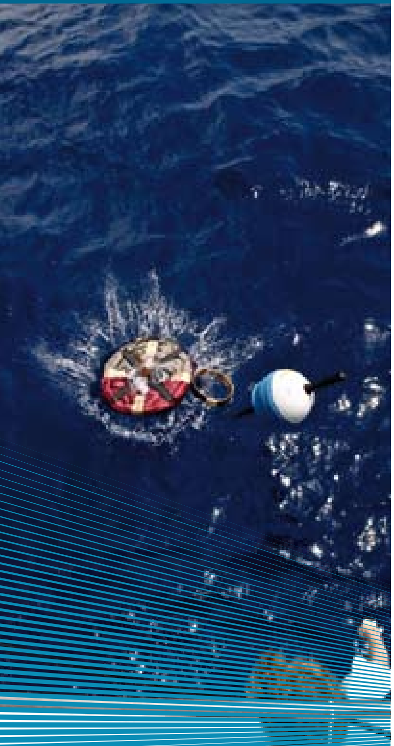
CLS
COLLECTE LOCALISATION SATELLITES

SPECIAL EDITION

SYSTEM

ARGOS LOCATION AT ITS BEST!

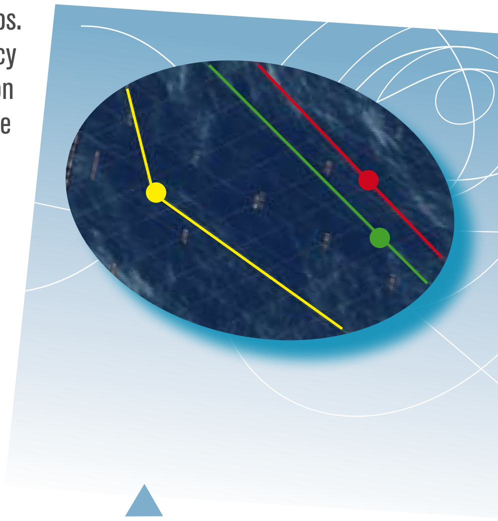


CLS has developed a new location processing algorithm for Argos. The new technique continues to measure the Doppler frequency shift while introducing two significant additions: the integration of platform dynamics and the use of a Kalman filter to calculate positions.

All Argos system users will now enjoy the following benefits:

- More positions,
- Better accuracy (an error estimate will be provided for all positions),
- Automatic correction or elimination of all unrealistic positions.

This new processing technique makes it possible to distribute up to 40% more positions and to improve accuracy by up to 65% while providing error estimates for each position, regardless of the number of messages received. These improvements are particularly significant for applications like animal tracking, where relatively few messages are received with each satellite pass.



Red: GPS fixes
Yellow: Argos locations using least squares analysis
Green: Argos positions using Kalman filter

Oceanographers or biologists, satellite tracking just got better!

Before ...

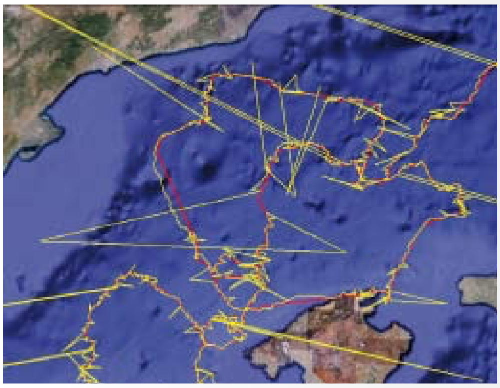
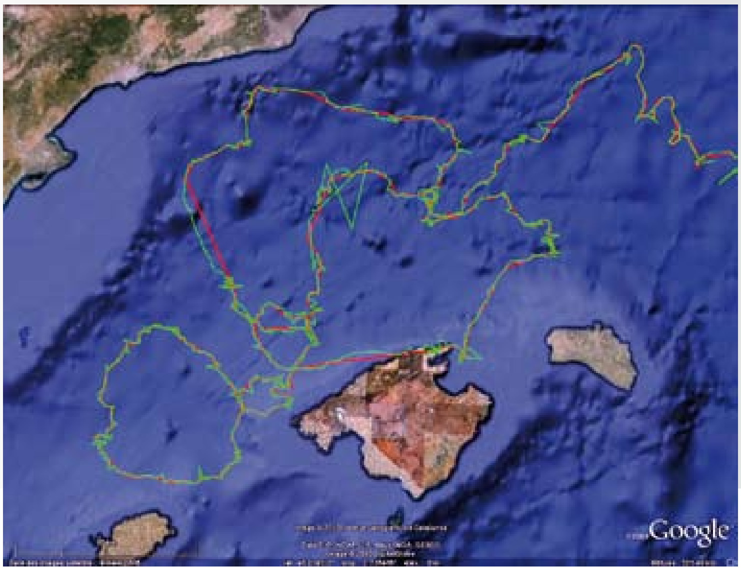


Figure 1 (left) A drifting buoy tracked for 6 months. The GPS tracks are in red, the Argos positions from the current processing system are in yellow.

