Using models to investigate a harbour porpoise bycatch problem in the southern North Sea – eastern Channel in spring 2005

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Abstract

At the Belgian coast a remarkably high number of dead harbour porpoises *Phocoena phocoena* washed ashore in the first half of May 2005. In total 16 were counted between 3 and 16 May. This is a number without known precedent in this area and in such a short period, and it arises concern given the species' conservation status. The state of decomposition of all porpoises was very similar. They were very decomposed, and it was estimated that they had died at least 2 to 3 weeks prior to their stranding. All carcasses were subjected to a necropsy. Two had been cut open ventrally, clearly indicating that they were bycaught in fishing gear. Bycatch was also the most probable cause of death of the other porpoises. Prior to the stranding in Belgium (and to a lesser extent The Netherlands), high numbers of dead stranded porpoises were reported from North Sea shores of Denmark and the United Kingdom. Given the mortality observed at Danish and British coasts, and the distribution and abundance of porpoises in the North Sea, we had expected that the animals that washed ashore at the Belgian coast in May 2005 would have originated from waters north of the area under Belgian jurisdiction. However, the models developed at MUMM to simulate the drift at sea of objects or oil, indicated that the animals most probably had died between the western part of Belgian territorial waters, and an area offshore Boulogne – Le Touquet off northern France (eastern Channel). The conclusions of this multi-disciplinary research are that (1) necropsies on severely decayed porpoises can in many cases reveal the cause of death of the animals, which in this case was certainly or most probably bycatch; (2) mathematical modelling of the drift of cetacean carcasses can play a useful role in revealing where the animals died and (3) in spring 2005 a porpoise bycatch problem existed in the southernmost part of the North Sea - eastern Channel.

Introduction

At the Belgian coast a remarkable high number of dead harbour porpoises *Phocoena phocoena* washed ashore in the first half of May 2005. Between 6 and 10 May not less than 13 were counted, and in total 16 were counted between 3 and 16 May. This number of strandings in such a short period of time is highly unusual in this area, where only 3 to 5 porpoises washed ashore annually a decade ago. Since 1995 strandings and sightings of porpoises have been steadily increasing. The increase in the number of porpoises in this area is most probably due to a shift of part of the North Sea population towards the south (CAMPHUYSEN, 2004).

The state of decomposition of all animals was very similar: they were all coded as 'fours'. This means very decomposed, with parts of the skin and fins missing, and in many cases intestines hanging free from the body and skeletal parts protruding through the skin (KUIKEN & GARCÍA HARTMANN, 1991). It is estimated that the animals had died at least 2 to 3 weeks prior to their stranding. The porpoises concerned immatures. The length of the 12 animals that were measured, ranged from 1.00m to 1.30m (average: 1.16m, S.D. 0.09m). Next to the porpoises, also two seals - in a similar state of decomposition - washed ashore.

A list of the strandings, with date and location, is given below. This list is completed with similarly decomposed harbour porpoises that washed ashore in the same period in the south-western part of the Netherlands (NL; personal communication Jaap van der Hiele). *Vlissingen* and *Cadzand* are very near to the border with Belgium, the other Dutch locations are 30 – 50km further to the northeast.

Species	Day	Place	Length (m)
Phocoena phocoena	3-May-05	Oostende	1.12
Phocoena phocoena	4-May-05	Vlissingen (NL)	
Phocoena phocoena	4-May-05	Vlissingen (NL)	
Phocoena phocoena	5-May-05	Oostende	1.20
Phocoena phocoena	6-May-05	De Haan	1.10
Phocoena phocoena	6-May-05	Middelkerke	1.20
Seal sp.	6-May-05	Nieuwpoort	
Phocoena phocoena	7-May-05	Knokke-Heist	1.25
Phocoena phocoena	8-May-05	De Haan	
Phocoena phocoena	8-May-05	Bredene	
Phocoena phocoena	8-May-05	Wenduine	1.02
Phocoena phocoena	9-May-05	Bredene	1.22
Phocoena phocoena	9-May-05	Koksijde	1.30
Phocoena phocoena	9-May-05	Koksijde	1.15
Phocoena phocoena	9-May-05	Koksijde	1.25
Phocoena phocoena	9-May-05	Blankenberge	1.00
Phocoena phocoena	10-May-05	Nieuwpoort	
Phocoena phocoena	10-May-05	Nieuwpoort	
Phocoena phocoena	11-May-05	Cadzand (NL)	
Phocoena phocoena	14-May-05	Renesse (NL)	
Phocoena phocoena	15-May-05	Bredene	1.14
Phocoena phocoena	15-May-05	Vrouwenpolder (NL)	
Seal sp.	15-May-05	Blankenberge	
Phocoena phocoena	16-May-05	Neeltje Jans (NL)	

What did they die of?

