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Ocean Colour Activities in UK NCEO

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Phytoplankton biomass and diversity

ECIS

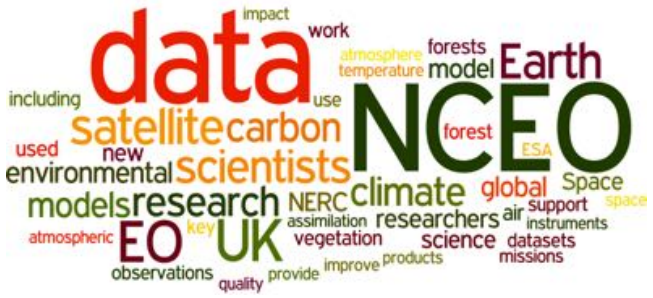
National Centre for Earth Observation
NATURAL ENVIRONMENT RESEARCH COUNCIL

UKRI Natural Environment Research Council

UK National Centre for EO (NCEO)

- > 100 scientists in leading UK universities and research organisations
- > 150 research papers every year
- Contributions to major, international, environmental science reports
- Championing the NERC EO community
- Encompasses work in international projects like ESA Climate Change Initiative

- **Expertise**
  - **space-based EO science**
  - **model-data merging, data assimilation**
  - **international EO data products**
  - **model evaluation to underpin Earth system/climate research**
  - **significant roles in mission planning**



National Centre for Earth Observation
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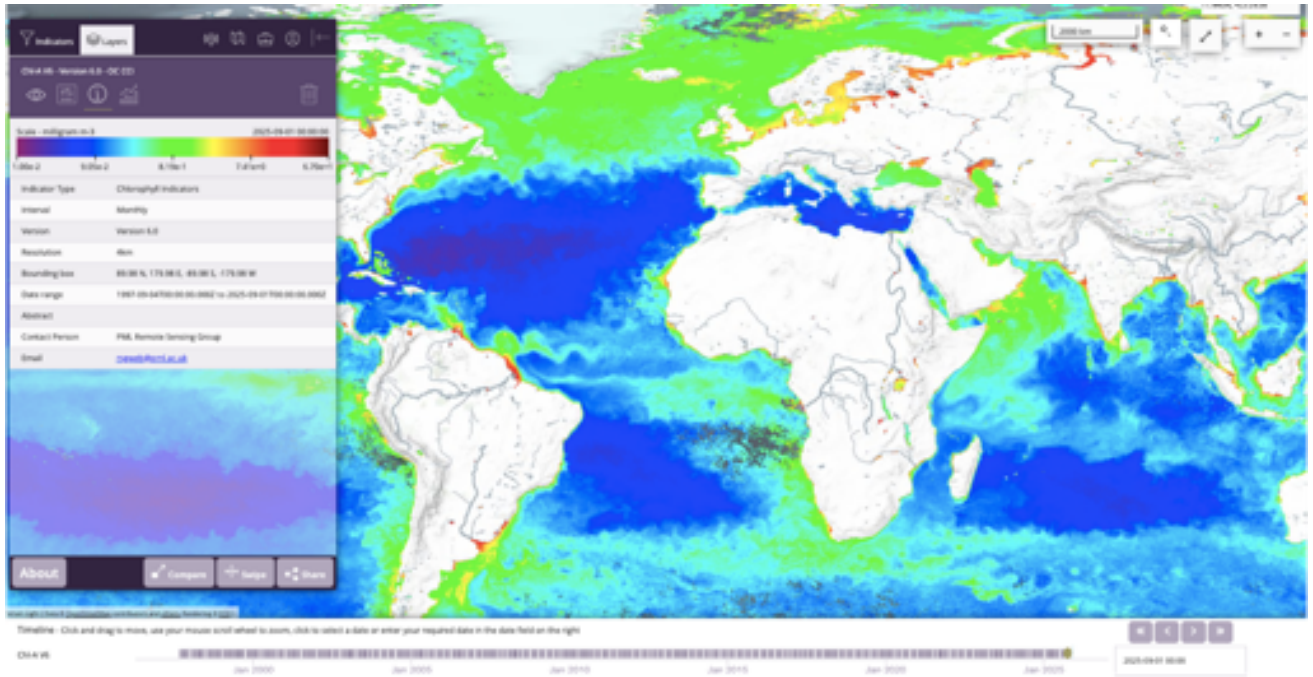
UKRI Natural Environment Research Council

Summary

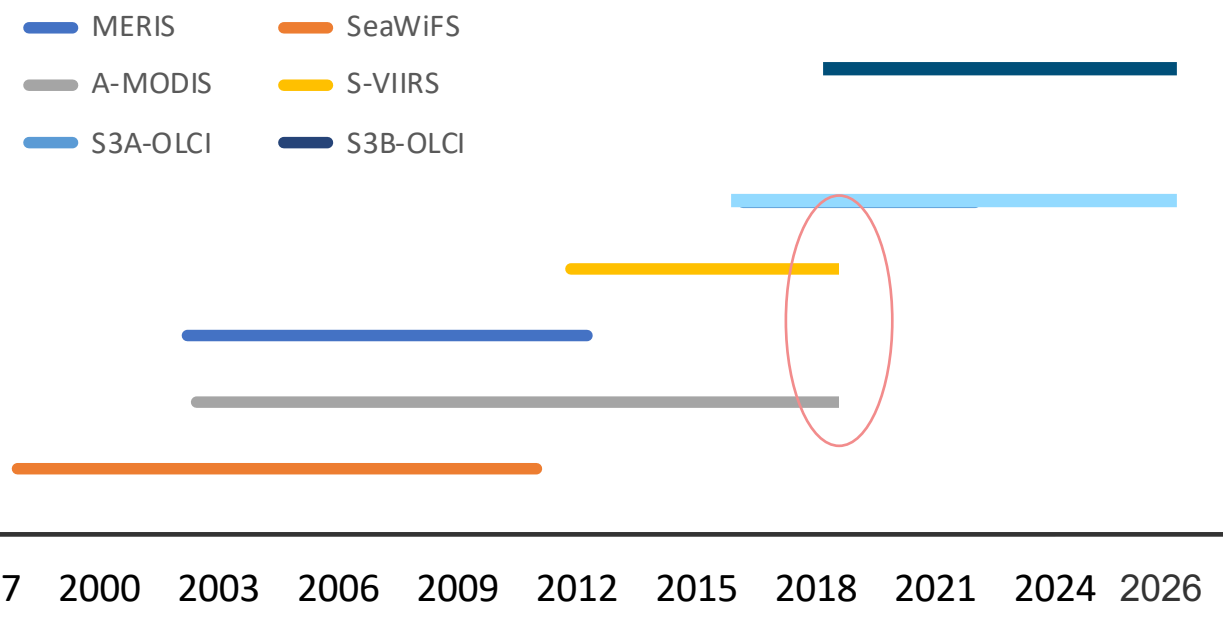
- NCEO research (as highlighted at IOCS 2023) includes: ocean colour algorithm development; validation using in situ observations; and understanding biological processes that underpin the ocean carbon sink and the global carbon cycle
- Research uses the ESA Ocean Colour Climate Change Initiative dataset
  - Particularly relevant given new IOCCG Working Group on Long-Term Datasets – see Break out 10 on Wednesday
  - Also, new ESA project Phytoplankton CCI (PhytoCCI) is investigating phytoplankton carbon and diversity as measured by pigments



