humidity were obtained from Chiba Meteorological Station for computation of heat flux through the water surface. Hourly averaged wind velocity was obtained from the same station for computation of oil spreading in eq. (1). Boundary conditions of temperature and salinity in the open ocean were obtained from the water quality database at the Fishery Station in Kanagawa Prefecture. Initial temperature and salinity conditions were obtained from the water quality database of the Environment Agency of Japan. Simulation was conducted for the period 1 May to 5 July 1997 in order to give the velocity field of $U_{current}$ a time step of Δt = 10 sec was used. The oil spill was simulated by imposing particles at the point of spillage (at 1005, 2 July 1997) and the distribution of the particles was simulated.

4.3 Results

On 2 July 1997, a strong wind persisted, ranging from SW to NE in direction (Fig. 4.1). The results of the model calculations show that during southwesterly winds, the contour lines of salinity and temperature spread across the longitudinal axes of the Bay. Surface water was transported towards the northern shoreline by wind-driven surface stress and confronted with inflows of river water along the western coast. During northeasterly winds, the contour lines of salinity and temperature became parallel to the eastern coastline (Chiba Prefecture) of the Bay.

The distribution of spilled oil particles on the surface at 1500 on 2 July (Fig. 4.2) and at 1100 on 3 July (Fig. 4.3) shows excellent agreement with photographic measurements from an airplane at 1500 on 2 July and a satellite image (SPOT II) obtained at 10:54 on 3 July, respectively. Spilled oil tended to spread across the longitudinal axes of the Bay (towards Kawasaki City in Kanagawa Prefecture and Futtsu in Chiba Prefecture). The residual currents, determined by integrating flows during the two tidal periods on 2 July (Figs. 4.4, 4.5), indicated that the directions of flow were from Yokohama City towards Futtsu, and northeast along the coast of Chiba Prefecture towards Chiba Harbor. Eddies around the islands constructed for a road across Tokyo Bay were clearly shown; in particular, large eddies were generated in the 5th layer (Fig. 4.5).

In order to evaluate the effects of these islands on the residual current, we conducted a simulation without islands over the same period. The spilled oil particles (Figs. 4.6, 4.7) tended to spread over a much broader area; in particular, more oil particles were transported along the coast of Chiba Prefecture towards Chiba Harbor. The residual currents without islands (Figs. 4.8, 4.9) included a strong stream from Yokohama City towards Kisarazu City in Chiba Prefecture and these currents extended along the coast of Chiba Prefecture towards Chiba Harbor, carrying oil particles towards the Harbor and promoting a broader spread of oil particles (Fig. 4.10). The islands prevented water exchange between the inner and outer Bay by generating large eddies.

4.4 Reference

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Mellor, G. L., and T. Yamada, Development of a turbulence closure model for geophysical fluid problems, Rev. Geophys. Space Phys., 20, No. 4, 851-875, 1982.

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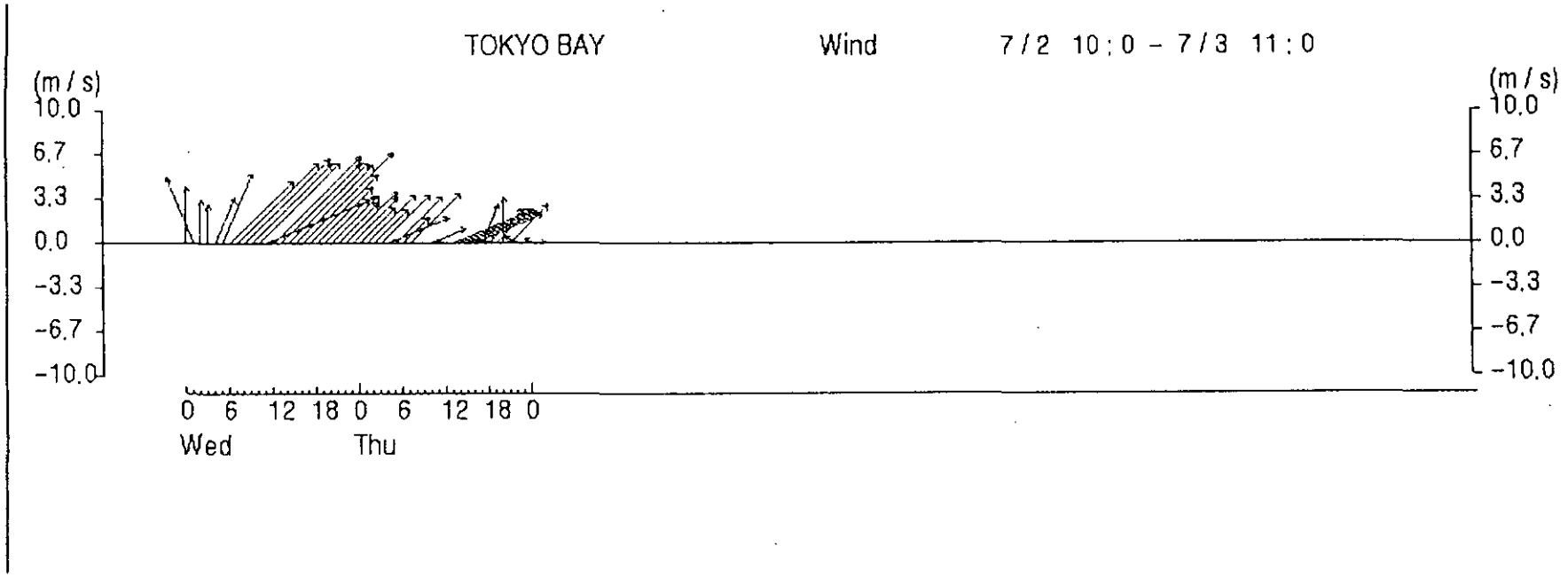

