WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (OF UNESCO)

DATA BUOY COOPERATION PANEL

DBCP-XXVII/Doc. 10.3

(23-Aug-11)

TWENTY-SEVENTH SESSION

ITEM: 10.3

GENEVA, SWITZERLAND
26-30 SEPTEMBER 2011

ENGLISH ONLY

ARGOS OPERATIONS AND DEVELOPMENT

(Submitted by CLS)

Summary and purpose of the document

As for past DBCP meetings, this document contains, in consolidated form, the summary report from CLS/Service Argos, covering report on 2010 – 2011 Operations and System Improvements.

ACTION PROPOSED

The Panel will review the information contained in this report and comment and make decisions or recommendations as appropriate. See part A for the details of recommended actions.

Appendices: **A**. Report on 2010 – 2011 Operations and System Improvements

-A- DRAFT TEXT FOR INCLUSION IN THE FINAL REPORT

10.3.1 Mr. Bill Woodward (CLS America) and Mr Michel Guigue (CLS/Argos) presented a report on Argos operations and system improvements during 2010-2011. The Panel recalled that Argos is a global satellite-based location and data collection system dedicated to studying and protecting our planet's environment. CLS, as a unique operator of the Argos system on behalf of NOAA, CNES and EUMETSAT, continues to maintain and improve a high operational service for all Argos users, especially for the meteorology and ocean community.

10.3.2 The Panel noted that the Argos instruments are currently onboard five NOAA POES and one EUMETSAT spacecrafts. In January 2011, Real-time Argos data is transmitted from all the NOAA satellites but only in selected geographical zones from METOP-A due to technical problems. This year EUMETSAT actually extended the activation of the METOP-A HRPT zone to cover much of the southern hemisphere. There were only 3 anomalies to notice (2 for NOAA-19 and 1 for METOP-A) since September 2010 with very few impacts for users. Two new satellites carrying Argos-3 instruments will be launched in mid-2012: METOP-B (EUMETSAT) and SARAL (ISRO).

10.3.3 The Panel further noted that in addition to the 3 existing Northern hemisphere (Svalbard, Fairbanks and Wallops) global antennas that acquire the globally recorded Argos telemetry transmitted by the satellites, ,a new antenna, Mc Murdo in Antarctica, acquiring 1/2 orbit of telemetry from METOP-A became operational since June 2011.

10.3.4 The Panel noted with appreciation that the real-time Argos antennas network is still growing. 60 regional antennas are operational in July 2011 included 15 compatible antennas with METOP-A AHRPT telemetry. Ongoing improvements to the real-time antennas are focused on redundancy of locations and coverage extension. Since January 2010, the Tromsoe Antenna was removed from the network (no impact on the network performance) and 8 new real-time antennas have been added (Resolute Bay, Edmonton, Moscow, Gander, Muscat, Manas, Al Udeid and Halley). Improving the Argos data timeliness continues to be a high priority for CLS (55 stations have mean dataset availability < 25 minutes). After improving the situation in the Indian Ocean last year, CLS is now focusing on the South Atlantic Ocean with 2 new stations since January 2010 (Halley an Mc Murdo) and thanks to the Argos real-time station upgrade project: 2 future new antennas provided by CLS and CNES (Ascension Island and Cape Town) and 2 existing stations upgraded (Davis and Rothera) to be capable of acquiring data from NOAA, METOP and SARAL satellites.

10.3.5 The Panel acknowledged that the two Argos global processing centers in Toulouse and Largo have been operating nominally since January 2010 with a 99.5% average system availability. The disaster recovery architecture implementation located into CNES Toulouse was completed in 2010. As is normal every year, several software improvements were implemented in 2010 and 2011 in order to fit with the user requirements. Main application improvements have addressed the implementation of the new Argos location processing method, the access to the Argos data via the Web service, and new functionalities and better performances for the Argos web site.

10.3.6 The Panel noted with interest that the third generation Argos system, Argos-3, is functioning 100%. It has been and continues to be operationally available on the METOP-A satellite since early 2007. In the context of the Argos-3 DBCP pilot project with 4 manufacturers involved, 57 Argos-3 drifters have been deployed globally at this time to further test Argos-3 capabilities.

10.3.7 Mr Woodward concluded that CLS is providing the GTS processing for all DBCP drifters and moored buoys in compliance with WMO and DBCP TT-DM recommendations. The CLS GTS processing system is monitored 24/7 in real-time as well as the quality of the data and the entire Argos system performance.

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REPORT ON 2010 – 2011 OPERATIONS AND SYSTEM IMPROVEMENT

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1. 2010-2011 Argos Highlights

1.1. Operations

- New METOP-A HRPT coverage extension zone since 18 January 2011.
- METOP-A / A-DCS anomaly in August and December 2010
- NOAA-19 DSP restart in August 2010
- Power outage done at CLS America in 2010 (no test in France in 2010)

1.2. System improvements

- 1 new global receiving station (1/2 orbit) for METOP-A in Antarctica
- 8 new HRPT antennas since January 2010
- 2 production Database servers in France have been replaced by 2 new and powerful database servers
- Implementation of the new Argos location method (Kalman filtering algorithm)
- Implementation of multi-broadcast of Argos-3 commands
- Improvement of the Argos web functionalities and performances
- Improvement of the Argos data processing performances

1.3. Outlook

- Continue to setup the new HRPT optimized network
- Integration of a new digital elevation model based on the model SRTM3
- Upgrade the BUFR version in the GTS processing chain: BUFR V3 to BUFR V4
- Possibility to send Argos-3 commands by e-mail
- Improvements of the Argos monitoring tools

- Reprocessing of Argos messages on archive database to improve the quality of the data delivered to users
- “One way” declarative data replication between the 2 global processing Centers.
- Integration of SARAL in the Argos processing
- METOP-B and SARAL satellites launch in 2012 with an Argos-3 instrument
- Procuring and installing new ground HRPT stations
- Development of an Argos-3/Argos-4 receiver chipset with CNES and the Norwegian Space Agency.

2. Argos space segments

2.1. Operational status

During 2010, Argos instruments were onboard five NOAA POES and one EUMETSAT spacecrafts. The status information on each spacecraft and its Argos various subsystems is described as follow:

Satellites	Launch date	NOAA status	Real time data (HRPT)	Stored data (STIP)	Data AVHRR
METOP-A (MA)	19-Oct-06	AM Primary	Ok/Nok*	Svalbard	Ok
NOAA-19 (NP)	06-Feb-09	PM Primary	Ok	Gilmore, Wallops, Svalbard	Ok
NOAA-18 (NN)	20-May-05	PM Secondary	Ok	Gilmore, Wallops	Ok
NOAA-17 (NM)	24-Jun-02	AM Backup	Ok	Gilmore, Wallops	Ok
NOAA-16 (NL)	21-Sep-00	PM Secondary	Ok	Gilmore, Wallops	Ok
NOAA-15 (NK)	13-May-98	AM Secondary	Ok	Gilmore, Wallops	Ok

Figure 1 : Argos Constellation

* Scheduled activities are defined on Orbit Switch ON and Switch OFF (see following chapter for more details).

2.2. METOP-A HRPT Switch Zone

To minimize the risk of failure to the AHRPT-B unit whilst still offering the user community a service, EUMETSAT has implemented a "partial" AHRPT service in those areas where risks of damage from heavy ion radiation are reduced.

For southbound passes, AHRPT side B was activated for all orbits over the North Atlantic and European area, starting at around 60°N. The AHRPT was then switched off before the spacecraft reaches the Southern Atlantic Anomaly region at around 10°N.

In January 2011, Eumetsat announced the extension of this activation zone while maintaining the same operational restrictions over the polar caps and South Atlantic anomaly. Furthermore, AHRPT operations will also be made in ascending orbits, but with more stringent risk reduction measures than applied for the descending passes given the availability of data via the Fast Dump Extract System (FDES) to cover the North Hemisphere.

Figure 2 shows the old METOP AHRPT activation zone.

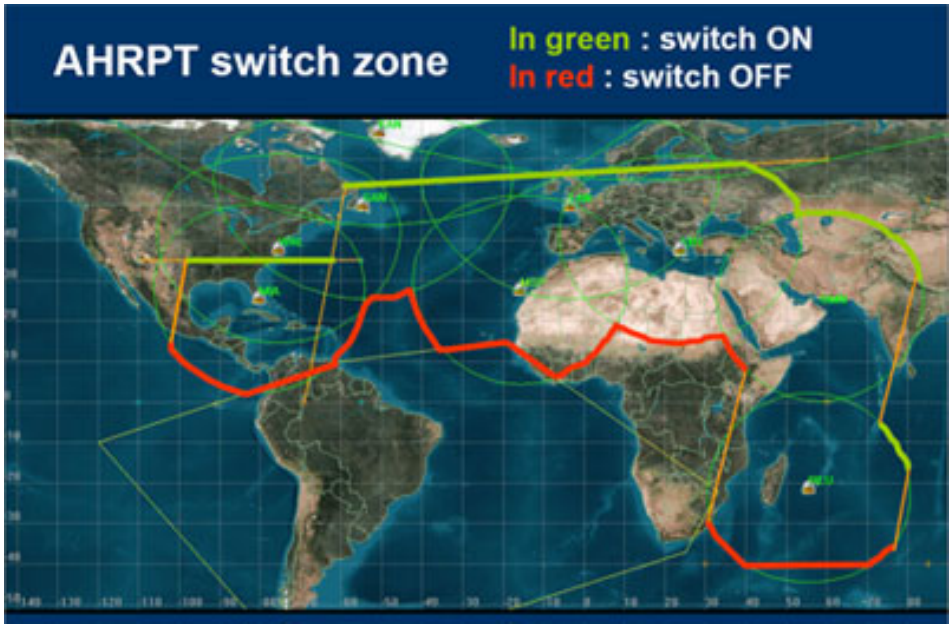


Figure 2 : A-HRPT Old Switch Zone

Figure 3 shows the extended activation zone of the AHRPT for both descending and ascending parts of the orbit. The extended AHRPT coverage is effective since 18 January 2011 as a pre-operational service.

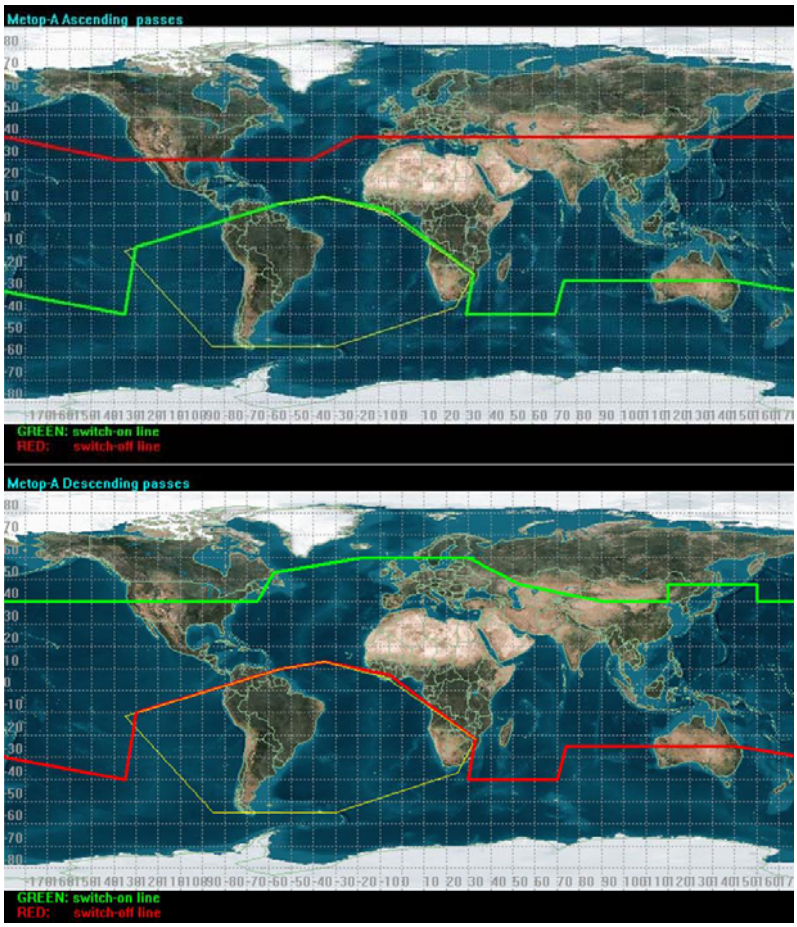


Figure 3 : A-HRPT Extended Switch Zone (Descending and Ascending orbits)