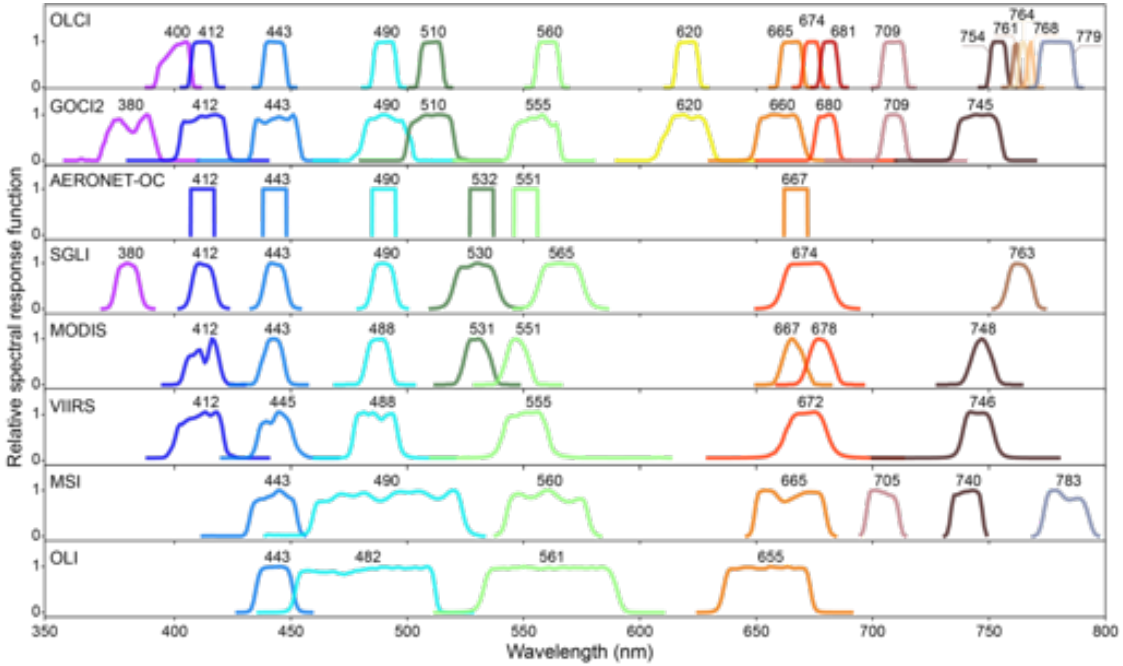
Ocean Colour CCI

- To create a long-term climate quality dataset need to merge multiple sensors:
- OC CCI accomplishes this by band-shifting sensors to a reference; inter-sensor bias correction; and harmonisation of approaches

- **Finite sensor lifetime:**
- OC CCI Version 6 includes:
  - SeaWiFS & MERIS - defunct
  - MODIS-Aqua & Suomi-VIIRS to 2020
  - S3A and B OLCI



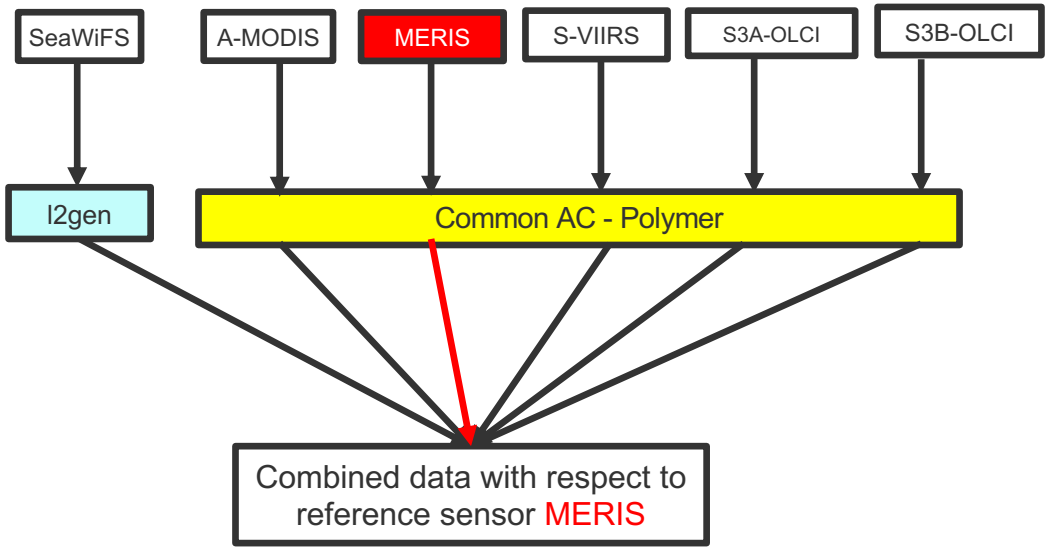
- **Different sensor band sets**
- V6 uses MERIS as reference sensor with 6 core bands



