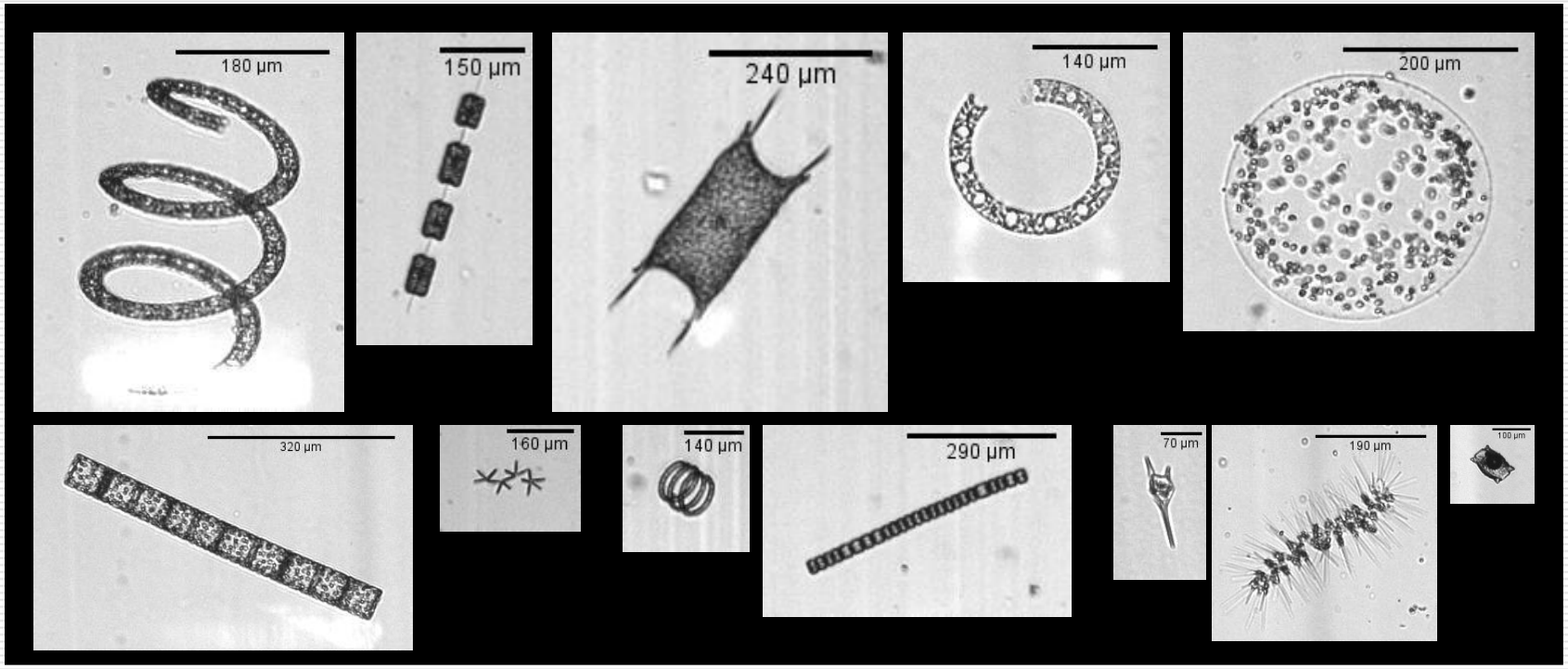
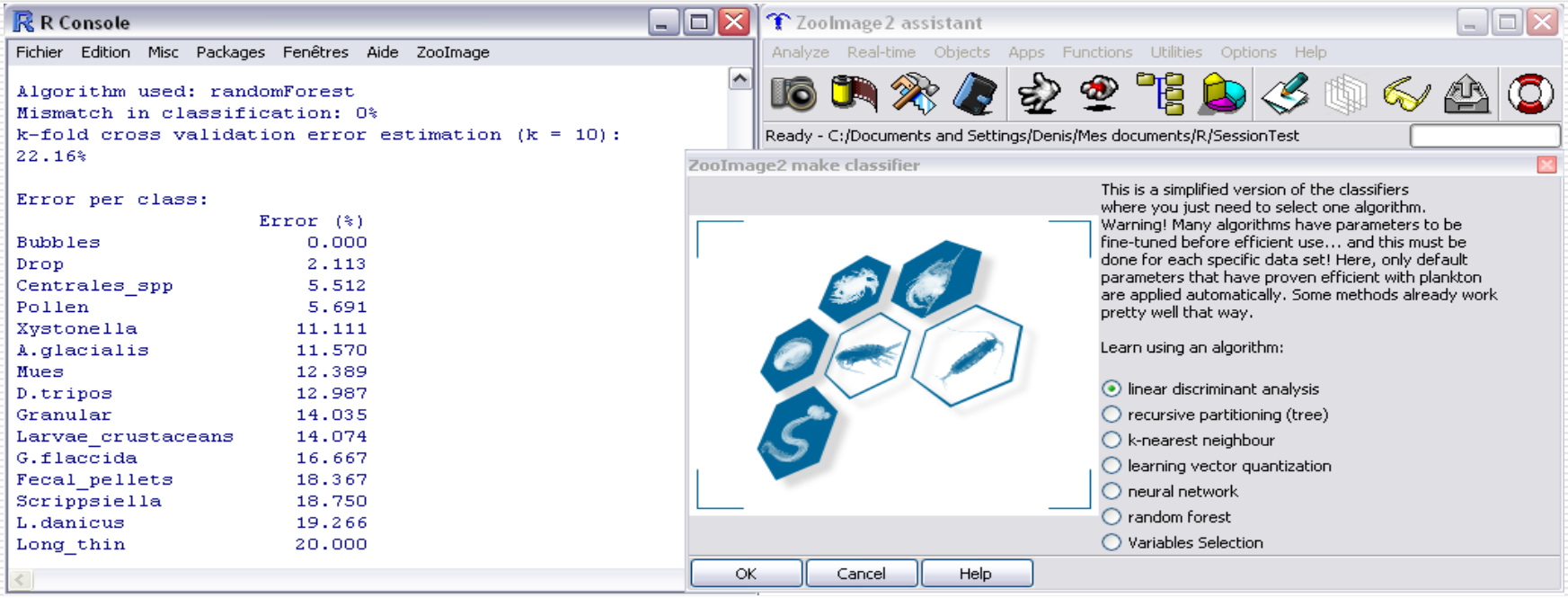
Towards a better classification of plankton digital images : suspect detection, error correction and real-time



Grosjean Ph., K. Denis, G. Wacquet, N. Ali, V. Rousseau, J.-Y. Parent, Ch. Lancelot, D. Hamad, F. Artigas, A. Lefebvre, C. Belin

Ifremer

What is Zoo/PhytoImage ?



