Finnish Marine Research Infrastructure
FINMARI

Chlorophyll fluorescent validation in Algaline ferrybox monitoring

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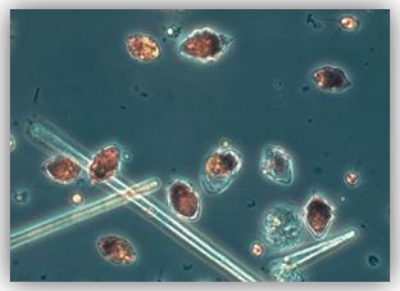
Marine Research Centre

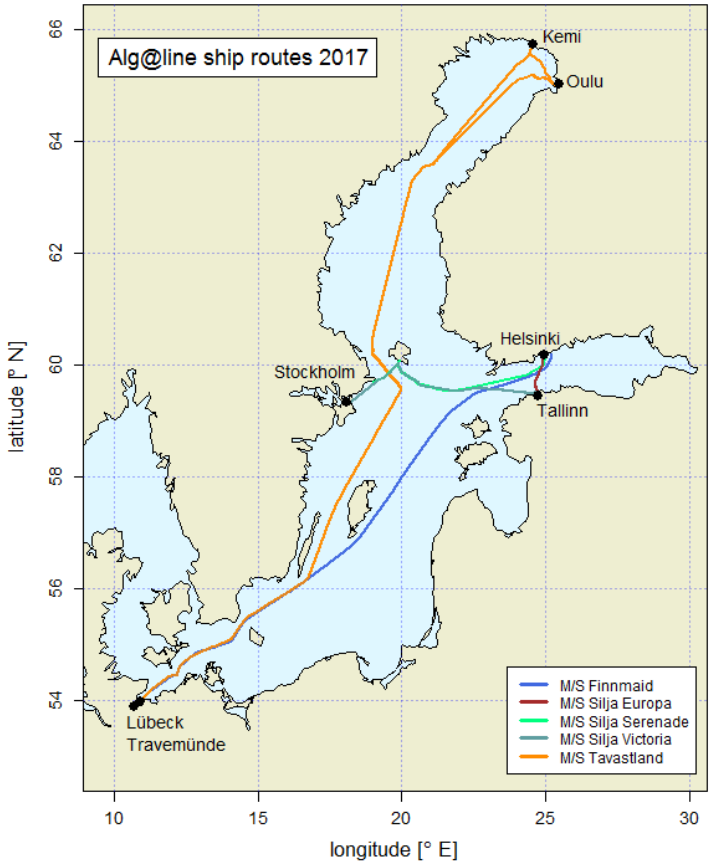
Alg@line

- Research and monitoring project using ‘ship-of-opportunity’ (SOOP) approach
- Started in 1993
- Automatic flow-through instrumentation and water samplers onboard commercial vessels, mainly ferries
- Cost-effective method offering more spatio-temporal coverage than traditional water sampling



Ferries and routes

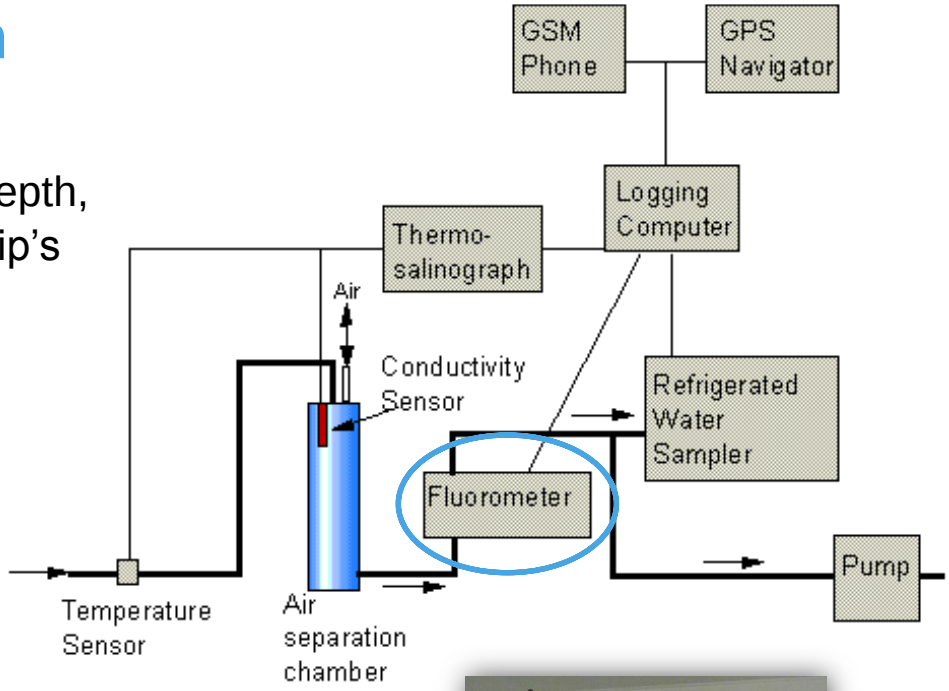
- M/S Finnmaid
  - Helsinki–Travemünde
- M/S Silja Serenade
  - Helsinki–Stockholm
- M/S Tavastland*
  - Oulu–Kemi–Lübeck



*co-operation with Swedish Meteorological and Hydrological Institute

Instrumentation

- Water is pumped from 5 m depth, through an opening in the ship's hull
- Air separation chamber
- Thermosalinograph
  - temperature
  - Salinity
- Fluorometers
  - chlorophyll *a*
  - phycocyanin
  - CDOM
  - turbidity



