRS, and Ocean and Land Colour Instrument - OLCI) onboard up to six polar-orbiting satellites (Aqua, Terra, SNPP, JPSS1, Sentinel-3a, and 3b). By taking advantage of their different overpass times, swaths, and viewing geometry, we decreased the impact of clouds and glint on data recovery. Additionally, we applied the POLYMER atmospheric correction (Steinmetz et al., 2011) to further improve data recovery in areas impacted by glint and adjacency effect (e.g. close to shore and clouds). POLYMER is an atmospheric correction based on a spectral matching method to decompose the top of the atmosphere (TOA) signal into an atmospheric model and an ocean reflectance model. A three-term polynomial fit is used to model the atmospheric reflectance with the first term accounting for non-spectral scattering such as sun glint, and the last term accounting for adjacency effect from clouds and white surfaces (Steinmetz et al., 2011). By utilizing the entire TOA spectrum and accounting for adjacency effects and residual glint in its polynomial fit terms, this method improves the retrieval of high-quality data around clouds and from pixels affected by sun glint compared to standard atmospheric correction methods (Frouin et al., 2009, 2012). The POLYMER atmospheric correction was initially developed for the Medium Resolution Imaging Spectrometer sensor (MERIS) but was adapted to produce consistent ocean color products between MODIS, VIIRS, and OLCI sensors among others (Steinmetz and Ramon, 2018).

Most operational level-3 products are available at spatial resolutions of 4 or 9 km. While this resolution is usually sufficient to capture important mesoscale spatial features in the open ocean, it does not resolve sub-mesoscale features like fronts, small eddies, and filaments around islands. Additionally, bottom reflectance in coastal waters prevents data recovery closer than 4 or 9 km from shore at these spatial resolutions. Moreover, it is a common practice in coastal studies to remove at least one neighboring pixel around shallow areas to limit the impact of adjacency effects and ensure no contamination from bottom reflectance. Therefore, the closest data recovered with a 4 km spatial resolution is most often centered at least 6 km away from the 30 m isobaths. However, most islands in the ocean are smaller than 2 km^2. For instance, the median island area in the 2593 km x 2593 km region analyzed around the Fiji Archipelago is ~0.06 km^2 with ~ 86% of all islands smaller than 2 km^2. Therefore, having the closest pixel 6 km away from shore, and a pixel size that is at least twice the size of ~ 86% of islands, limits our ability to accurately quantify their IME (see example around Niue island Fig. A2). With the approach presented here, we can maximize data recovery close to shore while keeping the nominal resolution of 1 km of the operational MODIS and VIIRS level-2 (L2) products. Ideally, we would produce this type of multi-satellite composite for the entire Pacific Ocean, but we had to limit our study area to four case-studies around islands of interest due to computational and data storage capacity limitations. In each case, the maps were large enough (i.e. > 1200 km x 1200 km area) to capture the full extent of the IME around the group of islands studied and were limited to a maximum size of 2600 km x 2600 km area.

All analyses for this study were conducted using the University of Maine's high-performance Linux computing cluster following the processing pipeline shown in Fig. A1. We downloaded level-1 (L1A) top-of-the-atmosphere radiance of MODIS-Aqua, MODIS-Terra, VIIRS-SNPP, and VIIRS-JPSS1 via NASA's common metadata repository application programming interface (CMR API), and the resampled 1 km spatial resolution OLCI-S3a and OLCI-S3b data via the Copernicus Data Space Catalogue API using the Python download utility "getOC" (see reference for GitHub: Haëntjens and Bourdin, 2017). We built two sets of satellite data. We downloaded the first set of images along the entire Tara Pacific transect (May 2016 to October 2018 see Gorsky et al., 2019; Lombard et al., 2023) and used it to compute sensor specific calibration coefficients based on correlation with continuous in situ data (see section 2.2). We refer to it as the 'calibration dataset'. The second set of images, referred to as the 'study dataset', consists of six-month long time-series of satellite images in the vicinity of islands of interest. We processed all downloaded L1A images into atmospherically corrected level-2 remote sensing reflectance (Rrs) data using the POLYMER algorithm (version v4.17beta2; Steinmetz, 2023) and ancillary data from the European Centre for Medium-Range Weather Forecasts reanalysis model version 5 model (i.e. ERA5). We removed bad quality data pixels by applying the flags and recommendations of POLYMER (see reference POLYMER flags). For comparison, we also generated the standard NASA Rrs using the atmospheric correction of SeaDAS (i.e. "l2gen") using the Ocean Color Science Software (OCSSW) V2022.3 and applying the Ocean Color default flags (see reference NASA OBPG flags). Subsequently, we projected each satellite image of the study dataset onto the same equally spaced 1 km spatial resolution plate-carré reference grid specific to each studied region of interest using nearest-neighbor interpolations from Python's SciPy library. We estimated [Chla] from all POLYMER and l2gen Rrs data using the OCx algorithm (i.e. chl_ocx; O'Reilly and Werdell, 2019) and the CI-OCx blended algorithm (i.e. chlor_a; Hu et al., 2019; O'Reilly and Werdell, 2019).