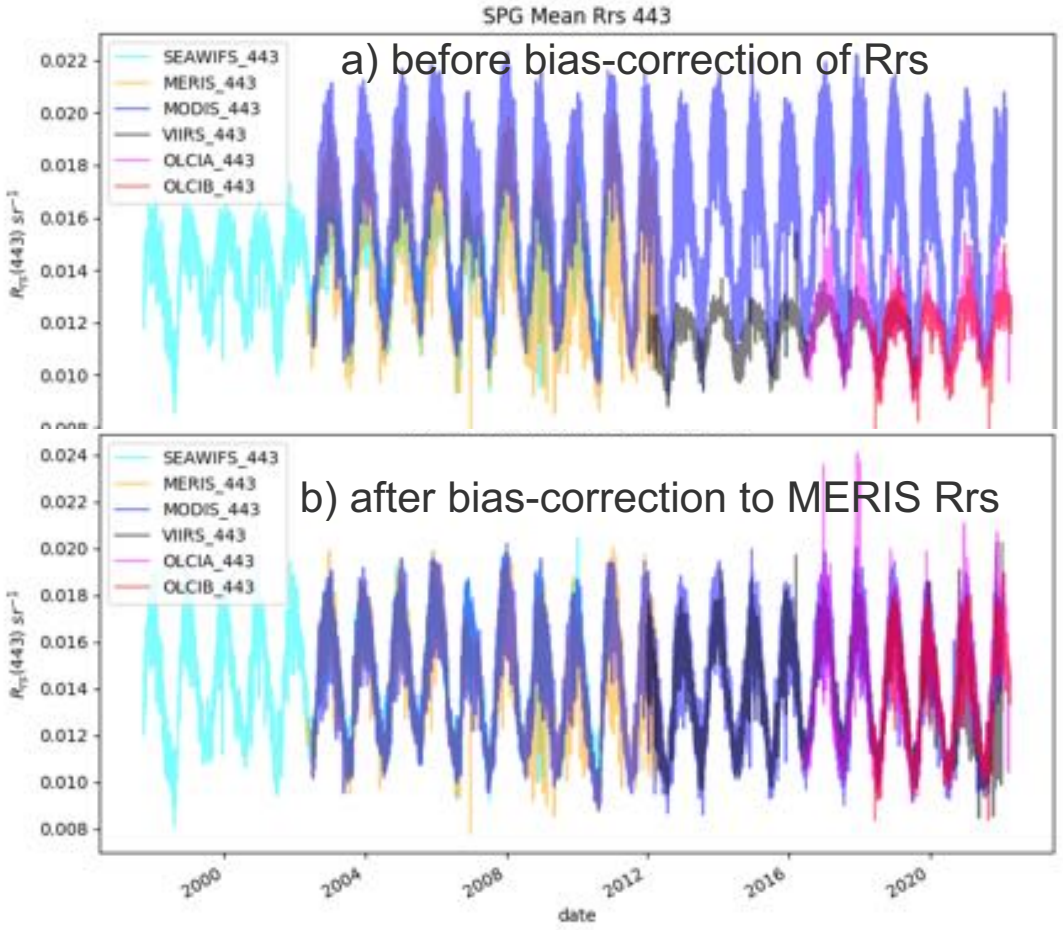
Ocean Colour CCI

- OC CCI merges multiple sensors using band shifting to a reference sensor, bias correction and harmonisation of approaches to produce a climate quality dataset

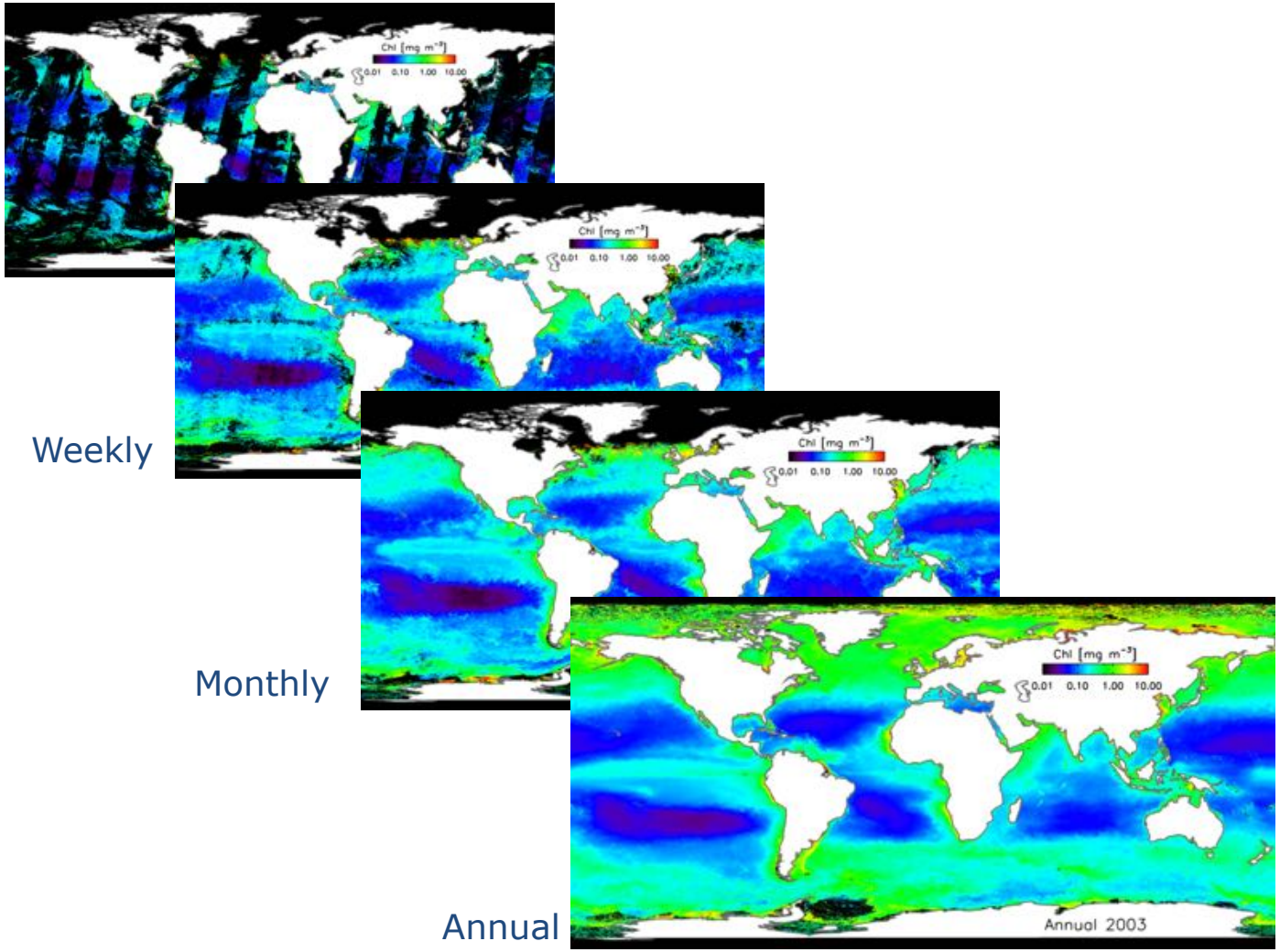
- **Common atmospheric correction**
  - Polymer for MODIS-Aqua, MERIS, Suomi-VIIRS, S3A and B –OLCI
  - L2gen for SeaWiFS