Figure 4.1 Wind direction during 2 and 3 July 1997.

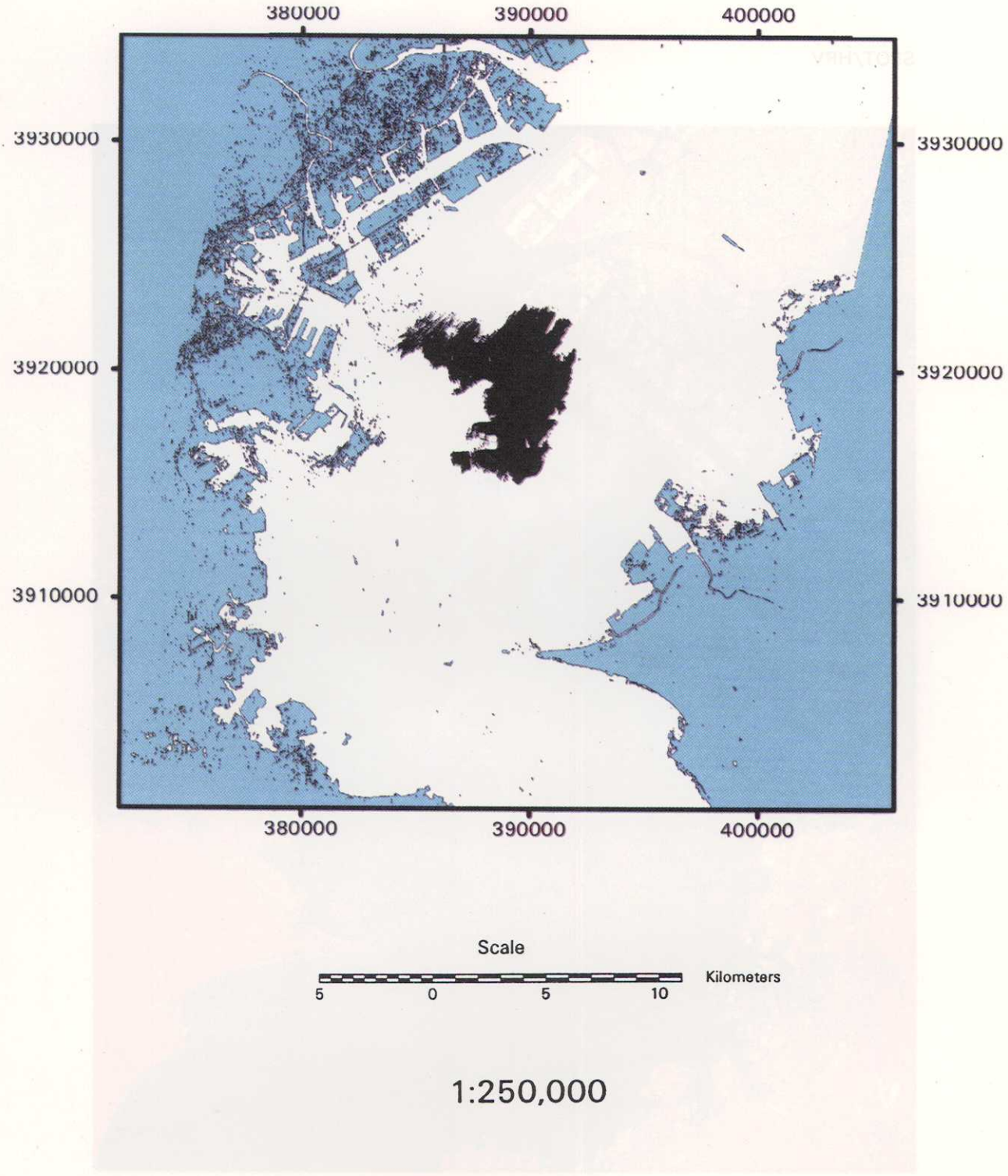

Figure 4.2 Distribution of spilled oil particles on the surface at 1500 on 2 July 1997.

