OPERATIONAL METOCEAN PRODUCTS AND SERVICES IN SUPPORT OF MARINE POLLUTION EMERGENCY RESPONSE OPERATIONS

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ABSTRACT

The World Meteorological Organization (WMO) in conjunction with IMO and UNESCO have established a framework for a global Marine Pollution Emergency Response Support System (MPERSS). National Meteorological Services are traditionally called upon to provide a range of meteorological and oceanographic data and services to support operations in response to various marine pollution emergencies, normally working closely with national response agencies when incidents occur in territorial or international waters. To ensure that similar services are available in developing countries and international waters WMO in 1994 established MPERSS. This system has been designed to provide a coherent, internationally coordinated approach to the provision of meteorological and oceanographic services worldwide to marine pollution incidents no matter where and when they happen.

Today, the quality and breadth of data products expected by marine industries has expanded considerably and the challenge is to ensure that they provide value to the present and future generation of maritime applications. Operational met-ocean services rely on complex and expensive data collection and real time synthesis systems that must interact in real time across international boundaries. The IOC/WMO Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) has been created to facilitate the development and application of globally distributed marine meteorological and oceanographic services and their supporting observational, data management and capacity building programmes. A close dialog between those people pioneering the development of the next generation of maritime service infrastructures and those using their output in maritime applications is essential to ensure value for money and maximum impact across all maritime operational services.

MARINE POLLUTION EMERGENCY RESPONSE SUPPORT SYSTEM FOR THE HIGH SEAS (MPERSS)

MPERSS's primary objective is to have in place a coordinated, global system for the provision of meteorological and oceanographic information for marine pollution emergency response operations outside waters under national jurisdiction. The oceans and seas are divided into areas for which National Meteorological and Oceanographic Services have accepted responsibility (Figure 1). The areas covered, termed Marine Pollution Incident (MPI) areas, are the same areas as the METAREAs of the IMO Global Maritime Distress and Safety System (GMDSS). The areas of responsibility together provide complete coverage of oceans and seas by meteorological and oceanographic information contained in the products prepared and issued by the participating National Meteorological and Oceanographic Services. Over each MPI area, the provision of meteorological and oceanographic information is coordinated by an Area Meteorological and Oceanographic Coordinator (AMOC). The AMOC is also available to provide relevant support and advice for waters under national jurisdiction within its area if so requested by the countries concerned.

An AMOC is a national service which may be National Meteorological Service, or National Meteorological Service which also operates oceanographic services, or National Meteorological Service liaising with Oceanographic Services where these are in operation.

The support supplied by an AMOC includes basic meteorological forecasts and warnings tailored for the area concerned. It may also include:

- Basic oceanographic forecasts for the area concerned
- The observation, analysis and forecasting of the values of specific meteorological and oceanographic variables required as input to models describing the movement, dispersion, dissipation and dissolution of marine pollution;
- In some cases, the operation of these models;
- In some cases, access to national and international telecommunications facilities;
- Other operational support.

The issued information may have been prepared solely by the AMOC, or by another Supporting Service, or a combination of both, on the basis of an agreement between the Services concerned. The location and contact (telephone, e-mail, telex, fax, etc.) details of any marine pollution emergency response operations authorities responsible within the designated Marine Pollution Incident (MPI) are maintained on the MPERSS web site: http://www.maes-mperss.org.

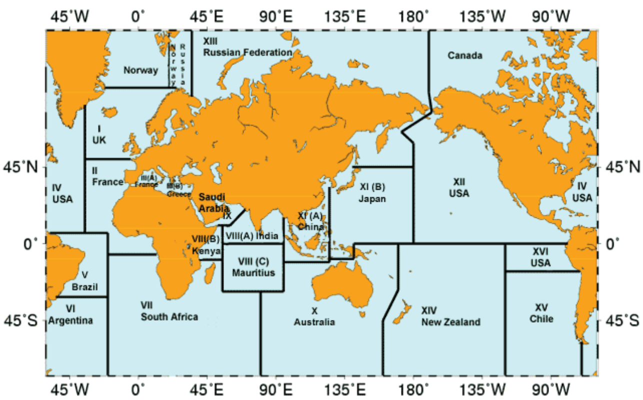

FIGURE 1 – MARINE POLLUTION INCIDENT (MPI) AREAS SHOWING RESPONSIBLE NATIONAL AGENCIES

EXAMPLE OF AN ACTUAL MARINE POLLUTION EMERGENCY WHERE MPERSS APPLIED

On Wednesday 13 November 2002, the single-hulled oil tanker Prestige sent a distress call offshore in the region of Cape finisterre (Galicia, Spain). The tanker, carrying 77,000 tonnes of heavy fuel oil was heading to Singapore via Gibraltar. The vessel developed a reported 30 degree starboard list whilst on passage in heavy seas and strong winds and hence requested partial evacuation of the crew. Twenty-four of the twenty-seven crew members were evacuated by helicopter while the captain, the first mate and the chief mechanic stayed onboard. The engine was damaged and the ship went out of control and drifted according to the weather conditions. Aerial observation revealed a fuel leak at sea.

On 14 November, the ship was towed to the north-northwest all day, and then to the south (Figure 2). On the 15th, it was torn over 35 metres on the right side. On the 16th, its towing was turned to the south-west to avoid the Portuguese waters. On the 19th at 9 am, the vessel broke in two, about 130 nautical miles off the Spanish coasts, west-southwest of Cape Finisterre. At 12 pm, the stern part of the Prestige sank into 3500 metres of water. The bow part followed at about 4 pm.