- **Bias correction to reference sensor**



OC-CCI V6: 4 km products

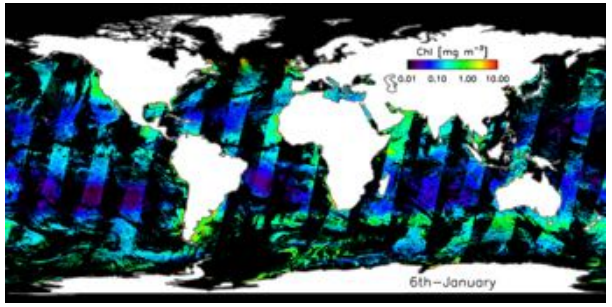


OC-CCI Products include:

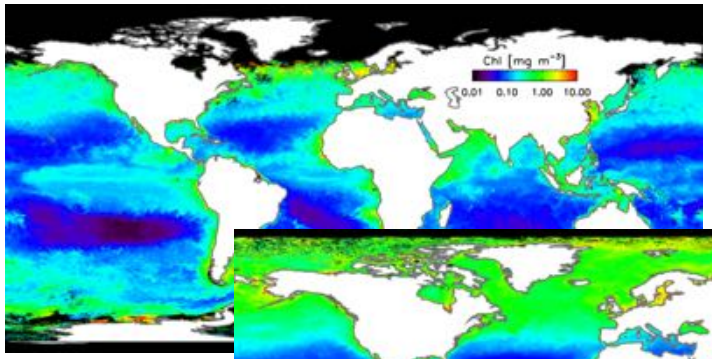
- Time series of 28 years: 1997-2025
- Remote-sensing reflectance (**Rrs**) 6 bands.
- Chlorophyll-a (**Chla**)
- Inherent Optical Properties (a_{ph}, a_{dg}, a_{tot}, b_b)
- Diffuse attenuation coefficient (**kd**)
- Per-pixel uncertainties (**Bias, RMSE**)
- Optical water classes (14)

OC-CCI V6: 1 km products

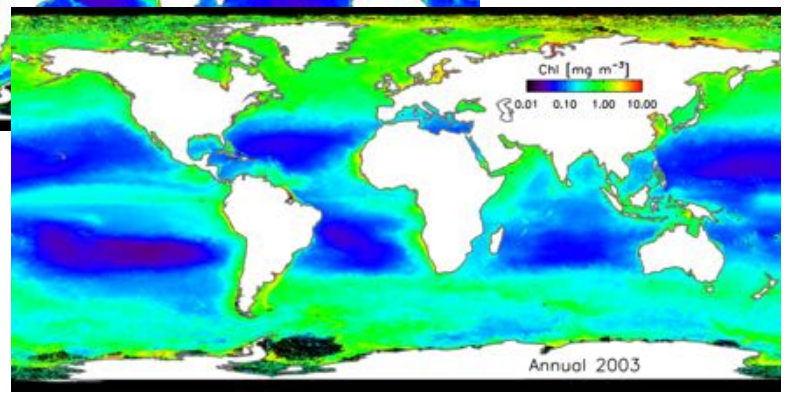
Daily



Monthly



Annual



OC-CCI Products include:

- Time series of 28 years: 1997-2025
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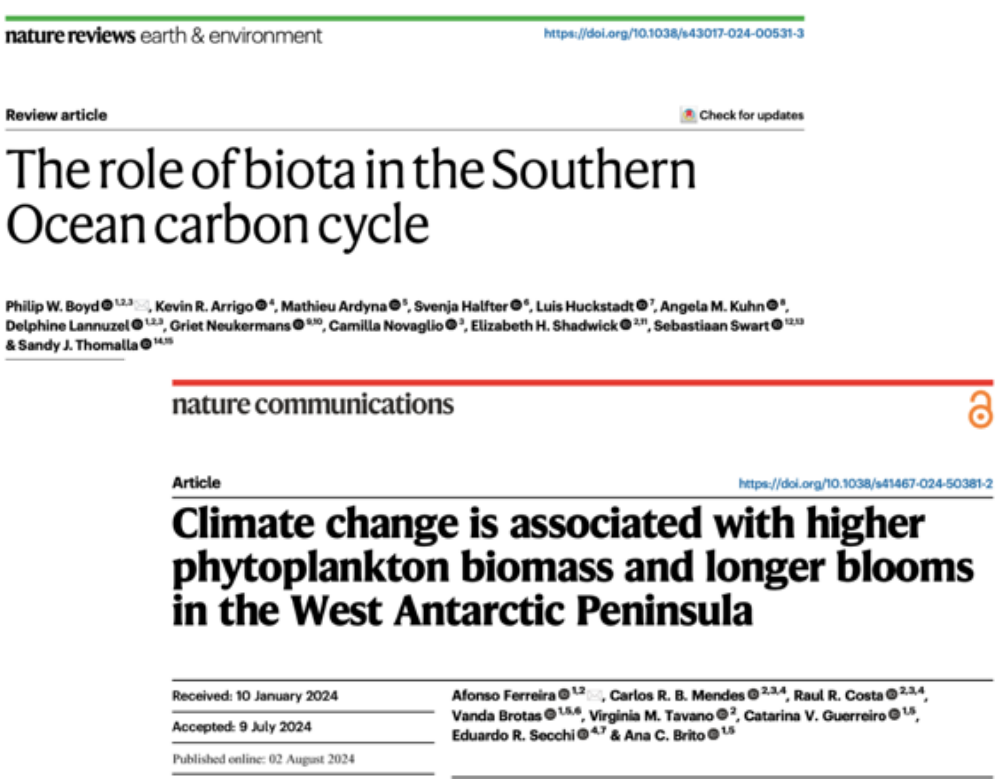
Outputs

- Ocean Colour CCI+ CDR used by a large international community
- In 2024 googlescholar showed ~200 entries with ~100 peer-rev papers acknowledging OC CCI inc one in *Nature Reviews Earth and Env* and two in *Nature Communications*



nature reviews earth & environment

https://doi.org/10.1038/s43017-024-00531-3

Review article

Check for updates

The role of biota in the Southern Ocean carbon cycle

Philip W. Boyd, Kevin R. Arrigo, Mathieu Ardyna, Svenja Halfter, Luis Huckstadt, Angela M. Kuhn, Delphine Lannuzel, Griet Neukermans, Camilla Novaglio, Elizabeth H. Shadwick, Sebastiaan Swart & Sandy J. Thomalla

nature communications

Article

https://doi.org/10.1038/s41467-024-50381-2

Climate change is associated with higher phytoplankton biomass and longer blooms in the West Antarctic Peninsula

