Geophysical Research Abstracts
Vol. 15, EGU2013-286-1, 2013
EGU General Assembly 2013

Effects of the Coriolis force on the oil spreading in instantaneous and continuous spill

Igor Brovchenko (1), Vladimir Maderich (1), and Kyung Tae Jung (2)

(1) Institute of Mathematical Machines and System Problems of the Ukrainian National Academy of Sciences, Kiev, 03187, Ukraine, (2) Korea Institute of Ocean Science and Technology, 454, Haean-Ro, Ansan, 426-744, Republic of Korea

The possible effects of the Coriolis force on the oil spill spreading have not yet investigated or even discussed despite the spreading time scale for large spills can be of many hours and days and releases can last days and months like in the “Ixtoc I” and “Deep Horizon” spills. Therefore, it is important to quantify possible effects of the Coriolis force on the dynamics of spreading of surface slick caused by continuous and instantaneous releases. The main goal of this work is to explore does the Coriolis force affect the oil slick spreading in gravity viscous regime. For this study a new shallow-water model for transport and spreading of slick of arbitrary shape was developed. The governing equations for oil slick are derived in shallow water approximation by means of the continuity and the momentum equations integrated over the oil layer in which the inertial terms are neglected and is assumed balance between gravity, frictional and the Coriolis forces. The oil-water friction is parameterized in frame of boundary layer theory including the Ekman layer friction. The numerical Lagrangian method based on smoothed particle dynamics is described. New similarity solutions of the model equations are obtained for unidirectional and axisymmetric spreading in gravity-viscous and gravity-viscous-rotational regimes for instantaneous and continuous releases. The results are extended for the case of continuous release in the field of currents by numerical simulation. It was shown that Coriolis term in the momentum equation can be omitted if slick thickness is much less of the laminar Ekman layer thickness. However, the Ekman friction should be retained at any thickness of slick for large times. The Ekman friction results in the essential slowdown of the spreading as well as in the deflection of the oil spreading velocity at 45^o from the direction of velocity in the non-rotation case. The new most important feature of the gravity-viscous-rotational regime is appearance of the circumferential velocity due to the Coriolis force. The oil moved away from the center of axisymmetric slick by spiral. The velocity components grow with distance from center of slick in the case of instantaneous spill whereas for constant release rate both components of velocity increase to the center of slick. In both cases circumferential velocity does not disappear at the edge of the slick. However, near the edge of slick thickness of boundary layer is less then the Ekman layer and vectors of spreading velocity should be directed normally to the edge.
In the real cases the flux from underwater blowout is distributed over some area of surface. In the case of point source the inertial terms in the momentum equations should be taken into account. The full numerical solution for instantaneous release coincides with analytical solution whereas asymptotic solution agrees well with full solution except inner area of the slick. It was sown that Coriolis force effect can significantly decrease oil slick area after few days after release. Therefore, Earth rotation can be important for the oil transport and weathering.