One of the characteristics of this spill was the weathering process of the oil that remained out at sea for a considerable period of time. This spill was "unique" in many respects, first with regard to drift, as it was really the very first time that a spill managed to contaminate 6 countries, and weathering, not to mention the highly significant effect of the slick break-up process and how that had an effect on the choice of response measures and techniques off shore and then inevitably on shore.

The offending oil was tracked throughout the entire time it was drifting in and around the Bay of Biscay and the westernmost reaches of the English Channel, thanks to French and Spanish floating buoys and ship-based and aerial data that was fed into various slick drift forecast models. The main slick spilt up into so many smaller ones on account of the wind and current regimes prevailing in the area that the oil drifted seemingly forever before eventually landing on the beaches in France and even then only after a period of steady westerly winds.

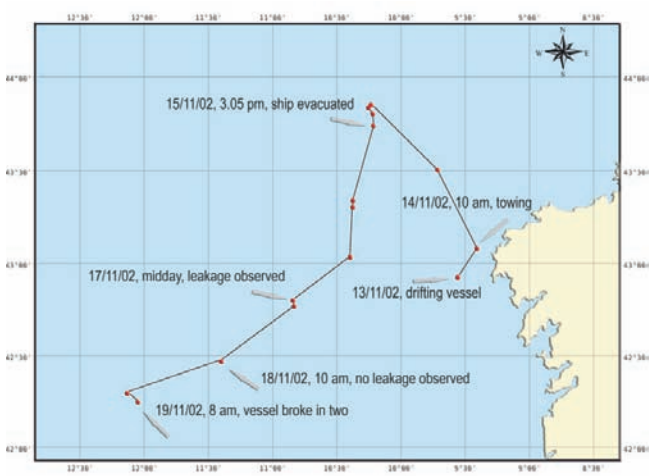

FIGURE 2 – TRACK OF THE PRESTIGE

The drift forecast committee with representatives of Météo-France, SHOM (Oceanographical and Hydrographic Service of the French navy), IFREMER and the maritime prefecture of the Atlantic met every day at Cedre's to prepare a chart gathering the nautical and aerial observations of the pollution and the drift forecast available for four days. This chart (Figure 3) was accepted as the national reference. It has enabled to follow the route of the hydrocarbons, to anticipate the threat for the coasts and to guide the ships intervening at sea.

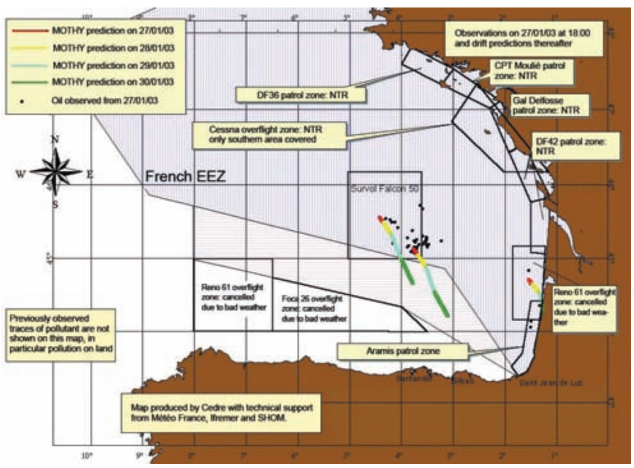

FIGURE 3: DRIFT PREDICTION MAP OF THE FUEL OIL FROM THE PRESTIGE, 27 JANUARY 2003, BAY OF BISCAY

Drift forecasts were sent to Meteorological Services of Spain, Portugal and Morocco by Meteo-France which is the AMOC over this area. Use of operational ocean forecasting systems have been undertaken (Daniel and al., 2005, 2006). It has highlighted both the potential and current limitations of the systems for these applications.

POTENTIAL FOR USE OF THE OPERATIONAL OCEAN FORECASTING SYSTEMS IN MARINE ACCIDENT EMERGENCY SUPPORT APPLICATIONS

Recent progress with development of operational ocean forecasting systems has produced systems with suitable levels of maturity for consideration for use in Maritime Accident and Emergency Support (MAES) scenarios. Whilst at present these systems are not widely used on a routine basis, demonstrations of capability have been undertaken. These demonstrations have highlighted both the potential and current limitations of the systems for these applications.

Systems for use in search and rescue and for response to incidents of pollution typically require inputs of environmental information such as wind speed and direction, current speed and direction, and in a polar environment, sea-ice cover. In addition, variables such as temperature and salinity (or equivalently density) and sea state can have an impact on survivability of a casualty, and on the sinking, weathering and dispersion of pollutants. In general, whilst systems may have access to real-time meteorological information, oceanographic data is usually specified as a single, constant climatological value, for example a prevailing current direction and climatological current speed, or values from a tidal database if in tidal waters.

Many of the systems in use, however, have the capability to ingest and exploit gridded model data, typically supplied in a standard format (e.g., GRIB). This opens up the possibility of use of outputs from the latest generation of operational ocean forecasting systems.