SPOT/HRV

Figure 4.3 Distribution of spilled oil particles on the surface at 1100 on 3 July 1997, by courtesy of NASDA.

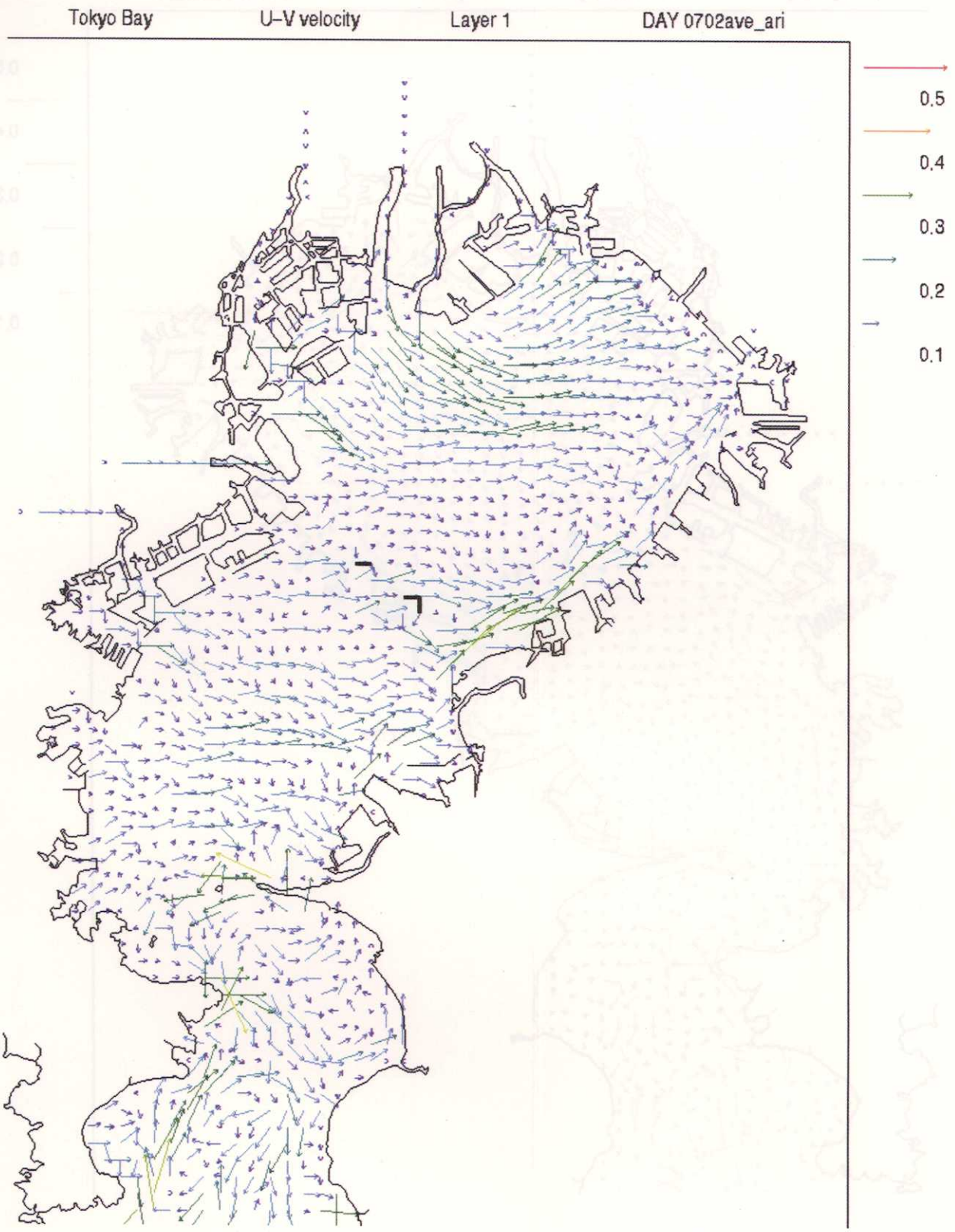

Figure 4.4 Residual currents on the surface on 2 July 1997.

