

Highly resolved data set on different phytoplankton pigments retrieved from underway spectrophotometry in the Fram Strait, Arctic Ocean

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Introduction

- Light absorption properties of marine phytoplankton influence the solar radiation into the ocean and control the light energy usable for photosynthesis.
- The shape and magnitude of the phytoplankton absorption spectra is controlled primarily by the concentration of various pigments and the level of package effect within the cells.
- In this study, four approaches to estimate phytoplankton pigment concentration from particulate absorption spectra derived from underway AC-S flow-through system, namely **Gaussian decomposition**, **singular value decomposition**, **neural network** and **empirical orthogonal function analyses**, are evaluated and intercompared.

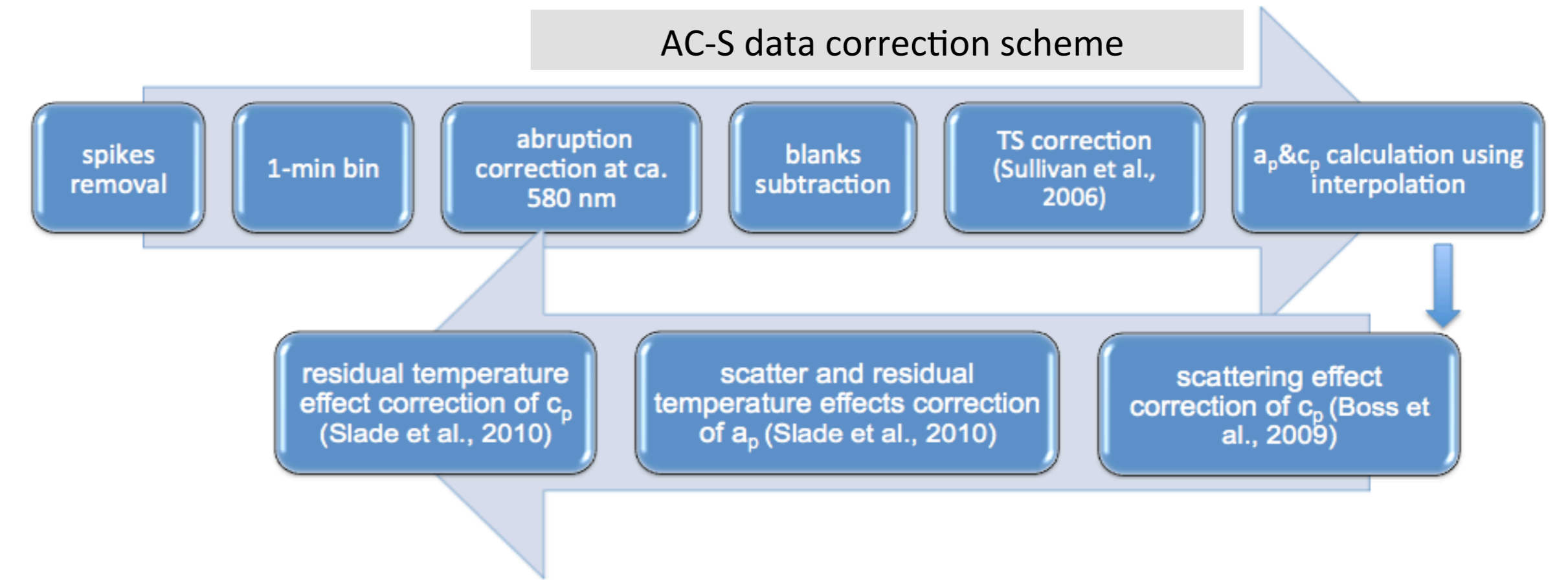
Data and Method

Cruises tracks with R.V. Polarstern

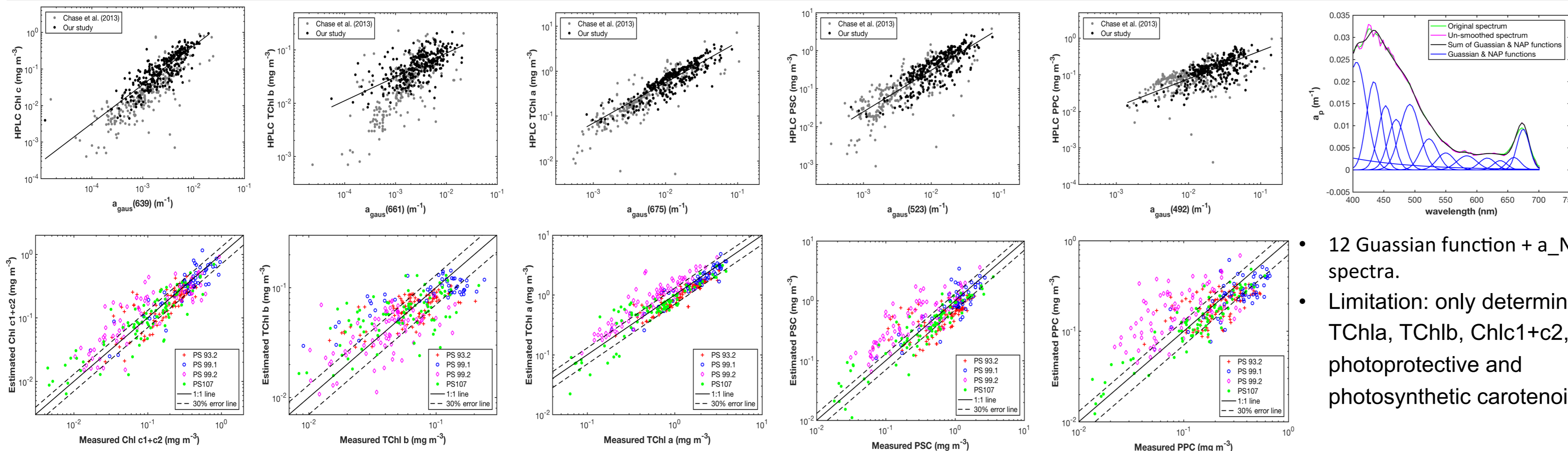
PS 93.2: Jul.-Aug. 2015, Svalbard – Fram Strait
PS 99.2: Jun.-Jul. 2016, Svalbard – Fram Strait
PS 107: Jun.-Jul. 2017, Svalbard – Fram Strait

Data

- Discrete water sampling every 3h
 - PS 93.2: a_p & a_{ph} (high performance spectrophotometer), Chl-a (HPLC)
 - PS 99.2 & PS107: a_p & a_{ph} (QFT-ICAM), Chl-a (HPLC)
- Underway AC-S measurements
 - Particulate absorption spectra