Forecasting systems for the ocean interior are typically configured to provide eddy-permitting or eddy-resolving resolution for the major ocean basins, with higher resolution models available for coastal regions of particular interest. Models are configured to include the representation of tides in strongly tidal regions, and sea-ice at high latitudes. The eddy resolving models are dependent either upon the assimilation of data, in particular satellite altimeter sea surface height data, or the realistic simulation of tides and tidal mixing to accurately represent the mesoscale fronts and eddies that characterize the ocean circulation. In addition, specification of an accurate bathymetry, and accurate surface wind stresses are essential to ensure realistic representation of the ocean currents.

Products delivered by the systems include 3D gridded fields of ocean state variables, including currents, temperature and salinity on a range of vertical levels and sea-ice concentration. Some systems are run daily, taking advantage of meteorological infrastructure to provide full operational support, whilst others are run less frequently on a pre-operational basis. The MAES applications clearly require fail-safe systems and operational, robust delivery mechanisms to deliver the data to the applications. Such capability is potentially available from the ocean forecasting systems that are currently run operationally, whilst many of the systems that are currently run pre-operationally have plans to develop full operational capability.

Demonstrations of oil spill drift predictions using case studies have highlighted some of the challenges in using the operational ocean forecast system outputs within the MAES applications. Comparisons of predictions from a number of systems identified significant differences in the predicted direction of drift (Figure 4), and highlighted the need for further investigation of the optimal strategy for interfacing the MAES applications to the operational ocean forecasting systems. Particular issues arising are: the optimality of the system output frequency, the use of mean fields compared to instantaneous fields, the resolution and frequency of the surface wind stresses used, the physical formulation of the ocean model, and the horizontal and vertical resolution of the ocean model. Despite these discrepancies, the ocean forecasting systems showed potential to improve the outcome of the drift predictions over and above that provided by the use of climatological data.

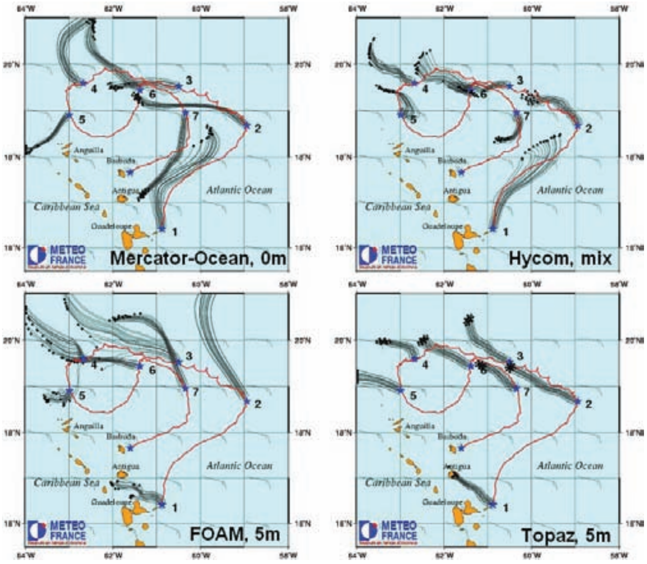

FIGURE 4 – COMPARISON OF DRIFT SIMULATIONS UNDERTAKEN BY MÉTÉO-FRANCE. SIMULATION USING THE MERCATOR-OCEAN PSY1V2 SURFACE SEA CURRENT (UPPER LEFT PANEL), HYCOM MIXED LAYER SEA CURRENT (UPPER RIGHT PANEL), FOAM 5 M SEA CURRENT (LOWER LEFT PANEL) AND TOPAZ 5 M SEA CURRENT (LOWER RIGHT PANEL).

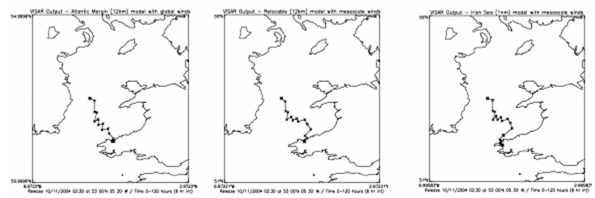

FIGURE 5 – COMPARISON OF DRIFT PREDICTIONS IN THE IRISH SEA UNDERTAKEN BY THE UK MET OFFICE. USING 12KM RESOLUTION CURRENTS AND 60KM RESOLUTION WINDS (LEFT), 12KM CURRENTS AND 12KM WINDS (CENTRE), AND 1 NAUTICAL MILE CURRENTS AND 12KM WINDS (RIGHT).

Separate studies exploring the sensitivity of surface drift predictions in SAR scenarios have highlighted the impact of high resolution surface forcing, particularly when used in conjunction with a high resolution ocean model (Figure 5).

These studies have identified the potential for the operational ocean forecasting systems to provide enhanced predictive capability for search and rescue and counter-pollution applications. However, to harness these capabilities to full advantage it is necessary to continue to develop the systems, and to begin to gather practical experience in their application to develop a more thorough understanding of their abilities and limitations.

Some practical experience of this nature was gained through demonstration of a high resolution modelling system at the UK Met Office in response to the grounding of the MS Napoli in Lyme Bay. A model with 180m grid resolution (Figure 6) was configured to study the potential spread of polluted sediment following the lift of the vessel from the sea bed. Predictions from the model were used to demonstrate the guidance that could be provided to the responsible agencies with respect to the possible consequences of lifting the vessel at particular states of the tide.

