THREE-DIMENSIONAL MODEL FOR OIL SPILL SIMULATION

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In the Gulf of Trieste there are two important oil terminals: Koper (Slovenia) and Trieste (Italy), the last with about 30*10**6 tons of yearly transport. A need for a reliable model appeared to be used as a tool at combating possible oil spills in the gulf. There are several oil spill models on the market, most of them being two-dimensional (2D). But according to our experiences 2D models cannot simulate very accurately the spreading of oil in coastal regions, especially in semi-enclosed gulfs as is the Gulf of Trieste. The main driving force of the circulation in the surface layers - where mainly the oil spill transport and fate processes take place - is the wind. But since the velocity field in the surface layer is usually very different from the depth averaged circulation as obtained by a 2D model, most 2D models take into account the influence of the wind forcing in a simplified way, taking the surface velocity (influencing the oil advection) as 3 to 4 % of the wind speed and a certain drift angle between the wind and current directions (usually between 10 to 17 degrees).

3D models should simulate the HD circulation more accurately, since they take into account non-uniform velocity distribution along the depth, the velocities in the surface layer being the most influenced by the wind. Additionally, the shear diffusion can be taken into account directly by different velocities in the uppermost layers.

Therefore our already developed, applied and verified 3D hydrodynamic (HD) baroclinic model (RAJAR and CETINA, 1991, 1992) was completed with the Transport and Fate (TF) module for oil spill simulation. In the HD module, the advection with the effects of wind, river inflow and thermohaline forcing is included. The TF module is based on the Particle Tracking method and includes mechanical spreading, dispersion, shear diffusion and evaporation. Tidal influence was not taken into account since tidal velocities are of the order of 4 to 8 cm/s, while the wind induced velocities are up to 30 cm/s. Besides the model should be as simple and as user-friendly as possible and the tidal influence demands relatively complex input data for the open boundary conditions.

Two modes are used for practical applications at combating oil spills:

- TACTICAL MODE is developed for a partly pre-prepared and partly real time simulations. Since the model should run on simple PC 486 computers, the HD part of the simulation would take too long simulation time, of the order of 8 hours (numerical grid is 59 x 51 x9). Therefore the HD part of the simulation is pre-prepared for 10 different winds (5 directions by 2 wind velocities). For a real case the velocity field is obtained by interpolation in about one minute. But the TF part of the actual spill is simulated directly for the given location, amount and type of the oil spill in 5 to 10 minutes.
- PROGNOSTIC MODE represents 50 pre-prepared diagrams for 5 wind conditions, 5 locations and 2 oil types. These can be used for a very quick first estimate of the size and of the direction of the oil patches.

Fig. 1 shows the simulation of oil spill by the complete 3D model and by the 2D depth averaged model, where no additional influence of the wind on the surface velocities was accounted for. The differences are essential. A research is going on with the study of the accuracy and applicability of both types of models.

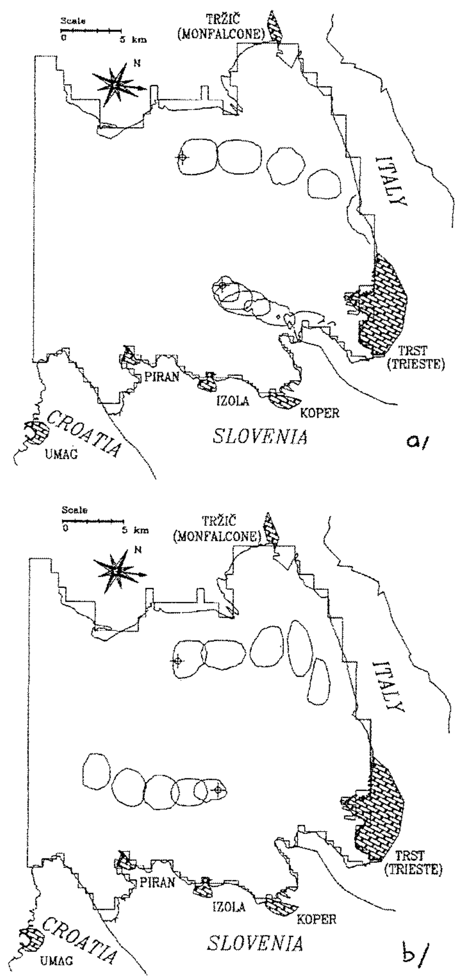

Fig. 1. Simulation of oil spreading for spill at two locations in the Gulf of Trieste with a WSW wind of 8 m/s. Oil slicks in 4, 10, 18, 28 and 40 hours after the spill of 75 tons of diesel fuel.

a) 3D model, surface layer

b) 2D depth averaged model

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A MODEL OF WINTER ATMOSPHERIC COOLING AND CONVECTION IN THE LEVANTINE BASIN

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Process studies investigating the dynamics and mechanisms of formation of the Intermediate and Deep Water in the Levantine basin are made, based on model simulations driven by initial oceanographic data and high resolution atmospheric forcing. The important effects of the interannual variability of winter atmospheric cooling in the formation process are emphasized by comparing realizations in different sets of conditions in different years.

The Princeton Ocean Model (POM) was used for simulations, initialized with real data. The periods of interest, supported by extensive synoptic data coverage were : (a) October 1986 - March 1987, (b) July 1988 - March 1989, and (c) October 1991 - March 1992, for which initial conditions covering the entire Levantine Basin and verification data at the end of the simulation were available. Persistent open boundary conditions for the semi-enclosed oceanic domain were determined by data extension and melding techniques, using synoptic / climatological data.

The 1987, 1989 and 1992 winters are characterized with massive LIW formation in the region. In addition, Deep Water was formed in the extreme winters of 1987 and 1992. The specific atmospheric and oceanic states leading to such differences are compared between these two cases.

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