Quality Control of Bio-Geochemical and optical Ferrybox data

Pierre Jaccard, Kai Sørensen, Anna-Birgitta Ledang, Dag Øystein Hjerman and Marit Norli

pierre. jaccard@niva.no

Outline

- BGC QA procedures from MyO
- QA on above water reflectance data

Quality Control Tests for Biogeochemical Data

Recommendations from MyO documents

1) Jaccard, P., Norli M, Ledang, A.B, , Hjermann, D.Ø., Reggiani, E.R., Sørensen, K., Wehde, H. Kaitala, S., 2013 WP15.

Real Time Quality Control of biogeochemical measurements. Version 2.0. June 2013, Rev 2014.

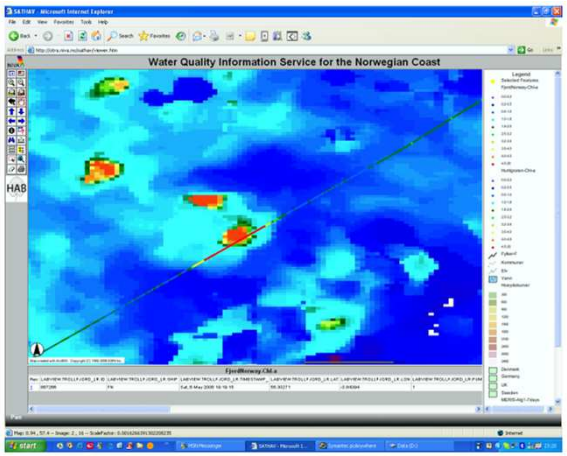
2) MyO 2. R&D Reference Report – WP15.2

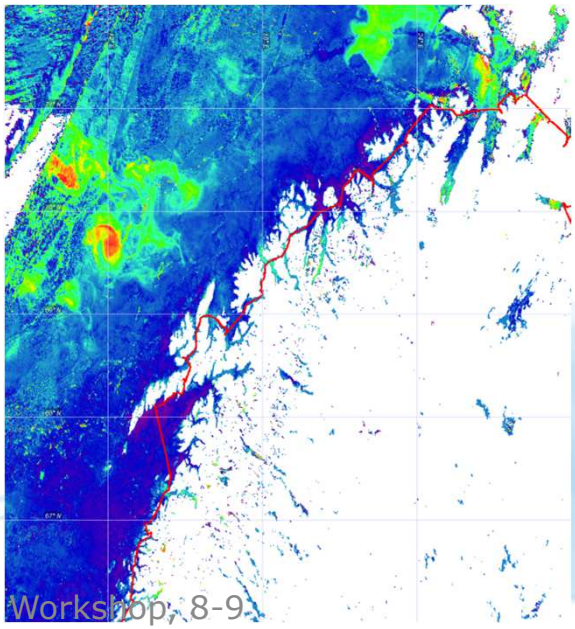
Reference: MYO2-INS-RRD-V1.1, In preparation

pierre. jaccard@niva.no

BGC data and sensors

- Living species –
  - Night and day variation
- Phytoplankton patchiness
  - BGC-reactions
- New technology and measuring principles
  - Proxy measurements for a geophysical parameter
  - Calibration issues
  - Sensor prototypes