Received: 10 January 2024

Accepted: 9 July 2024

Published online: 02 August 2024

Afonso Ferreira, Carlos R. B. Mendes, Raul R. Costa, Vanda Brotas, Virginia M. Tavano, Catarina V. Guerreiro, Eduardo R. Secchi & Ana C. Brito

nature climate change

Article

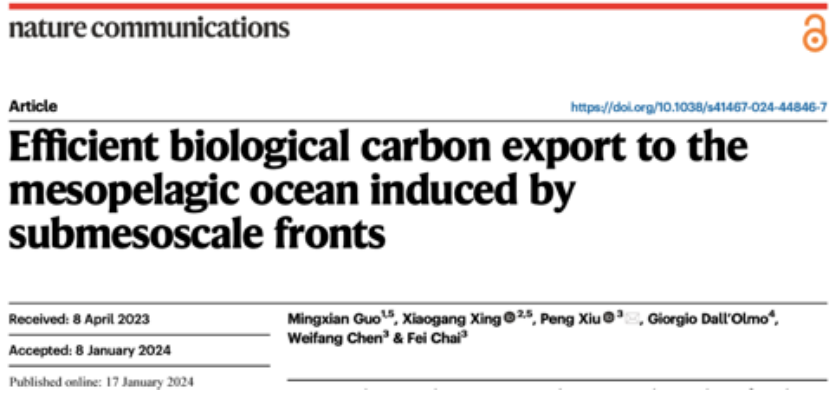
https://doi.org/10.1038/s41558-023-01768-4

Widespread changes in Southern Ocean phytoplankton blooms linked to climate drivers

Received: 5 October 2022

Accepted: 18 July 2023

Sandy J. Thomalla, Sarah-Anne Nicholson, Thomas J. Ryan-Keogh & Marié E. Smith



nature communications

Article

https://doi.org/10.1038/s41467-024-44846-7

Efficient biological carbon export to the mesopelagic ocean induced by submesoscale fronts

Received: 8 April 2023

Accepted: 8 January 2024

Published online: 17 January 2024

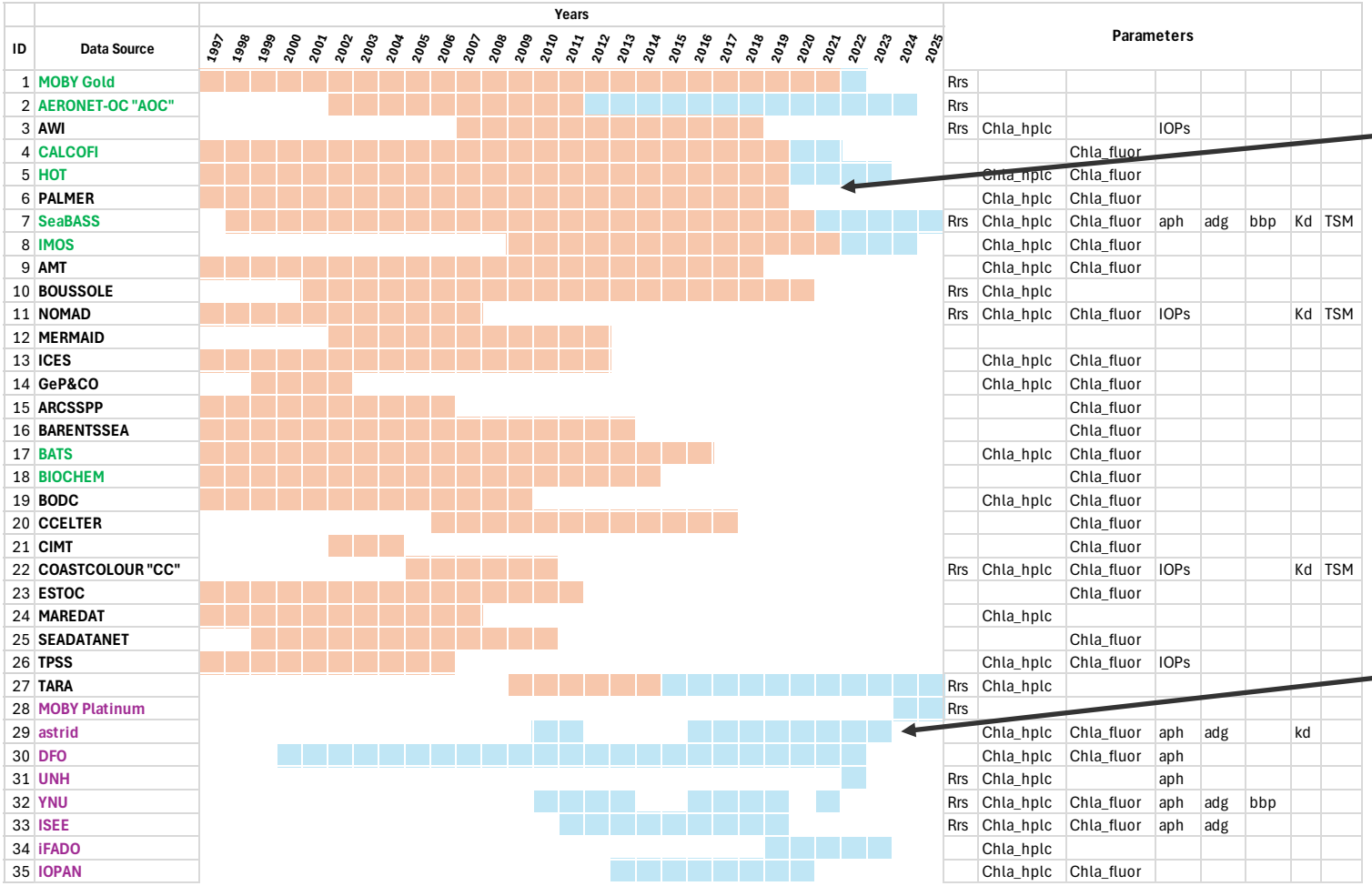
Mingxian Guo, Xiaogang Xing, Peng Xiu, Giorgio Dall'Olmo, Weifang Chen & Fei Chai

OC CCI V7: Plans and preliminary work

- Currently working on the next generation (Version 7); plans are to
  - Update the in situ database
  - Re-evaluate the System Vicarious Calibration
  - Undertake new round robins of in-water algorithms and atmospheric corrections
  - Investigate addition of NOAA-20 VIIRS (and re-addition of Aqua-MODIS and Suomi-VIIRS post 2019)
  - Investigate S3-A OLCI as reference sensor
  - In collaboration with ESA PhytoCCI add additional bands for OLCI era
  - Investigate additional sensors for inclusion in V8

