

Operational Use of Ocean Surface Drifters for Tracking Spilled Oil

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Abstract

During several field trials over the past few years, Argosphere ocean surface drifters have proved to drift with the thicker parts of oil slicks for up to several days. With GPS navigators integrated in Argos buoys, the positioning accuracy is improved, and tracking can be carried out in near real-time by direct communication between the buoys and oil spill response vessels.

A tracking system has been prepared, and was tested during the Norwegian Clean Seas Association (NOFO) oil-on-water exercise in the North Sea in June 1996. The system consists of several GPS-positioned Argos drift trackers, an Argos receiver, a GPS navigator for the ship's position, and a personal computer with software for logging and displaying positions.

The conclusions from the field trials are positive, suggesting that GPS-positioned Argos buoys are well suited for tracking the general position of an oil slick.

1. Introduction

For a number of years, SINTEF has used Argos-positioned buoys in many applications. During several experimental oil spills, Argosphere buoys, supplied by the U.S. Minerals Management Service (USMMS), have been used. The experience from these experiments is that in open water, this type of buoy has drift properties which are very similar to those of the thicker parts of an oil spill (Reed and Turner, 1994).

The advantage of the Argos system is that relatively small platforms (called PTTs) can be tracked world-wide over long periods of time (months or years) by the satellite-based Argos platforms which calculate the buoy positions and relay the information to earth stations. Small quantities of user-defined data can be transferred as part of the Argos signal from the buoy. However, the Argos system has some limitations, such as position accuracy (at best within 200 meters), long update intervals (in the North Sea satellite passes are about 1 hour apart), and a typical processing time of about 2 hours from a satellite pass until the user can receive the data from the ground station in Toulouse, France.

Recently, several manufacturers have integrated GPS navigators in their Argos buoys such that GPS positions are transmitted in the user-defined part of the Argos signal. In this way, the accuracy of the buoy position is improved and can be obtained more or less instantly if a receiver for Argos signals is within the horizon from the buoy. Dedicated receivers for such signals are off-the-shelf equipment.

The drift trackers are expected to be useful both during exercises and during real spill situations. The GPS navigator in the buoy provides quick and accurate platform positions. By using the Argos satellite system, it is also possible to track

and locate the buoys in cases where they drift outside the range of direct signal transmission between the buoys and the ship. The system is shown schematically in Figure 1.

The GPS-positioned Argos buoys transmit a signal every 90 seconds. If the most recent GPS position is always transmitted with the Argos signal, the buoy position is updated every 90 seconds. If the background and tidal current components are known for the actual area of operation, a ship captain will have enough information to estimate the buoy drift direction and speed to be able to position oil recovery units. Additional buoys could be attached to each recovery unit. In this way, a computer display would show both the drifting oil and the recovery units in the same plot, providing a radar-like image showing relative range and bearing.

The buoys would be useful for monitoring oil spills during a real spill situation. One or more buoys could be deployed in the slick to make it easier to monitor the position of the spill during low visibility operations or to approach the spill at a later time. Here the Argos system is important since a buoy can be tracked by the Argos platforms located in polar orbiting satellites.

This project (Jensen et al, 1996) has been carried out by SINTEF in co-operation with the Norwegian Clean Seas Association (NOFO), the Norwegian Pollution Control Authority (SFT) and the U.S. Minerals Management Service. The testing in the field was performed in the North Sea during the NOFO oil-on-water exercise in June 1996.

2. System Components

The main components of the oil slick tracking system are:

- a personal computer with logging and presentation software, connected to
 - a GPS navigator (for the ship's position)
 - an Argos receiver; and
- one or more ocean surface drifters each containing a GPS navigator and an Argos transmitter.

Positions from a GPS navigator installed in each drift tracker are stored in the ARGOS message record at preset intervals. The update interval can be set at any rate down to 1 minute, but testing prior to the sea trial showed that the interval had to be at least 10 minutes to get a stable buoy performance. This is probably associated with the start-up and shut-down procedures of the GPS navigator in the buoy. The ARGOS signals from one or more buoys are picked up by a ship-born ARGOS receiver interfaced to the computer. To obtain range and bearing between the ship and the buoy(s), a ship-born GPS navigator is interfaced to the same computer. Alternatively, a spare drift tracker can be started and located on board the ship with direct view to the ARGOS receiver antenna.