All dead animals that had washed ashore in Belgium were collected by MUMM, and subjected to a necropsy at the University of Liège, using a standard protocol (JAUNIAUX *et al*., 2002). Two of the animals had been cut open ventrally, clearly indicating that they had been bycaught in fishing gear. Some fishermen cut open bycaught animals, hoping that the carcass will sink and therefore not wash ashore. The most probable cause of death of the other porpoises was also determined as bycatch. This was indicated by a relatively thick blubber layer, the presence of stomach content, the absence of chronic lesions and the presence of some specific criteria (KUIKEN, 1996). Animals having died of illness and/or malnutrition typically show a very thin blubber layer and an empty stomach. Bycatch is

most likely to occur in bottom set gillnet fisheries. This kind of passive fishery is - apart from the marine mammal bycatch problem - relatively environmentally friendly. It is characterised by a low level of bycatch of benthic invertebrates or undersized fish, a minor bottom disturbance and low fuel consumption relative to the total weight of marketed fish. For tackling the cetacean bycatch problem in this fishery, the European Commission issued Council Regulation 812/2004[1]. This regulation does not take far-reaching measures in the southern North Sea, where porpoises were considered rare in the recent past, and where bycatches therefore occurred very rarely.

Prior to the stranding in Belgium (and to a lesser extent The Netherlands), high numbers of dead stranded porpoises had been reported from North Sea shores of Denmark and the United Kingdom. In mid-April, 55 dead porpoises were found on a stretch of beach of 10km in Denmark in only 24hrs. The most probable reason for this mortality was bycatch in the gillnet fishery for lumpfish *Cyclopterus lumpus*. Also at the east coast of the UK, between Berwick and the Wash Estuary, an unusually high number of dead porpoises had washed ashore in April (communication British Coastguard). Danish and British authorities have investigated these mortalities. Although porpoises have become fairly common in Belgian waters during the last years, especially in spring, we had expected that the carcasses that had washed ashore in May 2005 would have originated from waters north of the area under Belgian jurisdiction, given their state of decomposition, the mortality observed at Danish and British coasts, and the distribution and abundance of porpoises in the North Sea according to REID *et al*. (2003).

Where did they come from?

MUMM develops mathematical models to simulate the drift at sea of objects or oilspills (SCORY, 2005). In these models data of wind force and currents are used. The models were used to simulate the drift of the porpoise carcasses, and as such establish the most likely place where the animals had died.


Description of the model simulations

The area of possible origin of the dead porpoises was taken very wide: between 002°W and 010°E and between 48°N and 57°N. In that area (see figure 1), one point of release, indicating a priori a possible source for dead porpoises, is taken every ¼° in both directions. The model was run, after initialisation, for a period of one month (10 April to 10 May 2005). The model is driven by the tide and realistic atmospheric forcing (UKMO[2]).