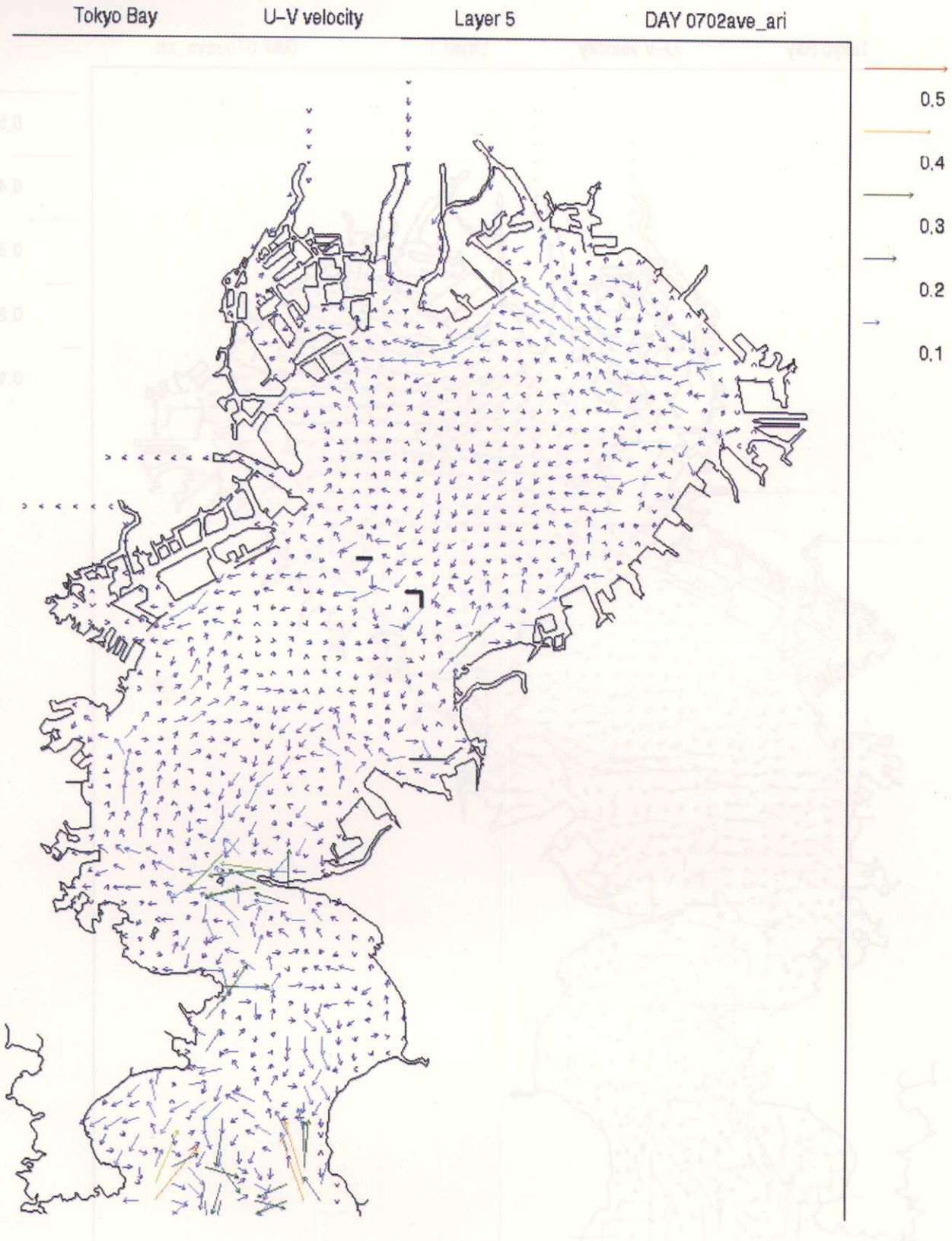

Figure 4.5 Residual currents in the 5th layer on 2 July 1997.