- Free (open source) software written in R and Java specialized to classify zoo- and phytoplankton digital images
- Machine learning (supervised) classification
- Adaptable to analyze *any* plankton image, e.g., images from the FlowCAM...

Zoo/PhytoImage version 3

Install latest R

(http://cran.r-project.org) then in R :

> install.packages("zooimage")

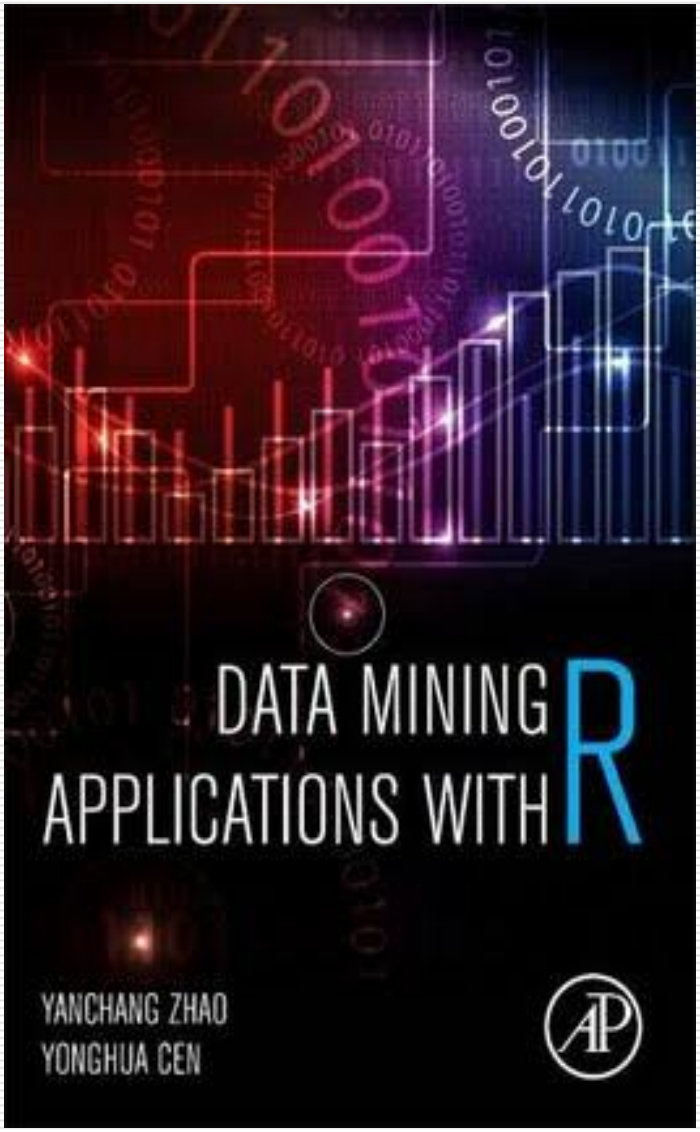
> library(zooimage)

See : Data mining application with R

ISBN 978-0124115118,
December 2013.
Academic Press, Elsevier.

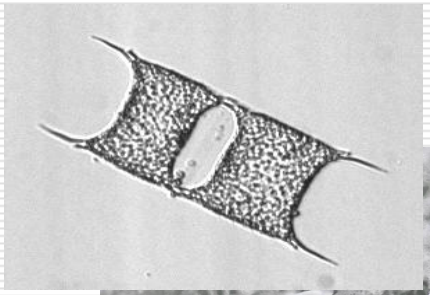
Chapter 12 is complete description and tutorial of Zoo/PhytoImage v.3.

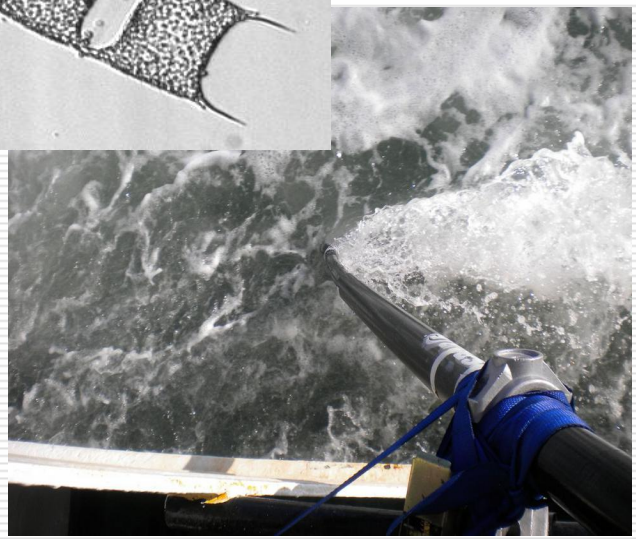
Version 5 near the end of this year

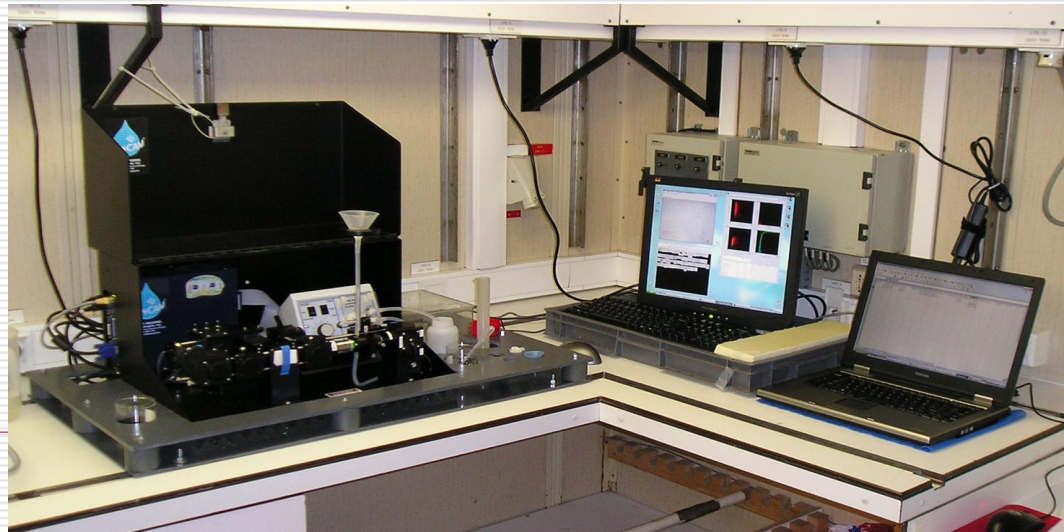


Application in real-time

- Combination of the FlowCAM with Zoo/PhytoImage
- Aboard the 'Belgica' (Belgian oceanographic ship)
- 25 groups discriminated in real-time (incl. 18 phytoplankton groups)
- Done a couple of years ago... but no more money for further work since then

