remote sensing

MDPI

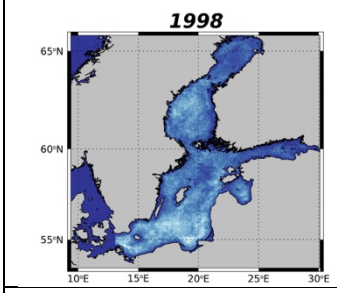
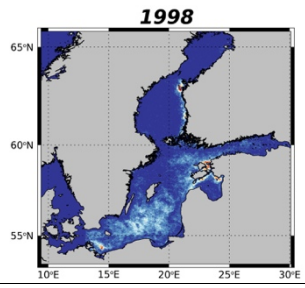
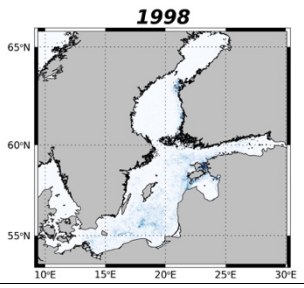
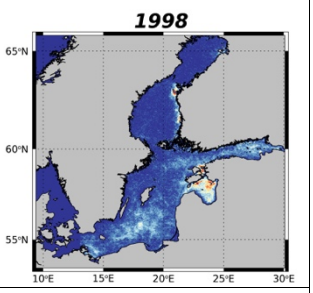
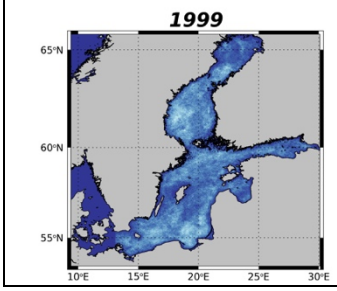
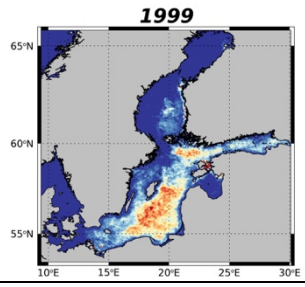
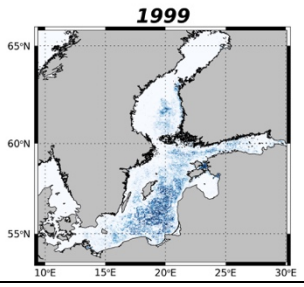
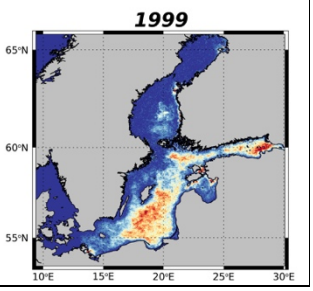
Article

Phytoplankton Bloom Dynamics in the Baltic Sea Using a Consistently Reprocessed Time Series of Multi-Sensor Reflectance and Novel Chlorophyll-a Retrievals

Vittorio E. Brando [1,*], Michela Sammartino [1], Simone Colella [1], Marco Bracaglia [1], Annalisa Di Cicco [1], Davide D'Alimonte [2], Tamito Kajiyama [2], Seppo Kaitala [3] and Jenni Attila [3]

[1] Consiglio Nazionale delle Ricerche, Istituto di Scienze Marine (CNR-ISMAR), 00133 Rome, Italy; michela.sammartino@artov.ismar.cnr.it (M.S.); simone.colella@cnr.it (S.C.); marco.bracaglia@artov.ismar.cnr.it (M.B.); annalisa.dicicco@artov.ismar.cnr.it (A.D.C.)
[2] Aequora, 1600-774 Lisbon, Portugal; davide.dalimonte@aequora.org (D.D.); tamito.kajiyama@aequora.org (T.K.)
[3] Finnish Environment Institute (SYKE), 00790 Helsinki, Finland; seppo.kaitala@ymparisto.fi (S.K.); Jenni.Attila@ymparisto.fi (J.A.)
* Correspondence: Vittorio.brando@cnr.it

Supplementary Materials

Spring bloom	Subsurface summer bloom	Concurrent subsurface and surface summer bloom	Surface summer bloom
			
			