... After

Figure 2 (right) In green, Argos positions are calculated using the new technique. These positions are much closer to GPS positions (in red). Unrealistic positions have been completely eliminated.



ARGOS FLASH SPECIAL EDITION

#19 09/2010

More positions, more accuracy…

More positions:

The processing system is now able to calculate positions using as few as one message per satellite pass. These positions are considered to be Class B. The median error for these positions varies between one and three kilometers, based on the platform type.
The number of positions we are able to distribute increases primarily due to the inclusion of these one-message positions. Also, previously discarded positions are also now considered to be valid by the new processing system's quality control.

More accuracy:

CLS measured positioning errors on several hundred Argos/GPS platforms, by comparing the Argos positions with the GPS fixes. For location classes 0,1,2,3 (at least four messages), the median errors* in positioning were reduced by nearly 20%. With two to three messages (Class A and B), the improvement in accuracy is even more noticeable since the positioning error has been reduced from 10% to 65% depending on the application. The improvement is thus particularly significant for applications where only a few messages are received per satellite pass.

Platform Type	4 messages or more	Less than 4 messages
Birds	1-3 %	50-85 %
Land animals	3-12 %	34-48 %
Marine animals	6%	56 %
Boats	1-3 %	40-47 %
Buoys	2%	47 %

Table 1 – Percent gain in the number of valid positions.

Platform Type	4 messages or more	2 or 3 messages
Birds	0 %	40-45 %
Land animals	2-6 %	60-65 %
Marine animals	10-15 %	10-50 %
Boats	15-20 %	40-50 %
Buoys	13 %	50 %

Table 2 – Percent reduction of median error. For example, a 50% reduction would mean that an observed error decreased from 1000 to 500 m.

These error measurements also demonstrated that the new technique is more robust when it comes to unrealistic positions: it corrects them by bringing them closer to the platform's trajectory or eliminates them completely. This means that the dispersion of positioning errors is now weaker.

Error estimations for all location classes:

Another of the new system's strong points is that it provides an error estimate regardless of the location class. Users working with Class A and B locations will now benefit from additional information regarding their accuracy and can thus compare these positions with those of Class 0,1,2,3.

*The median is the value that would divide a sample of numerically-ordered observed errors into two equal parts. Therefore, the median is the value below which 50 % of errors are situated. The median error is similar to the mean positioning error, but the latter is very sensitive to the presence of extreme values. From this point of view, the median is a more reliable value.

A FULLY TESTED TECHNIQUE

The new location processing has been subject to intensive operational testing for all Argos applications (animal tracking, buoys, floats, boats…). The tests were designed to gather comparative data between Argos and GPS positions for Argos platforms equipped with GPS receivers.

To date, several hundred platforms and 112,000 Argos positions have been tested to compare the two processing systems and determine positioning errors. This extensive comparison between Argos positions and GPS fixes (serving as reference) has demonstrated what the new algorithm can do and has generated the confidence needed to make this new service operational.

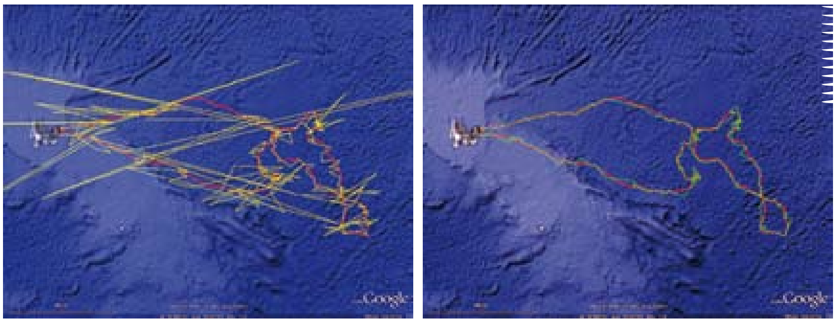
CLS extends a great deal of thanks to the users who kindly authorized access to their data so the new method could be qualified. Their generosity has made it possible for the entire community of Argos users to benefit from these positioning improvements.