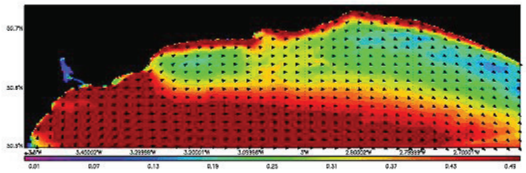

FIGURE 6 : WIND DRIVEN RESIDUAL CURRENT (KNOTS) IN LYME BAY DUE TO WIND FORCING IN THE 180M LYME BAY MODEL SET UP AT THE MET OFFICE TO INVESTIGATE THE POTENTIAL SPREAD OF POLLUTANTS FOLLOWING THE GROUNDING OF THE MSC NAPOLI.

Successful application of the outputs of the operational ocean forecasting systems to MAES response requires the MAES community and the operational ocean forecasting community to collaborate to further develop demonstration cases that allow experience to be gained, the suitability of models for this purpose to be improved, and confidence to be built between the two communities. Work will also be required to develop suitably robust interfaces between the operational ocean forecasting systems and the MAES applications.

AN EXAMPLE OF USE OF THE OPERATIONAL OCEAN FORECASTING SYSTEMS IN MARINE ACCIDENT EMERGENCY SUPPORT APPLICATIONS AT MET.NO

The Norwegian Meteorological Institute (met.no) has a national responsibility for weather and ocean forecasting in Norwegian waters. The responsibilities extend to the support of Marine Pollution Response (including oil spill fate and algal bloom forecasting), and to Search and Rescue (SAR) operations. Norway has taken on the role of MSI Coordinator for NAVAREA XIX, and has offered to take the responsibility as Coordinating Issuing Service for the corresponding METAREA XIX, that corresponds to the Arctic waters north of 71° N on MPI Area I.

Forecasting the drift of oil and objects are founded on forcing data from operational models for the atmosphere, ocean circulation and waves. The goal is to apply the best available forcing data for a given area and time span. In this context, met.no maintains three drift models to support marine emergency response:

1. an oil spill fate model (OD3D);
2. a model for surface drifting objects (LEEWAY); and
3. a model for ship drift.

Technically speaking, there are strong similarities between the models as well as the services for which they are used. Therefore, the models are implemented in such a way that they share a common user interface and dependence on a common processor for geophysical forcing data. Furthermore, all three models are based on a "particle" representation of the object or substance, so that the main difference lies in the particular characteristics of the particles. met.no has cooperated with leading centers of expertise on oil weathering and drift characteristics for floating objects, in an effort to attain state-of-the-art models.

Over the past few years, the met.no has recognized the similarities between the three drift models described above. An effort is underway to let them share the same methods for accessing geophysical forcing data (see Figure 7). The aim of the forcing processor is to provide a variety of available forcing data sets from met.no and external operational models. A default list of prioritized sources is maintained and checked for availability when a simulation is requested.

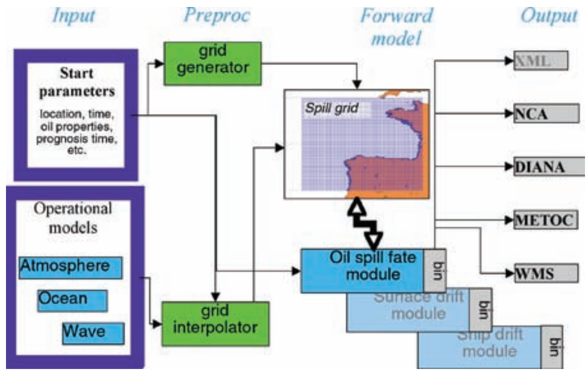

FIGURE 7 : SCHEMATIC OF THE MET.NO DRIFT MODELLING SYSTEM. THE THREE DRIFT MODELS – FOR OIL SPILL, SURFACE DRIFTING OBJECTS AND SHIP DRIFT – USE THE SAME FORCING PRE-PROCESSOR AND OUTPUT MODULES. THE OPERATIONAL MODELS FOR ATMOSPHERIC, OCEANIC AND WAVE DATA INCLUDE BOTH IN-HOUSE AND EXTERNAL SOURCES. OUTPUTS INCLUDE INTERNAL, USER-DEFINED AND OPEN-STANDARD FORMATTED DATA STREAMS.

Specific users can enter their information in web order forms, which are accessed from a common webpage, to set up and run the model. Results may be delivered to the users as e-mail attachments or as downloads from the website (see Figure 8). In addition, results are stored in an internal format for viewing with met.no's graphical display tool DIANA (http://met.no/diana/), that allows the duty meteorologist(s) to immediately view results in combination with other environmental information, in order to provide expert advice to the user. It also facilitates display of the results in a web mapping service client operating on the same website as the order form, thus enabling users with a web browser alone. DIANA is an open source code and could be used for the MAES applications.

