IMPACT OF THE PROGRESS IN OPERATIONNAL OCEANOGRAPHY ON OIL SPILL DRIFT FORECASTING IN THE MEDITERRANEAN SEA

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Abstract

Météo-France has national and international responsibilities to agencies fighting marine oil pollution. Météo-France can intervene at a national level within the spill response plan POLMAR-MER in case of a threat for the French coastline, and at an international level within the Marine Pollution Emergency Response Support System (MPERSS) for the high seas. In order to answer to these commitments, Météo-France developed MOTHY, a pollutant drift model. The model is operational and can be used 24h/24 for oil spills or drifting objects.

MOTHY is an integrated system that includes an oil spill model linked to an hydrodynamic coastal ocean model with real time atmospheric forcing from a global or limited area model. MOTHY has proved its efficiency, giving results very closed to the reality, during the Erika crisis (December 1999) in the Bay of Biscay.

So far, the effects of the general circulation and the associated large scale currents are not represented in the model. The present work focuses on evaluating the effects of these currents and comparing different methods to represent them in the MOTHY system.

Currents from different origins can be used and the first part of this work is to compare them:

- Currents derived from climatology
- Currents derived from altimetry
- Currents produced by operational oceanography systems.

The potential benefit of currents from operational oceanography system is obviously higher since forecasts will be available. However, currents from climatology and altimetry will be used as a reference. The optimal way to integrate this information in the MOTHY system for the different sources is also discussed.

The impact of these currents from different origins and of different methods of integration on the oil spill drift prediction is evaluated. Using two actual pollution cases, for which observations are available : the accidents of the *Haven* (1991) and the *Lyria* (1993).

Large scale currents

The present work focuses on evaluating the effects of large scale currents and comparing different methods to represent them in the MOTHY system. This effect is investigated in the Western part of the Mediterranean Sea where such currents are significant.

We have mainly used two actual pollution cases, for which observations are available : the accidents of the Haven (1991) and the Lyria (1993).

The Cypriot tanker Haven, a 109.700 tonnes - 313mt. long oil tanker, caught fire and suffered a series of explosions on the 11th April 1991, while at anchor seven miles off the coast of Genoa. The vessel was carrying approximately 144,000 tonnes of crude oil and it is estimated that over 50,000 tonnes of fresh and partially burnt oil were spilled into the sea. This caused the worst oil pollution incident ever in the Mediterranean Sea.

On August 1993, the 2,400-ton submarine Rubis collided with the 278,000 dwt 1,115-foot long oil super-tanker Lyria some 70 miles south of Toulon, tearing a hole in the tanker and causing an oil slick. The submarine damaged its bow. The spilled oil drifted for three weeks without reaching any coast.

Without permanent current, simulations show a drift which does not fit the observations (Figure 1).

Haven: 2 weeks forecast without permanent current

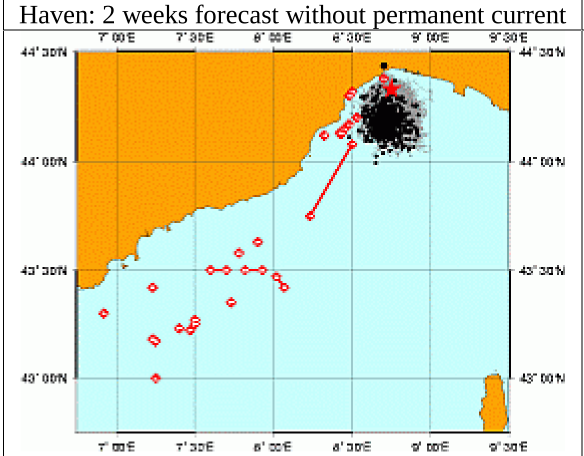


Figure 1 (a)

Lyria: 3 weeks forecast without permanent current

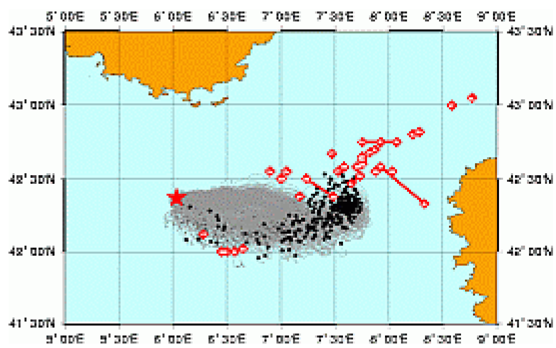


Figure 1 (b)

The red star is the starting point, red diamonds are the observations, black spots figure the final position of the slick forecasted by MOTHY

Due to the lack of operational oceanography system on the Mediterranean Sea, the only available (total) currents are monthly or seasonal means (derived from climatology or produced by operational oceanography prototypes) at a given depth level. We studied a complete month of atmospheric forcing and its mean effect at the 5 meters level. It appeared that we can consider a monthly mean of total currents at 5 meters level as the permanent part which is missing.

Use of currents derived from climatology

The Mediterranean Oceanic Data Base (MODB) (Brankart, 1998) provides seasonal climatology of currents at 5 meters depth reconstructed from historical hydrological data. These data are available on a quarter degree grid mesh. With a simple addition of these currents to the final current given by MOTHY, we get results closer to the observations (figure 2).