The logging software reads and decodes the ARGOS signals from the buoys, as well as from the ship-born GPS navigator, and stores the data in files. These files are read by the presentation software and the information displayed on the computer screen.

The GPS-positioned drift trackers used in this project have been developed for long term use. Hence a considerable effort has been put into reducing the battery consumption to a minimum while optimizing the tracking capability in terms of

coverage in time. Buoys of this type are produced by Clearwater Instrumentation in Massachusetts, and Technocean in Coral Gables, Florida.

The software comprises 3 separate computer programs running simultaneously. One program displays the buoy position on a map on the computer screen. The other two programs log, decode and store data in files. One of the computer's COM ports (standard RS-232 communications port) is interfaced to the Argos receiver for signal transfer from the buoys to the computer. The second COM port is connected to a hand-held GPS navigator for logging the ship's position.

The buoy data from the logging program are stored in ASCII files, one file for each buoy, and one file for the hand-held GPS. These ASCII files contain the most recent buoy position and the associated time.

At selected intervals, the display program checks every ASCII file for new positions. In case one or more buoys have new position updates, the computer display is refreshed with the new positions included.

The software for this application was developed for a personal computer running the Windows NT operating system. To receive the Argos signals, an Argos receiver from JOTRON Electronics, Norway, was used (Tron DEC, 401 MHz). The receiver was interfaced to the computer via a COM port. To get the ship position, a GARMIN 45 GPS navigator was used, connected to a second COM port on the computer.

3. Operational Test

3.1 Description of the Field Experiment

During the 1996 field experiments (Brandvik, 1996), the buoy tracking system was put to operational use on a demonstration basis. The experiment consisted of three releases of oil over two days.

On the first day, two slicks of 15 m³ each (called Charlie and Hotel) were released. Two buoys, one GPS/ARGOS and one Argosphere, were released in each slick and tracked for several hours. The positions of the buoys relative to the oil slicks, were logged by work-boats operating in the slicks.

On the second day, a subsurface release of 40 m³ (called Uniform) was performed. Two pairs of buoys (GPS/ARGOS and Argosphere), a total of 4 buoys, were released in the slick and tracked for approximately 10 hours.

3.2 Test Results

The location data received from the buoys used in the field experiment, as described in the previous section, were assembled in files by the logging program. Figures 3 and 4 show the trajectories of the buoys for the first and second day of the field experiment, respectively. This is called the track (or map) mode of operation where absolute positions are shown. The other mode of operation, the radar mode, is demonstrated in Figure 5, which shows the positions of the Charlie and Hotel slicks at the current time, relative to the main vessel, Gullbas. The figures demonstrate the two modes of operation available in the system. To obtain an indication of the relative drift track in the radar mode of operation, several of the most recent positions can be displayed.

On the first day of operation, the signals from the buoys were lost when exceeding a range of about 3 nautical miles.

The GPS-positioned Argos buoys used in this project had different size, shape and weight compared to the Argosphere drifters used by SINTEF in previous experimental spills. The additional draft of the GPS/Argos buoys (see Figure 2) will reduce the wind drift and thereby make these buoys drift slower compared to the slick and the Argosphere buoys. To check this, an Argosphere buoy was always deployed together with each GPS/Argos buoy. The work-boats reported that GPS/Argos buoys consistently drifted slower than the slick and the Argosphere buoys. In other words, the size, shape and weight of the Argosphere buoy should be adopted, to ensure that the buoys will have the same drift properties as the thicker parts of the slick, as verified in previous experiments (Reed and Turner, 1994).

4. Conclusions and Recommendations

4.1 Conclusions

- During the testing, the system worked as expected without problems.
- The range of the direct transmission of signals from the buoys to the ship was about 3 nautical miles. The range is a function of the antenna height.
- The accuracy of the relative positioning between the buoy GPS and the ship-born GPS navigator was similar to the absolute positioning of single buoys.
- The test buoys carrying the GPS equipment in addition to Argos did not follow the drift pattern of the thicker parts of the oil slicks. This problem can be solved by adopting the shape, size and weight of the Argosphere buoys.