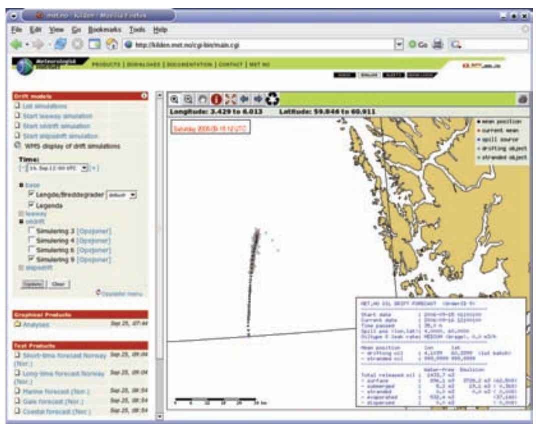

FIGURE 8 : SCREENSHOT OF THE WEB-BASED MET.NO DRIFT SERVICE USER INTERFACE. MENU AT LEFT PROVIDES ACCESS TO THE SIMULATION ORDER FORMS FOR OIL DRIFT, DRIFTING OBJECTS (LEEWAY) AND SHIP DRIFT, AS WELL AS TO RESULTS FROM PREVIOUSLY RUN SIMULATIONS. IN ADDITION, THE MENU GIVES ACCESS TO AN IMBEDDED WMS (WEB MAPPING SERVICE) CLIENT FOR SIMPLE VISUALISATION OF SIMULATION RESULTS, AS EXEMPLIFIED IN THE MAIN FRAME.

MPERSS SUPPORT FOR MARINE POLLUTION RESPONSE METAREA X

Introduction

The prime component of the Area X MPERSS is called the Oil Spill Trajectory Model (OSTM) operated by the Australian Maritime Safety Authority (AMSA) in Canberra Australia. Development of the OSTM system has taken place over the past 12 years along with other national decision support systems for maritime emergencies in MetArea X. *(Gilbert 1998, Baird & Gilbert 1998, Gilbert and Baxter 2002)* The system provides for the access and visualisation of near real time meteorological and oceanographic (metocean) data for over 47 million square kilometers of the world oceans spacing the Indian, Pacific and Southern Oceans.

The main use of this metocean data under OSTM is to provide coastal and off-shore oil spill drift, trajectory, impact and weathering modelling services for all Australian waters for the national marine spill contingency plan. OSTM provides Australian spill responders with a prediction of the likely movement of oil spills under the influence of ocean currents, tides and winds to determine environmental resources under threat and to position appropriate spill response equipment and countermeasures.

The MPRESS MetArea X system:

- Covers all Australian waters both near shore and off-shore deep water;
- Has accurate spill predictions for both forecasting and hindcasting;
- Provides a rapid output of results regardless of spill geographic location;
- Has the ability to adjust data inputs considering changing conditions and field observations;
- Provides forward and backward probability analysis for spills e.g. probability of where the oil will go or probability of where it originated;
- Is able to be used in remote field locations or effective transmission of model outputs to field operators; and
- Has a user friendly software interface that provides the generation of graphical/pictorial model outputs.

The main components of OSTM are two software packages: HYDROMAP (hydrodynamic model), and OILMAP (spill trajectory and oil weathering model). A range of data feeds and information is required to operate this software. The main data feeds and information outputs from OSTM are shown in Figure 9

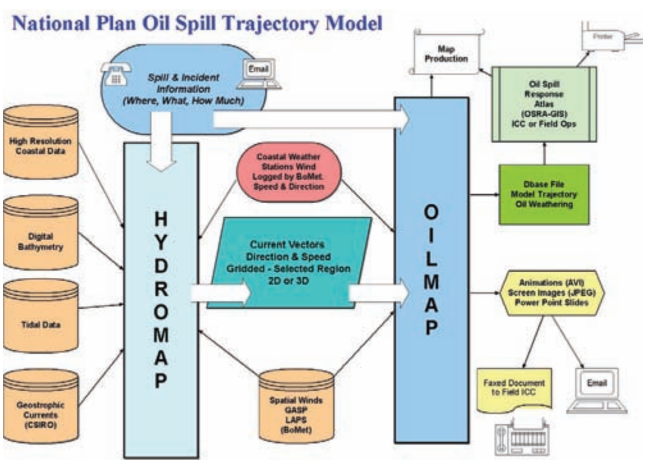

FIGURE 9

HYDROMAP is a predictive coastal hydrodynamic circulation model that simulates the flow of water currents within a specified region. On the continental shelf of Australia the major current-forcing mechanisms are tidal and meteorological i.e. wind. In deeper waters the influence of tides diminishes and the dominant current forcing mechanisms are thermodynamic and meteorological.

The OSTM software determines currents due to the forcing action of astronomical tides, wind stress and bottom friction. It also allows the import and addition of satellite derived geostrophic currents in deeper water environments where thermal-haline currents dominate. The output from HYDROMAP is gridded time steps of current vectors which are exported for use within OILMAP.

Use of Geostrophic Currents in OSTM

A major advantage of the OSTM system is that it allows the operator to combine external ocean current data with the predicted tidal and wind driven currents. This allows the visualisation, animation and use of large-scale offshore oceanic currents, associated fronts and eddies e.g. East Australia Current (EAC), Leeuwin Current and Indonesian Throughflow. An example of the integration of the geostrophic currents for northeast Australian water affected by the EAC is given in figure 10.

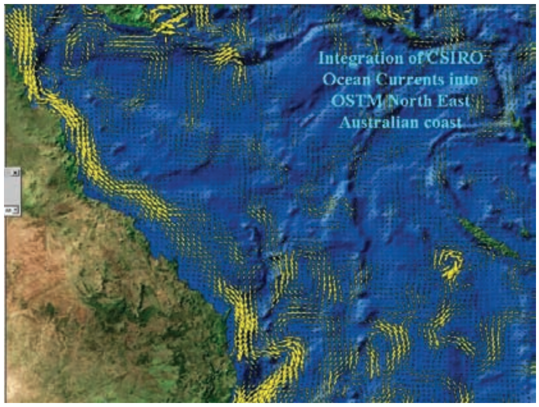

FIGURE 10.

