Project: WP15 INS TAC

Key Performance Indicators: Synthetic information to users on the quality of the product and of the service

Third release:
13 July 2011
https://doi.org/10.13155/76297

Authors for this deliverable:
Karina von Schuckmann, CNRS Paris, France
Henning Wehde, IMR, Bergen, Norway
Sylvie Pouliquen, Ifremer, Ctr. Brest, France
Marta de Alfonso, PdE, Madrid, Spain
Leonidas Perivoliotis, HCMR, Athens, Greece

1. Introduction

MyOcean is the implementation project of the GMES Marine Core Service, aiming at deploying the first concerted and integrated pan-European capacity for Ocean Monitoring and Forecasting (http://www.myocean.eu.org). The project objective is to observe, analyze and forecast the oceans at global and regional (European Seas) scales in order to provide a monitoring service for marine environment and security. Its target applications are marine safety, marine resources, climate and seasonal forecasting as well as marine and coastal environment. Based on the approach on combining space and in-situ observations and their assimilation into 3-D simulation models, the MyOcean Service aims to provide the best information available on the global and regional ocean. These information include temperature, salinity, currents, ice extend, sea level and primary ecosystems.

The purpose of MyOcean is not only to produce products but more to produce a product of high quality as well as to provide users with information on its quality. MyOcean is a system of systems and despite the fact that the quality assessment is organized and performed in each work package (WP) within the WPx.5, it is important to organize their activities in a coherent manner each time it's possible. For this reason a product quality transverse working group has been organized and in MyOceanII (MYOII) a dedicated WP is identified. The first meeting of this group was held in Lisbon in April 2010 and led to an agreement to use a common external PC dataset to assess the product whenever it was possible (TAC products for MFC, common climatology derived either from in situ or satellite). There was an agreement to use the INS TAC T&S product for comparison to in situ metric (Class4 for MFCs). There has been also an agreement that a black list generated either by MFC or TAC should be provided to the product originator. The conclusions of this meeting have been taken on board the validation of stream1 product and are visible in the WP Validation Reports available on alfresco: http://intranet.myocean.eu/share/page/site/ProjectReferenceRoom/documentlibrary#path=/02%20%20PC%20Deliverables/2.07%20%20ScVP%20and%20Reports&page=1/.

In the further course of the MyOcean project it becomes more and more clear that it is not only necessary to get information on the product quality, but also the provision of these information towards the users is of crucial importance. The working group therefore focuses also on the development of common information for the different users. A way to provide users with the current status as well as the quality of the service is possible via the use of so called Key Performance Indicators (KPI). A KPI is a relevant statistic, number or qualitative description that provides a measure of whether the system is performing as it should. Within MyOcean, KPIs are developed as a useful tool to monitor the product quality as well as to deliver an information chain to users including first internal users and later outside users in MYOII. The system can benefit of KPIs by the delivery of product quality information in the form of Traffic Light metrics that can then lead to more detailed indicators with the purpose to define that the data product is of good quality and/or to warn the user when it is degraded (Figure 1 shows an example from the Sea level TAC).

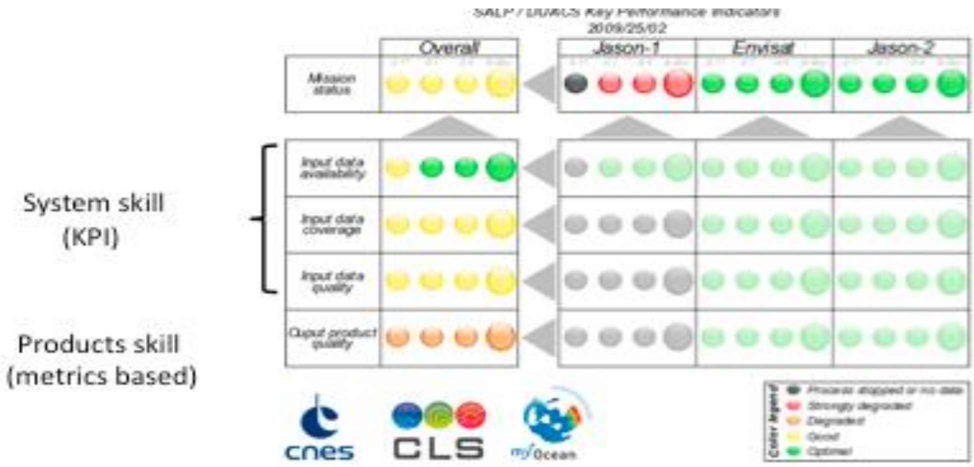

Figure 1: Example from SeaLevel TAC

KPIs are quantifiable performance indicators used to define success factors and measure progress toward the achievement of the organisation/system goals. They can be defined as an item of information collected on a regular interval to track the performance of a system. Hence, KPIs are important pointers to the functioning of a system and keeping track of them is one aspect of quality control (QC). KPIs should be seen as:

- Key: of fundamental importance indicating the success or failure of the system
- Performance: can be clearly measured, quantified and easily influenced the system providers
- Indicator: providing leading information on future performance.

A central theme of the definition of KPIs is the need to adapt performance indicators to the particular circumstances of the systems and procedures involved. Quality indicators need to be robust, i.e. show continuity in time. They need to be easy to implement, automate and to permit a delivery on a regular basis. They need to allow an easy access for the user, and hence to be characterized by clarity and readability. The main criteria for KPI definition within the INS TAC include:

- Criteria I: Is the control information key to the success of the system?
- Criteria II: Can we measure it and influence it?
- Criteria III: Does it provide leading edge indications of future developments?

The aim is to provide the user information on the three different validation steps, i.e. RTQC, quarterly assessment and delayed mode assessment.

2. General definition of KPIs as key indicators for the status of the InSitu-TAC products

The definition of KPIs will deliver quality information of several components of the MyOcean in situ data system. They will be used to indicate the state of several components of the data processing system which include:

- Data availability: monitor raw data delivery delay with regard to the nominal delay
- Input data coverage: Monitoring platform availability per day
- Output data quality: data consistency and meta-data information
- Output product quality: KPIs for different validation steps

KPIs for in situ products will be calculated by region (Arctic, NWS, Baltic, IBI, Mediterranean and Black Sea) and for the global ocean, by production unit (PU), by instrument/platform type as well as by product (T&S, biochemical, currents or sea level), depending on the type of KPI.

2.1 Data availability: KPI-1

The KPI to monitor the input data availability is the delay between the acquisition of the observation and the first delivery to the users. In other words, this indicator monitors the date of the measurement delivery delay with regard to the nominal delay – the percentage of data delivered within a threshold (date of measurement minus date of arrival). Hence, the initial creation date needs to be stored somewhere as a file can be updated a few times. Currently, the intension is not to change the index file and for the moment it seems to be advantageous to create another file (e.g. a second index file) for internal use containing the appropriate information. This KPI can be evaluated for every region by visualizing the data delivery delay as a function of time for each type of measurement (Figure 2).

The processing of KPI-1 will be performed for every region and platform type. Thresholds for the global component are given in section 3.1 and they do not differ between the different products. For the regional application, the situation is different. Data delivery of mooring data for example are automated on an hourly basis, and the used date of arrival needs to be fixed (e.g. once a day). However, specifications need to be provided and defined by each region, respectively.

File Type	**Description**
PF	Profiling Argo floats data received directly from Argo DACS. Temperature and salinity profiles in the upper 2000m with a nominal accuracy of 0.01°C and 0.01
XB	Expendable bathythermographs (XBTs, Temperature profiles with an accuracy within 0.03°c to 0.1°C)
CT	Conductivity-Temperature-Depth (CTD) from research vessels (accuracy on the order of 0.001°C for temperature and 0.001 for salinity after calibration). These files also contain data from sea mammals equipped with CTDs (accuracy on the order of 0.005°C for temperature and 0.02 for salinity, but the error can be larger depending of the availability of reference data for post-processing, see Boehme et al,2009) and some Sea Gliders.
OC	CTDs from the World Ocean database (Delayed mode products only)
MO	Moorings, mostly TAO, TRITON, RAMA and PIRATA moorings with an accuracy comparable to those of Argo floats.

BA	Data transmitted through the GTS of BATHY-type (temperature profiles only). This transmission system imposes that the data is truncated one place beyond the decimal point.
TE	Data transmitted trough the GTS of TESAC-type (temperature, salinity, current). This transmission system imposes limitations on the accuracy of the data (data is truncated two places beyond the decimal points). Data from Argo floats not yet received at the DACs, real-time TAO/TRITON data, etc ... belong to the TE data type.