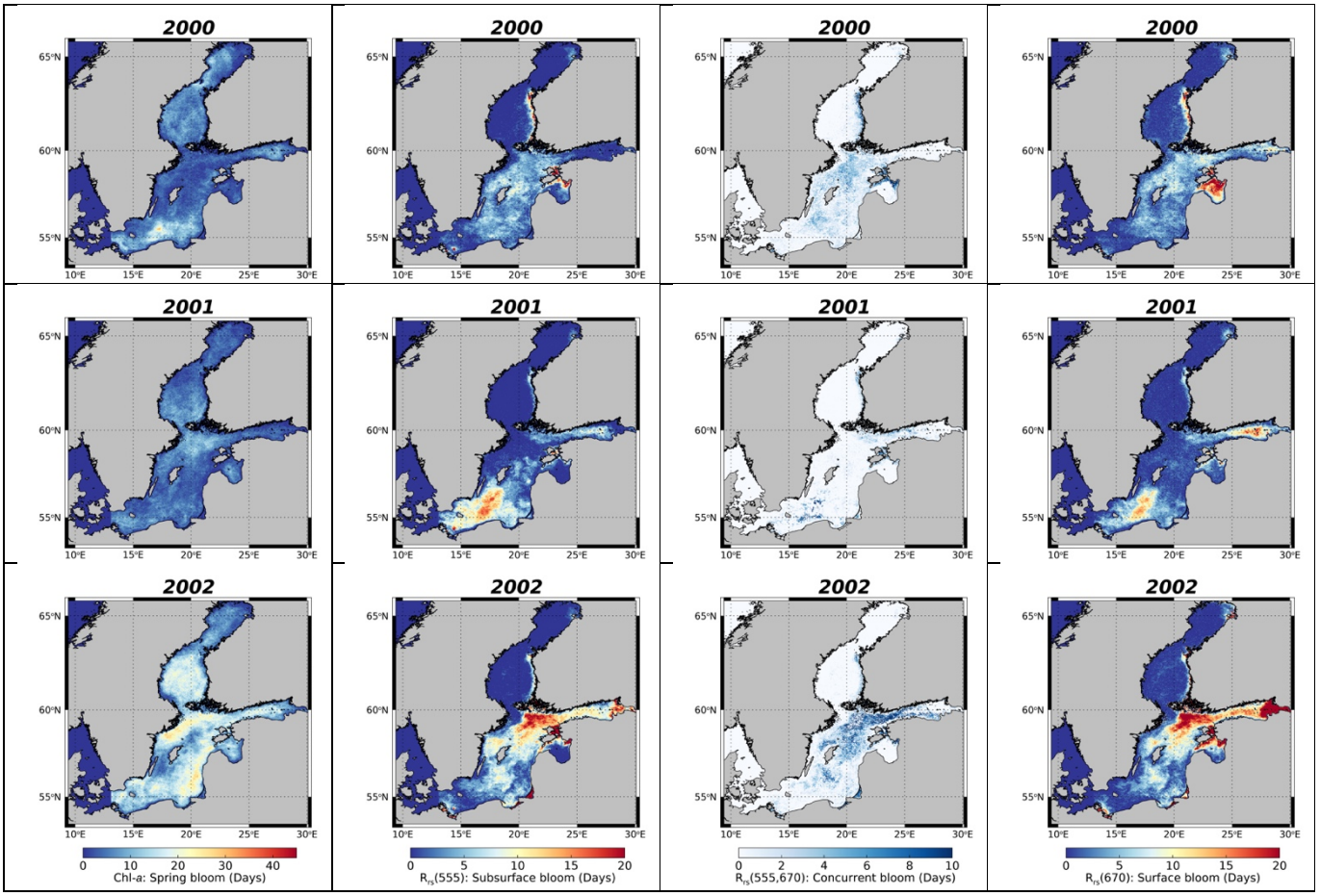


Figure S1. Spring and summer bloom spatio-temporal coverage from 1998 to 2019. First column: spring bloom; second column: subsurface summer bloom; third column: concurrent subsurface and surface summer bloom; fourth column: surface summer bloom.