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[1] Council Regulation (EC) No 812/2004 of 26 April 2004 laying down measures concerning incidental catches of cetaceans in fisheries and amending Regulation (EC) No 88/98; Official Journal of the European Union of 30 April 2004.
[2] UK Meteorological Office
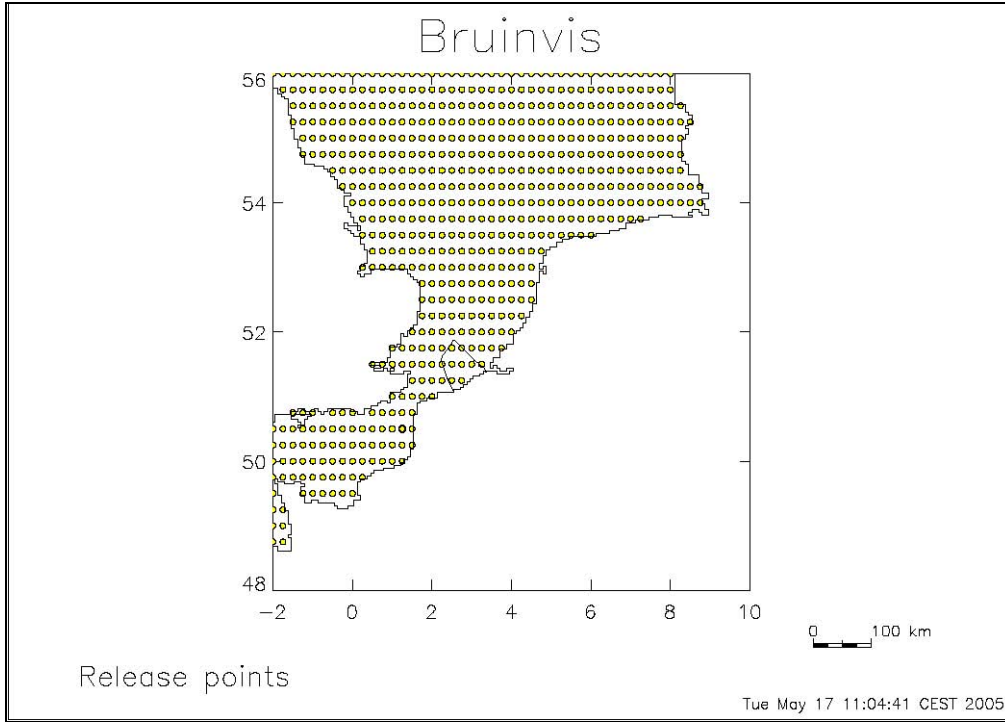
Figure 1: Positions where particles were released every 3 hours. The area concerned is the eastern Channel, the southern and part of the central North Sea; the area under Belgian jurisdiction is indicated.

During the model run, one particle was released at each release point every three hours. The drift of each particle was computed according to:

$$\frac{d\vec{s}_p}{dt} = \vec{u}_p = \vec{u}_w + \alpha D \vec{W}$$

where t denotes time, $\vec{s}_p$ is the position of the particle at time t, $\vec{u}_p$ is its velocity, $\vec{u}_w$ is the current speed computed by the hydrodynamic model (depth averaged current), $\vec{W}$ is the wind speed at 10m above the sea surface, α is the wind drift factor and D is a matrix that allows to introduce a deviation angle ϑ between the wind and the wind drift velocity (degrees). The deviation angle is to the right to the wind and it depends on the wind speed according to:

$$\vartheta = 40 - 8\sqrt{\left\|\vec{W}\right\|}$$

when the wind speed is less than 25ms⁻¹. ϑ is set equal to 0 when the wind speed is higher than 25 ms⁻¹. Two model runs were performed. In the first one, the wind drift factor was set equal to 0.03 (as usually done for the computation of oil drift). In the second run, the wind drift factor was set equal to 0.015.