Table 1: Description of file types monitored within the InSitu-TAC

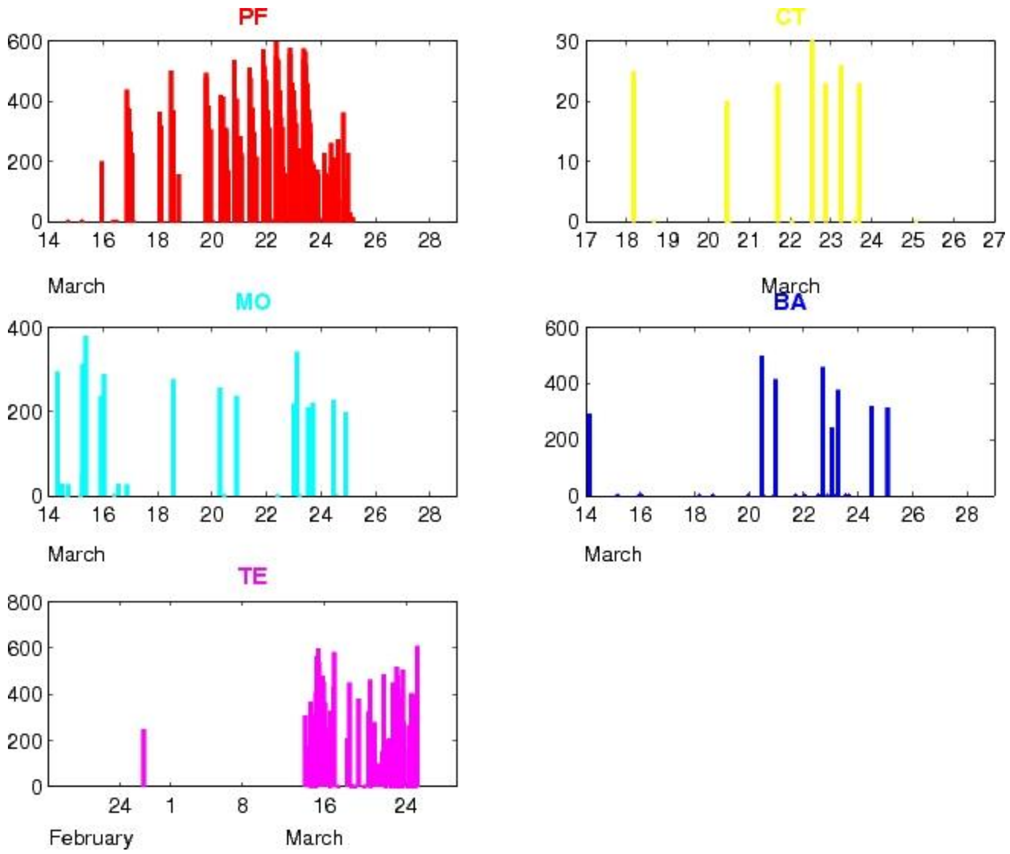

Figure 2: Difference of time_coverage_end minus date_update for different instrument types for the Arctic component. The data are stored in 7 files types (see table 1).

2.2 Input data coverage KPI-2: monitoring continuity

A KPI used to monitor the input data coverage is based on the platform availability per day, distinguished by region and instrument type. This KPI allows observing incoming data flow continuity for each platform and for different regions. An example is given in Figure 3 showing the input data coverage as a function of time for the global and Arctic component. The aim of this KPI is to check the number of platforms per day and hence, to monitor the data flow continuity by using the following formula:

$$INDEX(t) = (nX-X(t)) / nX \quad ,$$

where nX is the expected number of platforms X(t) as a function of time. This KPI supports the quality of the data processing system. The formula is developed for the global component and probably needs to be refined for the needs of the regional components, proposed by each region.