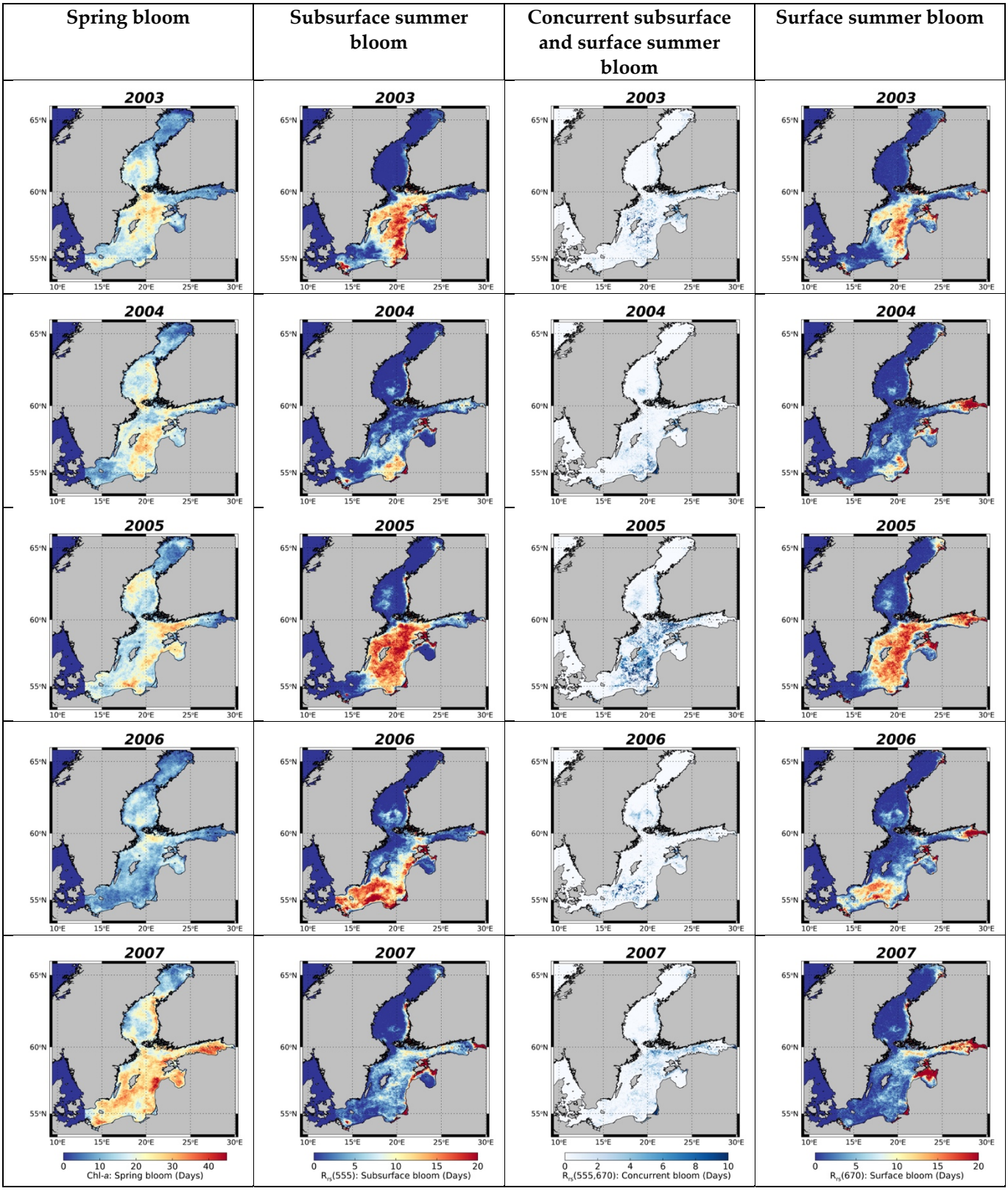


Figure S1 (cont.) Spring and summer bloom spatio-temporal coverage from 1998 to 2019. First column: spring bloom; second column: subsurface summer bloom; third column: concurrent subsurface and surface summer bloom; fourth column: surface summer bloom.