4.2 Recommendations

For tactical use of the buoys we recommend the following:

- The system will function with only one drift tracker, but as a redundancy we recommend two buoys as a minimum (in case of problems like low batteries, malfunction, damage or loss).
- For the application of tracking oil slicks, the buoy specifications should be modified to match those of the Argosphere buoy:
 - electronics, antennas and batteries should be built into a spherical float to get the correct drift properties (~30 cm diameter, 4.5 kg total mass).
 - the GPS navigator should operate continuously to supply new position updates for every Argos signal transmission.
 - lithium cells should be used to increase battery capacity.

5. References

Brandvik, P.J., *Description of the oil release, expected oil weathering, dispersant application and monitoring activities for the NOFO 1996 field trial, June 10 - 13.*- Project memo as input to NOFO's Operational plan for the exercise. 38 p. 1996.

Jensen, H., Løvås, S.M., Aamo, O.M., *Operational Use of Drift Trackers.* SINTEF Report No. STF22 F96231. 1996.

Reed, M., C. Turner, A., *The Role of Wind and Emulsification in Modelling Oil Spill and Surface Drifter Trajectories.* Spill Science & Technology Bulletin, Vol. 1, No. 2, pp.143-157. Elsevier ScienceLtd. 1994.

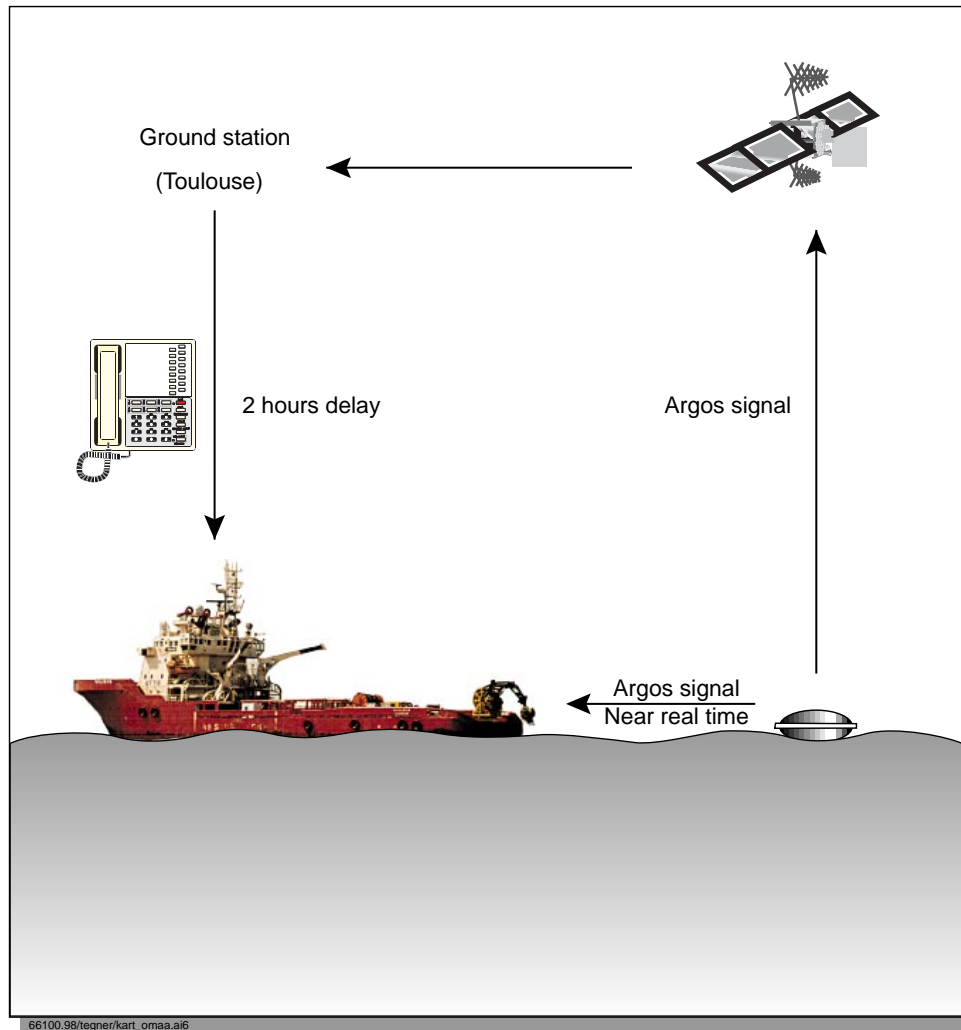


Figure 1 Schematic overview of the oil spill tracking system.