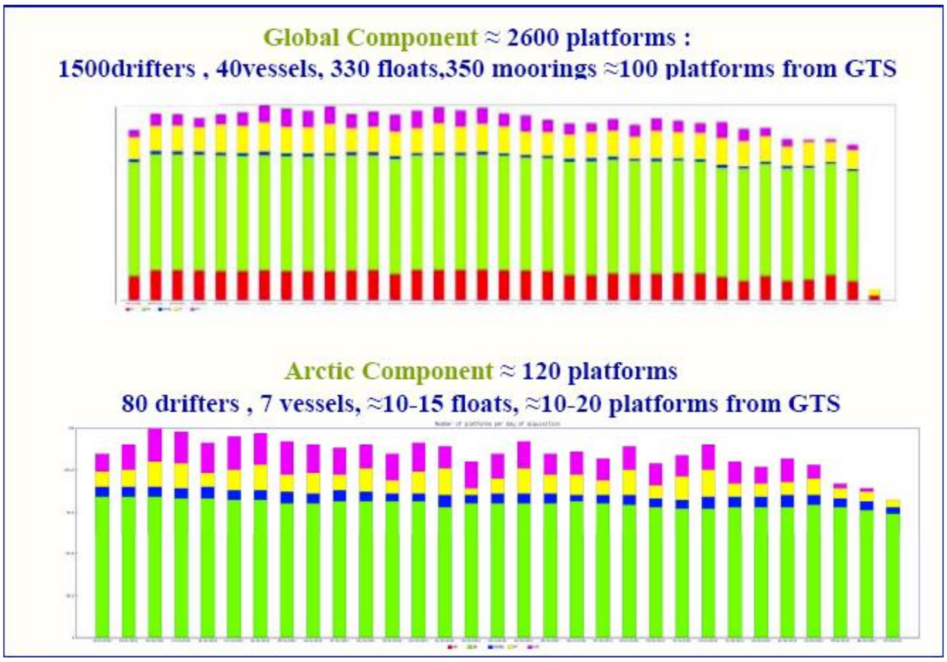

Figure 3: Monitoring the input data coverage as a function of time shown here for the global and Arctic component.

The definition of a threshold (nX) is a fundamental step for calculating this KPI, as well as to guarantee its efficiency. A definition of a global threshold for all platform types is not possible, especially for regional applications. Hence, KPI-2 will be performed in two ways, i.e. per platform (KPI-2a) and per production unit (KPI-2b). This delivers an optimal way to monitor the input data coverage continuity as well as a continuous detection of the source of upcoming data stream problems. A threshold nX can be then defined depending on platform type as well as regional specifications. Table 2 shows the production units (PU) for every region. Note that for Black Sea and the Arctic only KPI-2a needs to be calculated.

Region	**Production Unit (PU)**
Global	Ifremer, Niva
Arctic	IMR
Baltic	FMI/SYKE, BSH, SMHI
NWS	BSH, SMHI
SWS	PdE, Ifremer
Med Sea	HCMR, Ifremer,OGS, PdE, ENEA
Black Sea	IOBAS

Table 2: List of production units for each region.

2.3 Metadata quality KPI-3

To check the output data quality, a KPI needs to be defined which controls the meta-data information as well as the data consistency. Currently, random examination of monitoring data quality exists at the Coriolis data center for global in situ data which is performed in two steps:

1) Comparison of number of files on directory 'latest' and monthly to number of netcdf files contained by respectively index_latest.txt and index_monthly.txt.

2) Comparison of meta-data information in the netcdf file compared to those occurring in the index_latest.txt file and index_monthly.txt.

Daily data input provokes daily augmentation of latest directory and hence, of the index file. Based on this procedure, a daily automated monitoring of input data quality is possible. Once a month the monthly directory is updated and a monthly automated monitoring is possible. For this purpose a KPI is suggested which is needed to display the meta-data continuity by showing the percentage of continuous meta-data information as a function of time. This KPI will be calculated by region and each type of platform (periodically run the Format and FTP check: Ifremer will provide the tools developed for the test to the DUs to check their server periodically).

2.4 Output data quality KPI-4

To guarantee high output product quality, the quality control performance for different types of data and different regions needs to be monitored by corresponding KPIs. For this purpose, KPIs will be defined for different validation steps during the quality control procedure (Figure 4). The work of the INS TAC (in situ Thematic Assembly Centre) is dedicated to assure the accuracy of in situ observations through mainly two validation channels, i.e. first, real time quality control (RTQC) of in situ observations, and second, assessment of the product out of the quality controlled data sets. To monitor this data performance step, two KPIs can be defined. The first shows a histogram indicating automated flag delivery, including data with no flag (KPI-4.1, ➔ 100% of measurement should have a flag). KPI-4.1 is an intenal KPI for the data manager and all values below 100% must be red. The second KPI (KPI-4.2) will monitor the percentage of supposed good data (flag 1 and 2) as a function of time:

$$KPI\text{-}4.2\ [\%]\ (t) = (X/Y)*100,$$

where X is the number of data with flag 1 or 2 (good data) and Y the total number of data. For each region and parameter a percentage based on the INS-TAC PU-DU expertise will be evaluated. This KPI is also strongly correlated to the product and thus should be defined within different thresholds depending the product mentioned (T&S, biochemical, currents or sea level). This KPI will allow identifying either a degradation of the observing system behaviour or a weakening in the RTQC or DM procedures.