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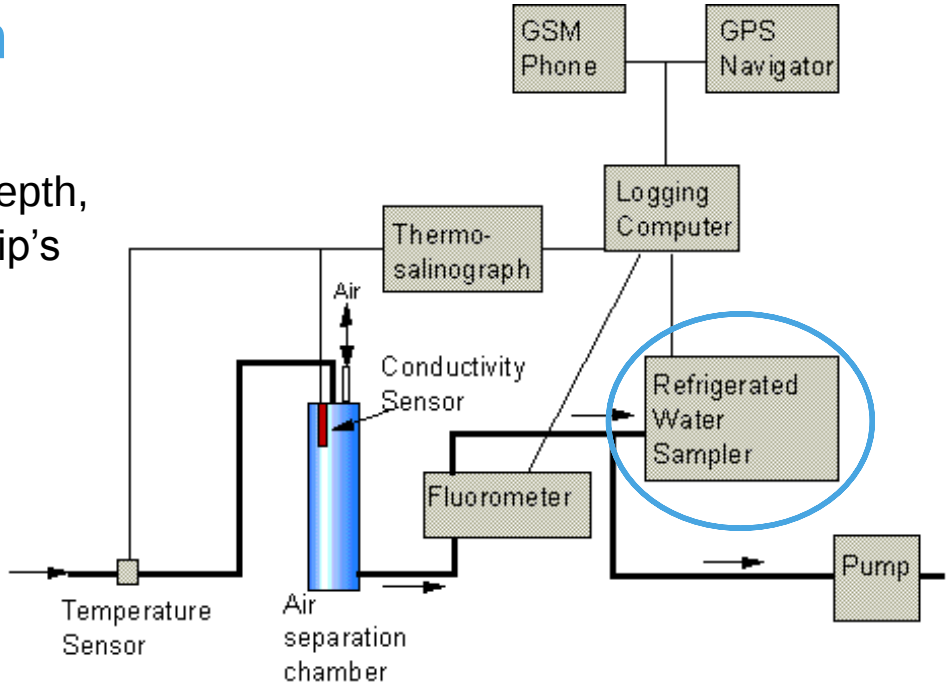
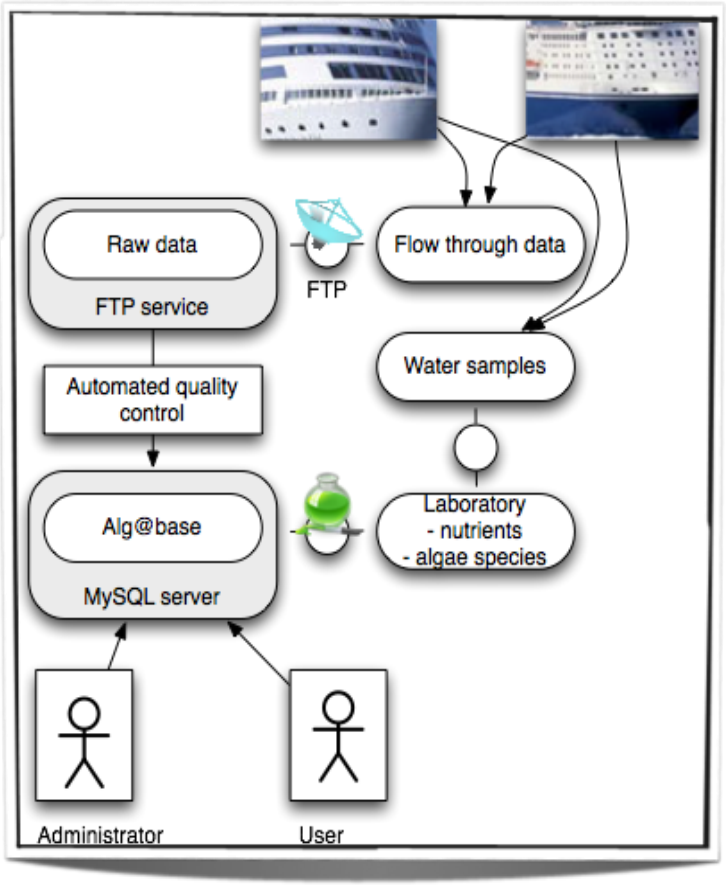
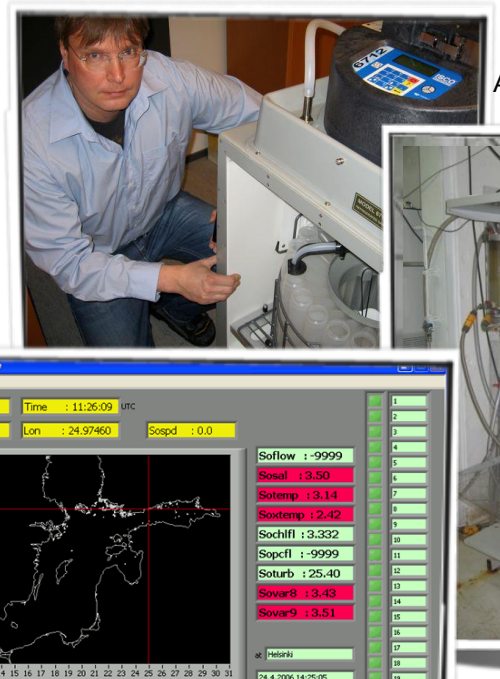


- **Automatic water sampler**
  - **24 x 1000 ml bottles**
  - **refrigerated**

Management



Alg@line dataflow



Automatic watersampler

Flow-through equipment

Ferrybox-software

Ferrybox-software controls operations of automatic flow-through and watersampling equipment onboard

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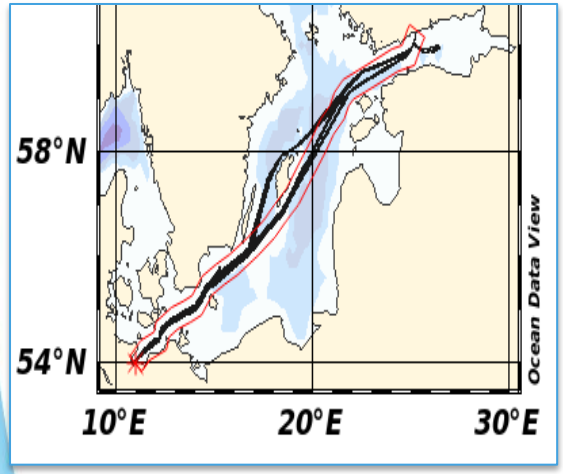
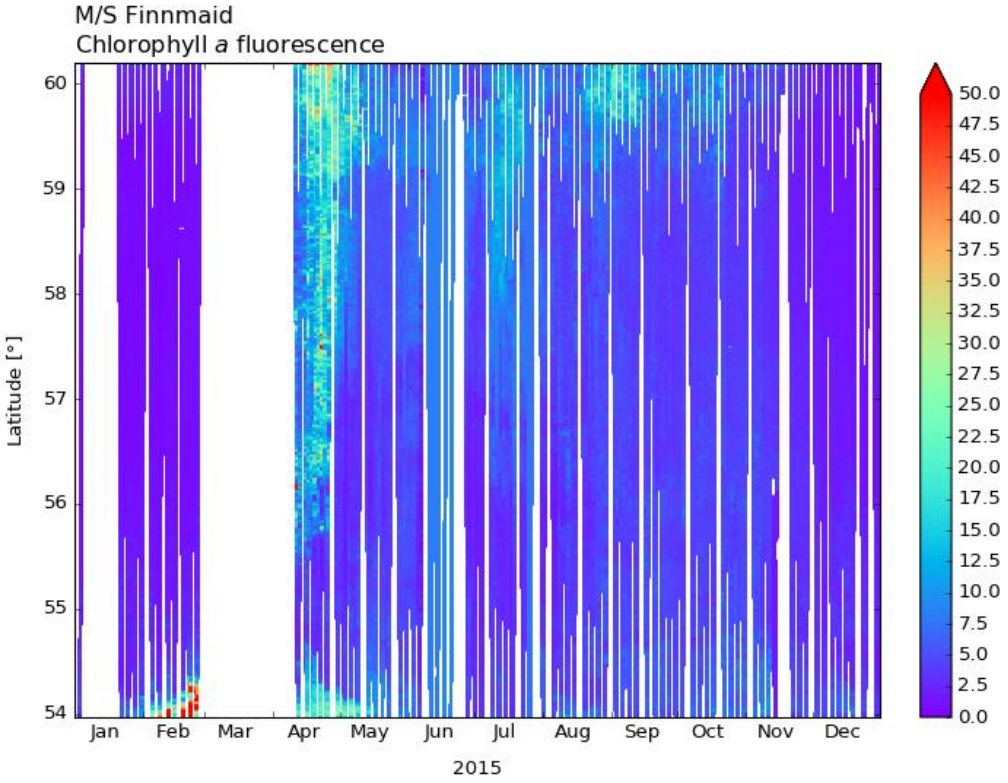
Finnmaid data presentation as ODV plots 2015