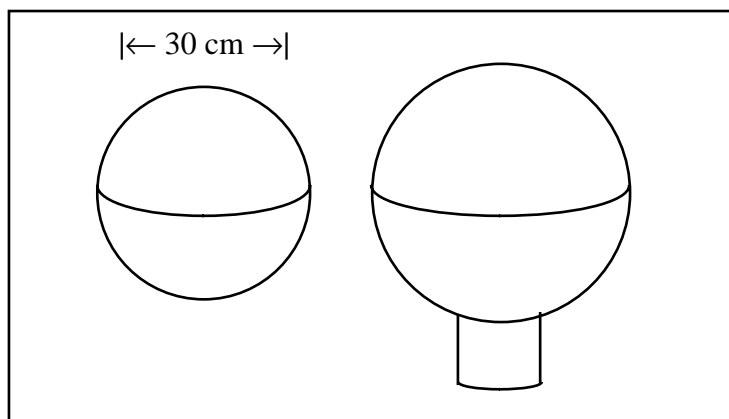


Figure 2 Shape and relative size of Argosphere (left) and GPS/Argos (right) buoys.

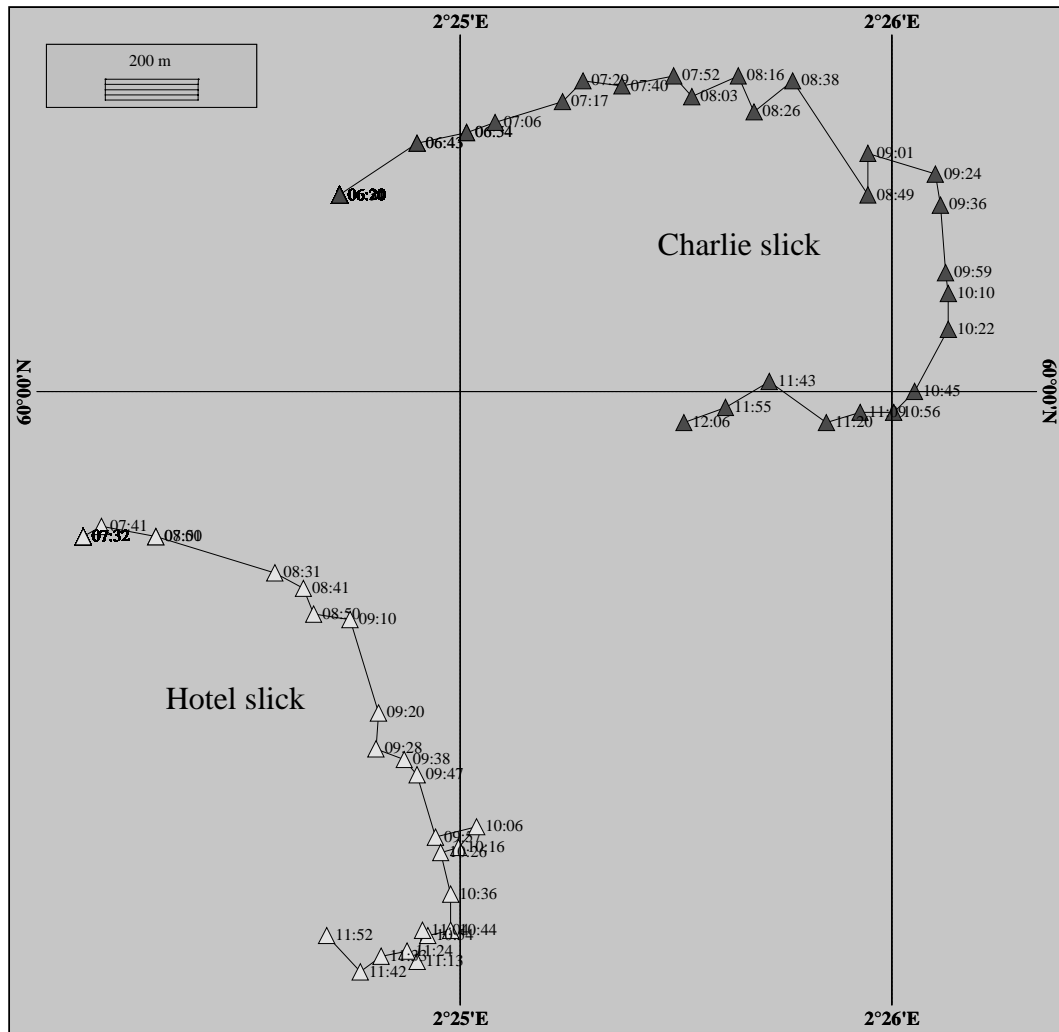


Figure 3 Trajectories for the two