It is essential that the effects of geostrophic oceanic currents are used in spill trajectory models. These large scale ocean circulations along with associated eddies and fronts are calculated by the CSIRO Marine Division using satellite altimeter data and provided to AMSA in a gridded NetCDF file format of current vectors. Individual files can be viewed and added together to use within the model or animated for visualisation of the ocean current trends in the region of interest. The CSIRO geostrophic file covers a region from 100N 570E to 600S 1850E at a spatial resolution of 0.25 degrees. These large-scale geostrophic currents are usually only accessed and used in OSTM when modelling in water depths exceeding 200m

Importance of Spatial Winds in the Spill Model

Accurate wind information, both present and predicted, is important for both modelling the speed and direction of water currents in HYDROMAP. Wind also influences the movement of the oil slicks on the water surface, this is modelled in the OILMAP software. Weather patterns can change on both synoptic (1-3 days) and seasonal scales. High and low pressure systems cause the wind to blow in different directions and at different speeds. Over the ocean this has an effect on the currents.

The main source of wind data is the Australian Bureau of Meteorology (BoMet) from its Automatic Weather Stations (AWS) around the Australian coast and offshore islands and territories as well as its atmospheric computer models. HYDROMAP has the ability to automatically extract gridded wind fields from the BoMet atmospheric models via the web site on FTP. This includes the Global atmospheric model (GASP) and Local atmospheric model (LAPS).

AMSA has access to the GASP model providing output as a global dataset at a spatial resolution of 1 degree and 3 hour time steps over a 96 hour period. The LAPS model output is a dataset that covers the area 65.0 degrees to 184.625 degrees East and 17.0 degrees North to 65.0 degrees South at a spatial resolution of 0.375 degrees and a time step of 1 hour over a 72 hour period. An example of this LAPS spatial wind dataset used in OSTM is shown in Figure 11.

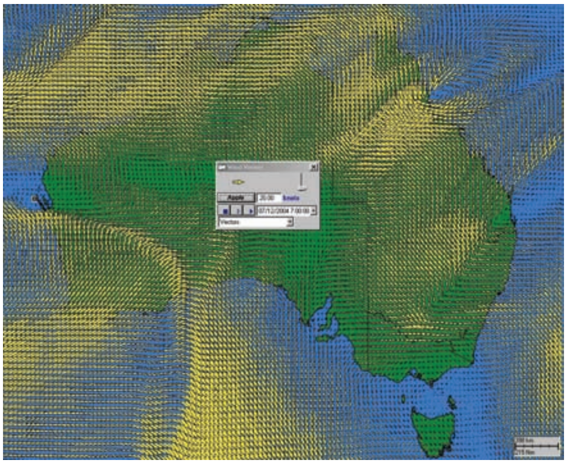

FIGURE 11

AMSA primarily will access sea surface wind velocities from BoMet atmospheric models via the internet (NetCDF format), extract these for the region of interest and visualise the data in the software. Wind velocity records can also be accessed from the BoMet as logged by local coastal weathering monitoring stations via the internet. AMSA can also access wind predictions provided by BoMet duty weather forecasters by telephone.

Oil Properties, Weathering and Spill Response

The features of OSTM allow the user to:

- Specify spill scenarios anywhere in Australian waters;
- Display spill trajectories over time intervals selected by the user;
- Grid any area within the geographic location for model operation;
- Allow allocation/editing of foreshore type for oil/shoreline interaction;
- Provide manual input or automatic import of wind speed/direction, both spatial wind or point wind datasets;
- Produce an animation of currents (vector direction/strength) over time period;
- Enter and edit oil types in the oil library;
- Enter sea temperatures for improved oil weathering predictions;
- Display and output oil slick properties as they change for individual slicks;
- Interrogate current vectors produced in HYDROMAP and edit if necessary; and
- Display natural resources impacted by the oil and measure extent of shorelines impacted by oil.

OSTM provides:

- Prediction of weathering and surface/sub surface transport of oil slicks;
- Prediction of the probability of key coastal/marine areas being impacted from a given site;
- Plotting of oil spill thickness contours as they spread and oil mass balances in tables, charts or graphics;
- Backtracking of the model to determine the likely spill release position;
- Selection of single, continuous or multiple releases of oil;
- Updating of predictions with over flight data at spill scene;
- Incorporation of boom-oil interaction;
- Plotting of spill dispersant application zones and modelling effects of dispersant use on drifting slicks;
- Performance of risk assessments for important shorelines and environmental resources;
- Accounting for floating or fixed sea ice for Antarctic waters;
- Use of NOAA's ADIOS extensive oil database of over 1,000 oils and fuels for weathering calculations; and
- Incorporation of chemical/physical properties of oils produced and imported into Australia.

The oil spill model also predicts oil trajectories for either instantaneous or continuous release spills and includes algorithms for spreading, evaporation, emulsification, entrainment, oil-shoreline interaction and oil-ice interaction. The oil's distribution and mass balance are predicted for the type of oil spilled. Model predictions can be refined with observed oil slick locations from surveillance operations. Floating barriers may also be added to implement simple booming strategies at selected locations, and the application of dispersant may be simulated to determine oil removal scenarios.