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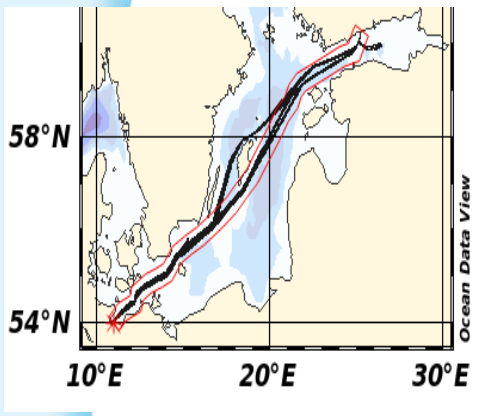
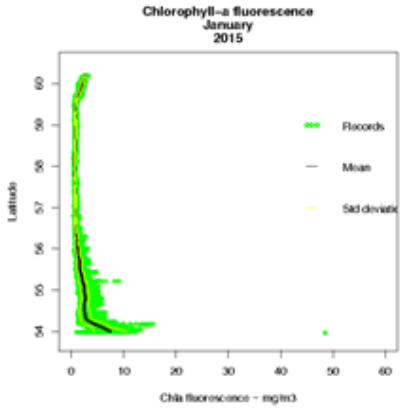
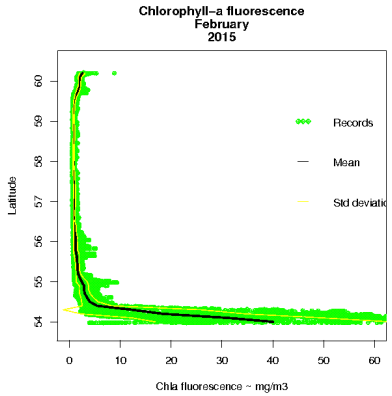
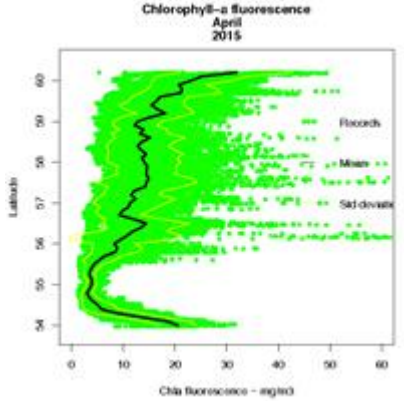
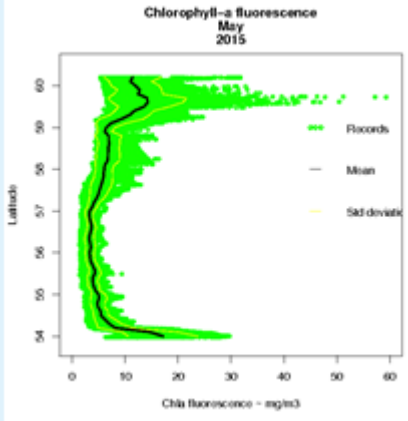
Baltic Chlorophyll fluorescence 2015
Monthy means and variation along latitude

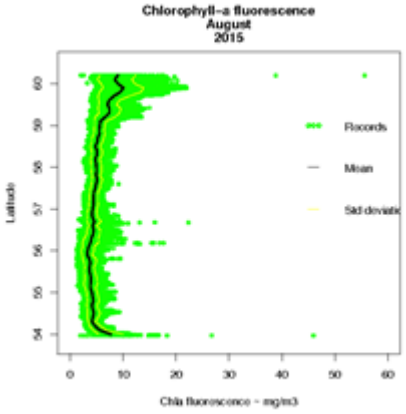


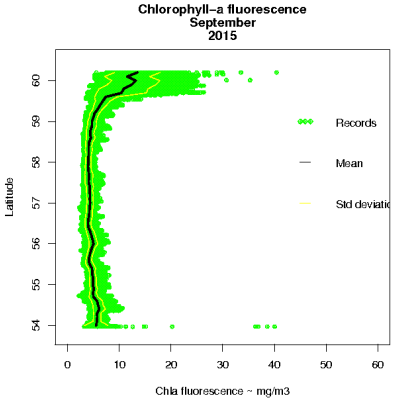


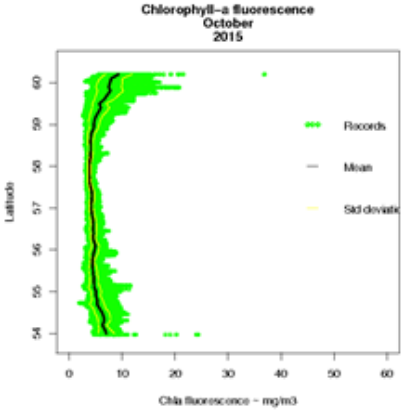












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Quality control

- QC flags 1, 4, 7 and 9 used
- Global and local range tests combined
- No biofouling testing

Table 6 Applicable QC tests by platform

	Profiles[1]	*Time Series/Trajectories*	*Isolated Samples*
	PF, GL, CT, SF, XB, SM	*GL, MO, RF, FB, TS, ML*	*BO*
Missing Value	x	x	x
Frozen Value	x	x	
Global Range	x	x	x
Local Range	x	x	x
Spike	x[1]	x	
Frozen Profile	x		
Biofouling		x	

Table 2 Quality flag scale. Codes mark procedure

Code	Meaning	Comment
0	No QC was performed	-
1	Good data	All real-time QC tests passed.
2	Probably good data	-
3	Bad data that are potentially correctable	These data are not to be used without scientific correction.
4	Bad data	Data have failed one or more of the tests.
5	Value changed	Data may be recovered after transmission error.
6	Not used	-
7	Nominal value	Data were not observed but reported (e.g.an instrument target depth)
8	Interpolated value	Missing data may be interpolated from neighbouring data in space or time.
9	Missing value	The value is missing