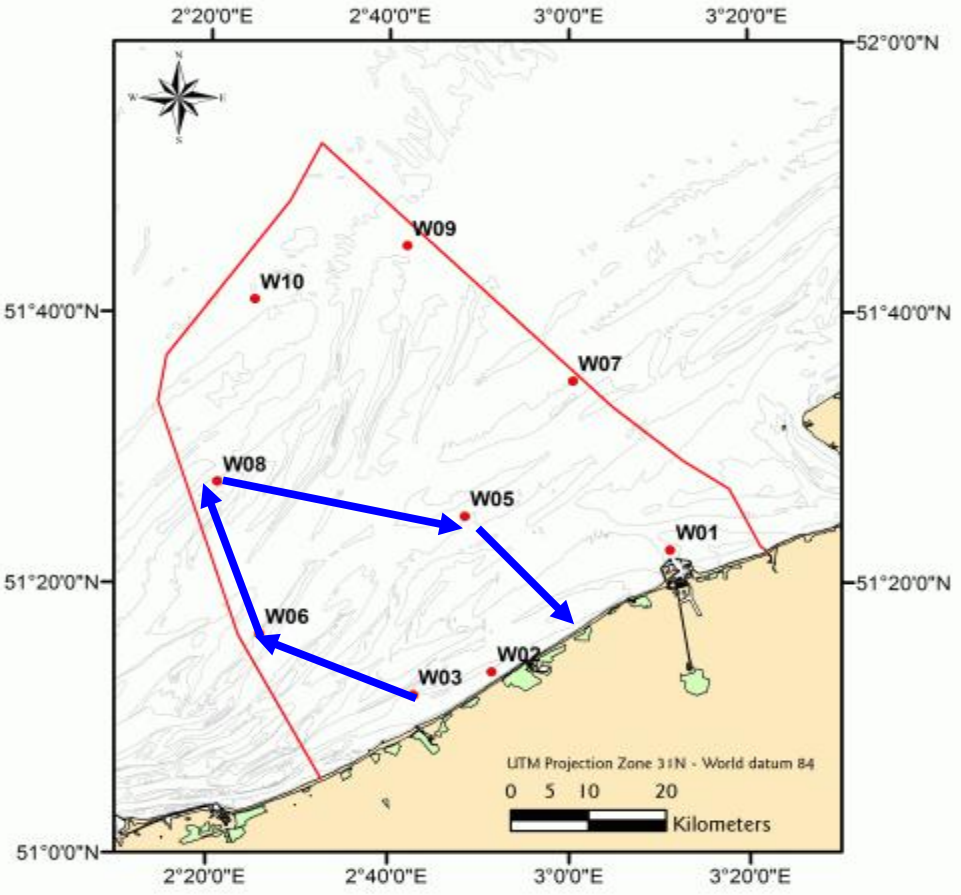






Real-time monitoring of North Sea phytoplankton

Application example: a one-day cruise in the Belgian Coastal Zone (BCZ).

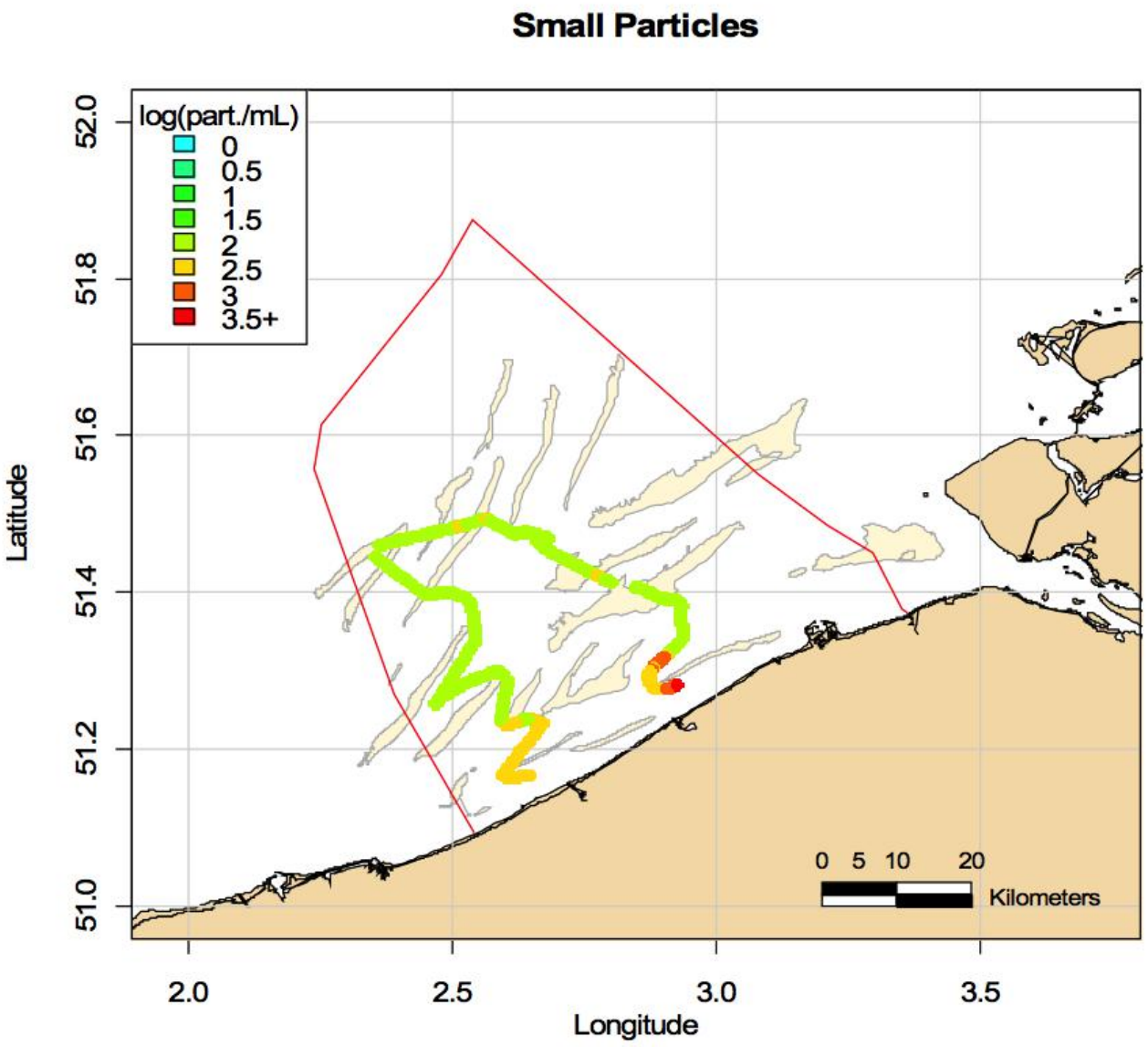


Real-time monitoring - results

Small particles dominating near the coast and the Schelde estuary.