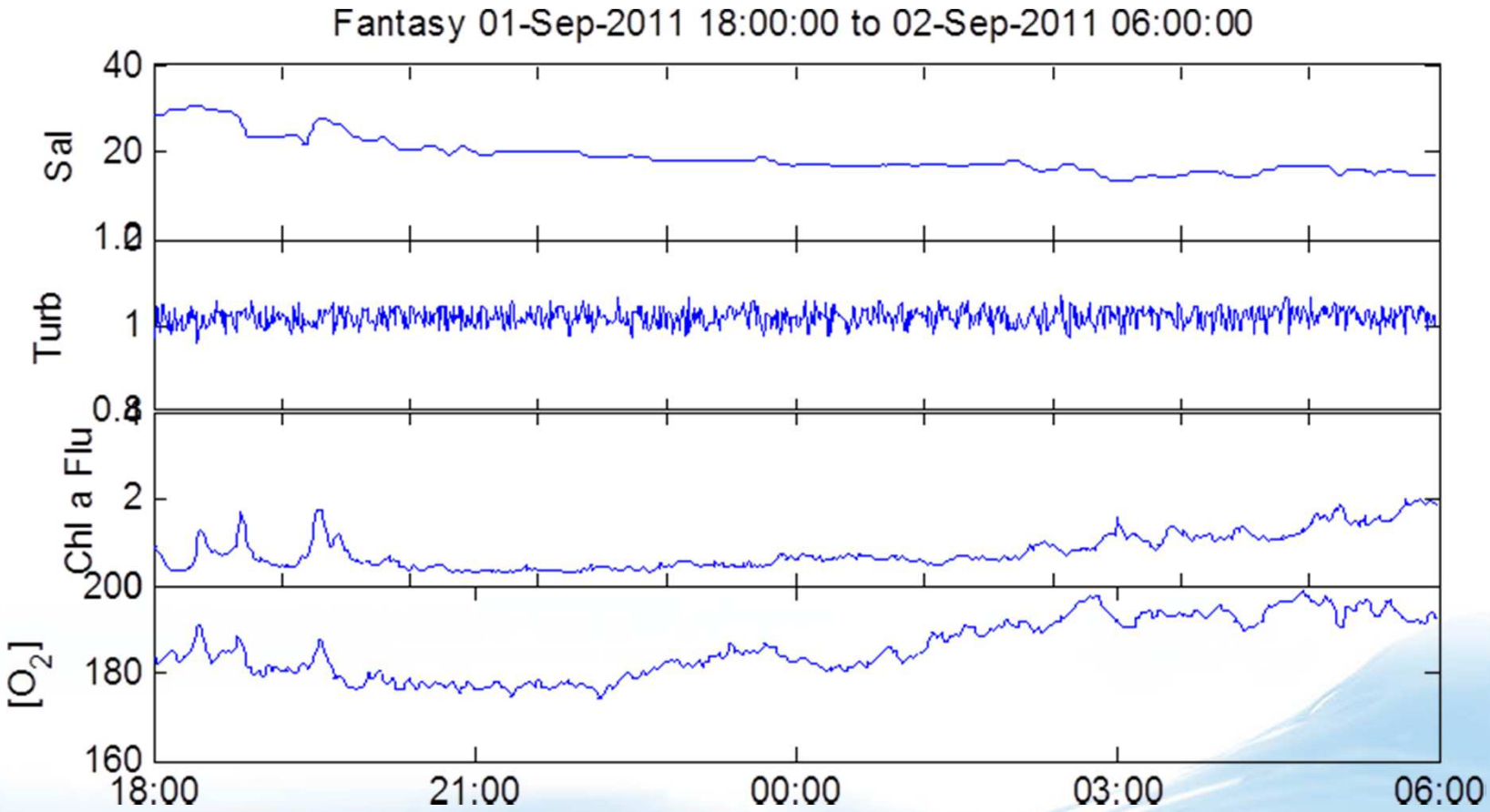




General Issues

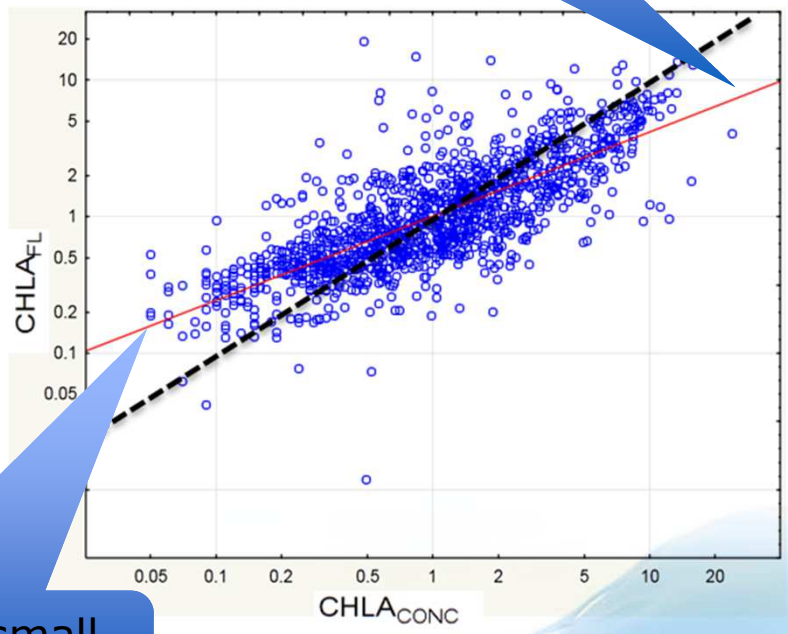
- Strong variability on all scales
- Variation of 2-3 orders of magnitude
- Sensor values often oscillate («noise»)
- General lack of extensive climatology (regional range)