2.3. Ascending Nodes Local hour

Situation in March 2011

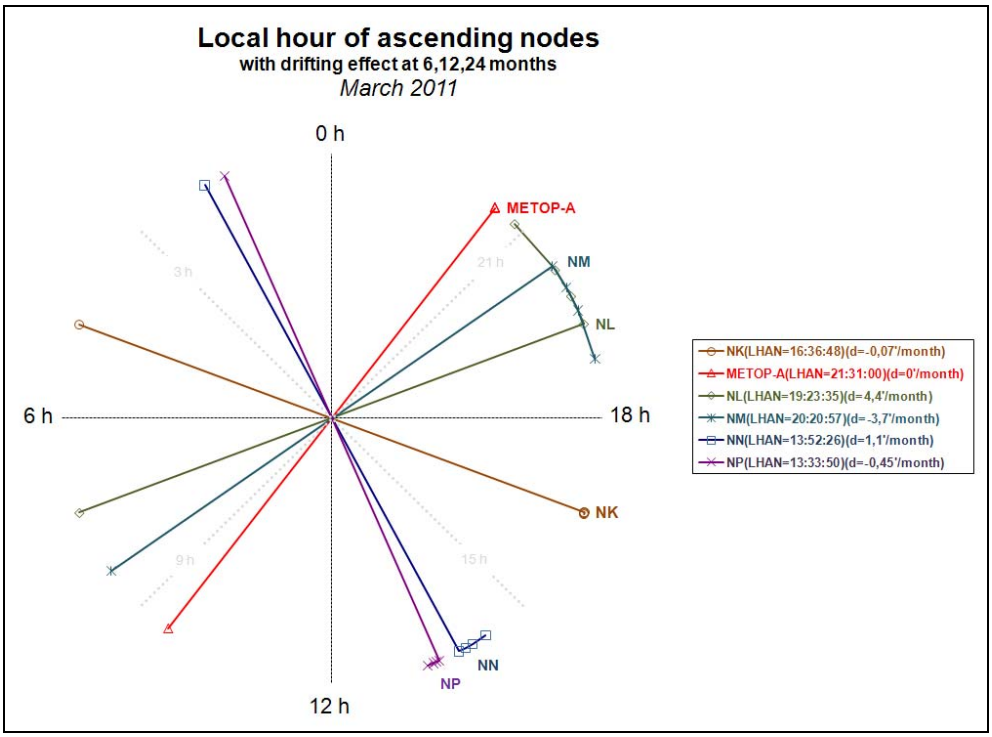


Figure 4 : Local Equator crossing time in March 2010

Projection in March 2012

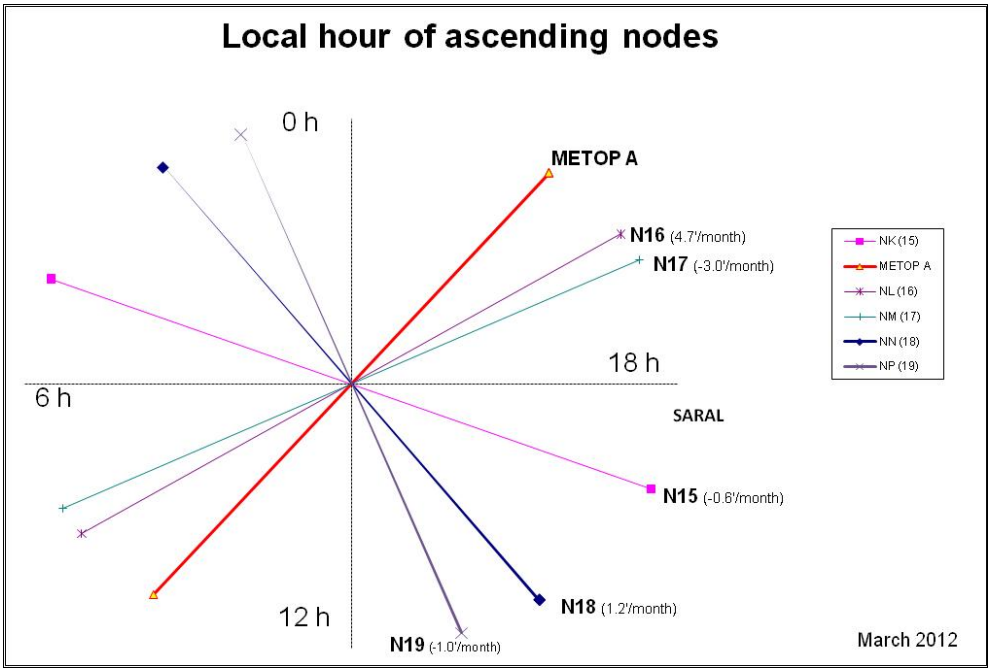


Figure 5 : Local Equator crossing time in March 2012 (Projection)

2.4. Anomalies

2.4.1. METOP-A

16/08/10: Telemetry anomaly. 30% missing messages. DSP ON/OFF

04/12/10: Telemetry anomaly. Missing HD messages: ADCS restarted

2.4.2. NOAA-19

03/08/10 16h07 TU: Empty Telemetry. DSP ON/OFF

2.4.3. NOAA-15 to NOAA18

NA

2.5. Maneuvers

04/12/10: Maneuver out of plane on METOP-A. Location and collection were unavailable during 2 days.

2.6. Next launches of satellites with Argos instrument

- METOP-B (EUMETSAT) with an Argos-3 instrument in 2012
- SARAL (ISRO) with an Argos-3 instrument in 2012
- METOP-C (EUMETSAT) with an Argos-4 instrument in 2017

The joint U.S. civilian-military NPOESS satellite program has been cancelled. The civilian side is being replaced by the NOAA “Joint Polar Satellite System” (JPSS). JPSS-1 is scheduled for launch in 2016 but will not carry either an Argos or a Sarsat system. NOAA is investigating the use of other platforms to carry these systems.

3. Argos ground segment

3.1. Global antennas (store and forward mode)

3.1.1. Operations

The two NOAA global stations of Fairbanks and Wallops acquire the global recorded telemetry transmitted by N15, N16, N17, N18 and N19. The Argos global center of Toulouse and Landover receive for each of these satellites, 14 orbits per day. Two of these 14 orbits per day and per satellite are blind orbits and, consequently, received with a delay except for N18 and N19.

The Eumetsat global receiving station of Svalbard acquires the global recorded telemetry transmitted by Metop-A as well as the two daily blind orbits of N18 and N19.

Figure 6 : Global antennas network

3.1.2. System improvements

A new global station at McMurdo in Antarctica (1/2 orbits) only for METOP-A is operational since 08/06/2011. Timeliness for the provision of METOP-A data collected out of HRPT coverage to users has improved from 115 to 65 minutes.

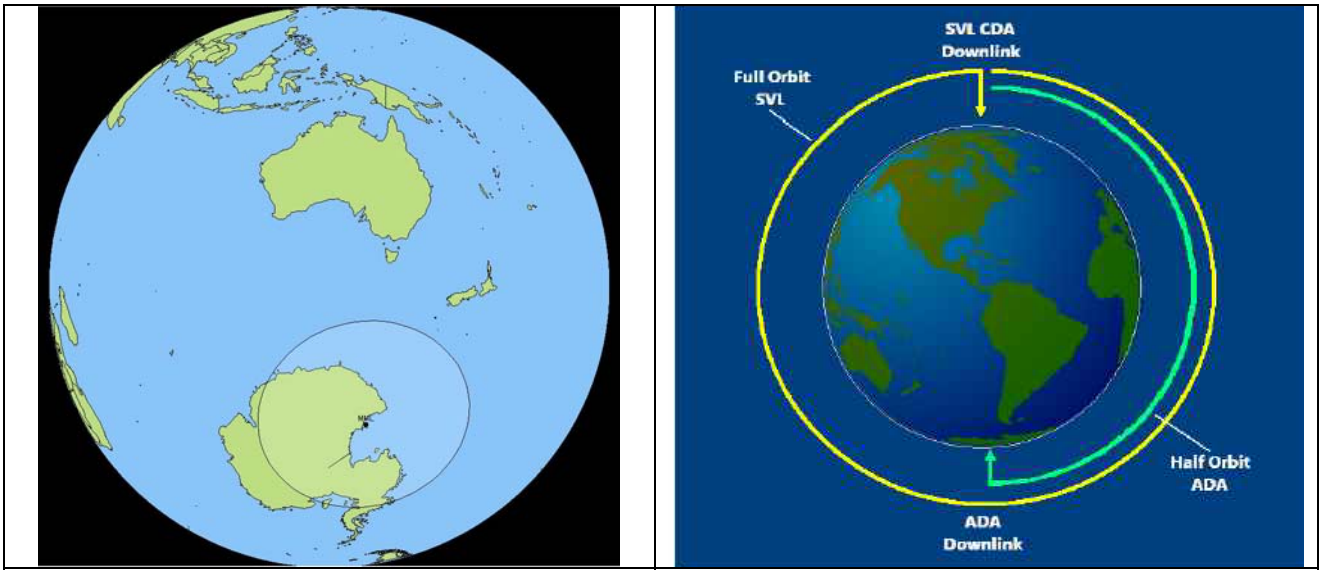


Figure 7 : METOP-A Mc Murdo Global antennas coverage and principle

Comparison of METOP-A data delivery time with and without Mc Murdo station:

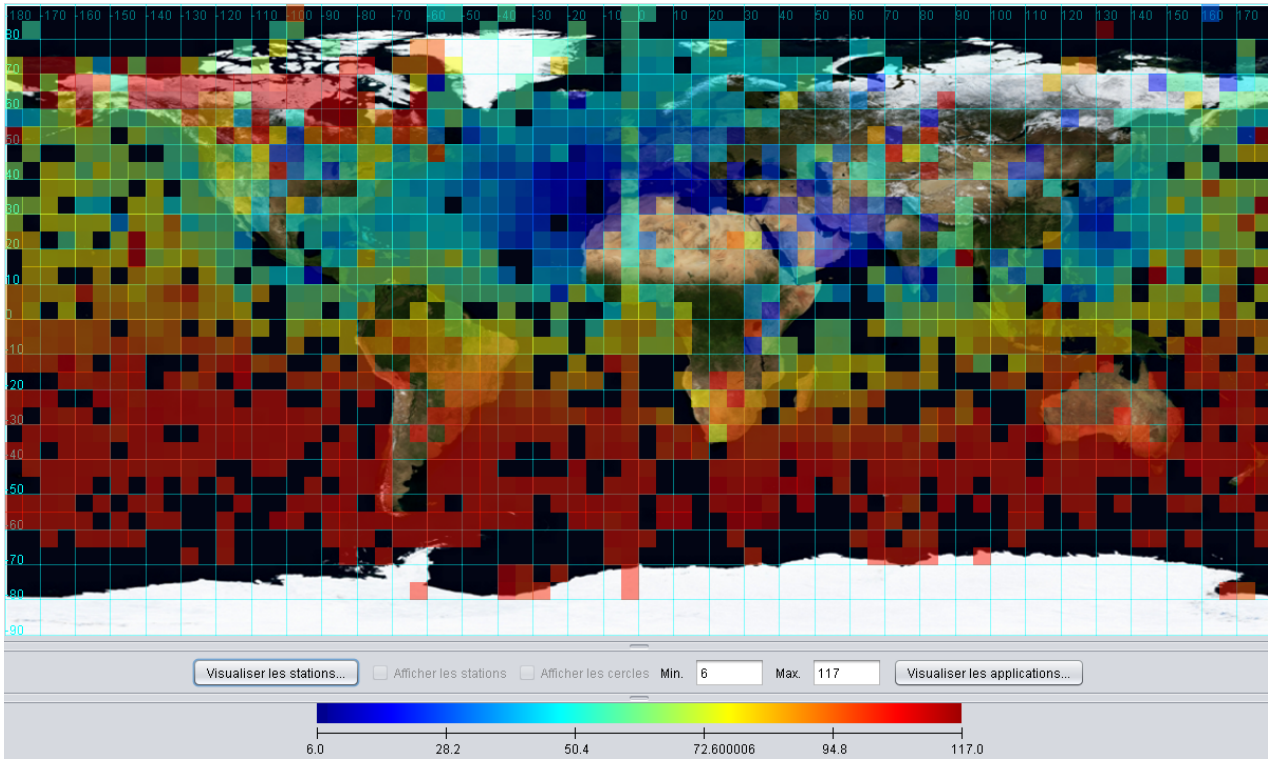


Figure 8 : METOP-A Data Mean Disposal Time in June 7, 2011 (in minutes)

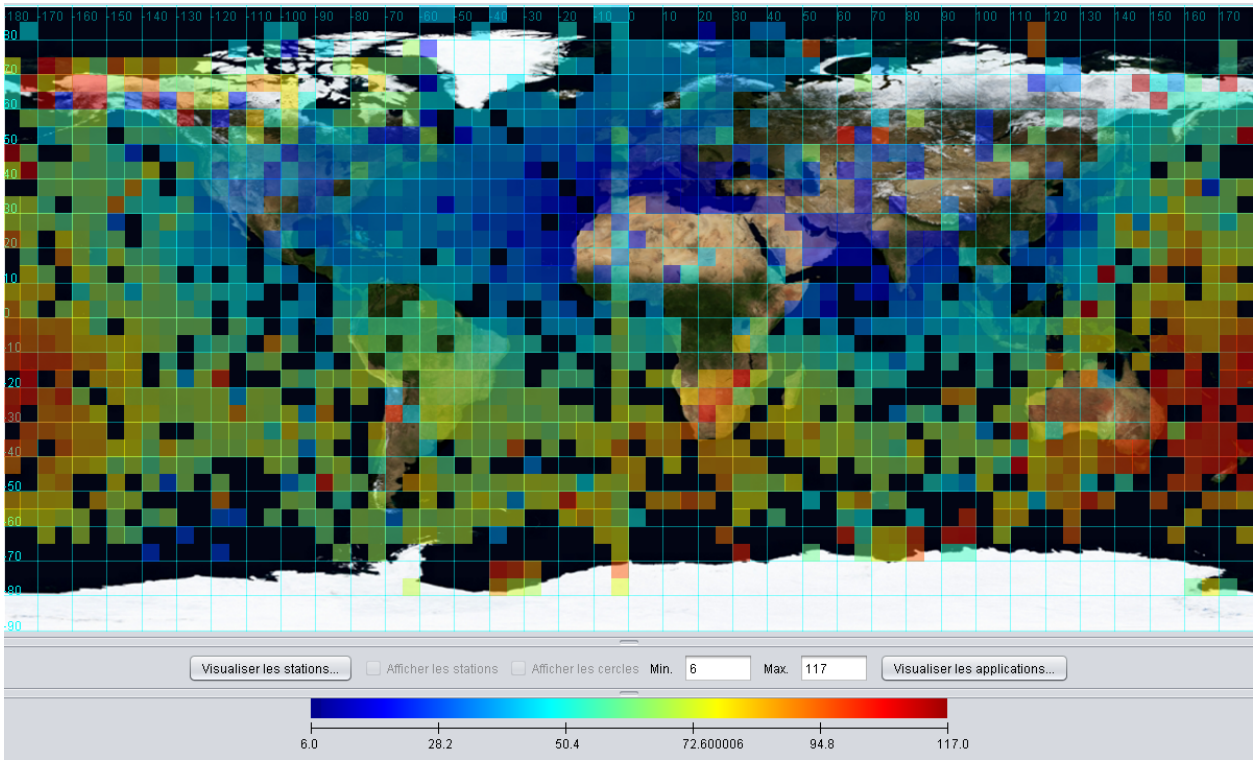


Figure 9 : METOP-A Data Mean Disposal Time in June 9, 2011 (in minutes)

Figure 10 : View of Mc Murdo site in Antarctica

3.2. Regional antennas (real-time mode)

3.2.1. Operations

The real-time network is still growing. Improvements are focused on redundancy locations and coverage extension. Today, both Toulouse and Landover processing centres receive Argos near real-time data from an average of 60 stations located all over the world.