Results of the models

We firstly started by identifying those particles that had reached the Belgian coast (from 2.54°E to 3.33°E) between 3 and 9 May 2005 (included). For each of these particles, we knew where and when it had been released. We then classified the particles according to the time taken to reach the coast (less than 7 days; between 7 and 14 days; between 14 and 21 days; more than 21 days). For each class, we produced a map showing the position of release. The size of each circle is roughly proportional to the number (in each class) of particles that have been released from that position and that have reached the coast in the specified time.
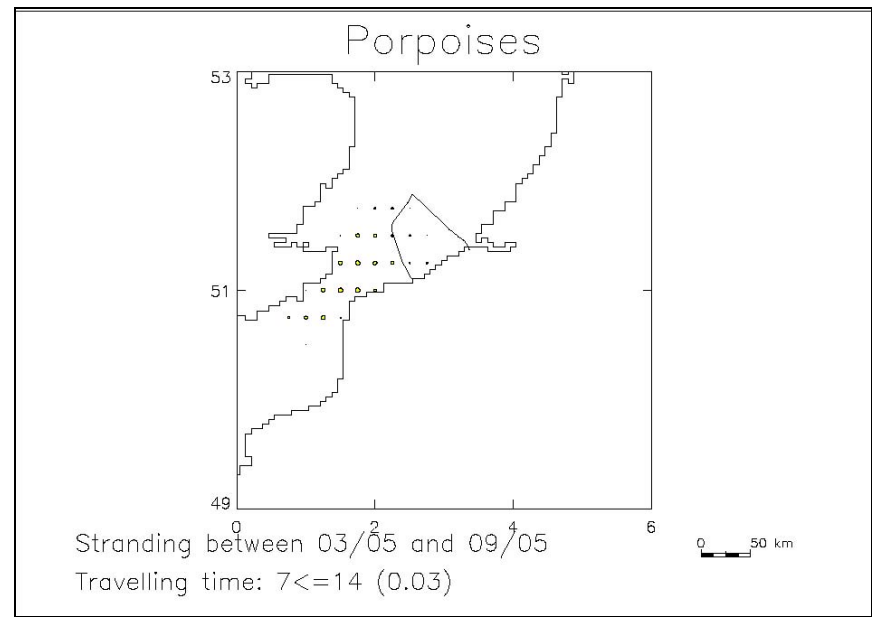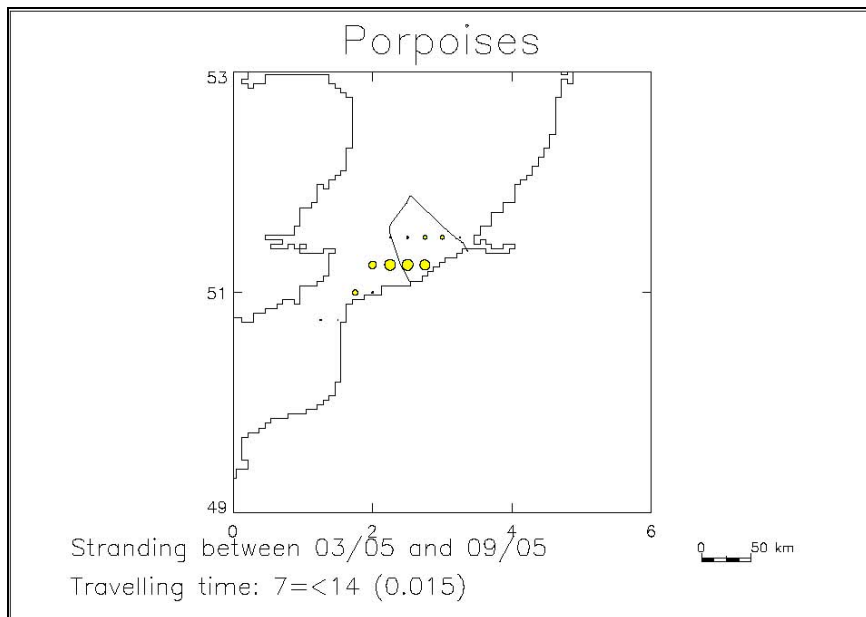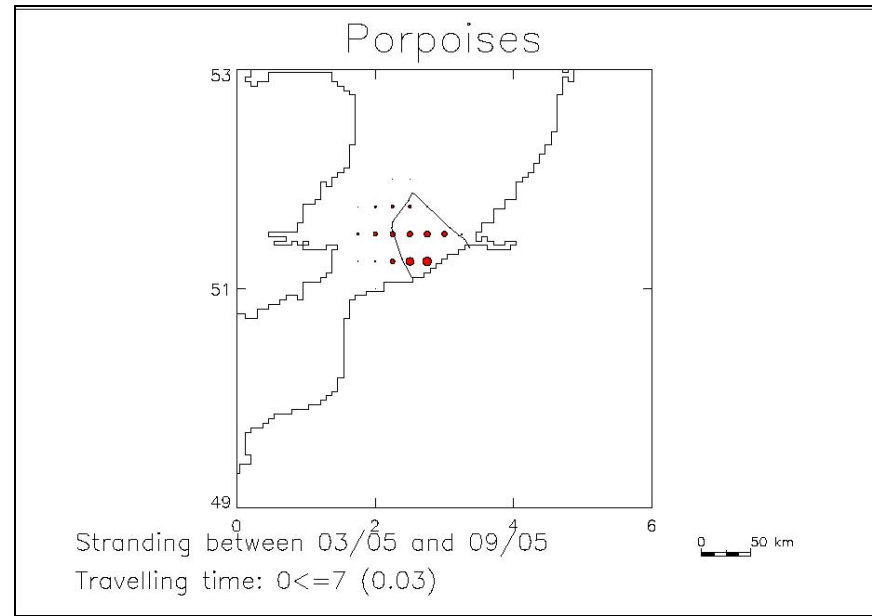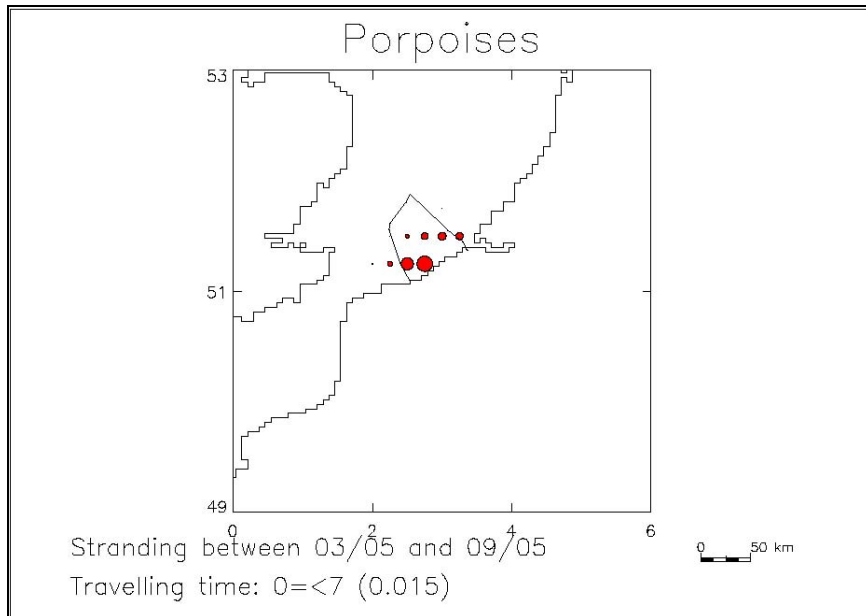
Figures 2 and 3: Particles that reached the coast in less than 7 days (above left and right), and between 7 and 14 days (below left and right). The circles indicate the release positions of the particles. The radius of each circle is roughly proportional to the number of particles released from that