2.2 In situ data and match-ups

We calibrated remote sensing products to minimize inter-sensor variability and biases using in situ data collected during the Tara Pacific Expedition (Gorsky et al., 2019; Lombard et al., 2023). We measured hyperspectral absorption (a) and attenuation (c) quasi-continuously near islands with a SeaBird ACs spectrophotometer mounted in an underway flow-through system. We computed particulate absorption and attenuation coefficients (i.e., a_p and c_p) by referencing these sensor measurements to hourly samples taken through a 0.2 µm filter (Dall'Olmo et al., 2009; Slade et al., 2010; Boss et al., 2019). Particulate beam attenuation at 660 nm (c_{p660}) was used as a proxy for particulate organic carbon (Gardner et al., 2006; Cetinic et al., 2012). We estimated absorption specific to Chla-containing particles using the line-height of the a_p peak at 676 nm (a_{p676LH}; Boss et al., 2013). We collected surface samples daily around 10:30 am local time for pigment analysis via high-pressure liquid chromatography (HPLC; see Gorsky et al., 2019; Lombard et al., 2023). We then estimated [Chla] from a_p by applying the well-constrained linear relationship between the logarithm of a_{p676LH} amplitude and the logarithm of total [Chla] estimated from HPLC (Fig. B2.a).

We performed match-ups between the calibrated [Chla] estimated from the underway system and the [Chla] estimated from satellites to choose the best algorithm (i.e. least noisy or biased) to compute [Chla] from satellite Rrs. We matched three different [Chla] products (i.e. chlor_a_polymer, chl_ocx_seadas, chlor_a_seadas) with the calibrated [Chla] estimated from the underway system following Bailey and Werdell (2006). We extracted and averaged underway [Chla] measurements within a ±3-hour period of each satellite overpass (i.e. Aqua and SNPP 13:30, Terra 10:30, Sentinel 3a and 3b 10:00, JPSS1 14:20 local time at the equator) and satellite data from the 25 closest pixels to underway data locations. We computed median coefficients of variation of Rrs for bands between 412 and 555 nm and for the aerosol optical thickness at 865 nm for each match-up and tested several homogeneity thresholds and minimum number of unmasked pixels to maximize the number of valid match-ups without introducing noise to the in situ-satellite correlations (Bailey and Werdell, 2006). Only match-ups with a minimum of 7 unmasked pixels and coefficients of variation lower than 0.15 were kept (Fig. B2(b), (c), and (d)). We compared the parameters of the robust linear regressions of valid match-ups to choose for the best [Chla] derivation methods (Table B1). We found 33% more valid match-ups with [Chla] computed using POLYMER Rrs (N = 428) than valid match-ups with [Chla] computed using SeaDAS Rrs (N = 321). [Chla] computed with the blended CI-OCx using POLYMER Rrs showed, on average, the highest coefficient of determination ($R^2_{chlor\_a\_polymer} = 0.78\pm0.05$), slopes closest to 1 ($slope_{chlor\_a\_polymer} = 0.99\pm0.10$), and intercepts closest to 0 ($intercept_{chlor\_a\_polymer} = -0.06\pm0.10$) when compared to in situ [Chla]. In contrast, the normalized root mean square error of the correlation between in situ [Chla] and [Chla] computed with the blended CI-OCx using POLYMER Rrs ($nRMSE_{chlor\_a\_polymer} = 21.81 \pm 6.34\%$) was higher than with the other two [Chla] computed using SeaDAS Rrs ($nRMSE_{chlor\_a\_seadas} = 16.55\pm1.70\%$ and $nRMSE_{chl\_ocx\_seadas} = 20.94\pm3.18\%$). Considering the smaller bias (slope closer to 1 and intercept closer to 0) and better data recovery (higher number of valid match-up) associated with the computation of [Chla] with the blended CI-OCx algorithm applied on POLYMER Rrs, we choose this method