Satellite tracking at its best…

Examples of new processing

▪ Elephant seal tracking…

With merely 2 messages per satellite pass on average, this marine mammal provides mainly Class A and B positions. The Argos track calculated by the new system no longer includes unrealistic positions.



Red: GPS fixes
Yellow: Argos locations using least squares analysis
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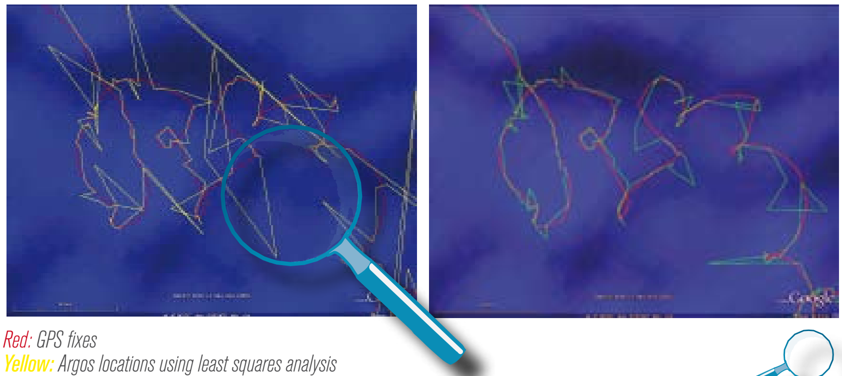
Data courtesy of Christophe Guinet CEBC-CNRS.

▪ Buoy tracking…

A close-up (a few kilometers) of a buoy tracked for 6 months.



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Yellow: Argos locations using least squares analysis
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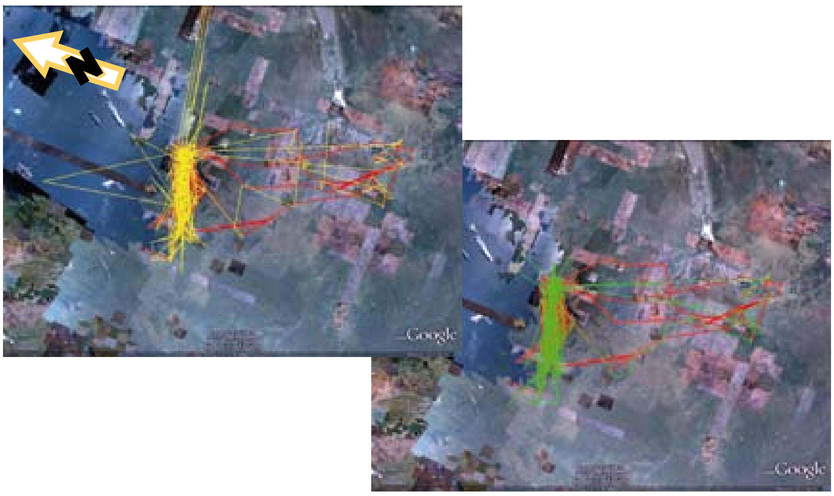
▪ Marabou stork (*Leptoptilos crumeniferus*) tracking

This marabou stork was tracked near Lake Victoria. The track in yellow was produced using a least squares analysis. The green track was obtained with the new algorithm. Unrealistic positions were automatically eliminated or corrected. This track is more realistic on a small scale and better represents the animal's movements.



Data courtesy of Neil Baker.

FAQ FLASH

How will the new processing change my data?

The new processing has been designed to have a minimal impact on user interfaces:

- *One message positions will be distributed as Class B locations,*
- *Error estimates for Class A and B will be available via both ArgosWeb and ArgosDirect,*
- *The position coordinates will be recopied in the field that previously held Solution 2 (second calculated solution or mirror image solution) in DIAG or PRV/A formats.*

What must I do to benefit?

The improvements described in this Flash will be automatically applied to all platforms. The positions will be distributed in the same format via your usual data distribution channel.

How can I optimize positioning performance?

The new algorithm is particularly effective if the maximum speed of the platform is realistic, because this value is used in the movement model and also by quality controls. For each application category, CLS will apply a maximum speed by default. Testing has proven that the default values work for all applications.

Nevertheless, we recommend that users verify this value by checking their Platform details on ArgosWeb. To do so, select Settings/Platform in the menu then click on a specific platform number. The maximum speed attributed to the platform is listed as Maximum speed. If the value does not correspond to your platform, you can easily modify this information on line. You can also contact the User Office for help.