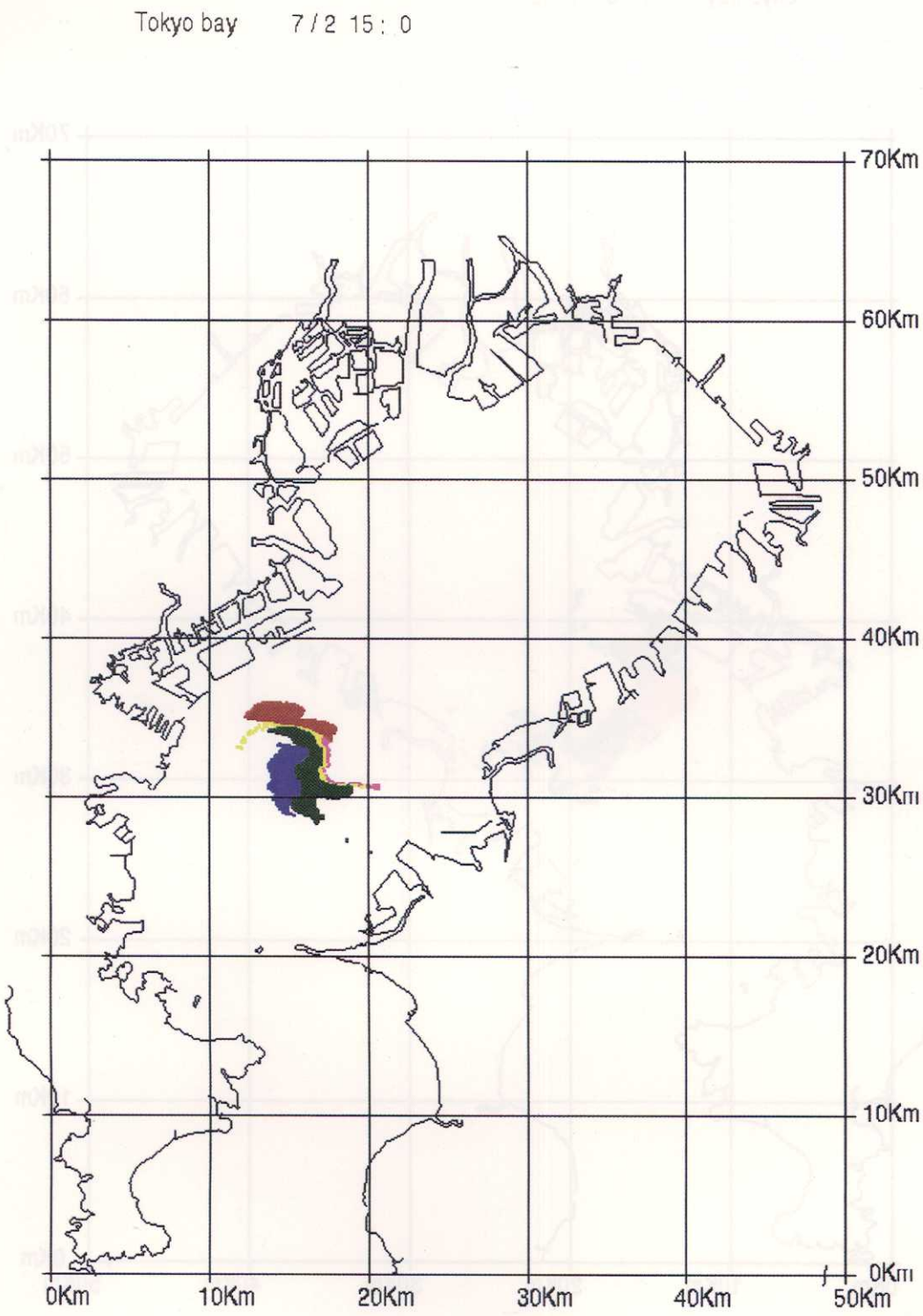

Figure 4.6 Simulated distribution of spilled oil particles at 1500 on 2 July 1997.