GPS/ARGOS buoys deployed the first day of the field experiment.

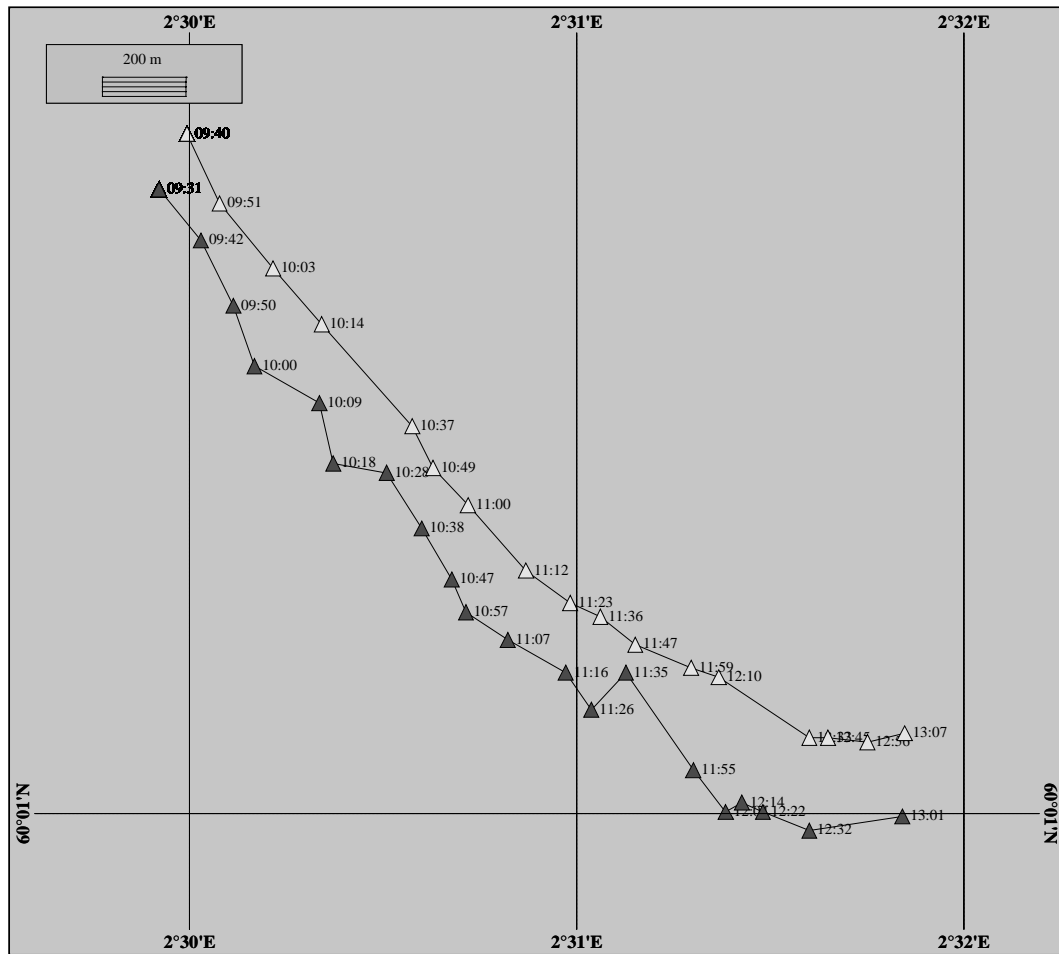


Figure 4 Trajectories for the two GPS/ARGOS buoys deployed the second day of the field experiment.