OC CCI V7: Updated in situ database

- The OC CCI in situ database (Valente et al. 2022: V22) has been updated
- Database is used to test in water algorithms and atmospheric correction approaches



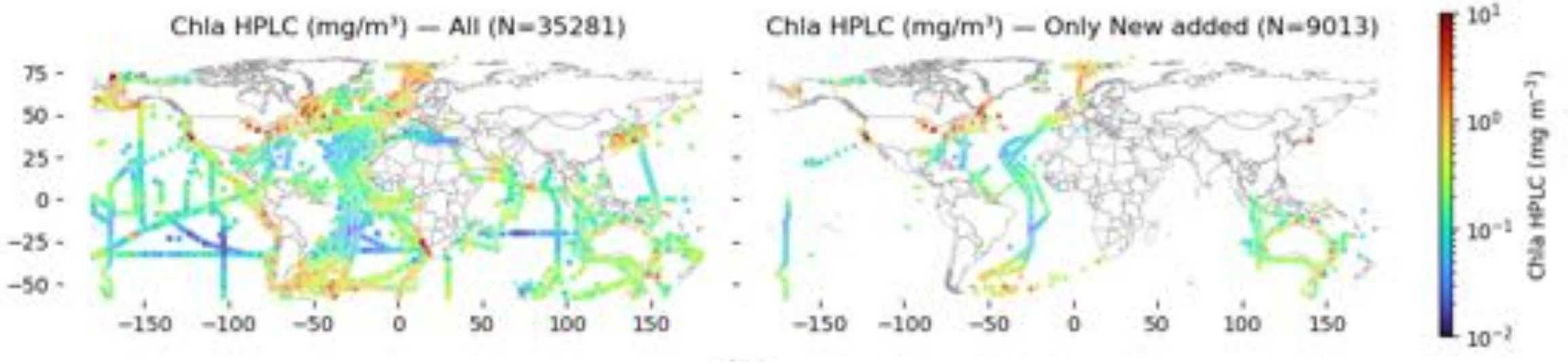
ID	Data Source	Parameters							
1	MOBY Gold	Rrs							
2	AERONET-OC "AOC"	Rrs							
3	AWI	Rrs	Chla_hplc		IOPs				
4	CALCOFI			Chla_fluor					
5	HOT		Chla_hplc	Chla_fluor					
6	PALMER		Chla_hplc	Chla_fluor					
7	SeaBASS	Rrs	Chla_hplc	Chla_fluor	aph	adg	bbp	Kd	TSM
8	IMOS		Chla_hplc	Chla_fluor					
9	AMT		Chla_hplc	Chla_fluor					
10	BOUSSOLE	Rrs	Chla_hplc						
11	NOMAD	Rrs	Chla_hplc	Chla_fluor	IOPs			Kd	TSM
12	MERMAID								
13	ICES		Chla_hplc	Chla_fluor					
14	GeP&CO		Chla_hplc	Chla_fluor					
15	ARCSSPP			Chla_fluor					
16	BARENTSSEA			Chla_fluor					
17	BATS		Chla_hplc	Chla_fluor					
18	BIOCHEM			Chla_fluor					
19	BODC		Chla_hplc	Chla_fluor					
20	CCELTER			Chla_fluor					
21	CIMT			Chla_fluor					
22	COASTCOLOUR "CC"	Rrs	Chla_hplc	Chla_fluor	IOPs			Kd	TSM
23	ESTOC			Chla_fluor					
24	MAREDAT		Chla_hplc						
25	SEADATANET			Chla_fluor					
26	TPSS		Chla_hplc	Chla_fluor	IOPs				
27	TARA	Rrs	Chla_hplc						
28	MOBY Platinum	Rrs							
29	astrid		Chla_hplc	Chla_fluor	aph	adg		kd	
30	DFO		Chla_hplc	Chla_fluor	aph				
31	UNH	Rrs	Chla_hplc		aph				
32	YNU	Rrs	Chla_hplc	Chla_fluor	aph	adg	bbp		
33	ISEE	Rrs	Chla_hplc	Chla_fluor	aph	adg			
34	iFADO		Chla_hplc						
35	IOPAN		Chla_hplc	Chla_fluor					