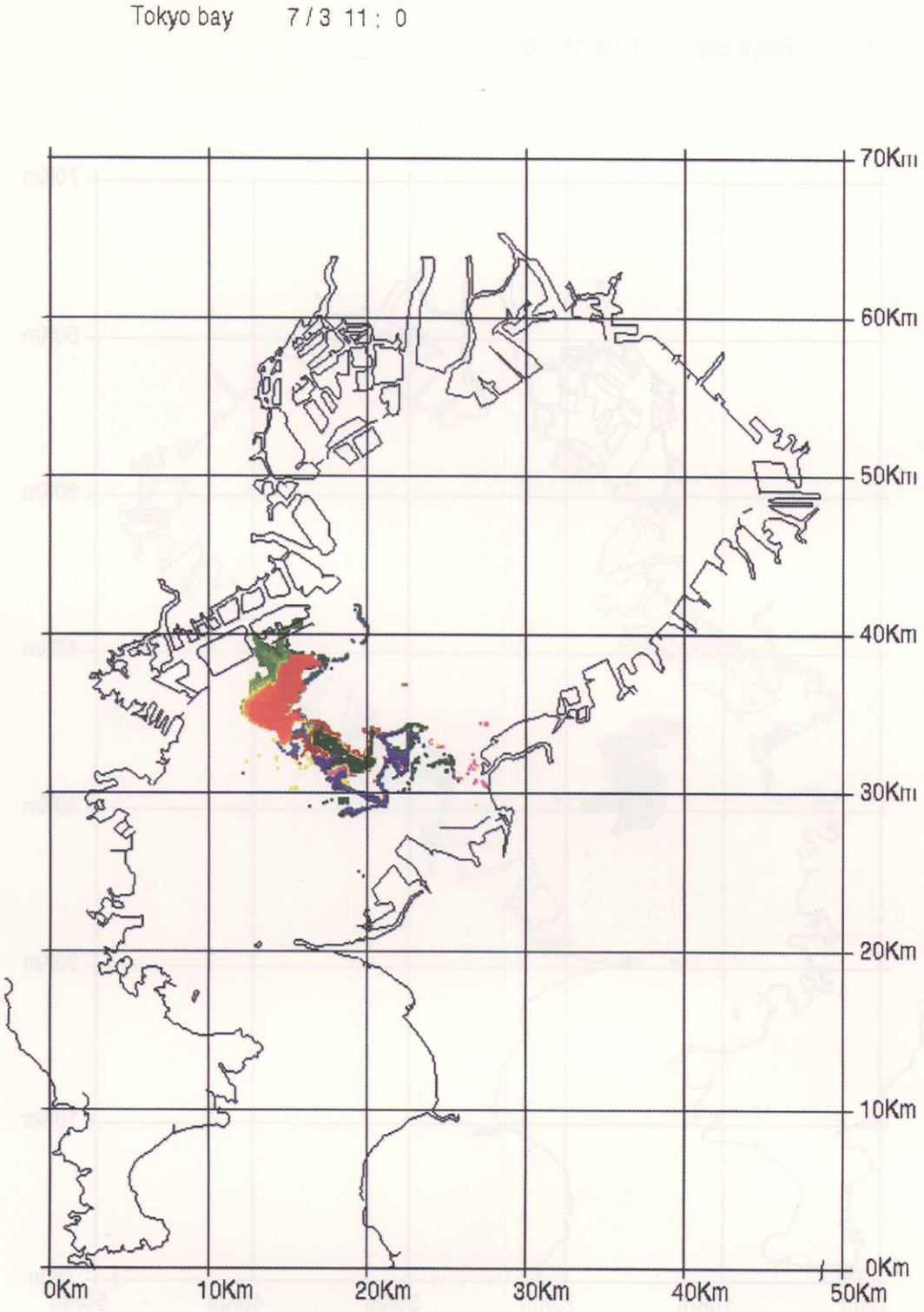

Figure 4.7 Simulated distribution of spilled oil particles at 1100 on 3 July 1997.