point that reach the coast. The results obtained with a wind drift factor set equal to 0.015 are shown in the left panels. Those obtained with a wind drift factor set equal to 0.03 are shown in the right panels.
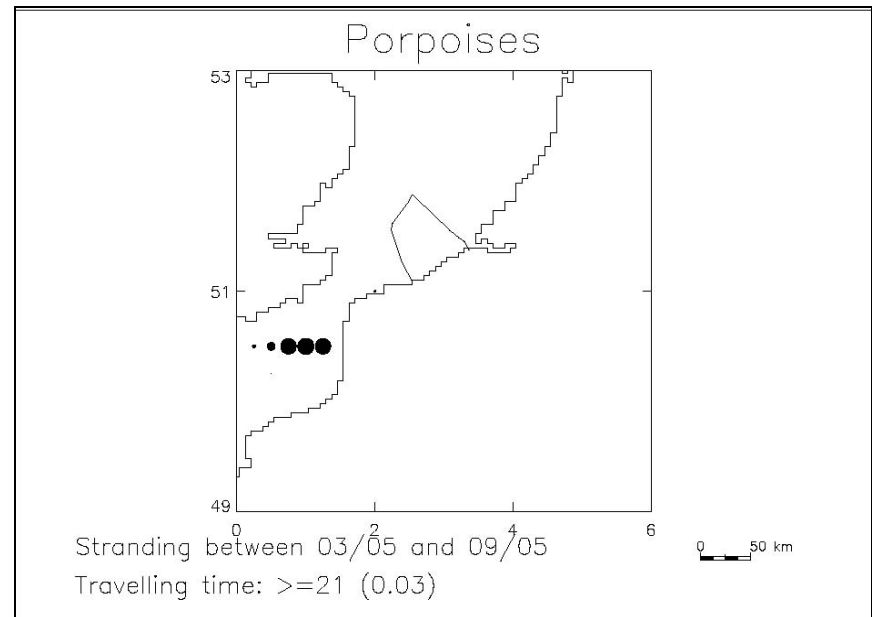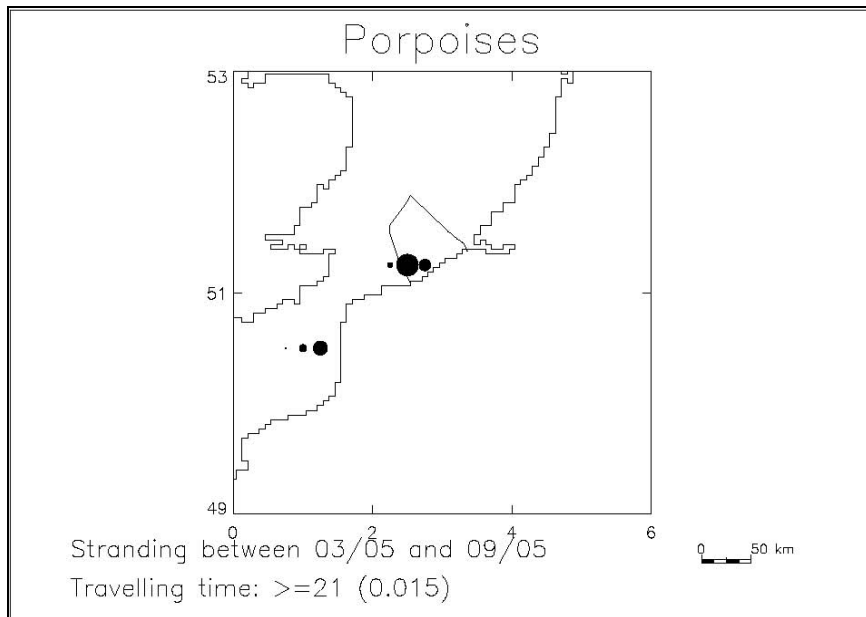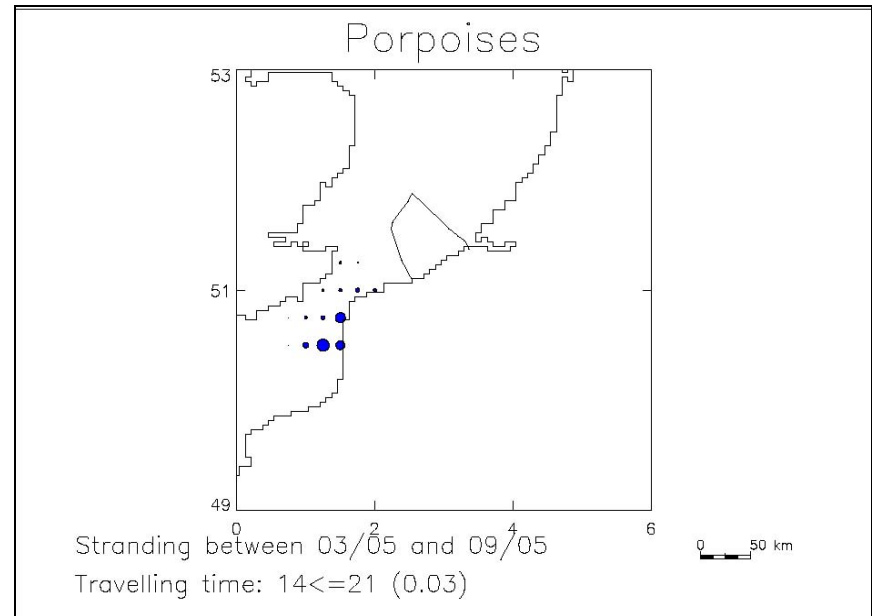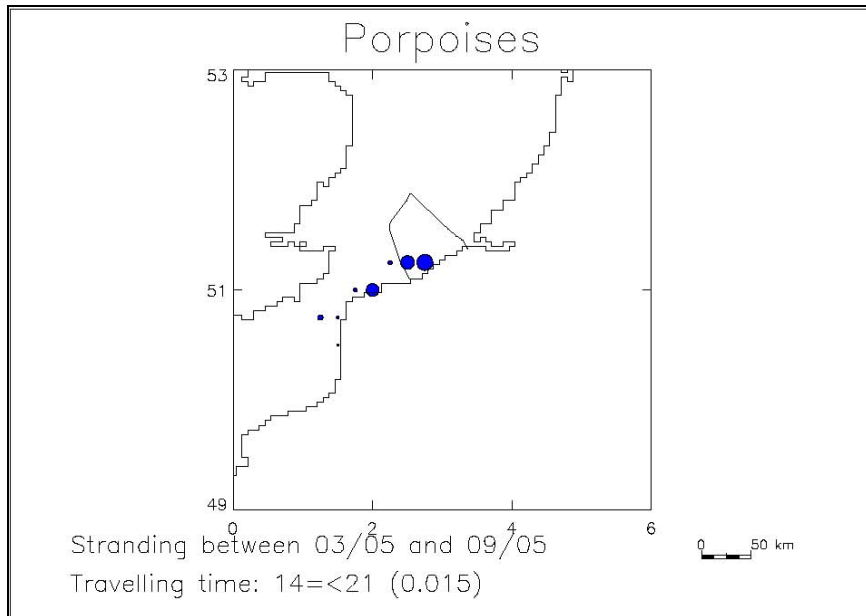
Figures 4 and 5: Modelling as for figures 2 and 3, but now the travelling time of the particles is between 14 and 21 days (above left and right) and greater than 21 days (below left and right).