The Tromsoe Antenna is removed from the network (No impact on the network performance).

Figure 11 : Regional antennas network in 2011

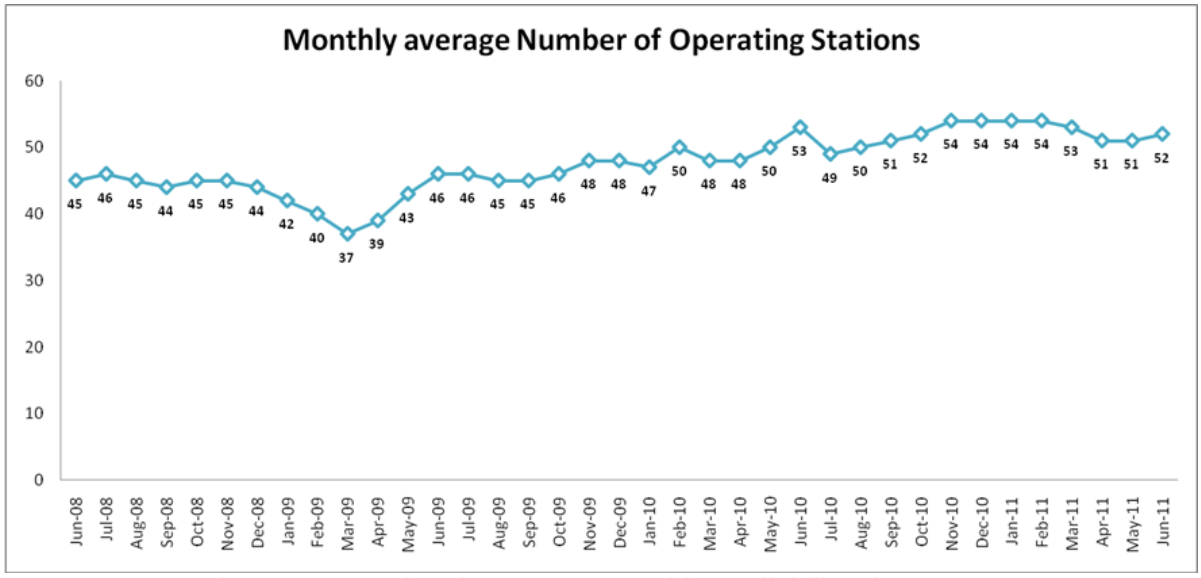


Figure 12 : Regional antennas monthly availability since 2008

The regional antennas network dedicated to METOP-A satellite is still growing with 15 compatible stations in July 2011:

code	name	operator
FL	France Lannion	METEO-FRANCE
HT	Hatoyama	JAXA
HW	Hawaï	NOAA NWS
LM	Lima	CLS PERU
MA	Miami	NOAA AOML
MM	Mc Murdo	NOAA
MO	Monterey	NOAA NESDIS
RV	Ramonville	CLS
SN	Svalbard	NOAA
SV	Svalbard	EUMETSAT
XA	Athens EARS	EUMETSAT
XM	Maspalomas EARS	EUMETSAT
XO	Muscat EARS	EUMETSAT
XR	Moscou EARS	EUMETSAT
XS	Svalbard EARS	EUMETSAT

Figure 13 : List for METOP-A compatible antennas on July 2011

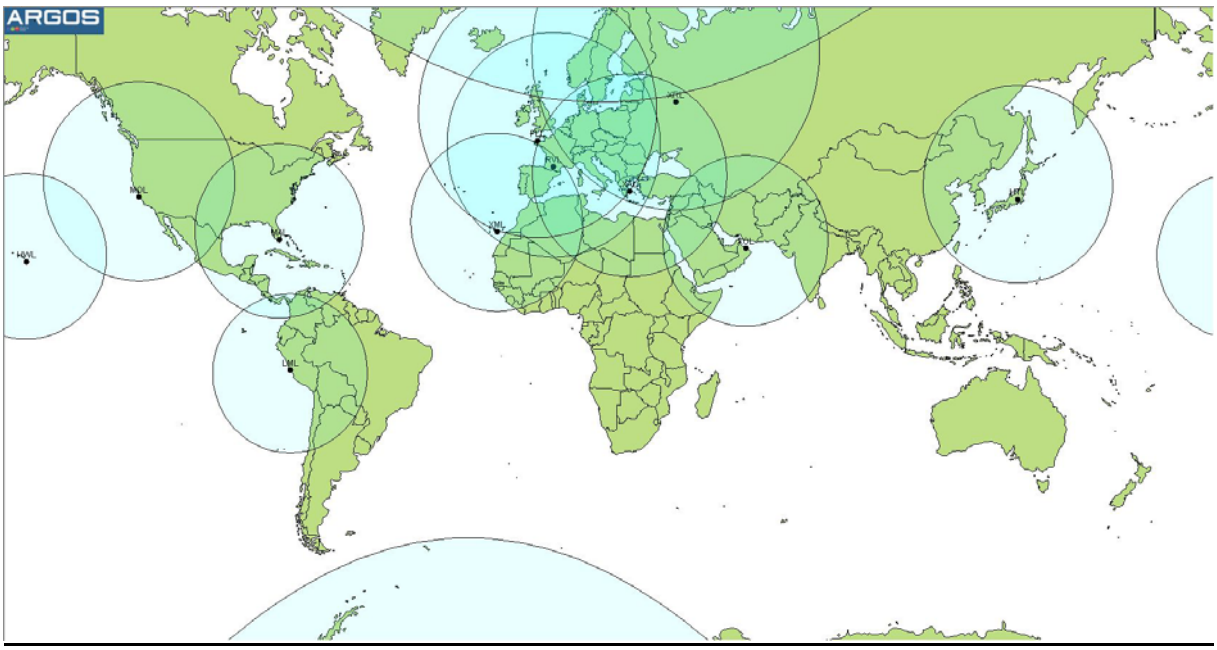


Figure 14 : Current METOP-A real-time coverage

Code	Station	Country	Operator	Longitude	Latitude	Recovery delay average (min)
AL	Al Udeid	QATAR	US AIR FORCE	51,32	25,13	
AN	Andersen	GUAM	US AIR FORCE	145,53	13,98	14
AT	Athens	GREECE	CLS	23,91	37,73	12
BA	Buenos Aires	ARGENTINA	INTA	301,50	-34,50	36
BL	Bali	INDONESIA	PT CLS INDONESIA	114,63	-8,39	12
CA	Casey	AUSTRALIA	BOM	110,72	-66,29	21
CF	Cape Ferguson	AUSTRALIA	NOAA NESDIS	147,32	-19,47	39
CH	Santiago	CHILE	METEO CHILE	289,60	-33,27	45
CY	Cayenne	FRANCE	IRD	307,70	5,00	18
DA	Darwin	AUSTRALIA	BOM	130,08	-12,47	15
DV	Davis	AUSTRALIA	BOM	77,97	-68,57	15
ED	Edmonton	CANADA	ENVIRONNEMENT CANADA	246,54	53,55	10
EL	Elmendorf - Anchorage	UNITED STATES	US AIR FORCE	150,38	61,39	15
GB	Libreville - N Koltang	GABON	CLS	9,68	0,36	15
GC	Gilmore Creek	UNITED STATES	NOAA NESDIS	212,50	64,98	11
GR	Sondre	GREENLAND	DMI	308,00	67,50	14
HF	Halifax	CANADA	CANADIAN COAST GUARD	296,40	44,70	10
HI	Hickam - Honolulu	UNITED STATES	US AIR FORCE	158,61	21,54	13
HR	Halley	UNITED KINGDOM	British Antarctic Survey	333,93	-75,08	17
HT	Hatoyama	JAPAN	Jaxa	139,83	36,00	10
HW	Hawaïi	UNITED STATES	NOAA NWS	204,50	19,50	15
HY	Hyderabad	INDIA	INCOIS	78,28	17,23	12
KA	Kandena-Okinawa	JAPAN	US AIR FORCE	128,30	26,56	15
LM	Lima	PEROU	CLS PERU	282.97	-12.3	10
MA	Miami	UNITED STATES	NOAA AOML	279,70	25,75	31
ME	Melbourne	AUSTRALIA	BOM	144,97	-37,82	13
MN	Manas	KYRGYZSTAN	US AIR FORCE	74,48	43,06	8
MO	Montererey	UNITED STATES	NOAA NESDIS	238,10	36,60	14
NO	Nouméa	NEW CALEDONIA	IRD	166,50	-22,30	21
NZ	Wellington	NEW ZEALAND	NIWA	174,77	-41,30	18
OS	Oslo	NORWAY	NMI	10,80	59,90	17
PE	Perth	AUSTRALIA	BOM	115,97	-31,95	14
PR	Lima	PERU	CLS PERU	282,97	-12,30	15

PT	Petropavlovsk	RUSSIA	CLS	158.39	53.01	12
RB	Resolute Bay	CANADA	Environment Canada	265,43	74,43	9
RE	Reunion Island	FRANCE	IRD	55,48	-20,85	22
RN	Reunion Island	FRANCE	METEO FRANCE	55,48	-20,85	10
RO	Rothera	UNITED KINGDOM	British Antarctic Survey	291,87	-67,57	12
RS	Lannion METOP	FRANCE	METEO FRANCE	356,53	48,75	9
SA	Cape Town	SOUTH AFRICA	SAWB	18,22	-35,55	15
SE	Séoul	KOREA, REPUBLIC OF	KMA	126,94	37,54	12
SG	Singapore	SINGAPORE	SMM	103,80	1,30	15
SH	Shanghai	CHINA	EAST CHINA SEA FISHERIES	121,55	31,29	11
SM	Sembach	GERMANY	US AIR FORCE	8,46	49,88	14
SV	Svalbard NOAA	NORWAY	NOAA	10	76	
TA	Papeete	FRANCE	IRD	210,45	-17,38	19
TW	Taïwan	TAIWAN, REPUBLIC OF CHINA	NTOU	120,27	25,05	18
UA	Valley Forge (Test)	UNITED STATES	US AIR FORCE	75,66	40,16	14
WE	Lannion	FRANCE	METEO FRANCE	356,53	48,75	13
WI	Wallops Island	UNITED STATES	NOAA NESDIS	284,54	37,95	13
XA	Athens EARS	GREECE	EUMETSAT	23,91	37,73	14
XE	Edmonton EARS	CANADA	EUMETSAT	246,54	53,55	20
XG	Gander EARS	CANADA	EUMETSAT	54,57	48,94	22
XK	Kangerlussuaq EARS	GREENLAND	EUMETSAT	50,71	67,02	17
XM	Maspalomas EARS	SPAIN	EUMETSAT	344,41	27,79	17
XO	Muscat EARS	OMAN	EUMETSAT EARS	58,60	23,62	17
XR	Moscou EARS	RUSSIAN FEDERATION	EUMETSAT	37,57	55,76	16
XS	Svalbard EARS	NORWAY	EUMETSAT	15,38	78,23	17

Figure 15 : List for Operational Antennas on March 2011 and delay statistics

Only 4 stations have mean dataset availability > 25 minutes, so CLS group has to help the following stations to improve their time responses:

- Buenos Aires (BA, Argentina)
- Cape Ferguson (CF, Australia)
- Santiago (CH, Chile)
- Miami (MA, United States)

3.2.2. System improvements

CLS is still focusing on the project of upgrading and optimizing in terms of performances this real-time receiving stations network. Since January 2010, 8 new real-time stations have been added to the Argos HRPT global network with 4 thanks to the Eumetsat EARS network extension. Here below is the list and the map of new Argos HRPT stations since January 2010:

Creation date	code	station	country	operator	longitude	latitude	Delay (min)
01/27/2010	RB	Resolute Bay	CANADA	Environment Canada	265,43	74,43	9,00
03/30/2010	XE	Edmonton EARS	CANADA	EUMETSAT	246,54	53,55	20,00
03/30/2010	XR	Moscow EARS	RUSSIAN FEDERATION	EUMETSAT	37,57	55,76	16,00
03/30/2010	XG	Gander EARS	CANADA	EUMETSAT	54,57	48,94	22,00
07/27/2010	XO	Muscat EARS	OMAN	EUMETSAT EARS	58,60	23,62	17,00
08/18/2010	MN	Manas	KYRGYZSTAN	US AIR FORCE	74,48	43,06	8,00
08/18/2010	AL	Al Udeid	QATAR	US AIR FORCE	51,32	25,13	
11/09/2010	HR	Halley	UNITED KINGDOM	British Antarctic Survey	333,93	-75,08	16,00

Figure 16 : List of new Argos HRPT stations since January 2010

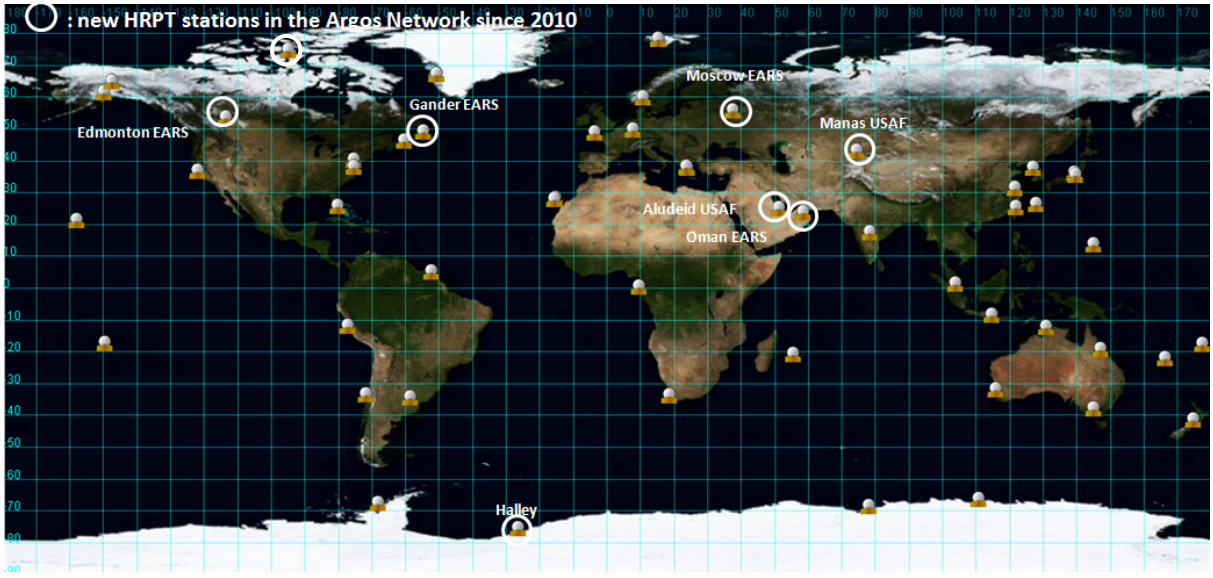


Figure 17 : New regional stations in 2010

The next figures represent the simulated Argos Data Mean Disposal Time taking into account the Argos satellites constellation, the Argos ground stations and data processing centers' performances. Data disposal time is defined as the elapsed time between when an observation is collected by an Argos platform and is available to the user.