3. Threshold definition for each product and region

3.1 Platform availability KPI-1

This KPI is product independent as one platform can provide different product observations. Moreover, if a platform is providing any data for a given period (i.e. a mooring under maintenance or broken), all products are impacted.

KPI-1

	Global	Arctic	Baltic	NWS	SWS	MedSea	BlackSea
PF	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w
XB	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w			X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	
CT	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w			X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	
MO	X<24h 24h<X<1w X>1w						
BA	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w
TE	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w	X<48h 48h<X<1w X>1w

3.2 Distribution Unit integrity

The KPI-3 is for internal use and will be computed at DU level

	KPI-3
Global	0<X<5 5<X<10 X>10
Arctic	X=0 0<X<5 X>5
Baltic	X=0 0<X<5 X>5
NWS	X=0 0<X<5 X>5
SWS	X=0 0<X<5 X>5
Med Sea	0<X<2 2<X<5 X>5
Black Sea	X=0 0<X<5 X>5

3.3 Real time temperature and salinity product

For the parameters T&S, automated checks during the first validation channel are described in von Schuckmann et al. (2010). The second channel includes methods either based on comparisons to a reference climatology, or to independent data sets as altimetry (global only). A detailed description on validation methods for T&S can be found in von Schuckmann and Cabanes, 2010 (Figure 4). Thresholds defined here are suggestions and those (as well as the definition of the KPIs itself) need to be tested. Moreover, specifications for the regional components need to be added.

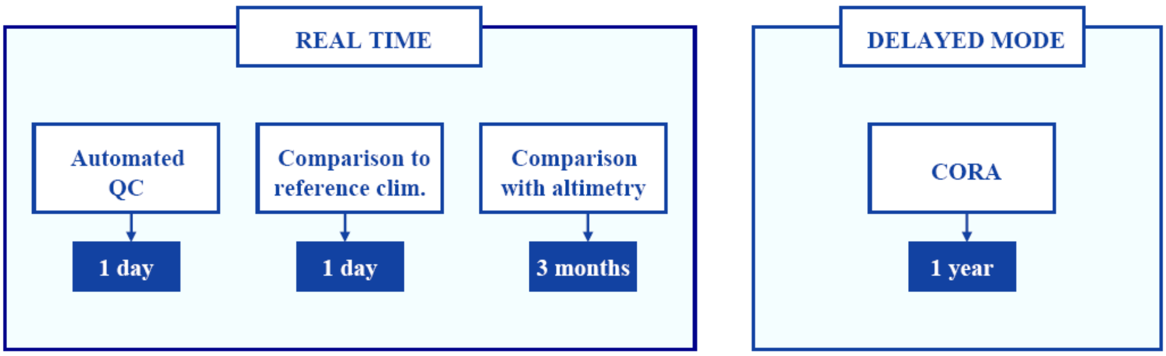

Figure 4: *Quality control procedures during the real time and delayed mode validation chain.*

Temperature and salinity after automated RTQC: KPI-2a

KPI-2a	Global	Arctic	Baltic	NWS	SWS	MedSea	BlackSea
PF	X<0.2 0.2>X<0.4 X>0.4	X<0.2 0.2>X<0.4 X>0.4	X<0.2 0.2>X<0.4 X>0.4	X<0.2 0.2>X<0.4 X>0.4	X<0.2 0.2>X<0.4 X>0.4	X<0.2 0.2>X<0.4 X>0.4	X<0.2 0.2>X<0.4 X>0.4
XB	X <0.4 0.4>X<0.6 X>0.6	X<0.1 0.1>X<0.3 X>0.3			X<0.4 0.4>X<0.6 X>0.6		
CT	X<0.4 0.4>X<0.6 X>0.6	X<0.1 0.1>X<0.3 X>0.3			X<0.4 0.4>X<0.6 X>0.6		
MO	X<0.1 0.1>X<0.3 X>0.3	X<0.1 0.1>X<0.3 X>0.3			X<0.1 0.1>X<0.3 X>0.3		
BA	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6
TE	X<0.4 0.4>X<0.6 X>0.6	X<0.1 0.1>X<0.3 X>0.3	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6