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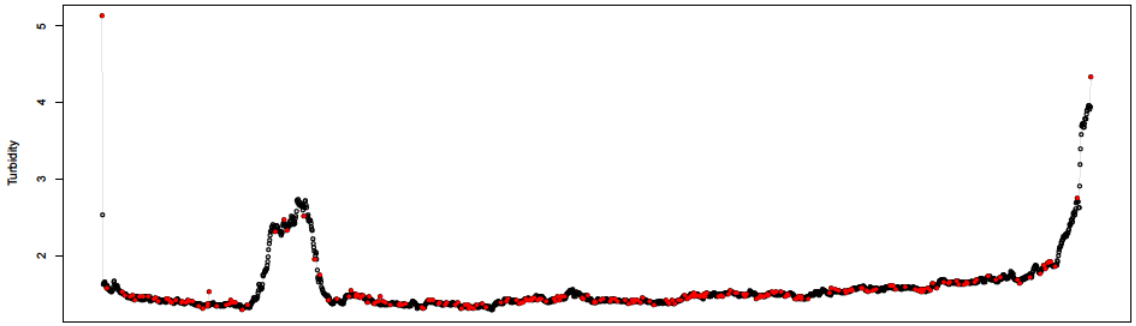
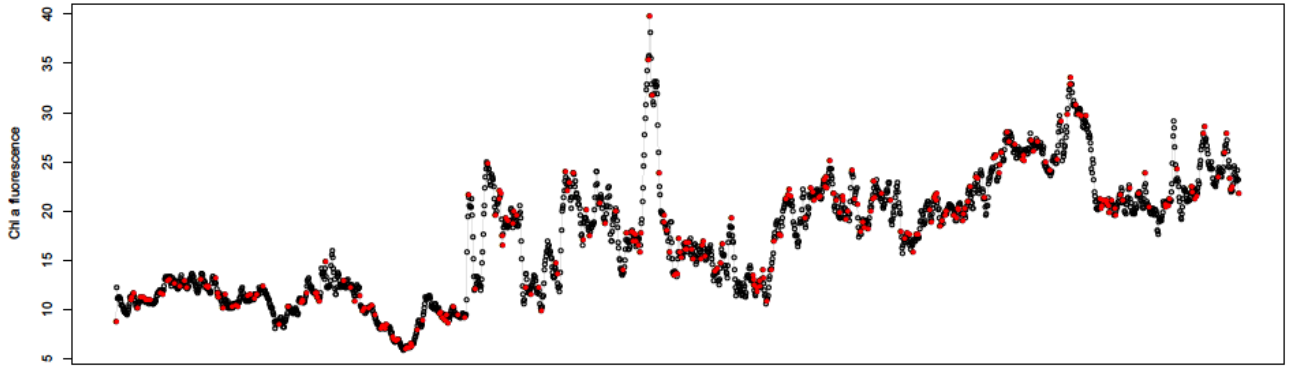
- Spike detection algorithm
- Ueda, T. 2009. A simple method for the detection of outliers. *Electronic Journal of Applied Statistical Analysis* **2**(67–76).

$$U_t = \frac{1}{2} AIC \approx n_g \ln(\sigma) - n_b \frac{\ln(n_g!)}{n_g} \sqrt{2}$$

- N = 5 bad…





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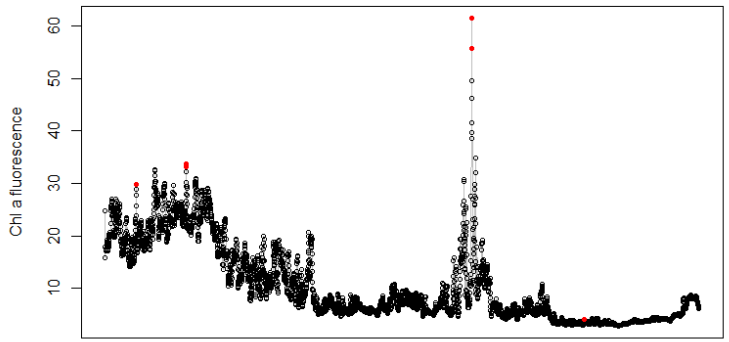
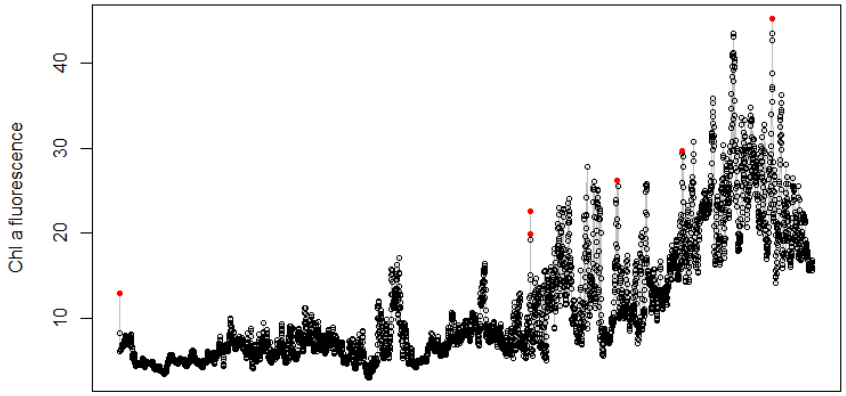
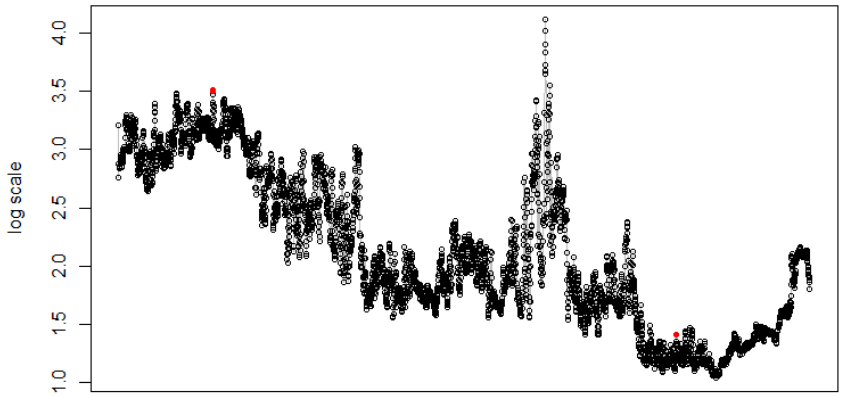
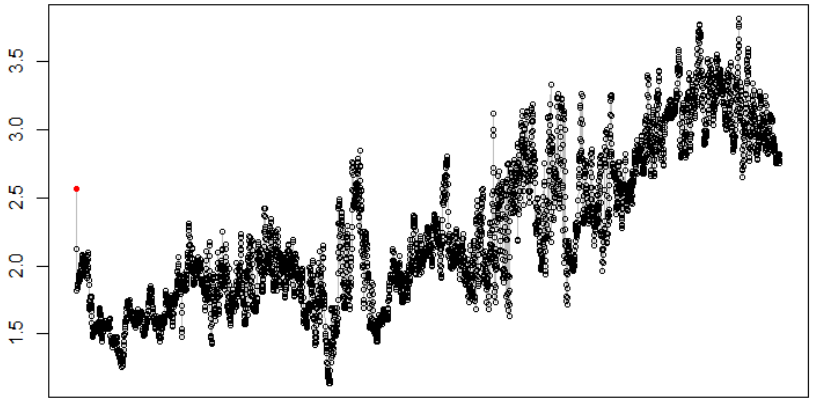
$$U_t = \frac{1}{2} AIC \approx n_g \ln(\sigma) - n_b \frac{\ln(n_g!)}{n_g} \sqrt{2}$$