Oscillations/Variations

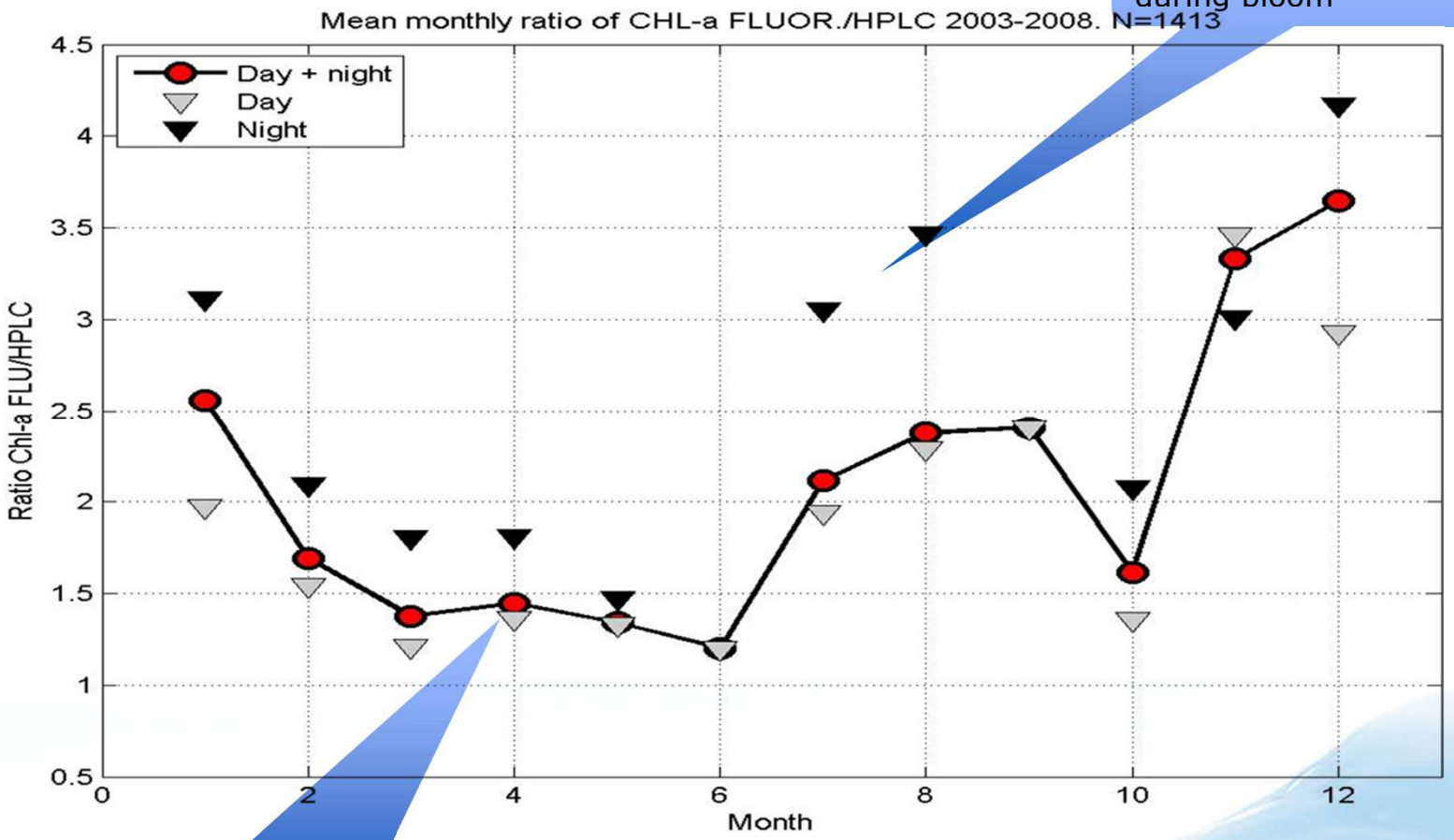


Chl a Fluorescence

- Proxy for estimation of phytoplankton biomass
- Day light, length of day
- Seasonal variations
- Species composition