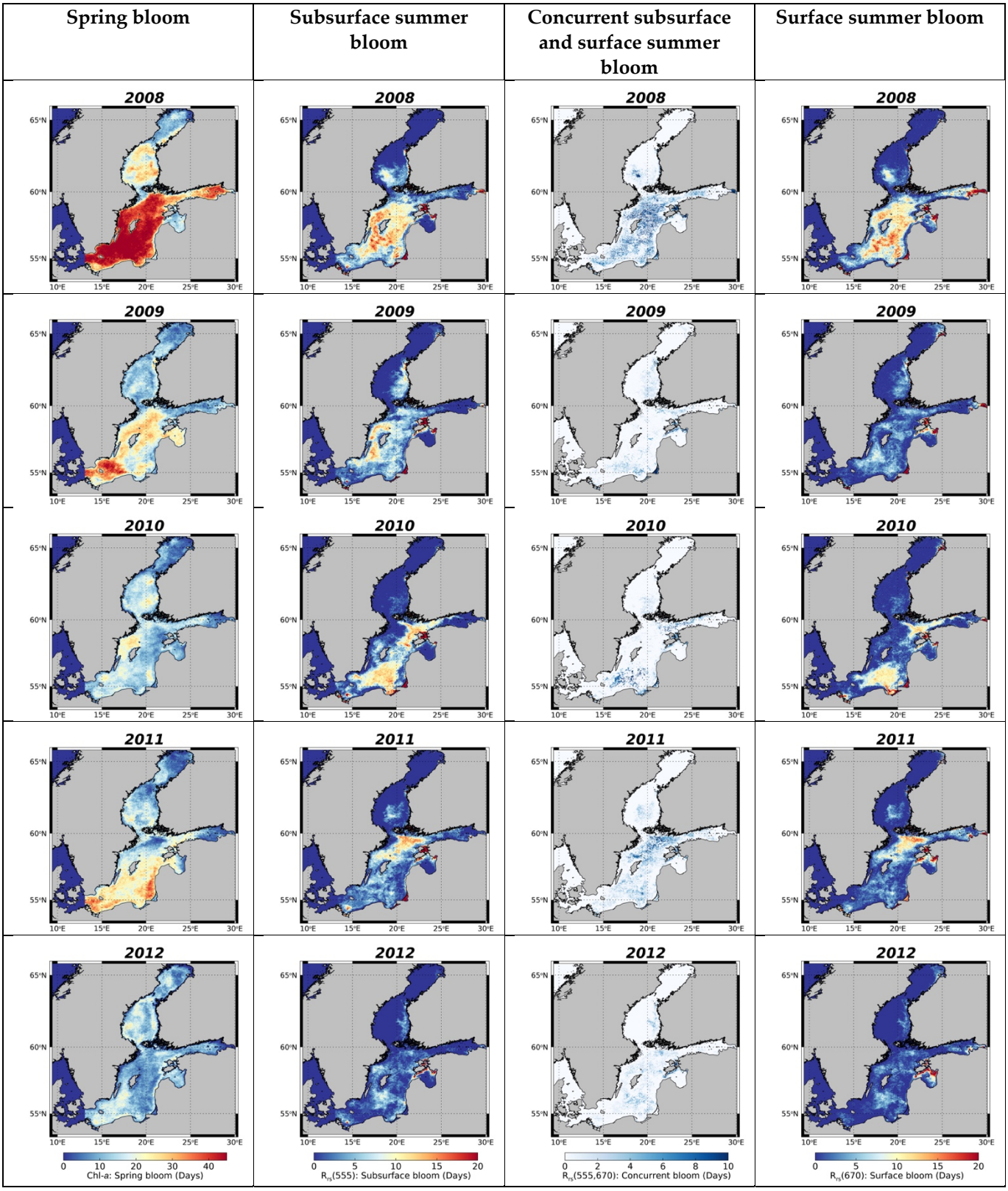


Figure S1 (cont.) Spring and summer bloom spatio-temporal coverage from 1998 to 2019. First column: spring bloom; second column: subsurface summer bloom; third column: concurrent subsurface and surface summer bloom; fourth column: surface summer bloom.