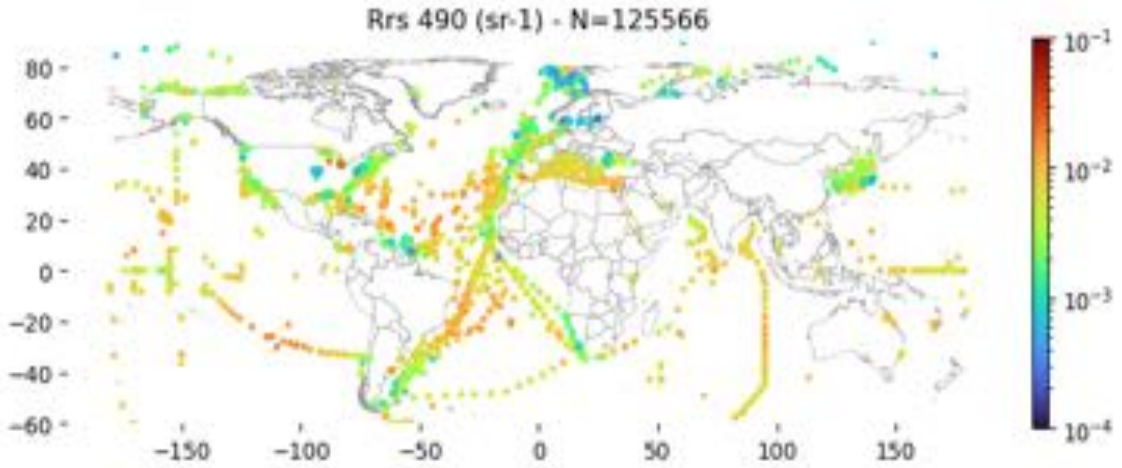
Extended time period

New data sources

Salem et al., in prep

OC CCI V7: Updated in situ database



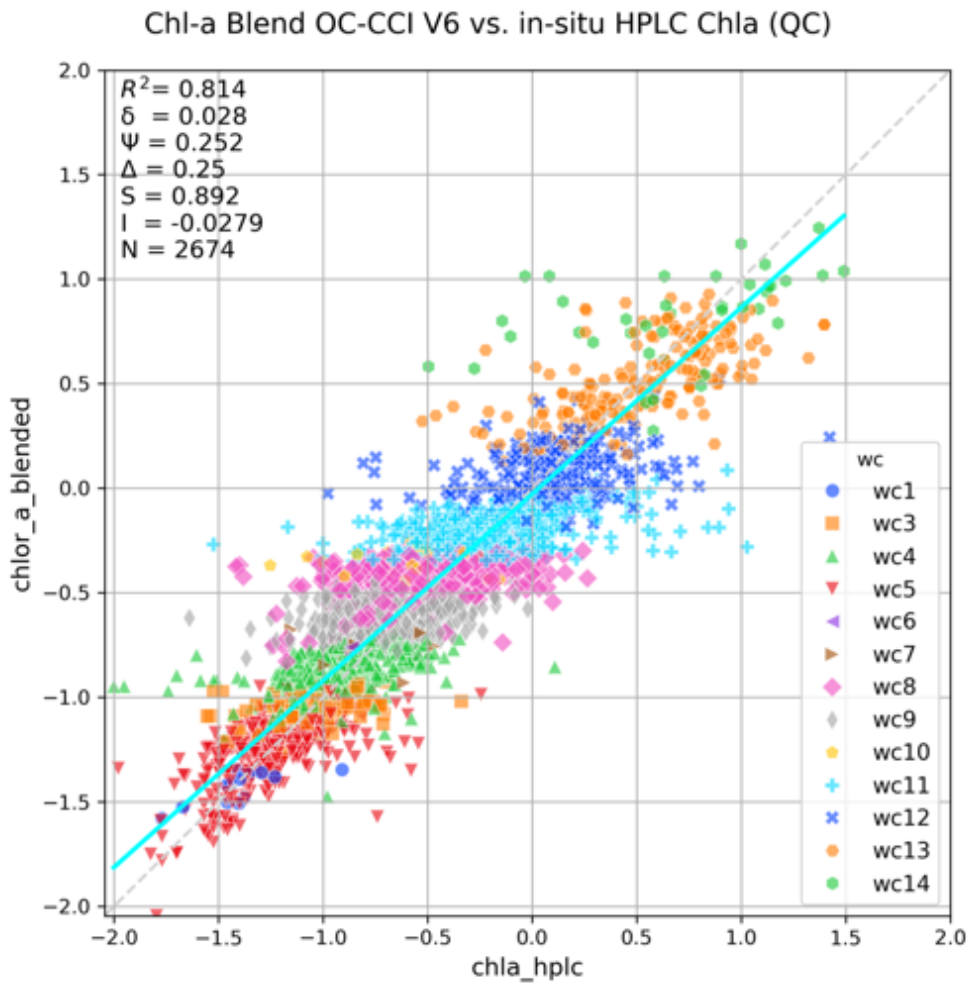


Variable	N (V22)	N (V25)	New data	% Increase
Chl-a HPLC	26,268	35,281	9,013	+34%
Chl-a Fluor	48,952	78,113	29,161	+60%
Rrs	68,641	135,525	66,884	+97%
aph 510	4,265	10,411	6,146	+144%
adg 510	1,654	2,903	1,249	+76%
bbp 510	792	82,139	81,347	>10,000%
TSM	1,546	1,841	295	+19%