Temperature and salinity after automated RTQC: KPI-2b

KPI-2	Gobal	Arctic	Baltic	NWS	SWS	MedSea	BlackSea
Ifremer	X<0.2 0.2>X<0.4 X>0.4	X<0.2 0.2>X<0.4 X>0.4	X<0.2 0.2>X<0.4 X>0.4	X<0.2 0.2>X<0.4 X>0.4	X<0.2 0.2>X<0.4 X>0.4	X<0.2 0.2>X<0.4 X>0.4	X<0.2 0.2>X<0.4 X>0.4
Niva	X<0.2 0.2>X<0.4 X>0.4						
IMR		X<0.1 0.1>X<0.3 X>0.3					
BSH							
PdE					X<0.1 0.1>X<0.3 X>0.3		
ENEA							
HCMR							
OGS							
IOBAS							

Temperature and salinity after automated RTQC KPI-4

	KPI-4.1	KPI-4.2
Global	target = 100% X<100%	TBD TBD TBD
Arctic	target = 100% X<100%	X<0.2 0.2>X< 0.4 X>0.4
Baltic	target = 100% X<100%	TBD TBD TBD
NWS	target = 100% X<100%	TBD TBD TBD
SWS	target = 100% X<100%	TBD TBD TBD
Med	target = 100% X<100%	TBD TBD TBD
Black Sea	target = 100% X<100%	TBD TBD TBD

Comparison to a reference climatology. After application of this NRTQC procedure the flag can be modified either automatically or after an operator-check. The same KPI as previously is run but should show improvement in the product quality, especially for KPI-4.1

Comparison to additional products: Quarterly assessments are performed in each region using additional information like comparison with altimetry for Argo floats, drifter black list from the SST TAC, anomalies from MFC. This information analyzed by a scientist should lead to an improvement of the previous indicators that need to be monitored.

Temperature and salinity after quarterly assessment: KPI-2a

KPI-2a	Global	Arctic	Baltic	NWS	SWS	MedSea	BlackSea
PF	X<0.1 0.1>X<0.3 X>0.3	X<0.1 0.1>X<0.3 X>0.3	X<0.1 0.1>X<0.3 X>0.3	X<0.1 0.1>X<0.3 X>0.3	X<0.1 0.1>X<0.3 X>0.3	X<0.1 0.1>X<0.3 X>0.3	X<0.1 0.1>X<0.3 X>0.3
XB	X<0.4 0.4>X<0.6 X>0.6	X<0.1 0.1>X<0.3 X>0.3			X<0.4 0.4>X<0.6 X>0.6		
CT	X<0.4 0.4>X<0.6 X>0.6	X<0.1 0.1>X<0.3 X>0.3			X<0.4 0.4>X<0.6 X>0.6		
MO	X<0.1 0.1>X<0.3 X>0.3	X<0.1 0.1>X<0.3 X>0.3			X<0.1 0.1>X<0.3 X>0.3		
BA	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6
TE	X<0.4 0.4>X<0.6 X>0.6	X<0.1 0.1>X<0.3 X>0.3	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6	X<0.4 0.4>X<0.6 X>0.6

Temperature and salinity after quarterly assessment: KPI-2b

KPI-2	Gobal	Arctic	Baltic	NWS	SWS	MedSea	BlackSea
Ifremer	X<0.1 0.1>X<0.3 X>0.3	X<0.1 0.1>X<0.3 X>0.3	X<0.1 0.1>X<0.3 X>0.3	X<0.1 0.1>X<0.3 X>0.3	X<0.1 0.1>X<0.3 X>0.3	X<0.1 0.1>X<0.3 X>0.3	X<0.1 0.1>X<0.3 X>0.3
Niva	X<0.1 0.1>X<0.3 X>0.3						
IMR		X<0.1 0.1>X<0.3 X>0.3					
BSH							
PdE					X<0.1 0.1>X<0.3 X>0.3		
ENEA							
HCMR							
OGS							
IOBAS							