Haven: 2 weeks forecast with seasonal current from MODB

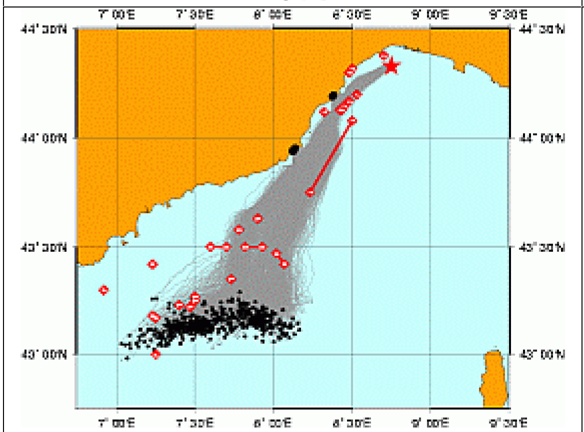


Figure 2 (a)

Lyria: 3 weeks forecast with seasonal current from MODB

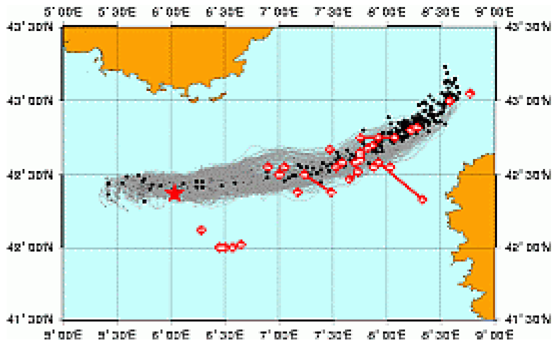


Figure 2 (b)

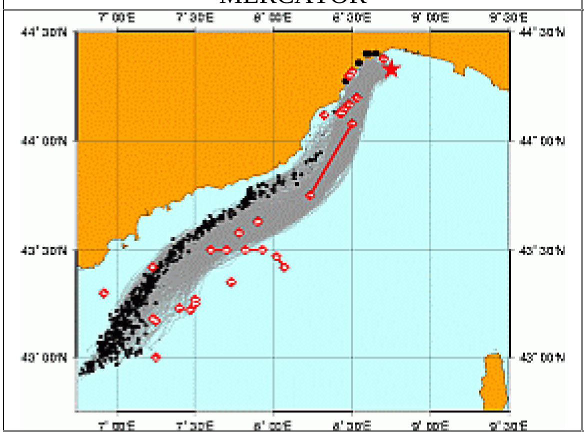
The red star is the starting point, red diamonds are the observations, black spots figure the final position of the slick forecasted by MOTHY

Use of currents produced by operational oceanography prototypes

We used monthly means calculated on a 1/8 degree grid mesh, with 3 years of simulation of the MERCATOR system (Madec, 1998). The MERCATOR mission seeks to develop and deploy a truly operational oceanography system capable of analyzing and predicting ocean conditions around the globe. This system will describe and predict ocean conditions over the whole ocean column continuously and in real time, at scales ranging from global phenomena to regional eddies.

The addition of the currents in the MOTHY system leads to better results than the MODB version, probably due to the better temporal and spatial resolution of these data (figure 3).

Haven: 2 weeks forecast with monthly current from MERCATOR



Lyria: 3 weeks forecast with monthly current from MERCATOR

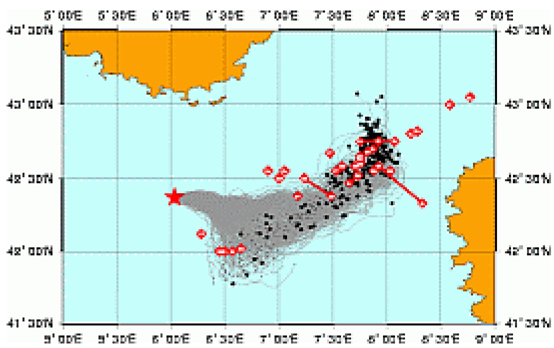
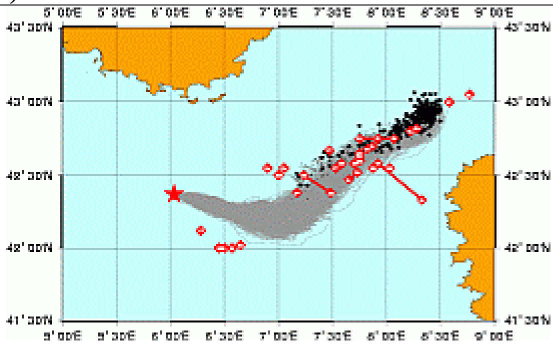


Figure 3 (b)

Figure 3 (a)	
The red star is the starting point, red diamonds are the observations, black spots figure the final position of the slick forecasted by MOTHY	

Use of currents anomalies derived from altimetry

From combined ERS-1 and TOPEX/POSEIDON altimetry data produced by the CLS Space Oceanography Division as part of the MAST-III MATER EC project (Ayoub, 1998), we calculated circulation anomalies. Then, we combined these anomalies with the yearly general circulation given by the MERCATOR system. This combination leads to the best results (figure 4).

Lyria: 3 weeks forecast with monthly current from MERCATOR + current from altimetric anomalies	 Figure 4
The red star is the starting point, red diamonds are the observations, black spots figure the final position of the slick forecasted by MOTHY	

Conclusions

Monthly current means from Mercator ocean model lead to consistent results with the observations. The use of altimetric data still improves the results. That is encouraging for a future use of currents from operational ocean models which will assimilate this type of data.

References

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