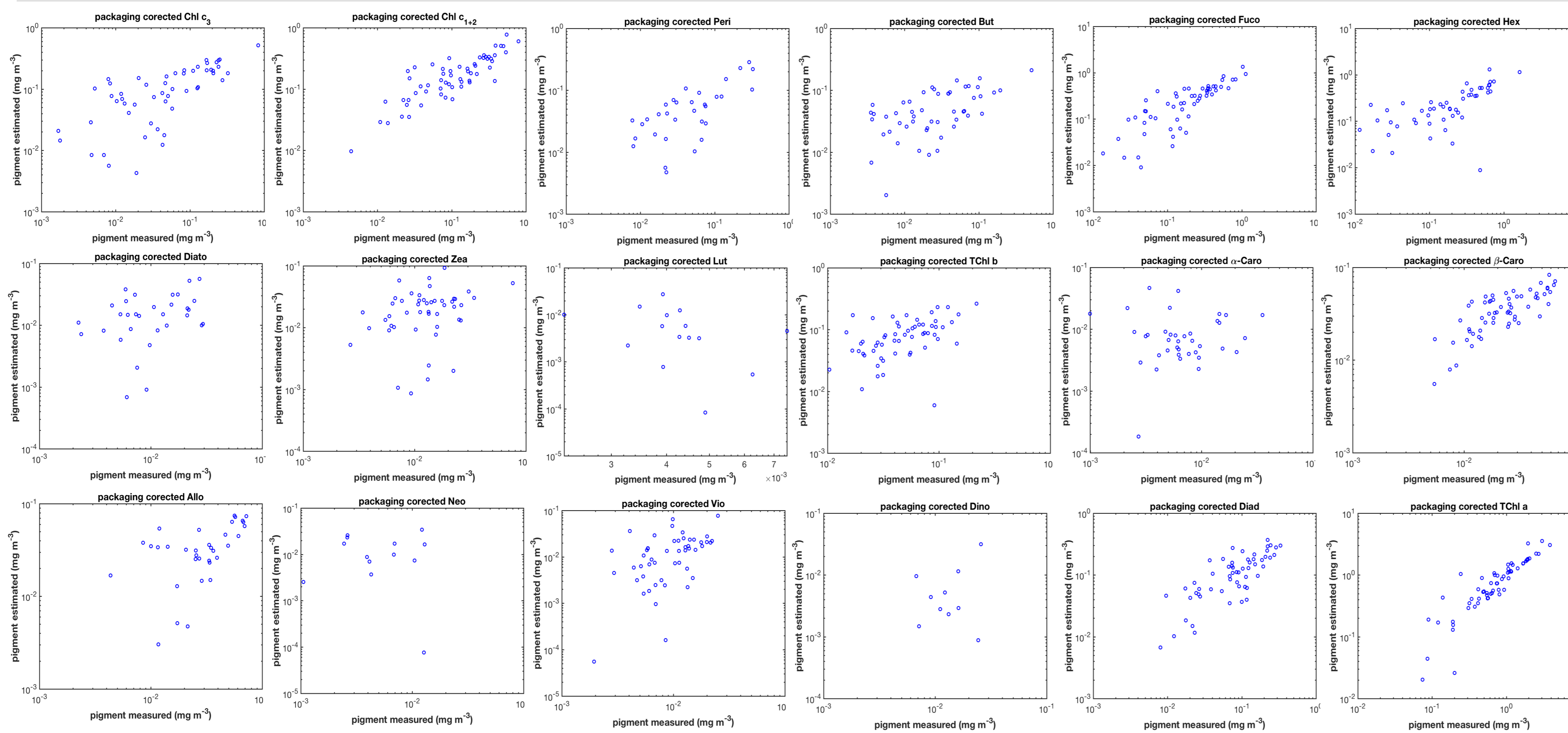
Gaussian Decomposition



- 12 Gaussian function + a_{NAP} spectra.
- Limitation: only determines TChl a, TChl b, Chlc1+c2, photoprotective and photosynthetic carotenoids.