Diurnal and seasonal variation

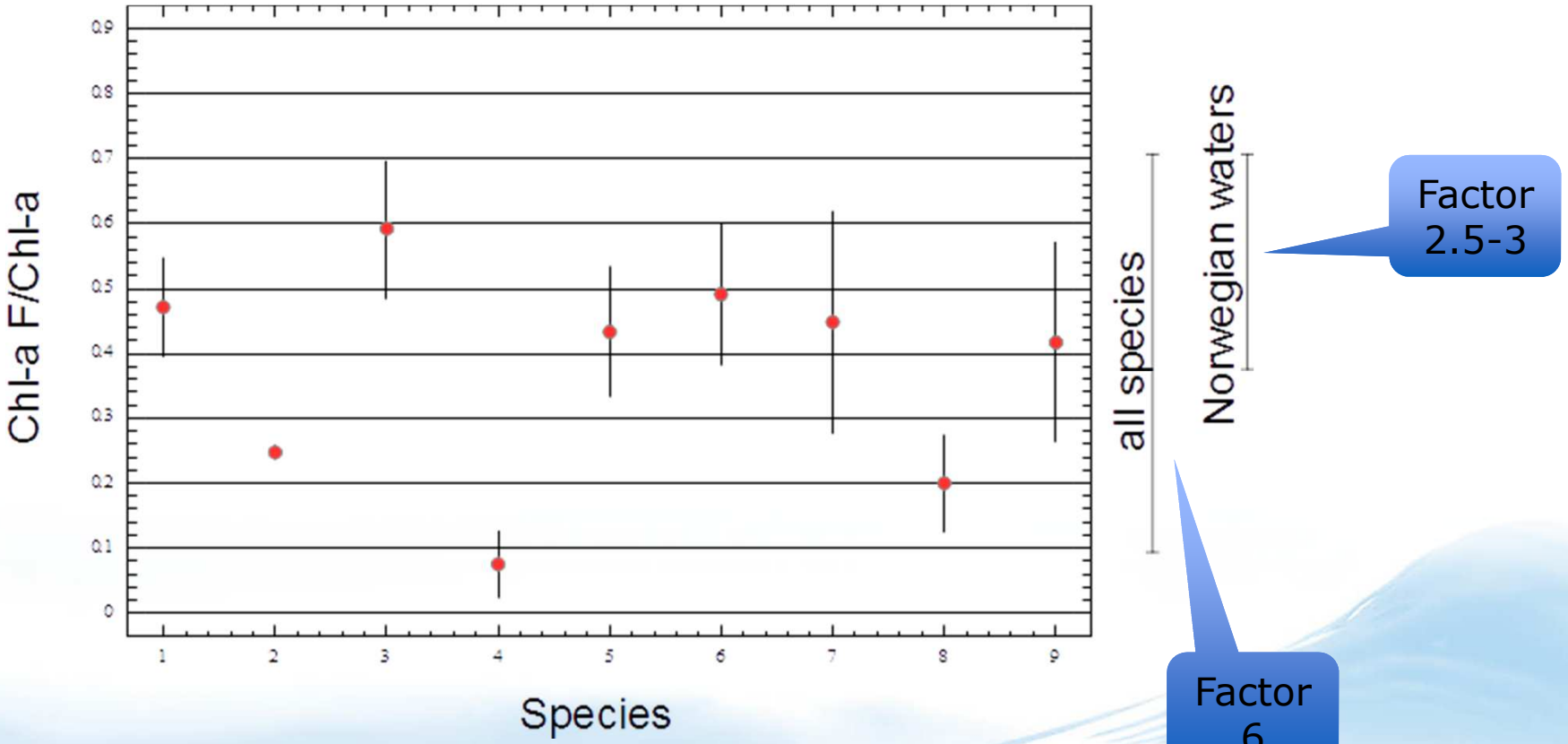


Day-night variation larger during bloom

Fluorescence high during night

Chla-Fl/Chl-a - Species

Nr.	Algekulturer
1	Chrysochromulina polylepis
2	Dunaliella tertiolecta
3	Emiliania huxleyi
4	Oscilatoria agardii
5	Prorocentrum minimum
6	Prymnesium parvum
7	Phaeodactylum tricornutum
8	Selenastrum capricornutum
9	Skeletonema costatum



MyO document – tests discussed in the document

- Global range test
- Regional range test
- Spike test
- Gradient test (and frozen profile test)
- Instrument comparison test
- Parameter relation test
- Calibration status test