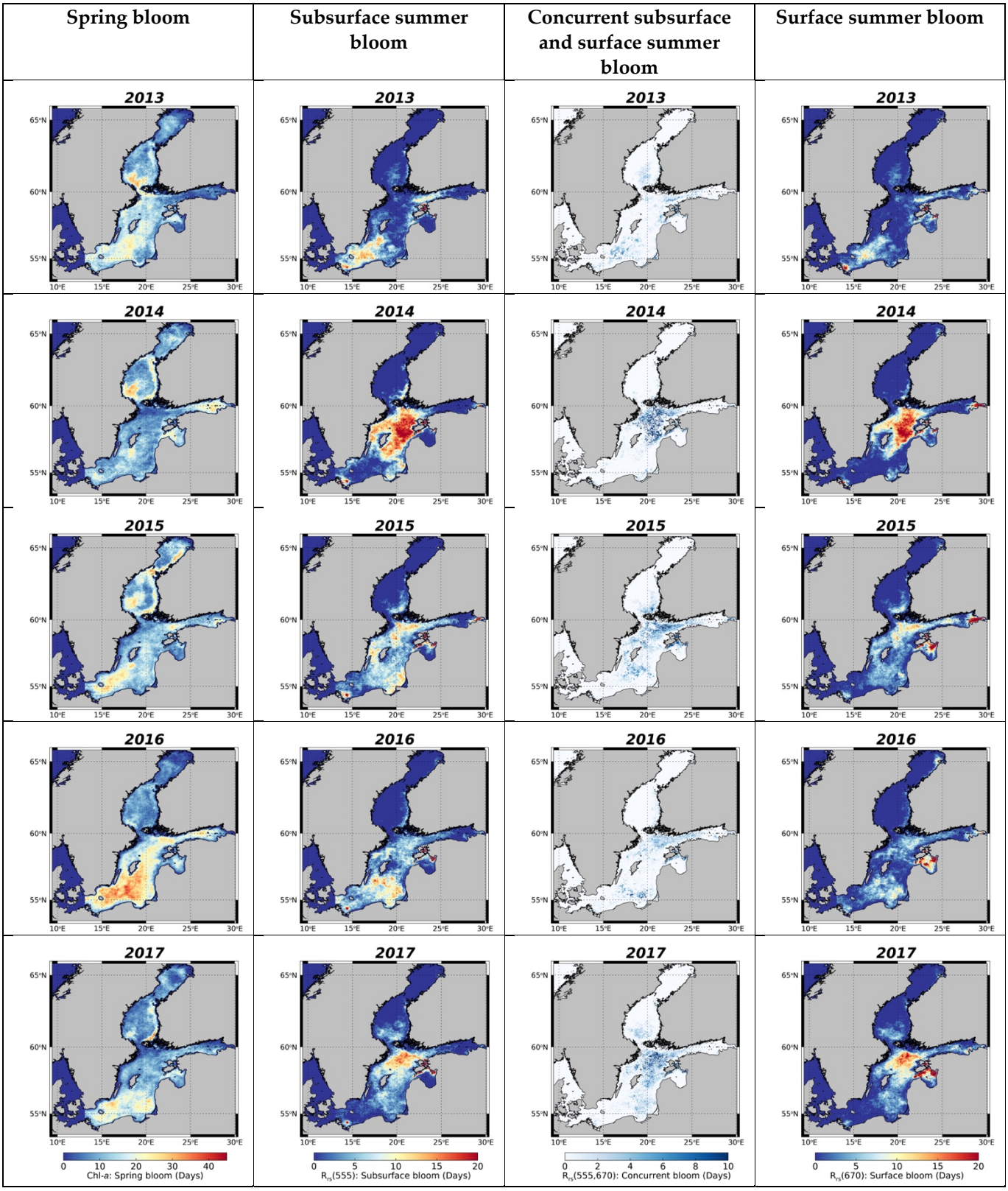


Figure S1 (cont.) Spring and summer bloom spatio-temporal coverage from 1998 to 2019. First column: spring bloom; second column: subsurface summer bloom; third column: concurrent subsurface and surface summer bloom; fourth column: surface summer bloom.