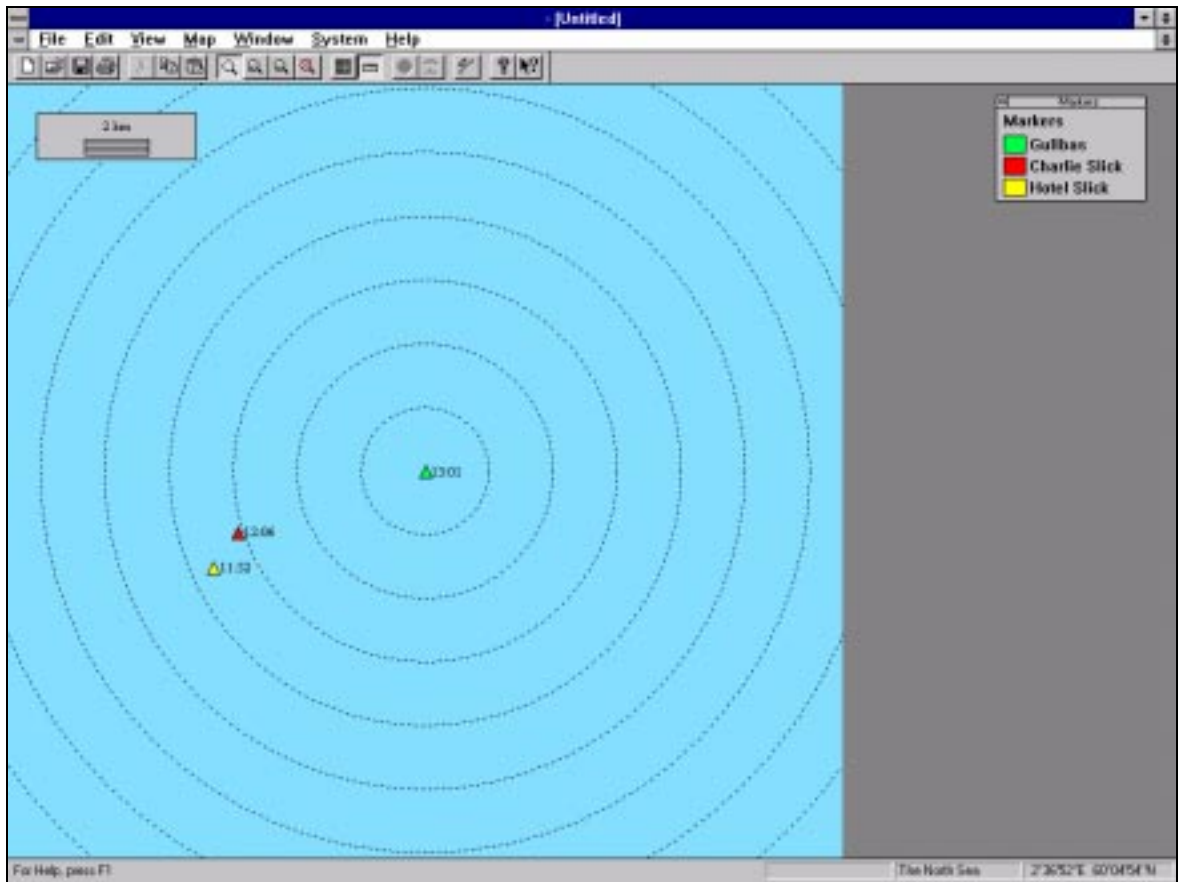


Figure 5 Display of the buoy tracking system in radar mode, showing only the last position of the buoys relative to the oil spill response vessel (Gullbas).