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Locating HMAS Sydney by back-tracking the drift of two life rafts

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1. INTRODUCTION

Several items from HSK *Kormoran* and HMAS *Sydney* were found in the days following the battle, and several attempts have been made in the past to use this information to arrive at an estimate of the location of the battle. To review all that information is beyond the scope of this report. Instead, we focus on the first two items found following the battle: the German life raft recovered by the Australian Troop ship HT *Aquitania* at 0630 23/11/1941 in position 24º 35’S 110º 57’E – hereafter ‘raft A’, and the German life raft recovered by the tanker MV *Trocas* at 1500 24/11/1941 in position 24º 6’S 111º 40’E – hereafter ‘raft T’.

Assuming the rafts abandoned HSK *Kormoran* at 1900 19/11/1941, they were adrift for 82h and 115h respectively. With no paddles and just shirts for sails, we can assume that the rafts drifted essentially downwind and with the currents. Van Burgel and Elliott (2008) have re-analysed the meteorological observations for the period the rafts were adrift, confirming earlier estimates that the wind was predominantly from the SSE. No oceanographic observations, however, are available so a precise reanalysis cannot be done for the ocean currents. Instead, we are obliged to rely on modern observations of the ocean currents of the region, and computer simulation to estimate the most likely location of the battle site by ‘back-tracking’ the drift of the rafts from where they were located, to where they would have been at a certain time previously, given an ensemble of likely estimates of the rafts’ velocity in the intervening time.

2. METHOD

An item at sea drifts at a velocity that is the sum of the velocity of the water (the ‘current’), and the velocity of the item with respect to the water (the ‘leeway’, in the case of an object simply drifting downwind). The current velocity, in turn, can be thought of as the sum of the tides, the surface layer wind-drift, and other features such as, on the west coast of Australia, the Leeuwin Current and its eddies.

For this study, we are advised (Art Allan, pers. comm, 2008 via D. Mearns) to estimate the leeway of the *Kormoran’s* heavily-laden rubber rafts as being 3% of the wind velocity. The rafts were drifting in deep water where tidal currents are negligible, so we will not consider the purely oscillatory motions due to tides. For the surface wind-drift, we have estimated this to also be 3% of the wind, following standard practice. Thus, two components of the total drift velocity can be estimated directly from the 1941 winds. For the period that raft A was adrift, these sum to 0.5m/s (1kt) along 345ºT, or 82nm over the 82h period.

The remaining component of the total velocity, however, cannot be estimated for 1941 because we know, from studies of the Leeuwin Current and its eddies using modern techniques (Griffin *et al.* 2001), that the variability due to random instabilities of the current is so great that satellite data for the period in question is required in order to estimate the current with any confidence.

Our most advanced technique for estimating this 'eddy velocity' is the one developed for the Bluelink project for the purposes of historical re-analyses, and routine forecasting, of ocean currents at high (10km) resolution in the Australasian region. The system relies on access to precise observations of sea level, which are only available (away from land) from 1992 onwards, when a series of satellites (the European Space Agency's ERS1&2 and Envisat, the NASA/CNES missions Topex/Poseidon and Jason, and the US Navy's GeoSat Follow-On) carrying accurate altimeters have been operating. The design and performance of the model are described by Oke *et al.* (2008), and Schiller *et al.* (2008).

The period spanned by the Bluelink ReANalysis (version 2.1) dataset is 1992-2006, providing estimates for the currents during 15 consecutive Novembers. Taking just the latter halves of these 15 months provides an ensemble of 225 essentially equally-probable scenarios of what the daily-averaged eddy currents might have been in late November 1941. To further increase the size of this ensemble (to 300), we have also used the velocity fields of the Bluelink ocean model run without data assimilation, for a selection of years (1993-1997) during which coastal sea level was generally below average, as it was in 1941, according to Steedman and McCormack (1991). Low sea level is an indicator of the Leeuwin Current being less strong than average.

