Improvement of existing operational oil spill and object drift prediction system in western Mediterranean Sea

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Abstract – Météo-France, due to its responsibilities in POLMAR-MER and MPERSS, developed MOTHY, a pollutant drift model. To improve forecasts on the Mediterranean Sea, several methods were tested to inject large scale currents (permanent part) into the MOTHY system. The best results were obtained with monthly means of currents at 5 meters (from Mercator prototype). The addition of altimetric corrections improved the results again. The potential benefit of currents from operational oceanography system is so obviously higher since forecasts will be available.

1 – Introduction

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. MPERSS is a system co-ordinated by the World Meteorological Organisation (WMO). Its primary objective is to provide marine meteorological support for marine pollution emergency response operations on the high seas. For this purpose, the oceans and seas are divided into areas for which national Meteorological Services assume responsibility. Météo-France is Area Meteorological Co-ordinator for western Mediterranean Sea and supporting service for eastern Mediterranean Sea.
In order to answer to these commitments, Météo-France developed MOTHY [1], a pollutant drift model. The model is operational and can be used 24h/24 for oil spills or drifting objects.

2 – MOTHY

MOTHY is an integrated system that includes hydrodynamic coastal ocean modelling and real time atmospheric forcing from a global or limited area model. The hydrodynamic coastal oceans is linked to an oil spill model, where oil slick is considered as a distribution of independent droplets. These droplets move with shear current, turbulent diffusion and buoyancy. New developments, exercises and training are jointly conducted with CEDRE. MOTHY has proved its efficiency, giving results very closed to the reality, during Erika crisis (December 1999) in the Bay of Biscay [2].
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.
We have mainly used two actual pollution cases, for which observations are available : the accidents of the Haven (1991) and the Lyria (1993). Since conclusions are identical for both cases, only the second one is presented here. On August 1993, a submarine collided with the oil super-tanker Lyria some 70 miles south of Toulon, tearing a hole in the tanker and causing an oil slick. The spilled oil drifted for three weeks without reaching any coast.

3 – MOTHY improvement

3.1 How to extract the permanent part of the available total currents ?

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 could consider a monthly mean of total currents at 5 meters level as the permanent part that the MOTHY system is missing.

3.2 Use of currents derived from climatology

The Mediterranean Oceanic Data Base (MODB) [3] 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 obtained results closer to the observations.

3.3 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 [4]. The addition of the currents in the MOTHY system gave better results than the "climatology" version, probably due to the better temporal and spatial resolution of these data.

3.4 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 [5], we calculated circulation anomalies. Then, we combined these anomalies with the yearly general circulation given by the MERCATOR system. The results obtained were the best ones.

On figure 1, you can see the MOTHY forecast in the Lyria pollution case (the red star is the starting point, red diamonds are observations) whereas on figure 2, you can see the forecast of the improved version.

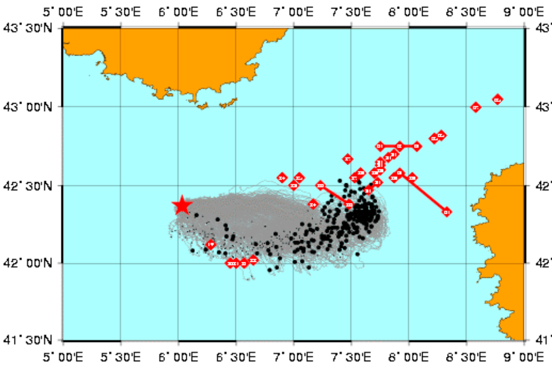

FIG. 1 : Three weeks forecast with the operational version

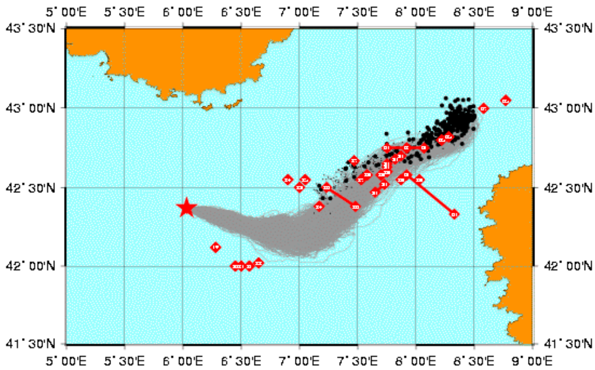

FIG. 2 : Three weeks forecast with the modified version (MERCATOR + ALTI)

4 – Conclusion

The use of current means (from climatology or models) to force the permanent part the MOTHY system is missing, gives results closer to the reality. But the potential benefit of currents from operational oceanography system is obviously higher since forecasts will we available.

References

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