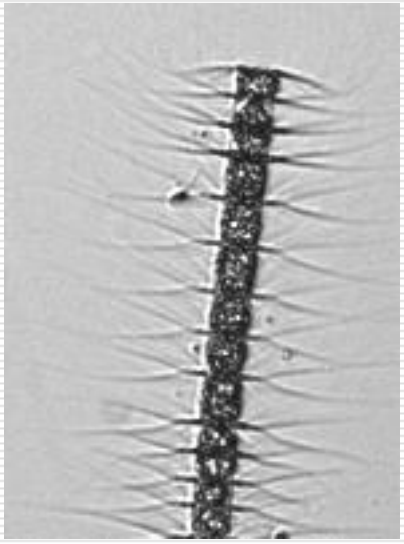
Notice the influence of sandbanks

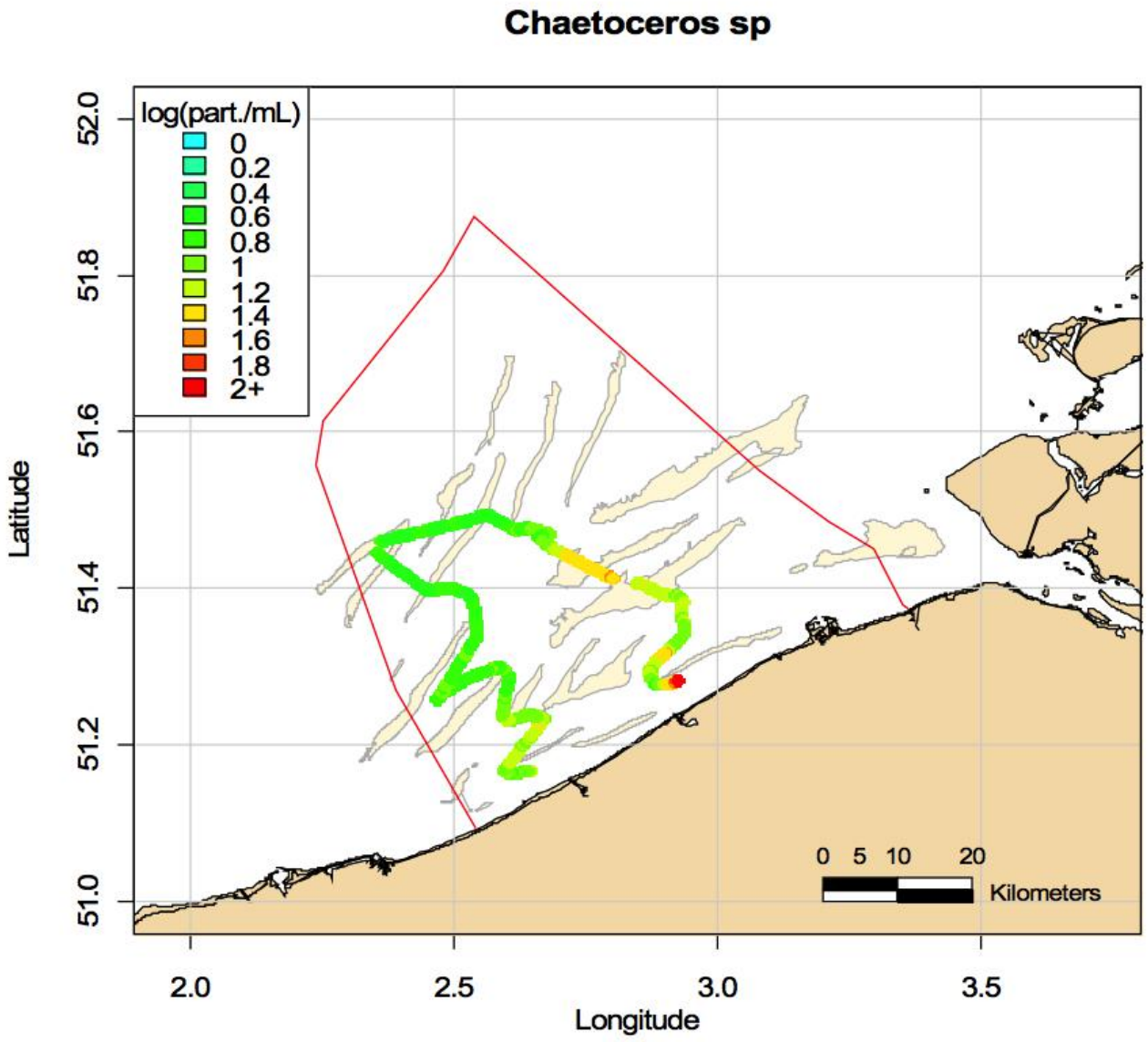
(no interpolation!)



Real-time monitoring - results

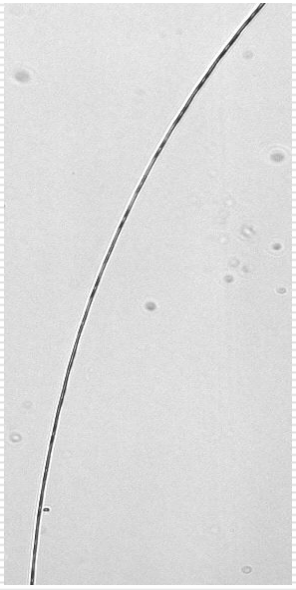
A neritic diatoms : *Chaetoceros sp*.