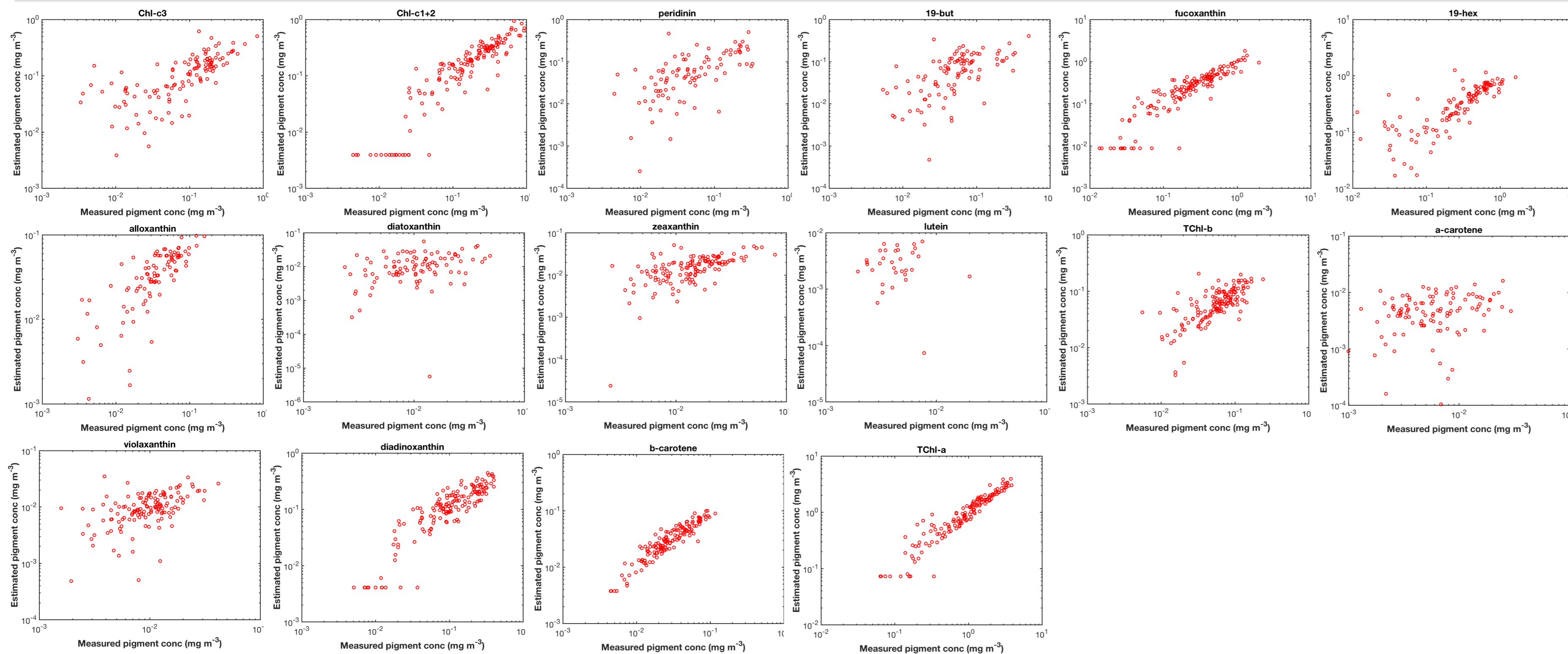
Pigments	S	I	r (log10)	RMSE (log10)	MAE (log10)	Bias (log10)
TChl a	1.20±0.04	-0.14±0.04	0.89	0.161	0.132	0.011
TChl b	2.25±0.17	-0.06±0.01	0.65	0.201	0.156	-0.001
Chlc1+2	1.28±0.05	-0.02±0.01	0.84	0.258	0.200	0.005
PSC	1.37±0.06	-0.13±0.04	0.81	0.265	0.216	0.016
PPC	1.73±0.13	-0.11±0.02	0.68	0.238	0.186	0.022