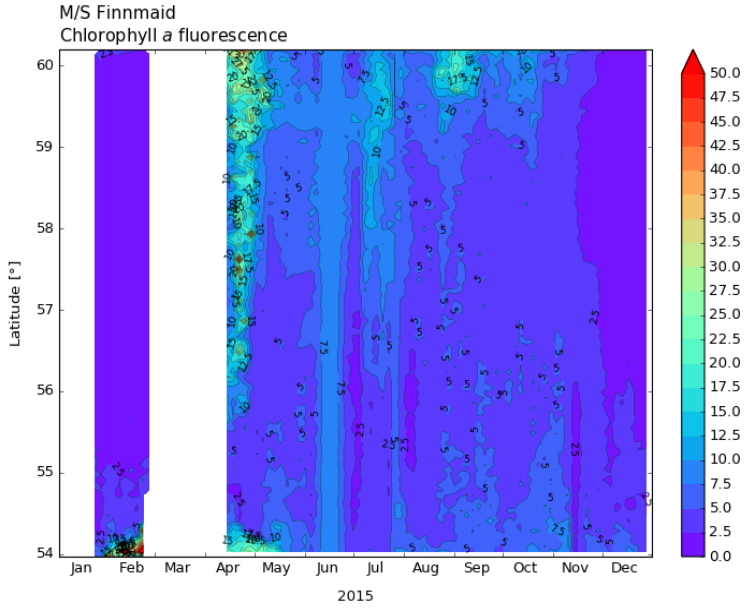
- Better implementation: N = 100
- Log-transform?










M/S Finnmaid
Chlorophyll a fluorescence
Latitude [°]
60
59
58
57
56
55
54
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2015
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
30.0
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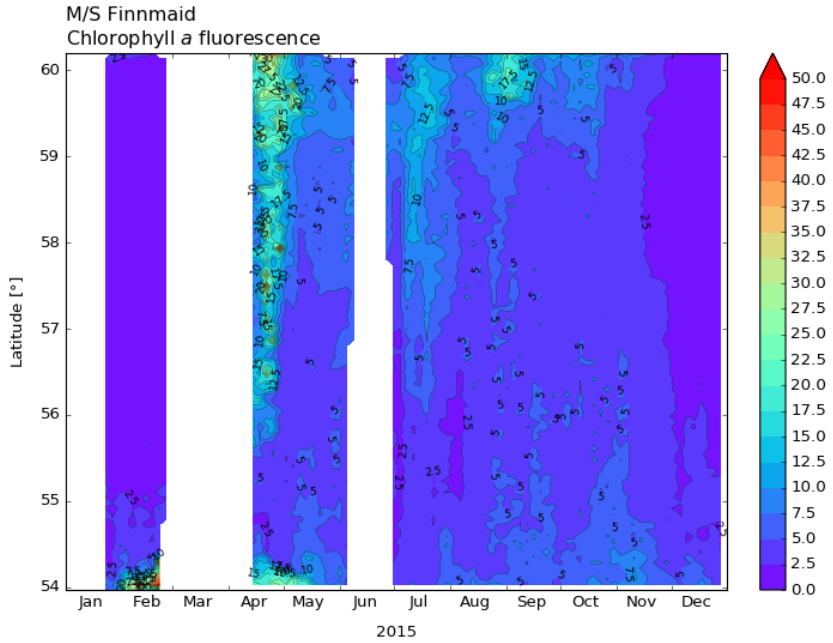
12.5
10.0
7.5
5.0
2.5
0.0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Chlorophyll a fluorescence
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Feb
Mar
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May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2015
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0

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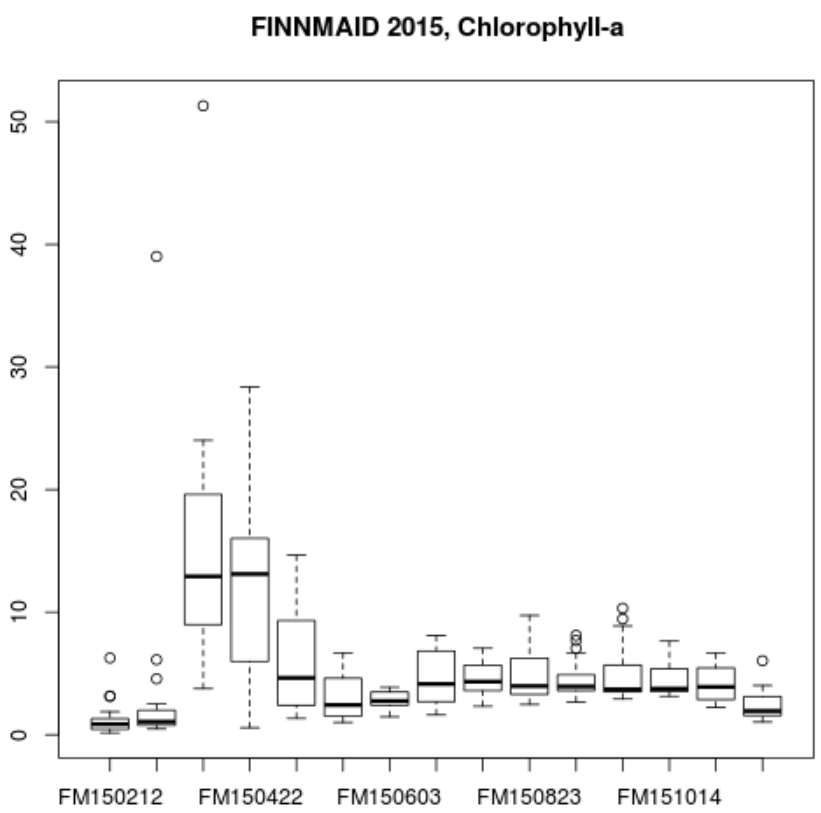
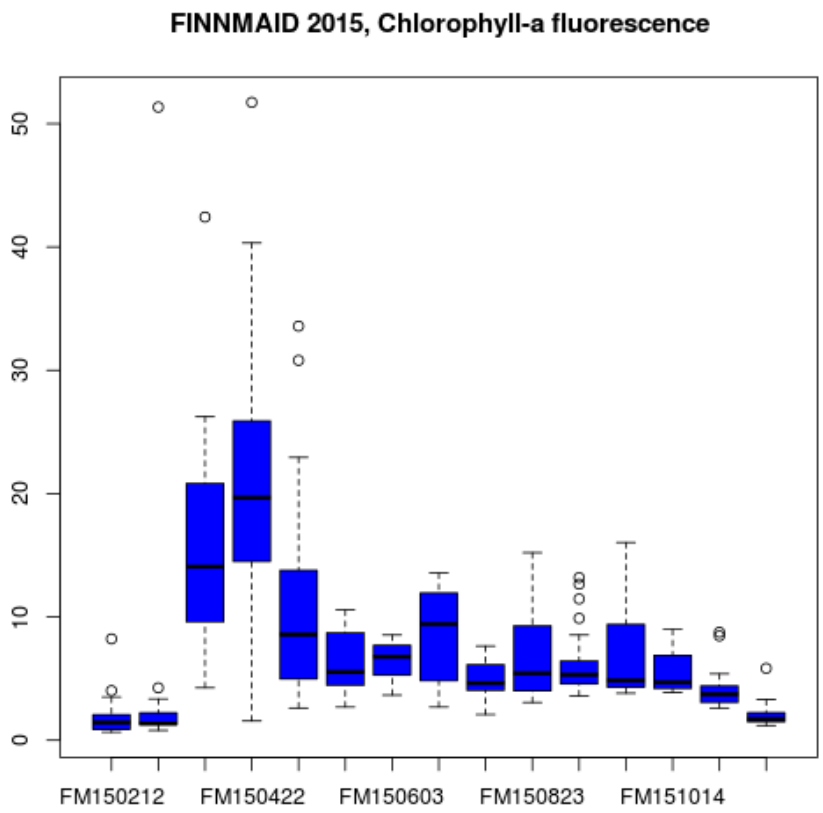
Chlorophyll-a anlysed from water samples and Chlorophyll-a fluorescence measured in situ (flow through water)