Temperature and salinity after quarterly assessment: KPI-4

	KPI-4.1	KPI-4.2
Global	target = 100% X<100%	TBD TBD TBD
Arctic	target = 100% X<100%	Index <0.2 0.2>Index< 0.4 X>0.4
Baltic	target = 100% X<100%	TBD TBD TBD
NWS	target = 100% X<100%	TBD TBD TBD
SWS	target = 100% X<100%	TBD TBD TBD
Med	target = 100% X<100%	TBD TBD TBD
Black Sea	target = 100% X<100%	TBD TBD TBD

3.4 Real time Sea Level product

To be coordinated by PdE and SMHI

KPI-2a	Baltic	NWS	SWS
MO			Index <0.1 0.1>Index<0.2 X>0.2

KPI-2b	Baltic	NWS	SWS
Ifremer			Index <0.1 0.1>Index<0.2 X>0.2
SMHI			
PdE			Index <0.1 0.1>Index<0.2 X>0.2

	KPI-4.1	KPI-4.2
Global	target = 100% X<100%	TBD TBD TBD
Arctic	target = 100% X<100%	X<0.2 0.2>X< 0.4 X>0.4
Baltic	target = 100% X<100%	TBD TBD TBD
NWS	target = 100% X<100%	TBD TBD TBD
SWS	target = 100% X<100%	TBD TBD TBD
Med	target = 100% X<100%	TBD TBD TBD
Black Sea	target = 100% X<100%	TBD TBD TBD

3.5 Real time Current product

To be coordinated by SMHI and OGS

KPI-2a	Global	Baltic	NWS	Med
MO				
DB				

KPI-2b	Global	Baltic	NWS	Med
Ifremer				
SMHI				
OGS				

	KPI-4.1	KPI-4.2
Global	target = 100% X<100%	TBD TBD TBD
Baltic	target = 100% X<100%	TBD TBD TBD
NWS	target = 100% X<100%	TBD TBD TBD
Med	target = 100% X<100%	TBD TBD TBD

3.6 Real time Biogeochemical product

To be coordinated by Niva

KPI-2a	Global	Arctic	Baltic	NWS	MedSea	BlackSea
PF		X<0.1 0.1>X<0,3 X>0.3				
CT		X<0.1 0.1>X<0,3 X>0.3				
MO		X<0.1 0.1>X<0.3 X>0.3				

KPI-2b	Global	Arctic	Baltic	Med Sea	Black Sea
Ifremer					
Niva					
IMR		X<0.1 0.1>X<0.3 X>0.3			
FMI/SYKE					
HCMR					
IOBAS					

	KPI-4.1	KPI-4.2
Global	**target = 100%** **X<100%**	**TBD** **TBD** **TBD**
Arctic	**target = 100%** **X<100%**	**TBD** **TBD** **TBD**
Baltic	**target = 100%** **X<100%**	**TBD** **TBD** **TBD**
Med	**target = 100%** **X<100%**	**TBD** **TBD** **TBD**
Black Sea	**target = 100%** **X<100%**	**TBD** **TBD** **TBD**

4. TRAFFIC LIGHT summary

The ensemble average of several KPIs will lead to a 'traffic-light-system' as shown in Figure 10. KPIs will be calculated by region and type of platforms. Figure 10 displays an application for the global ocean temperature and salinity in situ observations. The traffic light system will monitor the following elements:

- Input data availability: monitor raw data delivery delay with regard to the nominal delay
- Input data coverage: Monitoring platform availability per day
- Output data quality: KPIs for meta-data information
- Output product quality: KPIs for different validation steps

For each element, a threshold is defined to distinguish the KPI evolution into optimal (green color), good (yellow color) and bad (red color) data product. The thresholds are defined in the tables of previous paragraph and will be tuned on V1 products on the period July to December 2011 to arrive to the capability of advertising INS-TAC products as shown in Figure 5.