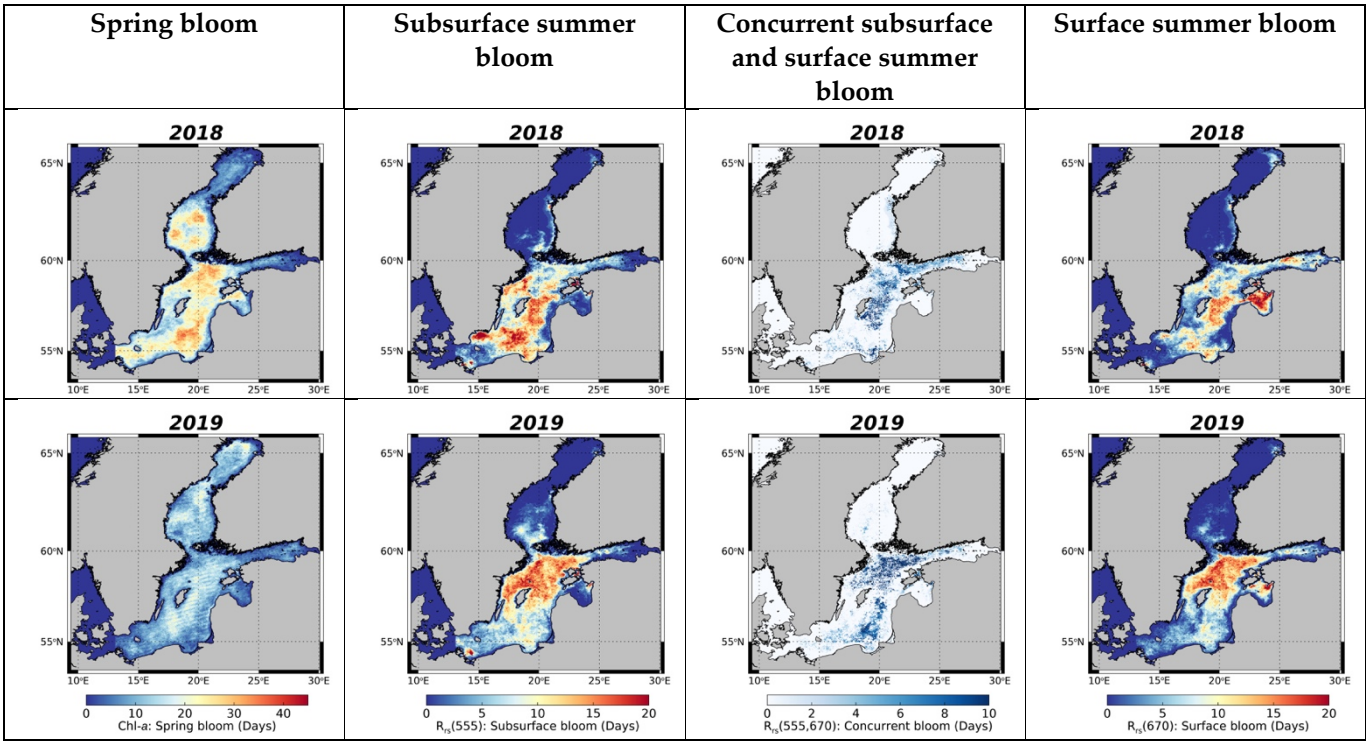


Figure S1 (cont.) Spring and summer bloom spatio-temporal coverage from 1998 to 2019. First column: spring bloom; second column: subsurface summer bloom; third column: concurrent subsurface and surface summer bloom; fourth column: surface summer bloom.

Table S1. Parameters set for $\boldsymbol{Chl\check{\alpha}_{MLP\_6b}}$ (a) Parameter sets to compute data pre- and post-processing, as well as MLP weights to derive Chl-*a*. (b) Eigenvectors and eigenvalues to define the MLP range of applicability.