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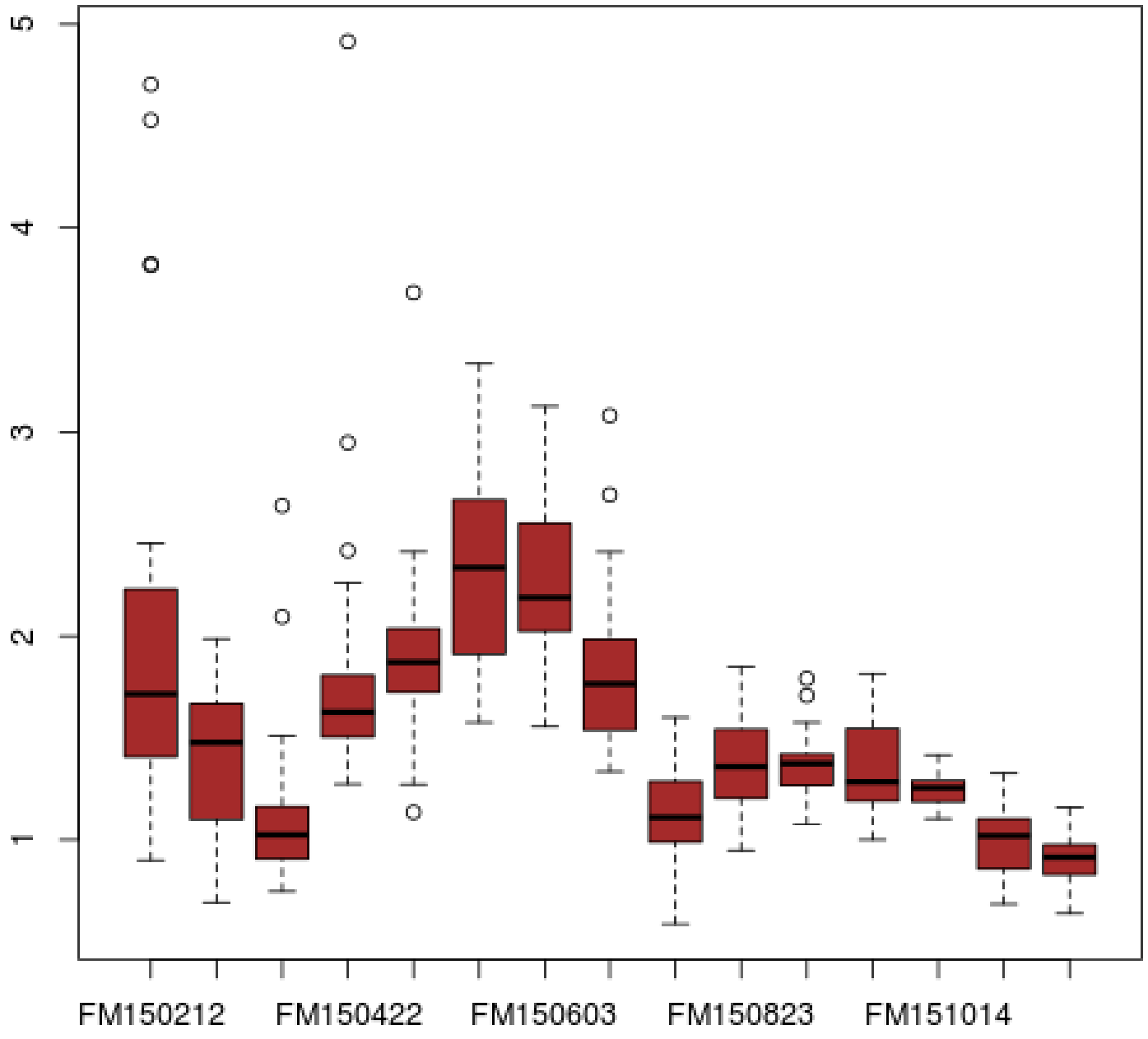
Taneli Uunari-Työntekijäinen, SYKE 22.3.2018