The Data Mean Disposal Time is composed of four typical delays:

- the revisit time (time for a platform to be seen by one of the Argos satellite),
- the time for the data to be downloaded to a ground station (it's nearly instantaneous for an HRPT station or it's the time for the satellite to reach a global station),
- the data retrieval time (average time for the data to be transmitted to the Argos Data Processing Centers),
- the processing time (requisite time for the data to be processed in the Argos Data Processing Center and to be available for the users).

Comparison between March 2010 and March 2011

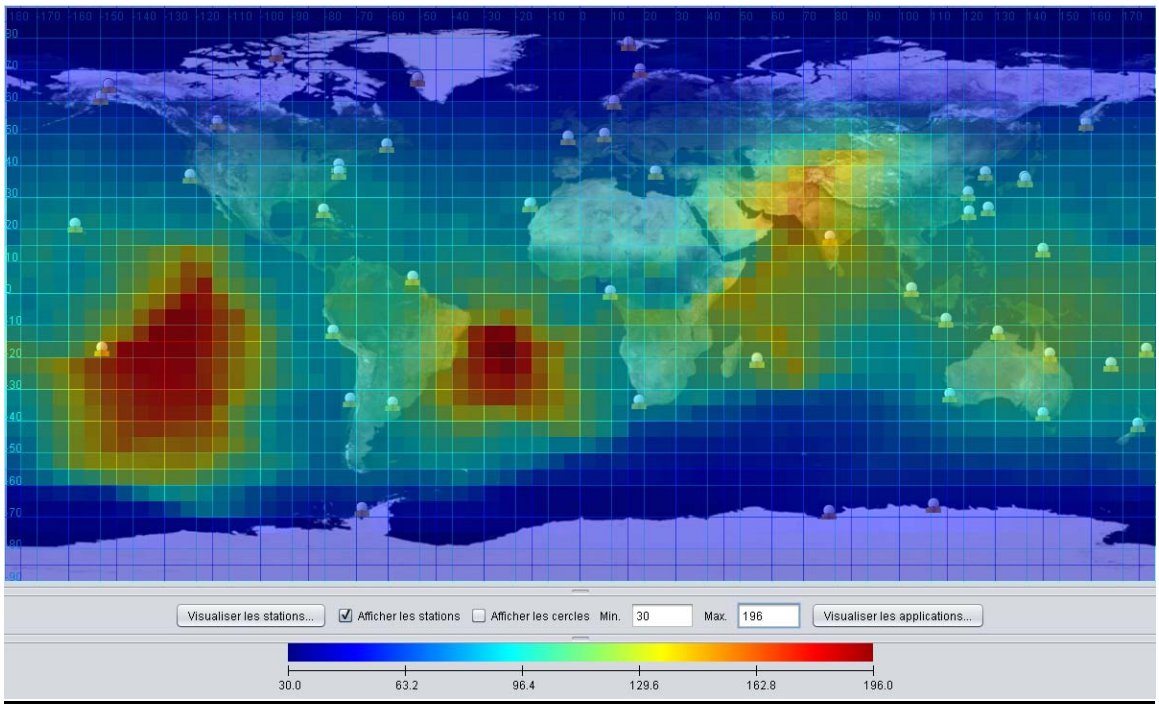


Figure 18 : Argos Data Mean Disposal Time in March 2010 (in minutes)

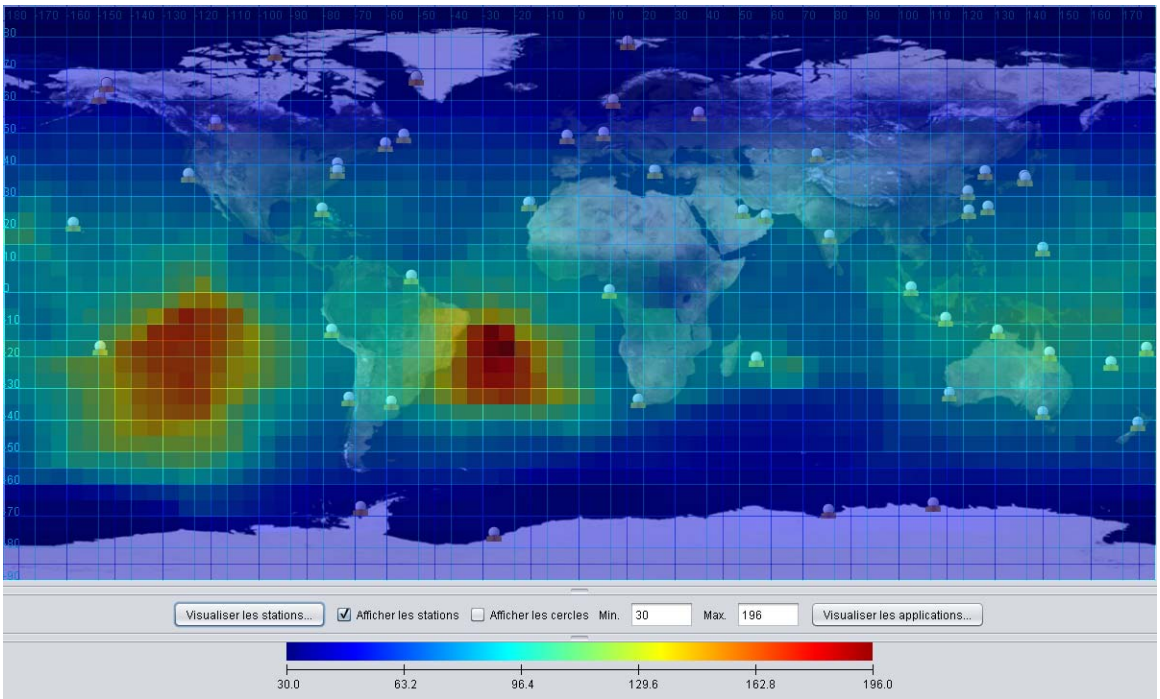


Figure 19 : Argos Data Mean Disposal Time in March 2011 (in minutes)

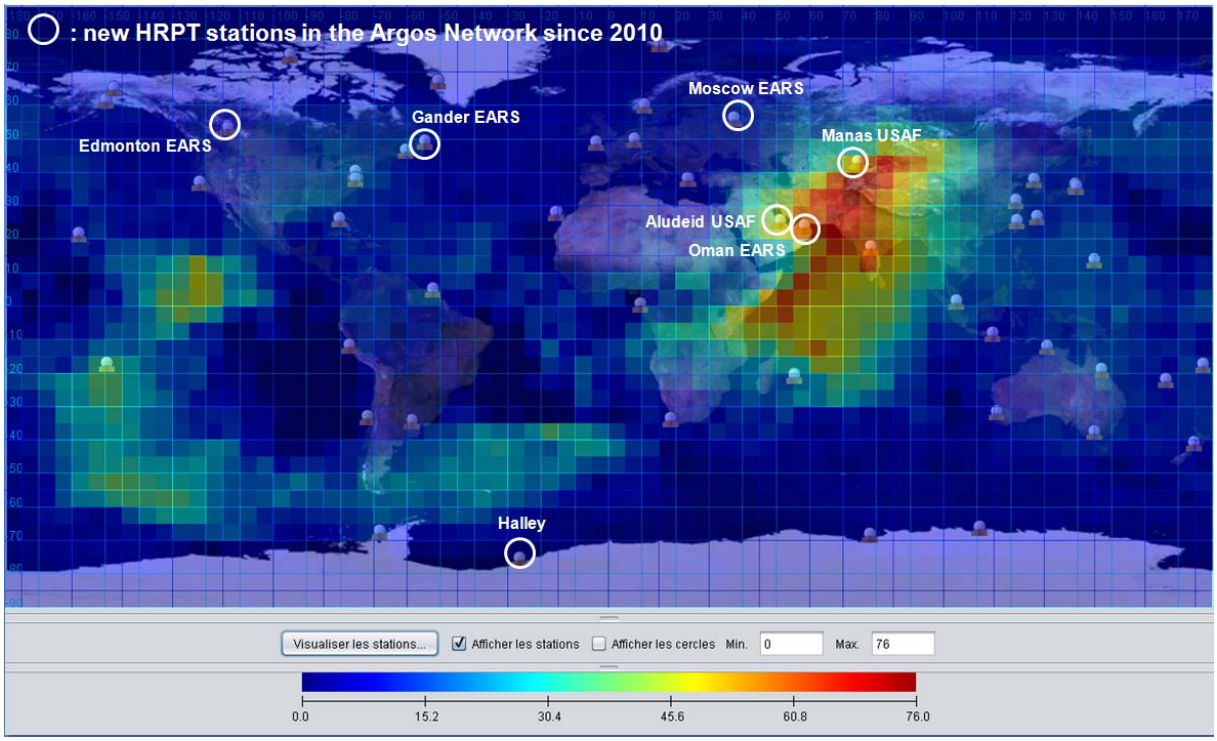


Figure 20 : Disposal time improvements* and new regional antennas locations

*average time saved in minutes between March 2010 and March 2011 situation

The improved performances in terms of data mean disposal time observed during the last year are mainly due to:

- improvements of the data retrieval time from HRPT ground stations to the Argos Data Processing Centers,
- greater availabilities over the year for some HRPT ground stations of the network,
- the extension of the MetOp-A HRPT zone.
- new HRPT stations which have been incorporated in the Argos ground stations network since the last year (see white circles on the Figures 17 & 20).

3.2.3. Status of the Argos real-time stations upgrade project

This project (presented during the 43th Operation Committee) aims at upgrading a significant part of the network so that it is capable of acquiring data from NOAA, METOP and SARAL satellites. Since the receiver developed in the frame of the upgrade is "agile" and multi missions, it should be possible to perform a light update to receive data issued from the future satellites which will carry the Argos-4 instruments. This project is led by CLS with the strong help and support of CNES.

System design studies

The system studies, as presented last year, allow us to select a set of 19 stations which will be upgraded. Among these 19 stations (see picture 1):

- 12 stations will be upgraded using our upgrade equipment (white circles)
- 2 new stations will be deployed (red circles)
- 2 stations will be upgraded by NOAA (yellow circles)
- 3 stations will be upgraded in partnership with Australia (orange circles)

Engineering

From an engineering point of view, the upgrade has been designed to be as flexible and easy as possible to be integrated in the existing station and to be operated. In that purpose:

- The interface with the existing station is strictly limited to a connection on the RF input;
- No interface is required from the station command and control system (except initializing the new sat to track);
- The upgrade doesn't modify the operational mission of the station since SARAL can be declared as a low priority sat.

During 2010, the new receiver has been developed and the acceptance tests have been successfully performed. At this time, 13 receivers have been manufactured and are ready to be installed in host stations.

Deployment

The deployment starts early this year. Lannion (France), Lima (Peru) and Bali* (Indonesia) are installed and operational. Hatoyama (Japan) has been postponed.

* On April 4th, 2011 Bali facilities burn and all equipment were lost except the antenna and the radom.

Tahiti and La Reunion are scheduled for the 2nd half of 2011.

For the other stations:

- the discussions are on the run with EUMETSAT for EARS network stations
- the negotiations are on the run with Australia
- the last two stations upgraded by NOAA are to be confirmed.

New stations procurement

The 2 new stations are in AIT phase. The acceptance tests are done since June 2011.

Contacts are on the run with the installation sites, respectively Ascension Island and Cape Town in South Africa.

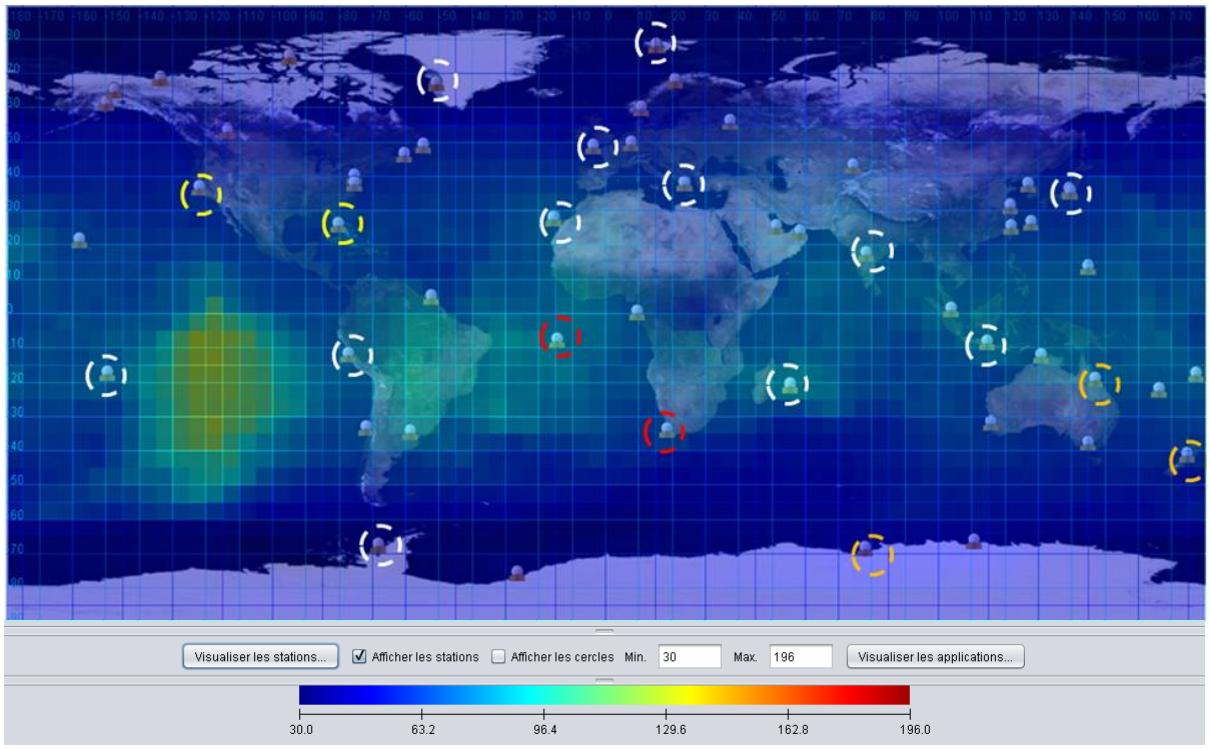


Figure 21 : Argos real-time stations upgrade project network

3.3. Processing centers

3.3.1. Operations

The two global processing centers in Toulouse and Largo were nominal over 2010 and first semester of 2011.