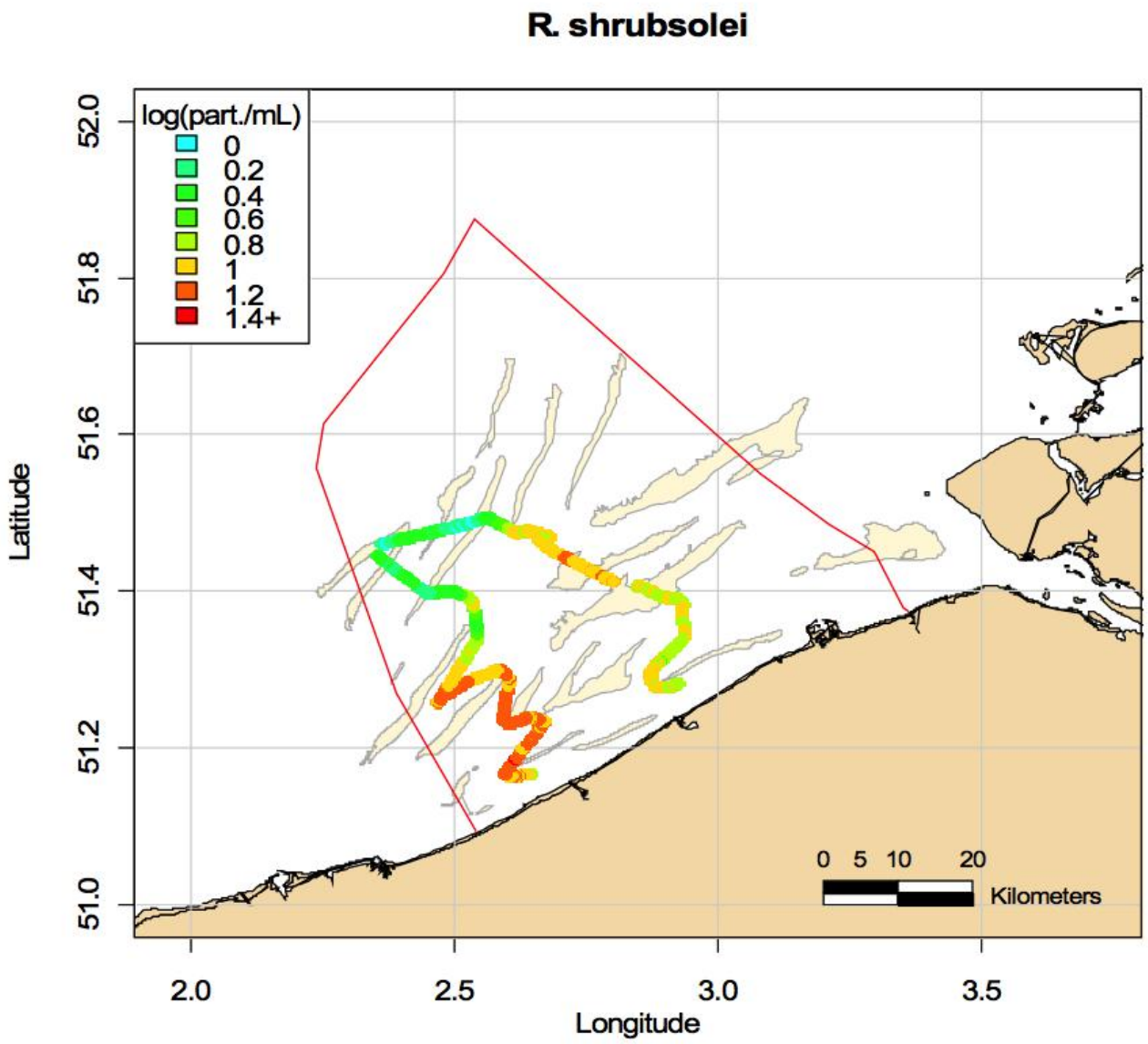




Real-time monitoring - results

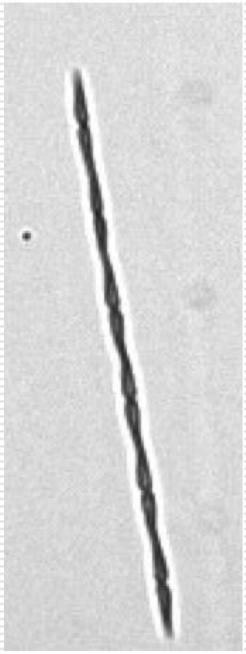
Rhizosolenia shrubsolei with a very different distribution pattern.

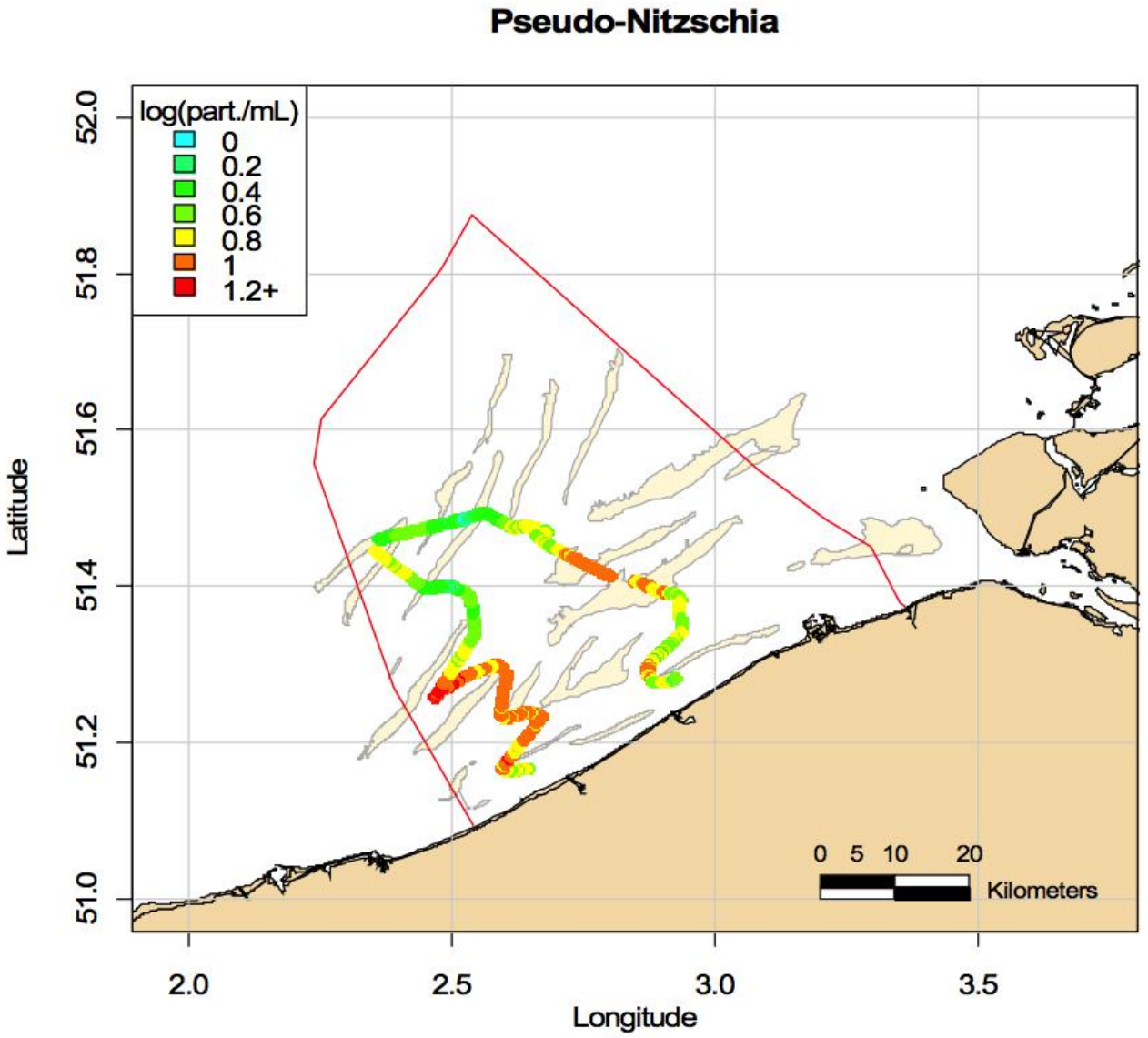




Real-time monitoring - results

Yet another distribution pattern : *Pseudo-nitzschia*.