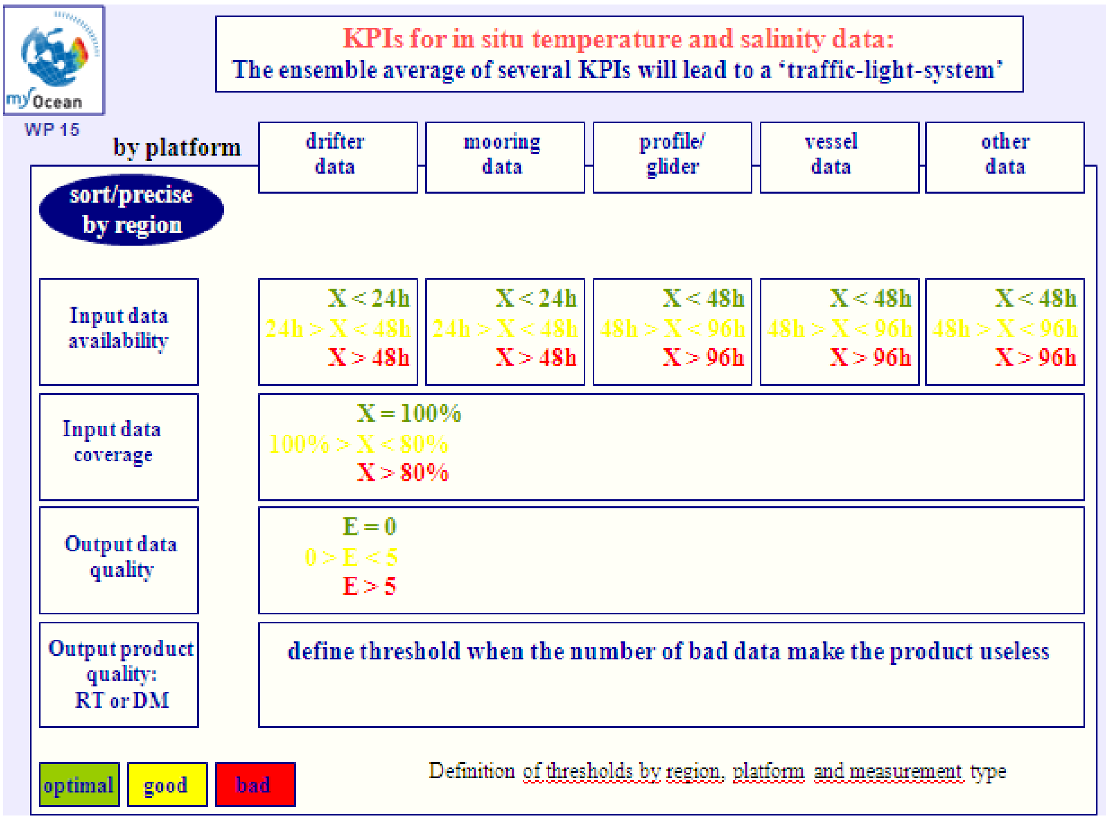

__Figure 5:__ Traffic Light information for each region & product to monitor the quality of the in situ data performance for global in situ temperature and salinity.

References:

Antonov, J., R. Locarnini, T. Boyer, A. Mishonov and H. Garcia (2006), World Ocean Atlas 2005, vol.2, Salinity, NOAA Atlas NESDIS, vol. 62, edited by S. Levitus, 182 pp., NOAA, Silver Spring, Md.

Boehme L, Lovell P, Biuw M, Roquet F, Nicholson J, et al. Animal-borne CTD-Satellite Relay Data Loggers for real-time oceanographic data collection. Ocean Science. 2009;5:685–695.

Cabanes, C. , C. de Boyer Montégut, C. Coatanoan, N. Ferry, C. Pertuisot, K. von Schuckmann, L. Petit de la Villeon, T. Carval, S. Pouliquen and P.-Y. Le Traon, 2010: CORA (CORIOLIS Ocean Database for re-Analyses), a new comprehensive and qualified ocean in-situ dataset from 1900 to 2008 and its use in GLORYS, Mercator Ocean Quarterly Newsletter, 37, 15-19.

Guinehut, S., C. Coatanoan, A.-L. Dhomps, P.-Y. Le Traon and G. Larnicol (2009): On the Use of Satellite Altimeter Data in Argo Quality Control, Journal of Atmospheric and Oceanic Technology, 26, 395-402.

Locarnini, R., A. Mishonov, J. Antonov, T. Boyer and H. Garcia (2006), World Ocean Atlas 2005, vol. 1, Temperature, NOAA Atlas NESDIS, vol. 61, edited by S. Levitus, 182 pp., NOAA, Silver Spring, Md.

von Schuckmann, K., B. Garau, H. Wehde, T. Gies, D. Durand and F. Reseghetti (2010), Real Time Quality Control of temperature and salinity measurements, MyOcean document.

von Schuckmann, K., F. Gaillard and P.-Y. Le Traon (2009), Global hydrographic variability patterns during 2003-2008, Journal of Geophysical