Discussion

The state of decomposition of the porpoises that washed ashore in the first half of May 2005 was very similar in all cases. It indicated that death had occurred in a defined, relatively short period of time. An uncertainty in this report concerns the actual date of death of the stranded porpoises, due to a lack of data on the speed at which dead porpoises decay in waters of around 10°C. According to the state of the carcasses, this period was estimated to be situated at at least two to three weeks prior to the stranding. Also data on the floating characteristics of dead porpoises at different states of decomposition, necessary for modelling the influence of the wind in the drifting process, is lacking. For these characteristics the values for the model used here, are those currently applied for oil at the sea surface, and an alternative thereof.

The models indicate that the porpoises most probably died in an area between the western part of Belgian territorial waters, and an area offshore Boulogne – Le Touquet in northern France (eastern Channel). During the last years an increasing number of porpoises has been observed in the southern North Sea and the eastern Channel in late winter and spring, after a virtual absence of some decades in this area. The necropsies revealed for all porpoises bycatch as the certain or most probable cause of death. In the area of origin indicated by the model a high number of professional gillnet fishermen are active. In spring this fishery targets predominantly Dover sole *Solea solea* and other flatfish, and it is carried out with small meshed (around 100mm) bottom set gillnets. Bottom set gillnet fisheries are known to have a bycatch problem in certain areas and periods, and recently measures were taken in the framework of the European Common Fisheries Policy.

From the results of this investigation some important conclusions can be drawn:

1) Necropsies on severely decayed porpoises can in many cases reveal the cause of death of the animals, which in this case was certainly or most probably bycatch.

2) Mathematical modelling of the drift of cetacean carcasses can play a useful role in revealing the origin of dead cetaceans.

3) A porpoise bycatch problem exists (or existed at least in spring 2005) in the southern North Sea – eastern Channel. It should be clear that only a proportion of bycaught porpoises wash ashore; this is very dependent on meteorological conditions. The number of porpoises washed ashore and their cause of death however indicate that commitments taken in international fora such as ASCOBANS, the European Habitats Directive and the international North Sea Conferences regarding incidental catches of harbour porpoises might not met in the southern North Sea – eastern Channel. The porpoise bycatch problem in this area is relatively recent, and follows the regional increase in the numbers of porpoises, most probably due to a shift of part of the North Sea population towards the south.

Acknowledgements

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