Redundancy is used at least once a month (Up to two times on one month). Redundancy means all Argos users rerouted to CLS or CLSA during an anomaly on the nominal global processing center.

CLS America moved to a new building in May 2011:

Figure 22 : CLS America new building

The disaster recovery architecture implementation was completed in 2010. The computer room is located into CNES Toulouse. Some of the Argos architecture components are DR compliant in order to improve services availability. But the main backup is based on the 2 global processing centers.

Figure 23 : Disaster Recovery Room located in CNES

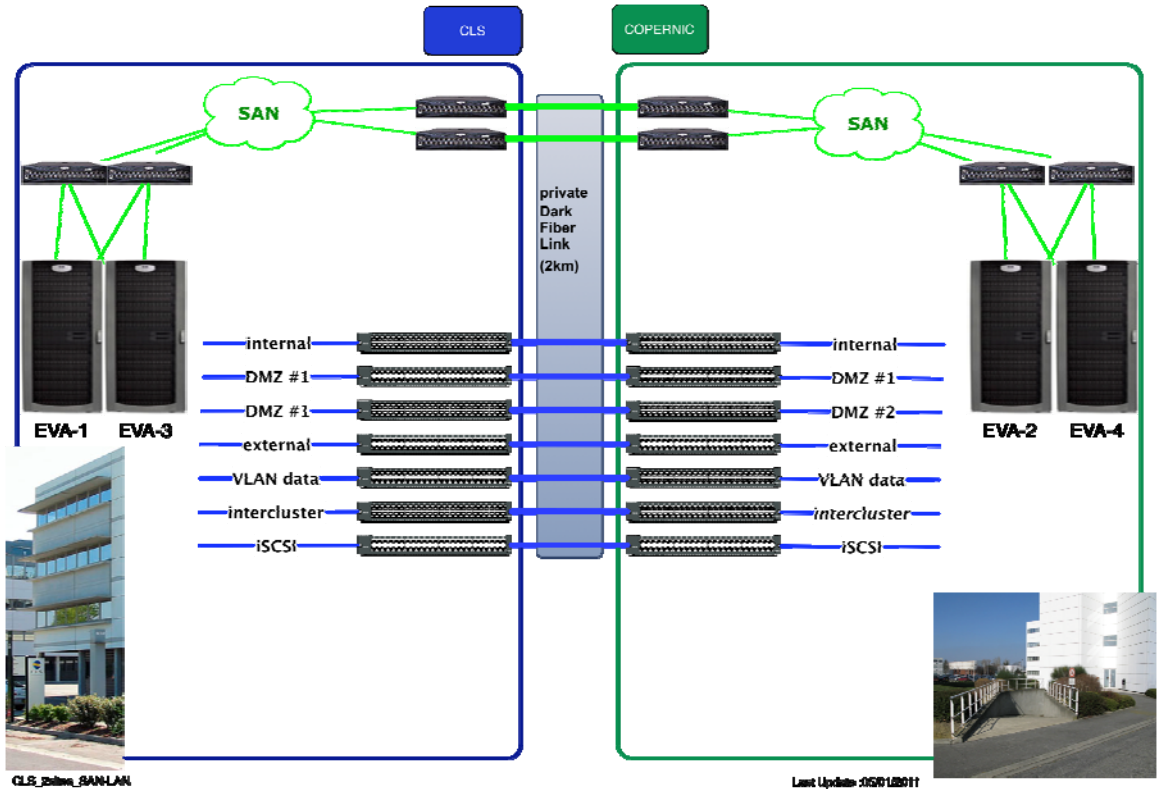


Figure 24 : Disaster recovery architecture diagram

In order to monitor the Argos processing centers, statistics are produced in real-time:

- on the availability of Argos data distribution tools,
- on the data delivery time for sample platforms,
- on Argos location delivery time for sample platforms,
- and on the percentage of data available in less than one hour.

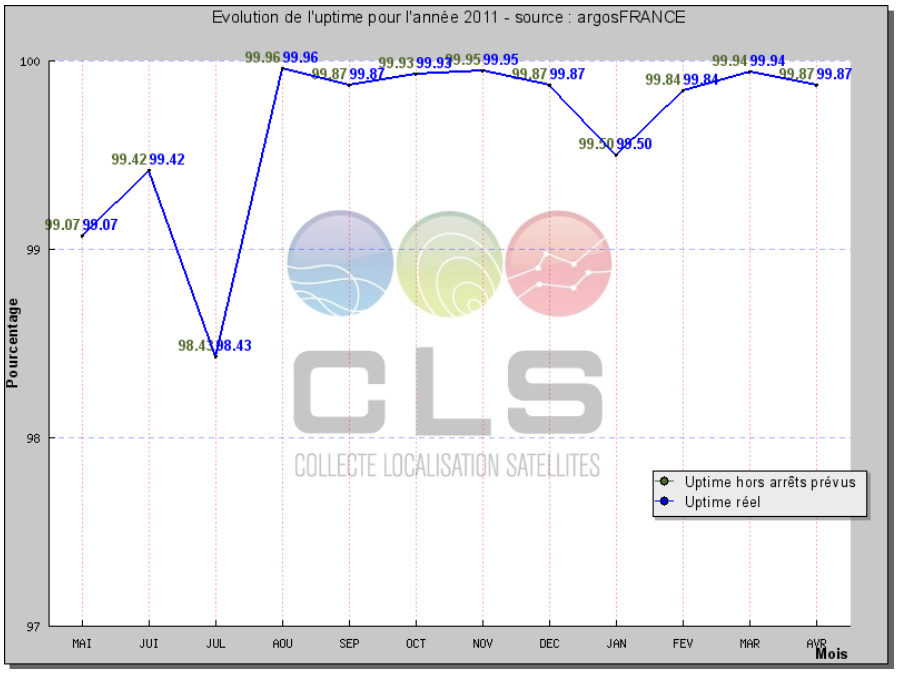


Figure 25 : ArgosWeb time availability in 2010 – 2011

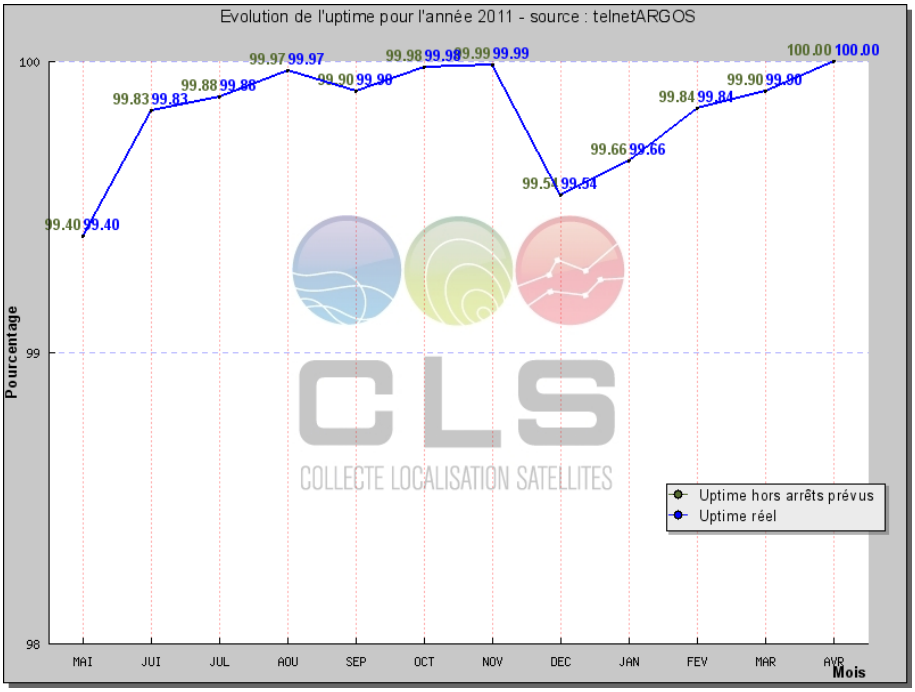


Figure 26 : ArgosServer time availability in 2010 - 2011

Figure 27 : Data delivery time for sample platforms*

Figure 28 : Argos location delivery time for sample platforms*

* Sample platforms are timing and orbit determination platforms. Every hour, the last data collection and location times for these three platforms are controlled. Collection and location latency on ID 108 (Fairbanks) is under latency of Ids 1(Toulouse) and 118 (Wallops Island) due to the transmitter location and the higher number of passes over this transmitter.

We can see major improvement on data and Argos location delivery time since 2008 due to a better real-time antennas network, a sixth operational Argos satellite in 2009 (NOAA-19) and enhancements of the Argos data processing performance.

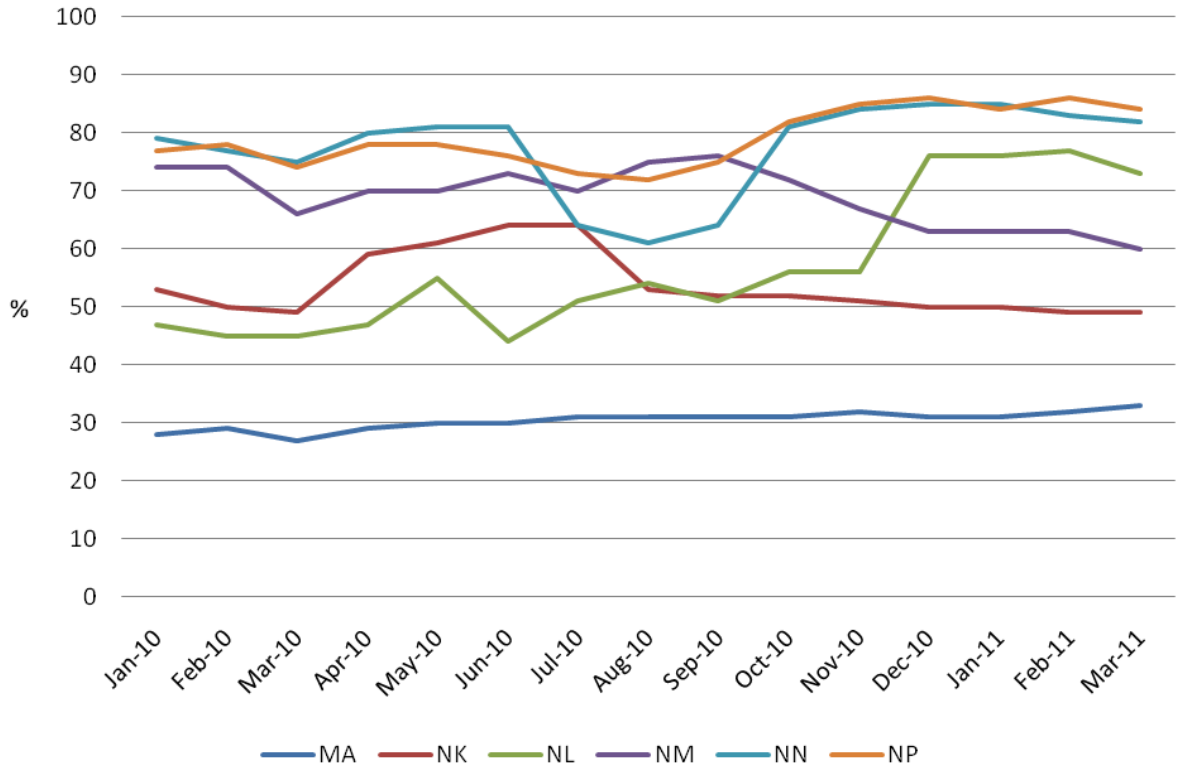


Figure 29 : Percentage of Argos data available in less than one hour*

*Percentage of data available in less than one hour means percentage of raw data processed one hour after its recording on board of the Argos Instrument. This statistics is representative of the real-time antennas network global coverage for each Argos satellite.

MA has a limited HRPT coverage due to HRPT problem onboard but a number of compatible station in progress: 15 real-time antennas compatible in July 2011.

NOAA N and M, operational satellites, get a better coverage than NK and NL.

3.3.2. Architecture

Each global processing center is autonomous and can work alone. In normal mode, both processing centers receive process and distribute Argos data to:

- North American users for CLS America,
- Users of the rest of the world for CLS France.