FINNMAID 2015, Fluorescence/Chl-a ratio



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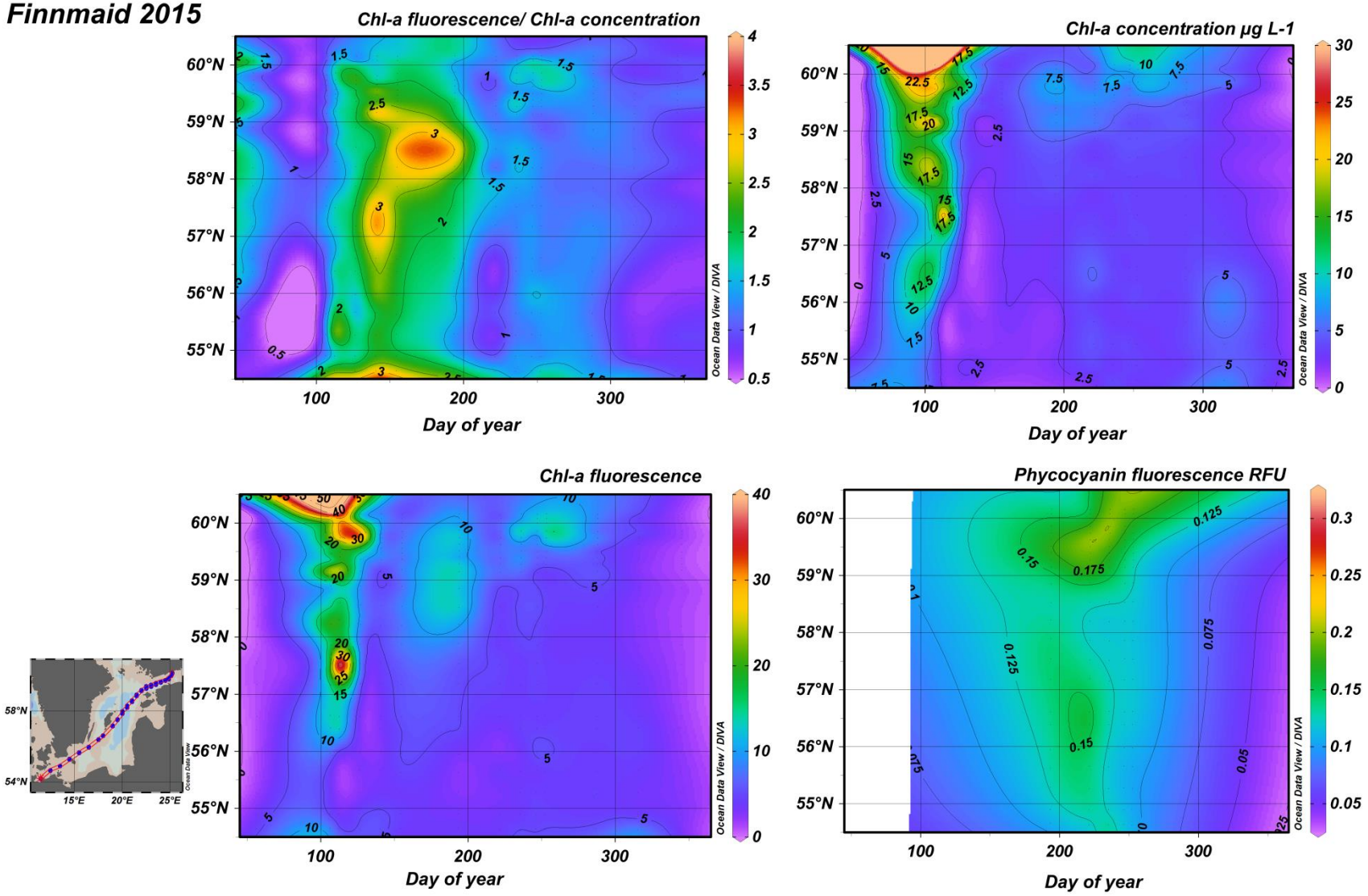
Taneli Uunari-Työntekijäinen, SYKE 22.3.2018