Global Range Test

- Need to accommodate expected extremes in oceans
- Regional ranges reported by partners Chl *a* fluorescence -0.1 to 100 *µg/l*
  - Small drift in calibration can cause small negative values
- Dissolved oxygen 0 to 900 µM

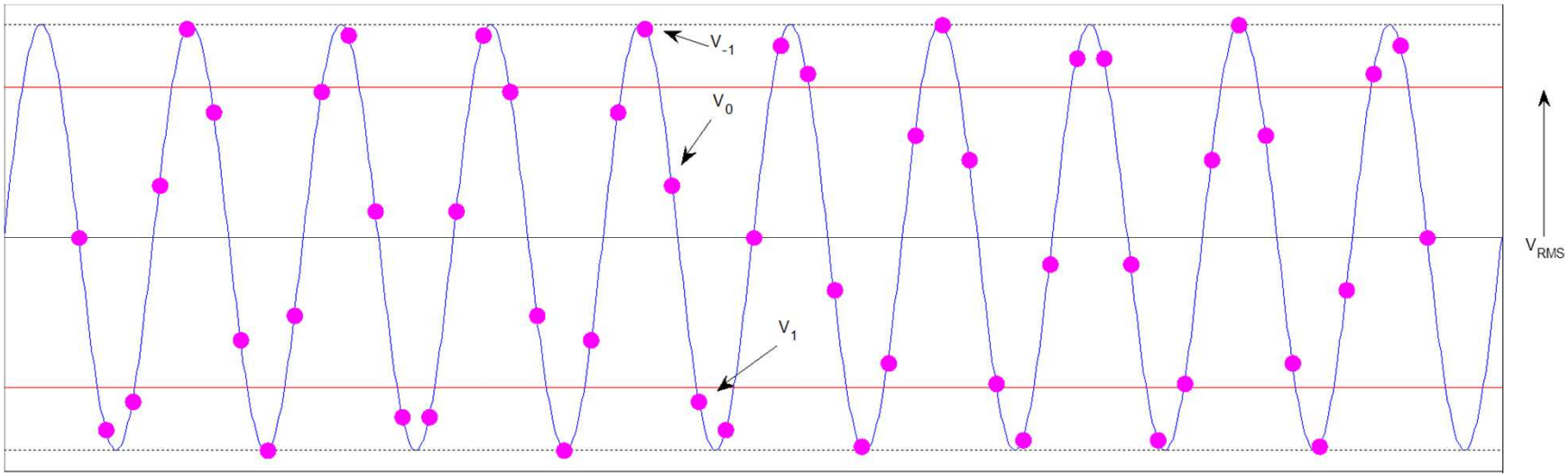
Regional Range Test

- Strong variability on all scales
- Can vary between 2-3 orders of magnitude
- General lack of extensive climatology

Spike/Gradient Tests

- Identify «background noise»
  - Resolve issue of oscillations in data (jfr Turbidity)
- Consider surrounding measurements
  - Resolve issue of strong variability
- Make it parameter and regional independent
  - Resolve issue of climatology
- Keep it simple
  - Near real time automated quality control

Step 0
Identify Background Noise



Consider data in neighborhood [-i,i] of V0
Assume a sine wave on the neighborhood
Then

$$V_{RMS} = \sigma_V$$

Step 1
Define a Threshold

- Threshold based on surrounding background noise and median
- Potential spike when V0 is outside this range

