BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

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Determination of the Search Zone for Phase 3 of the Sea Search Operations for the Airbus A330, Flight AF447

This note is a summary of the report from the working group which presents the work carried out on estimating the position of the wreckage of the airplane before beginning of phase 3. It does not take into account any information acquired during this search phase.

On Sunday 31 May 2009, the Airbus A330-203, flight AF447, took off from Rio de Janeiro Galeão Airport bound for Paris Charles de Gaulle. At 2 h 10 UTC, a position message and some maintenance messages were transmitted by the ACARS automatic system. The last known position of the aircraft was 2° 58.8' North and 30° 35.4' West. From 6 June 2009, some bodies and airplane parts were recovered by the Brazilian and French navies[1].

[1] See Interim Reports n°1 and n°2.

During the first phase, scientists were brought together in the context of a "Drift Committee" working group. The objective was to estimate a search zone based on calculations of the drift of the bodies and airplane parts that had been recovered. The use of the operational tools then available did not make it possible to define a limited search area. The first results based on the various oceanic and atmospheric models were not convergent, with errors of the order of one hundred kilometres after five days. These differences can be explained by the location of the accident being in an area that was difficult to model and to constrain, due to the lack of observations then available and to the difficulty for operational ocean models to reproduce on small scales. Further, there was a delay of five days between the last message sent by the airplane and the recovery of the first debris.

To prepare phase 3 of the sea searches, the BEA formed a new working group, enlarged by international partners, in order to identify the possibility of improving the reverse drift calculations. It was made up of representatives from the following scientific organisations: CNRS/Brest, University of Massachusetts/Dartmouth, INMRAS/Moscow, Mercator Océan/Toulouse, CLS/Toulouse, WHOI/ Woods Hole, IMT/Toulouse, SHOM/Brest, NOC/ Southampton, IFREMER/Brest and Météo-France/Toulouse.

The work of the group resulted in the definition of a limited search zone. The future report prepared by Michel Ollitrault from IFREMER will present the work undertaken by the whole group.

The first part of this report will be devoted to presenting the data used. The members of the working group were able to collect other observations, including the trajectories of several buoys on a zone near the last known position of the airplane, in the days that followed the accident. The compatibility of the various observations was checked.

The second and third parts of the report will be devoted to the methods used and their validation in the zone under study, mainly by comparison with the observations.

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The first method, called "objective analysis" consisted of calculating the surface current field by linear combination of the observed velocities of the drifting buoys. With the surface current field estimated several times a day, the reverse drift calculations for various bodies and airplane parts were undertaken. The error induced by imperfect knowledge of the current field was estimated.

The second method consisted of using different numerical ocean models with or without assimilation of the observations (such as temperature, salinity and currents). Similarly, various calculations of reverse drift were performed and the error for each model, in the zone studied, was estimated.

The influence of the wind on the surfaced drifting elements from the airplane was preponderant in the reproduction of their movements.

The fourth part of the report defines the search zone (see chart below).

In the light of the results obtained and using the weighting given to each of the approaches selected, a search zone was defined based on the statistics. To do this, six particles judged as being the most representative[2] were used for the reverse drift calculations. For each model or analysis, the mean of the estimated positions of these particles, on 1st June at 2 h 10 UTC, was kept. Subsequently, by using the estimated error of each method after five days, an area of high probability was determined[3].