The Bluelink model includes the effect of the wind as estimated, at 6h intervals, by the ECMWF ERA40 atmospheric reanalysis. But since we have already estimated the surface wind drift of the rafts based on estimates of the 1941 wind, we must avoid also including the effect of the modern wind in our estimate of the effect of current. To do this we have simply sampled the model flow field at 25m depth. The only alternative to this would have been to re-run the model many times (to generate an ensemble of eddy fields) with an estimate of the global wind field for 1941.

In addition to back-tracking the rafts' positions for these 300 scenarios, we also made forward-track estimates of the two rafts from the position of the battle - 26º 34'S, 111ºE, given by Theodore Detmers, captain of HSK *Kormoran*, for the intervals of time until each raft was located.

The 300 flow fields vary considerably, yielding a diverse array of simulated trajectories. For example, the flow fields on 20 November 1997 (Figure 1) and 22 November 1996 (Figure 2) are qualitatively similar in that the Leeuwin Current in both cases is flowing southward along the shelf edge, with warm offshoots separated by a cold, cyclonic (clockwise rotating) region. The details, however, are sufficiently different that the back-calculated launch points of the rafts differ by 45nm.

To arrive at an estimate of the most likely site of the battle, while also providing some indication of the uncertainty of this estimate due to the randomness of eddies, the average back-calculated launch point, for each November, was computed.

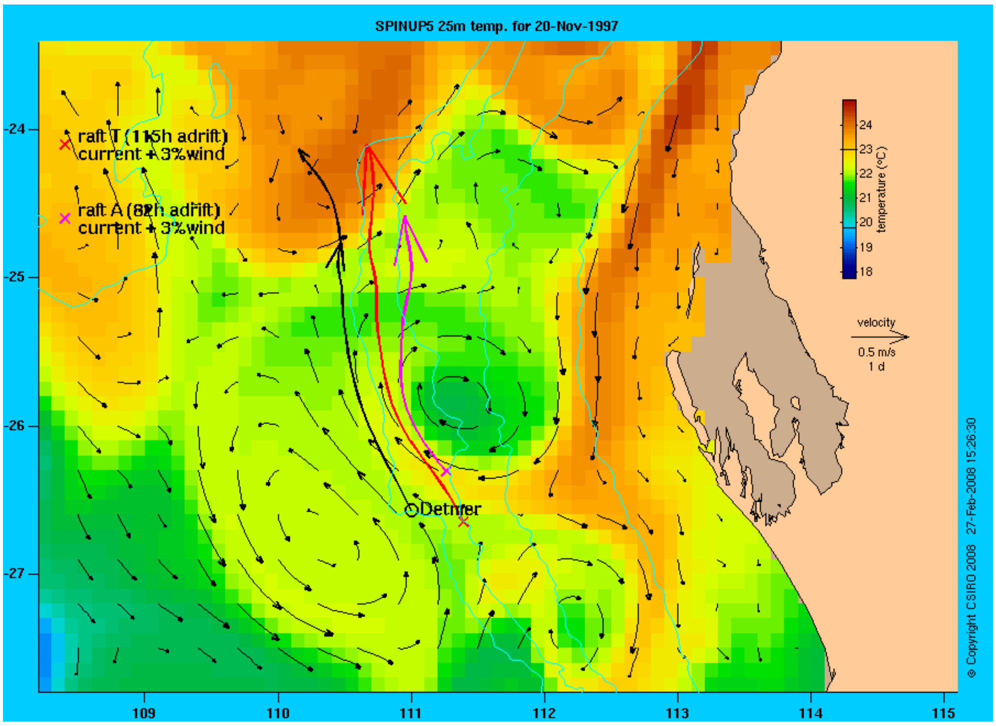

Figure 1 Trajectories of rafts T (red) and A (magenta) back-tracked from where they were found (arrow heads) to where they would have been 115 and 82h earlier (crosses), had the ocean current been what it was on 20 Nov 1997, and the wind been what van Burgel and Elliott (2008) estimated it to be in 1941. The black line shows the trajectories of rafts tracked forwards from Detmers' position, for the same two intervals of time. The colour background shows the temperature of the ocean as simulated by the model, while the black vectors show the current velocity field used for the trajectory calculations.