$\boldsymbol{\mu}_I$ =	-3.1603	-3.0312	-2.8155	-2.7409	-2.6652	-3.1614				
$\boldsymbol{\sigma}_I$ =	0.2588	0.1838	0.1592	0.1607	0.1756	0.2461				
$\boldsymbol{w}^{(1)}$ =	-0.7985	0.2080	-0.4472	0.4574	0.4361	-0.1427	-0.3852	0.2818	-0.5851	-0.2278
	0.0232	-0.1921	-0.0594	-0.0531	1.0587	-0.2680	-0.2595	1.9991	0.8481	-0.2425
	1.0904	0.4620	0.2267	0.5697	0.0892	-0.0123	0.2390	0.7510	0.4695	0.2861
	-0.2053	1.6031	0.4763	0.2052	-0.0905	-0.7447	0.4032	-0.1785	0.7916	0.0340
	-0.7415	-0.2967	1.0456	0.1586	0.1314	1.0432	0.3897	-0.3688	-0.6143	0.1766
	-0.4006	-0.5703	0.0161	0.8207	1.1073	1.0108	0.6197	-0.5683	-0.3330	0.5511
$\boldsymbol{b}^{(1)}$ =	0.9228	−0.0448	0.9684	−0.6415	−0.7833	0.3443	−0.0358	0.1046	−0.3144	−0.2158
$\boldsymbol{w}^{(2)}$ =	−0.6977	−1.4963	0.7168	−0.0015	0.5500	−0.6762	0.3854	0.9912	−1.0978	0.1195
$b^{(2)}$ =	0.0222	μ_c =	0.4514	σ_c =	0.4222					

(a)

$\boldsymbol{A}_{\boldsymbol{\eta}}$ =	0.5414	0.4267	-0.6601	0.2885	0.0760	0.0103
	0.3879	0.3196	0.1828	-0.6344	-0.5465	-0.1131
	0.3491	0.1479	0.3957	-0.1135	0.4552	0.6925
	0.3599	0.0411	0.4036	0.0934	0.4515	-0.7023
	0.3717	-0.2689	0.3437	0.6198	-0.5226	0.1188
	0.4083	-0.7873	-0.3055	-0.3294	0.1069	0.0126
$\boldsymbol{\gamma}_{\boldsymbol{\eta}}$ =	0.1902	0.0436	0.0073	0.0013	0.0002	0.0001

(b)

Table S2. Parameters set for $\boldsymbol{Chl\check{\alpha}_{MLP\_5b}}$ (a) Parameter sets to compute data pre- and post-processing, as well as MLP weights to derive Chl-*a*. (b) Eigenvectors and eigenvalues to define the MLP range of applicability.

$\boldsymbol{\mu}_I$ =	-3.0261	-2.8167	-2.7431	-2.6652	-3.1772					
$\boldsymbol{\sigma}_I$ =	0.1841	0.1593	0.1612	0.1756	0.2441					
$\boldsymbol{w}^{(1)}$ =	-0.8149	0.6125	0.4886	-1.7283	0.1723	-1.3147	-0.1986	0.5593	-0.6074	1.0013
	0.3055	-0.2773	1.1680	-0.0771	-0.7164	-0.5308	-0.4648	-0.5591	0.8691	-0.2908
	-0.2188	-0.0951	-0.0473	0.7476	-0.1234	-0.7198	0.1384	-1.5239	-0.1378	0.3588
	0.2802	-0.3076	0.2593	0.3506	0.8223	0.6078	0.1276	0.1461	1.1880	0.1785
	0.7466	0.4084	0.6168	-0.6832	0.5256	0.4628	-0.3990	0.5611	-0.1750	0.7758
$\boldsymbol{b}^{(1)}$ =	0.1153	-0.2870	0.2634	0.3949	-1.3440	1.0937	0.1572	-0.1864	0.5544	-0.4773
$\boldsymbol{w}^{(2)}$ =	-0.7542	-0.5349	-0.1937	-1.3911	1.0037	1.0101	0.6200	1.1492	1.0607	0.5309
$b^{(2)}$ =	0.4042	μ_c =	0.4514	σ_c =	0.4222					

(a)

$\boldsymbol{A}_{\boldsymbol{\eta}}$ =	0.4122	0.5290	-0.5869	0.4455	-0.0861
	0.3900	0.3457	0.1035	-0.5035	0.6812
	0.4137	0.2326	0.2784	-0.4306	-0.7154
	0.4587	-0.1118	0.6468	0.5851	0.1284
	0.5444	-0.7308	-0.3862	-0.1423	0.0126
$\boldsymbol{\gamma}_{\boldsymbol{\eta}}$ =	0.1399	0.0333	0.0022	0.0002	0.0001

(b)

Table S3. Parameters set for $\boldsymbol{Chl\check{a}_{MLP\_4b}}$ (a) Parameter sets to compute data pre- and post-processing, as well as MLP weights to derive Chl-*a*. (b) Eigenvectors and eigenvalues to define the MLP range of applicability.