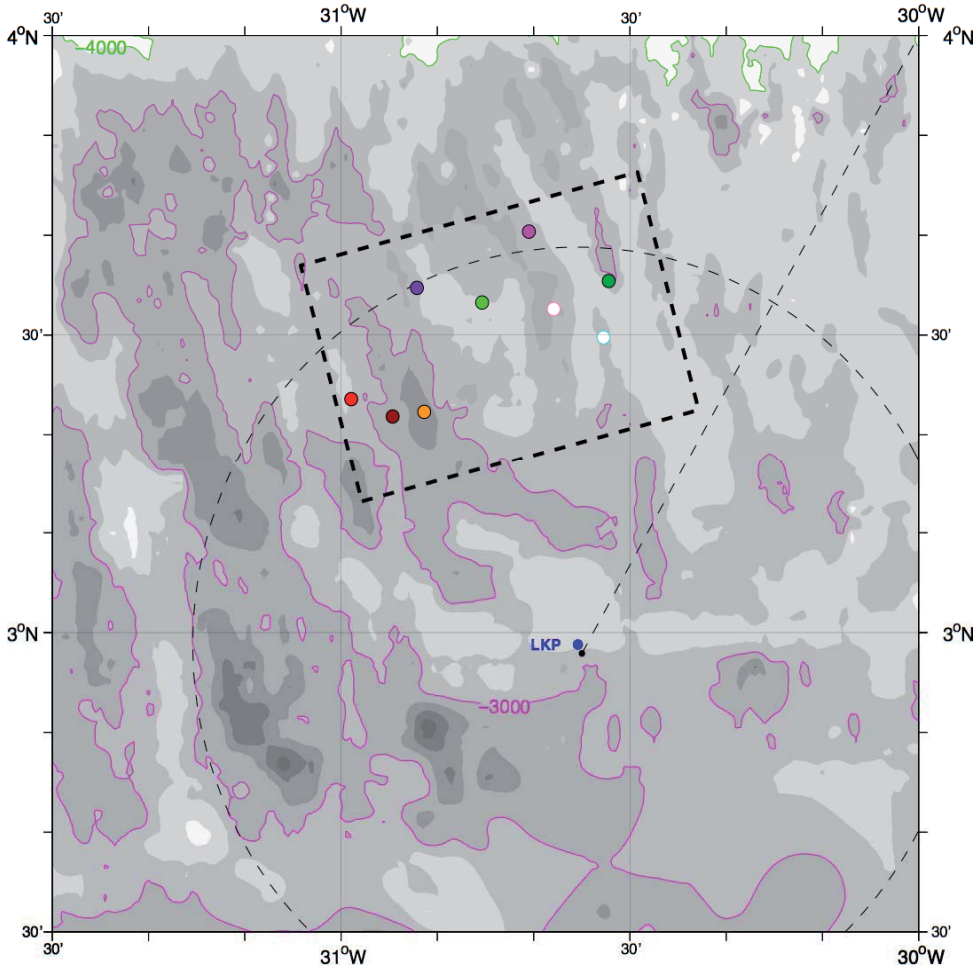
This zone was used by the BEA as the initial search zone.

[2]The representativeness of the particles is based on a knowledge of wind drag to as well as their date of recovery or observation.

[3]This zone corresponds to a statistically defined region and is based on reverse drift calculations of the selected models.

The following individuals participated in the "Drift Committee" working group:

- Bruno BLANKE – Centre National de la Recherche Scientifique (CNRS) / Brest
- Changsheng CHEN – University of Massachusetts / Dartmouth (USA)
- Nicolai DIANSKY – Institute of Numerical Mathematics - Russian Academy of Sciences (INM-RAS) / Moscow (Russia)
- Marie DREVILLON – Mercator-Océan / Toulouse
- Eric GREINER – Collecte Localisation Satellites (CLS) / Toulouse
- Fabien LEFEVRE – Collecte Localisation Satellites (CLS) / Toulouse
- Richard LIMEBURNER – Woods Hole Oceanographic Institution (WHOI) / Woods Hole (USA)
- Pascal LEZAUD – Institut de Mathématiques de Toulouse (IMT) / Toulouse
- Stéphanie LOUAZEL – Service Hydrographique et Océanographique de la Marine (SHOM) / Brest
- George NURSER – National Oceanography Centre (NOC) / Southampton (UK)
- Michel OLLITRAULT – Institut Français de Recherches pour l'Exploitation de la Mer (IFREMER) / Brest
- Denis PARADIS – Météo-France/ Toulouse
- Robert SCOTT – National Oceanography Centre (NOC) / Southampton (UK)



Search Zone Proposed

The points shown give the estimated mean positions on 1st June at 2 h 15 UTC of the six selected particles, for each model.

- ❒ In red, the PSY2AVG model, with an adjustment to the buoys' trajectories
- ❒ In brown, the FVCOM model that assimilates the speeds of the drift buoys
- ❒ In orange, the FVCOMW model that includes the interactions with the waves
- ❒ In violet, the ZOOM2 model with no assimilation but with improved physics
- ❒ In magenta, the same model, to which the drift due to waves was added
- ❒ In green, the objective analysis OI50, and in dark green the objective analysis OI85
- ❒ In pink, the objective analysis OI75 (illustrating the consistency, but not used here)
- ❒ In sky blue, the INMOM model (not used here, but also consistent)