$$\overline{x}_{-i,+i} \pm \sqrt{2}\sigma_{x,-i,+i}$$

Step 2
Reject or Accept

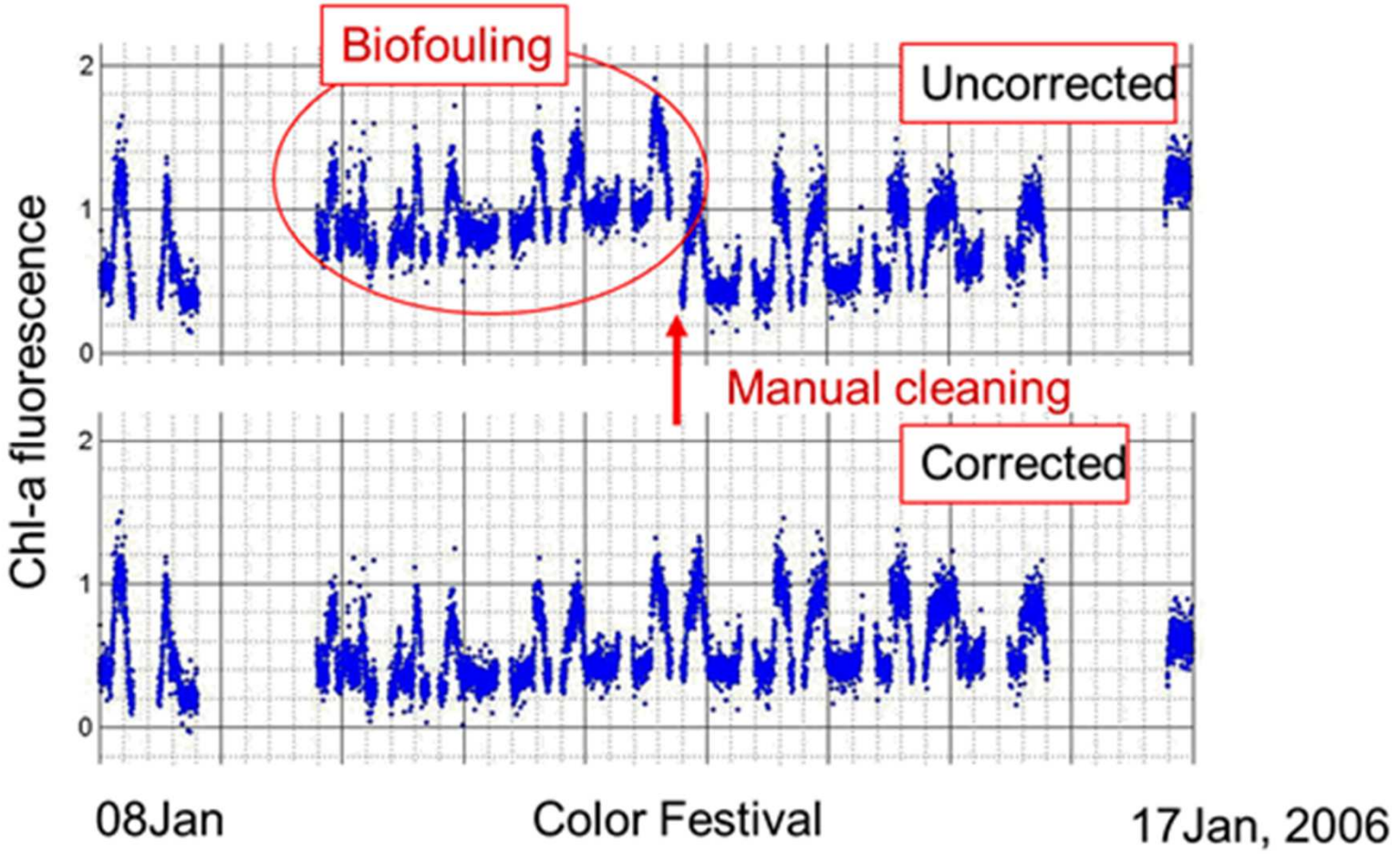
- Use AIC (Akaike Information Criterion) with and without V0
- If lower AIC without V0, then V0 is an outlier
- AIC as defined here can be thought as a measure of statisical entropy

$$U_t = \frac{1}{2} AIC = n \log \hat{\sigma} - \sqrt{2} \cdot s \cdot \frac{\log n!}{n}$$

Biofouling Test

- Applied to Ferrybox Chl *a* fluorescence
- Subsequent trips
- Identify cleaning events
- By definition a delayed mode correction

Biofouling test



QA on TriOS RAMSES above water reflectance data

NIVA. ESA contract with Richard Santer and Francis Zagolski

RAMSES-TriOS/Ferrybox Measurements with Concurrent MERIS/in-situ Reflectance Matchups
- A New Protocol for in-situ Data Processing

pierre. jaccard@niva.no

QA on TriOS RAMSES Measurements

- Hyperspectral radiance and irradiance measurements
- Relationship to BGC values are improving
- Issues
  - Sun position
  - Weather and sea state (ozone, wind, p_{atm}, AOT 865nm)
  - Moving platform
  - Platform dependent

Ed

Ld, Lu


TROLLFJORD


ColorLine Cruises


Sun position
Weather
Sea state
Moving
Installations
N75°
W10°
Hovedmeridian
E10°
E30°
Polarsirkelen
N65°
N55°
Image IBCAO
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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Google