In case of a problem with one of the two centers, the other one stays alive and is capable of receiving, processing and distributing Argos data to ALL users. The switch to the remaining alive center is completely transparent for the users. It means that the users continue to receive or to access their

data, without changing anything on their side. CLS has a 99.5% system availability with three processing centers in back-up (two nominal and one disaster recovery)

Figure 30 : CLS Toulouse Global Processing Center

The architectures of CLS France and CLS America processing centers are quite similar and based on the same principle. Each has the same three main subsets:

- the processing chain
- the Oracle database service
- the Web distribution

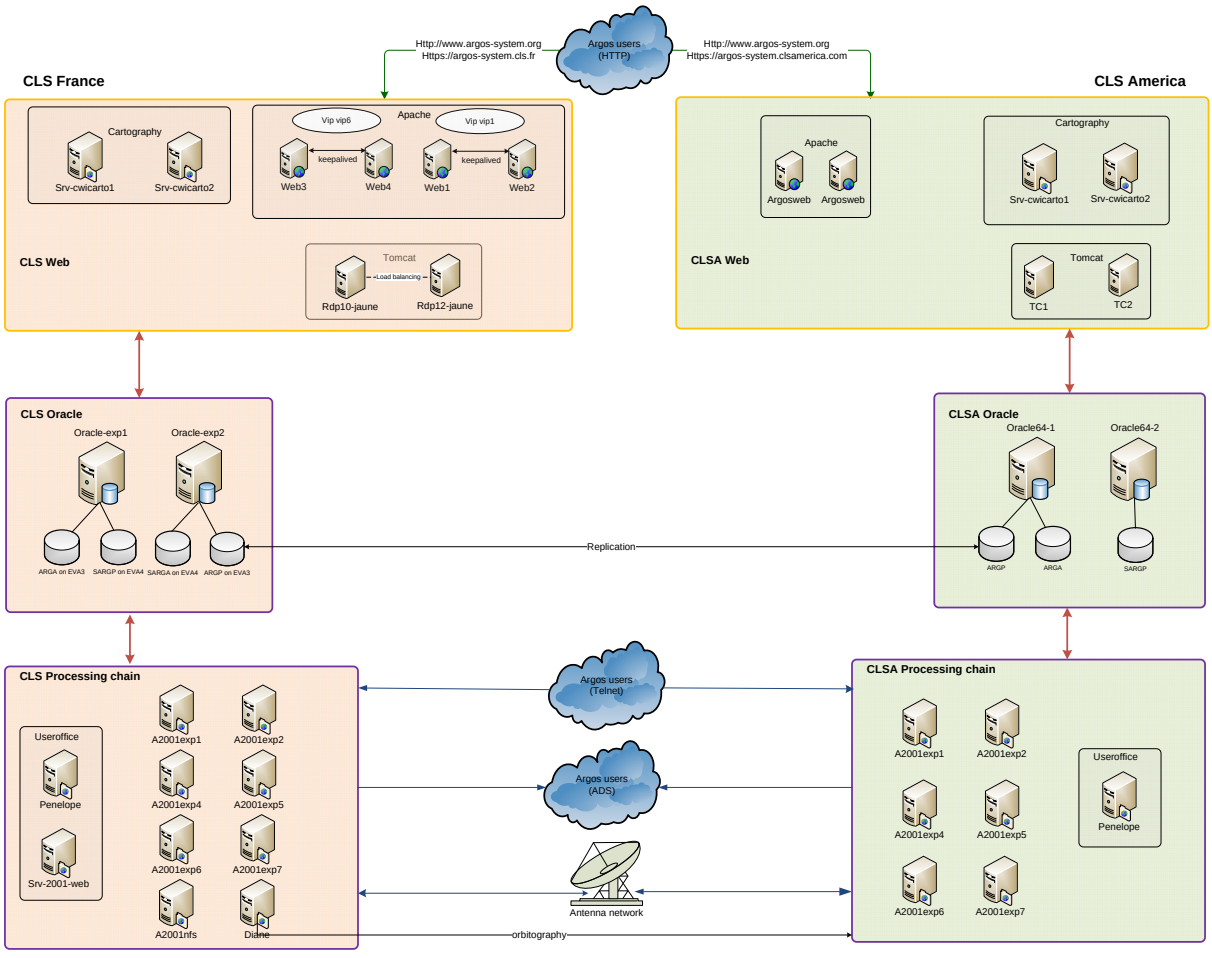


Figure 31: Architecture of the CLS France and the CLS America global processing centers

Processing chain

Composed of different software modules, the processing chain is in charge of receiving and processing the Argos data issued from the satellites and acquired by the global and real-time ground stations networks.

Argos data are processed in terms of collect and location, and stored into a database.

The processing chain is also in charge of distributing the data by ADS (Automatic Distribution System) or allowing users to access to their data using Telnet.

Oracle database service

At the heart of the computing architecture, the Oracle database is used to store the Argos declarative data as well as the processed data.

In order to keep a perfect coherency between CLS France and CLS America centers (mandatory to guarantee the redundancy between both centers), an automatic mechanism of replication is implemented between CLS France and CLS America databases.

Web distribution

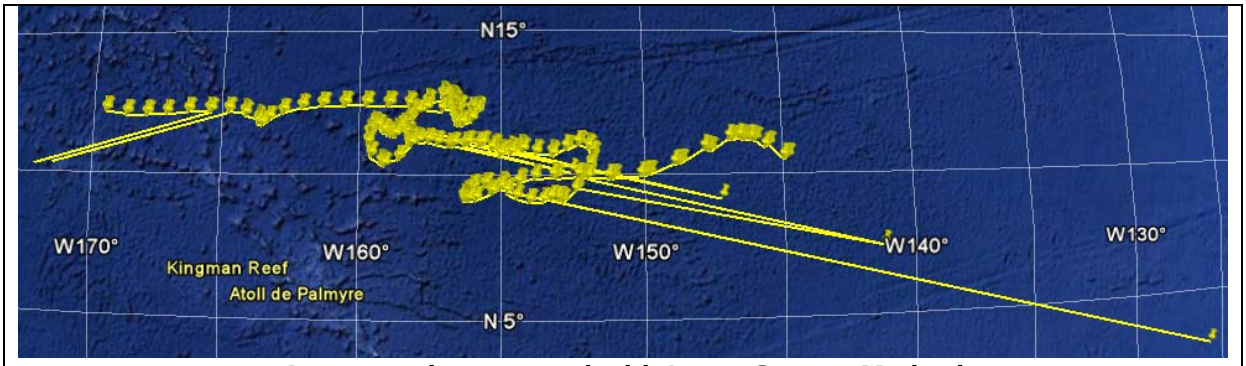
Based on a farm of Apache Web servers, the Web distribution allows the users to access their data using a Web cartographic interface. The service of maps is supported by two cartographic servers on which are running the mapping engines C-Map for the marine cartography and MapInfo for the terrestrial one. The application server is supported by Tomcat.

3.3.3. System improvements

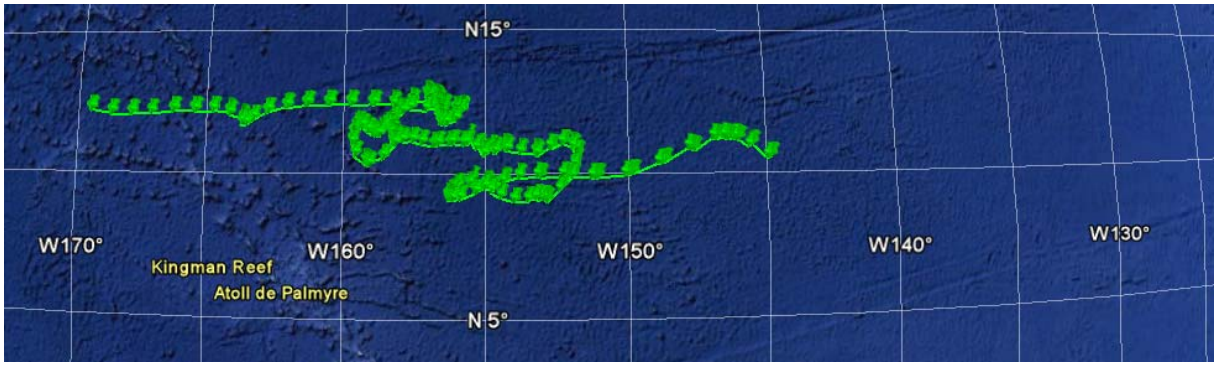
As every year, several software improvements were implemented in 2010 and 2011 in order to fit with the user requirements. These application improvements have concerned:

New location processing

Now the users can choose between two location algorithms: Least square method ("original" algorithm proposed to the users up to now) or Kalman filtering algorithm (new algorithm proposed to the users). The Kalman filtering algorithm offers many advantages, especially in case of harsh conditions locations. It delivers more accurate locations and it also allows computing locations with only one message in certain conditions. CLS also offers to the users the possibility to reprocess locations from January 1st 2008 using one or the other algorithm.



Argos track computed with Least Square Method



Argos track computed with Kalman Filtering Method

Figure 32: Comparison of both Argos location calculation methods for an Argo float

Access to the Argos data using Web service

CLS has developed in 2010 a new machine-to-machine/automatic interface called Web Service in order to distribute Argos data. This modern alternative to ArgosServer (Telnet) makes it possible for Argos users to contact CLS's database directly, via internet, and receive their data in CSV, XML and KML (GoogleEarth) format. The Web Service is a free access tool and delivers useful information such

as positions, error estimates, diagnostic data, raw messages, sensor data, etc. The user can choose the different types of data to download via filters.

Improvement of the Argos web functionalities and performances

Several improvements have been made on Argos Web interface:

- Possibility of accessing the Argos web through a PDA or a smart phone,
- Possibility of creating or renewing a SUA,
- Possibility of requiring new Id numbers,
- Possibility of consulting the most recent observation,
- Possibility of displaying only messages with checksum OK,
- Possibility of displaying locations of the observations.

The problem on Argos web performances (slow access from some countries, especially in Asia) has been found and solved by a modification of Argos web architecture.

Multi-broadcast of Argos-3 commands

To improve the Argos-3 downlink service, it is now possible to download one Argos-3 command on all the active Argos-3 payloads. In this case, only the first acknowledge received is taken into account.

Monitoring of the satellites housekeeping telemetry

Many improvements have been made on this new module to keep it more operational (performance improvements, bugs correction, integration of several change proposals).

Improvement of the Argos data processing performances

The improvement of the Argos data processing performances is a permanent action. The major performance improvements concerned HK and TM processing and also value added processing.

Pay bills online

Through web interface it is now possible for the users to pay their bills online.

SARAL ground segment upgrade

SARAL (Satellite with Argos and Altika) will carry an Argos-3 and a Doris instrument as well as a band Ka altimeter.

The purpose of this internal CLS project is to upgrade the Argos Processing Centers in order to take into account this new Argos-3 instrument which will be aboard SARAL.

The project includes the following activities:

- Developments: decoding and processing of telemetry plus computation of ephemerides.
- Qualification: integration of X and L-Band global and regional stations.
- Operation: update of procedures and instrument monitoring.

4. Argos user's applications

4.1. Monitoring Argos platforms

The number of science Argos platforms (except animals) operating is stable. In June 2011, 6339 platforms were active in the month.

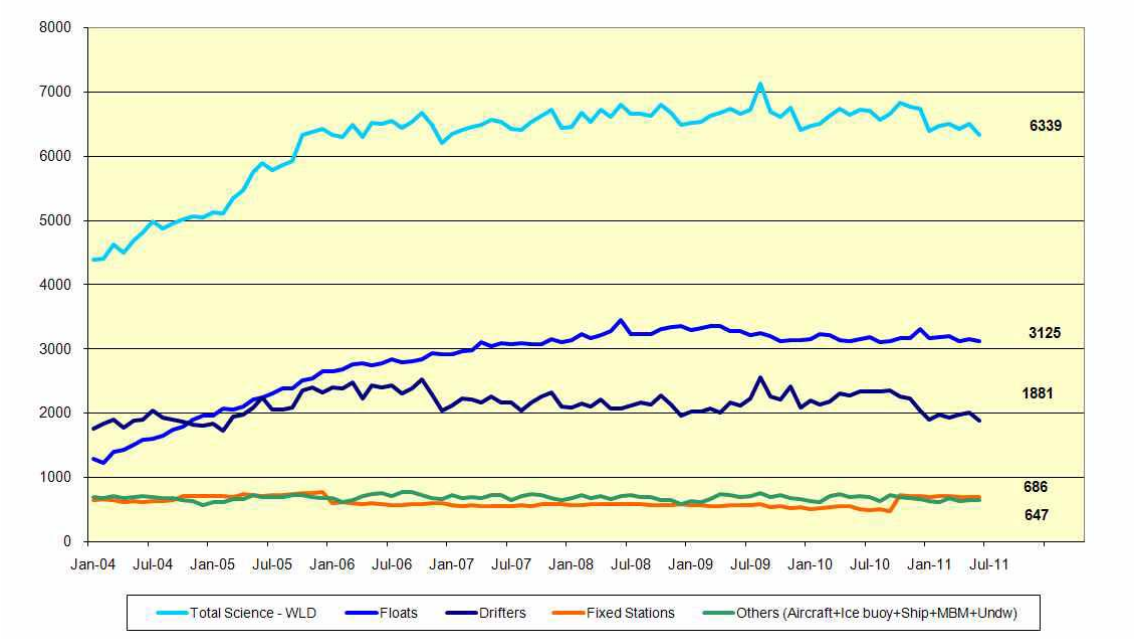


Figure 33: Monthly active ocean Argos platforms statistics

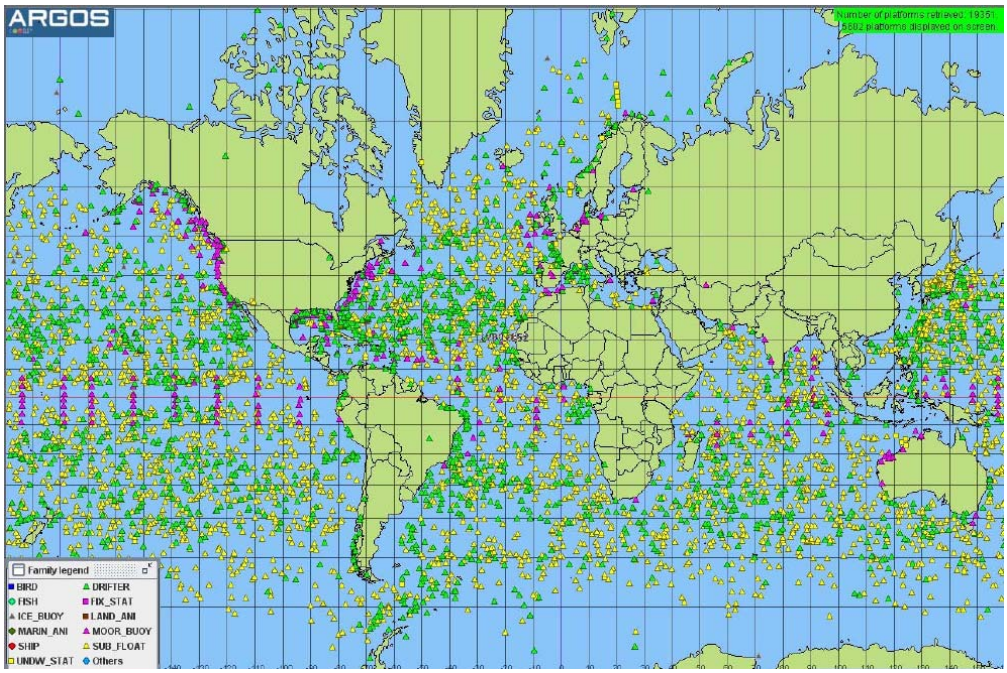


Figure 34 : Active ocean Argos platforms repartition over the world

4.2. Argos-3

The third generation Argos system, Argos-3, is functioning 100%. It has been and continues to be operationally available on the METOP-A satellite since early 2007. Although the Argos-3 downlink signal on NOAA-19 is currently turned off, more Argos-3 systems are scheduled to be launched. Specifically in mid-2012 two Argos-3 system on-board the SARAL satellite and on-board the METOP-B satellite will be launched.