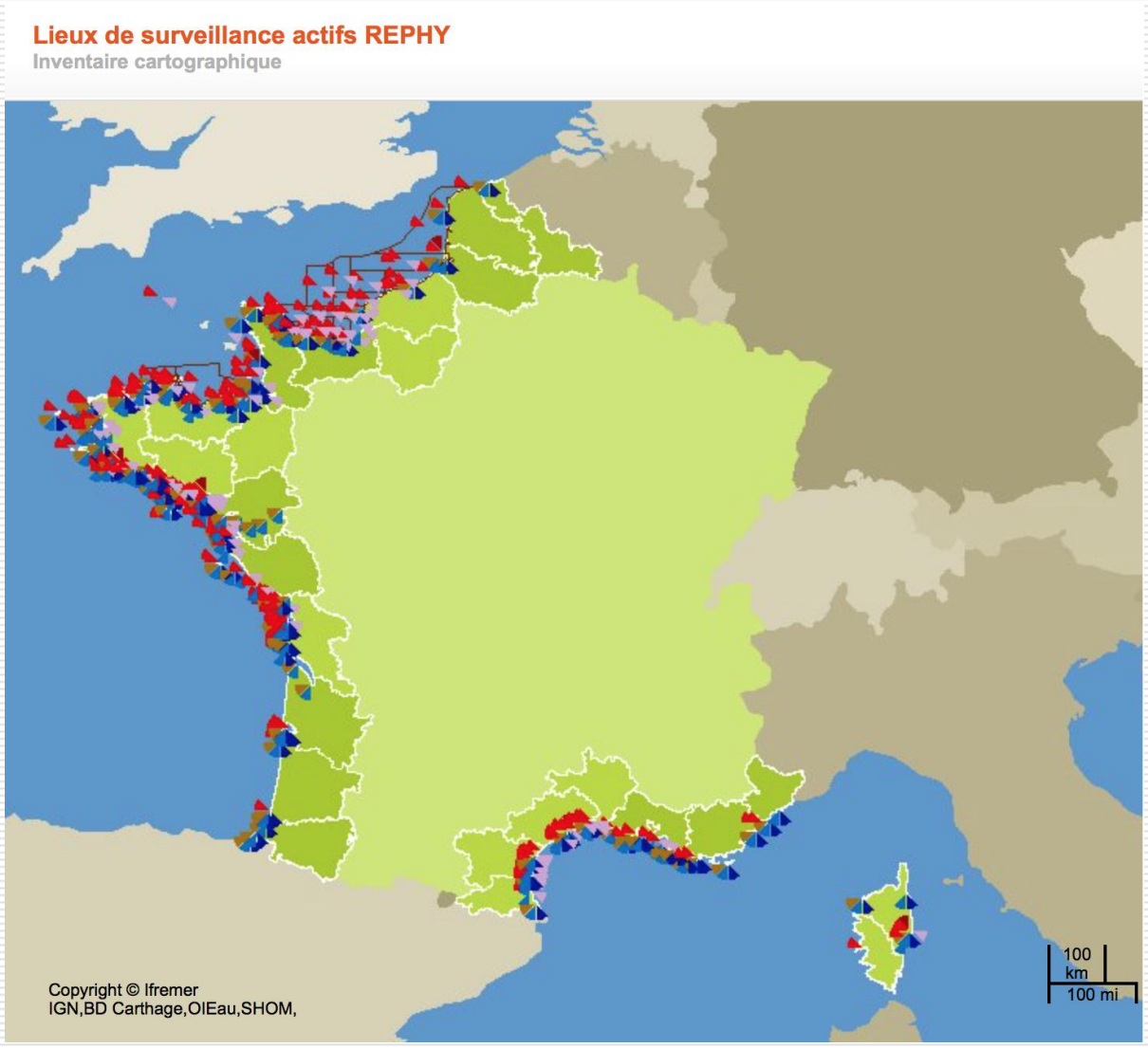




What about a higher taxonomic discrimination ?

Routine use in the IFREMER Rephy network

IFREMER Rephy



- French coasts
- All the dots on the map are stations included in the survey
- Starting to use the FlowCAM + Zoo/PhytoImage v.5 since mid 2014

(map from IFREMER)

Typical results with > 40 classes

Global error : 26 %

Error per class:

	Error (%)		Error (%)
Drop	7	Lauderia_Schroederella	24
Pollen	7	Thalassiosira_spp	25
C.fusus	8	Fecal_pellets	25
L.danicus	9	Long_thin	26
L.undulatum	12	Dark	32
Thalassiosira_spp_cells	13	D.fragilissimus	33
G.flaccida	14	D.brightwelli	35
Black_opaque	15	Aggregates	36
D.tripos	17	P.alata_indica	40
Centrales_spp	17	G.delicatula	46
Mues	18	Membranous	48
G.striata	18	R.imbricata_styli	50
Pseudo-nitzschia	19	Fibers	50
Euglenophyceae	20	Dictyochophyceae	53
T.subtilis	20	Protoperidinum_spp	68
Short_thin	22	Chaetoceros_spp	69
Clear	23	Larvae_crustaceans	71
N.longissima_Cylindrotheca	23	Ceratium_spp	79
A.glacialis	23	P.alata	93
Bubbles	23	C.danicus	95
Granular	24	C.decipiens	97