for the rest of the analysis to minimize differences between sensors while maximizing valid pixel recovery. Despite the well-documented degradation of the MODIS sensor onboard the Terra satellite and its potential impact on climate studies (Lyapustin et al., 2014; Xiong et al., 2019; Xiong and Butler, 2020), our analysis found no significant indication of reduced data quality in [Chla] estimates derived from MODIS-Terra Rrs. Correlations between in situ [Chla] and MODIS-Terra-derived [Chla] showed performance metrics (R^2, nRMSE, slope, and intercept) comparable to those of other satellite sensors included in this study (Table B1 and Fig. B2 b, c, and d). These findings suggest that the extensive correction and calibration efforts applied to MODIS-Terra data effectively mitigate the impacts of solar diffuser degradation, changes in scan mirror reflectance, and increased polarization sensitivity (Lyapustin et al., 2014). As a result, MODIS-Terra data can be reliably incorporated into the multi-satellite merged product used in this study.

2.3 Level-3 multi-satellite products merging

We followed a similar merging strategy to that of Copernicus' multi-satellite Global Ocean Colour processor (i.e. GlobColour): each sensor's satellite product was derived separately before merging them (Garnesson et al., 2019), rather than the strategy of the Ocean-Colour Climate Change Initiative (i.e. OC-CCI) which merges reflectances before calculating the products (Sathyendranath et al., 2019). This method offers two important advantages: (1) it does not require any band shifting procedure to merge Rrs between sensors with different spectral bands, and (2) it benefits from sensor-specific algorithm coefficients that account for variability in Rrs across sensors to produce consistent products (Garnesson et al., 2019). To improve consistency and minimize the differences across satellite sensors, we individually calibrated the [Chla] data from each sensor with the underway in situ [Chla] measurements (using parameters from their respective robust linear regressions, see Table B1) to produce "calibrated" products before merging them. This nudging method reduced the inter-satellite variability and improved the spatial smoothness of the binned products. Since [Chla] was calibrated to in situ data, the bias associated with the estimation of [Chla] from each satellite was centered, and likely reduced, to the bias of in situ data. For each study area, we binned the calibrated data temporally to reconstruct full satellite images. Time-series of 8-day periods were the smallest temporal binning we could achieve to recover nearly full satellite images in all the studied regions for six-month long time-series. Before computing the merged products of a given 8-day period and a given region, we grouped all re-projected level-2 images and removed outliers (see appendix C). To minimize the weight of outliers on the end level-3 products, the binning was performed with medians instead of averages. We produced a six-month long time-series of level-3 8-day medians of [Chla] for each of the four case-studies presented here. Each case-study region was centered geographically on an island sampled during the Tara Pacific Expedition, and each six-month time-series was centered temporally on the day of in situ sampling (Gorsky et al., 2019; Lombard et al., 2023). We propagated errors associated with [Chla] estimation, nudging, and merging throughout each step to represent the final [Chla] uncertainty denoted as the standard error of mean (i.e. SEM) of the merged product ($SEM^{f}_{[Chla]IME}$; see appendix B). We used this final uncertainty to determine if the [Chla] enhancement associated with an IME was significant or not.

End of review