Spill movement and impact zones can be provided in the following formats:

- Animation files (AVI format and compressed);
- Screen captures in JPEG format;
- PowerPoint slides in sequence;
- Dbase file for importing into the Oil Spill Response Atlas GIS;
- Word documents;
- Faxed printouts and;
- Google Earth KML formats.

Example Use Sunken Fishing Vessel

During November 2005 a fishing vessel sank in the Gulf of Carpentaria in a remote location of northern Australia with a large quantity of diesel still on board. Diesel fuel began to leak from the sunken wreck as determined by aircraft surveillance over a number of days (Figure 12). AMSA was tasked with determining the movement, spread and potential impacts of the leaking fuel.

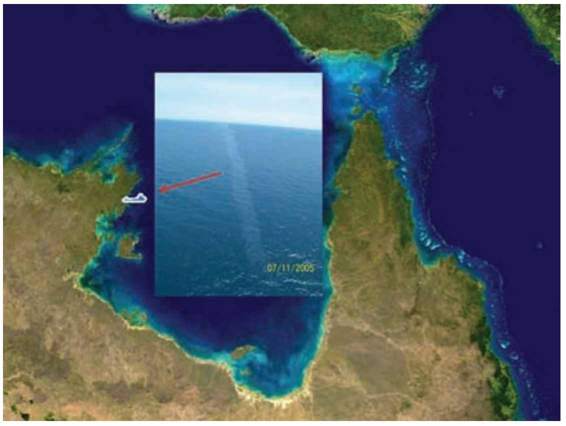

FIGURE 12

OSTM was used to determine the spill trajectory and weathering of the diesel fuel. (Figure 13) The oil plume rising from the sunken wreck was predicted to move towards both sea turtle breeding areas and offshore islands with vulnerable sea birds. The model also showed that the diesel fuel weathering under tropical sea temperatures was sufficient that little oil would reach coastline. The major environmental threats were for the off-shore islands and marine waters.

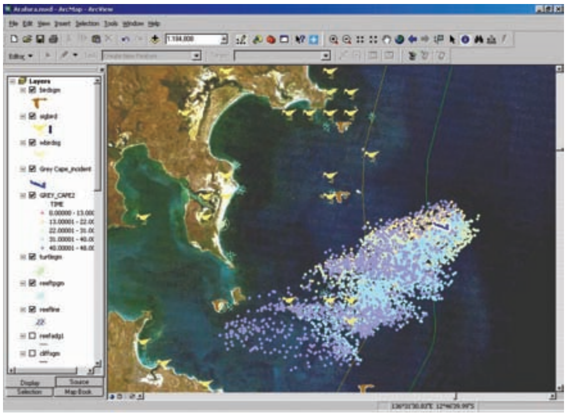

FIGURE 13

Example Use Grounding and Refloating of *Pasha Bulker*

During June/July of 2007 the coal carrier *Pasha Bulker* came around during heavy weather on the coast of Eastern Australia near the entrance to the port of Newcastle and suffered damage to its double bottom tanks. (Photo 1) During the following weeks a number of attempts were made by salvors to refloat the vessel but a risk of heavy bunker oil spill was always possible during the salvage attempts. AMSA operated OSTM to predict the movement and fate of any spills during the various refloating attempts for the planning of spill combat equipment, personnel and resources.

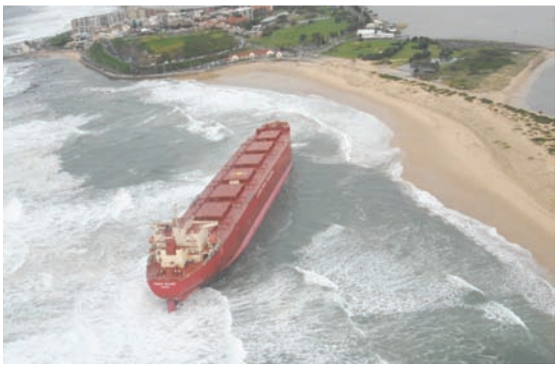

PHOTO 1.

In figure 14 an example of the prediction over 3 days from OSTM of any bunker fuel spill during the attempted refloat of the vessel on the evening of June 28 2007. Extremely variable winds and extensive storm fronts were apparent on the New South Wales (NSW) coast during this response phase so it was vitally important that constant monitoring and update of spill predictions were carried out by AMSA during the salvage operations. It was predicted that any oil released during this June 28 refloat attempt would move predominantly offshore with the predicted winds.

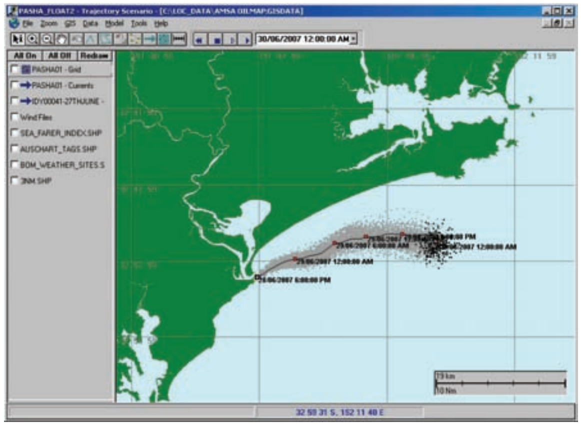

FIGURE 14.