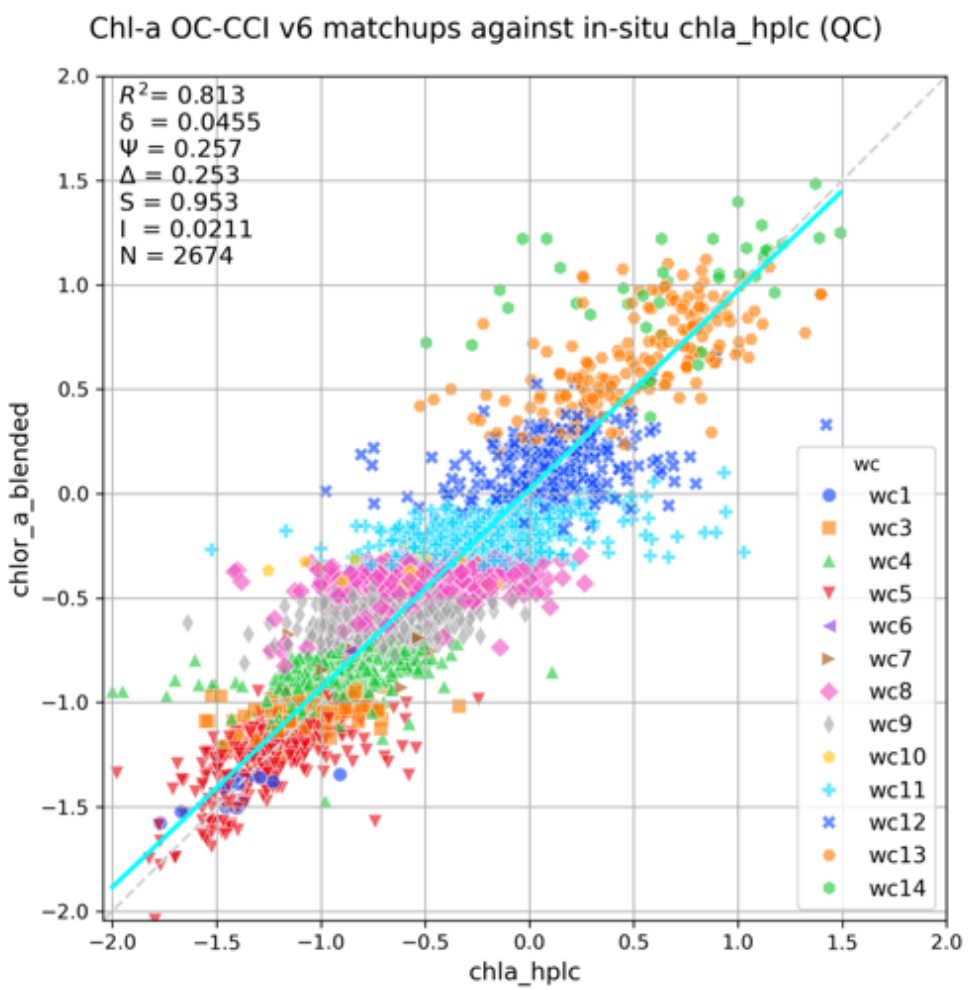
Salem et al., in prep

OC CCI V7: In-water Algorithms

OC CCI Version 6 matchups



Updated OC algorithms

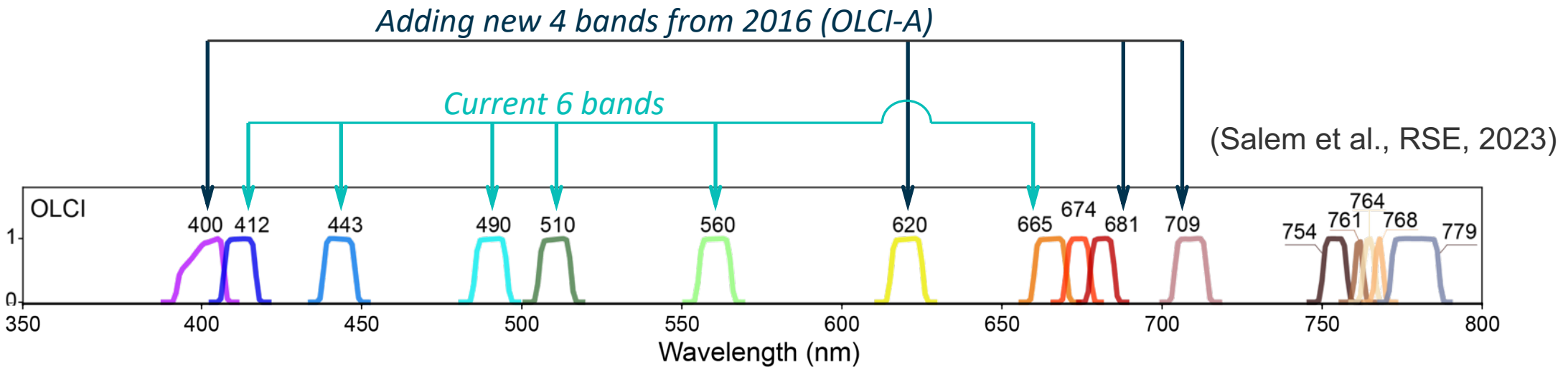


HPLC + QC

OC CCI V7: Addition of OLCI bands

- PHYTO-CCI is a new ESA project led by PML that aims to develop satellite-based data products for two GCOS ECVs : phytoplankton carbon biomass and pigment diversity see poster 116 on Tuesday!

- OC CCI V7 is adding four new bands (400, 620, 681, 709) for OLCI era in addition to the six traditional bands (412, 443, 490, 510, 560, 665) in response to requirement from ESA PHYTO-CCI project



Phytoplankton biomass and diversity

Contact

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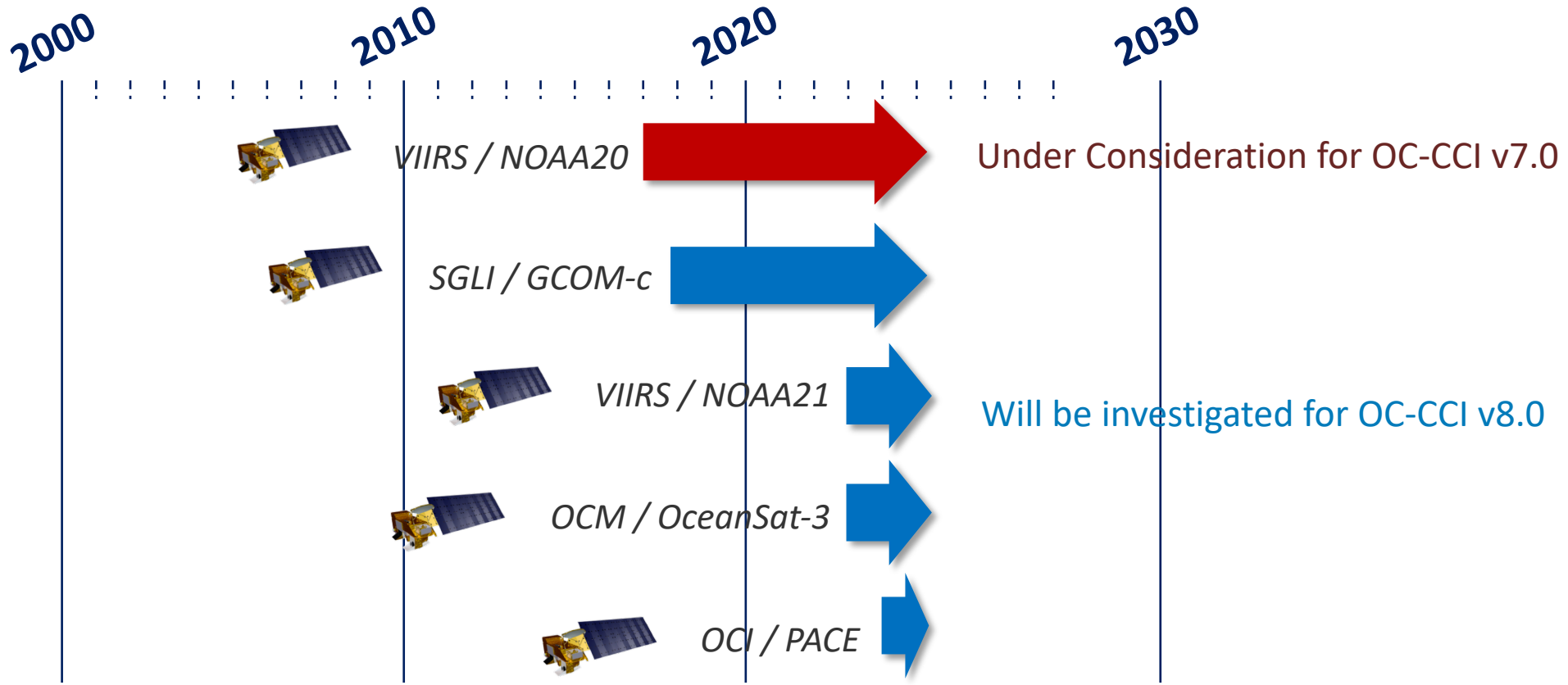
Science lead

gku@pml.ac.uk

Visit online

OC CCI V7: Investigation of new missions

- VIIRS-NOAA20 will be investigated for inclusion in OC-CCI v7.0.
- Other OC missions, such as GCOM-C/SGLI, VIIRS / NOAA21 and OCI / PACE, are being considered for integration into OC-CCI version 8, in consultation with the relevant space agencies.



Conclusions

- Multi-sensor integration is vital for long-term ocean-colour climate records.
- ESA OC-CCI delivers almost 28 years of consistent, climate-quality data.
- Bias correction and harmonised processing support cross-sensor consistency.
- Version 7 will investigate integration of an additional mission (NOAA-20 VIIRS).
- Additional sensors (NOAA-21, GCOM-C, OCI-PACE, OCM3) are being explored for future OC CCI versions
- See presentation in Breakout Session 10: Merged OC Product by Salem on Wednesday!