Warning: The maximum speed is a key element when it comes to calculating Argos positions. Be careful to avoid typos or other errors when entering this value.

Can I still access my location data from the old location processing system?

No. The new algorithm permanently replaces the preceding one in the Argos processing system.

What can I do if my tracks contain anomalies?

If you notice problems, these could come from the platform parameters entered in our system. Verify the platform type to be sure the maximum speed we apply by default is realistic for your application. Furthermore, make sure that the initial position entered for your platform is correct. Please contact the User Office if the problem continues.

FOR MORE FAQ, VISIT OUR WEBSITE AT / POUR PLUS DE RENSEIGNEMENTS CONSULTER
www.argos-system.org/html/system/faq_en.html

Focus: how it works

A movement model for all platforms

The dynamics of a platform tracked using the Argos system is essentially unknown: from its previous position, a platform can move in any direction and the distance likely covered increases with time. A "random walk" mathematical model is the most appropriate method for taking this into account (Rudnick, et al., 2004). The model's job is to predict the next position and its error based on previously calculated positions:

- Knowing that the platform can move almost anywhere since its previous position, it is best to consider that the platform has "on average" not moved at all. In other words, that the next position is equal to the previous position.
- Since distance increases with time, uncertainty about the location or about the error estimation also increases from the last position.

The rate at which the uncertainty surrounding the predicted location increases is a function of the maximum speed of the platform. The higher the maximum speed is, the faster the uncertainty grows. Please note that a maximum speed for each application is already used in quality controls by the Argos system (CLS, 2010).

Random walk is the most robust model for mobile tracking, because a minimal hypothesis about platform behavior is made. Coherent tracks are produced since dynamics are taken into account, making it possible to accumulate information on past positions, whether or not they come from the same satellite. To sum it up, the new technique is similar to the multi-satellite location process.

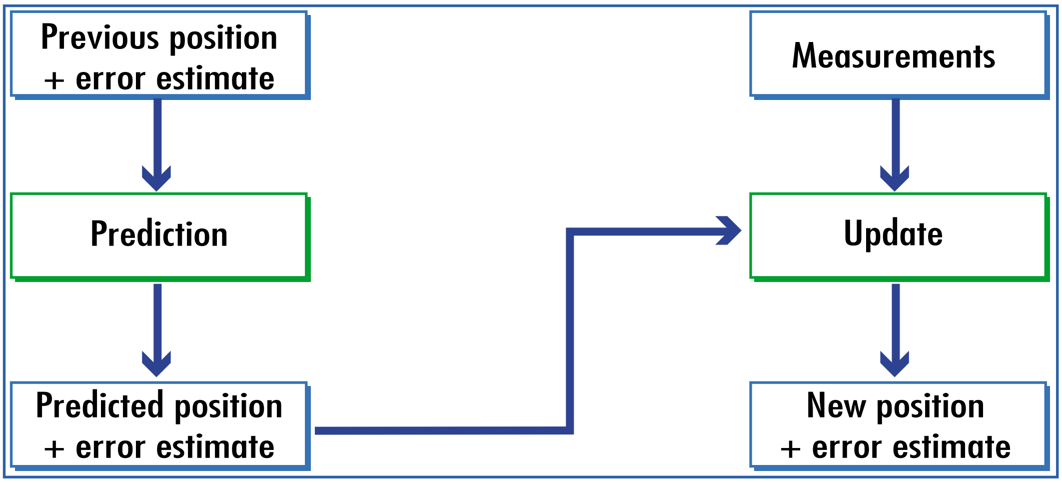
A positioning algorithm based on Kalman filters

With a least squares analysis (method used until now to estimate platform positions and transmission frequency), at least four messages must be received per satellite pass to produce an error estimate. Furthermore, at least two messages must be received per satellite pass to produce a position. The Kalman filter is a flexible and robust method that overcomes these limitations by taking into account platform dynamics. Kalman filters have proven to be particularly useful when it comes to tracking mobiles, and major improvements have occurred since the method was developed in the 1960s (Julier, et al., 1997) (Van Der Merwe, et al., 2001a).

Kalman filtering is a 2-step process:

- The filter predicts the next position and its estimated error based on the previous position and its estimated error, using a random walk model,
- The filter calculates the new position and its estimated error by updating the predicted position using frequency measurements acquired during the satellite pass.

The update can be made regardless of the number of messages received, and therefore, one-message positions can be calculated. In addition, the error estimate is an integral part of the algorithm and therefore systematically distributed to all users.



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