Many manufacturers have already integrated the Argos-3 PMT transceivers into their products and others are encouraged to do the same. Users are strongly encouraged to evaluate the Argos-3 capabilities for their data collection needs.

4.2.1. Argos-3 Test Program (DBCP 22, item 8.3.17)

At the DBCP 22 meeting in La Jolla the Argos-3 PMT was featured and a CLS "PMT Giveaway Program" was introduced as the mechanism whereby PMT's would be made available to users interested in 'test-driving'/evaluating the Argos-3 capabilities for their needs. The meeting invited participants and manufacturers willing to participate in this test program to make contact with the Argos team right away. The meeting stated that the ***"goal of the test program is to test Argos-3 new capabilities, define useful commands to users and make available ready-to-deploy platforms by the end of 2007. "***

In 2008 this 'test program' was formalized by CLS with the help and the cooperation of CNES, to create a project called the "**Argos-3 Implementation Plan**."

The objectives of this project are:

1. To know and control the Argos-3 system

2. To promote the Argos-3 system

The project is split into two distinct and consecutive phases:

A first phase, called Evaluation phase, has the following objectives:

- knowing and controlling the system by deploying a network of Argos-3 reference platforms
- pointing out, from a user point of view, the advantages and the disadvantages of the system
- getting all the elements to objectively promote the system
- developing Argos-3 platform prototypes which are representative of the user applications in order to validate optimized usage scenario of transmission and take advantage of the new Argos-3 functionalities

A second phase, called Promotion phase, has the following objectives:

- making aware, encouraging, involving and convincing both users and manufacturers to use the Argos-3 system
- developing operational user platforms (Argo floats, drifting buoys, animal platforms), using the experience gained from the Argos-3 platform prototypes, This includes development contracts with manufacturers.
- making these operational platforms available for the users in order to include them in organized pilot projects
- monitoring these Argos-3 platforms for at least 9 months or more and comparing their performance with similar Argos-2 platforms
- organizing an Argos-3 forum at which the results of the promotion phase will be presented to the Argos user community

The first phase is completed. The second phase started in 2009. 1500 Kenwood PMTs have been sold to Argos platform manufacturers.

Four manufacturers have completed the implementation of the Argos-3 PMT into their drifters: Clearwater, Marlin-Yug, Metocean and Pacific Gyre. These drifting buoys use the interactive data collection mode with Argos-3 and the “pseudo-ack” mode with Argos-2 (message transmitted N times under one satellite pass) since the PMT modem calculates satellite pass predictions. Preliminary studies showed that these improvements can reduce message transmissions by as much as 75% thereby increasing the buoys’ life expectancy.

4.2.2. DBCP Pilot Project for the Evaluation of Argos-3 Technology

The objectives of the Project are to:

i) Independently and objectively evaluate Argos-3 for use by the global data buoy community.

ii) Foster Argos-3 integration by buoy manufacturers.

iii) Provide Argos-3 equipped drifting buoys to the community for evaluation.

The first Argos-3 buoys were deployed during the summer of 2009. 29 buoys were deployed in one year during the first phase of the Argos-3 pilot project in Pacific, Atlantic oceans, Black and Mediterranean Sea.

At this time 28 additional Argos-3 buoys have been deployed globally in order to further test Argos-3 capabilities in the frame of the Argos-3 pilot project.

A big thank you goes to Dr. Luca Centurioni (Scripps Institution of Oceanography), the chairman of the Argos-3 Pilot Project steering team, for the ship opportunities coordination for deployment of the drifters by interested users.

Figure 35: Argos-3 buoy (Clearwater) deployment in Med. Sea

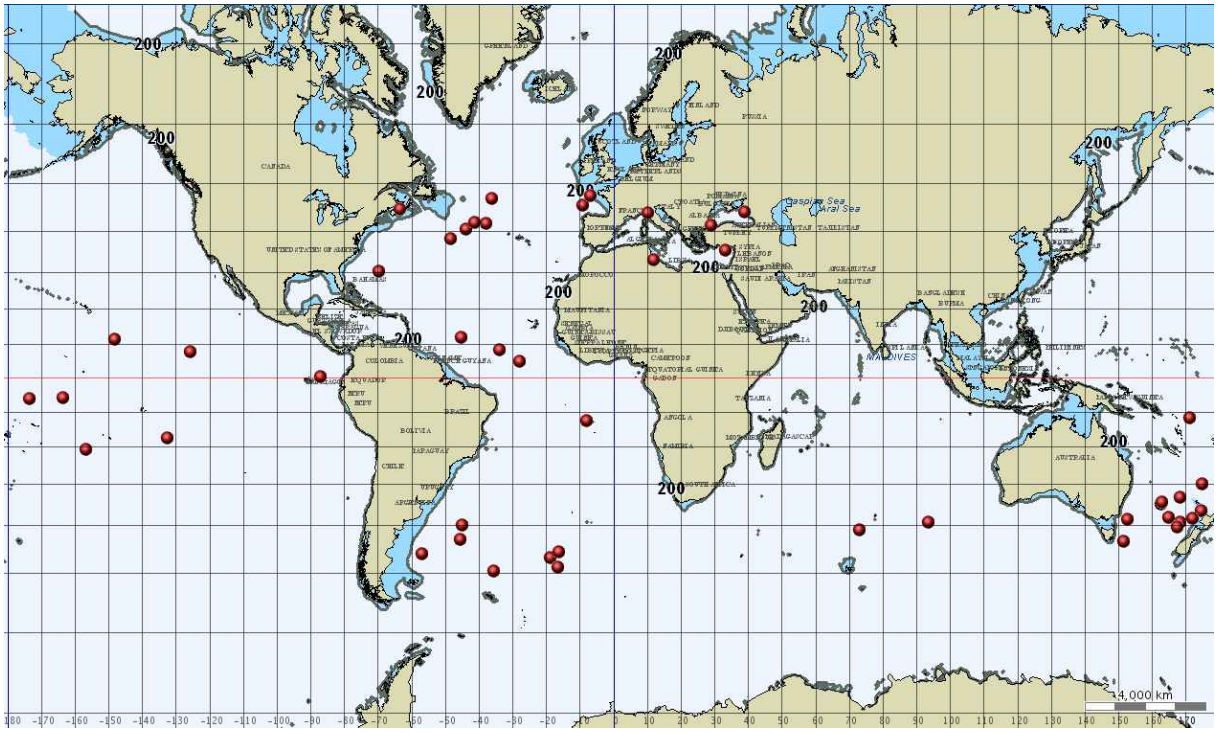


Figure 36: Map of last Argos location on July 21, 2011 for Argos-3 DBCP Pilot Project buoys

A total of 57 drifters have been deployed for Argos-3 system evaluation. CLS has provided technical assistance to all manufacturers involved in the Argos-3 integration effort and is participating in the evaluations of the performance of the buoys. CLS is processing the Argos-3 buoy data in real-time and inserting the data onto the GTS via the National Weather Service (in the U.S.) and Météo-France (in France). The initial conclusions are:

• A high performance for collecting hourly sensor acquisitions (>95%) for those buoys that are operating

• A large reduction (~75%) of the power consumption used for the data transmission, allowing a reduction in the size of the battery pack and/or increasing the drifter lifetime,

• Improved synoptic measurements (on average, more than 22 hourly observations collected per day),

• Optimization of the transmission leading to a better use of the satellite network and then better performance for users,

• Secure uplink transmission with an automatic checksum control,

• Remote commands via the Argos-3 downlink to change the mission parameters.

A report of the Argos-3 Pilot Project buoy evaluations will be provided by Dr. Centurioni.

4.2.3. Argos-3/Argos-4 chipset

Thanks to the Argos-3 implementation plan, we learned about the need to have of low power consumption PMTs as well as an Argos-3/Argos-4 receiver for the Argos community. In the frame of the European Artes-5 Program, the Norwegian Space Agency together with CNES are supporting a 2M€ contract for developing such solutions. CLS is actively setting up an industrial organization that will be involved in this 3-year development. Results of this project will be a set of tag prototypes dedicated to marine mammal tracking.

4.3. Data Timeliness

Minimizing the elapsed time between when a meteorological/oceanographic observation is collected and when it is inserted onto the Global Telecommunications system (GTS) is a high priority requirement of the DBCP community. By establishing operational regional satellite receiving stations at critical locations the data transmitted to the Argos system, and then immediately retransmitted by the satellite to the ground in real-time, can be received by CLS and disseminated within a very short period of time.

CLS has been managing an evolving and expanding network of regional receiving stations for many years responding primarily to the expressed needs of the DBCP community for timeliness of their data. An update of the current efforts and plans is given below.

4.3.1. South Atlantic Ocean Delays (DBCP 26, item 9.4.4)

Improving the Argos data timeliness continues to be a high priority for CLS. After improving the situation in the Indian Ocean last year with Hyderabad, La Réunion, Muscat and Aludeid, CLS is now focusing on the South Atlantic Ocean.

Data timeless in high latitudes has been improved with two new stations in Antarctica (in yellow on figure 37):

- The Halley regional antenna operated by the British Antarctic Survey.

- The Mc Murdo global antenna for METOP-A operated by NOAA.

Furthermore, thanks to the Argos real-time stations upgrade project (see chapter 3.2.3):

- Two new stations one on Ascension Island (United Kingdom) and another in Cape Town (South Africa) will be added in the Argos real-time stations network in 2012. Both antennas are in AIT phase and contacts are on the run with the installation sites (in red on figure 37).

- Two existing stations in Antarctica: Davis operated by The Bureau Of Meteorology (Australia) and Rothera operated by the British Antarctic Survey (United Kingdom) will be upgraded in 2012 to be capable of acquiring data from NOAA, METOP and SARAL satellites (in white on figure 37).

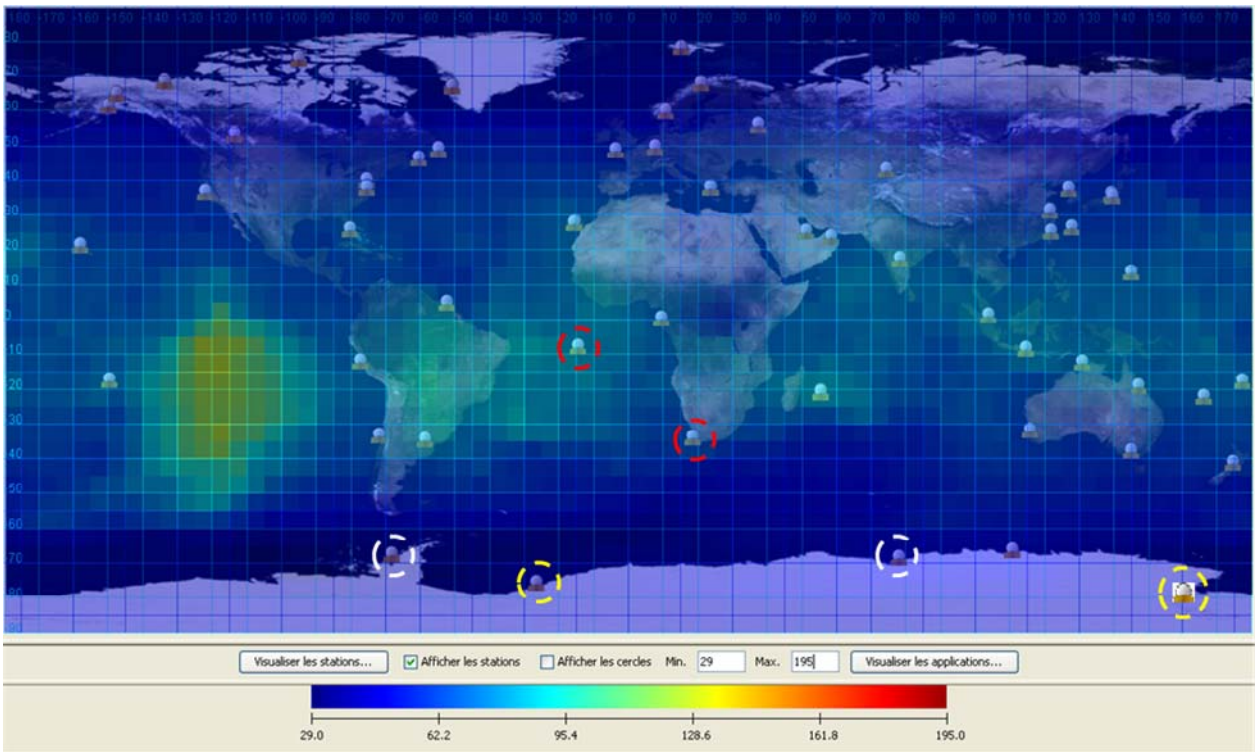


Figure 37: Expected data timeless after HRPT improvements in South Atlantic Ocean

4.4. Real-Time Monitoring and improvements for GTS

CLS is monitoring 24/7 a) the GTS processing system with real-time operational surveillance on the processing modules, b) the quality of the data and c) the system performance (time to process the data, number and size of bulletins)

In 2009 developed a GTS monitoring tool, with following statistics computed each day:

- Number of GTS platforms (with a WMO id) processed,
- Number of observations processed,
- Average disposition time (observation time –time inserted onto the GTS)

These 3 statistics are provided for:

- All types of bulletins
- Each type of text bulletins (BUOY, SHIP, TESAC, and SYNOP)
- Each type of buoy (ATLAS, DRIFTERS, ICE, TRITON and OTHERS)

In 2010, CLS has developed improvements on this GTS monitoring tool with same statistics provided now by ocean basin. CLS is waiting for the new DBCP TC to find a solution to publish these statistics on the JCOMMOPS website.