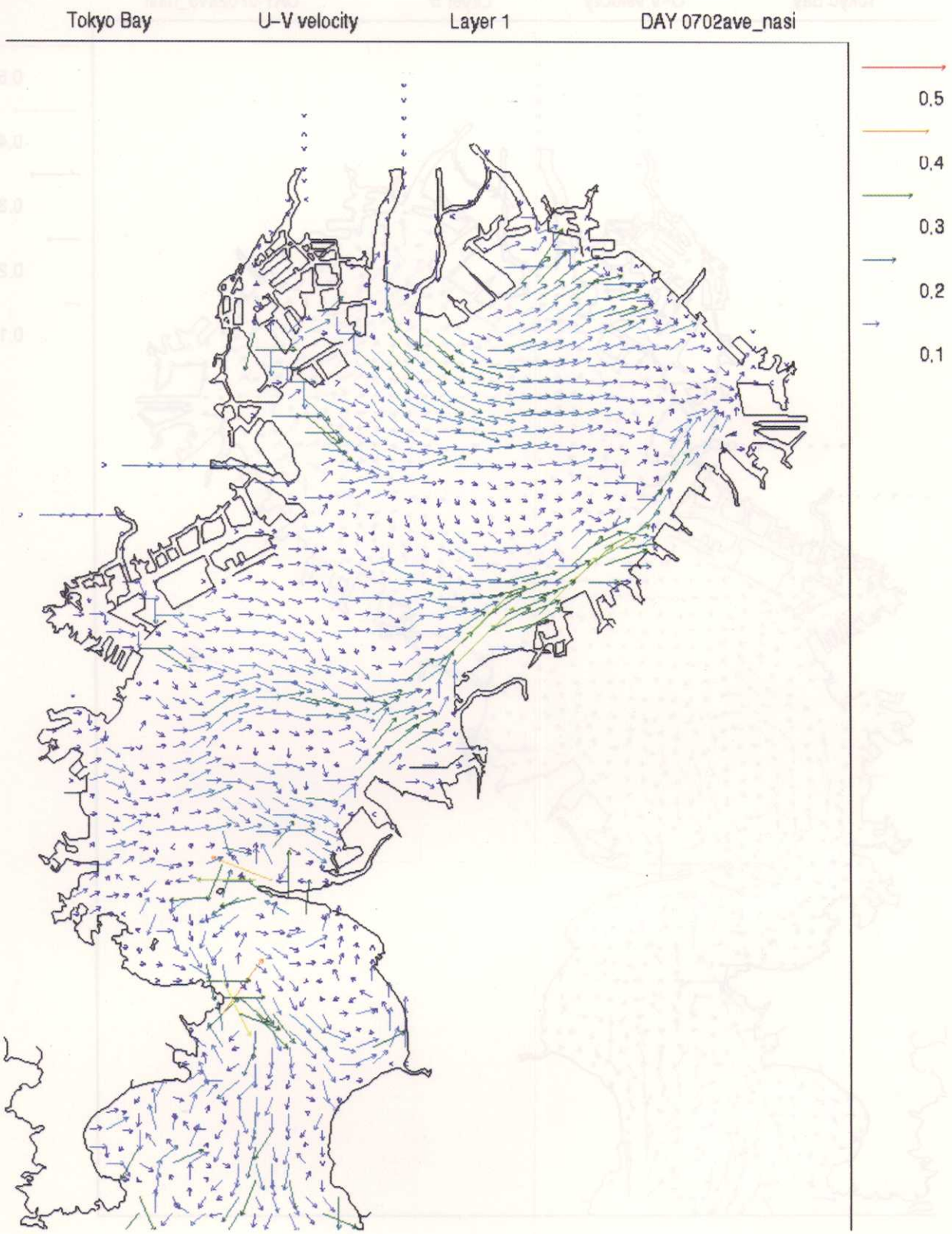

Figure 4.8 Residual currents on the surface in the absence of islands, 2 July 1997.

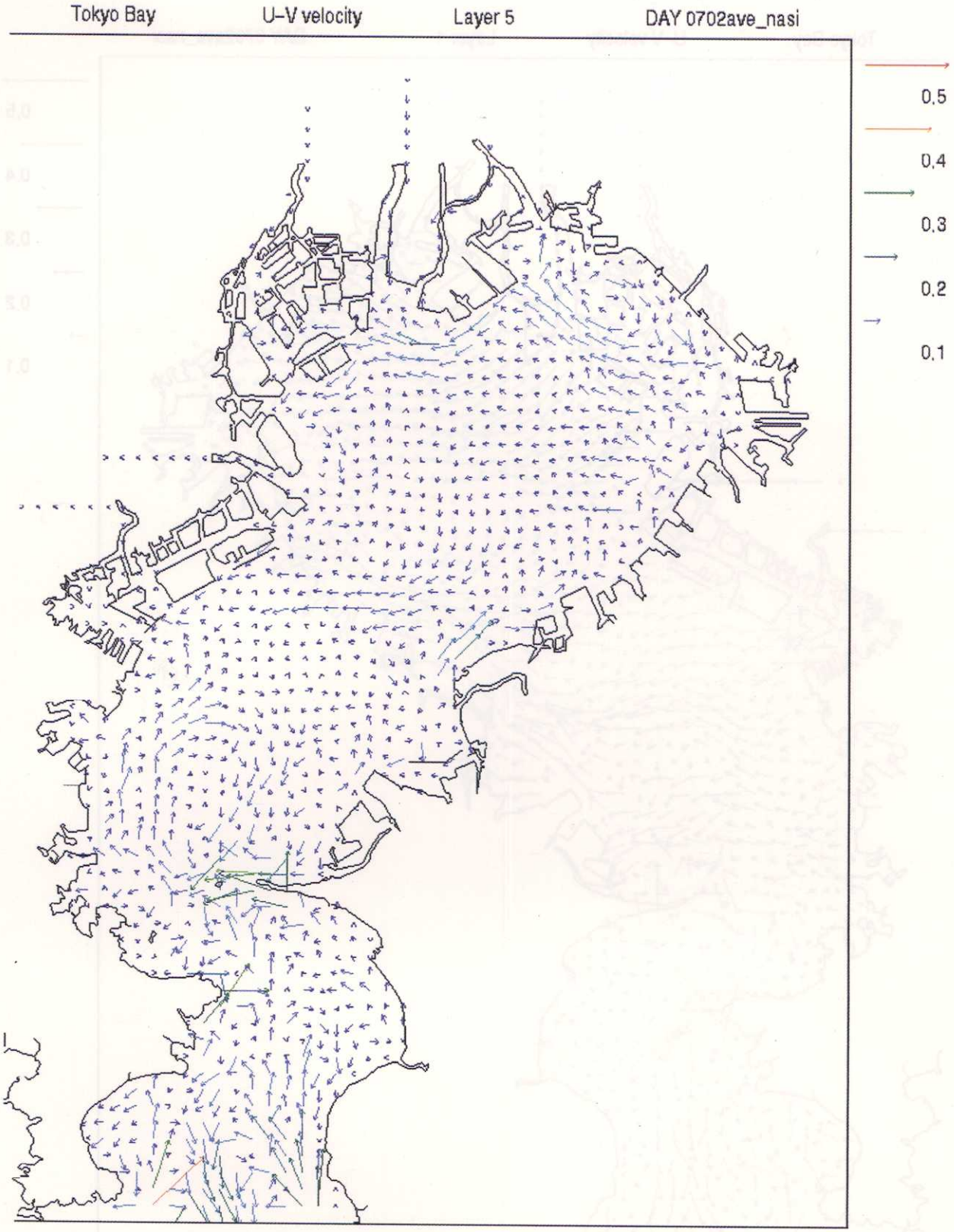

Figure 4.9 Residual currents in the 5th layer in the absence of islands, 2 July 1997.