$\boldsymbol{\mu}_I$ =	2.8167	-2.7431	-2.6652	-3.1772						
$\boldsymbol{\sigma}_I$ =	0.1593	0.1612	0.1756	0.2441						
$\boldsymbol{w}^{(1)}$ =	-0.6174	0.2034	0.7253	1.0515	0.0474	0.0997	0.6519	-1.6656	0.6970	-0.1716
	-1.1127	-0.1306	0.2030	1.1548	-0.8705	0.0725	1.6561	-0.2235	0.6987	-0.6721
	-0.2267	-0.6301	-0.7636	-1.0589	0.1177	-1.0289	0.4355	0.6953	0.1282	0.8138
	0.2296	-0.2580	-0.6872	-0.4056	0.2398	-0.1643	-1.2418	0.1531	1.1594	0.7056
$\boldsymbol{b}^{(1)}$ =	0.4852	-0.2917	-0.1048	-0.8069	-0.2888	-0.6771	-0.2772	-0.0232	-0.8001	-1.4607
$\boldsymbol{w}^{(2)}$ =	0.3641	-0.3879	0.7258	-0.8934	0.7117	-0.6568	-0.7913	-1.0948	0.5985	1.0093
$b^{(2)}$ =	0.2612	μ_c =	0.4514	σ_c =	0.4222					

(a)

$\boldsymbol{A}_{\boldsymbol{\eta}}$ =	0.3906	0.5649	-0.4288	0.5869
	0.4260	0.4463	-0.0934	-0.7814
	0.5037	0.0652	0.8349	0.2120
	0.6421	-0.6910	-0.3321	-0.0049
$\boldsymbol{\gamma}_{\boldsymbol{\eta}}$ =	0.1186	0.0222	0.0010	0.0001

(b)

Table S4. Parameters set for $\boldsymbol{Chl\check{a}_{MLP\_3b}}$ (a) Parameter sets to compute data pre- and post-processing, as well as MLP weights to derive Chl-*a*. (b) Eigenvectors and eigenvalues to define the MLP range of applicability.

$\boldsymbol{\mu}_I$ =	-2.8167	-2.7431	-2.6652							
$\boldsymbol{\sigma}_I$ =	0.1593	0.1612	0.1756							
$\boldsymbol{w}^{(1)}$ =	-0.1130	-1.9653	-0.2763	-1.1541	0.7444	2.2994	0.3464	-0.4559	0.6394	-0.4430
	-0.6697	-1.1620	-0.5601	-1.4582	-0.5943	0.7033	0.4399	0.6821	-0.9227	-0.6920
	1.2962	0.4112	-0.5035	-0.4019	0.3570	-1.8250	-0.0413	0.2534	-2.2069	-0.2563
$\boldsymbol{b}^{(1)}$ =	-1.2653	0.1386	0.0717	-0.0869	0.4218	-1.1003	0.2499	-0.7008	0.8449	-0.4670
$\boldsymbol{w}^{(2)}$ =	0.8700	0.8753	0.2782	-0.9477	1.1105	-0.7756	-0.0016	-0.4858	-0.4832	0.2159
$b^{(2)}$ =	0.2057	μ_c =	0.4514	σ_c =	0.4222					

(a)

$\boldsymbol{A}_{\boldsymbol{\eta}}$ =	0.5537	0.5860	0.5916
	0.5753	0.2445	-0.7806
	0.6021	-0.7725	0.2017
$\boldsymbol{\gamma}_{\boldsymbol{\eta}}$ =	0.0776	0.0046	0.0001

(b)