Some examples of monitoring products displayed by this tool are shown below:

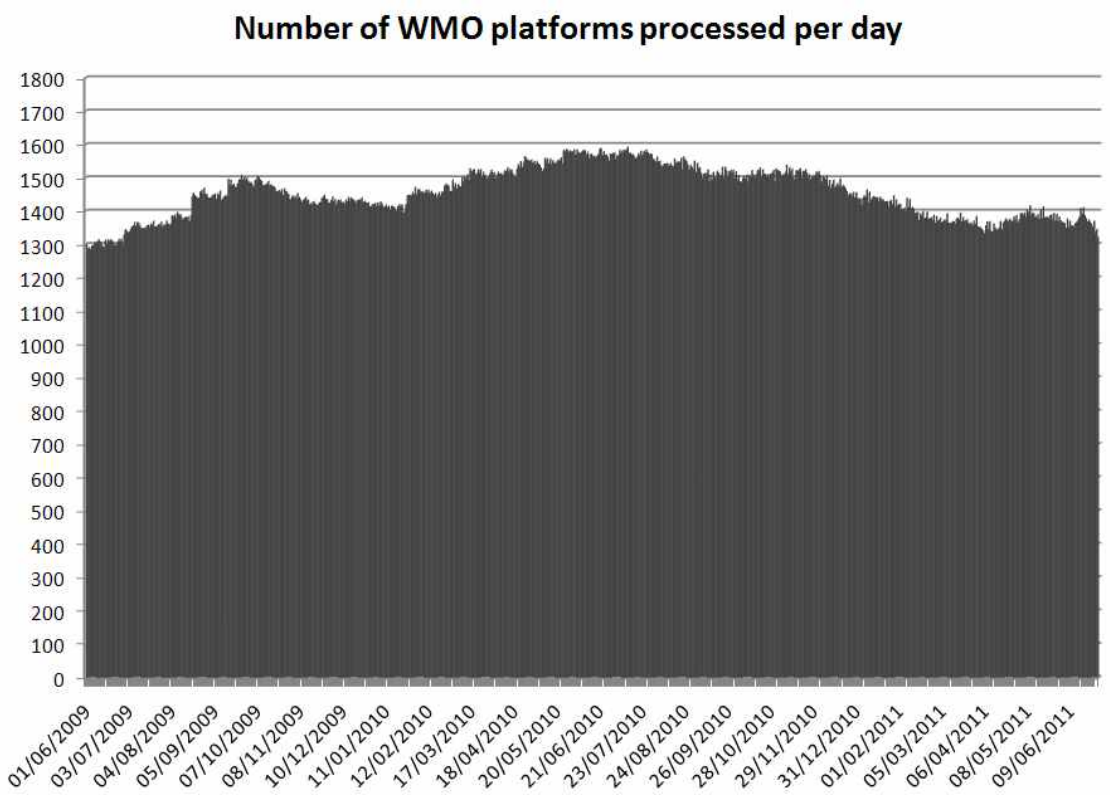


Figure 38: Argos platforms GTS processed per day

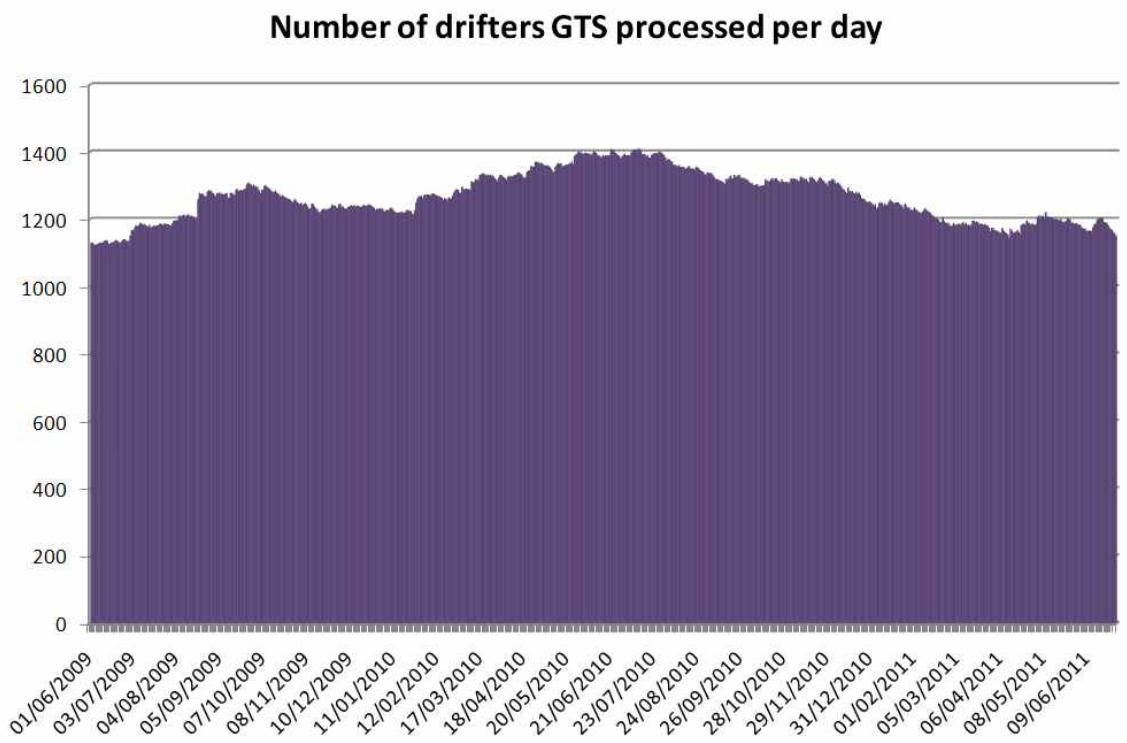


Figure 39: Argos drifters GTS processed per day

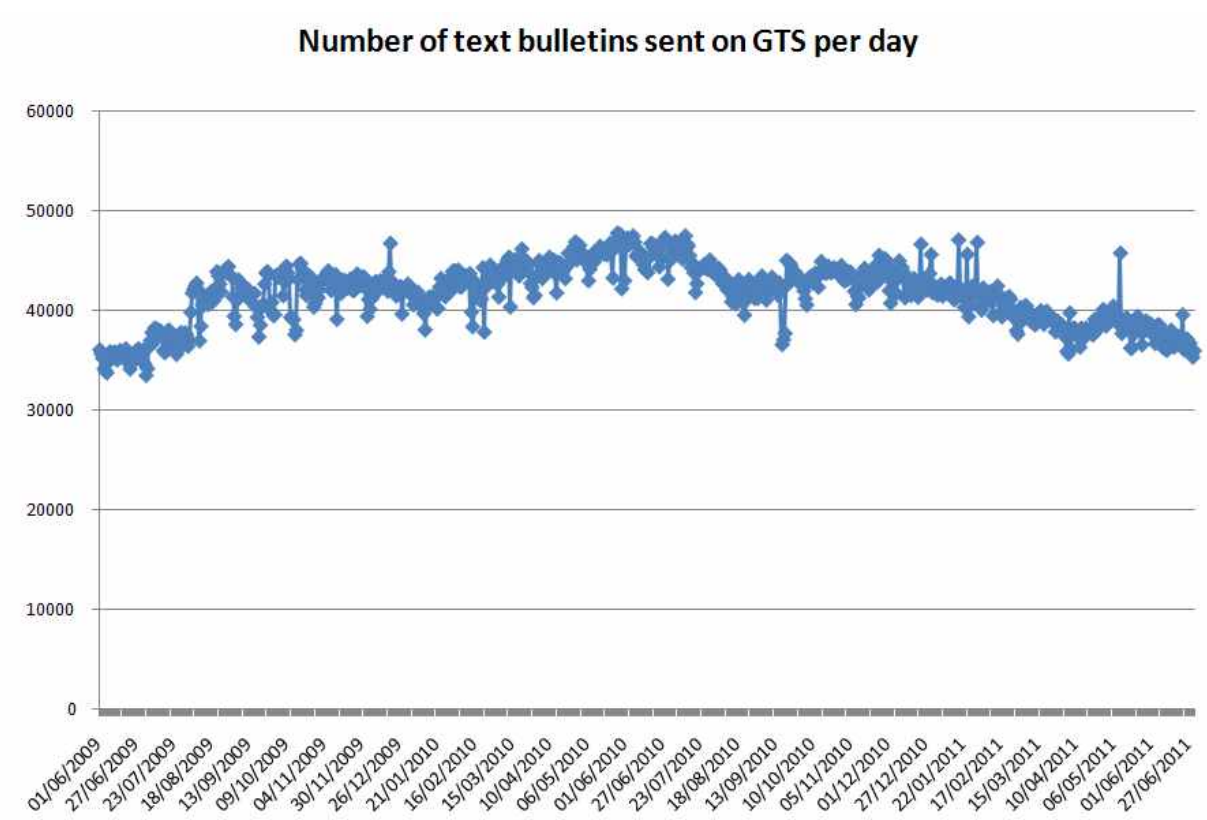


Figure 40: Number of GTS text bulletins produced by CLS per day

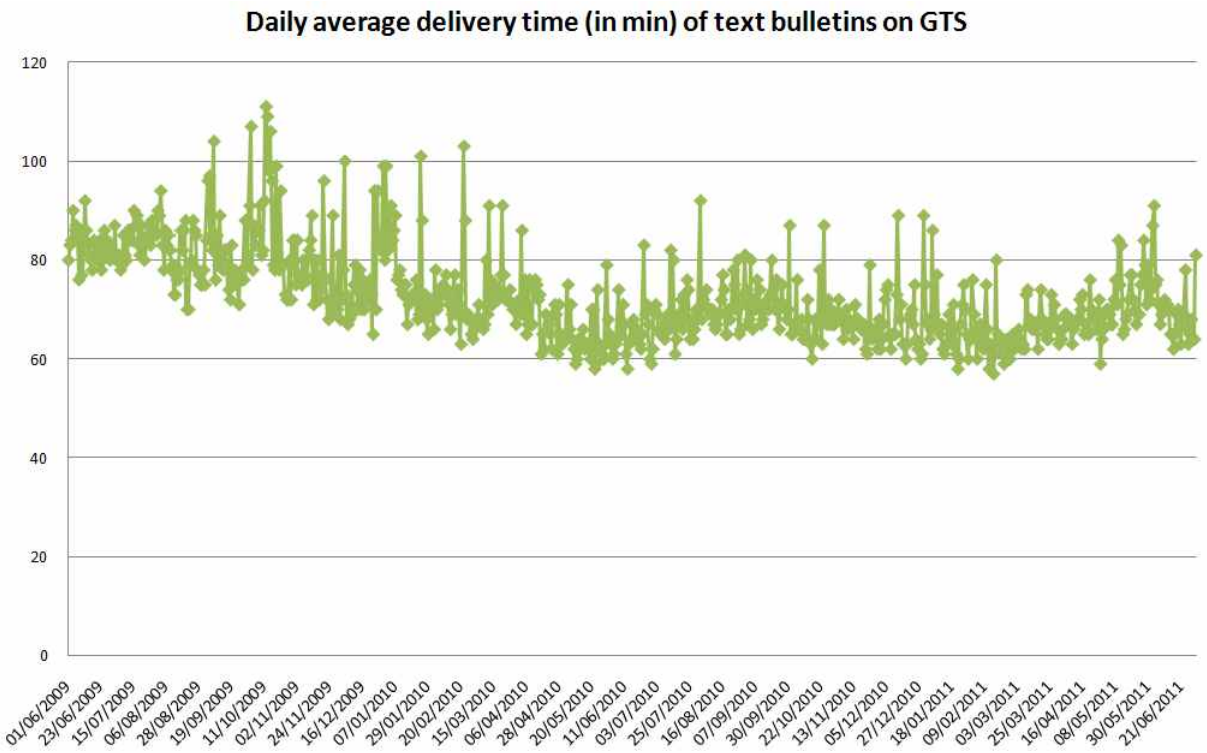


Figure 41: Daily average delivery time for all Argos GTS platforms processed by CLS

We can notice a return to the drifter network design size in 2011 with 1200 active drifters compared to the exceptional last year with as many as 1400 drifters operating in mid-2010.

2010-2011 GTS processing enhancements and operations at CLS:

- Upon a request from ET-OI (Expert Team on WIS-GTS Operation and Implementation) BUFR headers for buoys have been changed from IOZXiiLFVW to IOBXiiLFVW on 20 April 2011 at 12H00 UTC.
- Improvements have been made on the precision of the software module SAL_78 which computes salinity values with conductivity and sea temperature especially for BUFR. This work was made in collaboration with Dr. Iwao UEKI from JAMSTEC.
- GTS processing template for salinity drifters of ICM (Institut de Ciencies del Mar, Barcelona, Spain) have been implemented in 2011.
- BUFR coding for SYNOP observations is in course of validation. Deadline = end of 2011.
- CLS is working on the implementation of the latest BUFR version (V.4) in the Argos-GTS processing center. Deadline = end of 2011.
- New options in the CFG tool (allows PI to modify automatically GTS settings by emails and XML files) available before the end of 2011:

    - Bulletin headers (T1T2A1A2ii)
    - Drogue depth (ZdZdZd)
    - Drogue type (XtXt)

_____