Singular Value Decomposition + Non-Negative Least Square



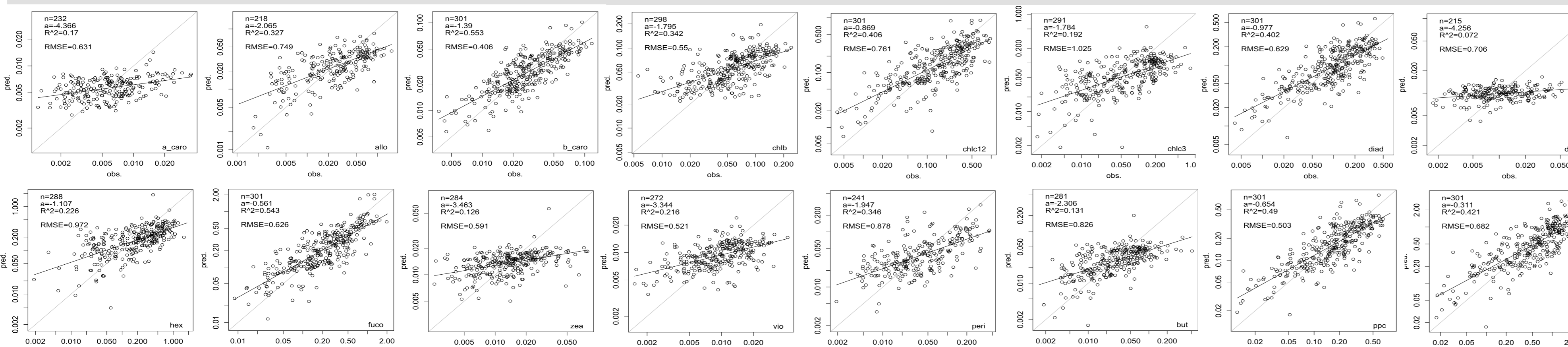
Pigments	S	I	r (log10)	RMSE (log10)	MAE (log10)	Bias (log10)
TChl a	0.99±0.05	0.03±0.06	0.89	1.243	1.141	-1.141
TChl b	1.82±0.34	-0.02±0.02	0.46	1.444	1.420	-1.420
Chlc1+2	0.91±0.07	0.05±0.02	0.85	1.260	1.199	-1.198
Chlc3	0.72±0.06	0.06±0.01	0.69	1.601	1.505	-1.505
Peri	0.71±0.08	0.01±0.01	0.67	1.490	1.432	-1.432
But	0.44±0.07	0.04±0.01	0.55	1.745	1.678	-1.678
Fuco	1.07±0.07	0.03±0.02	0.81	1.128	1.091	-1.091
Hex	0.93±0.09	0.03±0.03	0.63	1.147	1.082	-1.082
Vio	5.43±1.48	-0.04±0.02	0.50	2.076	2.062	-2.062
Diad	1.13±0.12	0.01±0.02	0.78	1.304	1.258	-1.258
Allo	1.03±0.18	0.00±0.01	0.49	1.616	1.591	-1.591
Diato	3.00±1.26	-0.02±0.02	0.32	2.044	2.022	-2.022
Zea	3.02±1.32	-0.02±0.02	0.27	1.953	1.934	-1.934
Lut	-17.6±13.0	0.08±0.06	-0.37	2.382	2.380	-2.380
a-Caro	119±3133	-1.00±26.4	0.08	2.218	2.196	-2.196
B-Caro	1.02±0.11	0.01±0.00	0.78	1.717	1.697	-1.697
Neo	26.0±97.4	-0.15±0.62	-0.15	2.336	2.314	-2.314
Dino	1.87±1.01	-0.02±0.01	0.15	1.905	1.896	-1.896

Neural Network



Pigments	S	I	r (log10)	RMSE (log10)	MAE (log10)	Bias (log10)
TChl a	0.92	0.06	0.96	0.248	0.175	-0.003
TChl b	0.75	0.02	0.69	0.032	0.022	0.003
Chlc1+2	0.95	0.01	0.90	0.089	0.055	-0.009
Chlc3	0.67	0.02	0.78	0.078	0.047	0.001
Peri	0.85	0.00	0.66	0.065	0.034	0.003
But	0.75	0.01	0.67	0.059	0.036	0.001
Fuco	0.97	0.02	0.90	0.138	0.078	-0.000
Hex	0.97	0.00	0.85	0.163	0.090	0.003
Vio	0.55	0.00	0.57	0.006	0.004	0.000
Diad	0.81	0.03	0.85	0.055	0.041	0.006
Allo	0.76	0.00	0.85	0.016	0.010	-0.003
Diato	0.41	0.00	0.44	0.010	0.007	0.001
Zea	0.62	0.00	0.62	0.010	0.007	0.001
Lut	0.068	0.00	0.30	0.003	0.002	-0.000
a-Caro	0.27	0.00	0.45	0.005	0.004	-0.001
B-Caro	0.88	0.00	0.92	0.009	0.006	0.001

Empirical Orthogonal Function



References:
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Outlook

- Further consider the influence of package effect to particulate absorption spectra, to get more accurate predictions of pigment concentrations.
- Different pigment concentration data will be used as input of CHEMTAX program to derive Phytoplankton Functional Types.