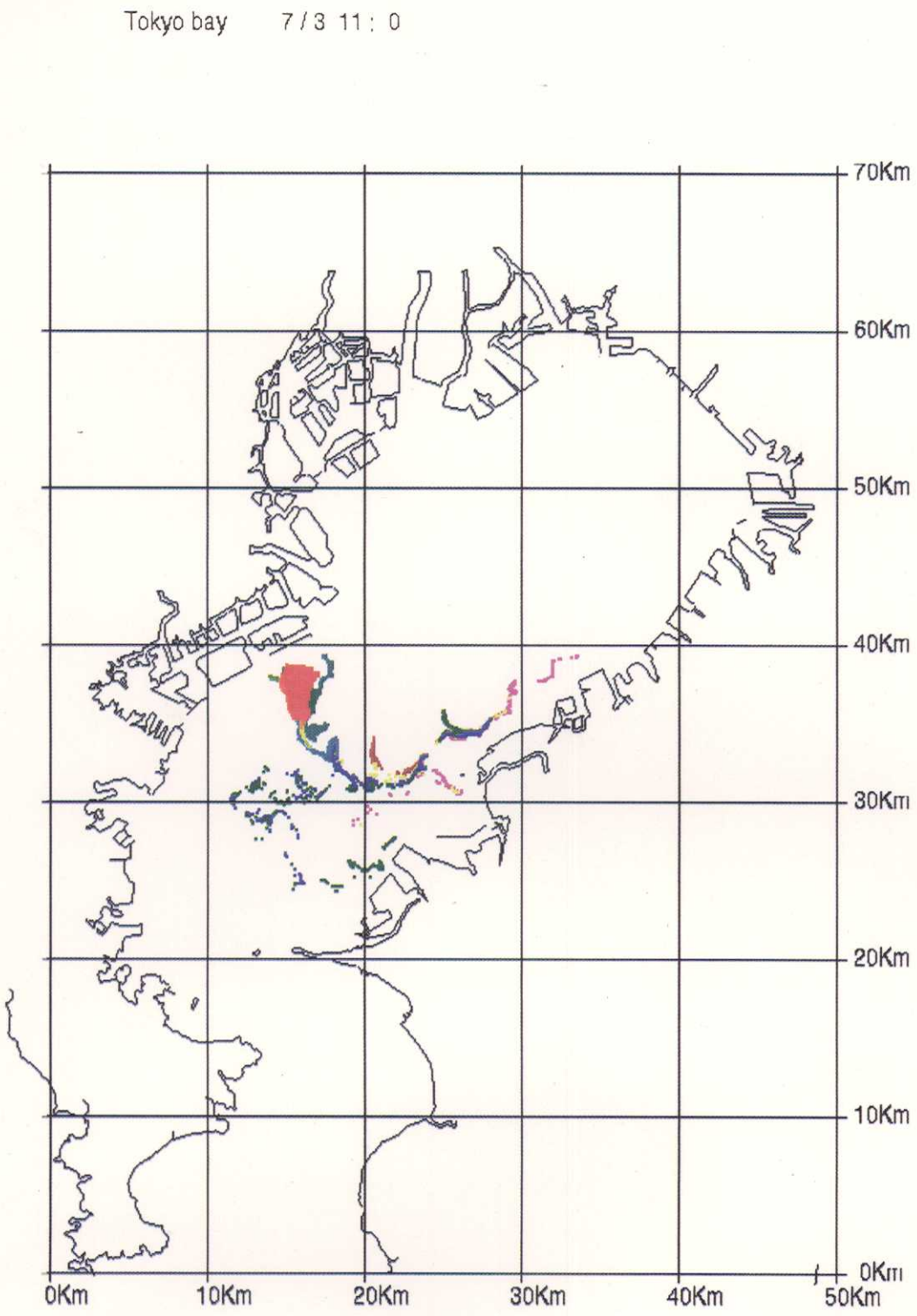

Figure 4.10 Simulated distribution of spilled oil particles in the absence of islands, 1100 on 3 July 1997.