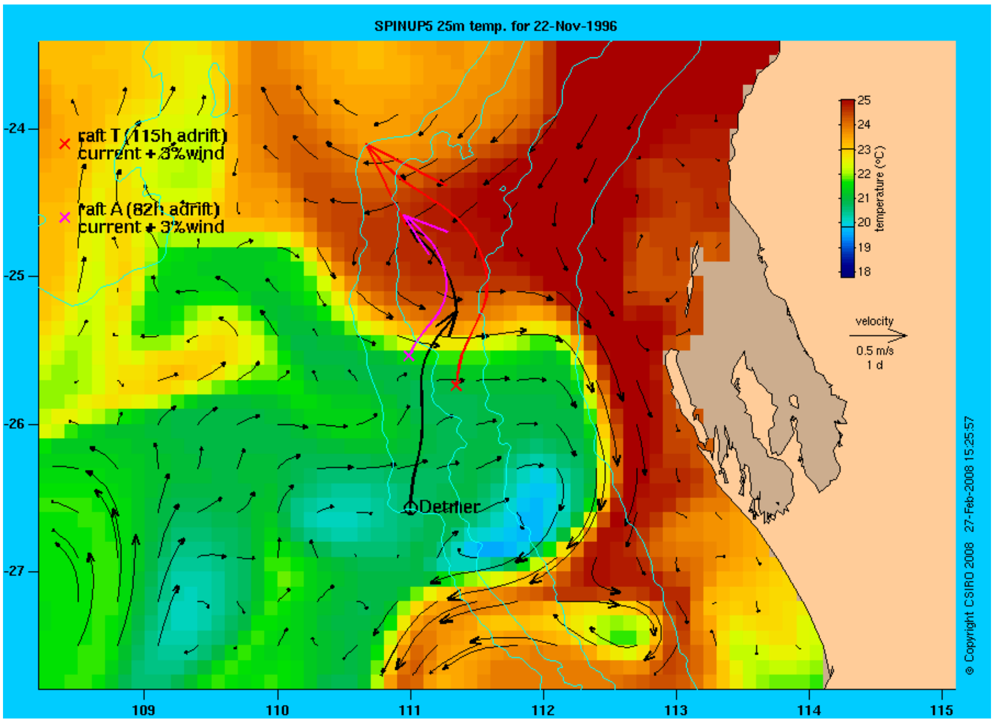

Figure 2 As above, but for 22 November 1996.

3. RESULTS

As shown in Figure 3, almost all of the annual-average launch points are north (up to 150nm) of Detmers' position, although three are south (up to 30nm). There is a cluster of estimates between 30 and 60nm NNE of Detmers' position.