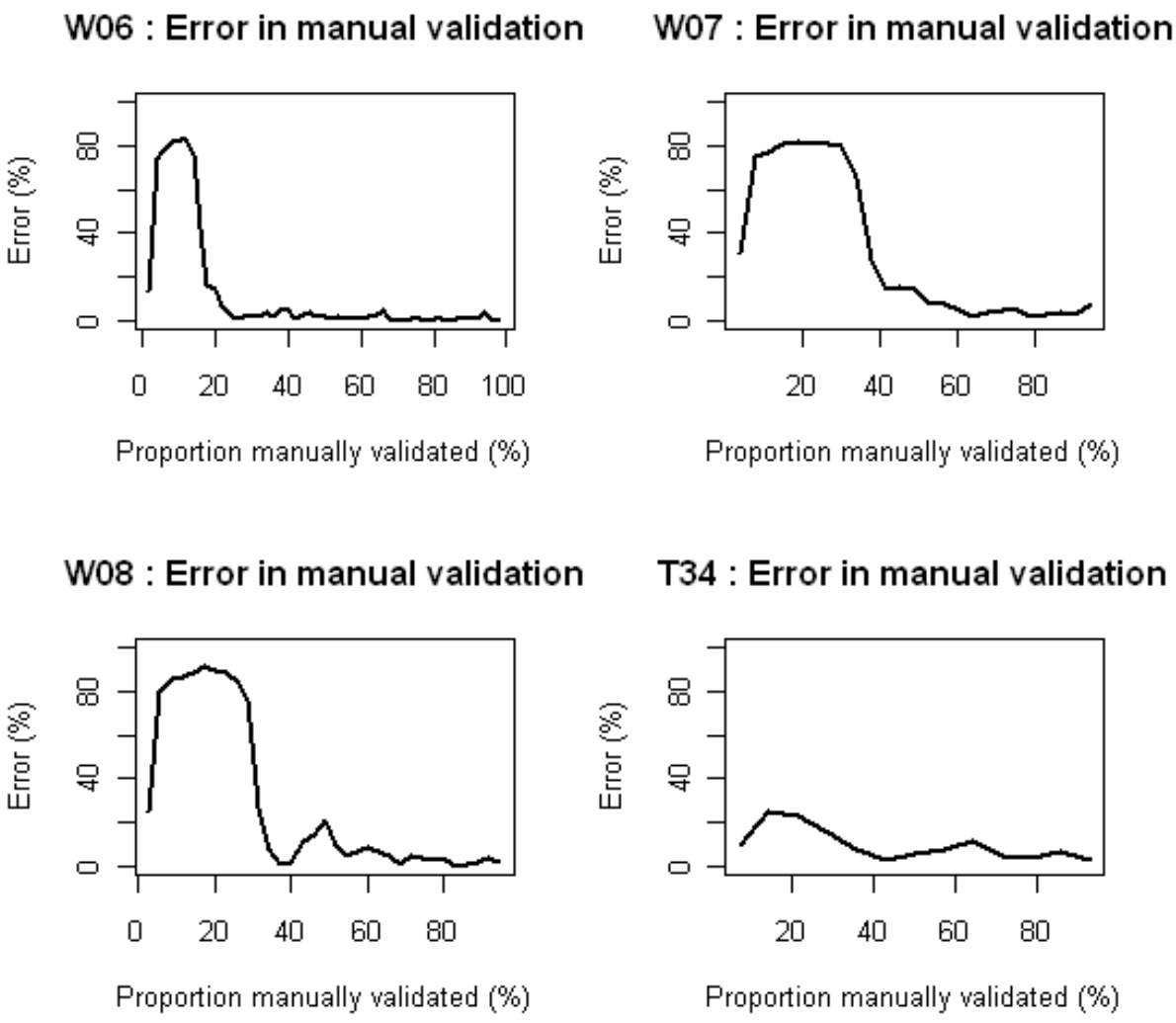
- On average, ¼ wrongly classified

- Large discrepancy of results: some classes are OK, other are completely wrong

Manual validation is required to lower the error down to acceptable levels for all classes

(from Tunin-Ley et al, 2011)

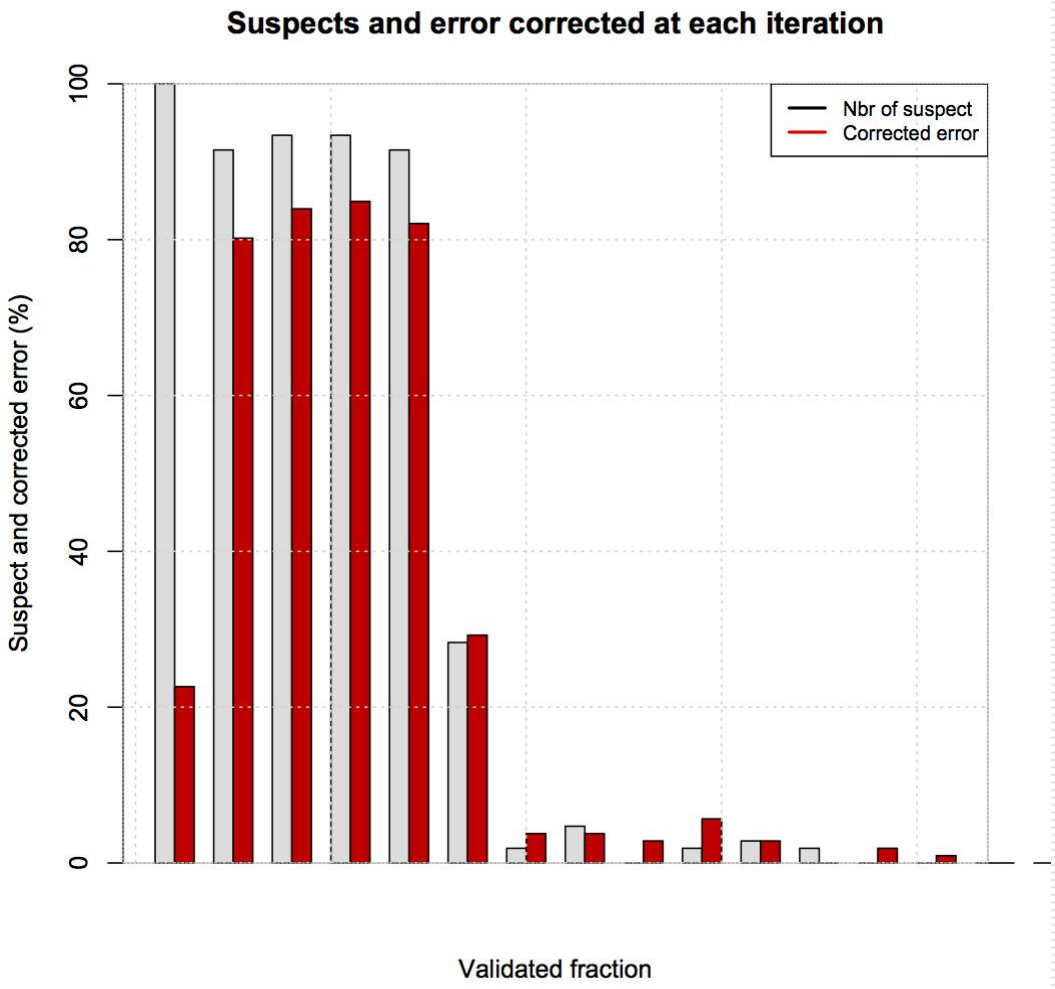
Detection of suspect particles



Application on four different samples

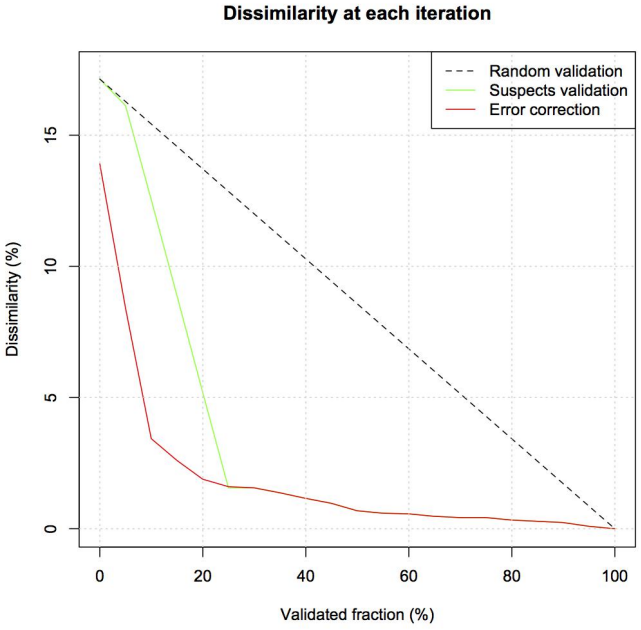
Suspect particles contain a large fraction of the error in most cases