QC

- Pre-screening
  - SZA < 75
  - Direct sun glint
  - Ship speed
- NIVA/Trios POLREF Processor
  - LUT extractor (view angles asymmetry)
  - Corrections for polarization, sun glitter
  - QC flags

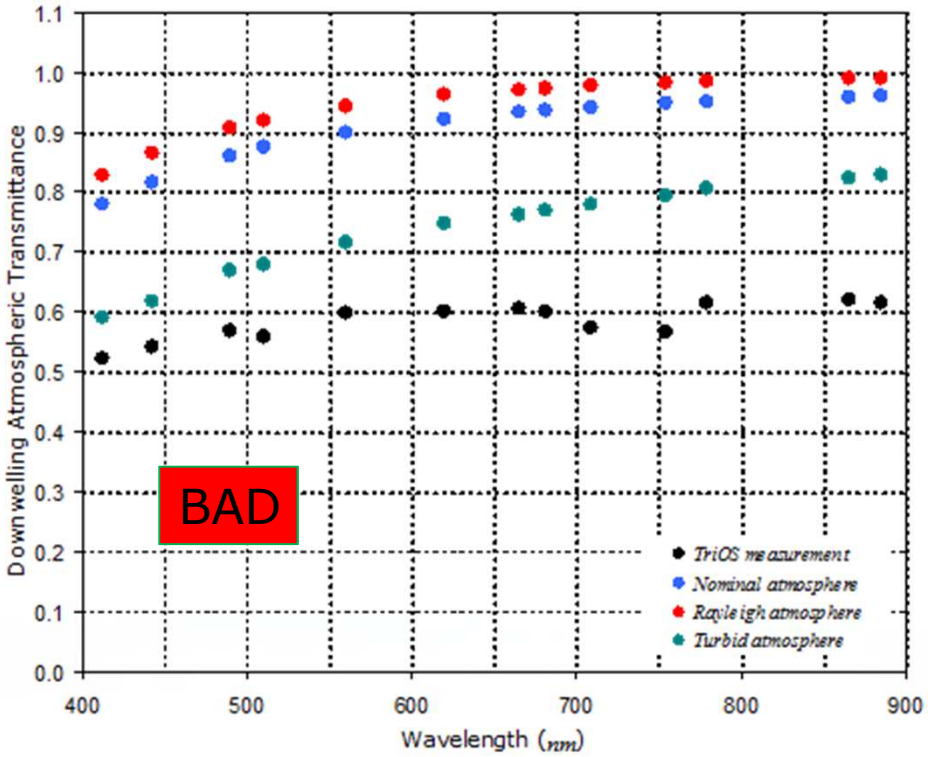
QC Flags

Flag name	Notation	Flag setting
Hight Glint	FHG	$L_{glint} / (R_{pol} \cdot L_{sky}) > 0.5$
High Transmittance	FHT	$T_{dw,meas} > T_{dw,Rayleigh}$
Low Transmittance	FLT	$T_{dw,meas} < T_{dw,Turbid}$
High atmospheric Radiance	FHR	$L_{sky,meas} > L_{dw,Turbid}$
Low atmospheric Radiance	FLR	$L_{sky,meas} < L_{dw,Rayleigh}$
Water-leaving Radiance	FWR	$L_{w,meas} < 0$

- Cloud flag: FLT
- Shadow flag: FWR
- Turbid Flags: FLT and FHR
- Rayleigh flags: FLR and FHT
- Glint flag: FHG

Flagg Low Transmittance FLT- Cloud

Trios
Nominal
Rayleigh
Turbid



Rough efficiency of NIVA/Trios Efficiency

- Color Fantasy (Starboard and Port side)
- 2009/07/03-2009/08/20
- 4218 measurements (spectra)

STARBOARD	Total	FLR	FLT	FHR	FHT	FHG	FLW
Total flagged	3792	785	2539	292	2542	6	1958
% bad	90	19	60	7	60	0	46

PORT	Total	FLR	FLT	FHR	FHT	FHG	FLW
Total flagged	3724	762	2786	292	2542	0	1774
% bad	88	18	66	7	60	0	42

400-500 measurements left on
each side of the ship for 50 days (~ 2*10/day).
(This means not 20 satellite matchups)

Further Studies

JeriCO: AAOT March-July 2014
HighROC: Cruise April 2014

Test of the Flags routines on these data