Due to the number and duration of unusual storm fronts and the effect of the EAC a number of offshore eddies of varying current speed and direction were formed in deep water off the NSW coast during these months of the operations. In figure 15 a snap shot of the geostrophic currents for the central NSW coast for early June 2007 is shown overlaid over a bathymetry profile of the continental shelf. Three major eddies of both clockwise and counter clock wise rotation developed during this time which could affect the movement of any oil both down or up the NSW coast depending upon which eddie was dominant and the exact location of oil movement from the spill site due to wind speed and direction.

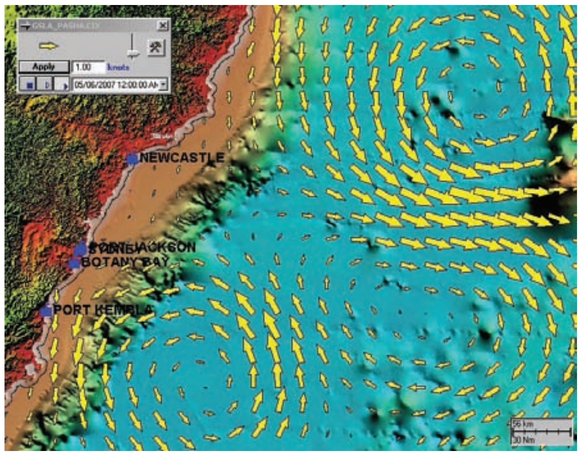

FIGURE 15

Exercise North West – SpillCon 2007- Use of OSTM

Metocean based spill models are a useful tools for contingency planning and for exercising spill response personnel and decision makers. During the 2007 SpillCon conference in Perth Australia OSTM was used interactively during the spill response planning workshop for delegates to exercise decision making during a major maritime accident involving an oil tanker accident in deep offshore remote location off the northwest of Australia. The output from OSTM was overlaid on a LandSat image of the Exmouth region of Western Australia representing a hypothetical spill of an offshore tanker spill impacting on the environmentally sensitive Ningaloo Reef marine park region. (Figure 16)

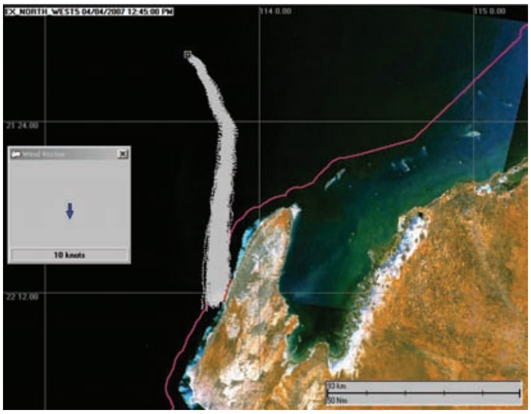

FIGURE 16

UPGRADES TO AUSTRALIAN SOFTWARE AND METOCEAN DATASETS

The system has demonstrated its effectiveness during its operational phase over recent years and various datasets and metocean information feeds are under constant enhancement and improvement.

Regular updates are made to the following fundamental datasets of OSTM:

- High resolution bathymetric data sets in the near shore/ continental shelf region;
- Tidal amplitudes and phase constants derived from altimeter satellite data currently (TPOX7.0);
- High resolution coastline datasets, and
- Use of maritime nautical charts and satellite imagery as underlay's for display of trajectory model outputs.

The components of OSTM were upgraded in June 2004 and recently during 2007. HYDROMAP, was implemented in 2004 and updated in 2007 and expands the modelling capability in the near shore region and supports the incorporation of live metocean data, including satellite observations of large-scale currents from CSIRO, and detailed wind data from the Bureau of Meteorology. A new version of the oil spill mapping component of the model, OILMAP, was also recently installed that provides improved GIS integration, linking to environmental data servers (EDS) and greater data visualisation. The OILMAP software is used by many governments, research institutes and oil companies in at least 40 countries, recently the New Zealand government has established a similar metocean system using the same software suite.

In addition to playing a key role during an oil spill response, spill numerical modelling linked to real time metocean data is becoming an integral part of evidence in court cases and has been used successfully as admissible evidence in a number of jurisdictions within Australia by AMSA.

Continuous upgrades of OSTM data and software have taken place over the past four years as operators have gained experience with the system and deficiencies have been identified. Feedback from National Plan users on the effectiveness of the predictions and information provided by OSTM is always encouraged. AMSA also has an on-going activity to monitor international developments in met-ocean modelling systems for marine incident response. Where new systems, software or fundamental data becomes available these will be assessed on a scientific, technical and cost/benefit basis to AMSA and the National Plan.

CONCLUSIONS

The Marine Pollution Emergency Response Support System (MPERSS) provides an internationally coordinated system of meteorological and oceanographic support for marine accident emergency response operations on the high seas.

Recent progress with development of operational ocean forecasting systems has produced systems with suitable levels of maturity for consideration for use in Maritime Accident and Emergency Support (MAES) scenarios. Some practical experience was gained through demonstration.

A key challenge is the integration of science and standards into operational services supporting maritime safety, emergency response, disaster risk reduction and maritime hazards with full users' support and interaction.

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