Chla fluor/Chla content ratio, FM 2015

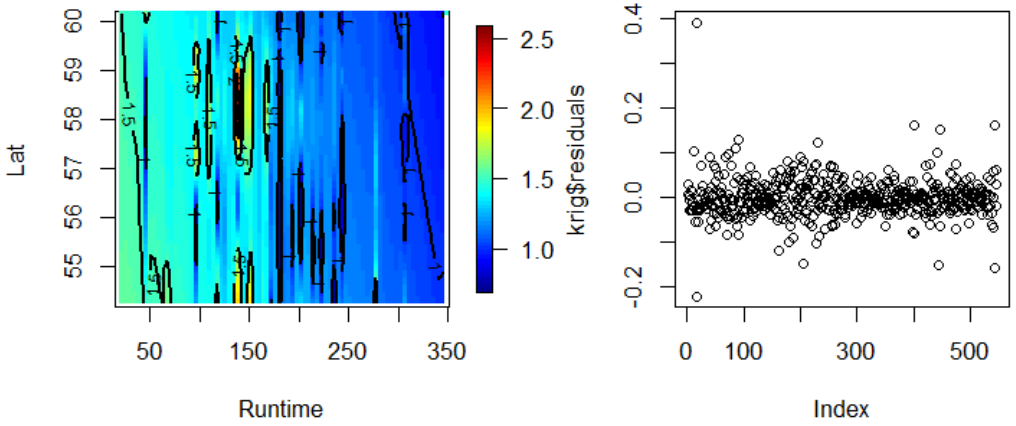
Finnmaid 2015



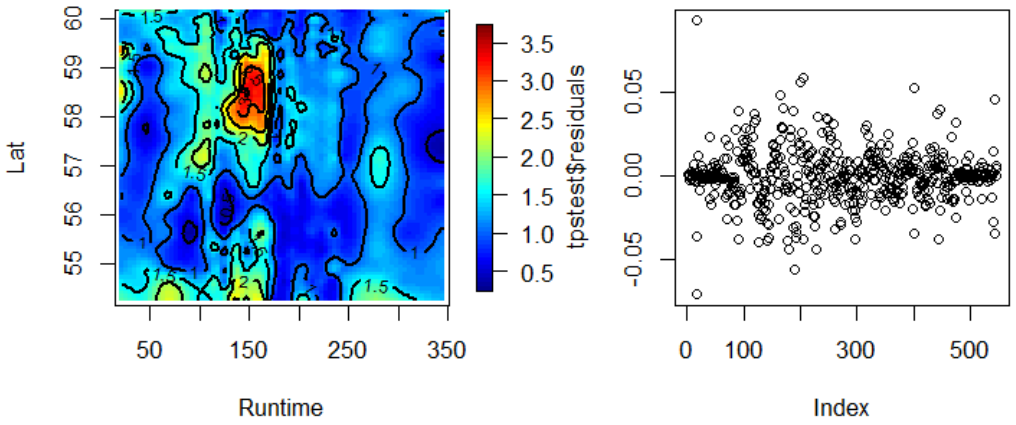
SYKE

Fitting ratio data with Kriging (R) and spline regression, FM 2015

Kriking

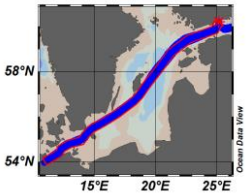


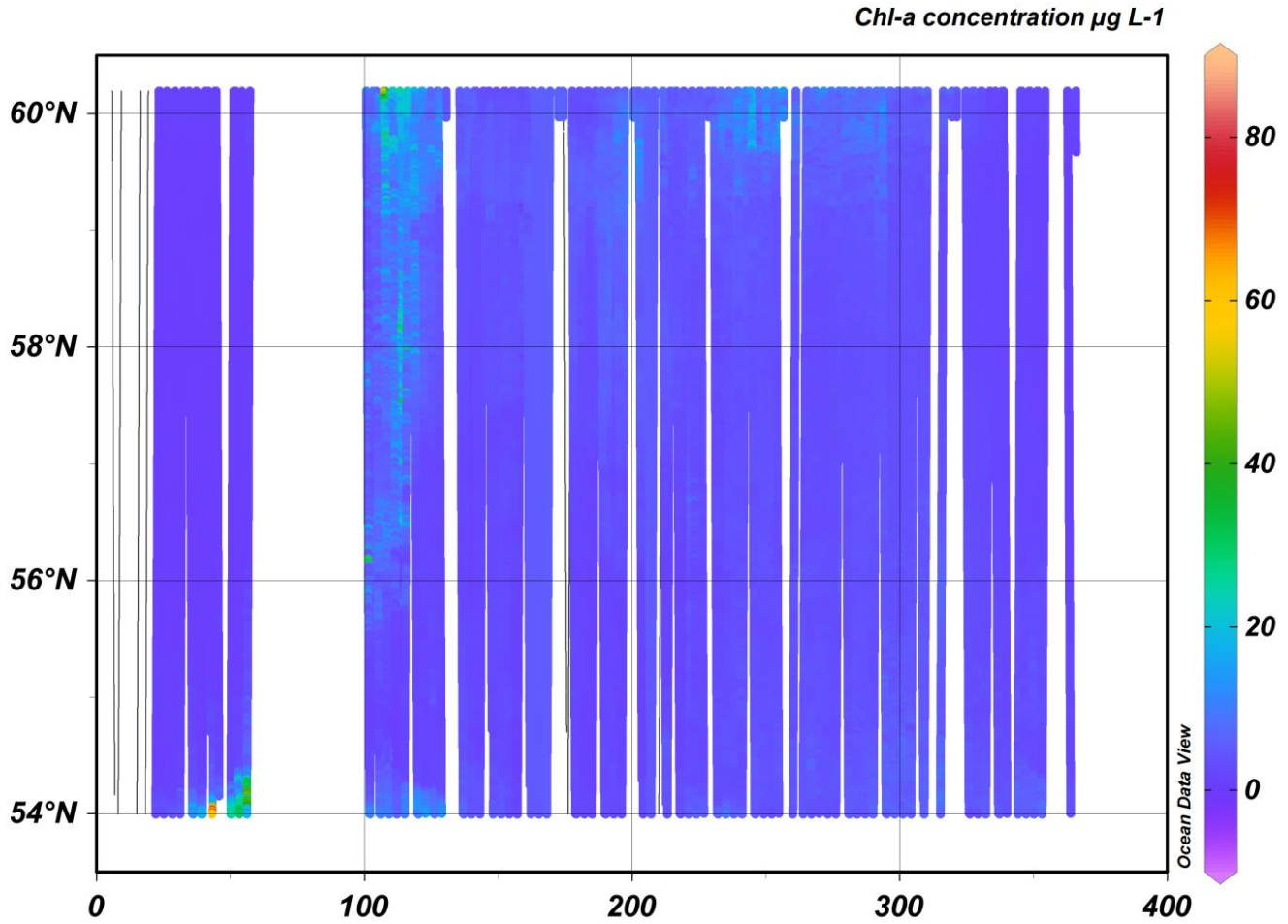
Spline regression



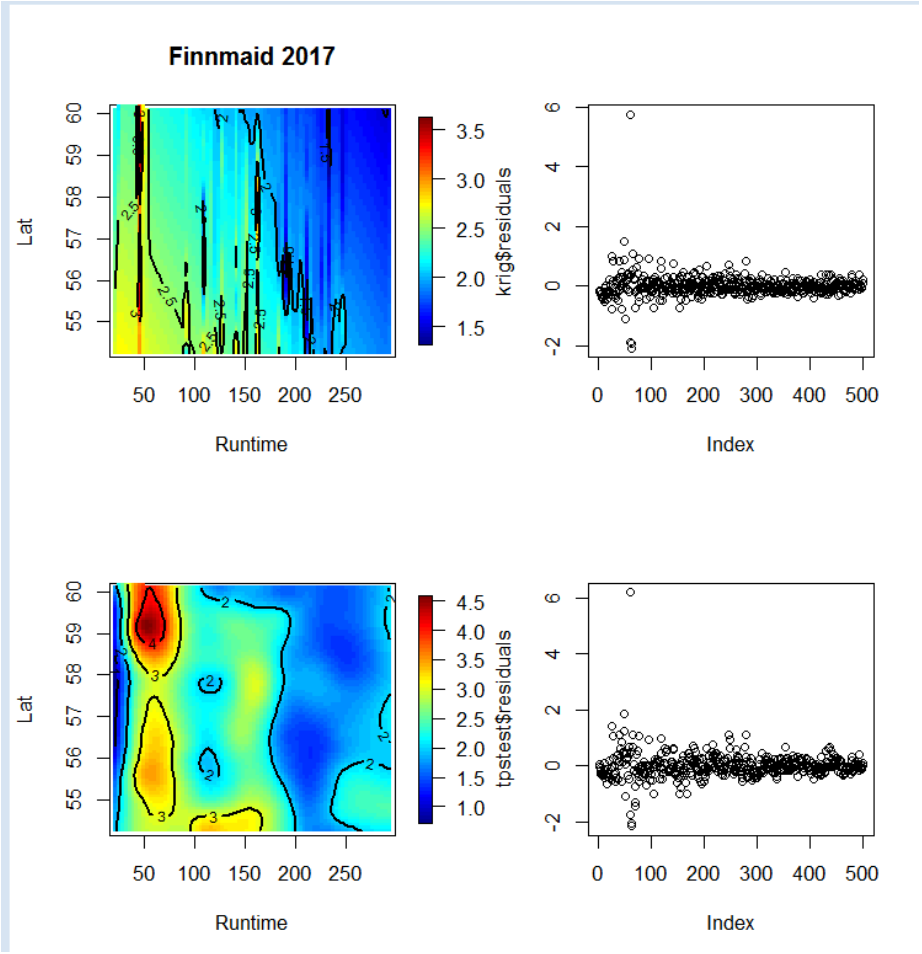
Corrected chla fluorescence FM2015

Finnmaid 2015





Fitting ratio data with Kriging and spline regression, FM 2017



- Thanks