Step by step validation of the suspect items



Gray bars = suspects

Red bars = error corrected after manual validation

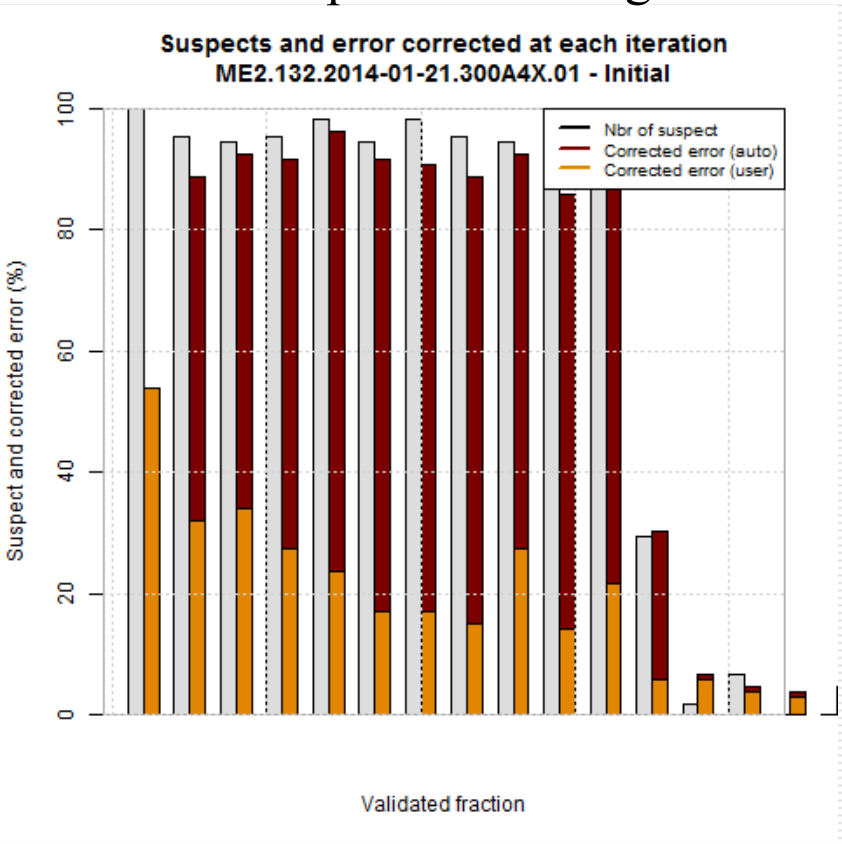


Active learning and statistical error correction

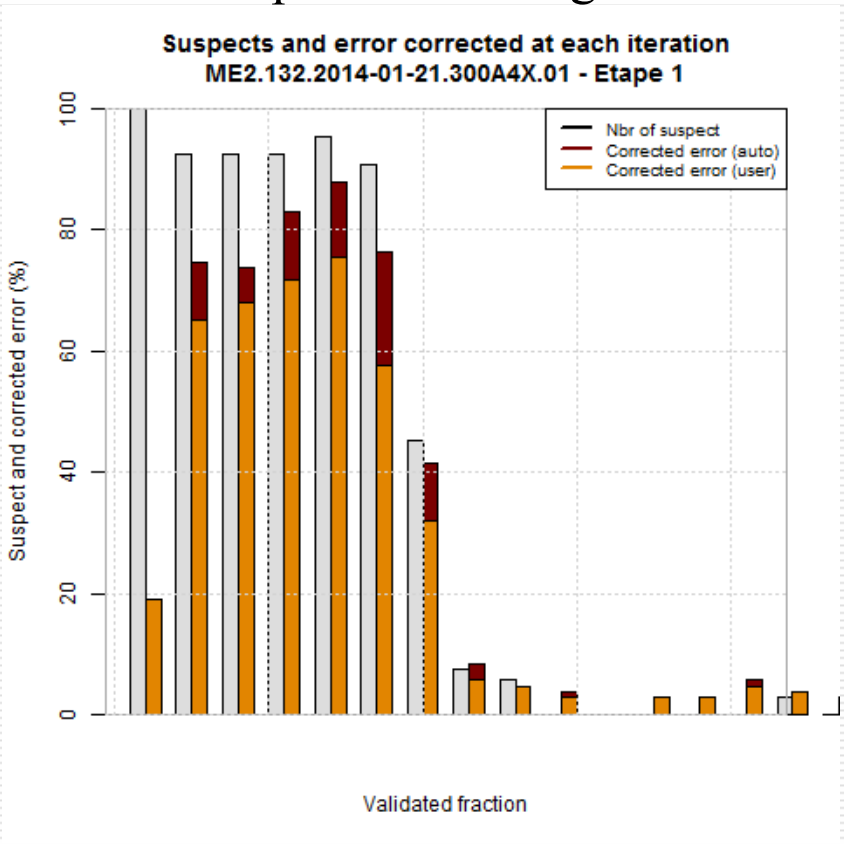
Brown bars = error statistically corrected

Orange bars = error that the user must correct

Without adaptative training set



With adaptative training set

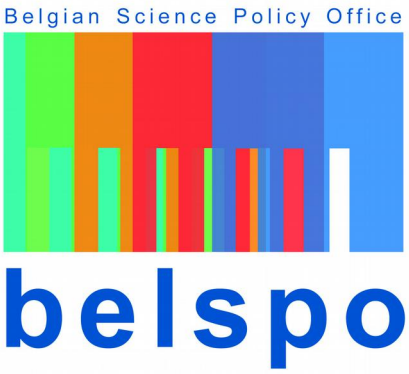


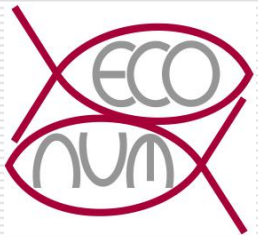
Conclusions & perspectives

- Image analysis (FlowCAM) combined with supervised analysis usable in real-time for coarse classification of phytoplankton

- Deployment in routine survey network with higher discrimination needs manual validation to lower the error (e.g., IFREMER - Rephy)

- Validation of suspects combined with statistical error correction greatly reduces the number of items to validate for a given error rate





Study in collaboration with ***IFREMER***, also funded by the ***Belgian Science Policy***