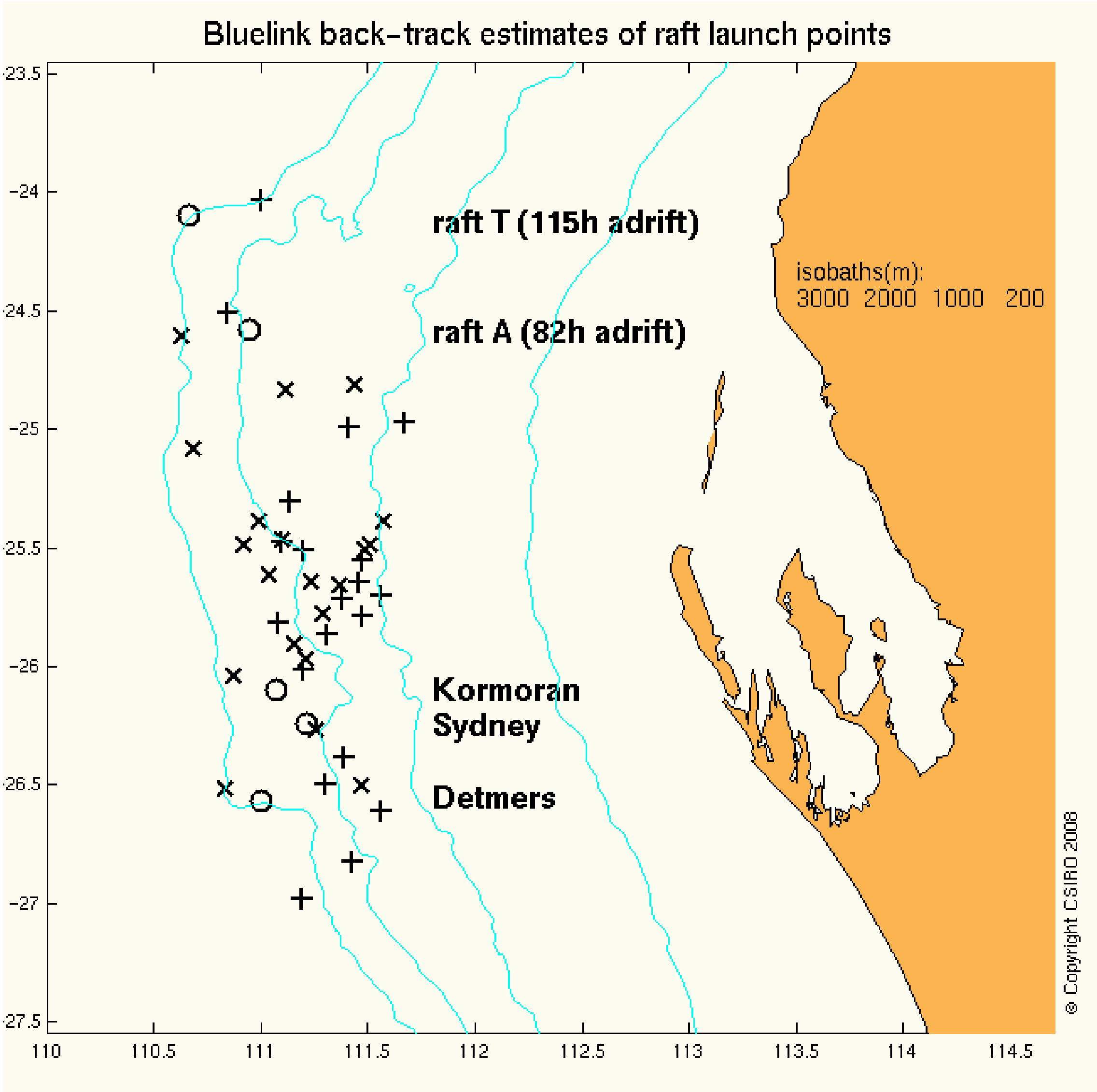

Figure 3 Summary of annual-average (one cross per modelled late-November) back-tracked launch points of raft T (+) and raft A (X). Circles show the recovery positions of both rafts, the actual resting positions of the two ships, and Detmers' recorded position.

4. DISCUSSION

The actual resting point of HSK *Kormoran* has turned out to be 90nm nearly due south of the recovery point of raft A, on the southern edge of the central cluster of the back-calculated launch points of both her rafts (Figure 3). If the net effect of the wind was indeed 82nm along 345T, this suggests that the net effect of the current in 1941 was some 15nm to the NE, which is a little more northward than our present estimate of the average, but not more so than is thought to commonly occur. It is also possible, of course, that we could have wrongly estimated the effect, or the strength or direction, of the wind, which would lead to different conclusions about the current, but there is no way of determining if this has occurred.

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